Educational Exhibit E-Posters and Traditional Educational Posters Chosen by the Annual Scientific Meeting Committee

In advance of the upcoming annual meeting of the Society of Interventional Radiology in Los Angeles, CA, the program committee wishes to highlight the educational exhibit e-posters and traditional educational posters that will be presented. The posters were chosen using blinded review. Authors are congratulated for their contributions.

Constantino S. Peña, MD, FSIR
Chair, 2018 Annual Meeting Scientific Program

EDITORIAL NOTES
Please note that abstract No. 1021 is out of order due to scheduling changes, and that small portions of text may be missing in some abstracts because of field limitations in the submission system.

Educational Exhibit E-Posters

Abstract No. 717

SAM or MALS, which is it? Case discussion, overview of disease entities, angiography and treatment

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MATERIALS: SAM is an increasingly recognized vascular disease in patients presenting with spontaneous intraabdominal hemorrhage. The etiology is unknown, but some studies have seen association with episodes of splanchnic vasoconstriction. This entity can sometimes be difficult to distinguish from MALS, which is more physical in its etiology, and can present with acute spontaneous intraabdominal hemorrhage. We present the radiologic findings of both entities, and discuss a case of spontaneous abdominal hemorrhage with diagnostic pearls, angiographic findings, and treatment.

RESULTS: Case of spontaneous intraabdominal hemorrhage: Selective catheterization of the celiac axis and SMA was performed using a 4-Fr glide Cobra catheter. Angiography demonstrated several mesenteric collaterals between the SMA and the gastroduodenal artery, and a 7-mm pseudoaneurysm along one of the SMA collateral side branches. Super selective catheterization was then performed, manipulating a 2.8-Fr microcatheter distal to the pseudoaneurysm. Embolization was then carried out using coils. Follow-up angiogram demonstrated successful embolization of the pseudoaneurysm.

CONCLUSIONS: SAM and MALS can present with similar symptoms and spontaneous intraabdominal hemorrhage, and therefore can pose a diagnostic dilemma. These entities should be suspected in cases of spontaneous intraabdominal hemorrhages. Diagnostic pearls include stenoses, aneurysms and collaterals within the splanchnic vessels. The patient’s age and characteristic appearance of the celiac axis may be helpful in differentiating the etiology. Some cases of SAM might have been previously mistaken as MALS. Interventional radiologists play an integral part in the treatment of symptomatic and large asymptomatic aneurysms. Transcatheter angiography with coil embolization is the standard of treatment in cases of spontaneous hemorrhage.

Abstract No. 718

Percutaneous transthoracic treatment of ascending aortic and root pseudoaneurysms: procedural aspects and guidance with multimodality imaging

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PURPOSE: Percutaneous transthoracic treatment of ascending aortic pseudoaneurysms offers an alternative, minimally invasive treatment pathway for nonsurgical candidates.
**Materials:** Ascending aortic pseudoaneurysms (AAPs) may arise in the setting of trauma, mycotic infections, and following cardiac surgery or aortic arch replacement. Open repair is currently the standard of care. Reoperation, however, requires resternotomy and cardiopulmonary bypass, frequently in patients with multiple comorbidities. Mortality rates have been reported to be 30% at 1 month with reoperation. There have been few cases that have been published regarding endovascular approaches to treating AAPs; however, not all lesions are suitable for endovascular management.

**Results:** A total of 4 patients underwent transthoracic percutaneous treatment between January 2015 and December 2016. All were deemed high-risk operative cases for open surgical repair by a multispecialty team. Imaging modalities used consisted of computed tomography, transesophageal echocardiography (TEE), and fluoroscopic guidance. Percutaneous transthoracic approaches were chosen for 3 out of 4 cases after multidisciplinary discussion for perceived difficulty assessing the PsA sacs from the thoracic aorta through small necks. The last case had a VSD closure device placed previously thus precluding access into the PSA from the thoracic aorta. See table. In all 4 cases, immediate post aortograms and TEEs demonstrated complete occlusion. 1 of the 4 patients, however, did require reintervention for partial recanalization of the PsA sac.

**Conclusions:** The treatment options for AAPs in the high-risk postoperative setting are limited. A multimodality non-endovascular percutaneous approach offers an alternative, minimally invasive treatment pathway.

**Abstract No. 719**

Radial artery pseudoaneurysms: characteristics, diagnosis, management options, and outcome analysis

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**Purpose:** There has been an increase in the number of radial artery catheterizations in the past few years with some departments using the radial artery for majority of arterial access procedures. The purpose of this poster is to study the characteristics of postcatheterization radial artery pseudo-aneurysm including diagnosis, management options and outcome analysis.

**Materials:** Pseudoaneurysms following arterial injuries are rare occurrences, but they have been described in the literature following vascular access attempts to arteriovenous fistulae, catheterization of arteries, arterial blood gas analysis, and other invasive procedures. We retrospectively analyzed our post catheterization complications of radial artery pseudo-aneurysms in the past 10 years. A total of 9 post catheterization radial artery pseudo-aneurysms were identified in this time frame. We analyzed the clinical presentation, diagnostic studies, management and outcomes for the patients.

**Results:** All 9 patients presented with swelling with 8 patients having pulsatility associated with the swelling. All patients received anticoagulants during the procedure. All patients had ultrasound including, color Doppler exams, which confirmed the diagnosis. Out of the 9 patients, 6 of them underwent thrombin injection while 3 patients were treated conservatively using compression. All the patients who had thrombin injection had complete resolution of the pseudo-aneurysm. The 3 patients who were treated conservatively failed initial management. One patient received thrombin injection which resulted in a successful outcome. The other two patients were treated at an outside facility and received surgical treatment with successful outcomes.

**Conclusions:** Post catheterization radial artery pseudo-aneurysm is a very rare complication of radial artery access. Ultrasound color Doppler readily provides the diagnosis and helps plan treatment. All patients required thrombin injection for successful treatment. Conservative management with compression alone was not successful in any patient.

**Abstract No. 720**

Interventional management of visceral artery aneurysms and pseudoaneurysms

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**Purpose:** The goals of this presentation include the following: Review the etiology, presentation, and diagnosis of visceral artery aneurysms (VAAs) and visceral artery pseudoaneurysms (VAPAs). Provide a systematic framework for triaging patients with VAAs and VAPAs based upon their clinical presentation and imaging features. Discuss current and emerging endovascular treatment strategies for VAAs and VAPAs.

**Materials:** VAAs and VAPAs are rare and potentially lethal entities involving the celiac artery, superior mesenteric artery, inferior mesenteric artery, renal arteries, and their branches. Clinical presentation and management is influenced by aneurysm type, location, size, and underlying risk factors.

**Results:** VAPAs are treated regardless of size, location, or symptomatology given the disproportionately increased risk of rupture and mortality if left untreated. VAAs should be treated if one or more of the following criteria are met: symptomatic patient, size >2 cm, growth >0.5 cm/year, superior mesenteric artery aneurysm >1.5 cm, pancreaticoduodenal artery aneurysm of any size, splenic artery aneurysm in women of childbearing age or patient with end-stage liver disease, and Ehlers-Danlos syndrome. Coil embolization is frequently used to
exclude the aneurysm sac via packing the aneurysm sac and often the feeding artery proximal and distal to the aneurysm. Stenting is preferred in certain situations when collateral flow distal to the aneurysm may be absent or inadequate.

**CONCLUSIONS:** Technical advancements in endovascular therapy have largely supplanted traditional open surgical treatment of VAAs and VAPAs. The interventional radiologist plays a critical role in identifying, risk stratifying, and managing patients with VAAs and VAPAs. Given the rarity and variability of these entities, a systematic framework is critical to appropriately selecting patients and guiding individualized therapy based on aneurysm type, location, size, pertinent vascular anatomy, and patient comorbidities.

**Abstract No. 721**

**Single-center experience in the management of iatrogenic femoral pseudoaneurysm: a retrospective analysis**

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**PURPOSE:** The purpose of this educational exhibit is to overview the various options for managing post catheterization femoral artery pseudoaneurysm (PCFAP). The incidence of PCFAP varies widely between 0.1% and 8% after femoral punctures. PCFAPs are likely related to poor technique, i.e., inadequate arterial compression following the removal of the catheter. A myriad of treatment options for PCFAPs are available including conservative management, external compression, US-guided thrombin injection and surgical excision. The purpose of this retrospective study is to evaluate the effectiveness of various therapies in the management of iatrogenic femoral pseudoaneurysms.

**MATERIALS:** After obtaining institutional review board approval, we conducted a retrospective analysis of 47 patients over a 2-year period at a tertiary care medical center who developed iatrogenic femoral pseudoaneurysms after femoral punctures. We recorded the following: 1) Cases where initial measures failed to treat the pseudoaneurysm, 2) The relation between sheath size and the volume of pseudoaneurysm, 3) The relation between sheath size and the final outcome after treating the pseudoaneurysm.

**RESULTS:** 47 patients developed PCFAP (mean age, 70 ± 14.3 years; range, 22-89 years). The PCFAP was treated successfully in 42 patients (89%). We noted five cases where conventional therapies initially failed to resolve the pseudoaneurysms. Failure was considered when the pseudoaneurysm increased in size despite treatment. The average volume of pseudoaneurysm was 12.1 cc. In our sample, there was no statistically significant relationship between the sheath size of the puncture catheter and volume of pseudoaneurysms. Univariate chi square tests demonstrated no statistically significant relation between sheath size of the puncture catheter and final outcome after treating the pseudoaneurysms (OR = 1.7; P = 0.62).

**CONCLUSIONS:** A myriad of treatment options currently exists for the management of iatrogenic femoral artery pseudoaneurysms. Small sized pseudoaneurysms can be observed. US-guided compression and thrombin injection remain highly effective and safe treatment options.

**Abstract No. 722**

**Use of D-Stat® flowable as a safe and economical alternative to traditional liquid embolic agents for endoleak repair**

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**PURPOSE:** Describe several endoleak repairs where D-Stat flowable was utilized as the primary embolic agent. D-Stat flowable is optimally used for gutter leaks or large volume aneurysm sacs that would otherwise necessitate use of large volume liquid embolics.

**MATERIALS:** Prevalence of abdominal aortic aneurysm in people over the age of 80 is 5.9% (Uflacker and Robison, 2001), with endovascular repair (EVAR) emerging as the operative treatment of choice. Subsequently, management of endoleaks, the most commonly encountered delayed sequela of EVAR, is paramount to ensuring long-term stability. The embolic agents available to treat endoleaks are diverse: coils, particles, and liquid embolics. A less expensive alternative embolic that functions similar to some liquid embolics is the D-Stat flowable. The viscosity of the D-Stat flowable is favorable for preventing nontarget embolization, it is a fraction of the cost of other liquid embolic agents, and it can be used in higher volumes in cases where the endoleak cavity is large or poorly defined. Thrombin, the active ingredient in a D-Stat flowable, allows for rapid hemostasis by converting soluble fibrinogen into insoluble fibrin and accelerates platelet activation. D-Stat flowable is marketed for hematoma prevention in patients high risk for bleeding following femoral access or prepectoral tissue tract formation. Only one case in the literature documents its intravascular use for endoleak treatment.

**RESULTS:** Five patients with endoleaks have been treated at our institution since 2016 with D-Stat flowable as the primary embolic agent. The treated endoleaks were type 1 (gutter leak), type 2, and type 3. Only one of the treated endoleaks had residual flow into the aneurysm sac on post embolization angiogram. All patients had an uncomplicated postprocedural course. Three of five patients have already had follow-up imaging with no residual endoleak and stability of the aneurysm sac. The remaining two patients will receive their follow-up CTA within 2 months.

**CONCLUSIONS:** D-Stat flowable can be a safe and effective alternative to traditional liquid embolics used in endoleak repair.
Abstract No. 723
Repairing a juxtarenal abdominal aortic aneurysm using a fenestrated endograft and a bifurcated device from different manufacturers
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PURPOSE: 1. Understand the indications for placing fenestrated aortic endografts. 2. Review the key imaging findings and anatomical measurements prior to placing a fenestrated aortic endograft. 3. Identify cases that potentially require a hybrid graft (combining separate endograft components from two different manufacturers). 4. Novel use of a steerable sheath (Aptus/Medtronic) to facilitate fenestrated graft placement. 5. List potential complications of abdominal aortic endovascular repair with a fenestrated graft.

MATERIALS: 57-year old male with an abdominal aortic aneurysm extending up to the renal arteries that is enlarging on follow-up CTA.

RESULTS: • Enlarging abdominal aortic aneurysm on most recent CTA with no infra-renal neck • Percutaneous EVAR with Cook fenestrated bifurcated stent graft • Bilateral renal artery stent placement • Deployment of an Endologix uni-body graft into the bilateral common iliac arteries • Completion angiography demonstrating good exclusion of the aneurysm with no immediate type I or delayed type II endoleak.

CONCLUSIONS: Percutaneous fenestrated endovascular repair of a juxtarenal abdominal aortic aneurysm with graft components from two different manufacturers can be performed safely and successfully with precise technique and attention to detail on preprocedural imaging in cases where it may not be reliably performed with a single manufacturer’s device.

Abstract No. 724
Pictorial essay and review of evidence for mycotic aneurysms in various arterial territories
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PURPOSE: We will provide a pictorial review of recommendations for the management of mycotic aneurysms in various vascular territories.

MATERIALS: Mycotic aneurysms (MAs) occur when arterial wall infection leads to wall weakening and abnormal dilatation with risk of rupture. Current guidelines for cerebral, aortic, visceral, and peripheral MAs are based on meta-analyses.

RESULTS: The etiology and management of MAs depend on their location, whether intracranial, intracavitary, or peripheral. The primary treatment is bactericidal antibiotics of 4-6 weeks with lifelong therapy if a retained device may become a nidus. Intracranial MAs most often develop in the setting of infective endocarditis. Despite antibiotics, up to 20% of intracranial aneurysms need endovascular therapy (EVT) or neurosurgery. Coil or liquid embolization is preferred for aneurysms in non-eloquent brain or patients needing cardiac valve replacement due to need for aggressive anticoagulation. To date, there have been no reports of postembolization infection of the embolic agent. Neurosurgery is preferred in patients with rupture, mass effect, or aneurysms in eloquent brain. Intracavitary MAs include aortic and visceral aneurysms. Aortic MAs occur most commonly in the suprarenal abdominal aorta followed by the thoracic aorta. Antibiotics alone have a 60-100% mortality rate, thus aortic MAs are managed with open surgical repair usually with in situ reconstruction. While EVT for aortic MAs has better short-term outcomes, more long-term complications were documented by Kan et al. Although more recent data show better outcomes with preoperative antibiotics and percutaneous drains, EVT is only recommended as bridging therapy in patients with high operative risk. Visceral MAs most often involve the superior mesenteric artery and can be managed with open ligation and resection or endovascular coil embolization and stent placement. Peripheral MAs are often found in long-term IV drug users. Ligation alone is associated with ischemic complications.

CONCLUSIONS: Management of MAs is multiple but depends primarily on the vascular territory. This educational exhibit will summarize current recommendations.

Abstract No. 725
Introduction to the treatment of cerebral aneurysms using the Pipeline™ embolization device
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PURPOSE: 1) Review the types of cerebral artery aneurysms and treatment options. 2) Summarize the Pipeline™ embolization device and its indications. 3) Demonstrate cases where Pipeline™ has been used.

MATERIALS: Recent endovascular advances have made it possible to treat once problematic cerebral artery aneurysms in the angio suite. Historically, wide neck saccular aneurysms have been treated in the operating room with clipping. With the Pipeline™ embolization device (Medtronic Neurovascular, Irvine, CA, USA), many wide neck saccular as well as fusiform aneurysms can be now be treated with promising results. The Pipeline uses a concept called “flow diversion,” which promotes stasis within the aneurysm sac. Over time, the Pipeline integrates with the vessel endothelium and effectively excludes the aneurysm sac.

RESULTS: The exhibit will display the different types of cerebral aneurysms and their respective treatment options. Additionally, the Pipeline’s mechanism of action, unique features, and special considerations will be discussed. Cases involving Pipeline deployment in the vertebrobasilar circulation will be depicted and discussed in detail. Lastly, conclusions from the PUFS trial will be summarized demonstrating the efficacy of the Pipeline device.

CONCLUSIONS: The Pipeline embolization device has changed the landscape for treating fusiform and wide necked cerebral aneurysms. At our institution, we have had good initial outcomes with the Pipeline device. Understanding the technical details and considerations when using the Pipeline is crucial to successful aneurysm treatment.
**Abstract No. 726**

**Retrograde to antegrade common femoral artery puncture inversion**

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**PURPOSE:** • Understand the role of common femoral artery (CFA) retrograde to antegrade puncture inversion (RAPI) in the treatment of peripheral arterial disease (PAD) • Learn different methods of puncture inversion • Learn some of the challenges of RAPI • Review the current literature on puncture inversion

**MATERIALS:** Conventional access for treatment of PAD includes retrograde and antegrade CFA access. RAPI allows treatment of iliac and infrainguinal disease on the same side or treatment of both limbs from a single access. RAPI may be useful in cases of challenging antegrade puncture inversion in obese patients.

**RESULTS:** RAPI was first described by Sadashiv in 1983 and modified by Hartnell in 1998. Seven articles were reviewed, and four techniques are described in the literature. Some of the described techniques involve modified material. However, RAPI can be easily achieved with standard material. A reverse curve catheter is reformed in the aorta and withdrawn to the tip of the sheath. The wire is selectively advanced in the SFA under fluoroscopy. The sheath and catheter are withdrawn together to the puncture site. The catheter and then the sheath are advanced over the wire in the SFA. Inversion is easier when puncture is near vertical. Puncture may be re-inverted to use a closure device. RAPI may be challenging in case of severe atheroma of SFA.

**CONCLUSIONS:** RAPI is a well-described technique with some advantages over AP. In experienced hands RAPI allows treatment of supra and infrainguinal disease of both limbs from a single access.

**Abstract No. 727**

**Together we stand: review of a challenging case requiring intraoperative cooperation between interventional radiology, otolaryngology, and neurosurgery**

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**PURPOSE:** 1. Utilizing a challenging case, highlight the ways that interventional radiology is uniquely able to facilitate operative management of severe vascular pathology. 2. Discuss a case of carotid stenosis resulting in vision loss and syncope requiring multispecialty intraoperative cooperation to achieve retrograde carotid arterial access and treatment.

**MATERIALS:** In an ever increasingly competitive environment, interventional radiology has sought to establish itself as a field ready and willing to improve patient outcomes with technical expertise and unrelenting technological advancements.

**RESULTS:** We present a case of a 42-year-old man with history of chemoradiation for throat cancer when he was 2 years old, hypothyroidism, and hypercholesterolemia who had complex occlusive disease involving his carotid and vertebral arteries and episodes of left eye vision loss. Prior imaging revealed a heavily calcified moderately severe stenosis in the proximal right common carotid artery as well as occlusion of the right vertebral, left common, and left vertebral arteries. The patient’s ocular symptoms were believed to be related to hypoperfusion and a complex right common carotid artery stenting procedure was planned. Given the complex vascular disease, intervention through surgical exposure of the right distal carotid artery was planned which would allow appropriate access and also permit cerebrovascular embolic protection. Image-guided step by step discussion of the procedure will be presented.

**CONCLUSIONS:** As discussion of competition for procedures escalate, we aim to focus on novel ways interventional radiology can build bridges of cooperation with other medical specialties to engender interdisciplinary cooperation that can ultimately benefit patient care.

**Abstract No. 728**

**Screening for pulmonary arteriovenous malformations in patients with hereditary hemorrhagic telangiectasia: a multicenter review**

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**PURPOSE:** Defining hereditary hemorrhagic telangiectasia (HHT). Manifestations of HHT. Interventional radiology’s treatment role. HHT Centers of Excellence. Screening paradigms for pulmonary arteriovenous malformations (AVMs).

**MATERIALS:** HHT is an autosomal dominant disorder characterized by vascular malformations that manifest as recurrent epistaxis, mucocutaneous telangiectasias, and visceral AVMs. A significant health risk for HHT patients is posed by pulmonary AVMs (PAVMs), which can lead to hemoptysis, hemothorax, TIA, stroke, or infection. First-line treatment for PAVMs is embolization. Approximately 30 to 50 percent of HHT patients have one or more PAVM; however, many of these patients may be asymptomatic with their PAVMs only recognized on screening. Here we will explore current screening paradigms used to detect pulmonary AVMs in HHT.

**RESULTS:** International Guidelines for Diagnosis and Management of HHT recommend screening patients using transthoracic contrast echocardiography (TTCE) with agitated saline. A comparative study found that TTCE was the best combination of high sensitivity and low risk to screen for PAVMs when compared to CT, pulmonary angiography, chest radiograph, and alveolar-arterial gradient (calculated from arterial blood gas). A survey of six HHT Foundation-designated Centers
of Excellence from across the country demonstrates a common algo-
rithm used to screen for and treat PAVMs: Patients undergo TTCE testing. If positive TTCE, proceed to chest CT angiography. PAVMs greater than or equal to 3 mm in diameter are treated with embolization; however, at our institution we use a cutoff of 2 mm. Patients follow up at specified intervals postembolization. Embolization tech-
niques vary amongst institutions with variable rates of recanalization/
revascularization.

**CONCLUSIONS:** HHT Centers of Excellence have implemented a com-
mon screening paradigm that can be adopted by medical centers and
providers everywhere to screen and treat suspected HHT patients to
prevent the dangerous and life-threatening complications of PAVMs.

**Abstract No. 729**

Don’t embolize me! Recognizing presentations of acute small-medium vessel vasculitides and potential pitfalls of embolic intervention

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**PURPOSE:** • Recognizing common imaging findings associated with small-medium vessel vasculitides and key clinical findings. • Identifying appropriate treatment strategies for various small-medium vessel vasculitides across different stages of presentation. • Understanding potential pitfalls of interventions such as coil embolization in the acute management of small-medium vessel vasculitides.

**MATERIALS:** Small-vessel vasculitides are rare and often misdiagnosed on initial presentation in acute settings; however, recognizing their imaging presentations is key to proper management. In particular, recognizing that embolic intervention in these situations should be avoided is important to avoid severe potential complications. Interventional radiologists can play a vital role in the diagnosis and treatment strategy for such patients.

**RESULTS:** This presentation will highlight the case of a previously healthy 62-year-old man with syncope and hypotension of unknown cause. He had a CTA which showed multiple “liver lesions” with active contrast extravasation and underwent coil embolization of two right lobe hepatic arteries. Postprocedure, the patient had a complicated hospital course—including fever, leukocytosis and persistently ele-

**CONCLUSIONS:** Vasculitides are rare, often misdiagnosed causes of acute abdominal pain. Recognizing their presentations based on imag-
ing and clinical findings is key for ideal treatment and avoiding compli-
cations of non-indicated embolization.

**Abstract No. 730**

Emergent embolization for massive hemoptysis

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**PURPOSE:** After reviewing this exhibit, the reader will 1) learn the indi-
cations of emergent embolization for massive hemoptysis, 2) under-
stand the relevant anatomy, 3) learn about the different embolization

techniques, and 4) understand the relevant risks and complications.

**MATERIALS:** Massive hemoptysis is a life threatening respiratory emer-
gency with asphyxiation as the main mechanism of death. Mortality
does not vary from 50-100% with conservative management. Studies have also demonstrated significant mortality rates with surgery in the emergent setting. There are many etiologies of massive hemoptysis including infection, chronic inflammation, malignancy, trauma, and congenital. Minimally invasive embolization techniques have been developed with safe and effective results.

**RESULTS:** We present a case-based pictorial review of different causes of massive hemoptysis, radiologic/clinical workup, description of common embolization techniques (including particles, glue, coils, and plugs), and follow-up for relevant risks and complications.

**CONCLUSIONS:** 1) Massive hemoptysis can occur in various clinical

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*Note: The above table provides examples of etiologies and their respective embolization targets or arteries. Further information and resources are available for a comprehensive understanding.*
**Abstract No. 731**

The role of interventional radiology in management of hemophilia  
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**PURPOSE:** This case presentation and review of the literature is expected to: 1. Review the epidemiology, pathophysiology and treatment of hemorrhage in hemophilia patients. 2. Describe the interventional radiologist’s (IR) role in the management of hemorrhage in a hemophilia patient. 3. Identify special considerations for Interventional procedures in the hemophilia patient.

**MATERIALS:** A rare X-linked condition, hemophilia affects one in 10,000 births. It results in an impaired ability to form fibrin clot due to coagulation factor deficiency. Hemophilia A, a manifestation of Factor VIII deficiency, is the most common (80-85% cases). Hemophilia B results from Factor IX deficiency. Phenotypic severity correlates with plasma concentrations of the deficient factors. Severe bleeding with minor trauma or surgery is characteristic of all hemophiliacs, whereas patients with moderate or severe hemophilia are prone to spontaneous bleeding. The World Federation of Hemophilia recommends prompt factor replacement as the mainstay of therapy for hemorrhage. However, advances in microcatheters and embolic agents have led recent hemorrhage and demonstrated persistent gastrointestinal bleeding or ascites. PSE represents an alternative in such cases. Two studies support its efficacy in cirrhotic patients with chronic relapsing HE: Yoshida et al reported long-term improvement in cognition following PSE performed at the time of TIPS compared with TIPS alone, while Uflacker et al reported effective control of HE with PSE. PSE is not commonly used due to high complication rates reported around the time of its original description; including post-embolization syndrome, splenic abscess, and death. However, early complications were related mostly to near complete embolization and inadequate medical prophylaxis. Recent improvements in periprocedural care and embolization technique have nearly eliminated severe complications. We present three cases illustrating the efficacy of PSE for severe post-TIPS HE and we review the pathophysiology underlying the therapeutic success.

**RESULTS:** We present a case of a 19-year-old male with mild hemophilia A complaining of right thigh pain and swelling after “play-fighting” with a friend. CTA revealed a large posterior thigh hematoma with extravasation from a branch of the profunda femoral artery. Recombinant Factor VIII therapy was initiated and IR was consulted for angiography. A pseudoaneurysm from a branch of the profunda femoral artery was identified and successfully coil embolized. No access site complications or re-bleeding occurred. No decompression of the posterior thigh compartment was necessary.

**CONCLUSIONS:** IR plays an important role in the management of hemorrhage in the hemophilia patient. Patients with profound factor deficiency or musculature bleed with impending compartment syndrome benefit most from early intervention. IR has the opportunity to improve the management of hemophilia patients by advancing our understanding of the disease and through self-promotion to our Hematology colleagues.

**Abstract No. 732**

Partial splenic embolization for treatment of refractory hepatic encephalopathy following TIPS in cirrhotic patients with TIPS dysfunction  
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**PURPOSE:** Understand the role partial splenic embolization (PSE) to treat refractory hepatic encephalopathy (HE) in patients who have undergone TIPS and are poor candidates for TIPS reduction due to the risk of recurrent variceal bleeding or ascites.

**MATERIALS:** TIPS creation results in portal decompression but risks new or worsened HE in cirrhotic patients. While post-TIPS HE responds to medical management in most patients, endovascular interventions to reduce portosystemic shunting may be required in patients with refractory HE. Shunt reduction or occlusion can cause recurrent gastrointestinal bleeding or ascites. PSE represents an alternative in such cases. Two studies support its efficacy in cirrhotic patients with chronic relapsing HE: Yoshida et al reported long-term improvement in cognition following PSE performed at the time of TIPS compared with TIPS alone, while Uflacker et al reported effective control of HE with PSE. PSE is not commonly used due to high complication rates reported around the time of its original description; including post-embolization syndrome, splenic abscess, and death. However, early complications were related mostly to near complete embolization and inadequate medical prophylaxis. Recent improvements in periprocedural care and embolization technique have nearly eliminated severe complications. We present three cases illustrating the efficacy of PSE for severe post-TIPS HE and we review the pathophysiology underlying the therapeutic success.

**RESULTS:** One patient received TIPS for treatment of variceal hemorrhage and demonstrated persistent gastric varices on CT. In this first case, we review our technique for PSE. Two patients received TIPS for refractory ascites. In each case, we present the clinical background and subsequent clinical improvement from PSE.

**CONCLUSIONS:** 1. TIPS reduction to treat refractory HE may result in recurrence of variceal bleeding or ascites. 2. PSE is an effective treatment for HE without the risk of variceal bleeding or ascites. 3. Technical improvements have markedly mitigated historical complications of PSE.

**Abstract No. 733**

Pictorial review of the bronchial artery system variant anatomy: what you need to know  
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**PURPOSE:** 1) Discuss causes and subsequent pathophysiology of hemoptysis related to the pulmonary vessels. 2) Review of the normal and variant anatomy of the bronchial artery system (using diagrams and angiographic findings). 3) Case review of endovascular therapies (techniques and different approaches). 4) How to avoid pitfalls of variant anatomy and what not to embolize. 5) Highlight potential possibly serious complications. 6) Surveillance follow-up imaging and clinical follow-up.
**Abstract No. 734**

**Versatile strategies for precisely tailored N-butyl cyanoacrylate (NBCA) embolization**

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**PURPOSE:** Review physiologic and embolic proprieties of NBCA. Highlight non-cerebrovascular applications of NBCA. Review technical and clinical context in several vascular territories.

**MATERIALS:** N-butyl cyanoacrylate (NBCA) is one of the most commonly used liquid embolic agents. While initially approved for CNS AVMs, its applications have expanded to peripheral vascular territories. NBCA embolic properties stem from its polymerization upon contact with intravascular ions and proteins. This results in a static solid cast-like material that occludes vascular flow. Polymerization kinetics of NBCA is affected by mixing with different ratios of Ethiodol. Ethiodol is radiopaque ethiodized oil that serves as both a contrast medium and a dilutional media affecting polymerization time. As the mixing ratio increases, polymerization time increases allowing deeper vascular bed penetration. Different concentration dextrose solutions i.e., (D5W, D10W) with or without dextrose flush line either as small aliquots or single bolus technique can add further versatility depending on the kinetics of the targeted territory.

**RESULTS:** A review of our institution’s use of NBCA in non-CNS applications was conducted to identify a myriad of NBCA usage in the arterial, venous and lymphatic systems for embolic purposes. Highlights of some of our cases are as follows: Arterial and Trauma Intervention Cases 1-4: Including embolizations of splenic pseudo-aneurysms, bronchial artery vascular malformations, internal pudendal artery hemorrhage and uterine artery pseudo-aneurysm after C-Section. Venous Intervention Cases 5-7: Including presurgical portal vein embolization, varicocele embolization and gastric variceal hemorrhage embolization.

**CONCLUSIONS:** NBCA as an embolic agent can be applied to various vascular territories. NBCA can be a versatile embolic agent and its polymerization can be tailored to the task at hand. The IR physician should be familiar with its properties and its potential as a liquid embolic agent.

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**Abstract No. 735**

**Cone-beam computed tomography speaks volume**

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**PURPOSE:** 1. Review the physics behind cone-beam CT (CBCT) 2. Review the established literature of CBCT use in interventional oncology (IO). 3. Pictorial review of CBCT usage particularly outside the scope of IO.

**MATERIALS:** CBCT is an invaluable tool in transarterial embolization of hepatic malignancies, increasing sensitivity of tumors and tumor-feeding vessel detection [1]. CBCT can be a versatile imaging modality that provides intraprocedural 3D volumetric imaging with low radiation dosage beyond the realm of its IO applications. In our institution, CBCT is commonly used as a critical problem-solving tool in non-oncologic interventions.

**RESULTS:** Via review of multiple procedures, we will demonstrate the practical challenges in these cases and CBCT as a problem-solving tool to tackle these challenges. Highlights of some of our cases are as follows: Cases 1-3. Hepatobiliary interventions: when there have been multiple biliary drainage catheters previously placed, it became challenging to precisely analyze the drainage pattern and to localize a new catheter. CBCT was used to better localize and visualize the complex system. Cases 4-13. Acute bleeding, from gastrointestinal tract, abnormal bronchial or pulmonary vasculature or arteriovenous malformation, or large splenorenal shunt, is common where interventional radiologist can provide elegant solutions. However, it can be sometimes challenging given the vast amount of anatomy variants and often subtle abnormalities. CBCT again was used to direct precise treatment plans. Case 14. Type 2 endoleak status post abdominal aortic aneurysm repair requires treatment when the endosac is rapidly enlarging and posing risk for impeding rupture. CBCT was used to localize the in- and out-flow vessels to target embolization. Case 15. In spite of the benign nature of renal angiomyolipoma, it carries a high risk for bleeding especially when it is larger than 4 cm in size. CBCT was used to find the exact feeding segmental renal artery to direct embolization and minimize nephron loss.

**CONCLUSIONS:** 1. Physics behind CBCT 2. Using CBCT as an intraprocedural problem-solving tool in both IO and non-oncologic cases.
Abstract No. 736

The key role of interventional radiology for the management of trauma critical care patients: a pictorial essay

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PURPOSE: Acute trauma is one of the leading causes of mortality and disabilities across all ages. While surgery often considered the definite treatment option for bleeding control, it is not always the ultimate solution for stabilizing trauma critical patients. Since Margolies et al. first described an endovascular technique to prevent hemorrhage in the trauma setting, nowadays interventional radiology (IR) is playing a key role in acute trauma management. The purpose of this exhibition is to present and summarize our experience of 65 trauma critical care patients whose life-threatening bleeding was initially controlled by IR.

MATERIALS: IR has much to offer in the evaluation and treatment of traumatic injuries. Current literature suggests that this role may expand in time due to desire for organ preservation and avoidance of surgery as well as due to improvements in transcatheter equipment.

RESULTS: From Nov. 2007 to Mar. 2017, 65 trauma critical patients with massive bleeding who were treated with IR were included in this exhibition. The patients were 46 men and 19 women with age ranging from 12 to 87 years (mean, 59.8 years; SD, 20.3 years). The mechanisms of acute traumatic injuries were traffic accident (TA) in 28 patients (43.1%), 15 of in-car TA and 13 of out-car TA, iatrogenic in 26 patients (40%), and fall from height in 8 patients (12.3%). The mechanisms of acute trauma in remaining three patients were as follows; saddle injury, being crushed by a falling big tree, and being injured by deep tackle during a soccer game. The most common organ injury was hepatosplenic system (42.8%).

CONCLUSIONS: For the optimal management of trauma critical care patients, multidisciplinary team approach must be required, including surgeons, interventional radiologist, and modern facilities and equipment. Although emergency laparotomy is still the standard treatment for hemodynamically unstable patients, IR has an accepted and significant role as an adjunct to non-operative management of acute trauma patients. IR also provides a significant contribution towards achieving the best clinical outcomes of trauma critical care patients.

Abstract No. 737

Peripheral arteriovenous malformations: an institutional case-based review with focus on interventional radiology management

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PURPOSE: In this exhibit, we aim to review cross-sectional and angiographic imaging findings of our institutional peripheral arteriovenous malformation (AVM) cases and provide a roadmap for the IR-based management of each lesion. Multiple cases of peripheral AVMs in various locations will be illustrated and treatment of each lesion will be discussed thoroughly. Recurrent challenging cases with the need for multiple episodes of endovascular management will also be demonstrated.

MATERIALS: AVMs are abnormally formed canals between arteries and veins, and radiologically have a nidus and twisted pattern of blood vessels where the arterial-venous communication exists without a capillary bed. Having myriad clinical presentation, they exist at birth and grow simultaneously with the patient and may be triggered to grow further after trauma, hormonal changes or infection. Although surgical resection has historically been considered the treatment of choice, endovascular embolization therapy is substituting as a less invasive method with equivalent success and, less mortality and morbidity rates.

RESULTS: The ultimate goal of AVM treatment is to obliterate the nidus and occlude the outflow tract with the primary technique depending on the location and angioarchitecture of the lesion. Strategies vary from antegrade to retrograde to direct puncture and occlusion is achieved by Glue, Onyx, alcohol, microcoils or vascular plugs. Postoperative pain and edema occasionally occur, and the patient should be followed regularly until significant symptomatic relief is achieved.

CONCLUSIONS: Although rare, peripheral AVMs are critical findings in everyday radiology as they can present with a life- or limb-threatening situation. Given the emerging role of IR in the management of this entity, it is imperative for every interventional radiologist to learn the technical aspects of the procedure.

Abstract No. 738

Balloon-assisted occlusion of the internal iliac arteries for the management of placenta accreta

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PURPOSE: To review the role of balloon occlusion of the internal iliac arteries to control bleeding in the setting of placenta accreta.

MATERIALS: Hemorrhage from placenta accreta is associated with a high rate of morbidity and mortality. Interventional radiology offers a unique treatment option to control preoperative bleeding via the use of balloon occlusion catheters to reduce/inhibit flow in the internal iliac arteries.

RESULTS: 1) To review the current treatment options for placenta accreta-related hemorrhage, and multidisciplinary management approaches 2) the appropriate setting and role of balloon occlusion techniques, 3) the technical challenges in performing the procedure, 4) the procedural indications, contraindications, and potential risks, 5) the procedural outcomes, and 6) To present a case series to illustrate the procedure and a review of the current literature.
CONCLUSIONS: After reviewing this exhibit, the viewer will become familiar with balloon occlusion techniques of the internal iliac arteries for management of placenta accreta-related hemorrhage, technical difficulties, appropriate patient selection, risks and contraindications, and patient outcomes.

Abstract No. 739
Collateral damage: uterine collateral arterial supply in the setting of different uterine pathologies
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PURPOSE: To review the implications of collateral uterine arterial supply in the management of uterine fibroids, postpartum hemorrhage (PPH), and uterine arteriovenous fistula (uAVF) with embolization.

MATERIALS: Uterine artery embolization (UAE) is a minimally invasive, uterine sparing, treatment option for women presenting with symptomatic fibroids, PPH, and uAVFs. In most patients, bilateral uterine arteries supply the uterus exclusively. However, collateral arterial supply to the uterus has been described, predominantly in the context of UAE for fibroid treatment. This may lead to incomplete embolization, which can impact clinical outcomes. Therefore, identification of potential collateral supply to the uterus is essential for achieving optimal clinical results.

RESULTS: Review of UAE procedures performed at a single institution yielded examples of collateral uterine arterial sources during embolization to treat fibroids, PPH, and uAVFs. Aortography from the level of the renal arteries was performed for initial evaluation of uterine arterial supply in all patients, and identified hypertrophied, tortuous ovarian artery collaterals. Selective angiography of the external iliac artery was required to identify round ligament collateral uterine supply. Three-dimensional cone-beam CT was also used to visualize arterial distribution of bilateral uterine arteries and an ovarian collateral feeding a uAVF. In regard to outcomes, identification of collateral uterine arterial supply allowed for single-session complete embolization in fibroid patients with collateralized round ligament or ovarian arteries, and the PPH patient in disseminated intravascular coagulation with predominantly ovarian artery supply to the uterus. In the patient with the uAVF, recurrent bleeding after initial transarterial embolization necessitated transvaginal embolization of the dominant vascular channel with Ethylene Vinyl Alcohol Copolymer (Medtronic).

CONCLUSIONS: In the setting of various uterine pathologies such as fibroids, PPH, and uAVFs, identification of collateral uterine arterial supply is essential to optimize clinical success of UAE.

Abstract No. 740
Solid embolics for embolization: a review of current indications, outcomes, recanalization rates, and complications
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PURPOSE: To discuss and compare the indications, outcomes, recanalization rates, and complications of solid embolics including coils, Amplatz plugs (AVP) and microvascular plugs (MVP).

MATERIALS: Embolization of vessels is used to provide a framework for thrombus formation in cases of pulmonary arteriovenous malformations (PAVM), hematomas, trauma, transjugular intrahepatic portosystemic shunt (TIPS), arteriovenous fistulas, arterial occlusions. Compared to coils, both AVP and MVPs have shorter occlusion times, with MVPs providing instantaneous occlusion. Multiple factors determine the choice of solid embolic for a given indication.

RESULTS: Coils: • Used for a large variety of indications including PAVMs, small to large caliber arteries, aneurysms. AV fistulas, gastrointestinal bleeds • Successful deployment and embolization for multiple indications with recanalization rates ranging from 8 to 15% across multiple procedures • Recanalization rate is operator dependent • Can be cost effective but may require multiple treatments/coils depending on packing density • Greatest complication is coil migration leading to nontarget embolization Amplatz Vascular Plug: • Used for PAVMs, splenic artery embolization, splenic artery embolization, arterial occlusion, AV fistula embolization, gastrointestinal bleeds, gastric varices, large cerebrovascular malformations • Successful deployment and embolization for multiple indications with recanalization rates ranging from 1 to 7% across multiple procedures • Minimal risk of migration • Reduced procedural radiation dose when compared to coils because of quick deployment Microvascular plugs: • Used for occlusion of neurovascular malformations, hepatic arterial skeletonization, pediatric GDA embolization, extracranial vasculature embolization, PAVMs • Successful deployment and embolization for multiple indications with low recanalization rates • High cost per plug but low recanalization rate

CONCLUSIONS: Overall, solid embolics are safe and efficacious. Recanalization rates appear to be lowest in microvascular plugs but there is higher cost per device. Indication, recanalization rate, cost, and user preference are taken into consideration when choosing an embolic.

Abstract No. 741
The key role of pelvic arterial embolization in the management of postpartum hemorrhage
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PURPOSE: To review the implications of pelvic arterial embolization in the management of postpartum hemorrhage (PPH), and uterine arteriovenous fistula (uAVF) with embolization.

MATERIALS: Pelvic arterial embolization is performed in various clinical settings of different uterine pathologies such as fibroids, PPH, and uAVFs. In most patients, bilateral uterine arteries supply the uterus exclusively. However, collateral arterial supply to the uterus has been described, predominantly in the context of UAE for fibroid treatment. This may lead to incomplete embolization, which can impact clinical outcomes. Therefore, identification of potential collateral supply to the uterus is essential for achieving optimal clinical results.

RESULTS: Review of UAE procedures performed at a single institution yielded examples of collateral uterine arterial sources during embolization to treat fibroids, PPH, and uAVFs. Aortography from the level of the renal arteries was performed for initial evaluation of uterine arterial supply in all patients, and identified hypertrophied, tortuous ovarian artery collaterals. Selective angiography of the external iliac artery was required to identify round ligament collateral uterine supply. Three-dimensional cone-beam CT was also used to visualize arterial distribution of bilateral uterine arteries and an ovarian collateral feeding a uAVF. In regard to outcomes, identification of collateral uterine arterial supply allowed for single-session complete embolization in fibroid patients with collateralized round ligament or ovarian arteries, and the PPH patient in disseminated intravascular coagulation with predominantly ovarian artery supply to the uterus. In the patient with the uAVF, recurrent bleeding after initial transarterial embolization necessitated transvaginal embolization of the dominant vascular channel with Ethylene Vinyl Alcohol Copolymer (Medtronic).

CONCLUSIONS: In the setting of various uterine pathologies such as fibroids, PPH, and uAVFs, identification of collateral uterine arterial supply is essential to optimize clinical success of UAE.
The role of interventional radiology in postpartum hemorrhage

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PURPOSE: This educational exhibit will review the epidemiology, pathophysiology, and therapeutic options of postpartum hemorrhage (PPH). Special attention will be paid to invasive placenta and the role of interventional radiology (IR) in PPH.

MATERIALS: PPH complicates 5-10% of all deliveries and results in around 150,000 deaths per year. Risk factors for PPH include: uterine atony, retained placenta and lacerations/wounds. Invasive placenta is a rare cause of PPH but carries a high mortality rate (6-10%). Initial management of PPH is conservative and involves uterine massage and the use of prostaglandins. When these techniques fail intrauterine balloon tamponade can be attempted. IR procedures and conservative surgeries such as bilateral iliac artery ligation (BIIAL) and uterine compression sutures are further options. Hysterectomy can be done if other methods fail. IR procedures include uterine artery embolization and placement of internal iliac or aortic balloon catheters. IR procedures can be done both before and after delivery.

RESULTS: There are conflicting reports of success of BIIAL with some studies showing no reduction in morbidity, blood loss or transfusion requirements. Ureteral injury was a potential complication. Future fertility was generally preserved with arterial ligation. Uterine artery embolization was found to have an 80-100% success rate and did not appear to compromise future fertility. Uterine necrosis and nontarget embolization were potential complications. Aortic balloons were found to decrease blood loss and transfusion requirements in patients with invasive placenta when inserted prior to cesarean delivery.

CONCLUSIONS: PPH is a significant public health issue. There are many treatment options which can preserve future fertility. IR procedures play a key role in the management of PPH and are generally safe, effective and can help the patient avoid a hysterectomy.

Abstract No. 743

Transcatheter embolization for control of intractable hematuria from prostate cancer

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PURPOSE: Discuss the role of transcatheter prostate artery embolization (PAE) in the treatment of intractable hematuria due to prostate cancer (PCa). Describe technical considerations in PAE. Report clinical experience with PAE to control intractable hematuria from PCa.

MATERIALS: Prostate cancer is the second most common cancer of men, worldwide. Hematuria associated with PCa is most commonly related to bladder or urethral invasion. First-line management involves continuous bladder irrigation, instillation of silver nitrate or alum, medical or hormonal management of prostate cancer, transurethral resection of prostate, or radical prostatectomy. For patients who are not surgical candidates or unresponsive to these methods, angiographic embolization techniques have been described, but are not currently incorporated in routine clinical practice.

RESULTS: Embolization of the iliac and pudendal arteries for intractable hematuria associated with PCa was first described in 1976. Technical developments, including the advent of microcatheters and cone-beam...
CT, have allowed for increasingly selective embolization. These techniques allow for superselective catheterization and in-situ evaluation of collateralization to avoid off-target embolization. The body of literature on PAE is most mature in the treatment of benign prostatic hyperplasia (BPH). These methods have more recently been adapted for cases of intractable hematuria, including those associated with PCa. Prior case reports describe high levels of technical success (88-100%) and moderate to good short-term outcomes (70-100%). Long-term follow-up does demonstrate modest recurrence (12-57%). Complications are generally minor and include postembolization syndrome and pain. Cases of PAE performed at our institution for intractable hematuria due to PCa are presented.

CONCLUSIONS: PAE is an emerging treatment strategy for intractable hematuria in cases of PCa. Developments in PAE techniques in the treatment of BPH continue to improve the technical outcomes in malignant hematuria. Further research is necessary to evaluate the clinical efficacy, effects on tumor burden and concomitant BPH and urinary symptoms.

Abstract No. 744

Embolization of sporadic large symptomatic hepatic arteriovenous malformations using n-BCA and detachable coils

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PURPOSE: This exhibit presents a case of selective, staged hepatic arterial embolization in a patient with large symptomatic hepatic arteriovenous malformations (AVMs). We detail a novel approach for providing symptomatic relief in the setting of multiple hepatic AVMs with the use of n-butyl cyanoacrylate (n-BCA) glue and detachable platinum coils in a patient who was not a liver transplant candidate because of the presence of metastatic thyroid carcinoma.

MATERIALS: Embolization of liver AVMs is reserved for patients who are not candidates for transplant but the high morbidity and mortality that has been associated with this treatment in the past makes this a controversial subject. Cases of hepatic necrosis and death have been reported in the literature following partuculate embolization with polyvinyl alcohol particles. The use of n-BCA glue in conjunction with detachable coils can be employed to achieve vessel occlusion at a potentially more proximal location, reducing the degree of arteriovenous shunting while minimizing the risk of tissue ischemia. The patient did not have hemorrhagic telangiectasia.

RESULTS: Our patient underwent three staged, transarterial embolizations of multiple large hepatic AVMs over the course of 22 months using this technique. The patient reported substantial improvement in overall functional status following each embolization with an associated reduction in dyspnea and fatigue. Diagnostic hepatic angiograms following each embolization revealed significant interval reduction in the degree of shunting within the AVMs. The patient did not experience any significant complications as a result of the three embolization procedures. The patient ultimately succumbed to complications that arose from an unrelated abdominal surgery 2 years following the final embolization.

CONCLUSIONS: Our experience supports staged hepatic artery embolization of large AVMs using n-BCA glue and detachable coils in symptomatic patients who cannot undergo liver transplantation. We believe this technique minimizes the risk of ischemia reported with particulate embolization by achieving a more proximal embolization while decreasing the degree of shunting.

Abstract No. 745

A systematic technical approach to performing prostate artery embolization: a primer for the novice operator

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PURPOSE: 1. Learn the technique and relevance of preprocedural imaging prior to PAE. 2. From access to embolization: Step-by-step approach to performing PAE. 3. Familiarize the PAE operator with the available device armamentarium.

MATERIALS: Robust medium to long-term data and the recent FDA approval of embolic agent (Merit Medical, Inc.) for PAE has paved the way for incorporation of this procedure into many vascular and interventional radiology (VIR) practices in the country. However, challenging prostate arterial (PA) anatomy, risk of nontarget embolization and lack of familiarity with this vasculature makes the PAE procedure challenging. Proper identification and catheterization of target arterial branches is paramount to achieve the best clinical outcomes and good safety rates; unnecessary catheterization increases procedure time and radiation exposure. In this exhibit we review critical steps in performing PAE for the novice operator.

RESULTS: This exhibit includes discussion of a step wise approach supported with multiple cases from our institution. This includes, 1. An optimized CT Angiography (CTA) protocol for evaluating PA anatomy. 2. Easy to perform postprocessing of CTA data to evaluate: Prostatic arterial anatomy: Origin, Course, Anastomosis Ideal C-arm angulation for visualizing PA 3. From access to embolization: Step-by-step approach 4. Cone-beam CT protocol prior to embolization to assess perfusion and nontarget embolization. 5. A tabulated display of best available choice of access, guiding catheters, microcatheters and wires for embolization.

CONCLUSIONS: The growth of PAE has allowed for a detailed investigation of the PAE technique. Viewers of this exhibit will benefit from having a comprehensive understanding of the PAE technique from our experience at a single-center academic institution which has been performing PAE since 2014.
Abstract No. 746

Transarterial management of mesenteric segmental arterial mediolysis

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PURPOSE: 1. Review the disease history of segmental arterial mediolysis (SAM). 2. Review imaging characteristics of SAM to aid diagnosis. 3. Describe the treatment of acute hemorrhage as a complication of Mesenteric SAM.

MATERIALS: Segmental arterial mediolysis is a rare noninflammatory vascular disease. Spontaneous intraabdominal hemorrhage is a common complication of mesenteric SAM. Mortality is as high as 50%. Imaging is characterized by many dissecting and fusiform aneurysms within mesenteric artery branches. It is most commonly seen in middle aged to elderly patients.

RESULTS: This educational exhibit will review characteristics of segmental arterial mediolysis and the treatment of spontaneous intraabdominal hemorrhage. We will discuss all cases of imaged diagnosed SAM at our institution (8 patients from 2014-2017), all presenting with acute intraabdominal hemorrhage diagnosed on CT. All patients were successfully treated with coil embolization by interventional radiology.

CONCLUSIONS: Mesenteric segmental arterial mediolysis can cause spontaneous intraabdominal hemorrhage with a high mortality rate. Interventional radiology is critical in treatment of these patients.

Abstract No. 747

Catheters and catheterization technique: an often neglected part of embolization procedure planning

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PURPOSE: The learning objectives for this educational exhibit include reviewing the characteristics of the most commonly used catheters for embolization, explaining the basis of their compatibility with different embolic agents, and presenting tips for catheter selection and use in different clinical situations.

MATERIALS: Embolization procedures are now being utilized routinely in the treatment of a variety of different conditions. In recent years, the indications for embolization have expanded and new agents have been and continue to be developed for use. As this trend continues, it is important for interventional radiologists to fully understand the catheters used to deliver these agents since decisions regarding catheter selection are often responsible for the success or failure of a particular procedure.

RESULTS: In response to the demand for embolization procedures, catheters with specific qualities are being developed for use in combination with specific embolic agents. The specific characteristics of these catheters, their indications for use in specific clinical situations, and the manner in which they interact with different embolic agents will be reviewed in this educational exhibit.

CONCLUSIONS: Understanding the characteristics of the catheters used for embolization procedures and the rationale behind the recommendations that certain catheters be used in association with specific embolic agents represents essential knowledge for interventional radiologists in order to ensure appropriate catheter selection and to optimize the outcomes associated with these procedures.

Abstract No. 748

Hereditary hemorrhagic telangiectasia: integrated clinical workup, multidisciplinary evaluation, and the role of interventional radiology at a tertiary care center

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PURPOSE: After reviewing this exhibit, the reader should understand the common clinical manifestations, diagnostic criteria, and clinical screening guidelines for hemorrhagic telangiectasia (HHT) with a focus on imaging characteristics and evolving treatment techniques for pulmonary arteriovenous malformations (PAVM).

MATERIALS: Hereditary HHT is an autosomal dominant genetic disorder of blood vessels which affects approximately 1 in 5,000 people and involves multiple organ systems. Given the widespread effects of the disease, a multidisciplinary approach at a tertiary care center recognized as a Center of Excellence is encouraged to provide care by clinicians familiar with the disease process. Interventional radiology (IR) plays an integral part in the assessment and treatment of HHT, regularly seeing these patients pre- and postoperatively in clinic primarily in the treatment of PAVM (reported to affect up to 50% of patients with HHT).

RESULTS: The primary indications for PAVM embolization include hemorrhage, cerebral abscess, and stroke and size > 3 mm. This exhibit will define screening recommendations for adults, children, and gravid patients. HHT embolization efficacy and complications will be discussed. It will explore the technological advances in catheters and embolization material which make targeting even very small PAVMs now possible. Postembolization imaging, including assessment of PAVM reperfusion, will be reviewed. Treatment recommendations and the limited role of IR involving gastrointestinal and liver vascular malformations are also addressed.

CONCLUSIONS: Management of HHT requires a multidisciplinary approach which may be unfamiliar to many practicing interventionalists. Clinical algorithms for HHT will be reviewed with an emphasis on recommended screening and treatment of PAVMs.
Abstract No. 749

Percutaneous, image-guided embolization of arterial pseudoaneurysms

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PURPOSE: Discuss techniques and advantages of percutaneous embolization of arterial pseudoaneurysms (PEPSA)

MATERIALS: Arterial pseudoaneurysms (PSAs) can occur secondary to penetrating or blunt trauma. Patients can present with enlarging hematomas or decreasing hemoglobin values. Treatment options include conservative management, surgery, and endovascular embolization. PEPSA is also an alternative treatment option that may provide advantages over endovascular embolization when there is reduced renal function, contrast allergy or inability to participate in angiography.

RESULTS: This exhibit reports 10 cases presenting with hemorrhage from PSAs within the peritoneal cavity (spleen, gastroduodenal artery, superior mesenteric artery, peripancreatic region), anterior abdominal wall (rectus sheath, inferior epigastric artery), and other axial soft tissue sites (shoulder, hip). 1 patient had AKI and 4 patients had superficial PSA which made PEPSA a more suitable option. The remainder of the patients who underwent PEPSA had either tortuous vessels, no definite feeding vessel on CTA or failed endovascular attempt. The embolic material utilized was thrombin and collagen (D-Stat®), and cyanoacrylate glue. Iodinated contrast was used for 3 patients; one patient showed an arteriovenous fistula to the right femoral vein and was treated with cyanoacrylate. Mean procedure time was 9 minutes. PEPSA was successful in 9 out of 10 patients where in 1 patient, PEPSA was initially successful but had recurrence of bleeding in other sites within the right rectus sheath hematoma due to coagulopathy that was treated by endovascular embolization. There were no procedure-related complications. In our exhibit, we will review the preprocedural imaging and the procedural techniques used in each case. Particular attention will be paid to patient selection and access planning. Choice of the embolic agent, as well as procedure length and both technical and clinical success will be discussed.

CONCLUSIONS: PEPSA may be used to treat PSA in intraperitoneal and soft tissue locations. This mode of therapy can be considered when there is satisfactory image-guided needle percutaneous access to a PSA.

Abstract No. 750

The pulmonary artery pseudoaneurysm: computed tomography, angiographic findings, and treatment

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PURPOSE: We will present the patients’ characteristics, their CT and angiography findings. We will review treatment methods and outcomes for the various pulmonary artery pseudoaneurysms.

MATERIALS: CT is a very useful for initial assessment of hemoptysis. CT shows the underlying lung parenchyma abnormality and abnormally dilated systemic arteries that may require embolization. In addition, CT can also be useful in the evaluation of hemoptysis of peripheral pulmonary artery origin. Pulmonary artery pseudoaneurysms are uncommon. However, an awareness of pulmonary artery pseudoaneurysm is important because its treatment is different from that of hemoptysis originating from bronchial or nonbronchial systemic collateral arteries.

RESULTS: Underlying lung abnormalities of the patients were tuberculosis, mycetoma, necrotizing pneumonia, and lung cancer on radiation therapy. CT finding was analyzed by means of axial, MPR, MIP images. Pulmonary artery and/or bronchial or nonbronchial systemic collateral arterial angiographies were performed. Endovascular treatment was performed by embolization of pulmonary artery pseudoaneurysm or embolization of bronchial or nonbronchial systemic collateral arteries using microcoils, n-butyl cyanoacrylate, or PVA particles. Immediate hemostasis was achieved, and pulmonary artery pseudoaneurysm disappeared on follow-up CT.

CONCLUSIONS: The treatment of hemoptysis from the pulmonary artery pseudoaneurysm can be different from that of hemoptysis originating from the bronchial or systemic artery. Familiarity with CT findings of the pulmonary artery pseudoaneurysm is necessary to facilitate prompt diagnosis and treatment.

Abstract No. 751

Uterine fibroid embolization: patient selection, appropriate image evaluation, and pre- and postprocedural management

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PURPOSE: 1. Describe the pathophysiology, presentation, and clinical features of uterine leiomyomas (fibroids). 2. Review the indications for uterine fibroid embolization (UFE), including abnormal uterine bleeding and bulk-related symptoms. 3. Review the imaging appearance of fibroids treatable by UFE. 4. Review key anatomy in the endovascular treatment of fibroids (including important anatomic variants). 5. Review need-to-know postprocedural complications after UFE.

MATERIALS: Uterine fibroids are the most common neoplasm of the female reproductive tract, found in over one-half of American women of reproductive age when evaluated ultrasonographically (1). While commonly asymptomatic, uterine fibroids can also cause severe symptoms, including abnormal uterine bleeding, as well as bulk-related symptoms such as increased rates of infertility, pelvic pressure, and pain. While hysterectomy has long been utilized as the definitive treatment for symptomatic fibroids, UFE has emerged as a more minimally...
invasive option for symptomatic fibroid treatment (2), with excellent long-term outcomes (3).

RESULTS: This educational exhibit will outline the pathophysiology, presentation, and clinical features of uterine fibroids. The indications for UFE will be reviewed, including abnormal uterine bleeding and bulk-related symptoms; important contraindications to endovascular treatment will also be discussed. The imaging characteristics of treatable fibroids on magnetic resonance imaging (MRI) and ultrasonography (US) will be illustrated in pictorial fashion. Key anatomic landmarks and structures for UFE (including important anatomic variants) will also be illustrated in pictorial fashion. Finally, common and uncommon postprocedural complications of UFE will be reviewed.

CONCLUSIONS: Apt clinical management of patients with uterine fibroids underlies procedural success with UFE. As such, the interventional radiologist maintains an important role in determining eligibility, managing procedure-related complications, and acknowledging further treatment options after UFE. It is important for the interventional radiologist to be able to manage preprocedural, procedural, and post-procedural issues when planning for UFE.

Abstract No. 752

Testicular infarction; a complication of preoperative renal embolization with Embospheres and Gelfoam: a case report

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PURPOSE: We are presenting a case of right testicular ischemia following right renal embolization using Embospheres and Gelfoam. The discussion includes the potential pathways for nontarget embolization of the testicular artery.

MATERIALS: Renal artery embolization has a wide range of indications including prenephrectomy infarction of renal tumors. A variety of embolic materials are available, such as metal coils, sclerosants (eg, glue, absolute ethanol, Lipiodol), and particulate embolic agents (polyvinyl alcohol particles and Embospheres). Renal artery embolization is generally considered safe and effective; however, it is not without potentially serious complications.

RESULTS: 59-year-old male patient with large right renal cell carcinoma (clear cell type) with invasion of the renal vein underwent preoperative right renal artery embolization using Embospheres and Gelfoam to decrease intraoperative hemorrhage and the need for postoperative transfusion. During the procedure a small ureteral artery seen arising from the distal right renal artery. Following the procedure, the patient underwent right nephrectomy with minimal blood loss. On postoperative day 2, the patient developed right testicular pain and swelling. Scrotal ultrasound showed heterogeneous right testicle with decreased vascularity and absent arterial waveforms. The patient was managed conservatively with continued progressive improvement. Clinical and radiological follow-up showed resolution of the transient testicular ischemia.

CONCLUSIONS: Renal arteries can have connections to adjacent vessels including the intercostal, testicular, and inferior mesenteric arteries. These communications are potential routes by which embolic material introduced into the renal artery may inadvertently lead to nontarget embolization. We present a case of nontarget embolization through a communication between the testicular artery and a ureteral branch arising from the renal artery. Conclusion: Small renal arterial branches and connections are potential route for nontarget embolization during renal artery embolization, leading to potentially serious complications including testicular infarction.

Abstract No. 753

A novel approach to treating myomatous erythrocytosis syndrome with uterine artery embolization

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PURPOSE: a) Understand the diagnosis and traditional management of myomatous erythrocytosis syndrome (MES) b) Describe a novel approach to treating MES with UAE

MATERIALS: MES is a rare condition in which patients develop secondary erythrocytosis related to uterine fibroids. The resultant increase in red blood cell mass leads to hyperviscosity, which can compromise circulation by causing tissue hypoxia and increasing risk of thrombosis. Though the differential for secondary erythrocytosis is broad, the diagnosis of MES has traditionally been confirmed when patients have restoration and maintenance of normal hematologic values following hysterectomy. The exact pathophysiology of MES is uncertain: some authors believe uterine myomas produce erythropoietin, while others theorize myomas alter renal erythropoietin production.

RESULTS: 61-year-old female with no past medical history was admitted with dizziness, right arm numbness. HCT was 65.9, and she was phlebotomized one liter. Initial workup revealed a gastrointestinal stromal tumor (biopsy proven), which was resected five months after initial presentation without subsequent improvement in erythrocytosis. CT A&P performed 2 years later revealed a 10 cm leiomyoma, which was confirmed on pelvic ultrasound. Despite being lost to follow-up for over 1.5 years, she had at least 22 documented phlebotomies since her initial presentation, often removing 500 cc of blood. Gynecology was consulted, and the patient was counseled on options of expectant versus surgical management with hysterectomy. Reluctant to undergo hysterectomy, the patient was referred to interventional radiology for venous sampling and possible UAE. The patient underwent venous sampling and UAE performed at the same sitting, over 6 years after her initial presentation. Erythropoietin levels normalized three weeks following UAE and hematocrit levels normalized seven weeks following UAE.

CONCLUSIONS: MES is a rare condition historically treated with hysterectomy that appears amenable to treatment by UAE.
Abstract No. 754

Splenic arterial interventions: a comprehensive pictorial review

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PURPOSE: 1. To review the anatomy of splenic artery and 3D printing to aid treatment planning only for complex elective cases. 2. To review indications for splenic artery interventions: traumatic and nontraumatic. 3. To review various techniques and outcomes of splenic artery interventions for individual indication.

MATERIALS: Splenic arterial interventions are increasingly used to treat various clinical conditions and in certain scenarios as an alternate to surgery. With wider understanding of its applications and advances in the techniques, the interventional radiologists must be familiar with various aspects of splenic arterial interventions. Here in we review the vascular anatomy, indications and contraindications to the procedure, outcomes for individual indications and various technical advancements to aid treatment.

RESULTS: Splenic arterial anatomy and utility of 3D printing for complex cases. - Indications, Technique and Utility of 3D printing for complex cases: > Trauma: Proximal and Distal splenic artery embolization, Arteriovenous fistula > Nontraumatic: Inflammatory pseudoaneurysm, Splenic artery aneurysm, Portal hypertension, Liver transplant: Steal syndrome, Thrombocytopenia (Hypersplenism, Chemotherapy induced thrombocytopenia, Preoperative)

CONCLUSIONS: Splenic arterial interventions are widely accepted for treatment of various clinical conditions such as trauma, aneurysm, portal hypertension, hematology, oncology and liver transplantation. This pictorial review outlines the common indications, newer advances in techniques and promising outcomes of individual indications. Continued review of data and research are necessary for better application of the knowledge and refinement in the outcomes.

Abstract No. 755

Uterine artery embolization for the treatment of cesarean scar pregnancy

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PURPOSE: To raise awareness of a relatively unrecognized complication of uterine artery embolization.

MATERIALS: Uterine artery embolization (UAE) is a safe, efficacious, and cost-effective alternative to traditional surgical options for treating symptomatic uterine fibroids. There have been case reports of perioperative embolic particle spread into the uterine cavity and vagina. The variability of clumping among embolic agents calls into question what the effect of particle exposure is within the endometrial cavity, as well as potentially within the abdomen during myomectomies and what complications and risks may be associated with this exposure. In our case, we visualized innumerable microspheres present in the myometrium, which subsequently spilled into the abdominal cavity. These spheres were visible in the abdominal cavity during robotic myomectomy.

RESULTS: A 41-year-old female presented with pelvic pain and severe urinary symptoms secondary to large uterine fibroid tumor burden risk of uterine rupture, hemorrhage, and hysterectomy. Medical treatment with systemic or locally administered methotrexate is common; however, there is no consensus on management. Additional modalities include dilation and curettage, resection of the gestational sac, and UAE. We present the case of a CSP treated with UAE at our institution.

CONCLUSIONS: CSP are rare and can be associated with catastrophic complications. Management involves administration of methotrexate, alone or in combination with other interventions. UAE is an effective means of treating CSP.

Abstract No. 756

A case of failed uterine artery embolization: peritoneal spill of microspheres during laparoscopic myomectomy two years after embolization

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discern the effect of embolic particles on these tissues. The cavity caused by perioperative spill and scatter of spheres during subcutaneous myomectomy 2 years after UAE demonstrates that the spheres had not incorporated into a matrix of chronic thrombus, as may be expected. This poses a concern for potential injury to the abdominal vasculature associated with the embolized fibroids, copious amounts of microspheres spilled out in a cascading, uncontrolled fashion into the peritoneal cavity.

CONCLUSIONS: The free-flowing nature of microspheres seen during myomectomy 2 years after UAE demonstrates that the spheres had not incorporated into a matrix of chronic thrombus, as may be expected. This poses a concern for potential injury to the abdominal cavity caused by perioperative spill and scatter of spheres during subsequent surgical treatments. Further research would be necessary to discern the effect of embolic particles on these tissues.

Abstract No. 757
Interventional radiology’s role in obstetric and gynecology emergencies
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PURPOSE: To discuss the role of interventional radiology in managing and assisting obstetric and gynecological emergencies.

MATERIALS: Interventional radiology procedures can provide significant benefit to the management of certain obstetrical and gynecologic emergencies, particularly in the setting of hemorrhage and trauma.

RESULTS: In this educational exhibit we will discuss the various obstetric emergency procedures performed by interventional radiology at our institution. We will provide a pictorial review of these cases performed at our multicenter academic institution. Such cases include bilateral uterine artery embolization for a bleeding mass in a Jehovah Witness patient with a hemoglobin of 4, bilateral iliac balloon occlusion in a pregnant patient with placenta accreta, preemptive bilateral iliac balloon occlusion for high-risk surgeries, embolization for arteriovenous malformations resulting in hemorrhage, embolization for bleeding cervical and endometrial masses in the setting of radiation therapy, and postpartum hemorrhage. These techniques help to preserve fertility in patients who would otherwise have hysterectomies for hemorrhage. Additionally, we will discuss the clinical indications, patient selection criteria and contraindications, technique, complications and results of the procedures described above.

CONCLUSIONS: Interventional radiology plays an important role in management of a wide variety of obstetrics and gynecological emergencies which are not well known outside of Radiology.

Abstract No. 758
Coming full circle: overview of novel indications for intervention via radial arterial access
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PURPOSE: 1) Technique overview and patient selection criteria for radial arterial access 2) Understanding indications for utilizing radial access in a variety of interventions

MATERIALS: Over the past decade, arterial access via the radial artery has become an increasingly popular technique for interventional radiology interventions. There has been extensive literature citing its safety profile, patient preference, and decreased cost when compared with a femoral access site for interventional radiology interventions, particularly transarterial chemoembolization. Although femoral access remains the predominant access technique for mesenteric and peripheral interventions, interventional radiologists are increasingly utilizing this technique for other indications, some of which will be highlighted in this exhibit.

RESULTS: i. Upper extremity embolization (e.g., tumor, AVM) ii. Subclavian recanalization for steal syndrome iii. Arteriovenous (AV) fistula/graft declot and angioplasty for dialysis access iv. Lower extremity angiography and recanalization v. Renal intervention vi. Mesenteric recanalization and hepatic artery intervention (e.g., transarterial chemoembolization (TACE))

CONCLUSIONS: Radial artery access for peripheral endovascular procedures appears to be safe and effective. There is a growing spectrum of potential indications for the use of radial artery access.

Abstract No. 759
Gone fishing: an interventional radiology voyage in foreign body retrieval
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PURPOSE: 1. Outline the incidence and clinical picture of patients with lost or embolized foreign bodies. 2. Discuss the causes of lost or embolized foreign bodies. 3. Demonstrate the imaging findings of foreign bodies. 4. Illustrate different interventional techniques for foreign body retrieval. 5. Demonstrate tips and tricks for foreign body removal in difficult situations. 6. Describe the outcomes of interventional removal of foreign bodies. 7. Outline potential complications.
MATERIALS: Lost or embolized Intravascular foreign body (IFB) have been encountered by interventional radiologists. Retrieving retained IFB is crucial to avoid potential adverse events. Minimal invasive procedures are efficient in retrieving IFB using different techniques and are more preferable than surgical management. Understanding the causes, clinical presentations and imaging findings of lost IFB facilitates the management and guides the use of proper retrieval technique.

RESULTS: We will support our presentation with multiple cases from our institution. We will present the etiology, as well as, the clinical presentations and imaging findings of these cases. We will discuss the details of the interventional techniques used in the management and the outcomes.

CONCLUSIONS: Retrieval of intravascular foreign bodies can be challenging depending on the type and location of the foreign body. After viewing the presentation, the viewer will be familiar with the various scenarios of lost and embolized IFB, and the various techniques for management. The viewer will recognize that interventional radiological techniques provide minimal invasive approach with high success rate compared to surgery.

Abstract No. 760

Equipment compatibility for transradial image-guided interventions: find your match!

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PURPOSE: 1. Discuss nomenclature and sizing of equipment currently available. 2. Draw attention to commercial inconsistencies of device sizing nomenclature and provide guidance on device selection for compatibility 3. Identify clinical situations that preclude the transradial approach as a suitable access route.

MATERIALS: The use of transradial access has been steadily increasing since its introduction in the late 1980s. Its advantages over transfemoral access such as lower risk of bleeding, shorter recovery period, and faster postprocedural ambulation time have been well documented in the literature. A significant proportion of equipment available was primarily designed for transfemoral procedures, which limits their application in transradial interventions. Commercial discrepancies of equipment description have also been recognized; these may cause confusion and inadvertently lead to incorrect use.

RESULTS: Explanation of equipment classification including but not limited to introducer sheaths, catheters, guide catheters, sheathless guide catheters, and guide extension catheters will be outlined. Potential device incompatibility due to commercial sizing (i.e., regular versus “low-profile” access sheaths, sheathless guides versus sheaths) will be addressed. Limitations of equipment precluding radial access such as length (i.e., catheters, balloon shafts) or lack of low profile systems (i.e., stent delivery) will also be discussed.

CONCLUSIONS: Transradial access for percutaneous image-guided procedures is increasingly being incorporated into clinical practice worldwide. Comprehensive understanding of the technical considerations, and limits of current devices are essential for optimizing efficiency of execution, troubleshooting, and mitigation of complications.

Abstract No. 761

Arterial complications of pancreatitis

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PURPOSE: The goal of this educational exhibit is to understand the arterial complications of pancreatitis and their treatment with directed therapy. The relevant anatomy, etiologies, pathophysiology, complications and risk factors associated with pancreatitis will be discussed as well as imaging findings. The treatment of these arterial complications will be described and the potential complications due to treatment. A systemic review of the more recent literature will be made.

MATERIALS: Pancreatitis is on the rise in the U.S. with nearly 210,000 annual hospital admissions. Patients usually present with abdominal pain, nausea or vomiting. Imaging, while not required, may be helpful in assessing the complications. Etiologies commonly include alcohol use and gallstones; however, may include less common etiologies such as trauma. Arterial complications, serious and potentially life threatening, include hemorrhage or pseudoaneurysms (PSA) of the adjacent splenic, gastroduodenal (GDA) and gastric arteries. Further, hemorrhage within a pseudocyst, a known nonvascular complication, may also occur.

RESULTS: This exhibit discusses relevant anatomy and imaging features demonstrated in illustrative cases. These cases include a patient with hemorrhage into a pseudocyst caused by a PSA arising from the right gastroepiploic artery and a splenic artery PSA. Coil migration after embolization of the GDA in a patient with history of trauma and alcohol abuse will also be described. Techniques will be discussed regarding various procedures employed. A systemic review of the more recent literature will also be performed.

CONCLUSIONS: Pancreatitis is on the rise, and IR will have an increasing role in the management of the potential complications. Understanding of the relevant imaging, anatomy and angiographic features is essential to a safe and successful procedure. While treatments may be life-saving, potential complications can occur, and therefore, risk and benefits must always be understood and weighed.

Abstract No. 762

Polyarteritis nodosa: a rare presentation and diagnosis made on angiography

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PURPOSE: Spontaneous perirenal hematoma is a rare but serious complication of polyarteritis nodosa and must be considered in patients presenting with this complication as their first presentation. Renal infarctions, liver infarctions, and ruptured microaneurysms are all
complications of polyarteritis nodosa. Our patient presented with a constellation of most of these findings on the initial presentation. The diagnosis of polyarteritis nodosa can be made on angiographic findings with high confidence.

**MATERIALS:** Our patient initially presented to the ED with abdominal pain. On her initial CT scan, she was found to have bilateral renal infarcts. MRA was performed which was negative except for the bilateral renal infarcts. The patient was worked up with TEE and lower extremity ultrasound to rule out clots, which were all negative. The patient was started on Eliquis for presumed embolic disease of unknown origin. Two weeks later, the patient presented again to the ED with abdominal pain. Her CT scan showed a large right subcapsular perirenal hematoma. Multiple infarcts in the liver were also noted on the scan. Interventional radiology was consulted for possible embolization of bleeding source. Angiography of the right renal artery was performed, which showed classical findings of polyarteritis nodosa, which are discussed in the next section.

**RESULTS:** Right renal artery angiography: A severe stenosis was visualized at the origin of the right renal artery with severe poststenotic dilatation. Large areas of devascularization were noted consistent with previously identified renal fracture/infarction. Severe irregularity of the visualized intrarenal vessels was noted, including multifocal stenoses and poststenotic dilatation. No active extravasation was noted. There was reflux of contrast into the abdominal aorta, with filling of adjacent lumbar vessels. Irregularity was noted within these vessels including focal microaneurysms. Filling of the right L1 lumbar artery was also noted again demonstrating the associated microaneurysms.

**CONCLUSIONS:** The diagnosis of polyarteritis nodosa can be made on angiography with the rare constellation of findings our patient initially presented with, as described above.

*Abstract No. 763*

**Percutaneous radial artery access: a pictorial review of technique and complications**

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**PURPOSE:** Describe relevant anatomy and procedural steps used in percutaneous radial artery access. Explain the risks and benefits of radial artery access. Recognize potential complications of radial artery access and describe their management.

**MATERIALS:** Femoral artery access is the traditional route for interventional procedures in interventional radiology. Due to contraindications to femoral artery access and as a means to improve patient comfort, alternative arterial access points have been explored. Cardiologists began percutaneous radial artery access for left heart catheterization and coronary angiography in 1989. Since then, its use in cardiology has progressively increased; some studies reporting radial artery access in up to 41.3% of their interventional cardiac procedures. Interventional radiology has adopted transradial access as an alternative approach, with its use becoming more widespread. With more frequent use of radial artery access, both common and uncommon complications have been identified.

**RESULTS:** We provide a procedural review of percutaneous radial artery access and its postprocedural complications. Anatomy and technique for obtaining radial artery access will be reported. Potential complications, including but not limited to, radial artery spasm, radial artery obstruction, and radial artery pseudoaneurysm will be discussed.

**CONCLUSIONS:** Understanding relevant radial artery anatomy in addition to the risks and benefits of obtaining radial artery access helps prevent complications and improves efficiency throughout interventional procedures. It is critical for interventional radiologists to understand the potential complications and how to approach performing such procedures.

*Abstract No. 764*

**Quadrilateral space syndrome: diagnosis and clinical management**

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**PURPOSE:** 1. Differential diagnosis of chronic shoulder pain. 2. Diagnostic workup of shoulder pain. 3. QSS, anatomy, diagnosis, treatment and outcomes.

**MATERIALS:** Quadrilateral space syndrome (QSS) is a rare disorder characterized by axillary nerve and posterior humeral circumflex artery (PHCA) compression within the space bounded superiorly by the teres minor muscle, inferiorly by the teres major muscle, medially by the long head of the triceps, and laterally by the humeral shaft. Impingement is most frequently due to trauma, fibrotic bands, or hypertrophy of one of the muscular borders. Diagnosis can be complicated by the presence of concurrent traumatic injuries, particularly in athletes. We will illustrate QSS through a series of cases emphasizing when to suspect the condition, how they are diagnosed and long-term outcomes.

**RESULTS:** We will illustrate the anatomy of QSS and then review a series of cases including cross-sectional imaging, angiographic work-up and follow-up imaging. QSS is often delayed in diagnosis; understanding its anatomy, cross-sectional imaging findings and its angiographic work-up is critical.

**CONCLUSIONS:** 1. QSS is a rare multifactorial condition. It is often associated with other shoulder trauma, complicating accurate diagnosis and delaying effective treatment. The presentation of QSS may be subtle, and careful imaging studies are essential in diagnostic management. 2. Understanding imaging findings of QSS through the review of cross-sectional imaging and angiographic studies.
Abstract No. 765

**Everything but the kitchen sink: different management techniques for patients with invasive placenta undergoing cesarean hysterectomy**

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**PURPOSE:** To review the different interventions utilized in decreasing intraoperative estimated blood loss (EBL) in the management of patients with invasive placenta undergoing cesarean hysterectomy (C-hyst).

**MATERIALS:** In the U.S., the incidence of invasive placenta has risen over the past several decades, thought to be secondary to the increasing rate of uterine instrument such as caesarean deliveries. Invasive placenta which often fails to completely detach during delivery and can cause severe bleeding, is now one of the leading causes of severe postpartum hemorrhage (PPH), with an estimated maternal morbidity rate of 60% and mortality rate of up to 7%. Patients with invasive placenta typically undergo C-hyst and can benefit from a variety of adjuvant procedures to decrease intraoperative EBL. Such procedures include surgical ligation of the internal iliac arteries, balloon occlusion of the aorta or iliac arteries, and arterial embolization following cesarean delivery and prior to the hysterectomy.

**RESULTS:** Four key procedures that can be utilized to decrease intraoperative blood loss are described in this section. These include: 1. Iliac artery ligation. 2. Iliac artery occlusion. 3. Intra-aortic balloon occlusion. 4. Uterine artery embolization. Explanations and illustrations of how the procedures are performed are included.

**CONCLUSIONS:** In the setting of invasive placenta, numerous endovascular and surgical techniques are available to decrease intraoperative EBL. As the incidence of invasive placenta has increased dramatically in the last decade, it is important for interventional radiologists to familiarize themselves with these numerous adjuvant procedures available in the multidisciplinary care of such patients.

Abstract No. 766

**Angio-Seal™ for the brachial artery: tips and tricks for effective hemostasis**

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**PURPOSE:** 1. Describe the safe principles of brachial arterial access 2. Understand the potential risks of brachial artery access 3. Patient selection and steps for safe deployment of an Angio-Seal [Terumo, Tokyo, Japan] in the brachial artery

**MATERIALS:** Brachial artery access can be a useful endovascular approach for peripheral and visceral artery intervention. It is, however, associated with higher complication rates compared to transfemoral access, particularly hematoma and thrombosis requiring surgical intervention. Hemostasis of the brachial has traditionally involved manual compression, but the off-label use of vascular closure devices has been suggested as an alternative.

**RESULTS:** The following steps are suggested for safe access and hemostasis of the brachial artery with off-label use of the Angio-Seal device

1. Ultrasound evaluation of the brachial artery including measurement of luminal diameter (<3 mm deemed unsuitable). 2. Ultrasound-guided access of the brachial artery overlying the distal humerus should be performed using a micropuncture set. 3. For hemostasis, prior to considering use of the Angio-Seal, brachial angiography should be performed to ensure the vessel can accommodate the 6Fr Angio-Seal device; if the sheath is occlusive (no flow beyond sheath), either due to small vessel caliber or spasm, the closure device should not be used. At our institution, fourteen 6Fr Angio-Seals were deployed into the brachial artery in 13 patients (10 Males, 3 Females mean age of 77 [range 59-89]) using the steps above over a three-year period. All were successful except for one pseudoaneurysm due to Angio-Seal maldeployment. No long-term adverse sequelae were identified.

**CONCLUSIONS:** Brachial artery access is an important access site for endovascular intervention. With careful patient selection and the use of brachial angiography, off-label use of the Angio-Seal device can be a valuable tool for effective hemostasis. This technique provides an alternative to manual compression with no long-term adverse sequelae identified in our patient cohort.

Abstract No. 767

**Techniques for management of intrapartum hemorrhage in abnormal placentation**

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**PURPOSE:** Review of the indications for interventional radiology involvement with abnormal placentation with an emphasis on prepartum imaging that would suggest a higher risk of intrapartum hemorrhage. Review of the techniques for intravascular interventions for patients with a high risk of intrapartum hemorrhage including internal iliac artery balloon occlusion and embolization strategies. Review of proper fluoroscopy technique in the pregnant patient.

**MATERIALS:** The spectrum of abnormal placentation from accreta to percreta can significantly increase the risk of intrapartum hemorrhage. Multidisciplinary teams including interventional radiologists have been instrumental in reducing the morbidity associated with delivery in these high-risk patients. Interventional radiology techniques for preventing and treating intrapartum hemorrhage have become essential to the successful care of these patients.

**RESULTS:** Discussion with images including patient preparation, selection of catheters, and step-by-step guide for prophylactic internal iliac balloon occlusion. Proper fluoroscopic technique in the pregnant patient and embolization strategies in the event of uncontrolled hemorrhage will also be detailed.
CONCLUSIONS: To recognize patients that are at a significantly increased risk for intrapartum hemorrhage. Review important pre-procedural considerations and technique for prophylactic internal iliac artery balloon occlusion in the pregnant patient. Gain an understanding of the role interventional radiology can play in the multidisciplinary care for high-risk abnormal placentation patients.

Abstract No. 768

Developing a transradial access program within a traditionally transfemoral interventional radiology practice

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PURPOSE: 1. To navigate the challenges associated with establishing a transradial access program in a predominantly transfemoral practice. 2. To understand the basics of transradial access. 3. To overcome certain common difficulties associated with transradial access 4. To understand the wide variety of procedures that can be done through the transradial approach.

MATERIALS: Although transradial access has largely been adopted by the interventional cardiology community, it has not found widespread implementation by interventional radiologists despite its many advantages. In preexisting interventional practices where transfemoral access has traditionally been preferred, multiple barriers exist to the introduction of an alternative vascular access approach.

RESULTS: This report will serve as a comprehensive guide to navigating the interventional radiology-specific challenges encountered during initiation of a transradial access program. In addition, multiple techniques will be introduced to circumvent the physical constraints of the interventional suite, thus expanding operator capabilities during transradial procedures. Failure to gain radial artery access has rarely been experienced within our practice and in the literature. Should the transradial approach fail, we favor subsequent transfemoral access. Generally, transulnar access is not preferred or attempted.

CONCLUSIONS: Adopting a transradial practice offers tangible improvements in quality and cost of patient care for interventional radiology procedures over the traditional transfemoral approach. Access site complications can feasibly be reduced in an otherwise challenging subset of patients. Interventional radiology practices that use transfemoral access will find they are already well-equipped for a transition to the transradial approach, without constraints imposed by equipment or space. Through education within and across departments, the transradial approach should continue to grow in popularity, finding application in a variety of interventional radiology procedures.

Abstract No. 769

Radial artery access for interventions in subacute trauma: a road less traveled

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PURPOSE: 1. Construct an algorithm to identify trauma patients suitable for radial artery access. 2. Highlight the advantages and pitfalls of transradial intervention, specifically in this patient population. 3. Present subacute trauma cases for which radial artery access was successfully utilized. 4. Discuss technical modifications of transradial technique used in the setting of trauma. 5. Discuss the recognition and treatment of complications associated with radial artery access.

MATERIALS: The radial artery has been a conduit for interventional cardiologists performing both coronary diagnostic and therapeutic interventions since it was first described in the late 1980s. Over the past two decades, interventional radiology has adopted this approach for a wide variety of procedures with both technical success and low complication rates. Procedure-specific considerations such as technical difficulty, as well as size and spasticity of the vessel, have traditionally limited the use of radial artery access in a trauma setting.

RESULTS: We will present an overview of benefits unique to transradial access in trauma with a focus on patient-specific factors that lead to an improved safety profile when radial access is preferentially employed. After reviewing the basic concepts of radial artery access, including recognition and management of complications, we present sample cases including: 1. 25-year-old M presented with grade 3 splenic laceration status postassault. He underwent proximal splenic artery embolization via left radial access. 2. An 18-year-old male with multiple traumatic liver lacerations and pseudoaneurysms underwent hepatic angiogram and coil embolization via left radial artery access. He was asymptomatic at 1-month follow-up. 3. 21-year-old male with transsection of the left radial artery secondary to a gunshot wound. Coil embolization was performed via right radial artery access. In all cases, no significant access-related complications were observed.

CONCLUSIONS: Radial artery intervention is a safe and feasible option for patients with subacute injuries. Appropriate patient selection and proficiency in recognition and management of procedure-specific complications are crucial to success.

Abstract No. 770

Management principles for liver trauma

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PURPOSE: To review common mechanisms of injury for blunt and penetrating trauma to the liver. To discuss indications for nonoperative, surgical, and interventional management of liver trauma and review
the underlying literature. To compare approaches and underlying principles of interventional management of hepatic trauma.

**MATERIALS:** The liver is the most commonly injured abdominal organ. While many hepatic injuries heal spontaneously, approximately 1 in 7 require interventions for hemodynamic instability or failed nonoperative management. Interventional radiology is an integral member of the trauma management team and can spare patients the morbidity and mortality risks of exploratory laparotomy. Thus, knowing indications and contraindications for intervention; patterns of injury that suggest surgical intervention; and principles of interventional management; can ensure that the interventionalist appropriately dispositions the patient.

**RESULTS:** Using a case-based approach, we illustrate the American Association for the Surgery of Trauma classification system for liver trauma. We present a review of current literature that influences the decision between operative, nonoperative, or interventional management, and we illustrate these principles with different clinical scenarios (e.g., hemodynamics, evidence of other injury). We also review the principles, technical steps, outcomes, and complications for interventional management of acute hepatic trauma, as well as downstream sequelae (e.g., biloma, major hepatic necrosis).

**CONCLUSIONS:** Hepatic trauma can be a significant source of morbidity and mortality. By understanding the mechanisms of trauma and literature underlying current management recommendations, the interventional radiologist can create an optimal treatment plan with the traumatologist and can offer optimal treatment for these patients.

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**Abstract No. 771**

**A rare case of extrinsic vascular compression by a hemostatic agent: “surgiceloma”**

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**PURPOSE:** To demonstrate potential complications arising from compression of local structures by retained hemostatic agents such as Surgicel. To describe clinical and radiographic findings associated with a “surgiceloma.”

**MATERIALS:** Surgicel is a hemostatic agent composed of oxidized regenerated cellulose. It is used to control postoperative bleeding, and functions by swelling as it absorbs blood, aiding in clot formation. Unabsorbed Surgicel has been shown to cause compression of nearby nerves and vasculature via formation of a so-called “Surgiceloma” (1-3). We present an interesting case in which excess Surgicel resulted in extrinsic compression of the common hepatic artery in a transplant patient.

**RESULTS:** A 38-year-old male with alcoholic cirrhosis and hepatic encephalopathy underwent orthotopic liver transplantation. No intraoperative complications were reported. Estimated blood loss was 1800 ml. On postoperative day 1, ultrasound Doppler showed slightly diminished resistive index in the main and right hepatic arteries. Overnight liver function tests trended upward, and a repeat ultrasound Doppler on postop day 2 was unable to visualize diastolic flow in the common hepatic artery. Hepatic artery angiography was performed which confirmed absent diastolic flow. The patient was taken to the operating room, where exploratory laparotomy revealed a large mass of expanded Surgicel compressing the common hepatic artery. Removal of the Surgicel resulted in a strengthened pulse, and subsequent intraoperative hepatic angiogram showed adequate hepatic arterial flow. Haptic and perihaptic vascular flow was normal on postoperative ultrasound Doppler four days later. Patient did well postoperatively.

**CONCLUSIONS:** Retention and expansion of hemostatic agents such as Surgicel may result in local neurovascular compression, leading to neural symptoms and/or decreased perfusion of associated organs. “Surgiceloma” compression should be considered as a differential in the setting of postoperative impaired perfusion, and judicious intraoperative use of hemostatic agents and their timely removal can avoid these potential complications.
occur. As clinicians performing TAVR, interventional radiologists should be acutely aware of the clinical presentation, imaging findings, and management of these associated complications. Our presentation aims to educate trainees and clinical practitioners caring for post-TAVR patients.

Abstract No. 773

To EKOS or not to EKOS: an algorithm for pulmonary embolism thrombolysis success
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PURPOSE: 1. Review the epidemiology and pathophysiology of pulmonary embolism. 2. Recognize imaging findings of pulmonary embolism using a multimodality approach. 3. Differentiate acute pulmonary embolism as massive, submassive, and non-massive. 4. Identify and distinguish pulmonary embolism that may benefit from catheter-directed thrombolysis (EKOS). 5. Identify potential adverse outcomes and initiate appropriate care.

RESULTS: 71-year-old with chest pain and shortness of breath presented to the emergency department. A computed tomography (CT) pulmonary angiogram demonstrated a large saddle embolus with filling defects extending into the lobar branches. Evidence of right heart strain on CT was noted and patient was categorized into the sub-massive group. Under fluoroscopic guidance, contrast angiogram revealed filling defects with diminished flow to the distal pulmonary arteries. An EKOS catheter was then placed and thrombolytic agent was infused at 1 mg per hour. After 15 hours, repeat angiography demonstrated resolution of clot with improved flow in the distal pulmonary arteries.

CONCLUSIONS: Pulmonary embolism (PE) is a major cause of hospital morbidity and mortality. PE can be categorized into massive or sub-massive based on clinical severity. Catheter-directed thrombolysis serves as a novel way decreasing clot burden and decrease adverse events when compared with conventional systemic tissue plasminogen activator. An algorithm for PE thrombolysis is presented which streamlines this process.

Abstract No. 774

Recent experience with acute mesenteric ischemia at an academic center: is there a growing role for endovascular therapies?
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PURPOSE: To review the etiology, clinical presentation, imaging findings, current management guidelines, and our institutional experience with acute mesenteric ischemia.

MATERIALS: Acute mesenteric ischemia (AMI) is a relatively infrequent but potentially deadly disease. Untreated, AMI will cause mesenteric infarction, intestinal necrosis, an overwhelming inflammatory response, and death. AMI can be difficult to diagnose, and early intervention has the ability to halt progression of symptoms. Early diagnosis and prompt treatment are the goals of modern therapy, but there are no randomized controlled trials to guide treatment.

RESULTS: We present four separate case illustrations of patients recently treated at our institution. Using these examples, we highlight the clinical presentation including physical exam and imaging findings as well as laboratory abnormalities that can help clinch the diagnosis of AMI. Discussion will be limited to arterial embolic and thrombotic disease. In all patients presented, endovascular management preceded operative intervention. We will discuss endovascular treatment techniques for AMI as well as indications for and findings of operative intervention. All patients recovered from the initial insult without significant morbidity or mortality and were eventually discharged from the hospital.

CONCLUSIONS: Given the grave outcomes that face many patients with acute mesenteric ischemia, we aim to elucidate factors that can aid in early diagnosis. We will review appropriate management including use of endovascular techniques illustrated through case presentations at our institution.

Abstract No. 775

Interventional radiology’s role in the treatment of pulmonary embolism
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MATERIALS: Pulmonary embolism (PE) remains a common reason for emergency room visits. After a clinical workup, the computed tomography angiogram (CTA) of the chest is the cornerstone of PE diagnosis. The role of PE alert teams is increasing, and the interventional radiologist plays a key role on these teams. These interventional radiologists
have an ever changing arsenal of treatment options to offer the patients with increasingly better outcomes.

**RESULTS:** The following IR treatments for PE will be discussed: 1) catheter-directed mechanical embolectomy, 2) catheter-directed fibrinolytic thrombolysis, 3) catheter-directed saline therapy and 4) ultrasound-enhanced catheter-directed therapy. Each treatment option will be discussed in detail with information about relative/absolute contraindications, advantages/disadvantages, limitations, procedure protocol, mechanism of action, imaging, complications, and outcomes.

**CONCLUSIONS:** The role of interventional radiology in the treatment of pulmonary embolism is in continuous change and advancement. It is important for the clinician, radiologist, and interventional radiologist to clearly understand the basics for each treatment option offered by IR.

**Abstract No. 776**

**Trevo™, Solitaire™, and Penumbra System™: a resident primer on stent retrievers and aspiration devices used in acute ischemic stroke intervention**

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**PURPOSE:** 1) Describe and illustrate the function of the Trevo™ (Stryker Neurovascular, Fremont, CA, USA), Solitaire™ (Medtronic Neurovascular, Irvine, CA, USA), and Penumbra System aspiration device (Penumbra, Alameda, CA, USA) devices for acute ischemic stroke. 2) Review current literature between the three devices. 3) Demonstrate cases where each device was used.

**MATERIALS:** In conjunction with IV TPA, endovascular intervention has recently become the mainstay treatment for acute ischemic stroke. Three endovascular devices are at the forefront of cerebral mechanical thrombectomy: the Trevo stent retriever, the Solitaire stent retriever, and the Penumbra System aspiration device. Recent literature has proved the efficacy of all three devices and changed the landscape of stroke therapy. With endovascular treatment for stroke being utilized at rapidly increasing numbers, in depth knowledge of these three devices is invaluable to the radiology resident interested in neuroradiological procedures.

**RESULTS:** The exhibit will display the unique features of each device including their mechanism of action and special considerations. Cases will be discussed demonstrating the efficacy of each device with pre- and postintervention angiogram images as well as pictures of removed clot burden. The cases will also provide valuable insight on how the devices are manipulated and utilized. Lastly, important conclusions from the SWIFT, TREVO 2, and ADAPT/FAST trials will be summarized.

**CONCLUSIONS:** The Trevo, Solitaire, and Penumbra are pivotal devices in the treatment of acute ischemic stroke. At our institution, we have had great success using stent retrievers in conjunction with aspiration thrombectomy when treating our stroke patients. As stroke intervention continues to grow and evolve, a thorough understanding of how each device is used and their special considerations are paramount to successful outcomes.

**Abstract No. 777**

**Oncolytic virus immunotherapy: future prospects for interventional oncology**

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**PURPOSE:** 1. Discuss the scope of interventional immuno-oncology. 2. Describe the concepts and mechanisms of immunosurveillance and tumor escape. 3. Define an oncovirus, its mechanisms, and current examples of oncoviral therapy. 4. Discuss the future prospects of image-guided delivery of biologic agents, in particular oncoviruses, for oncotherapeutic purposes.

**MATERIALS:** The concept of image-directed, minimally invasive oncolytic therapy has revolutionized the delivery of oncotherapeutics. Concomitantly immunotherapy using biologic agents to affect all three layers of tumor biology: the tumor, the niche, and the immune system has transformed the therapeutics that are delivered. In specific, the use of genetically modified tumor tropic viruses for oncolytic purposes is a promising and emerging therapy.

**RESULTS:** The ability to deliver a therapy tailored to specific cellular targets to the precise locus in which it would have its greatest impact is a profound development in how cancer is treated. Moreover, as early studies have suggested from trials with oncoviruses, this localized therapy may have potential to not only effect cellular changes to targeted cells but also to morph and redefine both the local target cells’ niche as well as impart distant effects on remote cells with a similar molecular profile. Image guidance for localized delivery offers a unique advantage in therapeutic response both in index and possibly metastatic lesions.

**CONCLUSIONS:** It is imperative for the interventional immuno-oncologist to have a strong foundation in the scientific principles underlying immune dysregulation in cancer as well as what oncoviruses are, how they function, and how they are currently delivered. It will be with this understanding that the future of oncolytic viral therapies can be better defined regarding both technical aspects of delivery and neoplastic lesion monitoring and future horizons in immune and cellular level modulation via local delivery of an image-guided microenvironment. The interventionalist is optimally suited and positioned to define and help design the future of image-guided immuno-oncology.

**Abstract No. 778**

**The impact of microbiome on interventional radiology**

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**PURPOSE:** 1. Define microbiome and its relevance to medicine. 2. Describe associations between microbiome and disease. 3. Review how catheters/tubes used in GI interventional radiology can investigate and manipulate the microbiome.
MATERIALS: The microbiome has recently attracted a great deal of attention, due to its expanding association with a host of health and disease processes. Microbiota includes the commensal, mutualistic, and pathogenic microorganisms inhabiting a biological environment. Studies of the microbiome of abscesses, catheter line infections, and the gut can better inform patient care.

RESULTS: Studies of microbiota can reveal pertinent clinical information. In one study, researchers retrospectively examined percutaneous abscess catheter drainages in the management of antibiotic-resistant lung parenchymal abscesses. Causative organisms were detected in 95% of the catheter-derived samples collected during interventional procedure, compared to detection rates of 21% in bronchoscopic cultures and 0% in blood cultures, indicating the specificity of abscess catheter drainage for microbiologic colonization. Studies also indicate that microbiological composition, particularly in the gut, varies vastly between patients and may inform personalized approaches to care in the interventional setting. An understanding of microbiomes may also yield fruitful information about patient outcomes following interventional procedures. In another application, studies of microbiota in central venous catheters have led to the development of novel technologies to prevent catheter-related bloodstream infections, the thirteenth most common cause of death in the United States.

CONCLUSIONS: Studies of microbiomes allow a greater understanding of biological local environments, which can better inform diagnostic and therapeutic care measures in the interventional setting. Such studies may also lead the way to more customized patient care, such as in the analysis of gut microbiota.

Abstract No. 779

Quadrilateral space syndrome: conventional angiographic correlation and confirmation with dynamic positioning

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PURPOSE: Quadrilateral space syndrome (QSS) is an uncommon neuromuscular syndrome encountered by radiologists and interventional radiologists. Upper extremity arteriography plays a vital role in definitive diagnosis of QSS. This exhibit will illustrate the vascular anatomy and angiographic abnormalities associated with QSS. It will also highlight angiographic maneuvers and position utilized to exhibit angiographic findings and establish diagnosis.

MATERIALS: QSS is an uncommon syndrome characterized by compression of axillary nerve and/or posterior circumflex humeral artery (PCHA) as they pass through the quadrilateral space. Patient can present with vascular (vQSS), neurogenic symptoms (nQSS) or a combination of both. Examination and electrophysiologic studies are usually normal and used to exclude alternate diagnoses. With severe symptoms, MRI of the shoulder can demonstrate teres minor (TM) and/or deltoid atrophy. CT or MR angiography can also be performed for additional information, however; definitive diagnosis is made with an upper extremity arteriogram obtained with maneuvers involving abduction and external rotation of the arm (AER). We present a case of nQSS alone that demonstrated atrophy of the TM with near complete occlusion of the PCHA with AER maneuver.

RESULTS: 43-year-old male presented with longstanding left shoulder pain and TM atrophy by MRI. EMG performed was normal. After maximal sterile preparation, right femoral artery access, passage through the aorta and left subclavian artery selective catheterization, angiographic images were acquired in 0-degree, 90-degree, and 180-degree AER. Subclavian, axillary artery and PCHA was widely patent with 0- and 90-degree abduction and PCHA was fully occluded with 180 degree AER, compatible with QSS.

CONCLUSIONS: QSS is an uncommon and challenging diagnosis. Angiography exquisitely exhibits characteristic findings to reach diagnosis if performed with appropriate positioning and maneuvers. An interventional radiologist should be cognizant of the clinical symptoms, angiographic abnormalities and appropriate maneuvers required. Moreover, thrombolysis or embolectomy can be planned/performed for cases with vascular QSS if acute thrombosis is encountered.

Transradial approach to dialysis access intervention

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PURPOSE: 1) patient assessment and case selection specific to transradial (TR) access in arterio-venous fistula (AVF) intervention 2) required equipment and devices 3) benefits of TR approach in AVF intervention 4) limitations of TR approach in AVF intervention 5) Complications specific to AVF in TR intervention

MATERIALS: Transradial access is an alternative to conventional venous access for AVF intervention. The purpose of this exhibit is to illustrate the various aspect of TR approach in dialysis intervention and familiarize the readers to the utility and limitations.

RESULTS: The TR approach differs from conventional transvenous (TV) access in that it allows treatment of all lesions (arterial) and venous (juxta-anastomotic and outflow) lesions in a single retrograde direction. As the access site is outside of the dialysis circuit, imaging is facilitated without the need for catheter/wire crossing of the fistula as in conventional TV access. Additionally, as the vascular sheath is outside of the circuit, flow occlusion by the sheath is avoided, which makes it ideal for long occlusions/stenosis and in case of non-maturing fistulas. Prior to TR access, assessment for suitability include US assessment of radial artery size to guide sheath size insertion (>2 mm) and occlusion is needed. History of prior wrist AVF or radial ligation is also important. Dedicated 6F hydrophilic radial sheaths is the typical working sheath in that it allows treatment of all lesions (arterial) and venous (juxta-anastomotic and outflow) lesions in a single retrograde direction. As the access site is outside of the dialysis circuit, imaging is facilitated without the need for catheter/wire crossing of the fistula as in conventional TV access. Additionally, as the vascular sheath is outside of the circuit, flow occlusion by the sheath is avoided, which makes it ideal for long occlusions/stenosis and in case of non-maturing fistulas. Prior to TR access, assessment for suitability include US assessment of radial artery size to guide sheath size insertion (>2 mm) and occlusion is needed. History of prior wrist AVF or radial ligation is also important. Dedicated 6F hydrophilic radial sheaths is the typical working sheath which allows for most low profile “AVF size” balloons to be used. Direct sheath injection allows imaging of the venous part of the circuit all the way into the central veins due to the flow dynamics. False positive includes “Inflow” artifacts at the anastomotic site due to inflow of unopacified blood from the artery into the fistula needs to be recognized and confirmed with sonography if needed. Limitation of the TR approach is mainly imposed by the sheath size (maximum 7F sheath)
which precludes the use of covered stents in ruptures, treatment of central venous lesions requiring larger size balloons.

**CONCLUSIONS:** TR approach is an attractive alternative approach to dialysis access intervention.

### Abstract No. 781

**Percutaneous arteriovenous fistula creation for hemodialysis**

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**PURPOSE:** 1. Familiarize clinicians with the novel technique of percutaneous endovascular AV fistula creation. 2. Discuss the available percutaneous AV fistula systems available.

**MATERIALS:** Traditionally, surgically created autogenous AV fistulas have been the gold standard vascular access for hemodialysis. However, the long maturation times, patency rates, and patient dissatisfaction with the procedure are issues. A minimally invasive procedure utilizing an endovascular percutaneous approach to AVF creation has been introduced to solve these issues. Surgically created AV fistulas have a primary patency rate of 20-40%, maturation times of 4 to 9 months and thrombosis rates of 17-25%. Percutaneous AV fistulas (pAVF) have been shown to have a 6-month patency rate of 96%, average maturation rates of 2 months, have 6 times less reintervention rate, and an overall low procedural complication rates. Currently, there are two percutaneous endovascular AV fistula systems on the market, everlinQ (TM) by TVA Medical and Ellipsys® by Avenu Medical.

**RESULTS:** Both systems utilize thermal energy to cut and create an anastomosis between the artery and vein with everlinQ: The ulnar vein and artery are accessed using 21-gauge needles and a microwire is used to advance the pAVF catheters into each vein and artery. Once at the level of the ulnar artery and vein, the magnets on the pAVF catheters are rotated until they are in alignment with each other and attract. An RF cutting current is applied for 1 second. The catheters are removed and an arteriogram is performed to demonstrate the anastomosis. Ellipsys: Under US guidance, a micropuncture needle is advanced into the brachial or cubital vein and then advanced to the level of a perforating vein and the radial vein. The needle is then advanced into the radial artery. A microwire is introduced into the artery and the pAVF catheter is advanced over it so the tip of the catheter is in the radial artery and base in the perforating vein. The catheter is closed so the artery and vein walls are pressed together. Pressure and thermal energy are applied until an anastomosis is made.

**CONCLUSIONS:** pAVF is a novel technique that aims to reduce the issues associated with surgical AVFs.

### Abstract No. 782

**Transhepatic hemodialysis access: the end of the line**

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**PURPOSE:** 1. Compare the advantages and disadvantages of different hemodialysis access site options. 2. Identify the indications and contraindications for transhepatic hemodialysis access. 3. Evaluate hepatic venous anatomy using preprocedure, non-invasive diagnostic imaging modalities. 4. Describe the procedural steps of transhepatic hemodialysis catheter placement. 5. Recognize complications related to transhepatic hemodialysis catheter placement.

**MATERIALS:** Tunneled hemodialysis catheters are a life-saving procedure for patients requiring temporary venous access as well as those who cannot receive arteriovenous fistulas or grafts. Since arteriovenous fistulas and grafts are preferred for long-term access, it is often preferable to avoid more easily accessible sites such as the subclavian veins in order to preserve these veins for future fistula or graft placement. If a patient has exhausted these more conventional access sites, the hepatic vein can be an important secondary option for hemodialysis access.

**RESULTS:** 1. Indications and contraindications: Choosing an access site and consideration of future fistula or graft placement. 2. Pre-procedure imaging and site selection: Evaluation of hepatic anatomy, existing hepatic parenchymal disease, and propensity for venous thrombosis. 3. Hepatic vein access: Image-guided access options and procedural steps. 4. Catheter site and sizing: Access site selection and catheter sizing. 5. Complications: Management of access site bleeding, venous thrombosis, catheter migration, bile leak, subcapsular hematoma.

**CONCLUSIONS:** 1. Preservation of hemodialysis access, whether for future fistula placement or to extend the longevity of native veins, is of utmost importance and the interventional radiologist should be intimately involved in management. 2. The transhepatic approach is a viable and safe route for hemodialysis catheter access. 3. Placement of a large-bore catheter in a hepatic vein has its own unique set of complications which are important to recognize.

### Abstract No. 783

**Ultrasound-assisted angioplasty for failing arteriovenous fistula**

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**PURPOSE:** Ultrasound assisted angioplasty for failing arteriovenous fistula (AVF) significantly reduces the radiation exposure to patient as well as operator. It decreases the amount of iodinated contact medium and fluid overload in these patients. This technique is durable and reliable; hence should be used more frequently and effectively.

**MATERIALS:** AVF acts as a life-line for most of the renal failure patients on hemodialysis. AVF salvage procedures include angioplasty with or without stenting of stenosis or obstruction involving the circuit. These
Parallax in radiology: a primer for radiology trainees

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PURPOSE: The purpose of this exhibit is: 1. To review the origin of parallax error in medical imaging. 2. To discuss the utility of parallax in localizing disease and therapeutic devices. 3. Teach trainees the principles and practical applications of parallax and how to localize an object in the angiography suite.

MATERIALS: Parallax effect is displacement or difference in the apparent position of an object viewed along two different lines of sight and is measured by the angle or semi-angle of inclination between those two lines. Using parallax allows the primary operator to localize objects under fluoroscopy. Applications include TIPS, CTO re-entry, PTC insertions, among others (Detailed images and applications to be included in poster).

RESULTS: Residents new to IR should follow these basic steps: 1. Keep your eye focused on the needle tip. 2. Keep it simple - always move image intensifier in the same direction (i.e., toward the head). 3. Remember the rules for needle position relative to target and its change in position relative to intensifier movement: Anterior = Anti-parallel (Away) Posterior = Parallel (Same)

CONCLUSIONS: An understanding of the parallax effect can aid Radiology residents when performing interventional procedures. Use of our technique enables localization of the needle tip relative to the object of interest, allowing easier access to vessels, abscesses and organs.

Abstract No. 784

Parallax in radiology: a primer for radiology trainees

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PURPOSE: The purpose of this exhibit is: 1. To review the origin of parallax error in medical imaging. 2. To discuss the utility of parallax in localizing disease and therapeutic devices. 3. Teach trainees the principles and practical applications of parallax and how to localize an object in the angiography suite.

MATERIALS: Parallax effect is displacement or difference in the apparent position of an object viewed along two different lines of sight and is measured by the angle or semi-angle of inclination between those two lines. Using parallax allows the primary operator to localize objects under fluoroscopy. Applications include TIPS, CTO re-entry, PTC insertions, among others (Detailed images and applications to be included in poster).

RESULTS: Residents new to IR should follow these basic steps: 1. Keep your eye focused on the needle tip. 2. Keep it simple - always move image intensifier in the same direction (i.e., toward the head). 3. Remember the rules for needle position relative to target and its change in position relative to intensifier movement: Anterior = Anti-parallel (Away) Posterior = Parallel (Same)

CONCLUSIONS: An understanding of the parallax effect can aid Radiology residents when performing interventional procedures. Use of our technique enables localization of the needle tip relative to the object of interest, allowing easier access to vessels, abscesses and organs.

Abstract No. 785

Malignant pleural effusions

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PURPOSE: 1. Provide a decision-making algorithm for malignant pleural effusions, including options of thoracentesis, tunneled pleural catheters, and pleurodesis. 2. Learn the appropriateness of tunneled pleural catheters, including indications, patient selection, and alternatives. 3. Discuss the risks versus benefits related to tunneled pleural catheter placement, including a review of important clinical trials. 4. Review the management of tunneled pleural catheter malfunction and complications.

MATERIALS: Malignant pleural effusions are an indicator of an end stage process. These effusions can be symptomatic and burdensome for patients. Interventional radiology can help in these patients by placing tunneled pleural catheters in selected patient populations. Therefore, it is important to have knowledge about the disease process of malignant pleural effusion, the different options for effusion, and the management of tunneled pleural catheter and associated complications.

RESULTS: Tunneled pleural catheters are a palliative option in end stage cancer patients with symptomatic malignant effusions. An interventional radiologist must have a complete understanding of the disease process. It is also important to learn about the available treatment options for management of malignant pleural effusion including thoracentesis, tunneled pleural catheter, and pleurodesis as well as indications and risks and benefits associated with each treatment option. This exhibit will review treatment options and indications for malignant pleural effusion, review important literature, and establish a decision-making algorithm for management of malignant effusions.

CONCLUSIONS: Interventional radiologists are often involved in end of life care. One of the interventions available include tunneled pleural catheters, which can improve the quality of life in patients suffering from recurrent, symptomatic malignant effusions. Therefore, it is important to understand the multidisciplinary approach to this disease to provide the most appropriate treatment option for the patient.
Abstract No. 786

Development and implementation of a third-year medical school subsurgical selective in interventional radiology: a single-institutional experience in a tertiary academic medical center

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PURPOSE: To devise an integrated sub-surgical selective program customized to introduce third-year medical students to the specialty of interventional radiology (IR). After participating in this module, the participant should be able to: 1) Describe the benefits of incorporating an IR surgical sub-selective into the medical school curriculum, 2) Design and implement a comprehensive curriculum for a third-year medical school subselective in IR, 3) Create a structured environment to introduce medical students to the clinical and procedural facets of IR.

MATERIALS: The recent evolution of IR into a distinct specialty with an independent residency training program has encouraged a national paradigm shift to expose medical students to the field earlier in their clinical education. One effective method of ensuring early exposure is to provide medical students the opportunity to rotate through interventional radiology by way of a structured surgical subselective in the third year, with the option of a focused sub-internship in the fourth year. In addition to the educational benefits to the students, such a rotation gives academic hospitals a platform to recruit exceptional candidates to the field of IR.


CONCLUSIONS: The creation and implementation of a third-year medical school surgical sub-selective in IR has the flexibility to suit any academic hospital training environment. Knowledge of common IR procedures is information that will prove invaluable in any specialty a student ultimately chooses as a career. The rotation itself additionally serves as a powerful recruiting tool for future generations of interventional radiologists.

Abstract No. 787

A new recruiting paradigm: master interventional radiologists seek to engage the medical student apprentice while training and recruiting the diagnostic radiology journeyman

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PURPOSE: Recognize factors medical students (MS) consider while selecting their future specialty. Identify processes that use these factors to attract MS to interventional radiology (IR). Implement educational experiences that capitalize on these factors

MATERIALS: Research indicates that familiarity with a specialty early in medical school increases the likelihood a student will choose it as their future career. In 2012, IR was recognized as a specialty, necessitating new recruiting and training paradigms. IR has three new training pathways, the Integrated IR Residency, the Independent IR Residency, and Early Specialization in Interventional Radiology (ESIR), which now require the Master IR to recruit the Medical Student Apprentice as well as the Journeyman Diagnostic Radiology (DR) resident to our profession. Factors considered by MS when choosing a specialty include early exposure, specialty-specific mentors and positive training experiences. This presentation shares a new recruitment paradigm utilized to introduce MS to IR early in their education and capitalize on factors MS use to select their future specialty.

RESULTS: Traditionally, MS are exposed to IR via clinical or DR rotations. With new IR residencies, recruiting must now include MS. Initial efforts required establishing an identity distinct, but not separate from DR. An IR Medical Student Interest Group and IR-focused electives were created, followed by out-reach efforts to foster mentorship and research opportunities early in MS education. Future directions include creating an IR acting internship and private practice experiences to provide well-rounded experiences that are available throughout medical school.

CONCLUSIONS: Most MS will have some experience with their future specialty choice by the end of the second year. In contrast, the majority of MS do not learn about IR until the third or fourth year. By refining existing educational and outreach offerings and creating new ones, we have introduced IR to MS early in their educational and career decision-making process. Providing opportunities throughout medical school for mentorship, research and positive educational experiences can encourage the pursuit of IR as a career.

Abstract No. 788

A program director’s guide to increasing recruitment of medical students to interventional radiology

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PURPOSE: To identify actionable strategies for residency program leaders to adopt and implement with the goal of increasing exposure and ultimately recruitment of informed medical students to interventional radiology.

MATERIALS: IR is gaining in popularity as evidenced by the increasing number of medical school applicants applying directly to integrated IR residency programs. Despite this, most medical students have limited exposure to IR. What are program directors doing to stimulate interest
in IR among medical students? Further, how are program directors increasing the profile of IR, recruiting the best possible talent? A questionnaire was designed to identify strategies that program directors of IR programs use to engage medical students. The questionnaire was administered online, and answers were collated through the Society of Interventional Radiology Resident Fellow Student Section, IR Residency Training Committee.

**RESULTS:** Several program directors responded to our pilot survey (responses are still being collected at the time of this writing with an expected nationwide roll out to follow shortly). Few offered a department website that provided information for interested medical students; a minority had a formal mentoring program for medical students where faculty served as mentors; only one had social media outreach initiatives. Most offered opportunities for first- or second-year medical students to shadow faculty and all had planned informal opportunities for medical students to meet faculty. Regarding education, few had a formal didactic curriculum for preclinical medical students on the topic of IR yet most had a dedicated IR interest group. A minority had a strategy to ensure sub-internship positions were filled with competitive outside applicants. Importantly, respondents were interested in hearing the results of the survey.

**CONCLUSIONS:** IR departments are actively employing strategies to recruit and inspire medical students to varying degrees. A high-level of interest expressed by program directors in learning of the results of the survey indicate an opportunity for incorporating successful strategies across programs, ensuring that IR continues to attract high-caliber medical students.

**Abstract No. 789**

**Y90 checklist for radiation safety in hepatic chemoembolization**

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**MATERIALS:**

**PURPOSE:** The purpose of the article is to highlight the radiation safety issues encountered in hepatic chemoembolization with Y90. The knowledge of these helps the interventional radiology staff and the radiologist in guarding against the unwarranted radiation exposure.

**RESULTS:** Transarterial chemoembolization for hepatocellular carcinoma or hepatic metastasis has been increasingly performed at various institutions these days. The procedure involves selectively cannulating the branches of hepatic artery with microcatheter and then administering radioactive microspheres through a catheter with the purpose of delivering high-dose beta radiation to tumor while minimizing the exposure to normal liver parenchyma. Following should be kept in mind — proper signage on the door, ALARA principles of time, distance and shielding, securing the Y90 dose, spill kit, GM counter, pretreatment survey of the vial and pretreatment survey of the patient, proper knowledge and setup of the administration kit, wearing lead thyroid shield, vest and skirt, radiation safety eyewear, acrylic sheets, post treatment survey of all staff as they leave the room, proper disposal of the linens, trash and survey of floor and fluoroscopic equipment. The catheters, gloves, syringes, towels, dose vial and other instruments used should be disposed in labeled waste container. General principles reducing the radiation exposure and improve image should be followed like optimization of the procedures, reducing dose—as low as reasonably achievable, antiscatter grids, minimize fluoroscopic time and images, collimation etc. No precautions are required if surgery is planned more than 34 days post Y90 treatment. The patient has to observe radiation precautions for 5days.

**CONCLUSIONS:** Knowledge of radiation safety issues during Y90 chemoembolization along with general radiation safety measures helps in reducing the radiation dose to patient and radiology staff.
CONCLUSIONS: Following the implementation of our program, there was an increase in verbal communication and feedback between nurses, technologists, and trainees during procedures. Improved coordination between trainees and technologists has resulted in more rapid and smoother image acquisition during procedures. We see benefits from our integrated simulation and believe this can be replicated across multiple sites and multiple healthcare fields.

Abstract No. 791

Entrepreneurship in interventional radiology: from bedside to bench to start-up

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PURPOSE: Entrepreneurship in IR is the cornerstone for the development of new devices and techniques. Often, lack of funding support is the limiting step precluding progress in IR entrepreneurship. We present key steps in the path to entrepreneurship and draw examples from Biodesign and i-Lab resources. 1. Define the opportunity and learn how to evaluate the unmet need and its market value. 2. Establishing the team; becoming incorporated and the need for legal assistance. 3. How to define market risks, challenges and competition. 4. How to devise a plan to clinical trials; we will debug the notoriously challenging FDA regulatory pathway—should you file a presubmission application? 5. Understand what works/fails via analysis of successful start-ups. Exiting start-ups

MATERIALS: Miniaturized devices, catheters and new imaging advances have put interventional radiology (IR) at the forefront for solving clinical problems. However, finding important needs unmet by current technology is only the initial step in a long path to entrepreneurship. Physicians today lack the training to translate an idea into a marketable product, leaving interventional radiologists unable to use their novel ideas to help patients.

RESULTS: N/A

CONCLUSIONS: IR is at the forefront of minimally invasive therapeutics across all organ systems—from drug delivery to vascular disease treatment. Bridging the gap between flexible technology and unmet clinical needs is a critical role that IR operators should play. This role will require a deeper understanding from clinicians about how to use technological advances and navigate business. However, collaboration with technology and entrepreneurship experts greatly helps physicians become entrepreneurs. Thus, academic centers have formed “biodesign” institutes, incubators where engineers, artists, clinicians, and investors combine their expertise to deliver new products to the bedside: these models demonstrate that collaboration, systematic protocols, and formal training can make entrepreneurship desirable, achievable, and impactful in IR. We will review in-depth the concept of biodesign institutes.

Abstract No. 792

International aid through interventional radiology: an experience in Lagos

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PURPOSE: This educational exhibit will detail our two-year experience regarding our partnership with Lagos University Teaching Hospital (LUTH) in Lagos, Nigeria. Our experience has allowed radiologists and radiologists in training to offer less invasive, more affordable procedures to their patients, in a hospital setting with limited resources. We hope that our project can serve as a template for other IR physicians to take upon IR-lead medical missions to developing nations, in an effort to spread IR skills and knowledge throughout the world.

MATERIALS: Developing nations throughout the world oftentimes suffer from a lack of resources making it difficult for nations to provide sufficient care to suffering patients. High costs for invasive surgeries including anesthesia costs make it difficult if not impossible for patients to afford the care they need. IR physicians in developed nations continue to develop innovative, less invasive, oftentimes more affordable techniques in treating a variety of diseases. It is incumbent upon IR physicians in developed nations to not only continue sharpening their techniques at home, but also to aid in spreading this knowledge to healthcare professionals internationally.

RESULTS: We embarked on two consecutive annual trips to Lagos, Nigeria to work with physicians and trainees at the Lagos University Teaching Hospital, in Lagos, Nigeria. We created a week-long educational curriculum for both trips. The mornings consisted of didactic lectures, and the afternoons were reserved for practical skills, which included ultrasound scanning, practicing IR skills on vascular and breast phantoms, and guiding them through ultrasound and CT-guided procedures on selected patients, including the first ever CT-guided biopsy performed at the hospital.

CONCLUSIONS: IR-lead aid missions will allow medical professionals to offer less invasive, more affordable care. Such efforts will not only serve the principal goal of philanthropy but will also help strengthen IR as a distinct subspecialty worldwide. We believe we have a reproducible template that can be used to introduce basic percutaneous image-guided procedures to trainees and physicians in low resource settings around the world.

Abstract No. 793

Improving medical student education in interventional radiology at your institution

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PURPOSE: To describe the many ways that interventional radiology can be integrated into the medical school curriculum.
MATERIALS: Because of the shift from IR fellowship to an IR residency, it is imperative that medical students gain exposure to our specialty. In most medical schools, the curriculum is packed, making it difficult to incorporate additional material. A strong IR curriculum with multiple opportunities for exposure will benefit students who might otherwise not learn about IR. It will also benefit the field of IR by widening the applicant pool, attracting more bright and motivated minds.

RESULTS: We have implemented IR exposure on a variety of fronts at all levels of training. We will describe the various opportunities made available to students at our institutions and discuss successes and shortcomings. Items discussed will include but not be limited to: 1. Integration into the preclinical coursework via case-based clinical presentations and anatomy coursework. 2. Integration into early clinical experiences with outpatient clinic exposure and a second-year IR elective. 3. Integration into the clinical curriculum with lectures, hands-on teaching, and electives during the third-year surgery clerkship, and fourth-year general IR and pediatric IR clerkships. 4. Sponsoring a student-led IR interest group, and supporting it by offering educational lectures, clinical shadowing experiences, group meetings, and hosting local or regional IR symposia. 5. Providing trainees with support for scientific endeavors. 6. Providing information about national resources for trainees. Survey data from 140 medical students across the country will be incorporated, identifying which components students feel are most important. Strategies for convincing medical school leadership to allow your participation in their curriculum will be discussed, focusing on the benefits that you can provide to the students.

CONCLUSIONS: Because of the new IR residency, medical student exposure will be crucial to the ongoing success of interventional radiology. There are opportunities for interaction at every level of training, and with the right strategy, interventional radiology can easily be integrated into undergraduate medical education.

Abstract No. 794

Contrast-enhanced ultrasound LI-RADS and its application to interventional radiology

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PURPOSE: After reviewing this educational exhibit, the reader should have a basic understanding of the following topics: • Fundamentals and rationale of contrast-enhanced ultrasound (CEUS) • CEUS Liver Imaging and Reporting Data System (LI-RADS) • Key imaging characteristics of both benign and malignant hepatic lesions • How CEUS can be implemented in various interventional therapies

MATERIALS: CEUS is a relatively new imaging modality within the United States but has been evaluated in numerous studies throughout Asia and Europe where it has been in practice for roughly 15 years. CEUS relies on the use of intravascular microbubbles as a contrast agent to identify and differentiate focal liver lesions. The benefits of CEUS are numerous and include real-time evaluation of arterial phase enhancement and washout, improved ability to identify lesions <2 cm over CT or MRI, and the benefit of being able to be used in patients with renal failure as the contrast agent is not excreted by the renal system. CEUS is now being utilized by the IR field to help guide treatment of lesions which may be difficult to detect under other traditional imaging techniques such as non-contrast US or CT. The American Board of Radiology (ABR) has also recently approved a LI-RADS classification system for CEUS to aid in accurately differentiate between benign and malignant focal liver lesions.

RESULTS: A brief overview of CEUS technique and protocol will be discussed. A graphical representation of the CEUS LI-RADS system will then be presented. A pictorial essay will follow demonstrating multiple benign and malignant focal liver lesions. The presentation will conclude with a case-based discussion of various CEUS-guided interventional therapies.

CONCLUSIONS: CEUS allows for the real time detection of benign and malignant focal liver lesions and can be used to guide interventional therapies. The recent FDA approval of CEUS as well as the ABR development and implementation of the CEUS LI-RADS demonstrate the value and benefit of this new imaging modality. A comprehensive understanding of this technology is a new weapon in the arsenal of interventional radiologists.

Abstract No. 795

Cost effective hands-on procedural training

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PURPOSE: We present a homemade phantom for US and US-guided procedure training. Our technique is based on the gelatin based phantom recipe; however, several modifications are added to improve the quality and the lifespan. The training with this phantom will improve the experience of hands-on training for medical students, residents and fellows.

MATERIALS: Hands-on ultrasound (US) training has been incorporated in the formal curricula of the most medical schools. Early exposure to standardized qualified training will allow trainees to be more experienced while working with patients. Commercial US phantoms are widely available, however, cost $400-600 for each. This led to creation of many low-cost ultrasound phantoms for US-guided vascular access or biopsy training. Gelatin models are commonly used; however, they have a tendency to rapidly melt, leak, and fall apart, so they cannot be used multiple times.

RESULTS: Construction Process: Start with slowly mixing 12% gelatin with 88% warming water in the pot on a slow fire for 15 minutes. 2. Refrigerate the mixture for 1 hr/2lb to make a rubber firm material. 3. Re-warm on a slow fire again until the consistency is homogenous clear liquid again. 4. The next step is to color the liquid gelatin. 1 cc/lb glycerin was used to prevent the dehydration and deformation of the phantom at room temperature. 1 cc/10 lb propionic acid was used with caution to prevent from molding and organic degeneration. We used 3/4 and 1/4 inch Penrose
drains filled with colored liquid and tied at both ends to simulate the vessels. A piece of a plastic was used to simulate a foreign body. 5. We repetitively layered and refrigerated the liquid gelatin in a pan containing the vessels and the foreign bodies so they won’t stay superficially based on relative density to liquid gelatin. 6. After the layering process refrigerate the entire pan for 12-15 hours to make a ballistic gel.

**CONCLUSIONS:** In our case the gross cost of the phantom was $10-12. The model is inexpensive, able to stay in room temperature, and has sonographic features similar to human tissue. We modified the traditional phantoms by adding propionic acid, glycerin, color and used rubber drains to simulate vascular structures.

**Abstract No. 796**

**PERT 101: establishing the role of the interventional radiologist in a newly implemented pulmonary embolism response team**

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**PURPOSE:** This educational exhibit will describe the role of the multidisciplinary pulmonary embolism response team (PERT) in the management of pulmonary embolism (PE). The exhibit will describe how to establish a PERT in both an academic and community setting. The unique role of the interventional radiologist within the collaborative decision-making process will be highlighted with a detailed review of current literature used to guide therapy in management of massive and submassive PE.

**MATERIALS:** PE is the third most common cause of cardiovascular death, and the single most common cause of preventable in-hospital death in the United States. The treatment of massive and submassive PE requires complex decision making and rapid mobilization of resources. Different society guidelines vary in definition of submassive and massive PE which creates confusion amongst treating physicians seeking generalized treatment guidelines. Based on preexisting rapid response team models, the PERT model allows for a standardized process. The interventional radiologist must be familiar with the PERT model and be knowledgeable of the multitude of treatment options available, including systemic thrombolysis, catheter-directed therapy, and surgical embolectomy.

**RESULTS:** An in-depth understanding of the multidisciplinary approach in management of massive and submassive PE is vital for the interventional radiologist to deliver effective therapy and foster collaboration. Training in diagnostic radiology allows the interventional radiologist to aid in diagnosis of more subtle imaging findings that can guide therapy. A robust knowledge in the most up-to-date literature allows the interventional radiologist to tailor therapy to each patient. Participation in national committees, such as the PERT consortium, keeps the practitioner at the forefront of new therapies and research.

**CONCLUSIONS:** With a thorough understanding of the multidisciplinary approach in the management of massive and submassive PE, the interventional radiologist is able to lead effective utilization of a PERT, provide therapy utilizing accepted treatment guidelines and management strategies, participate in longitudinal follow-up of patients, and contribute to research.

**Abstract No. 797**

**Do we need more residency spots for the integrated interventional radiology pathway?**

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**PURPOSE:** 1) To examine the results of the 2017 ACGME match for the integrated interventional radiology residency 2) To summarize expectations for the 2018 match and the impact of utilizing efforts from the Resident, Fellow Student section of SIR to develop interest in the IR pathway at the medical student level 3) To discuss the need to increase interventional radiology positions to meet the demand of medical students to pursue IR as a specialty directly.

**MATERIALS:** The National Resident Matching Program (NRMP) is a private, non-profit organization established in 1952 that provides a mechanism for matching the preferences of applicants for U.S. residency positions with the preferences of residency program directors. After every match, data from the NRMP is released demonstrating in detail the preferences and outcomes for senior medical students across various institutions. Data from the 2016 and 2017 NRMP report was analyzed to demonstrate the increase in applicants and interest in the integrated interventional pathway.

**RESULTS:** The 2017 NRMP postmatch data shows 563 applicants applying for 124 IR positions. 2016 data shows 183 applicants applying for 14 IR positions. 2017 ACGME match demonstrates a two-fold increase in the number of applicants applying for the direct integrated radiology pathway from the prior year. If the current trend continues, 2018 can expect a significant increase in the number of applicants applying for integrated IR positions.

**CONCLUSIONS:** Increasing the number of integrated interventional radiology positions for the upcoming 2018 match cycle is important to meet the demand of senior medical students. Overall, in 2016 only 7.65% of senior medical students who were interested in matching into a direct IR pathway were accepted compared to 22.02% in 2017. The data demonstrated above makes the case for increasing interventional radiology positions in order to provide opportunity to those medical students who have an early interest in IR. This poster will further evaluate the growing awareness of IR as a specialty and the demographics of who are applying for the integrated IR positions.

**Abstract No. 798**

**Computed tomography–guided renal hilar block: how and why we do it**

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**Purpose:** 1. To understand how to perform a renal hilar block. 2. To review possible indications for renal hilar block.

**Materials:** Nerve blocks are utilized in many areas of pain management both in diagnosis and treatment. Commonly performed nerve blocks include selective spinal nerve blocks and celiac blocks. The sympathetic plexus of the kidney runs along the renal artery. A diagnostic and therapeutic block can be administered by targeted placement of local anesthetics along the renal artery. There are a few conditions where this may be useful, specifically in flank loin pain hematuria syndrome (LPHS). LPHS presents with severe flank pain and hematuria. Autotransplant is a long-term treatment option, however, predictive models to predict success are needed. The renal hilar block has been described as a diagnostic tool in these patients.

**Results:** Renal hilar block is a relatively simple procedure for the interventional radiologist. Our group uses computed tomography to guide needle placement, given the high resolution and ability to predictably identify the renal artery. The patient is positioned prone for the diagnostic approach. A 21 G or 22 G needle is placed along the artery. Aspiration prior to local anesthetic is performed to confirm needle tip is not within the artery. We administer a mixture of Lidocaine and Bupivacaine with a total volume of 20 mL. One application is in flank loin pain hematuria syndrome. Pre- and postprocedure pain are reported by the patient on a 1-10 scale. Our institution will perform autotransplant for patients with a 50% reduction in pain after hilar block. Another application of the block is in renal ablation. The block can decrease postprocedure narcotic utilization. The effected side can be blocked by CT guidance during the renal ablation procedure.

**Conclusions:** Renal hilar block is a procedure that interventional radiologists can easily perform with CT guidance. Utilizing the block in renal ablation may improve patient postoperative pain. The block can be offered to urologists performing auto-transplant for LPHS as a diagnostic test.

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**Abstract No. 799**

Importance of effective communication in interventional radiology

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**Purpose:** Patient outcomes depend on successful communication. We aim to identify barriers to effective communication with patients and staff and review fundamentals of effective patient and team communication. We aim to draw key insights from patient partnership model and RESPECT model to help improve patient care.

**Materials:** Physicians’ ability to effectively and compassionately communicate information is key to a successful patient-physician relationship. ACGME identified interpersonal and communication skills as one of six areas in which physicians-in-training need to demonstrate competence.

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**Abstract No. 800**

Patient preparation and intraprocedural care: what every trainee needs to know

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**Purpose:** 1) To review the essential steps for patient preparation on the day of the procedure. 2) To review measures for prevention of surgical site infections. 3) To list patient monitoring equipment and guidelines and discuss interpretation of various physiologic and pathologic changes. 4) To discuss techniques for securing percutaneous catheters and wound care.

**Materials:** A structured approach to patient preparation on the day of the procedure and intraprocedural care facilitates efficient management with an emphasis on quality and safety. To ensure successful outcome and optimal patient care in the interventional radiology suite, it is essential to follow proper guidelines for prevention of surgical site infection and be familiar with patient monitoring equipment and interpretation of different physiologic and pathologic responses. Additionally, many procedures require drainage and vascular catheters to be left in place, and the securement of these catheters is crucial to avoid catheter dislodgment and associated complications. Familiarity with wound closure and care techniques, and suture materials used by interventional radiologists is also essential.

**Results:** The current health care environment demands increasing clinical productivity and affords less time with each patient, which can impede effective patient-physician communication. The use of patient-centered interviewing, caring communication skills, and shared decision making improves patient-physician communication.

**Conclusions:** Patients’ perceptions of the quality of the healthcare they received are highly dependent on the quality of their interactions with their healthcare clinician and team. There is a wealth of research data that supports the benefits of effective communication and health outcomes for patients and healthcare teams. The connection that a patient feels with his or her clinician can ultimately improve their health mediated through participation in their care, adherence to treatment, and patient self-management.
physiologic responses; Interpretation of pathologic responses) • Suture material • Percutaneous catheter securement techniques • Wound closure and care techniques

CONCLUSIONS: Every successful invasive procedure begins with a meticulous patient evaluation and formulation of a procedural plan. Careful patient assessment and preparation on the day of the procedure and understanding of techniques for prevention of surgical site infections, wound closure and catheter securement are essential in avoiding complications. This exhibit provides a comprehensive review of patient preparation and care on the day of the procedure; tips and tricks that every interventional radiology trainee needs to know.

Abstract No. 801

The interventional radiology suite: what every trainee needs to know: basic instruments of intervention and image guidance techniques

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PURPOSE: 1) To review the basic instruments required for every interventional radiology case. 2) To provide tips and tricks in organizing the procedural tray. 3) To review principles of using different imaging modalities for procedural guidance. 4) To discuss strategies for optimizing fluoroscopic image quality while ensuring proper radiation protection. 5) To review principles of catheter use.

MATERIALS: Becoming a successful interventional radiologist requires years of training and experience to master the skills required to perform different minimally invasive procedures. Familiarity with different instruments and understanding of the basics of imaging guidance techniques is essential. These techniques are expected to be learned during training and early career. However, there are no structured references in the literature and interventional radiologists are left to “pick it up as they go.”

RESULTS: • Introduction • Interventional tray (Basic instruments for intervention and organizing the interventional tray) • Ultrasound guidance techniques (Ultrasound set up and needle guidance with ultrasound) • Fluoroscopic guidance techniques (General information; Combining oblique views to localize the target; Determination of catheter tip direction; Fluoroscopy image quality and radiation exposure) • CT Guidance techniques (Use of CT gantry light / laser for needle guidance; Use of CT gantry angulation; Use of CT fluoroscopy) • MR guidance techniques

CONCLUSIONS: The basic principles of every interventional radiology procedure including instruments for intervention and their manipulation as well as image guidance techniques are nearly universal, and an understanding of these fundamental concepts and techniques is essential to successful interventional practice. This educational exhibit provides an easy reference to the basic components and techniques required for successful interventional procedures. Once a solid understanding of these basic principles is achieved, trainees can continue to learn the technical aspects of each interventional radiology procedure.

Abstract No. 802

Experience in Eldoret, Kenya, as a model for expanding interventional radiology to resource-limited regions

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PURPOSE: To educate the learner about the limitations and capabilities of interventional radiology practices in suburban African community settings similar to Eldoret, Kenya. To propose solutions for overcoming similar limitations in other international locations interested in initiating interventional radiology services.

MATERIALS: Although IR services have useful applications in resource-limited environments, many limitations, including access to expensive imaging equipment and supplies, have precluded these services from being offered in many regions. Two radiologists have started a burgeoning IR practice in Eldoret, Kenya, with a growing demand for their services. Creative methods for performing image-guided procedures have been devised using the resources available in this small city, which could be applied in other resource-limited settings.

RESULTS: The radiologists in Eldoret, Kenya have unrestricted access to modern ultrasound equipment, and thus tend to perform most procedures using ultrasound only. Radiography or an outdated but functional fluoroscopy machine are used to obtain final images postprocedure if needed. CT-guided procedures are also occasionally performed. The most commonly performed procedures include biopsies, abscess aspiration and drainage, and the placement of central venous catheters, percutaneous biliary drains, and percutaneous nephrostomy tubes. The patient purchases supplies such as biopsy needles if possible. Most patients have at least one postprocedure visit with the interventionalist.

CONCLUSIONS: An array of interventional radiology services can be provided in resource-limited regions by maximizing the use of ultrasound guidance and only utilizing fluoroscopy or radiography for confirmatory imaging. Although this deviates from interventional radiology standards of practice, many procedures can be safely performed in this manner, improving available healthcare to populations in resource-limited regions.

Abstract No. 803

Potential tools for the future of interventional radiology: intravenous hemostatic nanotechnology

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PURPOSE: We will review the latest breakthroughs in intravenous IV hemostatic nanotechnology. Increased familiarity and knowledge of
Anticoagulants: what an interventional radiologist needs to know

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PURPOSE: The interventional radiologist must have a clear understanding of how and when to use anticoagulants as well as how to manage patients that are prescribed these drugs. The objective of our educational poster is to give the practicing interventional radiologist a comprehensive but simple review of available anticoagulants, their pharmacology, and appropriate uses. Additionally, it is imperative for the physician to understand the appropriate use of intraprocedural anticoagulants and their appropriate reversal agents.

MATERIALS: Anticoagulants have been the cornerstone therapy for thrombus prevention and treatment since the discovery of heparin in 1916. Often times, they are associated with complications and adverse drug events. Interventional radiologists, nurses, and technologists must be familiar with different anticoagulation regimens, the pathophysiology, pharmacodynamics, and toxicity. Historically, patients who required anticoagulation have been placed on heparin in an inpatient setting, and frequently on warfarin as an outpatient. In the last several years, new directly acting oral anticoagulants (DOACs) have been brought to market.

RESULTS: The coagulation cascade is incited by trauma and/or vascular insult. Thrombin is one of the most potent activators of platelet and clotting factor mediated hemostasis. Thrombin can also induce thrombogenesis by fibrin polymerization, platelet receptor activation, and endothelium activation. Anticoagulant agents inhibit thrombogenesis by directly altering the clotting cascade. Alternatively, some of the newer agents, indirect inhibitors, will bind to plasma cofactors and catalyze the interaction with clotting enzymes.

CONCLUSIONS: Our educational poster aims to summarize the key points on the variety of available anticoagulants, including their pharmacology, toxicity, and pathophysiology. Additionally, we will briefly discuss the use of intraprocedural anticoagulants as well as the role of reversal agents. While much of this is learned during practice, there remains a significant need in the community regarding many of the newer anticoagulants (DOACs) and their appropriate use.

Abstract No. 804

Essentials of intra-procedural complications in interventional radiology

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PURPOSE: After reviewing this educational exhibit, the audience will become familiar with a vast array of intraprocedural complications encountered by the Interventionalists. We will include appropriate diagnostic criteria, common ECG patterns, management algorithms, and pharmacologic options.

MATERIALS: There has been a shift away from invasive procedures towards minimally invasive procedures, thus expanding the role of Interventionalists. In addition, medical advances have led to increased patient survival and consequently, an increasingly complex patient population. As a result, there has been an increased incidence of intraprocedural complications and emergency codes. Timely recognition of complications and initiation of basic management by the Interventionalist is imperative to improved patient outcomes.

RESULTS: We present a series of clinical vignettes which include pertinent imaging and ECGs that may be commonly encountered by the
Interventionalist. Each vignette will be followed by appropriate criteria for diagnosis and a management algorithm. Cases include mild contrast reactions, arrhythmias, sepsis, hypertension and hypotension.

**CONCLUSIONS:** The expanded role of minimally invasive procedures coupled with an increasingly complex patient population has led to an increase in intraprocedural complications encountered by the Interventionalist. With an enhanced understanding of intraprocedural complications, the Interventionalist will be able to institute therapeutic maneuvers in a timely fashion leading to improved patient outcomes.

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**Abstract No. 806**

3D printed models can reduce procedure time, complications, and contrast use when treating pulmonary arteriovenous malformations

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**PURPOSE:** 1. Describe methods to rapidly segment CT images and print 3D affordable models of PAVM. 2. Describe how these models can guide angiography. 3. Describe their role in education and patient consenting. 4. Illustrate cases of models reducing procedure time, complications, and contrast use.

**MATERIALS:** Recently, 3D modeling techniques have been incorporated in medicine, demonstrating utility in applications such as complex anatomical modeling, surgical planning, tissue engineering, medical training, and patient education. There is now a variety of free software and 3D printers that are available at minimal cost. We present cases in which 3D models created with minimal labor using low end printers have can significant impact in guiding treatment of PAVM. The overall aim is to provide educational materials on methods and techniques to allow wide use of 3D modeling.

**RESULTS:** Using free software and low-end 3D printers, methods will be described through multiple case illustrations where 3D modeling was successfully used in the embolization of PAVM in patients with hemorrhagic telangiectasia. Emphasis will be made on how such models can re-create patient’s anatomy for a more safe, rapid and cost-effective treatment of PAVMs. A specific case involving a 38 y/o with PAVMs will be reviewed where 7 foci were rapidly embolized without the need for large volume AP and oblique DSA runs. Several other cases will be illustrated where modeling led to embolization of PAVMs in under 30 minutes of procedure time with significantly lower contrast volumes and fluoroscopy times.

**CONCLUSIONS:** 3D printing has shown promise in personalizing surgical and interventional care. We believe that 3D modeling can be performed in most hospital settings without the need of significant resources or labor. Future considerations include studies involving cost-benefit analysis and overall impact of 3D printed models on patient outcomes.

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**Abstract No. 807**

The forgotten artery: clinical implications of the epiploic (omental) arteries: a case and systemic review

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**PURPOSE:** This educational exhibit aims to review the relevant anatomy and imaging findings related to the epiploic (omental) arteries. Different clinical case presentations and technical considerations will be provided, ranging from trauma to parasitization of vessels supplying tumors.

**MATERIALS:** The anatomy of the epiploic arteries will be discussed. Since the epiploic arteries are small and rarely clinically relevant, they are often overlooked; but may be extremely important as the primary supply to tumors or injured in trauma. Potential etiologies for Omental hemorrhage include trauma, pseudoaneurysm, or vasculitis. The epiploic arteries should also be considered in patients with primary and metastatic tumors as parasitization can occur and affect the success of locoregional treatment options.

**RESULTS:** Multiple cases involving the epiploic arteries are presented including pseudoaneurysm formation, vasculitis, and parasitization of vessels leading to liver tumors. Technical challenges and considerations will also be discussed for each of the cases along with review of the current relevant literature.

**CONCLUSIONS:** Epiploic arteries are small arteries that have potential for significant clinical consequences. Hemorrhage related to pseudoaneurysm rupture can be severe and potentially life threatening. Additionally, these arteries can be a significant supply for tumors. If not taken into account, the maximal response to locoregional therapy may not be achieved.

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**Abstract No. 808**

The anatomy of an interventional radiology sub-internship rotation

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**PURPOSE:** To describe the characteristics of a successful interventional radiology sub-internship (sub-I) rotation for medical students.

**MATERIALS:** The recent formation of integrated IR residency programs has led to increasing medical student interest in the field. As students can now match directly into IR there is a need to adequately expose them to the field, as well as to allow institutions to both showcase their programs and evaluate students sufficiently.
RESULTS: Several institutions have already created successful IR sub-I rotations for medical students. We have examined the curricula of IR sub-Is from Emory, Kaiser, Mt. Sinai, Vanderbilt, and Colorado to describe the characteristics required in a successful sub-I rotation. Several commonalities existed in all the Sub-Is reviewed. They have integrated students in all stages of patient care, including preprocedure planning and patient evaluation, participation in cases in the IR suite, postprocedure patient management, and discharge planning. The IR sub-I students are also included in multidisciplinary conferences, didactic lectures, participating in outpatient clinic, and rounding on inpatients. While all reviewed sub-Is included these aspects, the proportion of clinic and consult time to procedure time varied, as did the expectation for student presentations, and participation in call. From our review, the specific characteristics necessary for a well-rounded and successful IR medical student sub-I will expose students to the breadth of IR. Therefore, we propose the following weekly schedule for a strong IR sub-I: 1 clinic day, one half day of inpatient consults, and 3.5 days in procedural suites. Throughout students should attend didactics and participate in morning rounds, culminating in 1-2 case presentations at the end of the rotation.

CONCLUSIONS: Medical student exposure to IR is crucial to the success of integrated IR residency programs. We have proposed a basic weekly schedule for an IR sub-I that can be adapted by institutions to best fit their needs. This schedule provides students with first-hand experience regarding what a residency and career in IR might be like, allowing them to make informed career decisions.

Abstract No. 809
Easy-to-make simulator phantoms for interventional radiology training
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PURPOSE: Learn to build novel training phantoms for vascular access, nephrostomy and IVC deployment/retrieval using inexpensive, easy to acquire materials. Learn to incorporate hands-on simulation in IR training and recruitment of prospective students. Impact students’ interest/satisfaction with IR rotations using phantoms.

MATERIALS: Simulation allows trainees to gain familiarity with instruments and build technical skills risk-free. It also allows students hands-on exposure to techniques used by IRs. Commercial phantoms and animal models are available but can be prohibitively expensive or present hygiene concerns. Low cost, do-it-yourself phantoms are a convenient option for integrating simulation into training. We have designed 3 inexpensive phantoms for a variety of IR procedures.

RESULTS: We describe step-by-step instructions for building our low-cost phantoms for ultrasound-guided nephrostomy, internal jugular vein puncture and access, and inferior vena cava filter deployment/retrieval. Inexpensive household and hospital supplies are used to make the phantoms. Gelatin based ballistics gel is used to simulate soft tissue for ultrasound-guided nephrostomy and IJ access. Metamucil adds echotexture creating a more realistic appearance under ultrasound. A latex glove filled with water is used to simulate a kidney with overlying tongue depressors simulating ribs. Surgical tubing is used to simulate the internal jugular vein. Polyurethane tubing is affixed to plexiglass to simulate the IVC for filter deployment/retrieval. We describe our experience integrating simulation into our training program for rotating students, residents, and fellows. Trainees were surveyed after use to gauge the impact of the phantoms on their interest in pursuing IR as a profession as well as their comfort in the procedure room.

CONCLUSIONS: Simulation is indispensable in modern procedural training. Our low-cost do-it-yourself phantoms will benefit training programs looking for an affordable and easily accessible option. Trainees report that their experiences on these phantoms improve their comfortability in the procedure room. Students report feeling more likely to pursue IR as a result of their positive simulation experiences.

Abstract No. 810
Understanding retroperitoneal anatomy through examples of hydrodissection
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PURPOSE: 1) Review the anatomy of the retroperitoneal spaces and fascial planes including their contents and nearby structures such as nerves. 2) Enhance understanding of the use of hydrodissection to displace and insulate nontarget structures of the retroperitoneum from injury during renal and adrenal ablation.

MATERIALS: Morbidity from injury to nearby structures is a risk during ablation of the kidney or adrenal gland. Thorough preprocedure planning to avoid damage to stomach, duodenum, colon, pancreas, and nerves is necessary. In the case of close proximity of these structures to the ablation target, techniques to separate vulnerable structures with fluid can be performed. Knowledge of the retroperitoneal space anatomy is necessary to select the correct fascial plane for optimal protection of nontarget structures.

RESULTS: Retroperitoneal anatomy is described by a tricompartmental model. The anterior pararenal space, which includes portions of the duodenum and pancreas, as well as the ascending and descending colon, is bound by the parietal peritoneum and Gerota’s fascia (GF). The perirenal space contains the kidneys, adrenals, proximal ureters, fat, and lymphatic channels, and is bound by GF and Zuckerkandl’s fascia (ZF). The posterior pararenal space, contains only fat, and is bound by ZF, transversalis (TF) and the lateroconal fascia (LCF). In addition, a fourth retroperitoneal space, the great vessel space, contains the aorta and inferior vena cava, is not well defined by fascial planes, communicates with the posterior mediastinum. The respective fascial layers are laminated, and form potential spaces known as the interfascial planes. The interfascial planes extend superiorly to the liver and diaphragm; and inferiorly into the pelvis. These spaces and planes can be manipulated by hydrodissection to protect nontargeted organs, such as the...
stomach, bowel, colon, pancreas, and nerves from potential injury during ablation procedures.

CONCLUSIONS: Knowledge of the retroperitoneal spaces is important for optimal hydrodissection to prevention injury to nearby structures during ablation of the retroperitoneal organs.

Abstract No. 811

Regional symposia and other resources for medical student exposure to interventional radiology

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PURPOSE: 1. Describe the process of creating a regional interventional radiology (IR) medical student symposium (IRMSS). 2. Use survey data to highlight valued features of IR symposia and additional IR resources

MATERIALS: IR medical student symposia are designed to provide basic lectures, hands-on procedure simulation, and networking opportunities with IR faculty and trainees. Some are conducted by single institutions and others represent a multi-institutional collaboration of IR residency programs meant to generate wider geographic interest and allow for cost sharing. To decrease the financial burden on vendors, the Student and Resident Committee of the SIR has suggested that we move toward regional symposia. Our experience hosting several regional symposia and survey data from medical student attendees will be used to identify key symposium components and other IR resources valued by students.

RESULTS: The first Southeast IRMSS was held this year with faculty participation from 11 programs across the Southeast. We will describe the process of organizing a regional IRMSS and discuss the components that lead to success, such as location, cost/funding and the number of faculty, institutions and students involved. We will compare and contrast recent regional and local symposia including the Midwest, Southeast and Northeast Regional and New York City Symposia. Attendees of the Southeast IRMSS and the past New York City Symposium were sent a survey with questions regarding symposia and other IR resources. Results from 140 medical students across the country showed that mentorship opportunities through SIR, summer research opportunities, and local or easily accessible regional IR symposia are felt to be the most important IR resources for medical students. Students specifically valued regional symposia that offered the opportunity to learn specifics of each program involved.

CONCLUSIONS: IR symposia serve an important role in medical student exposure to IR. Our survey results indicate that while some students value a location close to their home institution, most were motivated to attend regional symposia for the introduction and exposure to multiple institutions in one day.

Abstract No. 812

The role of medical students in interventional radiology: third-year, selective, and sub-internship students

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PURPOSE: 1. Describe the different types of medical student rotations in interventional radiology: elective, selective and sub-internship. 2. Identify different stages of medical student learning using the RIME model. 3. Describe the daily operational benefits of a medical student team member. 4. Recognize the importance of medical student education to the future of IR.

MATERIALS: As the IR residency and ESIR are implemented around the country, medical students hoping to pursue a career in IR are seeking out earlier opportunities for exposure to our specialty before applying through The Match. Since our field is both unique and highly specialized, our experience with junior medical students has been limited in comparison to other surgical specialties. Therefore, it is important to find appropriate roles for medical students that are both educational for the student as well as beneficial for the day-to-day operations of the service.

RESULTS: 1. IR-specific rotations include the elective rotation, where a third-year student with no prior exposure rotates through IR for the first time, the selective, where the medical student on a general surgical clerkship selects to rotate through IR as part of their subspecialty experience to learn how perioperative problems are dealt with by IR, and the sub-internship, where the senior medical student functions as a fully integrated team member much like junior house staff. 2. Medical students can be categorized into the RIME hierarchy: Reporter, Interpreter, Manager and Educator. This categorization is useful in finding an appropriate service role for the student. 3. Students can function as excellent team members integral to the daily function of the service. Students can present new consults act as first-assist during procedures and perform postprocedure follow-up.

CONCLUSIONS: 1. There are multiple types of IR rotations which can be implemented to give students exposure to our specialty. 2. Regardless of stage of learning, the medical student can serve an important and useful role on the interventional radiology service. 3. Continued improvement and expansion of medical student IR education is essential to the future of interventional radiology.

Abstract No. 813

Interventional radiology residency interview invitations and dates: what should a medical student expect?

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PURPOSE: In its first application year of 2016-2017, the integrated IR residency was one of the most competitive specialties with 0.6 position per applicant. Similar to other competitive fields, however, scheduling interviews may be a challenge with few interview dates per program
and likely interview date conflicts. The objective of this study was to identify IR residency interview date patterns and potential scheduling conflicts.

**MATERIALS:** We reviewed an online thread of integrated IR residency interview dates posted during the 2016-2017 residency application season on the Student Doctor Network online forum. Anonymous medical student users regularly updated this thread with IR residency interview dates, as well as the day that an interview invitation was offered. We reviewed all programs listed on this thread for date of initial interview offer, number of interview dates, and the month and day of the week of the interview date. We also calculated the number of overlapping interview days.

**RESULTS:** In total, 54 programs’ interview dates were listed. Initial interview offers were sent predominately in October (67%) and September (24%). On average, each program offered 5 interview dates (range, 1 to 10). The most common months for interviews were November and December with 41 and 44 programs holding interviews during those months, respectively, followed by October and January with 14 and 17 programs, respectively. There were 282 total interview dates among the 54 programs. The most common days of the week for an interview were Friday, Tuesday and Monday; virtually zero interviews were held on the weekend. At least 8 programs offered same-day DR interviews. In total, there were 228 interview slots with at least one overlapping interview slot at another institution.

**CONCLUSIONS:** Most IR residency interviews invitations are sent in September and October, and majority are held in November and December, most commonly on a weekday. Although most programs offer several interview dates, there is considerable overlap with potential for scheduling conflicts. Our findings can help set expectations for medical students regarding residency interview invitations, as well as guide strategy for scheduling interviews.

**Abstract No. 815**

Three-dimensional printing: an invaluable tool for enhanced medical student engagement and clinical performance in interventional radiology

**PURPOSE:** • Recognize the role of three-dimensional (3D) printed vasculature in medical student exposure to interventional radiology (IR) • Employ 3D printing to increase medical student IR interest and knowledge • Explore the future benefits of 3D printed simulation at all levels of IR training

**MATERIALS:** The shift of IR training to a residency pathway creates a new and critical demand for medical student recruitment. Gaps in radiology education in US medical schools and low student understanding of IR both highlight this need for early exposure to IR. As 3D printed vascular anatomy is a feasible means of endovascular simulation, such models can be implemented as a highly interactive and engaging tool for early IR exposure. Using simulation based education also holds the potential for increasing future professional success and skill acquisition with reduced patient risk. Despite its clear utility, there are few examples of 3D printed IR simulation being used for medical student education.

**RESULTS:** Members of a newly created IR medical student interest group (IRSIG) used our institution’s 3D printing lab to create scale models of the aorta and inferior vena cava (IVC). These models were successfully used as recruitment tools at multiple student interest events. Students were able to simulate IVC filter deployment with equipment provided by our IR department. The IRSIG noted that using...
such simulations increased preclinical student engagement and interest in IR. The IRSIG grew from 3 to 83 students, including 61 preclinical students. These models can provide a simulation environment not just for medical students. Trainees of all levels, including residents and fellows, could derive benefit—especially those at institutions without access to live animal labs.

**CONCLUSIONS:** 3D printed vascular models and simulations are an effective tool for increasing overall medical student engagement with IR and are an important component of the overall strategy to increase medical student awareness of IR. The low cost and customizable options of 3D printing provide an affordable and accessible method to address the demand for early medical student exposure to IR while enhancing skill acquisition with reduced patient risk.

**Abstract No. 816**

**Abernethy malformation: a rare but important diagnosis prior to loco-regional therapy**

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**PURPOSE:** • To diagnose Abernethy malformation and other congenital extraportal systemic shunts (CEPS) on cross-sectional imaging and angiogram. • To understand the association with CEPS and the development of hepatic lesions. • To recognize the challenges of loco-regional therapy for hepatic masses in patients with CEPS.

**MATERIALS:** Abernethy malformation is a rare vascular anomaly consisting of a CEPS that diverts portal venous blood from the liver into the systemic circulation. Complete (Type I) and partial (Type II) diversion of portal venous blood into the systemic circulation have been described. Patients with CEPS have an increased incidence of developing hepatic lesions. The management for patients with CEPS is evolving and loco-regional therapy is reserved for patients with malignant hepatic lesions that are nonresectable. We will present a multimodality imaging review of two otherwise healthy patients with Abernethy malformation who presented with hepatocellular carcinoma (HCC). In addition, we will discuss an analytical approach to managing patients with CEPS undergoing loco-regional therapy.

**RESULTS:** CEPS is commonly diagnosed in childhood; however, many patients are asymptomatic into adulthood. The clinical manifestations can be broadly divided into features related to portal venous blood shunting, associated congenital anomalies or hepatocellular lesions. Symptoms related to portosystemic shunting include hepatopulmonary syndrome, metabolic dysfunction and hepatic encephalopathy. Congenital anomalies associated with CEPS include cardiac, genitourinary, biliary, splenic and skeletal malformations. In patients with CEPS, liver function is often well preserved, and patients do not typically develop cirrhosis.

**CONCLUSIONS:** The possibility of CEPS should be explored in young patients with hepatic lesions such as HCC without cirrhosis or other underlying risk factors such as hepatitis or hemochromatosis. Treating HCC in patients with Abernethy malformation can be challenging but understanding the pathophysiology and anatomy can help guide the treatment approach, particularly when selecting between types of loco-regional therapy.

**Abstract No. 817**

**The use of robotics in surgery and its potential applications for interventional radiology**

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**PURPOSE:** Summarize the current and future capabilities of surgical robotics. Emphasize their relevance and application to interventional radiology. Understand and recognize the advantages and limitations of robotic implementation for interventional procedures.

**MATERIALS:** A surgical robot is a computer-controlled device programmed to aid the positioning and manipulation of medical instruments. Advantages of robotics include three-dimensional imaging, mechanical improvement, stabilization of instruments, and improved ergonomics. Robotic surgery has been applied in several fields of general surgery, including gastric, colorectal, hepatobiliary-pancreatic, and endocrine surgery. It is also commonly used for gynecological and urological surgical procedures. Preliminary robotic IR techniques have mainly been focused on CT- and MRI-guided percutaneous biopsies, radiofrequency and cryoablation procedures. Besides for enhancing the accuracy and efficiency of these interventions, robotic assistance opens the door for telepresence surgery with the advantage of reducing the radiation dose to the radiologist.

**RESULTS:** This educational exhibit will illustrate common surgical procedures that are currently using robotics and provide examples of current and potential applications within IR such as robotic needle-guidance, stent placement, and tumor treatment. Several robotic systems that have been used and are being studied for image-guided interventions will be described. The results of clinical trials and published preliminary clinical experiences will be summarized. Finally, the advantages and limitations of robotics in IR will be discussed.

**CONCLUSIONS:** Although more research and clinical trials are certainly needed, robotic endovascular techniques have the potential to become an important part of vascular interventional radiology in the future. The combination of rapidly advancing engineering systems, expert medical knowledge and evidence-based research will undoubtedly lead to innovative clinical procedures that were unachievable beforehand.

**Abstract No. 818**

**The value of simulation: a discussion of implementation and development in the field of interventional radiology**

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**PURPOSE:** Summarize the current and future capabilities of surgical robotics. Emphasize their relevance and application to interventional radiology. Understand and recognize the advantages and limitations of robotic implementation for interventional procedures.

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**Abstract No. 819**

To sleep or not to sleep: guide for residents for the use of conscious sedation for common interventional radiology procedures

**D Cummings**, E **Kurz**, M **Lilly**, A **Desai**, J **Walsh**

**PURPOSE:** 1. Enhance diagnostic radiology residents’ knowledge of proper use of conscious sedation, analgesia, and anxiolytics for common interventional radiology (IR) procedures. 2. Review relevant pharmacology and physiologic effects of different sedative, analgesic, and anxiolytic agents. 3. Provide residents with the tools for identification and management of possible complications secondary to sedation.

**MATERIALS:** Anxiety, discomfort, and pain are several factors that can preclude a patient’s ability to tolerate an IR procedure. With the use of different medications, these factors can be controlled for the patient to safely, and comfortable undergo interventions. Use of these agents is considered safe, so long as the clinician is aware of their proper use and understand the appropriate response if the medication deviates from the expected effects. It is essential for the interventional radiologist and the resident, to be able to formulate a proper management plan taking into account the presedation evaluation, perioperative monitoring, and postprocedure recovery.

**RESULTS:** This educational exhibit intends to: 1. Discuss the levels of sedation and analgesia, along with the indications for the use of each level. 2. Present recommendations for the use of sedation, analgesics and anxiolytics agents for different common interventions. 3. Review management of complications secondary to medications for conscious sedation and analgesia. 4. Establish an example protocol for the evaluation and monitoring of patients undergoing sedation from a presedation, intraprocedural and postsedation standpoint.

**CONCLUSIONS:** In addition to learning the technical skills required for IR, residents play a crucial role in providing periprocedural care and monitoring patients while on the IR service. Knowledge of the proper use of common sedation and analgesics, their physiologic effects and management of possible complications, is vital for ensuring patient safety and well-being.
to specify vessel and less-emergent setting of nontarget embolization prevention will also be reviewed.

**CONCLUSIONS:** Non-liver-directed applications of the Flightplan for Liver and 3D roadmapping software algorithm are technically feasible. This user-friendly software has the potential to improve intraprocedural confidence, decrease contrast administration loads, and lower radiation dose with fewer digital subtraction angiographic runs. Specifically, this tool has helped the clinical practice and performance of prostate artery embolization, unclear gastrointestinal hemorrhagic blush sources, and avoiding sites at risk of nontarget embolization in our institution.

**Abstract No. 821**

**Comparison of minimally invasive weight loss procedures: surgical, endoscopic, and endovascular**

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**PURPOSE:** Review of most recent data concerning effectiveness, cost, and morbidity of surgical, endoscopic, and endovascular procedures for weight reduction.

**MATERIALS:** Bariatric embolization presents an interesting potential for the future of minimally invasive weight loss procedures. While the availability of laparoscopic Roux-en-Y gastric bypass and laparoscopic gastric sleeve procedures are well known, the most recent data on their respective effectiveness, cost, and complication rate are likely less well known. Further, recent innovation in endoscopy has produced several competing procedures for minimally invasive weight loss, knowledge of which can aid practice building as well as patient education during clinic visits.

**RESULTS:** A comprehensive literature search has been conducted on PubMed with pertinent papers selected to present the effectiveness, cost, and morbidity of laparoscopic Roux-en-Y gastric bypass and laparoscopic gastric sleeve procedures are well known, the most recent data on their respective effectiveness, cost, and complication rate are likely less well known. Further, recent innovation in endoscopy has produced several competing procedures for minimally invasive weight loss, knowledge of which can aid practice building as well as patient education during clinic visits.

**CONCLUSIONS:** This poster will concisely summarize the most recent data about effectiveness, cost, and morbidity, as well as pictorial illustrations of the competing surgical, endoscopic, and endovascular weight loss procedures, in an effort to inform interventional radiologists of minimally invasive weight loss procedures available to the patient and to referring physicians.

**Abstract No. 822**

**Supporting sobriety and safe sedation practices: a practical approach to managing patients with opioid dependence undergoing VIR procedures**

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**PURPOSE:** To offer insight and guidance on the periprocedural management of patients with a history of opioid addiction, including those using medication-assisted therapy, undergoing minimally invasive image-guided procedures.

**MATERIALS:** Opioid dependence is a growing problem globally and is considered a national epidemic. A mainstay treatment for opioid addiction is medication-assisted therapy. This treatment uses the Mu-receptor agonists buprenorphine and methadone. With an ever-growing number of patients, the use of these drugs has skyrocketed. Sedation and management of acute and subacute postoperative pain is recognized as a significant clinical challenge, including risks of respiratory suppression and withdrawal or relapse following use of a full opioid agonist. Other medical disciplines have explored treatment options for this patient population undergoing surgical procedures, but this has not been documented in the IR literature.

**RESULTS:** We will discuss case reports, expert opinions and available observation reviews to provide a valuable resource for the procedural management of patients on buprenorphine or methadone for opioid dependence. Limited data from randomized controlled studies will also be presented. Our presentation will provide an exhaustive review of the available literature, highlighting treatment options and providing a management framework for providers.

**CONCLUSIONS:** This exhibit will be a concise but thorough review for interventional radiologists preforming procedures on patients recovering from opioid addiction. We will provide a background of pharmacokinetics for partial and full opioid receptor agonists. A sound understanding of the risks and challenges associated with performing procedures on this patient population will improve clinical outcomes and patient satisfaction. An algorithm will be proposed to address periprocedural sedation and pain management in order to prevent withdrawal, further addiction and maximize pain relief.

**Abstract No. 823**

**Beyond biodesign: interventional radiologists partnering with large public city hospitals to lead the future of clinical software innovation**

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**PURPOSE:** 1. Learn the nature of innovation in interventional radiology. 2. Learn the history of innovation outside biodesign in IR. 3. Understand important steps for initiating a clinical software venture. 4. Learn differences in Biodesign innovation and clinical software innovation.

**MATERIALS:** “As practitioners with referral base extending across nearly all other medical specialties, and a history of disruptive innovation, IRs are well positioned to observe clinical unmet needs, and to facilitate interdisciplinary collaborative partners to [pursue disruptive clinical change]” (1). IR is known for advances in biodesign innovation, most notably with Dr. Dotter’s use of catheter devices for angioplasty. Notable IR leaders have lead clinical innovation projects outside of biodesign, including Dr. Lawrence Hofmann with the development of an employer-based data driven technology solution for expert second opinions to reduce healthcare costs (2).
RESULTS: A third-year IR resident with the mentorship of Dr. Curtis Lewis on the business of medicine took time off to develop innovative clinical software technology. Lessons learned include: 1. Focus on needs-based innovation over technology driven innovation (1). 2. Recruit team with the right skill sets of prior business success and proven development chops. 2. Power of partnering with large public city hospital. Specifically, partnered with clinical research team to develop the first clinical research electronic document management system for bringing together sponsors and research sites to have real time-controlled access to documents. 3. Early wins drive later success. Early partnership led to partnerships with 3 of the top 10 cancer research centers and a large endovascular device sponsor based in S. Jordan Utah with significant growth in electronic document usage within the application server (Table 1 above). 4. Investment decisions are based on two things. Prior team success and/or achievement of current success metrics.

CONCLUSIONS: Opportunities for innovation expand far beyond those that interface directly with the human body (3). Interventional radiologists have a unique perspective to play a leading role in the development of clinical software technology.

Abstract No. 824

Earth’s national lab: how the International Space Station can advance interventional radiology

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PURPOSE: To demonstrate the available tools, past methods, and feasibility of performing vascular research aboard the International Space Station (ISS) for the advancement of interventional radiology applications and procedures.

MATERIALS: The ISS is a research laboratory open to investigators for studying a diversity of disciplines, consequently bringing an assortment of equipment, microenvironments, and simulations that can accommodate many research goals. In its lifetime, many biomedical experiments have enjoyed much success aboard the ISS, observing the effects that microgravity, radiation, and other unique environmental conditions can have on human physiology, leading to the discovery previously unknown biological mechanisms. Experiments on vascular physiology are a mainstay aboard the ISS, with simulation and animal models in conjunction with medical imaging devices (ultrasound and x-ray) accessible for this purpose. In its history, interventional radiology (IR) is known to use innovative methods to discover and implement novel strategies to improve clinical care. Data derived from IR research in this unique experimental setting may have outstanding benefits yet to be realized.

RESULTS: Cardiovascular physiology has underlying regulatory mechanisms in place for adaptation of microgravity found in low-Earth orbit (LEO), causing measurable changes to systolic and diastolic function, mean arterial pressures, arterial media thickening, and intravascular concentrations of significant cardiovascular regulators (i.e., catecholamines, among others). Systems are currently developed and brought onto the ISS to determine the etiology of these physiological reactions including DNA microarrays, 3D cell culture and perfusion, and in vivo rat models for histological and gross examination.

CONCLUSIONS: IR research aboard the ISS is a viable, though largely unexplored medium which may contribute greatly to the elucidation of relevant biological mechanisms to develop novel interventions and improve patient outcomes here on Earth. As space travel becomes increasingly cost effective, IR is in a unique position to provide a minimally invasive and compact method for performing procedures in extraterrestrial environments.

Abstract No. 826

Technique for creating a low-cost fluoroscopy simulation unit for interventional training

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PURPOSE: Participants will learn how to construct a table-top fluoroscopy simulator from affordable and easily obtainable supplies for the purposes of interventional training.

MATERIALS: Developing coordination needed for fluoroscopic procedures can be challenging for trainees. Considerations to patient safety, radiation safety, and efficiency limit opportunities for hands-on experience in clinical practice. Over the past 20 years, simulation use in medical education has increased exponentially, providing experiential training in a safe, low-risk, and self-paced environment. Unfortunately, the cost of simulators can either prohibit acquisition or lead to heavy restrictions on their accessibility. Here we present a method for creating an extremely affordable table-top simulator that can be built with easily acquired supplies for fluoroscopic procedural training.

RESULTS: A simple phantom was created from clear polyethylene tubing and placed in a box to obscure the model from the operator’s view. A webcam and LED light source were secured to the top of the box and connected to a Raspberry Pi micro-PC. An on-off foot pedal was connected to the micro-PC and programmed to trigger live video display, replicating a fluoroscopic foot pedal. Python programming language was used in combination with the Open Source Computer Vision Library to process and display the live image on a PC monitor. This setup simulates using visual feedback from a monitor to manipulate
interventional tools. To make the simulation more realistic an image of the phantom can be subtracted prior to inserting the tools to replicate digital subtraction imaging. Additionally, overlaying an anatomically applicable radiograph to the image creates the appearance of the human body and its landmarks.

**CONCLUSIONS:** We have shown that a micro-PC, webcam, foot pedal, and phantom can effectively simulate fluoroscopy, providing trainees an opportunity to practice the hand-eye-foot coordination needed for many interventional procedures. Notably, the entire device described (excluding the monitor) totals less than US $100, removing what is often prohibitive cost as a barrier to providing simulation training.

**Abstract No. 827**

**Formal vascular interventional education for radiologic technologists**

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**PURPOSE:** To emphasize the benefits of a dedicated vascular interventional training program for radiologic technologists.

**MATERIALS:** In 1973, our Institution founded a postgraduate training program for radiologic technologists interested in pursuing a career in the field of IR. Our novel program was spurred by recognizing the dynamic, patient centered nature of IR required personnel with proficient understanding of anatomy and pathology, technical aspects of tools employed in IR procedures, and patient care skills beyond that of a radiographer. Since its inception our program has graduated 236 students.

**RESULTS:** The 12-month training program consists of didactic lectures and supervised clinical experience. Program faculty are primarily comprised of IR Technologists but also include interventional radiologists and physicists. The curriculum has evolved in parallel with the field of IR. Current curricular topics include advanced vascular anatomy, principles of patient care, radiation physics, diagnostic and implantable devices, and pathology-related procedures. Graduates of our program have demonstrated a 99% pass rate of the postprimary certification examination, compared to the 57.2% national average (1). Of the 55 students who have graduated since 2007, 12 (21.8%) have remained on staff as clinical IR technologists.

**CONCLUSIONS:** Proper education of future IR technologists is the primary purpose of our program. There are secondary benefits beyond contributing to the pool of well-trained IR technologists. The presence of students within the IR department encourages all IR staff technologists to stay abreast on clinical knowledge and act as role models to trainees. The program tends to retain former students as employees who possess the knowledge and skill set to function independently as a competent IR technologist immediately after graduation. Additionally, as the field of IR continues to evolve, now with its own designated residency training pathway, the presence of highly trained technologists is a requisite to ensure adequate skills in the next generation of interventional radiologists.

**Abstract No. 828**

**To continue anticoagulation? That is the question!**

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**PURPOSE:** 1. To briefly review the epidemiology of venous thromboembolism (VTE) and its clinical significance. 2. To review the anticoagulation agents currently available for the treatment of VTE. 3. To discuss pertinent randomized control trials evaluating the value of prophylaxis after initial therapeutic anticoagulation for VTE, including (1) EINSTEIN; (2) EINSTEIN-CHOICE; (3) AMPLIFY-EXT; (4) RE-SONATE, and (5) RE-MEDY.

**MATERIALS:** Venous thromboembolism (VTE) is the third leading cause of vascular mortality. It is a disease entity with high mortality and morbidity. One of many things to consider in management of patients with VTE is whether or not to continue anticoagulation after the initial course of treatment. The purpose of this presentation is to review the current anticoagulant therapies and available literature regarding this important topic to assist clinicians in critical decision-making.

**RESULTS:** The risk of recurrence within the first year after a provoked VTE is as high as 5 percent with an annual risk of 2.5% thereafter. The risk for unprovoked DVTs increases to 10 percent for first year risk and 5% for annual risk. Therefore, it is important to review the topic of anticoagulation after an initial therapeutic treatment course, which usually ranges from 3 to 6 months and up to 12 months. The EINSTEIN trials demonstrate the benefits of continued anticoagulation with Rivaroxaban at both treatment dose (20 mg) and prophylactic dose (10 mg). The AMPLIFY-EXT trial concluded that Apixaban reduced the risk of recurrent VTE at both treatment dose (5 mg) and prophylactic dose (2.5 mg). Similarly, in the RE-SONATE and RE-MEDY trials, Dabigatran was compared to both warfarin and placebo, demonstrating that it is yet another agent that is shown to reduce the risk of recurrent VTE, while also reducing the risk of clinically significant bleeding.

**CONCLUSIONS:** VTE is a disease entity commonly encountered by interventional radiologists. With the growing emphasis on the clinical IR model, it is important to have a complete understanding of the diseases we treat. Understanding not only the initial decision making of acute processes, but also the long-term care, is critical for the longitudinal care of our patients.

**Abstract No. 829**

**The Sunshine Act: development, implementation, and current controversies**

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**PURPOSE:** The goal of this exhibit is to review the development of the physician Open Payments Program (OPP), describe its current use and
implications for interventional radiologists (IRs), and detail a variety of
current controversies that exist surrounding this program.

MATERIALS: The physician Open Payments Program (OPP/Sunshine
Act) requires medical product manufacturers and group purchasing
organizations to disclose to Centers for Medicare and Medicaid Ser-
vices via the National Physician Payment Transparency Program any
payments or transfers of value to physicians or teaching hospitals. It
was designed to increase transparency of the financial relationships
between industry and physicians and hospitals. An understanding
of the OPP program, what interactions are reported, how to access
and dispute this information when needed, and current controversies
surrounding the OPP will help IRs make informed decisions regarding
their interactions with industry, based on what is best for their practice
from both an educational and patient care perspective.

RESULTS: This educational exhibit reviews the definition of COI, why it
was developed, when it was implemented, and who is affected. We discuss
the current status of the OPP and review literature about potential
impacts on IRs. We review the importance for physicians to monitor
what has been reported about them, and how to access the information
and initiate a claim dispute in a timely manner, if needed. A variety of
OPP system controversies are discussed, including (but not limited to):
overall goal of providing transparency to patients but no context is given
to the general public/patients, cumbersome process and timeline for IRs
to dispute data, misperception among public that such relationships are
illegal, analysis of various reporting loopholes that exist, the role of Med-
ical Communications Companies in these relationships, and what happens
to the OPP if the Affordable Care Act is replaced?

CONCLUSIONS: It is critical for IRs to understand the OPP, what is
reported, and how to dispute a claim so that they can make appropri-
ate choices in terms of how to interact with industry to meet both their
professional educational and patient care needs.

Abstract No. 830

Conflicts of interest and interventional radiology:
relevance, appropriate disclosure, and current
controversies

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PURPOSE: The goal of this exhibit is to review how conflicts of interest
(COI) may arise when interacting with industry and how interventional
radiologists (IRs) can ethically maintain these relationships in order to
promote growth, education, and advancements in patient care.

MATERIALS: Relationships between medical industry and IRs have
existed since the birth of the field, as seen with Dr. Charles Dotter and
COOK medical. Such relationships are integral for development of new
devices and techniques, which leads to critical growth of the specialty,
new and improved procedures, and better outcomes for patients.
However, when interacting with medical drug and device companies,
physicians must be cognizant of any conflicts of interest (COI) that
may exist or may be perceived by colleagues, hospital administration,
and the general public.

RESULTS: This educational exhibit reviews the definition of COI, why it
matters, whether the degree of the financial relationship matters, and
the concept of “potential” conflicts of interest. We provide an in-depth
analysis and discussion of a variety of topics related to COI, including
(but not limited to): COI and medical integrity, COI and medical
research, the role of leaders and management to guide collaboration
between IRs and industry, and educating trainees about COI. The
relevant IR and wider-scale medical literature on these topics will be
reviewed. In addition, we detail the challenges that exist in disclosing
financial COIs to patients, what the general public thinks about COI in
medicine, how this pertains to the physician Open Payments Program/
Sunshine Act, and COI and IR scientific presentations and publications.
COI disclosure policies from a variety of societies will be reviewed,
including the Society of Interventional Radiology, Radiological Society
of North America, and American College of Radiology.

CONCLUSIONS: While interactions between physicians and industry
play an important role in advancements in patient care by developing
new and improved technologies and procedures, IRs must be aware of
how conflicts of interest may arise and how to properly address them,
in order to maintain an ethical practice and trust of their patients.

Abstract No. 831

The Medicare quality payment program: implications for
an interventional radiology practice

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PURPOSE: Review the genesis of the Medicare and CHIP
Reauthorization Act (MACRA) • Understand the Quality
Payment program (QPP)
Models • Discuss Merit Based Incentive Payment system (MIPS)
and the Composite Performance scoring system (CPS) and outline the
difference between a patient facing and non-facing specialty • Provide
an outline of potential interventional radiology initiative to comply to
MIPS scoring categories

MATERIALS: Medicare constituted 15% of the federal spending in 2016.
Unsustainable health care cost with lack of quality control lead to the
bipartisan MACRA act of 2015. Beginning in 2019, Medicare Part B phy-
sician reimbursements will be based on the quality matrices reported for
the 2017 performance year. Fee for service will be phased out and sub-
sequently quality and value of care will determine bonus and penalties.
Understanding QPP is vital for all future physicians, both from a reim-
bursement perspective as well as providing a value-based health care. The
ramifications of QPP for an IR practice is not well defined and is evolving.

RESULTS: The poster will focus on the MACRA act of 2015. Specifically,
the different QPP models including Advanced Accountable Care Organi-
zations (A-ACOs) and MIPS will be elaborated. Criteria for MIPS including
quality measures, advancing care information, improvement activities and
cost as well as derivation of the composite performance scoring (CPS) will
be discussed. As IR is listed a subset of radiology, the question of patient
facing vs non-patient facing reporting parameters will be examined. The poster will conclude by illustrating some potential IR specific MIPS parameters to improve the quality and value of our specialty.

**CONCLUSIONS:** Medicare reimbursement will be tied to reporting quality and value-based matrices starting in the performance year 2017. Developing IR based MIPS and using registries to report outcomes are critical for IR practices in the future.

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### Abstract No. 832

**Imaging differentiation of uterine leiomyosarcomas from benign fibroids: what the interventional radiologist needs to know prior to uterine fibroid embolization**

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**PURPOSE:** 1. To review the clinical presentation and diagnosis of uterine leiomyosarcomas and fibroids. 2. To review the imaging modalities and associated imaging features used to differentiate uterine leiomyosarcomas and fibroids.

**MATERIALS:** Uterine-sparing, embolic treatment of symptomatic fibroids is increasing in prevalence due to recent advances and successes. Appropriate preprocedural diagnosis of benign fibroids is key. In particular, it is important to distinguish fibroids from uterine leiomyosarcomas, a rare, aggressive malignancy with an incidence of approximately 1-2 in 100,000 women. This can present a diagnostic challenge, as uterine leiomyosarcomas and fibroids have similar clinical presentations and imaging features. Furthermore, fibroids have a variable appearance on imaging. The diagnosis of uterine leiomyosarcoma can be made non-invasively on the basis of laboratory testing and imaging, of which magnetic resonance imaging with diffusion demonstrates the greatest utility. Postembolization, if a presumed fibroid demonstrates rapid growth, the diagnosis of uterine leiomyosarcoma must be considered.

**RESULTS:** 1. Introduction o Clinical presentation o Demographics o Risk factors and associations o Laboratory studies o Imaging modalities and imaging features o Ultrasound o Magnetic resonance imaging o Computed tomography o Nuclear medicine o Follow-up imaging

**CONCLUSIONS:** 1. Distinguishing between uterine leiomyosarcoma and fibroid can be challenging due to similar clinical presentation and imaging features. 2. Appropriate imaging studies, in conjunction with laboratory testing, can help distinguish between uterine leiomyosarcoma and fibroid.

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### Abstract No. 833

**The utility and challenges of cone-beam computed tomography guidance during transarterial chemoembolization of hepatocellular carcinoma**

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**PURPOSE:** 1. List advantages and disadvantages of cone-beam CT showing a variety of vascular and nonvascular cases where cone-beam CT served as a useful adjunct in the IR suite. 2. Discuss technical considerations.

**MATERIALS:** Many papers have described the usefulness of cone-beam CT during trans-catheter arterial chemoembolization. At our institution, we have successfully used cone-beam CT in many other
vascular and nonvascular applications as adjunct tools to achieve desired procedural outcome while diminishing risk of adjacent organ injury, nontarget delivery of embolization material, delineating anatomy in complicated intraprocedural cases, among other applications. We believe it has served to decrease complications and multiplicity of procedures, outweighing the technical considerations and radiation exposure. A variety of cases where this tool has proved useful will be shown with an analysis of technical considerations.

RESULTS: Cone-beam CT serves as a useful tool to delineate intraprocedural anatomy in complicated cases, ensure appropriate delivery of embolic agent, confirm a successful target postembolization, aid in tube placements (gastrostomy tube placement, intrabdominal abscess drainage and other cases traditionally done with fluoroscopy for which a cone-beam CT may decrease complications and need for multiple procedures), confirm appropriate calyceal stent placement for surgical planning, among other utilities for vascular and nonvascular interventional applications.

CONCLUSIONS: Cone-beam CT serves as a useful adjunct in the IR suite.

Abstract No. 835

Computed tomography evaluation of gastrostomy tube complications

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PURPOSE: 1. Review gastrostomy tube complications and their appearance on computerized tomography (CT). 2. Discuss recommendations on triaging gastrostomy tube complications discovered on CT for the non-interventionalist.

MATERIALS: Evaluation of the gastrostomy tube has traditionally relied on clinical and fluoroscopic examination with contrast. Gastrostomy tube complications described in the literature include minor complications such as tube dislodgement, tube occlusion, superficial stoma infection, leakage around the tube and minor bleeding. Major complications include bowel perforation, hemorrhage and peritonitis. The role of contrast-enhanced CT is well established in patients with acute abdominal pain, and gastrostomy tube complications are increasingly being discovered by non-interventionalists on CT. Nevertheless, the appearance of gastrostomy tube complications on CT has not been well described.

RESULTS: This exhibit will review gastrostomy tube complications and characterize their appearance on CT. This will include pictorials highlighting characteristic appearances of gastrostomy tube complications on CT. Interestingly, we present sparsely reported complications such as buried bumper syndrome and enteroenteric intussusception due to balloon migration, which can be evident on CT. We present a guide on triaging gastrostomy tube complications discovered on CT for the non-interventional radiologist, with recommendations for 1) complications requiring a simple solution, 2) complications requiring correlation with clinical examination or follow-up, and 3) complications requiring interventional radiology consultation.

CONCLUSIONS: The CT appearance of gastrostomy tube complications has not been well described. Viewers of this exhibit will gain an understanding of the CT appearance of gastrostomy tube complications. For the non-interventional radiologist, this exhibit can serve as a guide on how to appropriately triage gastrostomy tube complications discovered on CT.

Abstract No. 836

Segmental arterial mediolysis, an increasingly recognized entity! What radiology residents need to know?

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MATERIALS: SAM is a rare, nonarteriosclerotic, noninflammatory vascular disease of unknown etiology. It characterized by fusiform aneurysms, stenosis, dissections and occlusions mainly within splanchnic arterial branches. It mostly affects medium-to-large sized abdominal arteries with vacuolar degeneration of smooth muscle cells in the arterial media, followed by fibrin deposition at the medial-adventitial junction.

RESULTS: Although it can happen at any age, the typical patient is a middle to old aged patient with no gender predisposition. Reported presenting symptoms include a range between intermittent episodes of anorexia, abdominal pain and diarrhea to acute burning and tearing epigastric pain. The reason for abdominal pain is usually abdominal hemorrhage (into the peritoneum or mesentery) or arterial infarction. CT/MRA can demonstrate several patterns with SAM, most commonly aneurysms, occlusions, dissections and stenotic lesions at the same time with tendency to spare bifurcation sites. SAM can evolve rapidly over the course of weeks on follow-up imaging. The lesions are mostly seen in the splanchnic branches of the abdominal aorta, particularly celiac artery (60%) and superior mesenteric artery (17%). Differential diagnoses include atherosclerosis, fibromuscular dysplasia, systemic vasculitis, and neurofibromatosis. Transcatheter embolization is the treatment of choice for a ruptured dissecting aneurysm. Surgical bypass or resection of the injured arteries usually reserved for recurrent cases.

CONCLUSIONS: The hallmark of the disease is single or multiple abdominal splanchnic artery aneurysm(s) in a middle or old aged patient, presenting with abdominal pain and imaging findings of intraabdominal hemorrhage, without prior history of systemic vasculitides. It is important for us to recognize the entity and follow the patients closely, since despite successful treatment, SAM can be progressive and lethal.
Abstract No. 837

Heart of the matter: imaging of left ventricular assist devices—features, complications, and pitfalls

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PURPOSE: • Designs of the commonly implanted left ventricular-assist devices (LVAD) • Normal appearances of LVAD on imaging • Imaging evaluation of early and late complications of LVAD

MATERIALS: Left ventricular-assist devices (LVAD) have become an increasingly popular treatment option for both prolonging survival as well as improving quality of life for patients with heart failure. It may be used as a short-term bridging therapy until myocardial recovery, long-term bridging until cardiac transplant, or destination therapy for patients not eligible for transplantation. Given continued evolution of these devices, as well as more ubiquitous presence of LVAD in our patient population given chronically limited organ availability, it is critical for the interpreting radiologist to be familiar with the typical appearance of the LVAD, as well as the clinical and imaging findings of complications associated with the LVAD.

RESULTS: There are several commonly implanted LVADs, which can be divided into pulsatile-flow and continuous-flow types. Fundamentally, all devices contain an inflow cannula, a pump, and an outflow cannula. While echocardiography is routinely employed to image these devices in the intraoperative and perioperative periods, with many inherent advantages, computed tomography allows more comprehensive evaluation, including components not well-seen on echocardiography, as well as non-thoracic complications. Common complications include inflow and outflow cannula obstruction, hemorrhage, pericardial tamponade, thrombosis, aortic stenosis / insufficiency, right heart failure, and infection. More distally, LVAD is associated with hemolysis, biliary complication, organ infarcts from thrombo-embolic disease, and hemorrhage secondary to anticoagulation therapy employed to prevent the former.

CONCLUSIONS: As LVADs become increasingly commonly encountered in day-to-day practices of a radiologist, particularly at larger academic centers, it is imperative to be comfortable interpreting normal and abnormal imaging findings after LVAD-implantation and the associated clinical presentations, to better serve both our patients and the referring physicians.

Abstract No. 839

Abdominal 4D-DSA: feasibility and future applications

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PURPOSE: After reviewing this educational exhibit the audience will be able to: 1) Understand different manifestations and complications of various aneurysms. 2) Describe important imaging characteristics of aneurysms that would prompt endovascular or surgical intervention. 3) Discuss the implications of different aneurysms on patient prognosis and management.

MATERIALS: An aneurysm is an abnormal dilation of a blood vessel that typically occurs in arteries. With multiple causes and locations, aneurysms present clinicians with a diagnostic and therapeutic dilemma. Additionally, the complications from aneurysms can be fatal or debilitating to patients if they are not recognized in time and not treated appropriately. Ultimately, management of aneurysms depends on multiple factors, including making the correct diagnosis, identifying important imaging findings, and determining the most suitable treatment option.

RESULTS: This exhibit will illustrate the pathophysiology, imaging characteristics, complications, and management of various types of aneurysms. The authors have selected cases from our institutions of aneurysms with unusual manifestations and important implications on patient outcome. These imaging and clinical findings include: 1. Splenic artery aneurysm with extrahepatic portal hypertension and splenomegaly. 2. Traumatic pseudo-aneurysm of the portal vein with shock bowel. 3. Thrombosed coronary bypass graft aneurysm with myocardial infarction. 4. Mycotic ascending aortic aneurysm with impending rupture. 5. Endovascular repair of AAA with subsequent multi-organ infarction. We will be using peer-reviewed journals to support our case discussion, highlighting imaging findings and treatment options. Finally, a summary of clinical and imaging take home points will be discussed.

CONCLUSIONS: Interventional radiologists are playing a larger role in the diagnosis and treatment of aneurysms. It is important to be familiar with and recognize important imaging findings of various aneurysms, as certain features are predictive of high mortality if not properly identified and treated promptly. Awareness of different endovascular and surgical approaches is also necessary to improve the overall care of the patient.
eg, vascular malformations) during interventional procedures. Some of its limitations, particularly its susceptibility to motion artifacts, are being overcome with recent advances in image processing and reconstruction. These advances are facilitating additional applications for 4D-DSA, including in the abdomen.

RESULTS: This exhibit will explain how 4D-DSA images are acquired. It will describe how it is different from 2D- and 3D-DSA. Relative advantages and limitations of 4D-DSA imaging will be highlighted. The exhibit will illustrate current applications of 4D-DSA in brain and extremity imaging as well as the feasibility of performing 4D-DSA in the abdomen. The difficulties of using 4D-DSA in abdominal imaging will be explained along with recent technical advances to overcome them. Finally, current and future applications of 4D-DSA in abdomen will be illustrated with case examples.

CONCLUSIONS: 4D-DSA is a relatively recent angiographic imaging technique that provides anatomical detail and flow information in a 3D vascular volume. Recent image processing and reconstruction methods are addressing the main limitation of 4D-DSA—its susceptibility to motion artifacts. These techniques will allow its use in the abdomen. In addition to the spatial and temporal information provided by 4D-DSA, new methods are being developed for quantifying blood flow and velocity, which may provide a means of determining objective endpoints for interventional procedures.

Abstract No. 840
From tangles and webs to coils and plugs: what the interventional radiologist should know about hereditary hemorrhagic telangiectasia

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PURPOSE: To familiarize interventional radiologists with hereditary hemorrhagic telangiectasia (HHT) by reviewing the pathophysiology, epidemiology, and clinical manifestations of the disease, as well as its radiologic features and treatment options.

MATERIALS: HHT is a disease of vascular dysplasias affecting approximately 1 in 5,000 individuals. The formation of visceral arteriovenous malformations (AVM) greatly increases the disease morbidity and mortality. Visceral AVM are often diagnosed radiographically and commonly treated endovascularly by interventional radiologists.

RESULTS: Our institution is an HHT Center of Excellence, receiving referrals from a large geographic region. We combined our clinical experience with current literature to describe the most pertinent information for interventional radiologists. Mucocutaneous and gastrointestinal telangiectasias typically cause mild morbidity through hemorrhage. Visceral AVM can affect the lungs, brain, spine and liver and cause more severe sequelae. Pulmonary AVM place the patient at risk for brain abscess, stroke, and pulmonary hypertension. Cerebral AVM increase the risk of devastating intracerebral hemorrhage while spinal AVM are reported to potentially cause paralysis. Hepatic AVM can lead to cardiac failure and biliary ischemia due to shunting. Treatment of AVM is primarily via embolization with coils and plugs, with detachable coils becoming increasingly preferential. Microvascular plugs are an emerging option, and more rarely, the use of cyanoacrylate glue with distal balloon occlusion has been reported. Cerebral AVM are managed expectantly due to the risk of intervention, with coil embolization utilized for larger lesions.

CONCLUSIONS: The visceral AVM of HHT are capable of devastating complications if not diagnosed and treated efficaciously. Monitoring, early diagnosis and endovascular treatment are essential to improving long-term outcomes, making interventional radiologists pivotal in disease management.

Abstract No. 841
Understanding prostate artery anatomy essential for successful and safe arterial embolization

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PURPOSE: 1. Understand the prostate artery anatomy and appearance of the prostate artery vascular pedicles targeted for embolization. 2. Learn to identify the most common origins of the prostate arteries. 3. Review anastomoses and anatomic variants supplying the bladder, rectum, and penis that must be identified to avoid nontarget embolization.

MATERIALS: Prostatic artery embolization (PAE) is emerging as an effective, minimally invasive treatment for managing lower urinary tract symptoms (LUTS) caused by benign prostate hyperplasia (BPH). Successful PAE requires accurate identification and selective catheterization of the prostate arteries. CT angiography or cone-beam CT performed before embolization provides a detailed anatomic map to identify the prostate arteries and important variants for procedure planning.

RESULTS: Preprocedure CT angiography and cone-beam CT with detailed multiplanar and 3D reconstructed images provides an overview of the internal iliac and prostate artery anatomy to identify the prostate arteries and anatomic variants. The internal iliac artery most commonly divides into two major branches, the superior gluteal artery and a common trunk involving the internal pudendal and inferior gluteal arteries. Recent studies suggest the pudendal artery is the most common prostate artery origin, followed by the superior vesicle and obturator arteries. The prostate artery supplies superior (anterolateral) and inferior (posterolateral) pedicles as it enters the prostate. The anterolateral pedicle perfuses the central gland and is the primary target for embolization. Identification of variant anatomy, such as accessory pudendal arteries, middle rectal arteries, and alternate prostate artery origins provides important procedure planning to reduce fluoroscopy time, contrast dose, and avoid ischemic complications of non-target embolization.

CONCLUSIONS: Preprocedure and cone-beam CT provide detailed evaluation of the pelvic arterial anatomy. Effective and safe prostate artery embolization requires a comprehensive understanding of pelvic arterial anatomy, including the prostate artery origins, anastomoses, and variants.
**Abstract No. 842**

**Diagnosis and treatment of vascular malformations: a review of current practice and future directions**

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**PURPOSE:** To define vascular malformations, understand common classification nomenclature, and review diagnostic workup and treatment.

**MATERIALS:** Vascular malformations (VMF) encompass disorders in embryological development of vessels lined by endothelial cells. VMF may be isolated or arise in multiple locations throughout the body. While a classification system of VMF has long been established by the International Society for the Study of Vascular Anomalies (ISSVA) and is widely used, it is important to review other classification schemes, evaluative imaging, and treatments used in an ever-evolving practice. Depending on diagnosis, a range of treatments is currently available.

**RESULTS:** VMF can be separated into low and high-flow lesions. Low-flow VMF include capillary (CM), venous (VM), lymphatic (LM), and mixed malformations. High-flow types include arteriovenous malformations (AVM) and arteriovenous fistulas (AVF). Other classification systems such as the SE Mitchell Vascular Anomalies Flow Chart (SEM-VAFC) help physicians classify anomalies based on clinical symptoms, physical exam findings, and imaging. Low-flow VMFs can present with a variety of symptoms including pain due to thrombosis, recurrent infections (with LM), neuromuscular impairment, and cosmetic deformity. These symptoms can also be present in high-flow VMF, in addition to bleeding and heart failure. Ultrasound has some utility in the diagnosis and treatment of low-flow VMFs, but MRI is the preferred imaging modality. Time-resolved angiography with interleaved stochastic trajectories (TWIST) 3D MRA technique can be used to diagnose low-flow VMF subtypes with high sensitivity. For high-flow VMF, CTA, MRI, and ultrasound are key modalities for diagnostic evaluation. Interventional therapies are the gold standard of treatment. Depending on the lesion, sclerotherapy or embolization guided by US, fluoroscopy, or MRI can be used.

**CONCLUSIONS:** Vascular anomalies are a heterogeneous group of disorders that require multidisciplinary care and treatment. Knowledge of ISSVA and SEMVAFC is necessary to maintain a common and consistent language. Interventional treatments remain the gold standard of treatment for most VMF.

**Abstract No. 843**

**Going green: why indocyanine green fluorescence angiography matters for vascular and interventional radiology**

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**PURPOSE:** To demonstrate the benefits and potential VIR applications of Indocyanine Green Fluorescence Angiography (IGFA)

**MATERIALS:** IGFA is a relatively new imaging modality. Indocyanine green dye is injected and visualized with a near-infrared laser emitting charge-coupled device camera. IGFA has been successfully used for real-time imaging of extremity vasculature and is able to provide both qualitative and quantitative data. Although there is limited published data on the use of IGFA, multiple specialties have started using this new dye for imaging purposes and there is great potential for application to the field of VIR

**RESULTS:** Patients with critical limb injuries have been evaluated for salvage vs. amputation with IGFA by directly visualizing perfusion to the site of injury. It is then determined whether to proceed with amputation or attempt salvage by an alternative intervention. The camera is positioned at the site of injury using lasers for localization after which the indocyanine dye is injected. In real time, the camera transmits video imaging of the vasculature and surrounding soft tissue injury providing immediate qualitative data. Flow metrics can be calculated to serially monitor perfusion around the site of injury while correlating that with real-time vascular imaging

**CONCLUSIONS:** IGFA has been used in other specialties to visualize vessel opacification in real-time and obtain angiosomal flow characteristics to injuries before, during, and after treatment. The applications to VIR are vast including the potential for obtaining immediate poststenting results intraprocedurally with the goal of improving patency and perfusion success rates, as well as broader applications in the treatment of peripheral vascular disease. Furthermore, since indocyanine green has the added benefit of hepatic excretion, the application of IGFA to the field of IR as an alternative or adjunct to iodinated contrast could prove beneficial in patients with poor renal function. Additionally, this modality is attractive as it does not involve the emission of ionizing radiation, which is safer for our patients and IR personnel. Our field is expanding and innovating and IGFA may have a significant role in the future

**Abstract No. 844**

**Computed tomography angiography in abdominal solid organ trauma: a pictorial assay with angiographic correlation and management strategies**

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**PURPOSE:** Review imaging findings and grading of solid organ trauma (SOT) presented as an overview of computed tomography angiography (CTA) findings with angiographic correlation. Describe clinical scenarios and CTA findings which call for angiographic evaluation and
intervention based on a review of literature. Review different endovascular interventions, complications, and outcomes of SOT. Present a protocol to guide management of patients with SOT.

**MATERIALS:** Multi-detector dual phase CTA has become an integral part of the evaluation of patients with blunt trauma of the abdomen. Understanding the imaging findings and correlating with clinical status guides the management decisions for patients with SOT. Interventional radiology plays a pivotal part in patients with SOT. This educational abstract will present an overview of the CTA findings with angiographic correlation and various techniques for the management of these patients by interventional radiology.

**RESULTS:** CTA manifestations of SOT in the spleen, liver, and kidney include capsular and/or intraparenchymal lacerations and hematoma. CTA may also demonstrate infarcts or injury to the collecting system in the setting of renal injury. Findings on angiography include active extravasation, transection, pseudoaneurysms, and arteriovenous fistulae. Arteriovenous fistulae may also be seen in patients with renal injury. Types of embolic agents used are operator dependent and specific techniques employed will vary based on pattern of injury and anatomic considerations. These include coils, particles (polyvinyl alcohol and tris-acryl gelatin microspheres), n-butyl cyanoacrylate, and Onyx.

**CONCLUSIONS:** Solid organ trauma review - Overview of current AAST injury grading of spleen, liver, and renal injuries. - Pictorial and multimodality imaging review of CTA findings with angiographic correlation. - Clinical consequences of CTA findings. - Indications for endovascular management. Endovascular intervention - Treatment strategies and angiographic interventions based on injured organ, type of injury, and injury severity - Coil embolization - Particle embolization - Glue embolization - Onyx embolization - Outcomes and complications of various techniques protocol for management.

**Abstract No. 845**

**Diagnosis and treatment of deep vein thrombosis resulting from caval variants**

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**PURPOSE:** 1. Describe the embryological formation of the Inferior Vena Cava: the normal physiology and the anatomic variations that can occur. 2. Describe the pathophysiology of deep vein thrombosis in patients with variant IVC anatomy. 3. Recognize and describe May-Thurner syndrome as a unique diagnostic pitfall. 4. Describe the role of cross-sectional imaging in both diagnostic and therapeutic decision making. 5. Describe the procedural steps in endovascular treatment of deep vein thrombosis.

**MATERIALS:** Azygous continuation is a rare venous anomaly with a reported incidence of 1.5-2% in literature. The embryologic formation of IVC is complex. The IVC is derived from the subcardinal, supracardinal, and posterior cardinal veins. Any interruptions in the timely and sequential formation and regression of these veins can lead to anatomic variations, including absence of certain segments of the IVC, causing venous return to be redirected to the azygos system. Most patients remain asymptomatic, and azygous continuation is found incidentally on imaging. However, increased hydrostatic pressure within the azygos system can cause venous stasis of the lower extremities and viscera, predisposing to venous thrombosis.

**RESULTS:** We present a unique case of symptomatic DVT in a young female on OCPs. A 19-year-old woman presented with left lower extremity pain and swelling. Initial work up including lower extremity Doppler ultrasound did not reveal a thrombus. Further investigations with cross-sectional imaging revealed unique findings. CT imaging of the pelvis revealed a stenotic-appearing segment of the left common iliac vein, initially leading to a diagnosis of May-Thurner syndrome. However, imaging also revealed aberrant anatomy. The patient underwent thrombolysis. We present pictorial representation of this unique variant of azygous continuation and other variants of IVC anatomy. Procedure details and clinical findings are discussed in further detail.

**CONCLUSIONS:** Azygous continuation may predispose to symptomatic DVT. May-Thurner syndrome is a potential diagnostic pitfall. Cross-sectional imaging has immense importance in diagnosis of specific variants, helping guide interventional and therapeutic decision making.

**Abstract No. 846**

**Review of the etiologies, imaging findings, and image-guided treatments of chronic mesenteric ischemia**

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**PURPOSE:** 1. Review the various etiologies of chronic mesenteric ischemia. 2. Illustrate the multimodality imaging features of these disease processes. 3. Discuss the percutaneous treatment options that interventional radiologists can offer.

**MATERIALS:** Chronic mesenteric ischemia is a debilitating and difficult to diagnose entity with a wide variety of etiologies. Interventional radiologists are uniquely equipped to care for these patients with various diagnostic and percutaneous treatment options.

**RESULTS:** We aim to review the various etiologies of chronic mesenteric ischemia, their imaging findings, and image-guided treatment options. Specific etiologies reviewed include celiac and SMA atherosclerotic stenosis, aortic dissection, median arcuate ligament syndrome, vasculitis, mesenteric venous thrombosis, and fibromuscular dysplasia. Multimodality imaging findings on angiography, ultrasound, computed tomography, and magnetic resonance imaging will be presented.

**CONCLUSIONS:** Interventional radiologists possess unique diagnostic and interventional skills to offer patients suffering from debilitating chronic mesenteric ischemia. It is therefore essential for interventional radiologists to readily identify findings on various imaging modalities and provide percutaneous treatment interventions.
Abstract No. 847

Putting the heart before the hoarse: a rare case of Ortner syndrome and aortosternal venous compression in left recurrent laryngeal nerve palsy

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PURPOSE: • To present a unique case of two rare syndromes in a patient: Ortner syndrome (OS) and Aortosternal venous compression (AVC) • To present clinical and imaging profile of both syndromes

MATERIALS: OS is a rare cause of hoarse voice, where a left recurrent laryngeal nerve palsy (LRLN) occurs secondary to a cardiovascular disease. AVC refers to compression of the brachiocephalic vein between aorta and sternum. We present a unique case of a patient with a thoracic aortic aneurysm causing both rare syndromes.

RESULTS: A 70-year-old female presented with dysphonia and dysphagia of liquids for 2 months. She had a history of benign vocal cord tumor 30 years ago, and congestive heart failure with left ventricular diastolic dysfunction. She has recently been suffering from depression exacerbated by being unable to keep in touch with family over the phone because of her weak voice. Clinical exam showed a breathy, hoarse voice, and videostroboscopy showed left vocal cord paralysis in full abduction. Contrast-enhanced CT scan of the neck showed asymmetric abduction of the left vocal cord. IV contrast was seen refluxing in the left internal jugular vein and perivertebral venous plexus. The left brachiocephalic vein was significantly compressed by the brachiocephalic artery and left common carotid artery while passing between the sternum and great arteries. There was also a large aortic arch aneurysm, in the location where the LRLN wraps and passes behind it. These findings are consistent with OS, with superimposed AVC.

CONCLUSIONS: We describe the clinical and imaging profile of OS and AVC, caused by a large aortic arch aneurysm. A timely diagnosis of these syndromes is important, as the LRLN palsy is reversible with treatment of underlying cardiovascular disease.

Abstract No. 848

Technical pearls for perilous ablations

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PURPOSE: This exhibit aims to provide periprocedural adjunctive techniques to facilitate otherwise difficult percutaneous ablations, potentially increasing the number of tumors that can safely be treated and decreasing complications.

MATERIALS: Percutaneous tumor ablation is rapidly gaining acceptance as a minimally invasive treatment for the management of many soft tissue tumors. However, as the popularity of these procedures increases, so have the recognized challenges of treatment and complications. Over the last few years, several techniques have been published to improve patient safety and outcomes. This exhibit will summarize such maneuvers and illustrate other adjunctive techniques that have been found to be of particular benefit.

RESULTS: Imaging techniques: • ultrasound-fusion imaging for lesion localization • contrast-enhanced ultrasound to identify index lesion(s) • manual dose reduction during CT monitoring • scan technique for efficient image reconstruction Procedural techniques: • hydrodisplacement and other mechanical displacement maneuvers • ureteral stents to protect collecting system • bladder catheter to monitor urine output of solitary kidney • selective embolization to minimize bleeding • nerve monitoring to minimize risk for nerve injury • alpha blockade prior to adrenal ablation

CONCLUSIONS: Several techniques have been described to assist with difficult ablations, and have expanded the number of tumors that can be safely treated with percutaneous ablation. Tumor locations that were previously considered high-risk, in close proximity to vital structures, are now more accessible and amenable to ablation. These techniques may afford a greater number of patients the option of percutaneous ablation, decrease complication rates, shorten hospital stays, and improve oncologic outcomes.

Abstract No. 849

Application of ultrasound contrast agent in interventional radiology

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PURPOSE: To demonstrate various applications of the ultrasound contrast agent in invasive procedures such as 1) contrast-enhanced ultrasound (CEUS)-guided biopsy, 2) radiofrequency ablation (RFA) planning ultrasound, and 3) CEUS-guided RFA.

MATERIALS: Contrast-enhanced ultrasound (CEUS) is recently introduced for helping diagnose hepatic tumors. Its role has been primarily focused on differentiating benign and malignant focal hepatic lesions. However, ultrasound contrast agents can be used in interventional radiology to help target an isoechoic hepatic tumor or locate an index tumor precisely prior to biopsy or RFA.


CONCLUSIONS: CEUS can be applied to invasive procedures such as biopsy and RFA especially when a target nodule is isoechoic on gray-scale ultrasound.
Abstract No. 850

High intensity–focused ultrasound in pain management and palliative care: key concepts, review of the literature, and future directions

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PURPOSE: To familiarize interventionalists to the basics of high intensity-focused ultrasound (HIFU), its current applications, and its emerging role in pain management and palliative care.

MATERIALS: HIFU is a non-invasive image-guided thermal ablation technique that delivers focal ultrasound energy to a specified region. It induces thermal as well as mechanical damage that can consequently be monitored using ultrasound or magnetic resonance imaging. Its thermal effects include thermal fixation; while, its mechanical effects include cavitation, microstreaming, and radiation force. At present, HIFU is approved by the FDA for the treatment of metastatic bone cancer, prostate cancer, and uterine fibroids. Internationally, HIFU has been used as a palliative treatment for painful bone metastases and pancreatic cancer. While the advantages of HIFU therapy are remarkable, it is still a new intervention that requires further investigation.

RESULTS: HIFU targeted tissue can reach temperatures of 60-80°C within seconds of induction for ablation. It first causes denaturation of intracellular proteins, which is followed by cellular degeneration, liquefaction, and coagulative necrosis in the targeted region. These changes can be monitored real-time using ultrasound or magnetic resonance imaging. Additionally, the ablative effects of HIFU are highly confined to the targeted focal region, minimizing non-specific periablative tissue damage. In the context of pain management, HIFU is utilized in patients where both opioids and neurolytic therapies have failed. Furthermore, HIFU is not only non-invasive, but also provides rapid pain relief while demonstrating a high safety profile.

CONCLUSIONS: As HIFU continues to advance in various fields of medicine, such as pain management, it is important to critically evaluate and weigh the advantages and disadvantages of this new modality to maximize utility and improve clinical outcomes.

Abstract No. 851

Practice makes perfect: inexpensive homemade models for trainees to gain experience prior to performing ultrasound-guided biopsies on live patients

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PURPOSE: Understand the benefits of using simulation models to provide trainees with experience with ultrasound-guided (USG) biopsies. Learn how to create inexpensive, customized homemade models for trainees to perform USG biopsies at your institution.

MATERIALS: The first time most trainees perform a USG biopsy, the needle is in a live patient. It is not uncommon for the inexperienced trainee to lose sonographic visualization of their needle tip or lack the skills to keep the needle and target in the same sonographic window. To minimize patients risks, we started creating ultrasound phantoms for trainees to gain skills, prior to performing these techniques on live patients.

RESULTS: Our institution has created inexpensive homemade simulation models for USG biopsy practice with easily obtained materials. This presentation will describe a specific mixture of gelatin, psyllium, and food coloring to create an optimal consistency of opaque gel with echotexture which is formed into layers with various sized targets. The reader will learn to customize each biopsy model with various sizes of biopsy targets (0.5 cm - 2.0 cm) including commonly obtained items (ie, raisins, olives, cherry tomatoes, etc) within the deeper layers. By learning to create these inexpensive, re-usable USG biopsy phantom models, trainees can use the models to gain experience with the equipment and improve their hand-eye coordination prior to performing USG biopsies within live patients. Trainees are encouraged to use progressively smaller sized needles to target deeper and smaller targets to progressively improve their skill levels. If refrigerated between use, these models often last 10 to 14 days prior to discard, which allows trainees extensive time to improve their skills and familiarity with USG biopsy.

CONCLUSIONS: This presentation will help users learn how to create customized, inexpensive, re-usable home-made USG biopsy models to enable trainees to gain valuable experience and improve their skills prior to performing these procedures in live patients, increasing patient safety and simultaneously improving trainee competency.

Abstract No. 852

Preoperative computed tomography–guided lung nodule wire and radiolabeled localization: a single-institution experience

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PURPOSE: To understand the role of image-guided lung nodule wire and radiolabeled localization prior to video assisted thoracoscopic surgery (VATS) for wedge resection. To review our institution’s experience using four different preoperative lung nodule localization methods (microcoil, Q-wire, Homer, Technetium-99m labeled radiotracer) and their respective outcomes.

MATERIALS: Localization of small nodules offers a challenge to surgeons. Localization intraoperatively can be done with wires or radiolabeled material positioned close to the nodule. In the CT-guided percutaneous wire placement, the pleural end of the wire is visualized on the collapsed lung during surgery localizing the nodule to be selectively excised. Alternatively, the CT-guided radiolabeled localization approach requires injection of 0.3 mCi of Technetium-99m labeled...
radiotracer close to the lesion which can subsequently be identified intraoperatively. We aim to compare the different approaches (microcoil, Q-wire, Homer, radiolabeled) in this review.

RESULTS: Retrospective review at our institution (2013-2017) demonstrated 38 patients (67.1 ± 9.5 yrs) who underwent CT-guided lung nodule localization, 10 microcoils, 7 Q-wire, 1 Homer and 20 using radiolabeled approach. No statistical differences were found in the average nodule size for each approach with an average size of 13 ± 3 mm. The targeting distance, average distance of localizing wire to center of lesion, was microcoil 7 ± 4 mm, Q-wire 4 ± 5 mm, Homer 15 mm and radiolabeled 8 ± 7 mm. Average time to perform procedure with microcoils was 31.2 ± 9.1 min, Q-wires 22.6 ± 14.6 min, Homer 49.1 min, radiolabeled 34.9 ± 13.5 min. There were not statistically significant differences in pneumothorax rates between microcoils (r = 0.10), Q-wire (r = 0.14) and radiolabeled approach (r = 0.15). Pneumothorax developed in the single Homer case. Pleural surface was not reached by one of the microcoil wires. The diagnostic yield was 100% in our cohort.

CONCLUSIONS: Q-wire method was faster and localized closer, but the difference was not statistically significant. After this exhibit, the attendee will understand the differences in our experience with the four CT-guided lung localization methods used in our institution.

Abstract No. 853

Transcatheter arterial chemoembolization of hepatocellular carcinoma through extrahepatic arteries: a case series

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PURPOSE: Comprehensive evaluation of hepatocellular carcinoma (HCC) blood supply post transcatheter arterial chemoembolizations (TACE) is critical. Tumor blood supply should be thoroughly evaluated using cross-sectional imaging, both pre- and posttreatment. The exhibit also highlights HCC behavior after TACE, particularly the potential for extrahepatic arterial recruitment. Several cases of HCC requiring additional TACE via extrahepatic arteries after the initial TACE treatment are provided.

MATERIALS: HCC is a hypervascular tumor and receives the majority of blood supply from the hepatic arteries, therefore accounting for the success of arterial procedures such as chemoembolization. Occasionally post-TACE imaging demonstrates portions of HCC with unchanged arterial enhancement and washout characteristics suggesting poor response to treatment. Upon further investigation, the persistent enhancement is often related to additional extrahepatic arterial supply to the tumor. This additional supply may be preexisting or due to the changes in tumor behavior post TACE, including from the arterial recruitment characteristics of HCC.

RESULTS: Four cases are provided with a similar history of incomplete HCC response post TACE, all of which were found to have an additional, often much smaller, extrahepatic arterial supply. The extrahepatic arterial supply in all cases underwent an additional, successful TACE session. The extrahepatic arterial supply in these cases include the inferior phrenic artery, internal mammary artery, gonadal artery, and adrenal artery.

CONCLUSIONS: In conclusion, HCC is a hypervascular tumor that receives blood supply predominantly from the hepatic arteries. TACE via the hepatic arteries is often sufficient for complete tumor coverage; however, if there is incomplete tumor response, additional extrahepatic supply should be considered. This extrahepatic supply can be identified by close scrutiny of preprocedural imaging, ideally leading to complete tumor chemoembolization. Evaluation is particularly important after the initial TACE procedure, as HCC is known to recruit new arterial supply.

Abstract No. 854

Doxycycline-based sclerotherapy of aneurysmal bone cyst: an emerging alternative treatment strategy

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PURPOSE: To familiarize the reader with the growing indications and techniques for percutaneous sclerotherapy for aneurysmal bone cysts (ABC). Therapeutic techniques in two cases will be reviewed.

MATERIALS: ABCs are benign, locally aggressive lesions common in adolescents for which intervention is indicated due to pain, disruption of joint spaces, or growth disturbance. Historically treated by en-bloc resection, the current gold standard of management is surgical curettage; however, minimally invasive strategies including embolization and sclerotherapy have risen in prominence and proven efficacy. At our institution sclerotherapy using doxycycline mixtures has become an alternative management strategy, with several encouraging results.

RESULTS: Case 1: A 9-year-old boy presented with subacute gait disturbance and severe hip pain requiring admission for pain control and was discovered to have a 4.6 × 6.4 × 7.8 cm ABC in the right ischium of his pelvis. IR was consulted for definitive treatment by pediatric orthopedics. Percutaneous access into the ABC was obtained under fluoroscopic and ultrasound guidance. A mixture of 200-mg doxycycline, 5 cc of 25% albumin, 5 cc of contrast, 5 cc of air was injected under image guidance into the center of the ABC and allowed to dwell for 1 hour. Repeat treatment attempt was terminated after the ABC wall was found to have thickened, repeat plain radiography and MRI confirmed ABC ossification and decrease in size to 4.3 × 2.3 × 3.3 cm, with complete resolution of his pain and gait disturbance Case 2: A 7-year-old girl was discovered to have a 3 × 1.9 × 2.3 cm ABC in the medial aspect of the right clavicle. Definitive treatment by IR was sought after outpatient consultation. Percutaneous access was gained under fluoroscopic and ultrasound guidance. A mixture of 200 mg doxycycline, 5 cc of 25% albumin, 5 cc of contrast, 5 cc of air was injected under image guidance into the center of the ABC and allowed to dwell for 30 minutes. A repeat MRI in 1 month showed slightly increased size to 3.3 × 2.3 × 2.8 cm and evolving internal structure.
CONCLUSIONS: Percutaneous sclerotherapy with doxycycline is becoming recognized as an alternative treatment for ABCs.

Abstract No. 855

Computed tomography–guided percutaneous celiac plexus nerve block: a novel approach using a steerable needle enabling active guidance

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PURPOSE: 1. To review the common indications, patient selection, methods, and complications for CT-guided percutaneous celiac plexus nerve block. 2. To describe potential anatomic challenges when the more common posterior approach is used for celiac plexus nerve block. 3. A case example will be presented demonstrating the novel use of a steerable needle enabling active guidance (AprioMed Morrison™), allowing for a successful neurolytic celiac plexus block despite a challenging anatomic scenario.

MATERIALS: Patients suffering from advanced stage upper abdominal or retroperitoneal malignancies often experience debilitating abdominal pain. Conventional medical management of intractable pain can be inadequate, forcing clinicians to seek alternative modalities to provide appropriate palliation. A percutaneous celiac plexus nerve block provides analgesia by introducing a neurolytic agent across the sympathetic afferent visceral nerves. The use of CT-guidance for a posterior approach has emerged as the most common technique for this procedure. The challenging nature of retroperitoneal anatomy often necessitates novel approaches to improve the safe and effective delivery of the neurolytic agent, without injury to adjacent vital structures.

RESULTS: The target zone for neurolysis is guided anatomically by the celiac artery and root of the superior mesenteric artery. We describe a case of lung carcinoma in a 63-year-old female with extensive retroperitoneal metastases. The lack of retroperitoneal fascial planes due to mass effect made a standard straight needle path unsuitable for safe delivery of the neurolytic agent. As a result, a steerable needle was chosen, which allowed for optimal positioning in the retroperitoneal space by a posterior unilateral approach. The patient’s preprocedure pain of 7/10 decreased to 2/10 postprocedure.

CONCLUSIONS: The use of a steerable needle with active guidance can be helpful in navigating challenging retroperitoneal anatomy encountered during CT-guided percutaneous celiac plexus nerve blocks. This approach may optimize a unilateral approach if a bilateral paraspinal/transcrural approach is unfavorable and may result in the enhanced palliation of abdominal pain.

Abstract No. 856

Interventional oncology: understanding chemotherapy and chemotherapy regimens

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PURPOSE: Understand the basics of chemotherapy for the common cancers involving the liver (hepatocellular carcinoma, colorectal cancer, and neuroendocrine cancer) to prepare the interventional radiologist for an active role in Tumor Board.

MATERIALS: If interventional radiology is to become the fourth pillar of oncology, the interventional radiologist must become familiar with the language of cancer. One of the main components of cancer therapy is chemotherapy. Unfortunately, most radiologists are not familiar with details of chemotherapy to “speak the language.” Interventional radiologists need to understand chemotherapy and the different chemotherapy regimens utilized for the most common cancers that they will encounter in Tumor Board. Moreover, they need to understand the literature and trials supporting the chemotherapy regimens.

RESULTS: The Exhibit reviews the chemotherapy regimens available for the most common cancers encountered by the interventional radiologist. For hepatocellular carcinoma, Sorafenib and Regorafenib are reviewed including their indications, contra-indications and possible adverse reactions. Similarly, the chemotherapy regimens for colorectal cancer are reviewed including FOLFOX and FOLFIRI. Neuroendocrine cancers regimens are also covered. Finally, new agents such as immune checkpoint inhibitor drugs (pembrolizumab and nivolumab) are detailed. The new agents are approved for cancers with specific genetic features, not just tumor type. Nivolumab has also just been approved as a second line chemotherapy agent for hepatocellular carcinoma.

CONCLUSIONS: To become an interventional oncologist and have an active role in Tumor Board and referring services, the interventional radiologist must have a good understanding of the basics of chemotherapy for the most commonly encountered cancers.

Abstract No. 857

Renal angiomyolipomas: from A to Z, what the interventional radiologist needs to know

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PURPOSE: In this exhibit, we aim to provide interventional radiologists with a comprehensive review of the epidemiology, clinical symptomatology, different imaging characteristics, and IR-based treatment of renal angiomyolipoma (AML). Different cases of AML from our institution will be illustrated and discussed with main focuses on angiographic findings, embolization techniques, the key role of IR in the management of these tumors and possible post-IR treatment complications.

MATERIALS: AMLs are benign triphasic renal mesenchymal neoplasms composed of a dysmorphic vasculature, smooth muscle and mature adipose tissue that occur sporadic (80%) or associated with tuberous sclerosis (TS) (20%). Diagnostic challenge rises when the amount of intratumoral fat is low (lipid poor AML, up to 5% of cases), an aggressive type is present or an exophytic pattern is seen. Tumors larger than 4 cm or presence and size of intratumoral aneurysms larger than 5 mm
are at increased risk of bleeding and therefore, intervention is required. Postembolization syndrome, nontarget embolization, abscess formation, and pleural effusion are described potential complications of IR-based embolization treatments.

RESULTS: Multiple various management options are available for AMLs including total or partial nephrectomy, ablation (selected cases with small size), and arterial embolization. Choice of an appropriate strategy is determined based on AML size, number of lesions, presence and size of aneurysm, clinical features, and presence of TS. Selective renal angiogram, super-selective angiogram of renal artery branch and embolization utilizing alcohol, glue, Gelfoam, Onyx or Micro coils are simplified technical steps of endovascular treatment which have demonstrated higher technical success and lower mortality rates when compared to nephrectomy.

CONCLUSIONS: A thorough knowledge of the combination of the typical and atypical imaging findings of AML to make the correct diagnosis and recommendations to guide the management, and the key role of IR-based endovascular treatment seems warranted for every interventional radiologist.

Abstract No. 858

Clinical and technical considerations in adrenal artery embolization for symptomatic adrenal tumors

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PURPOSE: A case report will illustrate the important clinical and technical factors involved in endovascular management of a symptomatic adrenal tumor. A review of the literature will help elucidate common lesions, the pathology behind their symptomatology, and techniques for avoiding pitfalls.

MATERIALS: The vast majority of adrenal tumors are dismissed as asymptomatic incidentalomas. Less than 10% of incidentally discovered adrenal tumors have clinically significant endocrine functionality and even fewer are malignant. However, even benign lesions, like adrenal myelolipomas, can result in massive traumatic or spontaneous retroperitoneal hemorrhage because of the unique vascular architecture of the gland. Yet, it is this same complex structure that necessitates careful planning and execution of endovascular therapies.

RESULTS: 1. A case of massive spontaneous retroperitoneal hemorrhage secondary to bilateral hepatocellular carcinoma adrenal metastasis will illustrate important clinical and technical considerations. 2. Variant arterial anatomy arising from the celiac axis, aorta, inferior phrenic, renal and intercostal arteries is made more convoluted by variant anterior spinal and renal artery anatomy. 3. The selection of embolic agents is in part determined by whether the goals of therapy are palliative pain relief, hormone suppression, tumor debulking, or hemostasis. 4. Possible postprocedural adverse events, such as pleural effusion, hiccups, symptom recurrence or acute adrenal insufficiency, can be altered by the extent of therapy.

CONCLUSIONS: A wide variety of primary, metastatic, malignant, neuroendocrine and benign tumors can occupy the adrenal parenchyma. An understanding of the adrenal vascular anatomy, the underlying disease pathology, prevalence of commonly symptomatic lesions, and clinical indications for endovascular therapy can assist in appropriate embolic selection, preprocedural planning, and complication mitigation.

Abstract No. 859

Alphabet soup of immuno-oncology: what the interventional oncologist needs to know

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PURPOSE: Immuno-oncology is a rapidly evolving field in cancer therapy. The currently employed immune therapies are first line chemotherapy regimens in lung, colon, liver cancer. The interventional oncologist should be aware of these first line therapies, effectiveness and mechanisms. Knowledge of the common immunotherapies makes us better participants in tumor boards

MATERIALS: Cancer immuno-oncology is used in standard of care therapies in most common cancers. Words like PD1/PDL1, CTLA4, ADC, checkpoint inhibitor and other commonly used jargon can be intimidating and confusing for the tumor board attendee from IR. This informative poster/presentation will make a simplified, logical approach to these more novel therapies and how they are being used. This hopefully will help us be better tumor board members and be able to understand how these could potentially be used with loco regional therapies.

RESULTS: More proficient understanding of immuno-oncology therapies and how they impact the interventional radiology patient.

CONCLUSIONS: Cancer immuno-oncology is used in standard of care therapies in most common cancers. Words like PD1/PDL1, CTLA4, ADC, checkpoint inhibitor and other commonly used jargon can be intimidating and confusing for the tumor board attendee from IR. This informative poster/presentation will make a simplified, logical approach to these more novel therapies and how they are being used. This hopefully will help us be better tumor board members and be able to understand how these could potentially be used with loco regional therapies.

Abstract No. 860

Making sense of liver-directed therapies for hepatocellular carcinoma: Barcelona Clinic Liver Cancer versus Hong Kong Liver Cancer staging systems

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PURPOSE: Give an overview of treatment options for hepatocellular carcinoma (HCC). Understand the factors that have an impact on the
type of treatment modality suitable for the individual patient, which in turn influence patient survival. Recognize the differences between the Barcelona Clinic Liver Cancer (BCLC) staging system and the Hong Kong Liver Cancer (HKLC) staging system and determine a consensus among clinician preference.

**MATERIALS:** HCC is the second leading cause of cancer-related death in men and the sixth leading cause of cancer death in women worldwide. Tumor-related factors such as tumor size, number of lesions, underlying liver function, and performance status impact the type of treatment modality suited for an individual patient. Various options including resection, transplantation, ablation, transarterial chemoembolization/radioembolization, and Sorafenib are available to patients and can sometimes be confusing for clinicians.

**RESULTS:** The BCLC and HKLC are used to guide treatment based on stage and predict survival outcomes. However, which one is superior? The BCLC has been more extensively used as it has been more well established and can sometimes be confusing for clinicians. The HKLC has been more recently developed. Main criticisms of BCLC include it being generated from a small cohort and from a Western population, which may not be universally relatable. The HKLC was developed from a larger cohort and is more aggressive in management strategy.

**CONCLUSIONS:** Multiple treatment options are currently available for HCC. As IR becomes increasing more clinically oriented the IR physician must understand the clinical implications of HCC treatment to help guide physicians towards appropriate treatment for each patient. Typically, the BCLC staging system was used for this purpose; however, the HKLC was more recently developed. This review will touch on the main points of each and compare their abilities to place patients in curative treatment groups and predict survival.

**Abstract No. 861**

**Anatomy of a hepato-specific nerve block for liver interventions**

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**PURPOSE:** Review sensory nervous anatomy of the liver and targets for the hepatic nerve block on imaging and cadaveric dissection correlation • Identify scenarios for use of hepatic nerve block • Review procedure for performing nerve block • Recognize potential complications of the nerve block and their management

**MATERIALS:** IR has an expanding role in the management of liver disease. The majority of these procedures are performed under conscious sedation. This poses a significant issue in the form of intra/periprocedural pain that is frequently managed with opiates. Safer and more effective alternatives are required as the patients may be sicker and the accompanying side effects, significant and potentially a source of increased morbidity. Whilst other nerve blocks such as a coeliac axis or paravertebral block can be useful, these can be more time and resource intensive (requiring CT). We have successfully developed in our practice a nerve block that is targeted to the hepatic hilum and supplemented this with neural blockade around the hepatic IVC. We have studied the distribution of the concerned nervous supply in cadavers and the distribution of injected substances under ultrasound. Here we will present the anatomy of the liver innervation and imaging and cadaveric correlates and present the distribution of our block injections on imaging in live patients.

**RESULTS:** A 22G needle is placed under US (trans hepatic) so that the tip lies between the portal vein and the hepatic artery. Another 22G needle is placed so that the tip is sited in the space between the hepatic IVC and the liver, just above the hepatic venous confluence. Via each needle, 5 ml of 1% lidocaine with epinephrine (1:200000) is injected to assess for potential intravascular leakage. If there is no reactive tachycardia, 3 ml of contrast followed by 10 ml of 1% ropivacaine is instilled through each needle. Analgesic effect takes place usually within 15 to 20 minutes and can last up to 8 hours.

**CONCLUSIONS:** A hepatic nerve block is a useful adjunctive analgesic procedure in the IR armory. Performing the block safely and efficaciously can be enhanced by understanding the anatomy and targets needed to obtain an efficient block.

**Abstract No. 862**

**Radiation segmentectomy with Yttrium-90 for the treatment of metastatic disease to the liver: a single-institution experience**

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**PURPOSE:** To describe our early experiences with radiation segmentectomy using Yttrium-90 (Y90) glass microspheres for metastatic liver tumors and draw conclusions about patient selection, technical considerations, treatment outcomes and patient safety.

**MATERIALS:** Y90 radiation segmentectomy has become increasingly prevalent and accepted as a treatment method for both primary and secondary liver cancers. While lobar treatment has been well characterized, concerns about liver toxicity and a desire to deliver higher doses of Y90 to target lesions have increased interest in superselective techniques. Radiation segmentectomy, defined as radioembolization of two or fewer hepatic segments, has been described as a therapeutic option for hepatocellular cancer (HCC) not amenable to surgical resection or percutaneous ablation. While the effectiveness and safety of radiation segmentectomy has been studied for HCC, there have been no studies about its uses in secondary hepatic malignancies.

**RESULTS:** Since 2014, our multi-site institution has performed five Y90 radiation segmentectomy procedures for metastatic liver tumors, including colorectal cancer, leiomyosarcoma, and hemangiopericytoma. This presentation will describe our early experience, with particular focus on a unique case of metastatic hemangiopericytoma, to draw insight about: patient selection, in particular the imaging and anatomical criteria; technical considerations including radiation dosage; treatment outcomes which ranged from near complete response to disease progression; and patient safety which included a case of hepatic abscess.
CONCLUSIONS: Our early experience with Y90 radiation segmentectomy for metastatic liver cancer supports its technical feasibility and therapeutic potential, as demonstrated by tumor response, but also of the important need for further study to delineate its safety and clinical effectiveness.

Abstract No. 863

Use of a 3-way for multiple dose vial Y-90 radioembolizations is cost, fluoroscopic dose, and time efficient

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PURPOSE: The reader shall learn an off-label method to inject multiple doses of yttrium-90 (TheraSphere; Nordion, Ottawa, Canada) by use of a very simple to use and commonly available 3-way stopcock. This method potentially saves procedural time, fluoroscopic dose, and cost (i.e. only 1 micro-catheter used).

MATERIALS: Radioembolization with yttrium-90 (Y90) is delivered via glass or resin particles for patients with primary and secondary liver tumors. TheraSpheres are glass particles with Y90 that are injected via a proprietary delivery apparatus. Some therapies require 2 or even 3 dose vials to achieve the calculated dose, with each dose vial, attached connecting tubing (“D” line) and microcatheter having to be disposed in the radioactive waste following individual dose delivery. This necessitates replacing and repositioning a new microcatheter before injecting each additional dose.

RESULTS: We will describe how we have successfully delivered two dose vials of TheraSpheres via parallel outflow “D” lines attached to a standard 3-way stopcock to the hub of a micro-catheter for radioembolization. No dose misadministration occurred. Delivery apparatus set up and off-label arrangement of multiple dose vials in parallel will be described. Delivery method with particular focus on ensuring clearance of particles from the stopcock apparatus will be discussed.

CONCLUSIONS: We have developed an off-label method to efficiency deliver multiple dose vials of TheraSphere via a single standard 3-way stopcock. This procedure has been successful in 11 patients who needed 2 dose vials per treatment. Theoretically, 3 dose vials could be delivered via a single microcatheter via use of 2 stopcocks.

Abstract No. 864

Imaging findings after Yttrium-90 radiation segmentectomy for hepatocellular carcinoma

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PURPOSE: The aim of this comprehensive review is to provide an illustrative summary of the most relevant imaging findings encountered after radiation segmentectomy (RS). We believe this will help radiologists interpret these findings which can influence clinical management and treatment decision-making.

MATERIALS: Yttrium-90 radioembolization is a therapy that has gained rapid clinical acceptance for treatment of hepatocellular carcinoma (HCC). RS is a technique that can deliver high doses (>190 Gy) of radiation selectively to the hepatic segment(s) (≥2) containing the tumor.

RESULTS: With IRB approval, we retrospectively reviewed our Y90 database. Inclusion criteria were: a) Child-Pugh A patients, b) solitary HCC, c) underwent RS and d) had imaging follow-up studies. A cohort of 62 patients was obtained. Median follow-up time to last imaging study was 17 months (range, 2-120). Complete response by mRECIST at 1-month follow-up was seen in 21 patients (34%). A complete response was seen in 60 patients (97%) by EASL and 40 patients (65%) by WHO criteria at any time following Y90. Worrisome enhancement was seen in 32 patients (52%) at 1-month follow-up with complete resolution seen in 20 of these patients (63%) without local disease progression on follow-up imaging 3 months post-Y90. Of the 62 patients, 11 (18%) had disease progression at some point in their follow-up with a median TTP of 2.4 years (95% CI: 21.5-7). Unique findings such as capsular retraction and segmental atrophy was seen in 55 (89%) and 56 (90%), respectively.

CONCLUSIONS: Oncologic imaging response assessment is a complex task which continues to evolve as new treatments are being developed. Imaging plays a major role as it is the method by which treatment success, recurrent disease, and complications are assessed. This evaluation affects subsequent patient management. Response assessment after RS requires a learning curve with common pitfalls that can lead to false positive interpretations and additional (possibly unnecessary) treatments. Findings such as benign geographical enhancement, capsular retraction, and segmental atrophy are some examples of unique post RS response that are not seen in any other treatment.

Abstract No. 865

Percutaneous re-insertion technique of dropped-out pancreatic ductal tube after pancreaticoduodenectomy

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PURPOSE: 1. To understand re-insertion methods of pancreatic duct tube 2. To understand the technical differences of two methods 3. To learn clinical results and impact of the technique

MATERIALS: Pancreatic duct tube (PD tube) is placed after pancreatecoduodenectomy (PD) to reduce the intraluminal pressure at the site of pancreaticojunostomy, so that, in case anastomotic leakage occurred, to minimize pancreatic juice leakage into intraperitoneal space. However, sometimes patients accidently pull out drainage tubes, or spontaneous pancreatic fluid leakage may occur after surgery. In such
cases, percutaneous drainage or operative "re-insertion" are common choice of salvage.

RESULTS: Transjejunal approach: 1. MPD is visualized from catheter inserted through surgical drain placed near pancreaticojejunostomy. 2. Blind jejunal loop is punctured percutaneously with 18-G needle, and the needle is advanced near pancreaticojejunostomy and then guide wire and 5Fr sheath is inserted. 3. Guide wire is further advanced into MPD. 4. Pancreatic drainage tube is inserted into MPD over the wire. Bidirectional approach: 1. MPD is visualized from catheter inserted through surgical drain placed near pancreaticojejunostomy. 2. Through the drain tube, pancreatic ductal tube covered by 5Fr sheath is inserted into elevated jejunum through Anastomosis leakage site. 3. Goose neck snare is inserted from jejunum and tangled with the sheath. 4. The sheath is tugged out to the skin by tug of wire method. 5. Another guide wire is inserted through surgical drain tube into MPD. 6. Pancreatic ductal tube is inserted into MPD over the wire.

CONCLUSIONS: Percutaneous re-insertion is a less invasive and effective salvage technique for postoperative pancreatic duct dropout. By selecting transjejunal approach and bidirectional approach properly, percutaneous re-insertion of pancreatic duct tube is possible.

Abstract No. 866

Case analysis and review of interventional radiology-directed treatment for enterocutaneous fistulae that fail conservative management

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PURPOSE: This exhibit will describe our attempt at treating a complex case of refractory fistulae while also reviewing the multiple treatment options for enterocutaneous fistulae (ECF). Based on our experience and a literature review, we will discuss the most effective, low-cost approach to refractive ECF treatment.

MATERIALS: While some ECF can be reliably treated by conservative measures, a large number are refractory and thus require minimally invasive percutaneous intervention. Most causes of ECF originate from postoperative and/or inflammatory disease with associated complications such as abscess, sepsis, and/or malnutrition. The burden of refractory ECF also incurs an increased mental and financial burden on patients with an overall decreased quality of life. Not all ECFs are the same, thus the IR physician must demonstrate proper judgement when developing a treatment plan while also recognizing that some cases must simply be deferred to surgery. Each patient should be evaluated independently with additional factors accounted for such as fistulae location, size, and quantification of fluid output.

RESULTS: Our focus will be on a specific case demonstrating refractory ECF that have failed to close after 8 months of conservative treatment and numerous catheter exchanges. Our patient initially presented with necrotizing pancreatitis and was placed on extracorporeal membrane oxygenation (ECMO). Key images will be used to demonstrate pertinent findings of fistulography and procedural technique. We will describe our attempt in fistulae closure utilizing a fibrin sealant. Our findings will be compared with other similar cases and alternative techniques previously described in the literature.

CONCLUSIONS: Management of refractory enterocutaneous fistulae have been made easier and more efficient with the use of percutaneous catheter-directed treatment. Fibrin sealants, as well other treatment options, have proven to be an effective means of fistula closure. Nevertheless, selection of a treatment option will depend on each individual patient and availability of treatment products.

Abstract No. 867

Hydrodissection in challenging percutaneous drainages: a pictorial review of different scenarios and management

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PURPOSE: To present a pictorial review of the techniques, anatomical considerations, and management in varied cases of hydrodissection in percutaneous challenging drainages when no safe percutaneous window exists.

MATERIALS: Percutaneous drainages of abdominopelvic abscesses are sometimes technically challenging as a result of anatomic access limitations and absence of safe percutaneous windows imposed by vital structures and create a safe path for challenging drainages. In all the cases, the drainages were successfully performed with no significant complications. All patients recovered completely and were discharged after successful abscessograms and drains removal. We will focus on materials and techniques that will assist the interventional radiologist. We will highlight the unique considerations and pitfalls to avoid injuring vital structures when encountering challenging drainages.

RESULTS: Hydrodissection is a useful technique to displace safely vital structures and create a safe path for challenging drainages. In all the cases, the drainages were successfully performed with no significant complications. All patients recovered completely and were discharged after successful abscessograms and drains removal. We will focus on materials and techniques that will assist the interventional radiologist. We will highlight the unique considerations and pitfalls to avoid injuring vital structures when encountering challenging drainages.

CONCLUSIONS: Hydrodissection is a safe and effective technique in percutaneous challenging drainages when no safe percutaneous window exists. After reviewing this pictorial review, the attendee will be able to understand and add the hydrodissection option when facing challenging drainages.

Abstract No. 868

Long-term survivors after Kasai portoenterostomy: their
complications and the role of interventional radiology

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PURPOSE: 1. To review complications of long-term survivors of Kasai portoenterostomy focusing on the essential role of interventional radiology in their transition to adult care facility. 2. To review cases in order to outline unique challenges and helpful procedural techniques when caring post-Kasai patients

MATERIALS: Since its first introduction in 1959, Kasai portoenterostomy has been a primary salvage procedure for infants with congenital biliary atresia. Twenty-year survival rates with native liver have been reported around 20 to 40%. Many of these patients suffer long-term hepatic complications related biliary drainage, cirrhosis and portal hypertension, which leads to eventual liver transplantation at an older age. As surgical techniques and postoperative management skills have improved, many of these patients survive into their adulthood without liver transplantation and transition into an adult care facility. Once these patients develop hepatic complications, interventional radiology plays an essential role in their multidisciplinary care as these patients are best managed by minimally invasive percutaneous or endovascular procedures as in other complicated hepatobiliary patients.

RESULTS: Complications of adult Kasai survivors include but are not limited to gastrointestinal variceal bleeding, hypersplenism, biliary stricture, and obstruction as well as cirrhosis and hepatocellular malignancy. A case-based pictorial review will present unique challenges and complex postsurgical anatomy of these patients while introducing helpful tips and procedural techniques during the intervention.

CONCLUSIONS: Long-term surviving post-Kasai patients pose unique challenges in adult interventional radiology practice. Understanding their clinical course, complex anatomy, as well as useful skills, will be essential to interventional radiologists as the number of these survivors increases.

Abstract No. 869

Three-dimensional printing of biliary anatomy for preoperative planning

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PURPOSE: Benefits of MR cholangiopancreatography and three-dimensional (3D) Slicer software to elucidate normal/variant biliary anatomy in preoperative surgical planning.

MATERIALS: MRCP provides biliary anatomic information that aids preoperative surgical planning. Visualization of this information is traditionally via maximum-intensity projection of the data and direct viewing of the cross-sectional images. We will demonstrate variant anatomy and pathology using imaging processing, analysis and 3D reconstruction in the open-source 3D Slicer software package.

RESULTS: Hepatobiliary surgery encompasses an array of life-saving procedures including complex tumor resections and liver transplantation. Pre-operative mapping using MRCP scan data is a preferred means of visualization of the hepatobiliary structures. We demonstrate the use of 3D Slicer software for preoperative visualization of biliary anatomy. This process is broken into 3 stages: 1) Collecting MRCP data. It is important that the scan data is acquired using thin image slice thickness to allow for accurate 3D visualizations of good quality. 2) Segmentation of biliary anatomy. 3D Slicer has multiple tools for segmentation of anatomic structures. Difficulty in segmentation is related to the contrast of structures, which is generally high relative to the background, as well as the magnitude of noise present, which may also be high. We process the scan data before segmentation using advanced algorithms to reduce the amount of noise with minimal effect on anatomic boundaries. 3) Producing 3D biliary models. The resulting segmentations produce 3D rendered images that may be viewed stereoscopically, as well as 3D printed models that may be taken to the operating suite. Five cases from our institution are presented to demonstrate normal anatomy, anatomic variants and pathology.

CONCLUSIONS: Using 3D Slicer to produce models of biliary anatomy can demonstrate variant anatomy and pathology clearly, and allow user interaction with the generated models, which may improve spatial understanding of the 3D characteristics of the biliary tree and aid preoperative planning.

Abstract No. 870

Manmade lakes in the liver: the when, the why, and “what now?” of iatrogenic bilomas

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PURPOSE: 1. Review the incidence and risk factors for postsurgical and postpercutaneous ablation complications, with a focus on bile leak and biloma. 2. Discuss the clinical presentation and key imaging features for early and accurate diagnosis. 3. Discuss management strategies for iatrogenic bilomas, including clinical indications for intervention.

MATERIALS: The incidence of iatrogenic bile leaks is rising as less invasive surgical techniques and percutaneous hepatic interventions climb. Radiologic diagnosis is critical to patient management, as clinical signs and symptoms of postoperative or postablation bile leak may be non-specific. Prompt diagnosis and identification of which bilomas require intervention reduce the significant morbidity and mortality that can be associated with bilomas. In this exhibit, we aim to review the imaging features and management strategies of iatrogenic bilomas, with particular attention to what the interventional radiologist should know about when and why to intervene.
RESULTS: 1. Incidence and most common mechanisms of injury for iatrogenic bilomas. 2. Clinical presentation of patients with iatrogenic biloma. 3. Risk factors associated with bile leak and biloma after surgery or ablative therapies, including patient factors, treatment history, and tumor location. 4. Key multimodality imaging findings of biloma with a focus on differentiating bilomas from other postsurgical and postprocedural fluid collections. 5. Sample cases to highlight the multimodality imaging features of bilomas. 6. Management strategies for iatrogenic biloma, with special attention to various percutaneous drainage strategies. 7. Indications for interventional therapies such as percutaneous drainage and biliary stenting.

CONCLUSIONS: As hepatobiliary interventions increase, the rate of iatrogenic biloma will undoubtedly rise. This is an important topic for every interventional radiologist to become familiar with, as understanding the imaging and clinical nuances of this complication help determine the appropriate times to intervene. By increasing our knowledge of how to diagnose and manage iatrogenic bilomas, we can improve patient outcomes and become a more effective member of the patient care team.

Abstract No. 871 — Withdrawn

Biliary debris vacuum aspiration using the Penumbra system

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PURPOSE: 1. To identify vacuum aspiration as a possible solution to biliary obstruction. 2. To list major complications that may occur with this technique.

MATERIALS: Biliary obstruction can result in biliary stasis and elevated serum bilirubin, which often can be relieved using ERCP and percutaneous biliary drains (PBDs). However, due to biliary sludge, tumor overgrowth, or debris in the biliary system, PBDs can become obstructed. We report two cases of persistent biliary obstruction treated with percutaneous biliary aspiration using a novel technique with the Penumbra aspiration catheter.

RESULTS: Patient #1: 44-year-old male with 6-year history of PSC and autoimmune hepatitis presented with repeated episodes of cholangitis and an associated serum hyperbilirubinemia (31.4 mg/dL total bilirubin). Despite multiple treatments with ERCP and bilateral PBD placement, his bilirubin continued to increase. Patient #2: 69-year-old male with ischemic cholangiopathy secondary to DDLT one-year prior. His PBDs repeatedly became occluded despite routine exchanges with aggressive hand aspiration. Technique: For both patients, intraprocedural cholangiograms showed extensive debris in the biliary system. Under general anesthesia, access to the duodenum was achieved using an indwelling biliary catheter, which was exchanged for a 10- or 11-Fr sheath. A Penumbra Indigo Aspiration System was then advanced through the sheath and into the common bile duct. Vacuum aspiration using the Penumbra system was performed beginning at the distal common bile duct and ending at a peripheral duct. Debris was removed during these treatments. The first patient’s bilirubin normalized to 11 mg/dL eight weeks later, and the second patient continued to have significant PBD output four weeks later.

CONCLUSIONS: Our cases demonstrate the feasibility of using the Penumbra aspiration system, under special circumstances, as an adjunct to biliary drainage recalcitrant to traditional techniques. Although no immediate complications were experienced in our cases, major complications including sepsis and bacteremia can occur; therefore, care must be taken while planning and executing any intervention for biliary obstruction.

Abstract No. 872

Percutaneous transhepatic biliary endoscopic holmium laser lithotripsy, a single-center experience

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PURPOSE: Overview of biliary ductal lithiasis and treatment modalities. Describe biliary endoscopic holmium laser lithotripsy (BELL) in the treatment algorithm for biliary ductal lithiasis. Describe the equipment and techniques utilized in BELL. Review patient demographics, indications, and technical success rates for BELL over a 5-year period. Discuss the future role of interventional radiology (IR) in the treatment of biliary ductal lithiasis.

MATERIALS: Intra and extrahepatic biliary ductal lithiasis is a significant source of morbidity in the United States with a rising prevalence. Specifically, intrahepatic disease is estimated to affect approximately 1% of the adult population in the Western world. Endoscopic retrograde cholangiopancreatography (ERCP) is the mainstay therapy for extrahaepatic biliary ductal lithiasis, whereas partial hepatectomy is the first-line treatment of intrahepatic disease. BELL, with origins in endourology, serves as an effective minimally invasive alternative in treating biliary calculi.

RESULTS: Patients are initially evaluated to determine whether criteria are met for BELL, including clinical examination, additional imaging and/or laboratory studies. In preparation for endoscopy, patients undergo percutaneous cholangiography with placement of an internal/external biliary catheter which is sequentially upsized to 20F to accommodate the endoscope. Following a 6-week tract maturation period, patients are able to undergo BELL. Between 2005-10, 31 patients were treated with BELL for biliary ductal lithiasis not amenable to other treatment modalities. 67% patients underwent multiple interventions for complete resolution of disease with a mean of 2.03 sessions. We achieved a 100% technical success rate within our cohort, defined as cholangiogram-proven stone-free status following the treatment course.
CONCLUSIONS: BELL is a safe and effective alternative for patients with biliary ductal calculi not amenable to other treatment modalities. Endoscopy, as used in BELL, is an area with great potential in the field of IR.

Abstract No. 873
The role of U-type percutaneous cholecystostomy in the management of acute cholecystitis requiring long-term drainage
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PURPOSE: 1. Discuss the clinical challenges of percutaneous cholecystostomy (PC) dislodgement. 2. Describe a secure novel technique U-type PC.

MATERIALS: Most cases of acute cholecystitis (AC) are managed by cholecystectomy. PC is an accepted, non-operative management option. In selected series, the incidence of dislodgement of a PC may be as high as 16% and associated with significant morbidity (Howard, Int J Surg, 2009). In the event of PC dislodgement, management may be conservative, if the acute phase of AC has resolved. PC re-insertion may be necessary if there is recurrent AC or bile leak. The risk factors for PC dislodgement are not clearly defined in the literature. An uncooperative patient and morbid obesity can be associated with PC dislodgement. A PC with a design that reduces likelihood of dislodgement would be of great value especially in patients requiring long-term drainage.

RESULTS: This exhibit presents 6 patients in which a novel U-type PC was used to provide more secure access to drain the gallbladder that prevented PC dislodgement. The mean age was 63 with 4 males and 2 females. The U-type PC requires two separate access sites where a catheter with a middle locking pigtail was utilized. The technique of the U-type PC placement will be described in further detail through illustrations and imaging. Patients chosen were either designated to go to hospice, had altered mental status or large body habitus with an increased risk of PC dislodgement. The mean follow-up was 20 weeks. There were no instances of catheter dislodgement of the U-type PC during the follow-up period. All U-type PC placed were 10.2 Fr. Only 2 patients required PC exchange to 14 Fr during the follow-up period. There were only 3 episodes of catheter occlusion/malfunction due to retained debris. None of the U-type PC patients experienced inadvertent catheter dislodgement, bleeding, peritonitis or pleural effusion.

CONCLUSIONS: Inadvertent dislodgement of a PC can represent a significant clinical problem. This exhibit describes a novel technique of U-type PC placement that provides an alternative to conventional single-entry, locking pigtail catheter for long-term gallbladder drainage in selected patients.

Abstract No. 874
Therapeutic options for biliary leaks: an evolving role for interventional radiology
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PURPOSE: The learning objectives of this educational exhibit are three-fold: 1) To discuss the incidence, etiology and anatomic considerations of biliary leaks; 2) To describe the management options for biliary leaks; and 3) To describe innovative percutaneous techniques to manage biliary leaks.

MATERIALS: Biliary leaks represent a challenging problem following either abdominal trauma, rupture of liver abscesses, or after surgical interventions with an incidence of 0.5 to 21%. Anatomic considerations include a clear depiction of the biliary tree anatomy, as well as site and extent of bile duct injury with percutaneous transhepatic cholangiography (PTC). The surgical management of biliary leaks can be associated with high morbidity and mortality. For that reason, endoscopic and percutaneous techniques have evolved as innovative options for managing this problem.

RESULTS: Percutaneous options include biloma drainage, percutaneous transhepatic biliary drainage (PTBD), embolization of the leaking biliary radicle, stent graft placement, rendezvous procedure or ablation of the leaking biliary segment. Biloma drainage and PTBD represent the most common procedures but can sometimes be challenging due to the central location of the biloma or non-dilatation of the biliary ducts for PTBD. Chronic biliary leaks can also be managed with drainage, but when these techniques fail, the refractory leak can be managed with embolization of the leaking biliary radicles or ablation of the entire biliary segment using alcohol, acetoacetate and liquid embolics (N-butyl cyanoacrylate glue or Onyx) may be performed.

CONCLUSIONS: Biliary leaks require a multidisciplinary team-based approach for optimum management. Innovative percutaneous techniques including percutaneous transhepatic biliary drainage (PTBD), embolization, ablation, rendezvous procedure and stent graft placement by IR should be considered an important tool in the armamentarium. Understanding the pearls and pitfalls of each approach is vital.

Abstract No. 875
Recurrent pyogenic cholangitis: essentials for the interventionalist
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PURPOSE: At the conclusion of this exhibit, the participant should be able to: 1. Define recurrent pyogenic cholangitis clinically, pathologically, and epidemiologically 2. Recognize multi-modal imaging
findings in: -acute disease -chronic disease -postprocedurally, including complications 3. Discuss treatment and utilization of interventional radiology in a multidisciplinary approach to treatment

**MATERIALS:** Recurrent pyogenic cholangitis is a disease of the biliary system characterized by the formation of multiple pigmented stones, biliary strictures, and repeated episodes of cholangitis. Though historically linked to Asia, recent years have seen rising rates in the West. Radiology not only plays an essential role in diagnosis, but also in treatment.

**RESULTS:** Though ultimately of uncertain etiology, recurrent pyogenic cholangitis is thought to result from chronic infection, resulting in intrahepatic stone formation, biliary strictures, and recurrent episodes of cholangitis. As such, the disease most often presents with classic findings of right upper quadrant pain, fever, and jaundice, in addition to leukocytosis and elevated bilirubin/liver enzymes. Multimodal imaging techniques, including ultrasound, CT, MR, and fluoroscopy demonstrate classic pathologic findings, including multiple intrahepatic stones, alternating dilation and stricture of the bile ducts, and eventually cirrhosis with sequelae of portal hypertension. Given the multidisciplinary approach to treatment, and often complex history of prior surgeries and complications, the Interventionalist plays an essential role. This includes percutaneous biliary drainage, basket removal of stones, balloon dilation of strictures, and drainage of abscesses. Need for multiple treatments often necessitates the minimally invasive techniques of IR, which can be made easier in certain cases with a choledochojejunosomy with cutaneous limb.

**CONCLUSIONS:** Recurrent pyogenic cholangitis is a complex disease of ultimately uncertain etiology with rising rates of occurrence in the West. Recognition of the disease and its complications, as well as treatment options available to Interventionalists is essential to successful patient treatment.

### Abstract No. 876

**Indications for the use of percutaneous transhepatic biliary drainage versus endoscopic retrograde cholangiopancreatography**

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**PURPOSE:** 1. To discuss indications for the use of percutaneous transhepatic cholangiography (PTC) with or without percutaneous biliary drainage catheter (PTBD) placement vs. endoscopic retrograde cholangiopancreatography (ERCP), with a focus on the difference in indications between the two modalities. 2. To discuss how failed ERCP can result in its own indication for subsequent PTC, with a nod to the predicament this can place Interventionalists in as they perform PTC on patients for whom the procedure might not otherwise be indicated. 3. To discuss the technique, procedure and complications associated with PTBD and ERCP

**MATERIALS:** PTC is an important diagnostic tool when assessing patients with jaundice. When used with external or internal biliary drainage, it is referred to as PTBD. PTBD is a well-established biliary drainage procedure for the treatment of biliary obstruction. Patients with biliary obstruction typically present with jaundice and pruritus with a serum bilirubin over 3 mg/dL. Biliary obstruction can be due to iatrogenic, benign or malignant disease states. Many patients with biliary obstruction may be treated with endoscopic retrograde ERCP. Those who fail ERCP, may require PTBD to achieve necessary biliary decompression. While ERCP is a useful tool in the diagnosis and treatment of pancreatobiliary disorders, it is also one of the iatrogenic causes of biliary obstruction along with sphincterectomy and surgery.

**RESULTS:** In collaboration with our endoscopy partners, we will outline and provide image-rich detailed technique for PTC/PTBD and ERCP.

**CONCLUSIONS:** Both PTC/PTBD and ERCP are important tools in diagnosis and treatment of pancreatobiliary disorders. Those who fail ERCP may require PTBD to achieve necessary biliary decompression. Because failed ERCP may become its own indication for PTC, a close working relationship between IR and GI is paramount to efficient clinical practice and effective patient care.

### Abstract No. 877

**Fluoroscopy-guided sternoplasty: institutional experience and review of literature**

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**PURPOSE:** 1. Review the anatomy and imaging characteristics of sternal fractures. 2. Compare the conventional treatments of sternal fractures and their risks. 3. Describe the mechanism, benefits and risks of sternoplasty.

**MATERIALS:** Sternal fractures occur in 3% to 8% of cases involving motor vehicle collisions. Prognosis is excellent for isolated sternal fractures. The overall mortality of sternal fractures is 0.7%. Computed Tomography (CT) is the imaging modality of choice in the diagnosis. Usually the fracture is transverse and is non-displaced. Associated injuries include aortic, myocardial contusions, retrosternal and mediastinal hematomas. Although most heal spontaneously, it can be very painful which limits respiration, predisposing to atelectasis and pneumonia, especially in patients with underlying lung disease.

**RESULTS:** The first patient is a 70-year-old male with chest pain following a fall, with history of osteoporosis and prostate cancer. Chest CT reveals a comminuted sternal fracture at the sternomanubrial joint. The second patient is an 86-year-old female with history of lung cancer presenting with pain after a motor vehicle collision. A mildly displaced fracture of the lower sternal body was found. Pain was the main concern in these patients. After general anesthesia, under fluoroscopic guidance, an 11-gauge trocar was introduced into the sternal fracture using the AP and lateral projections. Under direct fluoroscopic guidance, cement was instilled into the sternal fracture line. After the procedure both patients had immediate reduction in pain. There were no further complications.

**CONCLUSIONS:** Operative fixation may be indicated for displaced or unstable fractures, which cause debilitating chest pain or associated...
with flail chest. Localized injections or indwelling catheters for pain control are other options. However, all these have their own inherent risks. Sternotomy is minimally invasive and has potential for immediate and long-term pain relief and is a viable alternative to open surgery, indwelling catheters or injections. However, with limited cases, more studies are needed to establish clinical efficacy.

**Abstract No. 878**

**Diagnosis and nonsurgical treatment options for pulmonary aspergilloma**

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**PURPOSE:** Learn about the radiographic, serologic, and microbiologic diagnostic tests for aspergilloma. Learn about the nonsurgical treatment options for aspergilloma, including systemic antifungal medication, intracavitary instillation and endobronchial administration of antifungal medication, bronchial artery embolization, and radiotherapy.

**MATERIALS:** Pulmonary aspergilloma can lead to life-threatening hemoptysis with a mortality rate of approximately 38%. Surgery is currently the mainstay of treatment for aspergilloma but is associated with considerable mortality and morbidity. Furthermore, many patients with pulmonary aspergilloma are poor surgical candidates due to limited pulmonary reserve or other underlying diseases. Here, we propose a treatment algorithm for inoperable patients with pulmonary aspergilloma along with a review of the literature.

**RESULTS:** Diagnosis of aspergilloma requires both radiographic evidence and serologic or microbiologic evidence of Aspergillus species involvement. For inoperable patients, alternative options exist. Intracavitary instillation of antifungal medication was shown to be successful at treating hemoptysis in 85%-100% of cases in two large retrospective studies and the success of endobronchial administration of antifungal medication has been demonstrated through several case series and reports. We propose that symptomatic inoperable pulmonary aspergilloma patients undergo intracavitary instillation or endobronchial administration of antifungal medication for definitive treatment. For those that present with acute hemoptysis, we recommend bronchial artery embolization or radiotherapy for management prior to definitive treatment. We do not recommend systemic treatment with amphotericin B as monotherapy because of its low cure rate, but systemic azoles may be considered as an adjunct therapy as they have been shown to be effective in approximately 50% to 60% of cases.

**CONCLUSIONS:** We propose a simple treatment algorithm for inoperable patients with pulmonary aspergilloma. However, with limited data, we encourage centers to include their nonsurgically treated patients in a prospective registry to help establish and compare the efficacy of these nonsurgical treatments.

**Abstract No. 879**

**Diagnostic and interventional management of pleural effusions: a clinical perspective**

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**PURPOSE:** Define the difference between transudative and exudative effusion. Discuss the diagnostic imaging findings and clinical/interventional management of pleural effusion, empyema, and lung abscess and alternative surgical/medical treatments. Describe indications for tunneled vs. non-tunneled drainage catheters and when intrapleural fibrinolytic therapy is necessary. Show imaging of various pleural effusions and how they were managed at our institution.

**MATERIALS:** Approximately 1.5 million patients are diagnosed with pleural effusion each year in the United States. Pleural effusion is accumulation of fluid in the pleural space and can be transudative or exudative. Empyema is a purulent fluid collection and a lung abscess is parenchymal necrosis with confined cavitation. These conditions were traditionally treated with antibiotics and large-bore surgical chest tubes. IR has become an essential part of the management by offering patients minimally invasive solutions.

**RESULTS:** Diagnostic modalities include chest radiograph and ultrasound initially and CT as the study of choice for evaluation of pleural pathology and underlying lung disease. Light’s criteria is used to differentiate transudative vs. exudative effusions. Transudative effusions can be managed by conservative treatment or antibiotics alone. On the other hand, exudative effusions or complicated effusions (empyema, malignant effusions, and hemothorax) typically are managed by drainage. The treatment options to be discussed include therapeutic thoracentesis, drainage catheter placement, fibrinolytic therapy, pleurodesis, medical treatment with antibiotics, and surgery.

**CONCLUSIONS:** IR plays an essential role in the management of pleural effusions, empyema, and lung abscess. IR is now considered the mainstay of treatment with less morbidity and mortality than surgery. Now that IR is its own clinical entity the interventionalist must be able to understand the indications for pleural drainage/thoracentesis and when medical or surgical management is more appropriate. Understanding clinical situations makes us a valuable asset to the Pulmonologists and Cardiothoracic Surgeons.

**Abstract No. 880**

**Pull-type percutaneous radiologic gastrostomy: a simplified technique using a frugal innovation!**

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**PURPOSE:** To learn a new innovative technique for putting large-bore (24-Fr) gastrostomy tube using conventional PEG set under fluoroscopic guidance with minor modifications from described techniques.
MATERIALS: Current Interventional radiology practice includes two techniques for gastrostomy insertion, viz. Pull and push type. Pull type is more convenient and preferred while putting large-bore tubes (>20 Fr). Push protocol always requires gastropexy while putting large-bore tubes. Some operators use gastropexy in pull technique as well. We devise an innovative method of Pull gastrostomy obviating gastropexy while using a frugal and indigenous snare device and the PEG set.

RESULTS: We used PEG24 PULL-S set (Cook, Bloomington, IN) and a self-made snare using 0.81 mm, 150 cm hydrophilic guide wire (Terumo, Europe, NV) and 16-Fr suction catheter (50 cm). After routine fluoroscopic gastrostomy technique, we inflate the stomach with a 12-Fr NG tube, confirm apposition with abdominal wall and pass this snare device through mouth and position it in body of stomach. This snare device has a large perimeter (40 cm) which could be easily targeted under fluoroscopy while puncturing with 16-G cannula and reduces fluoroscopy time. The blue guide wire (PEG24) is passed through this snare loop and caught by pulling the loose ends of Terumo wire until it traps the blue wire into the catheter and brought out through the mouth along with the suction catheter and snare device. Rest of the steps are same that of percutaneous endoscopic gastrostomy (PEG). Care needs to be taken to cover both outer ends of suction catheter while it is passed across GE junction since it can decompress the inflated stomach. A similar study (1) describes targeting the snare device provided in the gastrostomy kit, but we found it difficult owing to small area of the snare loop and 2D image guidance.

CONCLUSIONS: A simplified technique using frugal indigenously designed hardware is technically easier and uniformly successful. It significantly reduces the fluoroscopy time and overall cost by using hardware provided within a prepacked PEG kit and a hydrophilic guidewire.

Abstract No. 881

Efficacy and safety of percutaneous computed tomography–guided celiac plexus neurolysis/block in treating intractable abdominal pain

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PURPOSE: The objective of this educational exhibit is to demonstrate the effectiveness and safety of percutaneous CT-guided celiac plexus neurolysis/block as a method of providing analgesia for patients with intractable chronic abdominal pain.

MATERIALS: After obtaining institutional review board approval, we reviewed the charts of 20 patients with intractable chronic abdominal pain who were treated by CT-guided celiac plexus neurolysis/block within the last 4 years, between April 2015 and August 2017. They consisted of 11 males and 9 females, the age of patients ranged from 29 to 84 years with a mean age of 56. The abdominal pain was caused by pancreatic cancer in 11 patients (55%), other abdominal malignancies in 7 patients (35%) and chronic pancreatitis in 2 patients (10%). All the patients had severe abdominal pain defined as 7 to 10 of 10 on the 0-10 visual analogue scale (VAS). 18 patients (90%) received celiac plexus neurolysis using absolute alcohol (dose ranging from 10-35 cc) and 2 patients (10%) received celiac plexus block using bupivacaine. The procedure was done via posterior approach in 16 patients (80%) and anterior approach in 4 patients (20%). The patients were followed in four days and four weeks intervals for complications and pain relief.

RESULTS: Nine patients (45%) reported significant improvement of abdominal pain within four days of the procedure. Eight patients (40%) reported no improvement of abdominal pain within four days of the procedure. Six patients (30%) reported recurrence of abdominal pain within four weeks of the procedure. In regards to complications, four patients (20%) reported transient diarrhea, one patient (5%) had transient hypotension and one patient (5%) had transient tachycardia and hypoxia.

CONCLUSIONS: CT-guided celiac plexus neurolysis/block is a safe option for palliative treatment of intractable abdominal pain unresponsive to conventional medical treatment. Upon review of the recent literature, Edelstein et al reports short-term pain relief of abdominal pain in a majority of patients receiving this procedure. However, further well-designed prospective randomized studies may be warranted to evaluate the long-term effectiveness of this therapy.

Abstract No. 882

An effective method for maintaining jejunal access during exchange of gastrojejunostomy feeding tubes with occluded jejunal lumens

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PURPOSE: The purpose of this educational exhibit is to demonstrate a novel technique for exchanging gastrojejunostomy tubes with occluded jejunal lumens precluding over-the-wire exchange. At the conclusion of this educational exhibit attendees will be able to: - Identify the equipment necessary for the procedure - Understand the technique for creating the simple device for the exchange - Describe the steps for successfully performing the exchange

MATERIALS: Gastrojejunostomy feeding tubes are an effective way to provide postpyloric feeding with concomitant gastric access. Cannulating the duodenum for postpyloric access is often difficult and over-the-wire exchange is optimal for gastrojejunostomy changes. Unfortunately, the jejunal ports of gastrojejunostomy tubes are prone to clogging, often necessitating replacement without over-the-wire access. The goal of this exhibit is to demonstrate a method to exchange gastrojejunostomy feeding tubes with occluded jejunal lumens, preventing over-the-wire exchange, without losing jejunal access.

RESULTS: Equipment Necessary: 65-cm Berenstein catheter, nonabsorbable suture, stiff wire Procedure Steps: 1. Pull external bumper on gastrojejunostomy (GJ) back to port/hub 2. Suture through tip of 65 cm Berenstein, needle through one wall then out the tip 3. Tie suture loosely as lasso around GJ, cut off needle and extra suture 4. Deflate retention balloon 5. Push Berenstein into tract and run alongside the occluded GJ until the lasso progresses off the end of the GJ in the
jejunum 6. Send stiff wire into Berenstein 7. Remove occluded GJ and Berenstein, maintaining jejunal access with the stiff wire 8. Place new GJ tube in standard fashion

CONCLUSIONS: Gastrojejunostomy feeding tubes with occluded jejunal lumens have presented a vexing problem for interventional radiologists due to the common difficulty in cannulating the duodenum once jejunal access is lost. The described technique is simple and uses tools and techniques commonly available to interventional radiologists to enable maintenance of jejunal access during the exchange, which may prevent the need for a prolonged procedure with repeat duodenal cannulation.

Abstract No. 883
CT-guided percutaneous alcohol ablation of the pancreas: a novel outpatient treatment approach for disconnected pancreatic duct syndrome
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PURPOSE: 1) Discuss the epidemiology and treatment options of DPDS. 2) Illustrate imaging and patient selection. 3) Describe CT-guided percutaneous alcohol ablation of isolated pancreatic tissue, highlighting different percutaneous approaches and how to monitor the alcohol treatment zone to ensure adequate treatment coverage. 4) Discuss follow-up care and potential complications.

MATERIALS: DPDS is a morbidly debilitating disease that is usually a complication of acute necrotizing pancreatitis (ANP). DPDS is defined as necrosis of at least 2 cm of the pancreas with subsequent discontinuity of the pancreatic duct and isolation of a viable segment of the pancreatic tissue. Endoscopic stent placement has been shown to have variable success while surgery has known inherent risks and morbidities. A less invasive alternative treatment would be considered invaluable. We report 3 cases which were successfully treated by CT-guided percutaneous alcohol ablation as outpatients.

RESULTS: We present 3 cases of ANP complicated by DPDS associated with an end-fistula and persistent peripancreatic fluid collection (PFC). 2 males and 1 female were treated with a mean age of 67. Patients selected had refractory drainage despite resolution of the PFC after percutaneous drainage. Percutaneous alcohol ablation of the isolated pancreas was performed under CT-guidance either using GA or moderate sedation. In 2 patients, multiple sessions of ablation were needed. Alcohol is non-radiopaque which required mixing it with tantalum powder to allow careful monitoring of the ablation zone on CT. The average daily drain output prior to the ablation was 33.3 ml. Minimal output after ablation was reached at an average of 10 days. Drains were removed at an average of 14.6 days postablation. The ablation was clinically successful in all 3 patients with no recurrence of the PFC. There were no complications.

CONCLUSIONS: DPDS is a debilitating disease associated with long-term morbidities. Percutaneous alcohol ablation of isolated pancreatic tissue offers a safe, less invasive and less expensive outpatient treatment alternative. Further studies are required to confirm safety and efficacy of percutaneous alcohol ablation to treat DPDS.

Abstract No. 884
The role of interventional radiology in management of the complications of bariatric surgery
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PURPOSE: • Pictorial review of different bariatric surgical procedures. • Describe the complications of these procedures with case examples. • Highlight the role of interventional radiology in the management of complications.

MATERIALS: The worldwide prevalence of obesity exceeds 1.9 billion adults, with at least half a billion procedures completed yearly on a worldwide basis. Three main categories of bariatric surgical procedures are described as restrictive, malabsorptive, and a combination of both. Restrictive procedures such as laparoscopic adjustable gastric banding (LAGB) and sleeve gastrectomy (SG) promote early satiety by reducing gastric capacity, while malabsorptive procedures such as jejunoileal bypass and biliopancreatic diversion alter nutrient absorption in the small intestine. Roux-en-Y bypass, the second most common bariatric procedure worldwide is considered both restrictive and malabsorptive, while SG is the most common procedure done worldwide. Complications after bariatric procedures include anastomotic leak, anastomotic narrowing, seroma/hematoma/abscess, and splanchnic venous thrombosis. Surgical management of these complications results in high morbidity.

RESULTS: Interventional radiology may be called upon for both routine and urgent care of patients undergoing bariatric surgery. This educational exhibit will present: • Overview of bariatric procedures including anatomical and physiological principles of each procedure and the incidence of common complications. • Role of interventional radiology in managing complications with case examples: – Placement of gastrostomy tubes in the gastric remnant, determining efferent vs afferent loop for placement of gastro-jejunostomy access. – Drainage procedures for postoperative collections and sclerotherapy of seromas. – Technical considerations of percutaneous access for LAGB ports. – Endovascular management and outcomes of postoperative portal vein thrombosis.

CONCLUSIONS: Interventional radiology has an increasing role in management of complications of bariatric surgery. It is vital to know the different anatomical and physiological considerations in these patients in order to optimize outcomes.

Abstract No. 885
Percutaneous image-guided antegrade pancreatography and duct cannulation for interventional radiologist and gastroenterologist-assisted rendezvous pancreatic duct interventions
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Abstract No. 886

“The easy way out”: the role of interventional radiology in the repair of a subtype of esophageal atresia

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PURPOSE: 1. Describe advanced gastroenterology interventions in the pancreas and pancreatic duct. 2. Explain preprocedure imaging evaluation of pancreatic duct and adjacent anatomy suitable for percutaneous access. 3. Define various techniques for rendezvous pancreatic duct cannulation. 4. Illustrate technical failures, complications, and patient management.

MATERIALS: Advanced endoscopic gastrointestinal procedures are increasing in number and scope and offer additional treatment options for a variety of pancreatico-biliary problems. Interventional radiology-gastroenterologist antegrade rendezvous procedures in the biliary system are currently used during endobiliary stent placements, cholecystectomy drain conversion to duodenal-choledoch-cystostomy stents and for hepatico-jejunostomy anastomosis problems. Difficult intraluminal orifice angulation, long-distance bowel lumen navigation with single/double balloon enteroscopes and altered surgical anatomy often cause retrograde guide wire cannulation difficulties during endoscopic-guided therapies. Antegrade access across ductal occlusions or obstruction and passage of long exchange wires that are grasped endoscopically offers an alternative to treatment of strictures and occlusions. Cannulation of the pancreatic duct (PD) is technically more difficult than the biliary system due to a deeper oblique retroperitoneal pancreas location, smaller with a shorter window for access, overlying large and small bowel and adjacent vascular structures. Image-guided access requires a combination ultrasound/fluoroscopic or CT guidance.

RESULTS: Three cases, at CHI Health Creighton University Medical Center Bergan Mercy, involved chronic pain attributed to obstruction of the pancreatic duct. Causes for ERCP failure. Determinants of cannulation success. US/CT-guided cannulation of the pancreatic duct. Complications

CONCLUSIONS: • Pancreatography and duct cannulation is technically possible with favorable anatomy • Careful cross-sectional anatomy review and planning is necessary to map safe and suitable access routes • High-resolution ultrasound may be necessary for PD visualization and access • Awareness of complications allows for quick management algorithms

Abstract No. 887

A clinically oriented guide to nonvascular interventional uroradiology

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PURPOSE: 1. Outline the scope of nonvascular urologic procedures commonly performed by interventional radiology. 2. Encourage clinically oriented problem solving to choose intervention(s) most appropriate for specific patient care goals with attention to surgical alternatives. 3. Review common procedural pitfalls and their potential solutions. 4. Discuss postprocedural patient care and device maintenance.

MATERIALS: The interventionalist works synchronously with urology in the treatment of many urologic conditions. In this rapidly progressing field, interventional radiology has begun shifting to a more primary and independent role in patient care. In addition to guiding follow-up and device maintenance, there is an impetus to demonstrate competence in patient management decisions. Although consultation with urology is encouraged when appropriate, it may not always be readily available or necessary. A sophisticated understanding of common urologic pathologies, their etiology, relative urgency, and treatment options is paramount to providing appropriate and timely service.
RESULTS: This educational exhibit will present the following: 1. A pathology-based approach to nonvascular urologic procedures an Interventionalist may be called to perform, including indicators of urgency. 2. Brief procedural descriptions, including common pitfalls and a guide for trouble-shooting. 3. Comprehensive review of associated procedural complications and their management. 4. Recommended follow-up and maintenance for urinary tract interventions.

CONCLUSIONS: Interventional uroradiology is ubiquitous in any hospital-based Interventional practice. Familiarity with not only the technical aspects of the procedures, but also the urologic diseases and relevant patient characteristics aids the Interventionalist in appropriate triage and enhanced procedural selection. The authors suggest an advanced knowledge of these practices will promote referring clinician satisfaction, streamline a burdened healthcare system, and most importantly improve patient outcomes.

Abstract No. 888

Combining the new with the forgotten: using intravenous pyelography with cone-beam computed tomography for the placement of a difficult nephrostomy tube

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PURPOSE: Describe our technique for using cone-beam CT for the technically difficult nephrostomy tube placement.

MATERIALS: While most nephrostomy tube placements are successfully placed under ultrasound guidance, every so often a case presents itself that challenges this method. Whether this be secondary to the increasing size of the patient, placement in a non-dilated collecting system for urinary divergence, or other difficult patient conditions. With the increasing accessibility to cone-beam CT, the Interventional radiologist no longer needs to rely on a single modality for placement.

RESULTS: As the patient enters the Interventional radiology suite, approximately 100-150 ml of low-osmolar nonionic iodinated contrast is administered via peripheral intravenous catheter. The patient is then placed in the prone position on the fluoroscopy table and prepped and draped in the usual sterile fashion. After 10 minutes from contrast administration, the kidney is imaged by fluoroscopy to identify contrast within the renal pelvis. A cone-beam CT is then obtain and using the multiplanar reformats, the approach to the lower pole calyx is identified and mapped accordingly. Depending on software, this map is then superimposed on the real-time fluoroscopy for tracking of the needle. One in the collecting system, we procedure with placement of the nephrostomy in the typical fashion.

CONCLUSIONS: Utilization of cone-beam CT can improve the technical success and safety of routine nephrostomy tube placement in situation where ultrasound would otherwise be suboptimal.

Abstract No. 889

A different approach to intragenitourinary drainage

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MATERIALS: Pyometrocolpos is an infection of fluid within the vagina and uterus seen in patients with congenital genitourinary malformations. The incidence of this anomaly is reported to be between 0.1 and 3.8% and patients can present in infancy, adolescence, or even adulthood. Patients often present with AKI, UTI, or sepsis and immediate drainage is recommended for treatment. There have been reported cases of subcutaneous drainage with successful relief of symptoms, but also with recurrences without definitive corrective surgery. We have reviewed a case of a 14-month-old child with pyometrocolpos at Children’s National Medical Center in Washington, DC to introduce an ultrasound-guided introital drainage technique. This study was approved by the IRB board at CNMC. The patient’s initial presentation, initial treatments and clinical course, introital drainage, and subsequent follow-ups, imaging, and clinical assessments were reviewed.

RESULTS: 14-month-old previously healthy female initially presented with sepsis secondary to UTI and abdominal US revealing 9.6 × 6.2 × 5.7 cm pyometrocolpos. Initial intervention by the urology team were vaginoscopy and percutaneous drainage via anterior abdomen. However, pt was readmitted 25 months postprocedure with a recurrence. To mitigate further recurrence, introital drainage by the IR team was decided. Under ultrasound guidance and using standard Seldinger and serial dilation techniques, 10.2 French pigtail drainage catheter was placed into the pyometrocolpos via introitus. Three weeks later, the drain was removed and vaginoscopy revealed epithelialized tract along the drainage catheter path. No reaccumulation of fluid was noted in 30 months follow-ups.

CONCLUSIONS: 1. Percutaneous or laparoscopic drainage of pyometrocolpos provides immediate resolution; however, recurrence is of concern. 2. Introital approach provides natural drainage tract as well to prevent recurrences in case immediate urogenital reconstruction surgery needs to be deferred.

Abstract No. 890

Percutaneous nephrolithotomy and the role of the interventional radiologist

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PURPOSE: To evaluate the role of Interventional Radiology (IR) in the management of nephrolithiasis.

MATERIALS: The purpose of this study is to evaluate the role of Interventional Radiology (IR) in the management of nephrolithiasis.

METHODS: The management of nephrolithiasis has evolved significantly over the past few decades. Initially, solely medical or surgical management was performed. With the advent of percutaneous nephrolithotomy (PCNL), IR has played an integral role in the management of nephrolithiasis.

RESULTS: Patients with nephrolithiasis can be managed either surgically or non-surgically. Despite advances in surgery, laparoscopic and open techniques are still the gold standard for stone removal. In patients with large and complex stones, extracorporeal shock wave lithotripsy (ESWL) or PCNL is preferred. In the past decade, the utilization of PCNL has increased significantly. PCNL allows access to large renal units and is associated with a lower rate of complications compared to open surgery. The role of IR in PCNL is to facilitate stone extraction. This includes the placement of nephrostomy tubes, dilatation of calyces, stone basketing, and stone extraction.

CONCLUSIONS: Interventional radiologists play an essential role in the management of nephrolithiasis. They provide access to the renal collecting system, which is necessary for successful stone extraction. This is achieved through the placement of nephrostomy tubes, dilatation of calyces, and stone basketing. The role of IR is to facilitate stone extraction and ensure石的成功移除。
Abstract No. 891

Interventional radiology table for two: diagnosis and treatment of acute pregnancy-related pathology

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PURPOSE: 1. Identify acute pregnancy-related pathology and associated key diagnostic imaging features. 2. Define the role of IR in the treatment of obstetric patients and indications for acute intervention. 3. Explore relevant procedural techniques, outcomes, and potential complications.

MATERIALS: Women may present with unique pregnancy-related pathology in the prepartum, peripartum, or postpartum period. Understanding of the diagnostic features of these pathologies is key to prompt diagnosis and treatment. In the acute setting, interventional radiologists have the unique opportunity to provide potentially life-saving care to both mother and fetus.

RESULTS: Using an image-rich, cased-based format, the following pregnancy-related pathologies and associated interventions will be discussed, including indications, technical steps, and potential complications. 1. Hydronephrosis → percutaneous nephrostomy 2. Placental invasion → internal iliac artery catheterization-assisted cesarean section 3. Postpartum hemorrhage → arterial embolization 4. Postpartum fluid collection → percutaneous drainage 5. Ureteral injury → percutaneous nephroureteral stent placement

CONCLUSIONS: Pregnancy predisposes women to a number of acute conditions, some of which are potentially fatal. Interventional radiologists can play an integral role in obstetric care by aiding in early diagnosis and providing noninvasive treatment options. In order to be an effective consultant, it is vital that interventional radiologists have a good understanding of the treatments discussed as well as the potential risks/complications to both mother and fetus.
Abstract No. 893

Transabdominal oocyte retrieval and in vitro fertilization status post ovarian relocation due to pelvic radiation and chemotherapy

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PURPOSE: Fertility preservation can be difficult in patients with history of cancer, especially if they have received radiation, chemotherapy, and ovarian transposition. In some cases, a multidisciplinary approach with interventional radiology (IR) may be necessary to attempt transabdominal oocyte retrieval instead of traditional transvaginal approach performed by reproductive endocrinology.

MATERIALS: Because unforeseen circumstances may prevent standard conception, cancer survivors may rely on assisted reproductive technology (ART) to conceive. We present a case of a 24-year-old G0 patient diagnosed with colorectal carcinoma (CRC), requiring pelvic radiation and chemotherapy. CRC is rare in the early decades of life, though estimated incidence is approximately 10%, with a 6% mortality rate.

RESULTS: To preserve fertility and avoid radiation, the patient had her ovaries reattached to her abdominal oblique musculature. Initial attempt at transvaginal oocyte retrieval was unsuccessful as prior ovarian transposition had failed resulting in radiation exposure to right ovary. Because the left ovary was still transposed, transvaginal retrieval of oocytes was not possible. IR was consulted to assist with a transabdominal ultrasound-guided approach for retrieval. The left abdomen was prepped with normal saline to avoid damage to oocytes. A 16-gauge aspiration needle (Vitrolife single lumen) was advanced into the left ovary under ultrasound guidance. The needle was used for aspiration until all dominant follicles were collapsed under ultrasound guidance. Embryology team confirmed retrieval of 12 eggs. From those, ten were mature, seven were fertilized, three embryos were formed, and only one had normal genetics that led to the birth of a healthy boy.

CONCLUSIONS: This case highlights the importance of multidisciplinary teamwork, particularly in young patients with extensive radiation and chemotherapy. Also, transabdominal ultrasound-guided egg retrieval can help avoid surgery for difficult positioning of artificially relocated ovaries, particularly when performed by an IR physician.

Abstract No. 894

Air arthrography to confirm intraarticular positioning for shoulder injections

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PURPOSE: Understanding the technical facets and benefits of air arthrography to confirm intraarticular needle placement in shoulder injections so that this technique may be applied in practice.

Abstract No. 895

Successful percutaneous management of large benign osseous lesions (ABC, GCT) of the acetabulum ameliorating need for surgery

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PURPOSE: Describe adjuvant image-guided treatment techniques successfully used in two cases of expansive paraacetabular lesion (aneurysmal bone cyst and giant cell tumor), managed in an interdisciplinary setting with goal of decreasing tumor burden, avoiding a large exposure surgery, extent of curettage, and possibly reducing local recurrence rate or further surgery

MATERIALS: Aneurysmal bone cyst and giant cell tumors are aggressive benign osseous lesions that occur in the young, frequently present in paraarticular location and large in size, therefore posing a treatment challenge for preserving function, joint and bone stock. Traditional treatment is surgical, either complete resection or curettage. Due to variable healing and recurrence rates, adjuvant therapies have evolved including use of cement, high-speed burr, argon beam coagulation,
Difficult osteoid osteoma ablations: technical considerations, procedural findings, and follow-up

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PURPOSE: 1: Describe the imaging characteristics and epidemiology of both typical and atypical osteoid osteomas. 2: Describe four cases of atypical osteoid osteoma ablation emphasizing techniques utilized for safe and effective ablation. 3: Present imaging and clinical follow-up of atypical osteoid osteoma ablation.

MATERIALS: Percutaneous radiofrequency ablation of osteoid osteoma has displaced surgery as the accepted first-line treatment. Osteoid osteoma is most common in the femur/tibia where ablation tends to be more straightforward. Less often, the lesion can present in technically challenging areas such as the juxta-articular cortex or metacarpals. Atypical location may increase the risk of complication, such as articular cartilage damage, and/or result in decreased efficacy. In the following poster we will present four cases of atypical osteoid osteoma, the techniques used for ablation, and clinical/imaging follow-up.

RESULTS: Our successfully performed osteoid osteoma ablation cases consist of multiple atypical locations including sub-glenoid, sub-chondral femoral head, and metacarpal. Additionally, a fourth case involving a large osteoid osteoma of the femur that required dual-zone ablation. Special techniques employed include 5% dextrose in water insulation of sensitive structures, such as adjacent neurovascular bundle, multiple ablations performed through the same trocar, and advanced techniques to avoid dermal injury in metacarpal ablation. All patients had resolution of their symptoms without imaging or clinical evidence of complication on follow-up.

CONCLUSIONS: These cases of atypical osteoid osteomas demonstrate technical considerations for safe and effective ablation.
Purpose: 1. Introduce barbotage as a minimally invasive, image-guided therapy for calcific tendonitis (CT). 2. Describe patient selection criteria to maximize procedure efficacy. 3. Review sonographic anatomy and procedural technique and tips relevant to the barbotage procedure.

Materials: CT is a painful disorder due to deposits of calcium hydroxyapatite in tendons, most commonly affecting the rotator cuff tendons of the shoulder. Although the disease subsides spontaneously in most cases, 10% of patients will continue to have pain and may have loss of shoulder range of motion when the deposits do not resolve despite conservative measures, which include NSAID therapy and corticosteroid injections. Operative treatment can have significant morbidity. Barbotage is a minimally invasive method to treat CT by disrupting and fragmenting the intratendon calcifications facilitating their resorption. The technique has rarely been described in the IR literature.

Results: Patients who fail conservative measures are screened for appropriateness of the barbotage procedure. Rotator cuff tears are a relative contraindication and patients with calcific deposits in the early resorptive phase tend to respond better to barbotage. Under ultrasound guidance, the intratendon calcium deposits within the distal rotator cuff tendons are localized with ultrasound. An 18 or 20-gauge needle is inserted into the deposits and lavage with saline performed, allowing removal of the calcium into the syringe. Subacromial bursal injection of corticosteroid is used to decrease postprocedure pain.

Conclusions: The barbotage procedure is a minimally invasive, well tolerated, image-guided therapy for CT. Although rarely described in the IR literature, interventionalists are well positioned to offer this procedure to carefully selected patients. Familiarity with musculoskeletal anatomy and procedural technique is essential to ensure optimal success.

Abstract No. 899

Computed tomography-guided transosseous approaches to access difficult-to-reach lesions

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Purpose: To illustrate the utility of CT-guided transosseous routes to provide access to otherwise difficult-to-approach lesions for targeted interventional therapies.

Materials: As minimally invasive therapies grow in their breadth, interventional radiologists are called upon more frequently than ever to assist in patient management in order to decrease morbidity and mortality. However, not all percutaneous interventions are straightforward. Target lesions may be immediately adjacent to critical vascular, deep within the abdomen, or nearby osseous structures may prohibit a safe trajectory. Here we demonstrate four transosseous routes to lesions that are often considered inaccessible, but now possible under CT guidance.

Results: Four patients were referred to the interventional radiology service for biopsy and/or treatment of lesions that were otherwise difficult to access. These included a mediastinal ectopic parathyroid adenoma, transplant pancreas within the pelvis, focal anterior prostate lesions, and a sacral neuroma. In each case, the patient’s preprocedural cross-sectional imaging was reviewed, and CT scout imaging was obtained to plan the safest route. A transsternal approach was used for the biopsy and cryoablation of the mediastinal ectopic parathyroid adenoma. Biopsy of the transplant pancreas was performed using a translumbar route. A transpubic approach was used for biopsy and microwave ablation of the anterior prostate lesion. A transsacral route was used to achieve pulsed radiofrequency ablation of the sacral neuroma. In three cases, the Arrow OnControl Powered Bone Access drill was used to create 11-gauge access, through which pulsed RFA energy, core biopsy, and/or cryo- or microwave ablative devices were introduced. There were no complications for the described cases.

Conclusions: Transosseous access through several routes can be performed safely and serve as a potentially robust path to lesions often thought to be inaccessible throughout the body. These methods are currently under more detailed investigation at our institution for both diagnostic and therapeutic interventions, further expanding the breadth of interventional radiology.

Abstract No. 900

Minimally invasive procedures performed by interventional radiology for the management of acute and chronic pain: a pictorial review

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Purpose: To review the various minimally invasive procedures performed by interventional radiology for the management of acute and chronic pain. This educational exhibit will detail all the necessary steps to incorporate these procedures to an existing interventional radiology practice.

Materials: Management of chronic pain is a common reason for seeking medical care. Opioid overuse has resulted in the current opioid addiction crisis. In 2015, prescription medications contributed to 20,101 of the 52,404 accidental deaths, roughly 38%. In 2012, 259 million opioid prescriptions were written (1). The medical community and patients can both be served by minimally invasive percutaneous interventions to treat the most common pain syndromes, low-back pain and headache/migraines. For example, lower back pain is expected to affect 80% of the population at least once in their lifetime, 1% to 2% causing significant disability (2). Furthermore, these procedures can be performed on an outpatient basis, requiring little to no sedation, shorter recovery time, and fewer major complications (3). We discuss lumbar epidural steroid injections, selective nerve root injections, sacroiliac injections, and sphenopalatine ganglia blocks.
Abstract No. 901

Superior hypogastric nerve block for postprocedure pain after uterine fibroid embolization

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PURPOSE: The purpose of this abstract is to review the preprocedure preparation, equipment, and technique of superior hypogastric nerve block during uterine artery embolization from a transradial approach.

MATERIALS: Superior hypogastric nerve block (SHNB) has been found to be a useful adjunct in the control of postprocedure pain after uterine artery embolization (UAE) and can decrease opioid use. Traditionally, SHNB is performed after embolization of the contralateral side from a right femoral approach with the catheter over the aortic bifurcation for clear identification of the arterial anatomy. However, when taking a transradial approach, the location of the bifurcation may be less obvious.

RESULTS: All patients undergoing UAE at our institution have a preprocedure MRI. Careful evaluation of the MRI prior to SHNB can identify the location of both the aortic bifurcation, and confluence of the IVC, relative to the spine, both of which should be avoided during SHNB. In addition, placement of the catheter into either uterine artery does demonstrate where the bifurcation is located similar to from a transfemoral approach. The procedure is performed with a 21-22g needle under fluoroscopic guidance, aiming for the portion of the LS-S1 vertebral body which is safe to access based on MRI. Once bony resistance is felt, dilute contrast is gently injected confirming position in the prevertebral space which can often be better identified on a lateral view. 20 cc 0.5% bupivacaine is then injected in this space with in the AP view to visualize even bilateral distribution of anesthetic.

CONCLUSIONS: SHNB is an excellent adjunct for UAE postprocedure pain. Review of MRI or other cross-sectional imaging is important to identify the vascular anatomy of the aorta and IVC. Placement of a catheter in either uterine artery can also be helpful to identify the bifurcation even from a transradial approach. Both AP and lateral views during SHNB are helpful to confirm proper location of needle and distribution of anesthetic.

Abstract No. 902

Interventional pain management: pudendal neuralgia

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PURPOSE: 1. To review the most common causes, symptoms and presentations of pudendal neuralgia. 2. To examine the diagnosis criteria for pudendal neuralgia. 3. To review the normal anatomic course of the pudendal nerve and associated structures which surround the nerve. Relevant CT correlation will be discussed. 4. Review the different treatment options of pudendal neuralgia. Indications for diagnostic anesthetic block, pulsed radiofrequency treatment and cryoablation will be discussed.

MATERIALS: Chronic pelvic pain is generally defined as lasting more than 6 months. Peripheral neuralgias such as Pudendal Neuralgia can be difficult to diagnose and can be confused with other more common etiologies. Diagnosis of pudendal neuralgia as described by the Nantes criteria consist of 1) pain in the distribution of the pudendal nerve, 2) worsened by sitting, 3) pain does not awakened patient, 4) no sensory loss on clinical examination, and 5) positive anesthetic pudendal nerve block.

RESULTS: The distribution of the pudendal nerve (PN) is defined by the 3 branches; the rectal, perineal and clitoral in women or penile in men. Patients with pain in the distribution of the PN undergo PN block for diagnosis of pudendal neuralgia. The PN arises from S2-S4 nerve roots. The nerve travels between the sacrospinous and sacrotuberous ligaments. After passing through the ligaments it is in close approximation with the piriformis muscle and the sciatic nerve. Once passing the ischial spine, it enters Alcock’s canal where it is in close approximation to the obturator internus muscle. The nerve can be targeted with CT or MRI guidance using the ischial spine and Alcock’s canal for diagnostic block or to deliver the treatment. Diagnostic nerve blocks are performed with bupivacaine. Treatment options include steroid block, pulsed radiofrequency and cryoneurolysis. Image-guided local treatments are a part of a multimodal approach to treating pudendal neuralgia. Oral neurologics, physical therapy and avoidance of ongoing nerve injury are cornerstones of the management of pudendal neuralgia.

CONCLUSIONS: Image guidance allows for precise targeting of pelvic nerves. Interventional radiologists can diagnose and treat pudendal neuralgia.

Abstract No. 903

Pain in the pelvis: computed tomography–guided superior hypogastric plexus alcohol ablation for the treatment of chronic pelvic pain

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PURPOSE: 1. Review the utility of CT-guided superior hypogastric plexus neurolysis (SHPN) for the treatment of chronic pelvic pain. 2. Discuss patient selection, indications, contraindications, risks, and
benefits of the procedure. 3. Review case-based imaging to illustrate the procedure in detail.

**MATERIALS:** Image-guided superior hypogastric plexus neurolysis has been described in the literature and utilized clinically as an effective treatment for refractory chronic pelvic pain from malignant and non-malignant etiologies. Yet, in many cases, patients with chronic pelvic pain are inadequately treated with opioid and adjuvant medications with minimal pain relief and detrimental medication side effects. In these cases, interventional radiologists can provide significant and timely quality of life improvements to patients by performing image-guided SHPN.

**RESULTS:** We present a case series of patients suffering from chronic pelvic pain where interventional radiology worked in conjunction with palliative care clinicians to improve pain management by performing CT-guided SHPN with alcohol. Indications for the procedure, including patient selection criteria will be reviewed. Case-based imaging detailing the procedure steps and our institutional strategies will be presented along with clinical follow-up and complications.

**CONCLUSIONS:** Despite being identified as an effective treatment for chronic pelvic pain, CT-guided SHPN is often underutilized with current treatment strategies relying on opioid and sedative medications. Given interventional radiology’s role in multidisciplinary pain programs, it is necessary for IR physicians to offer SHPN as part of an ever-expanding repertoire of palliative pain therapies and to educate our fellow clinicians of the effectiveness of image-guided SHPN.

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**Abstract No. 904**

**Therapeutic strategy for pelvic lymphorrhea**

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**PURPOSE:** 1. To deepen the knowledge about relevant anatomical structures for pelvic lymphatic intervention. 2. To summarize the standard method of intranodal lymphangiography (IL) and subsequent embolization of pelvic lymphorrhea. 3. To discuss different treatment strategies of pelvic lymphorrhea depending on traumatic and congenital etiology

**MATERIALS:** Lymphorrhea occurs both congenital etiology such as lymphangioleiomyomatosis and iatrogenic cause. Pelvic lymphorrhea is among the major postsurgical complications of gynecological, urological, or lower gastrointestinal surgery. Current standard treatment of pelvic lymphorrhea is conservative therapy; however, there are many cases resistant or refractory to conservative therapy. We here demonstrate that safe and feasible technique to perform intranodal lymphangiography and subsequent embolization of lymph vessel for refractory lymphorrhea.

**RESULTS:** 1. Brief description of lymphatic anatomy and summary of technique. 2. Summary of technical implications of performing pelvic lymphography and subsequent embolization; (i) Traumatic lymphorrhea: lymphorrhea of serous lymph fluid; caused by lymph node dissection of external iliac or obturator lymph node; antegrade IL from inguinal lymph node visualizes lymphorrhea, and direct puncture of the target lymph vessel and embolization of the lymphorrhea is performed; for multiple lymphorrhea, embolization from inguinal lymph node is selected. (ii) Congenital lymphorrhea: lymphorrhea of chylous lymph fluid; caused by lymphatic dysfunction and resultant over-flow of pelvic lymphatic reservoir due to reflux of lymph flow from intestinal lymph system; thus, treatment should be prevention of reflux in addition to embolization of lymphorrhea. 3. Presentation of our experienced cases

**CONCLUSIONS:** We illustrate different treatment strategies of pelvic lymphorrhea depending on etiology. Serous lymphorrhea is treated with embolization of lymphorrhea while chylous lymphorrhea requires prevention of reflux of lymph flow and treated with embolization of lymphorrhea.

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**Abstract No. 905**

**Sphenopalatine ganglion block: an overlooked interventional radiology technique for migraine treatment**

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**PURPOSE:** To review the treatment protocol and anatomic accessibility of the SPG block in patients with recurrent, chronic and acute migraine headaches. This will be done by discussing the pathophysiology and interventional radiologic therapeutic technique behind the procedure.

**MATERIALS:** Migraine remains a common burden in society. This is validated not only through the personal burden of financial and societal impairments, but also from employment sick days and loss of work place productivity. Migraines are estimated to cost the US over 13 billion dollars annually. These costs stem from ER visits, hospitalizations, preventative treatments, and medical management. Medical management of migraine headaches often proves insufficient and SPG block provides an innovative, adjunctive outpatient treatment option with excellent results alleviating symptoms.

**RESULTS:** The SPG houses parasympathetic ganglia in the pterygopalatine fossa posterior to the middle nasal turbinate. Hypersensitivity of the SPG is suspected to be a key culprit of migraine etiology. Afferent fibers from the trigeminal nerve initially synapse on the superior salivatory nucleus (SSN). The preganglionic parasympathetic fibers of the SSN are associated with postganglionic fibers of the SPG. Inadvertent postganglionic parasympathetic stimulation of the SPG via the pons through the trigeminal chain results in vasodilation of cranial vessels and activation of nociceptors. Thus, leading to perpetual feedback and consequently, migraine cycles. Direct block of the SPG with 4% Xylocaine effectively blocks the neurological circuit which feeds this migraine cycle.

**CONCLUSIONS:** SPG block is an effective treatment for migraine with minimal risk and complication profile. Consequently, this procedure can efficiently reduce personal and societal setbacks and halt the symptoms of this debilitating disease.
Percutaneous accesses to diagnose and intervene in lymphatic disorders: a review to highlight the role of interventional radiologists

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Purpose: To describe the various options available for percutaneously accessing and diagnosing pathologies affecting the lymphatic system and to illustrate the role of percutaneous treatment of congenital and acquired disorders.

Materials: Imaging plays a key role in a diagnosis of lymphatic disorders, which often manifest as accumulation of lymph or result in mass effect. Historically, pedal lymphangiography was used for diagnosis, requiring direct exposure of small lymphatic ducts. This has largely been replaced by lymphoscintigraphy following interstitial injection of a radioactive nuclide. Recently, magnetic resonance (MR) lymphangiogram following interstitial injection of gadolinium has evolved as a viable alternative to study flow dynamics. Alternatively, percutaneous accesses can be combined with cross-sectional imaging techniques such as cone-beam computed tomography (CT), multidetector CT, and MR imaging to evaluate a range of lymphatic pathologies and simultaneously provide an avenue for intervention. Interventionalists, with their expertise in percutaneous access, can play a pivotal role in the diagnosis and management of these disorders. In this exhibit, we review several percutaneous accesses and describe methods to intervene in a wide range of lymphatic disorders.

Results: The lymphatic system can be percutaneously accessed in many ways – via the lymph nodes, directly into a lymphatic malformation, or through the intrahepatic lymphatics, paravertebral lymphatics, or thoracic duct via a transabdominal or transvenous route. The type of access chosen depends on the pathology and the treatment planned. This review will describe the key technical aspects of each access. It will also describe the interventions performed to manage congenital disorders such as lymphatic malformations and acquired disorders such as lymphatic leaks. Finally, the review will discuss the role of contrast agents used for diagnosis and embolic agents used for intervention.

Conclusions: This presentation will provide the viewer an opportunity to review and become familiar with the percutaneous options available to access the lymphatic system and the interventions used to manage a wide range of lymphatic disorders.

Sacroplasty simplified: reducing the pain in the rear

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Purpose: 1) Review relevant recent and past literature regarding the efficacy of sacroplasty. 2) Review the indications, contraindications, and potential complications of sacroplasty. 3) Review the most common sacroplasty techniques. 4) Demonstrate a case performed in our department.

Materials: Kyphoplasty and vertebroplasty have emerged as widely accepted adjuncts to conservative care and alternatives to surgery in the treatment of spinal compression fractures and painful metastatic lesions. A similar form of treatment in the sacrum, sacroplasty, adds a degree of technical challenge and complexity given size, shape, and orientation of the bone. A number of techniques and approaches have been developed for this procedure and familiarity with these variations is important for effective patient care.

Results: Sacroplasty produces long-lasting and durable pain relief which has been documented for up to 18 months. Sacroplasty is a relatively safe procedure, with rare reports of complications including venous intravasation resulting in pulmonary embolus, infection, and compromise of the sacroiliac joints or sacral neural foramina. In a retrospective multicenter analysis of 243 patients, there was only 1 major complication (neuroforaminal impingement with radiculopathy). The rate of treatment failure where no pain relief is experienced appears limited to 3%. Imaging techniques utilized include fluoroscopy, computed tomography, and CT fluoroscopy. Technical approaches for sacroplasty include short-axis, angulated short axis, long axis, trans-iliac, and midline approaches. Interventions include traditional cementoplasty, balloon-assisted cementoplasty, and radiofrequency-assisted cementoplasty. An example is shown from our institution of a patient with sacral insufficiency fractures, treated with CT-guided longitudinal approach balloon assisted sacroplasty who reported a significant reduction in pain at 24 hours.

Conclusions: Sacroplasty is a safe and effective treatment for painful sacral insufficiency fractures with efficacy rates similar to kyphoplasty. Familiarity with the variety of approaches and technical considerations is helpful to achieve technical and clinical success.

Successful upper thoracic vertebroplasty with cone-beam computed tomography otherwise inaccessible by conventional fluoroscopy

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Purpose: Describe our technique for using cone-beam CT during vertebral body ablation and augmentation for upper thoracic vertebral bodies spanning T2 through T6.

Materials: Biplane fluoroscopic image guidance for spine procedures is generally limited to the lower thoracic and lumbar spine as overlapping anatomy obscures the field of view in the upper thoracic spine. Alternatively, while computed tomography can provide adequate visualization of the of the upper thoracic spine, there are technical constraints secondary to the small bore of the scanner and axial projection imaging. With the use of cone-beam CT, the visual and technical
limitations can be alleviated, allowing access to symptomatic lesions in the upper thoracic spine.

**RESULTS:** Using a biplane fluoroscopic technique, the region of interest in upper thoracic spine is identified. Cone-beam CT is then obtained, improving visualization of the relevant anatomy. Using the multiplanar reformats, the approach to the lesion is identified and mapped accordingly. Access to the vertebral body is then obtained using the guidance of biplane fluoroscopy and cone-beam CT as needed. Additionally, cone-beam CT is used to confirm final needle placement prior to ablation and to monitor bone cement administration.

**CONCLUSIONS:** Painful upper thoracic vertebral body lesions and fractures are no longer too technically challenging for the interventional radiologist. By routinely using cone-beam CT, upper vertebral body ablation and augmentation can be safely and successfully performed.

**Abstract No. 909**

**Cone-beam computed tomography for spine interventions: a case-based review**

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**PURPOSE:** The purpose of this educational exhibit is to illustrate the utility of cone-beam CT (CBCT) for vertebral interventions in interventional radiology. The advantages and disadvantages of CBCT compared to fluoroscopic or standard multidetector CT guidance will be demonstrated through a case-based review. The techniques and approaches to various spine procedures with CBCT will be shown. Clinical and procedural outcomes will be reviewed.

**MATERIALS:** CBCT is a versatile tool with established utility in vascular and nonvascular procedures. CBCT allows volumetric data acquisition with the ability to reconstruct images in any plane. For spine interventions, the benefits of CBCT include real time guidance for needle placement, ease of accessing target in plane with vertebral body or disc space, convenience of performing procedure in the interventional radiology department, and the ability to assess for pre or postprocedural complications without transferring the patient to and from another room. At our institution, CBCT is often used in conjunction with fluoroscopy to add biopsy guidance overlay and to have the ability to supervise dynamic portions of the procedure in real time. In contrast, the use of standard multidetector CT relies on trial and error and operator experience for access as well as incremental imaging for dynamic procedures.

**RESULTS:** Multiple clinical cases will be presented to illustrate the utility and versatility of CBCT for spine procedures. Cases include: biopsy of hypermetabolic vertebral body lesion, disc space biopsy, preoperative image-guided localization for ventral meningioma, vertebral augmentation in a patient with Harrington rods, and RF ablation of metastatic lesion. Procedural and clinical outcomes will be discussed. A case of aborted vertebral augmentation due to new imaging findings seen on CBCT will be presented. A failed disc space biopsy will be shown, and the limitations of CBCT will be discussed.

**CONCLUSIONS:** CBCT is a valuable and versatile tool for spine interventions. At our institution, it is the preferred modality for image-guided spine procedures by some operators.

**Abstract No. 910**

**Small needles, big results: a guide to fluoroscopic spinal pain procedures for an interventional radiologist**

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**PURPOSE:** To give an overview on the techniques, indications, and medications for fluoroscopic-guided spinal pain procedures including: epidural spinal steroid injections (cervical, thoracic, and lumbar), facet (zygopophysial) joint injections, and atlanto-occipital injections.

**MATERIALS:** Chronic back pain affects millions, limiting mobility, hampering quality of life, and often producing disability. Symptoms may include limited range of motion and radiculopathy in the lower back to nausea, headaches, and referred pain in the upper cervical spine. Unfortunately for many, conservative treatment through physical therapy, NSAIDs, and narcotic analgesics often provides only limited relief. Joint and epidural injections with anesthetics and/or steroids can provide relief felt immediately, lasting weeks to months. Fluoroscopic guidance allows for confirmation of needle placement providing safe delivery of anesthetics and/or steroidal injections for the interventional radiologist.

**RESULTS:** We will 1) discuss the indications for fluoroscopic-guided spinal interventions to include atlanto-occipital injections, facet joint injections, and epidural spinal steroid injections; 2) discuss the medications utilized in these procedures for optimal symptomatic relief; and 3) outline the technique of these spinal interventions in a step-by-step manner, with graphical assistance to highlight important anatomical considerations.

**CONCLUSIONS:** Fluoroscopic-guided spinal interventions provide safe and effective pain relief in patients with chronic back pain and associated symptoms. Symptomatic relief can be experienced immediately and last up to months allowing for improvements in mobility, function, and quality of life in affected patients. These procedures yield a large return in pain relief for a small technical investment making them a worthwhile procedure to add to an IR practice.

**Abstract No. 911**

**Persistent left superior vena cava in Waardenburg syndrome**

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**PURPOSE:** We present a case of Waardenburg syndrome type II found to have a persistent left superior vena cava (PLSVC) draining into the coronary sinus. The prevalence of PLSVC is increased in patients with chromosomal and genetic abnormalities. However, this is the
first description of its presence in association with Waardenburg syndrome. Differential diagnosis of left paraspinal central venous catheter tip and its implications will be reviewed.

**MATERIALS:** A 5-year-old girl with Waardenburg syndrome type-II with persistent foramen ovale, left diaphragmatic hernia, dysmorphic facies, and hypoxia was referred to us for Peripherally Inserted Central Catheter (PICC) placement after multiple failed attempts by the PICC service. Her history is significant for cecal volvulus with resulting bowel infarction and small bowel resection. She underwent repeated laparotomies for ischemia and abdominal compartment syndrome with resulting short gut syndrome requiring total parental nutrition.

**RESULTS:** During our procedure, initial access via the right basilic vein did not allow central advancement of the 0.018" wire. Venographic images demonstrated chronic total occlusion of the right brachiocephalic vein. Subsequently, access via left brachial vein was performed with the wire advancing along the left paraspinal line and not crossing to the cavoatrial junction. Venography at this point demonstrated a persistent left superior vena cava draining into the right atrium via the coronary sinus. The PICC was then advanced over the wire and imaged in the coronary sinus before retraction and successful positioning in the left superior vena cava. Three months later, there was concern for an infectious process and a Computed Tomography scan of the chest was performed with resultant imaging of the PLSVC on cross-sectional imaging.

**CONCLUSIONS:** To our knowledge, this is the first reported case of Waardenburg syndrome in association with persistent left superior vena cava. Its incidental discovery during a peripherally inserted central venous catheter highlights the challenges that can arise during central venous placement in the pediatric population.

**Abstract No. 912**

Interventional magnetic resonance-guided joint injection prior to diagnostic magnetic resonance shoulder arthrography: starting an IMRI program

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**PURPOSE:** To describe our initial experience with magnetic resonance (MR)-guided shoulder arthrography using a 3 Tesla scanner at a single center.

**MATERIALS:** MRI provides excellent soft tissue contrast in joint imaging, but often requires direct joint injection of gadolinium (Gd) to visualize cartilage and ligaments, and MRI-guided joint interventions are not routinely performed.

**RESULTS:** MR protocols were optimized to visualize saline/contrast with reduced needle artifact. During each case, the slice of interest was defined, and vitamin-E strip was used to select the skin entry site. A 20-gauge 15-cm MR-compatible needle was introduced into the glenohumeral joint space using a fast PD-weighted sequence. Real time T1-weighted MR was used during saline injection to confirm needle position by correlating with saline distension. Real time T1-weighted MR was also used during Gd injection. 29 MR-guided shoulder arthrograms (mean age, 17 years; mean weight, 72 kg) were performed by 4 interventional radiologists with anterior approach from Jan-Sep 2017 on a 3 Tesla scanner. Technical success was 100%. The amount of dilute Gd volume injected ranged from 8-17 mL (mode, 15 mL), with no immediate complications. Mean interventional procedure time was 33 ± 10.8 min, and combined interventional and diagnostic MRI procedure time averaged 76 ± 16 min. Mean procedure time for the initial two procedures for all 4 operators was 41 min (range, 28-62 min) but was 30 min (range, 19-58 min) for subsequent cases, p<0.05 demonstrating the quick learning curve. Joint distension was optimal in all cases. Gd extravasation lined along the needle tract in 19 cases (66%), in fibers within 5 cm in 7 cases (24%) and in fibers beyond 5 cm in 3 (10%). One patient experienced self-limited pain attributed to the intervention. MR arthrogram was normal in 4 patients, labral tear in 18 and other lesions (shoulder impingement/dislocation, torn ligament, etc.) in 7.

**CONCLUSIONS:** MR-guided Gd injection of the shoulder can be easily learned and successfully performed with few complications, real-time visualization of Gd distribution, no ionizing radiation and potential improved workflow efficiency. It may be a feasible entry procedure in instituting an interventional MR service.

**Abstract No. 913**

Strategies of interventional procedures for complications after pancreaticoduodenectomy

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**PURPOSE:** To understand and build appropriate strategies of interventional procedures for complications after pancreaticoduodenectomy (PD).

**MATERIALS:** PD requires resection and anastomosis of intestines, bile duct and pancreas. PD is known to have as high as 30% o 40% morbidity and 5% mortality. Various complications can occur after this highly invasive operation, treatment of which often necessitates interventional approaches. It is, therefore, essential for interventional radiologists to have accurate knowledge and skills to deal with these complications after PD.

**RESULTS:** 1. Nonvascular complications including pancreatic fistula, bile fistula and abscess. Percutaneous drainage should be considered for these conditions. Especially, pancreatic fistula is regarded as the most severe one, due to its potential affect to surrounding tissues including vessel walls. Percutaneous transgastric pancreatic duct drainage can be a challenging, but good option for treating pancreatic fistulas. 2. Vascular complications Transarterial embolization has been regarded as a first-line treatment for these conditions. The most common site of
arterial bleeding is from the gastroduodenal artery stump. Embolization of the hepatic artery is the simplest treatment, although it often accompanies clinical dilemmas; the risk of liver infarction. In such situations, several useful techniques including covered stent placement applying “pull-through” technique has been reported.

CONCLUSIONS: Case-based review of appropriate interventional procedures for various complications after PD is presented.

Abstract No. 914

Champagne imaging in interventional radiology: how to implement contrast-enhanced ultrasound into an interventional radiology practice in the United States

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PURPOSE: • Briefly review the value that contrast-enhanced ultrasound (CEUS) with the recently FDA-approved Lumason contrast agent can provide for an interventional practice • Discuss the logistical hurdles to implement CEUS in an interventional practice • Provide a cost overview of microbubble contrast agents and steps for their utilization • Review ultrasound software requirements for CEUS

MATERIALS: CEUS involves using microbubble contrast agents and specialized ultrasound techniques such as contrast-harmonic imaging to optimize signal and suppress background. The contrast agent Lumason was recently FDA approved for use in the United States for liver imaging.

RESULTS: There are multiple potential uses for CEUS with Lumason in an interventional radiology practice; however, several logistical hurdles to immediate implementation exist. 1. The microbubble contrast agents, like other imaging contrast agents, are now regulated as medications. Consequently, the agents need to be brought onto the pharmaceutical formulary, usually via an application to the P&T committee. 2. A coding and billing process should be in place. Patient charge for Lumason at our institution is ~ $80/cc. 3. Nursing staff in the practice should be trained in microbubble administration, which involves careful timing and appropriate preparation of the suspension. This training is straightforward and usually provided by the vendor. 4. Likely the biggest hurdle to implementing a CEUS program is the cost of obtaining the required ultrasound imaging technology. Appropriate imaging must be performed with low-mechanical index software as microbubbles are destroyed by normal higher mechanical index imaging. The software addition can run $5 to 15K. Training in use of the software will also be necessary.

CONCLUSIONS: CEUS has many potential uses in IR; however, there are hurdles to its implementation. An understanding of the role of integration with the pharmacy, necessary staff training in contrast administration and software operation, and cost of the microbubble agent and software can facilitate its integration into your practice. Further background on these issues and our experience overcoming the hurdles will be presented.

Abstract No. 915

American Association for the Surgery of Trauma: a guide for interventionalists

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PURPOSE: Review of the American Association for the Surgery of Trauma (AAST) guidelines related to vascular and interventional radiology (IR) procedures. Review common level I trauma cases and terminology with cased based imaging examples. Discuss recommendations for integrating IR into an essential clinical part of the trauma team.

MATERIALS: Trauma is the leading cause of mortality in Americans 1 to 44 years old and accounts for over 150,000 deaths and 3 million non-fatal injuries per year, with one-third of these patients dying from exsanguination. Current practice guidelines emphasizing nonoperative management in trauma patients have led to an established role for IR to aid in treatment in the emergency setting. The AAST guidelines are evidence-based guidelines for clinical practice in the acute trauma setting and provide a system by which to classify trauma patients.

RESULTS: Procedures offered by IR in the acute trauma setting include balloon occlusion and transarterial embolization (TAE) used to stop or reduce hemorrhage, stabilizing the patient and avoiding open surgery. The AAST currently grades splenic injury from Grade I-V. This grading system is mainly based on the surface area of spleen covered by hematoma, and by the severity of the laceration. Recent success has been reported in treating Grade V injury patients who are unstable with TAE, groups previously treated with surgery. The grading scale in hepatic injury is graded I-VI. Because the nontherapeutic laparotomy rate has been reported as high as 67%, there has been a trend in nonoperative management in liver trauma. Kidney injuries are graded from Grade I-V. Recent reports advocate mandatory angiography regardless of grade when the clinical condition allows it.

CONCLUSIONS: In an evolving health care landscape, patients deserve solutions with the least mortality and morbidity, combined with the safest available solution. IR is a field that has been at the forefront of advancing these ideals. The use of the AAST guidelines allows for an evidence-based system of grading patient’s injuries and allowing for the most effective and efficient management of traumatic injuries.

Abstract No. 916

Radiation safety for the interventional radiologist

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PURPOSE: Attendees will learn how to reduce radiation doses to both patients as well as themselves during both fluoroscopic and CT-guided
Abstract No. 917

Products to improve safety in interventional radiology: device descriptions, review of safety applications, and correlation with available literature

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PURPOSE: The goal of this exhibit is to review a variety of interventional radiology (IR) products which claim to have a safety component, describe their use, and educate the reader on the level of evidence and amount of data that supports or refutes the use of each product.

MATERIALS: A variety of products are available for use in the IR suite that have a safety component. Some involve radiation safety, while others have minimal, if any, data to support certain safety claims. IR physicians and trainees must develop an understanding of these devices, which ones are supported by scientific data, and how one can cost-effectively incorporate their use into practice.

RESULTS: This educational exhibit reviews concepts of how specific devices may improve procedural safety, relating to overall patient safety, procedural efficiency, operator safety, and radiation safety. We present a detailed review of IR products which claim to have a safety component, including description of each product, indication for use, cost analysis, potential safety benefits to patients and/or operator, and analysis of the available literature which may support or refute the use of such devices. Products discussed include (but are not limited to): distal embolic protection devices, anti-reflux micro catheters, steerable microcatheters, disposable radiation absorbing drapes, ultrasound-accelerated catheter-directed thrombolysis, ultrasound guidance and/or micro puncture kit use for vascular access, various techniques for track embolization when performing image-guided percutaneous biopsy, computer-assisted biopsy technology, centesis kits with safety/retractable needle, and the use of blunt-tip trocar technique to access difficult intraabdominal locations for percutaneous biopsy and/or drain placement.

CONCLUSIONS: Awareness of the various safety-related products available in the IR suite is important for the interventional radiologist to be able to safely and cost-effectively incorporate their use in appropriate clinical scenarios.

Abstract No. 918

Utilizing Epic Questionnaire form to create a comprehensive interventional radiology status board

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PURPOSE: Discuss the importance of an interventional radiology status board (IRSB) to improve daily work flow, improve communication and enhance patient safety in interventional radiology (IR). Explain the implementation of the Epic Questionnaire Form (EQF) to create the IRSB.

MATERIALS: IR is a busy service with many patients that makes coordination of patient care challenging. Incorporating an efficient IRSB provides an excellent communication tool among staff and improves patient safety. Many institutions utilize Epic as their electronic medical record software. University of Cincinnati implemented Epic in 2012 and there was a need for a more comprehensive IRSB. We were able to design a dedicated IRSB that meets such needs. We here share the IRSB design.

RESULTS: Communication among busy IR team members is crucial for a safe and efficient work flow. We utilized the EQF to build the IRSB. The EQF was built utilizing screening questions integrated into a form linked to the procedure order placed by referring physicians. The information is displayed in full and normal platforms. The designed IRSB utilizes colors to reflect patients’ phase of care. The IRSB displays extensive information for each patient listed under the IR suites. This information is filled using a drop-down menu. Information displayed includes name of the
procedure that can be edited. Other information includes name of IR physician, allergies, preprocedure requirements such as consent, H&P, labs, premedications, etc. Other information displayed include patient positioning, site of procedure, working side of IR table or equipment needed such as ultrasound. We also included information that is specific to certain procedures such as TACE or TARE. It also displays when the patient is ready to proceed to the IR suite. All information has an aesthetic display format. There is no time limit for the information entered in the EQF. We will discuss the build design that allows to reschedule the procedure without losing any information entered in the EQF.

CONCLUSIONS: IR service necessitates efficient coordination of patient care and precise communication among IR team members. An IRSB that is specifically designed to meet the needs of a busy IR service is essential and invaluable.

Abstract No. 919

Interventional management of Budd-Chiari syndrome

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PURPOSE: To describe interventional techniques for management of Budd-Chiari syndrome (BCS), including TIPS creation, hepatic vein stenting, and IVC stenting. An overview of each technique, and the relative success of each approach in relieving hepatic and extra-hepatic vascular congestion will be discussed.

MATERIALS: BCS is a rare condition characterized by hepatic venous outflow tract obstruction affecting approximately one in 100,000 persons globally. Presentation can range from asymptomatic to fulminant liver failure. Medical management is rarely sufficient for a majority of patients. Aside from liver transplantation, the sequelae of BCS can be effectively managed using endovascular techniques including hepatic vein stenting, IVC stenting, and transjugular intrahepatic portosystemic shunt (TIPS) creation. In particular, TIPS creation has emerged as an effective, minimally invasive means of decompressing the congested liver even in high-risk groups of BCS patients.

RESULTS: The most common approach for TIPS creation is from the right hepatic vein to an intrahepatic segment of the right portal vein. Modifications of this technique are often necessary due to extensive hepatic vein and IVC occlusion in BCS patients. These modifications include starting the intrahepatic track from the remnant hepatic vein stump or direct intrahepatic portocaval shunt (DIPS) creation from the IVC. In patients with occlusion of the IVC, TIPS creation is delayed until after IVC recanalization. Rarely, TIPS creation is complicated by portal vein thrombosis, necessitating anticoagulation or mechanical thrombolysis. Additionally, endovascular procedures such as angioplasty and stenting of hepatic venous and inferior vena cava occlusions have been used in BCS patients to reduce morbidity.

CONCLUSIONS: Interventional management of BCS includes TIPS/DIPS creation, hepatic vein stenting, and IVC stenting. Depending on the indication of the procedure and location of occlusion, any of the three techniques can be effective for patients. TIPS creation in particular has been shown to delay need for liver transplant in BCS patients.

Abstract No. 920

Transjugular intrahepatic portosystemic shunt flow reduction through controlled deployment of a balloon expandable stent graft: the “dumbbell” technique

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PURPOSE: Refractory hepatic encephalopathy (HE) or progressive liver failure following placement of a transjugular portosystemic shunt (TIPS) may necessitate shunt reduction. We describe a technique utilizing a single balloon expandable stent graft deployed in a precise and controlled fashion, allowing for incremental enlargement of the stent and corresponding reduction of the portosystemic gradient.

MATERIALS: TIPS reduction was performed on two patients. 67-year-old white female (Patient A) with complications of medically refractory HE and liver decompensation two weeks following TIPS implantation and a 53-year-old white male (Patient B) suffering from chronic low clinical grade HE after receiving a TIPS over a decade prior.

RESULTS: Both procedures were outpatient based, under conscious sedation. TIPS reduction was performed utilizing the controlled deployment of a single balloon expandable stent graft (Viabahn VBX, Gore, Flagstaff, AZ). Standard right internal jugular venous access was obtained, followed by initial venography and determination of the portosystemic gradient. The stent graft is positioned within the TIPS, the sheath (10F) is retracted, leaving approximately one third of the distal stent exposed. The balloon is inflated and the distal stent graft flares. Following this, the balloon catheter is retracted, using the sheath to gently buttress the flared portion of the stent, such that the upper third of the stent graft can then be inflated, leaving a waist centrally. The waist is incrementally inflated until the desired portosystemic gradient is achieved. Both procedures were technically and clinically successful. At 1-month after the procedure, Patient A had substantial improvement and a 53-year-old white male (Patient B) suffering from chronic low clinical grade HE after receiving a TIPS over a decade prior.

CONCLUSIONS: TIPS reduction is not common but is warranted in certain clinical scenarios. Multiple techniques for TIPS reduction have been described, although none universally adopted. We describe a technique that we believe is simple, reliable and effective.

Abstract No. 921

Review of unique complications with the Viatorr stent graft for TIPS

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**TIPS** creation can be associated with a unique type of complications; complications. Steps required to place this device to prevent major stent associated with the use of covered stents. The interventional radiologist needs to significantly, from 50% with the use of bare metallic stents, to over 80% with the use of covered stents. The interventional radiologist needs to be familiar with the unique design of the Viatorr and with the technical steps required to place this device to prevent major stent associated complications.

**RESULTS:** Technical steps to place the device will be review. Potential technical complications related to improper sizing or placement of the device can occur. Stents that end too short into the hepatic vein (HV) may result in dysfunction of the shunt. Stents that are too long can rarely result in IVC thrombosis. HV thrombosis has been reported but is mostly of no clinical significance. Misplacement of the covered portion inside the main portal vein could be associated with thrombosis/stenosis of the main PV or its main branches. Liver infarcts and potentially lethal liver failure can occur. A stent that is too deep inside the main PV could also interfere with a future orthotopic liver transplant. Inadequate tension, very angulated access tracts, or very small portal veins; may result in having the false impression that the radiopaque gold marker is at the parenchyma/portal vein junction, when in reality the device is still too deep inside the portal vein.

**CONCLUSIONS:** Misuse or misplacement of the Viatorr stent graft for TIPS creation can be associated with a unique type of complications; some can be life threatening.

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**Abstract No. 922**

**Balloon occlusion transvenous obliteration of superior rectal veins for treatment of bleeding rectal varices in portal hypertension: case report**

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**PURPOSE:** Learner should be able to: 1. Understand the pathophysiology of rectal varices in portal hypertension. 2. Understand the common medical, endoscopic or surgical management of rectal varices. 3. Indications and techniques for endovascular management of rectal varices.

**MATERIALS:** Life threatening rectal variceal bleeding requiring intervention is rare. Rectal varices are formed by the intrinsic rectal venous plexus (IRVP) that get afferent inflow from the Superior Rectal Veins; tributaries of IMV. Middle and inferior rectal veins that form the efferent pathway drain the IRVP into the iliac system. Medical management of liver cirrhosis and portal hypertension along with endoscopic banding or sclerotherapy is the first line therapy for rectal varices. Surgical options are variceal or IMV ligation. Endoscopic interventions include TIPS, embolization of afferent vessels and BRTO of outflow vessels.

**RESULTS:** A 63-year-old woman with a history of non-alcoholic liver cirrhosis presented with persistent rectal bleeding and life threatening acute blood loss anemia from large rectal varices. TIPS was placed to manage both rectal and esophageal variceal bleeding and recurrent ascites. Portal vein was found to be partially thrombosed with initial HVPG of 28 mm Hg; reduced to 13 mm Hg post TIPS. IMV angiogram revealed persistent retrograde flow and tortuous and dilated superior rectal veins supplying very large rectal varices. Life threatening bleeding, persistent 13 mm Hg HVPG gradient and PV thrombus prompted the decision to sclerose the rectal varices. Balloon occlusion transvenous obliteration of superior rectal veins using a foam solution of Air, Sotradecol and Ethiodol (3:2:1) followed by coiling was performed resulting in complete thrombosis of the rectal varices. Patient did not have any further rectal bleeding.

**CONCLUSIONS:** Bleeding from the uncommon portosystemic collaterals in portal hypertension like rectal varices is rare; however, understanding the pathophysiology of these collateral pathways will help in evaluating and potentially treating the source of bleeding. The management goal is similar to esophageal and gastric varices, that is, to decrease portal pressure using TIPS, obliteration of inflow or BRTO of outflow vessels.

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**Abstract No. 923**

**Sinistral portal hypertension: diagnosis and management**

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**PURPOSE:** 1) Understand the pathophysiology of sinistral portal hypertension (SPH) and its sequelae. 2) Illustrate diagnostic features, imaging findings and treatment options of sinistral portal hypertension. 3) Compare various treatment options in SPH with particular emphasis on endovascular therapy.

**MATERIALS:** SPH, also known as “left-sided portal hypertension,” occurs when splenic venous pressures are elevated. The most common cause is splenic vein occlusion secondary to pancreatic disease that results in splenic vein thrombosis and/or stenosis. The resultant venous hypertension leads to the formation of submucosal gastric varices. Portal vein pressures are typically not elevated. The clinical picture ranges from asymptomatic to life threatening upper GI bleeding.

**RESULTS:** SPH should be considered as a potential cause of upper GI bleeding. The diagnosis of SPH is challenging and depends on exclusion of more common causes first. CT and MRI may demonstrate the cause of the splenic vein occlusion and delineate the vascular anatomy for endovascular therapy. Portal venography may be needed to differentiate classic portal hypertension from sinistral portal hypertension. Upper GI endoscopy may show submucosal gastric varices, which may not be amenable to endoscopic treatment. Furthermore, isolated gastric varices may occur, which are thought to have a lower pressure threshold for bleeding than esophageal varices. Treatment strategies have evolved from splenectomy to endovascular therapy including...
splanic vein recanalization, splenic artery embolization and gastric varical embolization. Patient selection is crucial in the endovascular management of this unique entity.

**CONCLUSIONS:** Sinistral Portal Hypertension is an uncommon cause of potentially life-threatening upper Gl bleeding. Given the unique diagnostic features and treatment strategies, it is essential to understand the underlying disease process and management.

**Abstract No. 924**

Management of stomal variceal hemorrhage in the setting of portal hypertension: an overview of the pathophysiology and an approach to interventional management of this less common but life-threatening emergency

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**PURPOSE:** To provide an overview of the unique pathophysiology behind acute stomal variceal bleeds in patients with portal hypertenssion, outline available management paradigms, and discuss an emergent case with massive stomal hemorrhage treated with TIPS, BATO, and embolization with Gelfoam slurry, multiple sizes of particles, and liquid embolic glue.

**MATERIALS:** Portal hypertension and its associated sequelae are well-described in the literature. Although not commonly encountered, patients with portal hypertension and stomal varices presenting with hemorrhage have their own subset of technical treatment challenges. Approximately 30% of cirrhotic patients with PH and stomas experience recurrent stomal hemorrhage. Reduction of PH is the definitive therapy for bleeding stomal varices (BSV), preferably through transjugular intrahepatic portosystemic shunts (TIPS). Unfortunately, not all patients are TIPS candidates, therefore, familiarity with other interventional techniques is needed to best serve these patients.

**RESULTS:** The basic pathophysiology of BSV as well as the its unique differences compared to other gastrointestinal bleeds will be described. Various treatment approaches will then be presented, including but not limited to portal venous access via TIPS, portacaval puncture with or without direct intrahepatic portacaval shunt (DIPS), percutaneous transhepatic and transsplenic access, and percantaneous access directly to the portal venous system via splenic vein, ectopic varices, or native portosystemic collateral vessels such as the umbilical vein (example provided). If PH persists after TIPS/DIPS or access only is obtained, additional procedures to lower the varix pressure such as balloon-occlusion via BATO and BRTO in combination with various embolization and sclerotic agents will also be discussed. An example of massive hemorrhage via a stomal varix in a cirrhotic patient with Crohn's disease with portal hypertension treated with TIPS, BATO, and embolization with Gelfoam slurry, multiple sizes of embolic particles, and liquid glue will be provided.

**CONCLUSIONS:** Management of BSV requires familiarity with numerous interventional techniques for not only portal venous access but also varix embolization.

**Abstract No. 925**

Intravascular ultrasound guidance as a problem-solving tool for intrahepatic portosystemic shunt creation in the setting of severe polycystic liver disease

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**PURPOSE:** To describe the use of IVUS-guidance as a problem solving tool to safely create an intrahepatic portosystemic shunt in the setting of severe polycystic liver disease (PCLD).

**MATERIALS:** PCLD has been considered a contraindication to intrahepatic portosystemic shunt creation due to potential cyst rupture, hemorrhage and decreased technical success. Advances in image-guided techniques have begun to challenge this assumption in certain clinical scenarios. We describe use of IVUS to safely create an intrahepatic portosystemic shunt in a patient with severe PCLD.

**RESULTS:** A 70-year-old woman with PCLD/PCKD and a history of bilateral nephrectomy, liver mobilization and cyst fenestration presented with refractory ascites. Liver biopsy demonstrated no histologic abnormality, and she was presumed to have extrinsic portal compression due to the innumerable hepatic cysts resulting in increased transcapillary pressures. Renal transplantation was deferred due to her portal hypertension. CT imaging demonstrated a potential safe trajectory from the IVC to the main portal vein through the caudate lobe without significant cyst burden. She was referred for portosystemic shunt creation to address the ascites and improve her renal transplant candidacy. Using IVUS, a direct path between the retrohepatic IVC and main portal vein was identified matching the preprocedure trajectory anticipated on CT. A single pass was made, avoiding any cysts, and the portosystemic shunt was created using a stent graft without any complications. Ascites resolved at follow-up, and she is currently being assessed for potential renal transplantation.

**CONCLUSIONS:** While PCLD has historically been a contraindication for portosystemic shunt creation, advanced imaging techniques such as IVUS-guidance can significantly improve procedural safety and increase the availability of the procedure in this patient population.

**Abstract No. 926**

An unknown entity in medicine: portosystemic shunt syndrome

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**PURPOSE:** To describe clinical and radiographic findings associated with portosystemic shunt syndrome (PSS).

**MATERIALS:** Patients with cirrhosis and portal hypertension (PH), may form shunts between the portal and systemic circulations that bypass the hepatic sinusoids, to reduce PH. These shunts grow as PH increases and divert portal blood into the systemic circulation. PSS refers to the
Management of hepatic encephalopathy

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PURPOSE: To provide an overview of the available treatment options for hepatic encephalopathy, as well as their benefits, limitations, and complications.

MATERIALS: Hepatic encephalopathy (HE) is a debilitating neuropsychiatric condition which occurs in the setting of liver failure or extensive portosystemic shunting. Severity ranges from mild confusion and personality changes to somnolence and coma. Overt HE affects approximately one third of patients with liver failure and is thought to result from accumulation of metabolic byproducts, particularly ammonia, in the blood. Multiple treatment options are available with the potential for complete symptomatic reversal.

RESULTS: Initial therapy for mild encephalopathy is conservative, with appropriate nutrition, avoidance of dehydration, and mitigation of aggravating factors (especially bleeding and infection). Reduction of blood ammonia levels may be achieved via lactulose, lactitol, and rifaximin administration. Protein restriction can cause increased mortality and should be avoided. Variceal bleeding can exacerbate HE secondary to the increased protein load introduced into the gut. In patient in whom a TIPS is indicated secondary to refractory variceal bleeding, a constrained TIPS may be performed, either via incomplete dilation or placement of a smaller stent within a larger one.

CONCLUSIONS: HE is a common and debilitating condition, but is potentially reversible with appropriate management.

Abstract No. 929

Hepatic artery stenosis post liver transplantation: efficacy, durability, and safety of endovascular interventions

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PURPOSE: Upon reviewing this exhibit, the learner will 1) have a greater understanding of the commonly encountered complications following liver transplantation, 2) appreciate the role interventional radiologists have in the care of posttransplant patients, and 3) describe interventional procedures performed in post-liver transplant patients.

MATERIALS: Approximately 6000 liver transplantation surgeries occur in the United States every year. This life-saving procedure offers a chance at life for many patients with complications of end-stage liver disease. However, despite the exceptional technical skills of transplant surgeons, the morbidity associated with liver transplantation is high. Vascular complications include hepatic artery, hepatic vein, and portal vein stenosis/occlusion, IVC stenosis/occlusion, and portal hypertension. Nonvascular complications include obstructive cholangitis, biloma, bile leak, and malignancy (HCC). Minimally invasive techniques have been developed for the diagnosis and treatment of many of these complications with effective results.

RESULTS: We present a case-based, systematic review of commonly performed procedures for the management of post-liver transplant complications. We examine early, mid, and late posttransplant vascular and nonvascular complications. Vascular interventions include IVC, hepatic vein, hepatic artery, or portal vein angioplasty or stenting. Nonvascular interventions include percutaneous biliary drain, balloon dilation, and biliary stent placement for obstructive cholangitis, TIPS for recurrent portal hypertension, and TACE/TARE for recurrent hepatocellular carcinoma.

CONCLUSIONS: Interventional radiologists play an important role in the diagnosis and treatment of many of the most commonly encountered complications of liver transplantation.
Arterial complications of the posttransplant liver - Interventional procedures and patient outcomes with hepatic artery intervention

**Purpose:** To evaluate the efficacy, safety, and durability of endovascular treatment for the hepatic artery stenosis (HAS) after liver transplantation.

**Materials:** Hepatic artery stenosis (HAS) following transplantation is an uncommon but significant complication. Its incidence in adults ranges from 1.8% to 11%. Most hepatic artery stenosis arises at the anastomosis site within 3 months after transplantation and usually related to arterial injury by a vascular clamp during transplantation. HAS is associated with a 30–40% risk of liver failure. Early diagnosis and intervention may help to reduce ischemic damage to the graft, consequent bile duct damage, and progression to hepatic artery thrombosis (HAT). Traditional treatment of hepatic artery complications has been surgical, with hepatic artery revision or retransplantation. Endovascular therapy of HAS with balloon angioplasty and or stenting may provide a less-invasive treatment option. Doppler US is the imaging modality of choice for diagnosis and follow-up with reported sensitivity for the detection of HAS of 80-90%

**Results:** The technical success rate was 100% (26/26). Of these 26, n = 20 patients underwent primary PTA and 6 underwent stenting. Outcomes were evaluated based on vessels’ patency, velocity, and resistive index (RI) measured using Doppler ultrasound. The Kaplan-Meier estimates of the primary patency of PTA (n = 20) were 65.0%, 35.0% and 35.0% at 1, 6 and 12 months, respectively. The Kaplan-Meier estimates of the primary patency of stents (n = 6) at 1, 6 and 12 months were 83.3%, 33.3% and 33.3% respectively. Eight of 20 PTAs (40%) PTAs required a secondary intervention whereas two (33.3%) of the primary stent cases required a secondary intervention. Seven of the 10 patients with secondary procedures underwent a tertiary intervention. One procedure complication was encountered and managed immediately with no consequences.

**Conclusions:** Endovascular interventions for posttransplant HAS have high technical success rate, low risk of complications and acceptable primary patency. Close surveillance is important as re-stenosis and re-intervention rates are high.

**Abstract No. 930**

Hepatic artery interventions in the posttransplant liver: case reports

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**Purpose:** Brief review of liver transplantation and surgical anatomy - Arterial complications of the posttransplant liver - Interventional procedures on the hepatic artery in the posttransplant liver - Case reports and patient outcomes with hepatic artery intervention

**Materials:** Arterial complications of liver transplant include hepatic artery stenosis, thrombosis, pseudoaneurysm formation, and splenohepatic arterial steal syndrome. Although arterial complications are uncommon they are an important cause of morbidity, mortality, and retransplantation. Early diagnosis and treatment is critical in hepatic artery stenosis to avoid progression to thrombus or biliary ischemia. Treatment of stenosis includes percutaneous transluminal angioplasty (PTA) or stenting. Hepatic artery thrombosis is a severe complication with high mortality and the potential to lead to graft failure. Emergency revascularization is paramount and can be performed utilizing a bolus or infusion of thrombolytics, followed with PTA or stenting. Hepatic artery pseudoaneurysm is a rare complication and interventional treatment includes the use of microcoils or stent placement. Lastly, splenohepatic arterial steal syndrome is a rare complication consisting of decreased graft perfusion secondary to diverted flow through a large splenic or gastroduodenal artery, and treatment includes embolization or ligation.

**Results:** Case reports at our institution demonstrate how prompt interventional revascularization can decrease the incidence of serious complications and improve overall outcomes in patients with hepatic artery complications. Our study will highlight clinical cases of hepatic artery stenosis, thrombosis and pseudoaneurysm formation in post-transplant patients and review management and treatment pathways for this patient population.

**Conclusions:** Early diagnosis of arterial complications is critical for graft salvage in liver transplant patients. Prompt interventional therapy can often prevent long-term sequelae, or provide a bridging measure for re-transplantation.

**Abstract No. 931**

Wound care refresher: caring for the infected portacath

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**Purpose:** Review the physiologic phases of wound healing and closure after removing a portacath from an infected subcutaneous pocket. Discuss the different wound care management options.

**Materials:** An infected portacath can be deadly. Despite the great care and adherence to strict sterile standards during placement and with each access, inevitably the interventional radiologist will be consulted for marginal removal of the device. While removal of the portacath may require marginal surgical skill, the aftercare has only gotten more complicated with different methods and techniques to improve and speed up wound healing.

**Results:** Wound healing occurs through four phases: hemostasis, inflammation, proliferation, and remodeling. While a clean surgical wound can be closed by the use of stitches, staples, tapes, or glue, otherwise known as closure by primary intention, this type of closure may lead to abscess in an infected subcutaneous wound. Therefore, infected wounds should be closed by secondary intention, or delayed closure once wound is determined to be aseptic. For successful closure by secondary or tertiary intention, a moist, necrotic- and bacterial-free wound environment must be meticulously maintained. Different methods and techniques to obtain this environment include sterile wet-to-dry gauze packing, gauze packing impregnated with iodineform or silver compounds, or by using negative-pressure therapy with a vacuum-assisted device. Each of these therapies differs in cost, and risks and benefits.
Abstract No. 932

Alternative site placement of implanted vascular access devices

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PURPOSE: 1. This exhibit will review alternative placement sites of implanted vascular access devices (IVADs) and discuss benefits, outcomes, patient perspectives, case examples, and complications; 2. The technical considerations of site-specific IVAD placement as well as a pictorial guide will be reviewed.

MATERIALS: IVADs have become a staple of interventionalists’ portfolio and are most frequently placed in the chest wall. Brachial or basilic catheter access with upper extremity IVAD placement is a popular alternative for many patients. Recent literature has shown the upper extremity IVAD to be equivalent in safety and non-inferior in placement success and durability. Although the availability of this port location is widely known, the technical considerations may be less well known to the interventionalist who does not perform this procedure frequently. Similarly, lower extremity IVAD access options are available and present a unique set of challenges and considerations.

RESULTS: The most common IVAD approach is via the internal jugular or subclavian vein with ipsilateral chest wall placement of the port. In situations when access to the internal jugular or subclavian vein is contraindicated or not preferred, brachial/basilic or femoral venous access are alternative considerations for safe and durable IVAD placement. Femoral placement technique is less well described but may be the only option in patients with an inadequate or absent SVC.


Abstract No. 933

Anti-fouling strategies in catheter development

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PURPOSE: Discuss the major mechanisms and pathophysiology of catheter fouling. Describe current methods targeted at preventing infectious and thrombotic complications. List and describe new innovative methods of prevention in catheter design.

MATERIALS: Central venous catheters are ubiquitous in healthcare and a central tool to interventional radiology. Over the past several decades there has been minimal advancements in catheter design, composition and catheter coatings. However, recent innovations can disrupt biofilms, alter flow dynamics, prevent molecular adsorption and modulate immunologic changes. Using case studies, we will demonstrate various complications encountered with catheters such as fibrin sheaths, thrombosis, fracture and infections and list how recent findings can address these complications.

RESULTS: Developments in preventing catheter associated infections have been directed at applying sterile techniques, manufacturing safe catheter materials and applying coatings. Various materials such as polytetrafluoroethylene have been shown to have decreased infectious complications. Impregnation of catheter materials with antibiotics, silver or chlorhexidine can improve outcomes. Similarly, thrombosis can be prevented by targeting steps along the thrombosis pathway. Intuitively and through study, preventing protein and platelet adsorption and adhesion is an effective strategy which can be achieved by super-hydrophilic materials, zwitterions, specialized surface patterns and creation of slippery surfaces. Impregnation of catheter materials with thrombolytic or anticoagulant agents can also help to prevent poor outcomes.

CONCLUSIONS: While multiple innovative methods are being developed to prevent catheter associated infections and thrombosis, only a limited number of them have reached clinical practice. Current prevention methods involve frequent monitoring, use of sterile techniques or systemic medications. It is important going forward to be aware of new strategies that may be available to the patient and providers to improve outcomes and patient experience and to be able to apply these in an efficient and effective manner.

Abstract No. 934

Vascular access models: inexpensive, homemade vascular access phantoms for trainees to gain experience with ultrasound-guided percutaneous vascular access

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PURPOSE: • Understand the benefits of using simulation models for ultrasound-guided (USG) vascular access • Learn to create inexpensive, customized models for trainees to perform USG vascular access models at your institution

MATERIALS: The first time most trainees perform USG vascular access, the needle is inside a live patient. It is not uncommon for the inexperienced trainee to lose sonographic visualization of their needle tip or lack the skills to keep the needle and target vessel in the same sonographic window. To minimize patients risks, we demonstrate how to create vascular access models for use with ultrasound for trainees to gain skills, prior to performing vascular access on live patients.

RESULTS: This presentation teaches the reader how to create inexpensive homemade gelatin-based models for trainees to gain USG vascular access practice using easily obtained materials. We describe a specific mixture of gelatin, psyllium, and food coloring to create an optimal consistency of opaque echotextured gel containing fluid-filled surgical tubing embedded within the layers which simulates target
arteries and veins. The reader will learn to customize each model with additional soft-tissue structures representing additional organs which must be avoided while gaining access. By learning to create these inexpensive, re-usable USG vascular access models that trainees can use the models to gain experience with ultrasound and improve their hand-eye coordination, learn to visualize the needle tip on transverse views, view the entire needle on longitudinal views and maintain both the needle and target in a single plane, all prior to performing USG percutaneous vascular access within live patients. If refrigerated between use these models often last 10 to 14 days, which allows trainees extensive time to improve their skills and familiarity with USG percutaneous vascular access.

CONCLUSIONS: This presentation will help users learn how to create customized, inexpensive, re-usable home-made USG vascular access models to enable trainees to gain experience and improve their skills prior to trying to gain US-guided vascular access in live patients, increasing patient safety and simultaneously improving trainee competency.

Abstract No. 935

May-Thurner syndrome: treatment options for the interventional radiologist

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PURPOSE: 1. To review the anatomy and pathophysiology of May-Thurner syndrome. 2. To review the clinical evaluation and imaging findings associated with May-Thurner syndrome. 3. To review therapeutic options available for May-Thurner syndrome using illustrative case presentations.

MATERIALS: May-Thurner syndrome results from venous outflow obstruction of the left lower limb secondary to compression of the left common iliac vein by the right common iliac artery. Often under-recognized, May-Thurner syndrome can lead to multiple complications including recurrent deep venous thrombosis (DVT), postthrombotic syndrome and phlegmasia cerulean dolens. Treatment includes medical, endovascular, and surgical options. We hope to provide a concise overview of the diagnosis and management of May-Thurner syndrome using illustrative cases.

RESULTS: We will provide an overview of the clinical and radiological findings of May-Thurner syndrome. Additionally, we will discuss potential treatment strategies that the interventional radiologist should be aware of including medical, endovascular and surgical options. Through the use of illustrative case presentations, we will present an overview of therapeutic techniques including pharmaco-mechanical thrombolysis and angioplasty/stenting.

CONCLUSIONS: May-Thurner syndrome places patients at high risk for thrombosis-related complications in the left lower limb. It is important to consider this diagnosis when presented with a patient with left lower extremity DVT. Endovascular treatment has become the mainstay management option for these patients.

Abstract No. 936

Superior vena cava recanalization: an overview of endovascular techniques

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PURPOSE: 1. Illustrate various image-guided techniques for endovascular SVC recanalization and reconstruction. 2. Correlate techniques with success rates and long-term SVC patency per literature review. 3. Show examples of complications and their management.

MATERIALS: Patients with chronic indwelling central venous catheters or malignancy can develop acute and/or chronic SVC occlusion. When symptomatic, this condition is called SVC syndrome, and can cause a range of mild to life threatening symptoms including facial, chest wall, and upper extremity swelling, visual disturbances, and airway obstruction. While malignant SVC syndrome can sometimes be treated successfully with external beam radiation, catheter-related SVC syndrome and some malignant obstructions will require either open surgical reconstruction or percutaneous endovascular management [1].

RESULTS: A series of cases will be used to illustrate different endovascular approaches and techniques used to cross and reconstruct an SVC occlusion. Cases will incorporate traditional catheter and wire techniques from a jugular, femoral, and/or upper extremity approaches. We will show reconstruction using a variety of self-expanding and balloon expandable stents placed at various locations in the SVC, “double-barrel” reconstruction from both upper extremities and sharp recanalization where traditional techniques have failed. Procedural details for each method will be summarized through case-based pictorial reviews. We will show examples of complications including SVC rupture, in-stent re-thrombosis, and cardiac tamponade. A literature review will be performed to discuss technical and clinical success rates and outcomes including long-term SVC patency rates.

CONCLUSIONS: To maximize success in patients requiring SVC recanalization, IR physicians should be familiar with both traditional techniques and more complex methods such as sharp recanalization. As well, understanding appropriate management of procedural complications is integral to achieving good outcomes.

Abstract No. 937

Sharp needle recanalization for central venous stenosis: brachial approach

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PURPOSE: To review techniques, tips/tricks, and potential pitfalls related to sharp recanalization of the central venous system using a brachial approach.
MATERIALS: Sharp recanalization of the central venous system is a rarely performed but potentially valuable procedure for patients with symptomatic venous occlusions or limited options for central venous access. To date, techniques have been described using femoral and internal jugular approaches, but no dedicated series has been published regarding technique or outcomes via a brachial approach.

RESULTS: From our institutional series and a review of the literature, we will discuss: 1. The spectrum of central vascular occlusions and benefits and the limitations of jugular and femoral approaches to recanalization. 2. Technical considerations in utilizing a brachial approach for sharp recanalization. 3. Adjunctive techniques and devices, including angioplasty/stenting and the use of energy-emitting endovascular devices.

CONCLUSIONS: Sharp recanalization using the brachial approach has been made possible by the availability of long endovascular needles. Using the appropriate technique, this approach may be more appropriate and effective than either a femoral or jugular approach in a subset of patients.

Abstract No. 938

Percutaneous endovascular construction of the inferior vena cava in a pediatric patient with symptomatic inferior vena cava agenesis

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PURPOSE: To describe a novel percutaneous endovascular management technique for IVC agenesis, illustrated in the case of a 14-year-old male with symptomatic agenesis of the suprarenal IVC.

MATERIALS: IVC agenesis (IVCA) result from embryologic dysgenesis and occurs in up to 0.1% of the population. It is most commonly asymptomatic but when symptoms develop, unprovoked deep venous thrombosis (DVT) or lower extremity venous congestion are the most frequent manifestations. The rarity of this condition has precluded consensus regarding appropriate management, with prior reports suggesting lifelong anticoagulation and/or open surgical reconstruction. Here, we report a case of symptomatic agenesis of the suprarenal IVC treated via endovascular construction of the absent segment.

RESULTS: A 14-year-old male with chronic progressive nausea was found to have absence of a 10 cm segment of suprarenal IVC with collateral flow occurring via markedly dilated retroperitoneal, ascending lumbar, and perigastic vessels. Given the risks and prolonged recovery which would accompany surgery, he instead underwent percutaneous management. Under general anesthesia, vascular access was obtained via the right IJ and common femoral veins. A 6-F, 80-cm Berenstein occlusion balloon catheter was advanced via the right IJ sheath into the short segment of native suprarenal IVC to act as a target during bridging puncture. Through the femoral sheath, a Rubicon catheter and Rosen wire were advanced to the most cranial extent of the infrarenal IVC and then through the vessel wall into the extravascular retroperitoneal fat. Once adjacent to the suprarenal remnant, a 17-gauge, 50.5-cm Colapinto needle was thrust into the suprahepatic remnant, and a bridging 20 mm × 8 cm Wallstent deployed across the gap. No complications were encountered. Stent patency and symptomatic improvement were documented over the next 2.5 years.

CONCLUSIONS: This case demonstrates the feasibility of percutaneous de novo IVC reconstruction with establishment of orthotopic central venous flow and decompression of markedly dilated collateral vessels. Further studies will be necessary to establish rates of technical and clinical success, as well as of long-term patency.

Abstract No. 939

Portal vein embolization with Histoacryl and Lipiodol: the quick, easy, and cost-effective approach

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PURPOSE: • Describe how portal vein embolization (PVE) is performed at Stanford. • Show advantages of the glue technique.

MATERIALS: • PVE prior to major hepatic resection is an excellent way to promote hypertrophy of the future liver remnant (FLR), reduce hospital stays and postoperative liver dysfunction, and improve overall survival in HCC patients. • Accepted PVE criteria includes a FLR to total liver volume ratio > 40% in cirrhotic patients and > 50% in patients with marginal liver reserve. • We describe a safe and cost-effective method to perform PVE including: glue embolization using a 3:1 mixture of Lipiodol to Histoacryl, placement of an Amplatzer vascular plug, and glue embolization of the outflow tract.

RESULTS: Procedure: • Ultrasound-guided access of segments 5 or 6 portal vein with a 6 fr Brite tip sheath followed by main portal venogram. • Segment 8 portal venogram with a 5 fr SOS Omni catheter centrally. • Placement of a 105 cm Renegade HiFlo microcatheter peripherally. • Paint the portal veins from peripheral to central using 3:1 mixture of Lipiodol to Histoacryl using the microcatheter as a paint brush. • Repeat in all segments of the lobe until the original accessed portal vein is the only one remaining. • Main portal venogram and right portal venogram embolization with an Amplatzer plug. • With Kumpe catheter peripheral to the vascular plug glue embolize from plug to skin while pulling out the catheter and sheath together. Advantages: • $36 per tube Histoacryl versus $243 per vial of Embospheres and $86 MicroNester. • Visualization of the embolized portal veins and confirmation of non target embolization. • Amplatzer plug limits encroachment of glue towards the FLR and backfills small portal veins. • Positioning of the 5 fr catheter at the origin of the segment prevents excess glue from non target embolization to FLR. • Tract glue embolization is quick and limits bleeding. • FLR to total liver volume ratio > 55%.

CONCLUSIONS: Glue embolization of portal vein segments using a “paintbrush-like” technique and Amplatzer vascular plug is a simple and cost-effective way to promote hypertrophy of the FLR and reduce postoperative complications in major hepatectomy.
Abstract No. 940

Current practice in image-guided treatment for variceal hemorrhage: a technical guide

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PURPOSE: Varices are a common sequela of portal hypertension. A major complication of varices is massive hemorrhage, which is associated with a high mortality. The purpose of this poster is to highlight the current techniques and approaches to intervention for variceal hemorrhage.

MATERIALS: This is a case-based review of current minimally invasive image-guided techniques used to treat/embolize varices of the esophagus, stomach, rectum, and stoma.

RESULTS: The transjugular intrahepatic portosystemic shunt (TIPS) allows for decompression and selective embolization of the portosystemic collaterals and has shown to decrease rates of bleeding for esophageal varices. Advanced TIPS techniques such as the gun-sight technique may be utilized in patients where conventional TIPS is challenging or not feasible. Isolated gastric varices allow for alternative techniques such as coil or plug assisted retrograde transvenous obliteration. There are many classification systems that have been described for gastric varices, which are based on anatomical and hemodynamic differences. Understanding these differences is important for clinical management decisions and the appropriate use of obliteration procedures. Rectal varices may be treated by TIPS placement. Transhepatic access to the portal system can be performed in patients who are not amenable to TIPS. Once access to the rectal varices is obtained, a dual micro catheter technique may be utilized for embolization. Parastomal varices are not always easily recognizable. A high clinical suspicion must be maintained, and access is key in its management. Both transhepatic and direct percutaneous approaches should be considered for optimal treatment. Choice of embolic materials is done on a case by case basis. Temporary and permanent agents may be utilized in the treatment of varices.

CONCLUSIONS: Many techniques exist for managing patients with variceal bleeding. Familiarity with these options are vital in selecting a safe, technically feasible approach that provides optimal results.

Abstract No. 941

 Congenital portosystemic shunts: what the interventional radiologist needs to know

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PURPOSE: • Discuss the anatomic classification and various associations of congenital extrahepatic portosystemic shunts (CPS). • Review pathophysiology and clinical significance of CPS. • Describe the role of imaging in the diagnosis of CPS. • Discuss the decision algorithm in the management of CPS with focus on balloon occlusion test, role of angiography and pressure measurements and endovascular treatment options.

MATERIALS: Congenital portosystemic shunts (CPS), also referred to as Abernethy malformations, are rare congenital vascular anomalies of the splanchnic venous system by which portomesenteric blood drains directly into a systemic vein, bypassing the liver. CPS are classified into intra- or - extrahepatic variations and are further sub-classified into two main types. Type 1 has diversion of portal blood into the systemic circulation with absent intrahepatic portal branches and in type 2 the intrahepatic portal branches are intact; however, the portal flow is partially diverted into a systemic vein. CPS are frequently associated with other congenital anomalies including heart defects, malrotation, and genitourinary malformations. CPS can result in a variety of clinical manifestations ranging from symptoms secondary to abnormal hepatic development, the portosystemic shunt itself, or the associated congenital abnormalities. Imaging is essential in the early diagnosis of CPS and its various associations. Management decision algorithm includes tissue diagnosis for underlying liver pathology, measurement of porto-systemic gradients before and after balloon occlusion of the shunt, evaluation of venous drainage pattern of critical organs. Treatment algorithm depends on type of CPS. One or two step, partial or complete endovascular occlusion has now become the preferred treatment option for type 2 CPS.

RESULTS: Multiple cases highlighting the role of interventional radiology in the diagnosis and management of congenital extrahepatic portosystemic shunts will be presented.

CONCLUSIONS: Interventional radiology has a significant role in the multi-disciplinary management of congenital portosystemic shunts ranging from early diagnosis to endovascular management, with safe and effective results.

Abstract No. 942

Making a varicocele a $teal

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PURPOSE: To provide the practicing interventional radiologist with a fiscal understanding of the costs associated with varicocele embolization and to offer more cost effective alternatives to coil embolization.

MATERIALS: Varicoceles are a cause of male infertility/subfertility and scrotal pain affecting 15% of the male population and 40% of the subfertile/infertile male population. Varicoceles are often left sided (85%) but can be bilateral (15%). Endovascular treatment of varicoceles classically involved the use of coils for venous embolization. Recent technological advances have seen a shift towards the use of endovascular plugs and occlusion devices. While a single coil is far cheaper than an occlusion device, varicocele embolization requires the use of multiple coils which can raise the cost of this procedure, especially when hospitals may not be reimbursed for every coil used. Furthermore, the
additional use of microcatheters/wires and microcoils for more sub- 
selective embolization can further increase costs.

**RESULTS:** In this poster, we present the experience of a single-center 
transitioning from the use of Interlock coils to vascular plugs (Artvent- 
itive EOS) in the treatment of varicoceles. Technically, the distal aspect 
of the varicocele is catheterized after venographic mapping and a 
single Artventive EOS plug deployed. Venography is then performed 
confirming occlusion. A slurry of Gelfoam and Sotradecol (between 1 
and 3 cc) is then used to emboize the midportion of the varicocele. 
Finally, a second endovascular plug is used for proximal occlusion. 
Post embolization venograms are used to confirm successful embo- 
lization. Infrequently, in complex anatomy, more than two plugs may 
be required.

**CONCLUSIONS:** Varicocele coil embolizations can become costly due 
to the number of coils needed to occlude the gonadal veins. Although 
newer endovascular occlusion devices are more expensive per unit, in 
our experience, successful varicocele embolization can be typically be 
performed using 2 of these devices per side. This exhibit will highlight 
the financial savings/fiscal considerations associated with endovascu- 
lar occlusion plugs and the technical factors associated with achieving 
successful embolization.

**Abstract No. 943**

**Plug-assisted retrograde transvenous obliteration (PARTO) of portosystemic shunts utilizing antegrade cyanoacrylate injection**

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**PURPOSE:** 1. Review etiology and anatomy of portosystemic shunts and 
gastric varices. 2. Describe technique of using of glue and Amplatzer 
device in the treatment of portosystemic shunts and gastric varices.

**MATERIALS:** Hepatic encephalopathy (HE) and gastric variceal bleeding (GVB) are frequently encountered yet serious complications in the setting of portal hypertension. Balloon-occluded retrograde transverse 
ousuo (BRTO) utilizing sclerosant has classically been the conventional 
procedure for management of these complications, but often required 
long balloon inflation time. Typical sclerosant agents such as ethanol- 
amine oleate or sodium tetradeyl sulfate (STS) have been described. 
However, sclerosant toxicities leading to major adverse events have 
been reported. We report 6 patients with gastric varices or portosys- 
temic shunts who were treated with PARTO utilizing cyanoacrylate; we 
will discuss technique, efficacy and success rate.

**RESULTS:** A single-institution review from January 2014 to September 
2017 were analyzed retrospectively. A total of 62 patients underwent 
either BRTO or PARTO of gastric varices or portosystemic shunts. 6 
patients underwent PARTO with antegrade cyanoacrylate injection, 
consisting of a 50:50 male:female ratio with a mean of 62 years old. 
Patients treated had large gastric varices or portosystemic shunts 
which either resulted in GVB or HE. The mean total procedure time 
was 89 minutes. The mean time from glue injection to termination of 
the procedure was 11 minutes. The mean diameter of the shunt was 2.5 
cm. The mean size of the Amplatz plug utilized was 1.6 cm. Technical 
and clinical success was 100%, ie, no recurrence of GVB or HE during 
follow-up period. There were no procedure-related complications. We 
will discuss the technique utilized in full details.

**CONCLUSIONS:** PARTO of portosystemic shunts utilizing Cyanoacrylate 
can be an effective alternative in treating BGV and HE with good short- 
term outcomes. Further studies are required to confirm safety and effi- 
cacy of PARTO utilizing Cyanoacrylate.

**Abstract No. 944**

**Variant variceal presentations of portal hypertension and 
their management**

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**PURPOSE:** - Describe anatomy, pathophysiology, and treatment options 
for variant variceal hemorrhage via a review of 5 cases.

**MATERIALS:** Case 1: cirrhosis and portal hypertension, bleeding gastric 
varices via splenorenal shunt. Plug-assisted retrograde transvenous 
obliteration of gastric varices. No subsequent episodes of bleeding. 
Case 2: alcoholic hepatitis, ventral wall hernia containing jejunum with 
associated jejunal varices, which eroded through the skin causing “foun- 
tain-like” bleeding episodes. A direct intrahepatic portocaval shunt 
(DIPS) created. Pre/Post DIPS gradient: 15/9 mm Hg. No further epi- 
sodes of bleeding. No coil embolization performed due to reversal of 
flow within jejunal veins after DIPS. No subsequent episodes of bleeding. 
Case 3: cirrhosis, splenomegaly, SMV stenosis, and an ileal conduit with 
bleeding stomal varices. A TIPS was placed. Pre/Post TIPS gradient:18/3 
mm Hg. No gradient across SMV stenosis. Stomal varices embolized 
after TIPS creation. No further episodes of bleeding. Case 4: hypercoag- 
uble disorder and splenoportal-mesenteric thrombosis with stenosis 
of splenic vein causing bleeding gastric varices. TIPS created, with pre/ 
post gradient of 8/4 mm Hg. Angioplasty of splenic vein performed, 
with increase in antegrade flow and decrease in collateral flow. No fur- 
ther episodes of bleeding. Case 5: sinusoidal portal hypertension due to 
thrombosed splenic vein and consequent splenoportal varices supplying 
blooding gastric varices. No gastrospinalenour shunt. TIPS not cre- 
ated due to lack of intrinsic liver pathology; anatomy not amenable for 
BRTO. Splenic artery angiography proved hepatopedal flow in spleno- 
portal varices to portal vein, which precluded transhepatic embolization. 
Pt chose splenectomy over partial splenic embolization.

**RESULTS:** A comprehensive review of the literature in PubMed was 
carried out with pertinent papers selected regarding variceal mani- 
festations of portal hypertension, their treatment modalities, and their 
outcomes. Representative images were selected for illustration.

**CONCLUSIONS:** Variant variceal manifestations of portal hypertension, 
the pathophysiology behind varices, and treatment strategy will be 
reviewed in 5 cases.
Abstract No. 945

Myth or fact? Pelvic pain at coil site following gonadal vein embolization for pelvic congestion syndrome

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PURPOSE: 1. Review of relevant left ovarian vein anatomy. 2. Review technique of ovarian vein embolization. 3. Follow-up considerations post embolization.

MATERIALS: Gonadal vein embolization is common with multiple reported techniques. There are growing reports of patients feeling pain and discomfort at the site of embolization.

RESULTS: 43-year-old woman with symptoms of pelvic congestion and severe bilateral pelvic varicose veins undergoes pelvic venography/unilateral left ovarian vein embolization corresponding to CT imaging. Selective left renal venography showed a large, refluxing left ovarian vein. Selective embolization was performed in the following coil-sclerosant-coil sandwich method: 1. Embolization with detachable/pushable coils in the lower vein. 2. Injection of sodium tetradecyl sulfate foam in the mid vein. 3. Embolization with the same coils in the superior vein. Post embolization venography showed no reflux. Of note, the lower coils were placed lower than our usual technique due to the degree of reflux in this patient. She had pelvic congestion relief, but at the 2 and 6-week follow-ups, she reported the sensation of feeling the coils with mild focal discomfort in her left pelvis.

CONCLUSIONS: Refluxing left ovarian vein commonly causes pelvic varicosity. It courses to an almost 90-degree insertion in the left renal vein. Embolization successfully treats pelvic varicosities, with complete resolution of symptoms in 75% of patients. Anecdotal reports of patients “feeling the coils” or having focal pain/discomfort are becoming more prevalent. Though theoretical, placing coils inferior to the sacroiliac joint may result in symptoms from mass effect on adjacent structures; specifically, the ilioinguinal and genitofemoral nerves. We utilize a sandwich method of embolization; however, given the degree of reflux into the left ovarian vein in this patient, we placed coils lower than usual. While technically successful, this case was the first to report a sensation of coils in our experience. Large retrospective studies are needed to better correlate the anatomy and symptomatology, which may help prevent this increasingly prevalent complication.

Abstract No. 946

A pictorial review of advanced inferior vena cava filter retrieval techniques

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PURPOSE: After reviewing this exhibit, the reader should be able to recognize advanced techniques for difficult inferior vena cava (IVC) filter retrievals, including imaging findings, with a focus on difficult case scenarios.

MATERIALS: IVC filters are essential to the management algorithm of treating patients with deep venous thrombosis with contraindication to anticoagulation, having been shown to be effective in preventing fatal or massive pulmonary embolism (PE). IVC filter placement has significantly increased in the past decade due to the development of retrievable filters. Most filters can be retrieved with standard techniques from a right transjugular approach using a standard retrieval snare or recovery cone. Advanced techniques may be needed when filters are tilted or have fractured, migrated, angulated, or have penetrated or adhered to the caval wall.

RESULTS: A variety of methods are currently available for complicated IVC filter retrieval cases. These include the use of modified snare, endobronchial forceps, laser sheet assisted, stiffer wire displacement, balloon displacement, loop-snare-over wire technique, “sandwich” technique, “telescopic sheath” technique, and “sling” technique, among others. The procedural details and imaging for the main advanced retrieval techniques will be reviewed in this exhibit. Avoidance of complications will be discussed.

CONCLUSIONS: Techniques and algorithms for advanced IVC filter retrieval will be reviewed with an emphasis on approach for difficult cases.

Abstract No. 947

Single-institution experience of using steerable deflecting sheath for advanced inferior vena cava filter retrieval

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PURPOSE: The learner should be able to: 1. List the most common device-related complications of a retrievable IVC filter. 2. Understand the standard and modified techniques for IVC filter removal. 3. Recognize the use of a steerable deflecting sheath to facilitate removal of an IVC filter with embedded hook.

MATERIALS: Use of retrievable IVC filters (rIVCFs) has grown exponentially. Retrieval rates for rIVCF has been historically very low, as low as 8.5%. The most common reason is loss of the patient to follow-up. Common device-related reasons for retrieval failure are filter tilt (43%); embedded hook (39%) and large clot burden (18%); ≥25% of filter volume. Complications are directly related to the dwell time. Standard filter retrieval involves a snare and sheath combination to engage, collapse and remove the filter. Common modification of standard technique includes Single or Dual Access Sling technique or Balloon displacement. Advanced techniques include Laser or Endobronchial forceps dissections.

RESULTS: We present 4 cases (3 Celect; 1 Gunther Tulip), in whom an alternate technique using a steerable deflecting sheath was used to
release the embedded filter hook from the caval wall. All cases had multiple prior failed retrieval attempts. The sheath has a radiopaque tip with 180° deflection and curve retention capabilities. The tip is deflected into a candy cane shape, steered under the filter apex and traction is applied to the sheath to disengage the embedded hook. In one case the sheath was used to facilitate the sling technique. After it is detached, the hook remains in contact with the caval wall due to filter tilt, hindering the snaring of the hook. The steerable sheath also facilitates this by passing the snare under the hook of the tilted filter, and as the deflected tip of the sheath is straightened and pulled back, the hook is easily snared allowing filter retrieval.

CONCLUSIONS: Understanding the indications, risks and complications of a temporary IVC filter retrieval and the role of device-related complication is important to plan the retrieval technique. Use of a steerable deflecting sheath to retrieve IVC filters with hook embedded in the caval wall is an alternative technique.

Abstract No. 948

Inferior vena cava filter retrieval: what every interventional radiologist needs to know

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PURPOSE: Describe different inferior vena cava (IVC) filters types. Review complications of prolonged IVC filter placement. Explain standard retrieval techniques. Review challenges of IVC filter retrieval and Advanced techniques to deal with them.

MATERIALS: The idea of a mechanical interruption / control of the caval flow to prevent thrombi reaching the right heart from lower extremity DVT has been in practice since before 1950s when surgical caval interruption was used. However, it hasn’t been until later in the 20th century that implantable devices—IVC filters—became readily available and commonly used. Their use, however, did come with variety of complications especially as indwelling times got longer and longer. These problems prompted the search for removable option filters. Although the newer generation of removable filters are designed and tested to be easily retrievable, filter retrieval still could pose a significant challenge for a variety of reasons. In this exhibit we run through the different standard and advanced techniques of IVC filter retrieval and illustrate some of the challenging situations that the interventional radiologist should be aware of.

RESULTS: IVC filters have some complications including but not limited to caval perforation, filter migration/rotation, filter fracture, embolization, and IVC thrombosis. Filter retrieval is important to avoid some of these complications before—or limit/stop them if complications has already occurred. The standard technique of filter retrieval depends on engaging a hook on the filter top (e.g., with snare) and then advancing a retrieval sheath over the filter. However, challenging situations can sometimes arise, usually due to either inability to grab the filter hook (e.g., due to filter tilting or coverage of the hook by tissue) or dense adherence of the filter to the IVC wall. For those situations, a variety of advanced techniques have been developed.

CONCLUSIONS: IVC filters can have a variety of complications with prolonged indwelling time hence mastering the standard and advanced techniques for their retrieval is an important skill for every interventional radiologist.

Abstract No. 949

Superior vena cava filter interventions and retrieval: technical considerations and potential pitfalls

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PURPOSE: This exhibit showcases the clinical and technical considerations for Superior Vena Cava (SVC) filter interventions with particular emphasis on filter retrieval. This exhibit will include examples of SVC filter retrieval performed at our institution. Through these cases, we will review the literature on placement, filter selection, and the unique risk and complication management profile primarily related to extraction.

MATERIALS: Compared to interventions involving inferior vena cava filters, SVC filter interventions are far less commonplace. There is a higher degree of technical difficulty and increased risk of potential major complications secondary to the anatomy and location of the SVC. Additionally, there is insufficient data regarding the incidence of submassive or massive PE secondary to upper extremity deep venous thrombosis (UEDVT). Due to the relative infrequency of SVC filter interventions and lack of data supporting their use, many interventionalists are unfamiliar with the procedures, particularly filter retrieval.

RESULTS: Most commonly, SVC filter placement is undertaken in extraordinary circumstances for the prevention of pulmonary embolism in patients with UEDVT when systemic anticoagulation is contraindicated, and any additional PE carries significant mortality risk. As with any filter placement, there is potential risk for complications associated with device integrity. Injury to adjacent anatomic structures is magnified by proximity to the right main pulmonary artery, the right pleural space, the aorta, and the right atrial appendage. Retrieval after the filter is no longer needed may be ideal, though the procedure itself is not without risk. The interventionalist must carefully weigh the risks and benefits of device abandonment versus retrieval. Many of the techniques and devices used in IVC retrieval (including laser sheaths and forceps) may not be safely translatable to use in the SVC.

CONCLUSIONS: 1. Review of SVC filter placement and retrieval; 2. pitfalls and technical considerations for SVC filter interventions; 3. management of complications.
Abstract No. 950

A comparison of current inferior vena cava filters and their associated complications

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PURPOSE: 1. To explore the differences in inferior vena cava filter (IVCF) products on the market today and discuss their advantages and disadvantages 2. To report complications of current IVCFs

MATERIALS: Two types of IVCFs that exist in the market today, permanent and retrievable filters. The use of retrievable filters has increased since the first retrievable IVCF was approved in 2003. Although retrievable filters are used more commonly than permanent filters, the majority of retrievable IVCFs are left in place permanently, with retrieval rates as low as 8.5%. This prolonged filter dwell time has been associated with increased complications including filter migration, filter fracture, inferior vena cava injury, dissection and hemorrhage. The Food and Drug Administration found that 87% of use-reported events were attributable to retrievable IVCFs, where as 13% were associated with permanent devices.

RESULTS: Table 1 displays the key differences between the current leading filters on the market today. This includes maximum deployed length, material, design, approach and filter images. Exhibit the major advantages/disadvantages of the various type of filters and their complications.

CONCLUSIONS: Depending on the need, certain IVCFs offer greater advantages than others. Interventional radiologists are required to have an understanding of the key differences between filters and their associated complications.

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Product Name</th>
<th>Maximum Deployed Length (mm)</th>
<th>Material</th>
<th>Design</th>
<th>Approach</th>
<th>Permanent / Retrievable / Convertible</th>
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<tr>
<td>Argon Medical</td>
<td>OptionElite Filter*</td>
<td>56.5</td>
<td>Nitinol</td>
<td>Conical</td>
<td>Femoral/ jugular/ antecubital/ popliteal, standard or over-the-wire</td>
<td>Optional (permanent or retrievable)</td>
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<tr>
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<td>Vena Tech Lp Filter</td>
<td>43</td>
<td>Phynox Wire</td>
<td>Conical</td>
<td>Femoral/ jugular</td>
<td>Permanent</td>
</tr>
<tr>
<td>VenaTech Convertible Filter</td>
<td></td>
<td>60</td>
<td>Cobalt Chromium</td>
<td>Conical</td>
<td>Femoral/ jugular</td>
<td>Convertible</td>
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<td>Denali Filter</td>
<td>50 (unconstrained)</td>
<td>Nitinol</td>
<td>Bilevel, conical</td>
<td>Femoral/ jugular</td>
<td>Optional (permanent or retrievable)</td>
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<tr>
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<td>N/A</td>
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<td>Bilevel, conical</td>
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<td>Permanent</td>
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<td>Greenfield Stainless Steel Vena Cava Filter</td>
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<td>316 L surgical stainless steel</td>
<td>Conical</td>
<td>Femoral/ jugular</td>
<td>Permanent</td>
</tr>
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<td>Titanium Greenfield Filter</td>
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<td>50</td>
<td>Beta III titanium alloy</td>
<td>Conical</td>
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<td>Permanent</td>
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<tr>
<td>Cook Medical</td>
<td>Bird’s Nest Filter (40 mm indicated caval diameter)</td>
<td>80</td>
<td>Biocompatible stainless steal</td>
<td>Varying unique Design</td>
<td>Femoral/ jugular</td>
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<td>51</td>
<td>Conichrome</td>
<td>Conical</td>
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<td>Conical</td>
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<tr>
<td>Cordis / Cardinal Health</td>
<td>OptEase Filter*</td>
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<td>Nitinol</td>
<td>Double basket</td>
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<tr>
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<td>Nitinol</td>
<td>Double basket</td>
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</table>

Abstract No. 951

Transjugular liver biopsy: ABC for residents and fellows

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PURPOSE: To review the basic technique and indications of TJLB. To review the technical challenges of TJLB in altered liver anatomy. To understand the potential minor and major complications of TJLB and how to avoid them.

MATERIALS: TJLB is an established technique used to obtain liver biopsies and perform hemodynamic studies of the liver venous and portal circulations. TJLB is indicated in patients with severe ascites and/or severe coagulopathies to decrease the risk of bleeding complications.


CONCLUSIONS: TJLB is an established endovascular technique that is used more frequently now days to obtain liver tissue and measure the...
Abstract No. 952

The effects of pneumatic compression on common symptoms and overall quality of life secondary to lymphedema of the lower extremities

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PURPOSE: • Evaluate how PCDs affect the quality of life of patients with lower extremity lymphedema. • Evaluate how PCDs affect common LE lymphedema symptoms. • Establish how LE lymphedema symptom reduction affects overall quality of life.

MATERIALS: Lower extremity (LE) lymphedema is a common, incurable disease with substantial mortality. Current evidence-based clinical practices aim to improve lymphatic drainage from the lower extremity. There is well-documented evidence on the efficacy of pneumatic compression devices (PCD) in managing lower extremity lymphedema. However, there is little published literature on the effects of PCDs on patients’ quality of life.

RESULTS: Survey data collected from 25 lower extremity lymphedema patients receiving successive prescribed PCD treatments for at least 3 months at a single medical practice. The principal outcomes for analysis were self-reported relief of symptom and overall quality of life. 76% (n = 19; p<0.05) of respondents treated with PCD reported a high or better overall quality of life (QOL) compared to a pre-PCD treatment of 12% (n = 3). Patient-reported outcomes indicate significant reductions in LE pain (from 40% to 12%), LE swelling (from 64% to 12%), LE heaviness (from 60% to 12%), and 36% (n = 9) of PCD-treated patients reported at least a high level of daily ambulation compared to 8% (n = 2) before treatment. However, at p<0.05, reduction in levels of limb tightness (R = 0.73), swelling (R = 0.70), and heaviness (R = 0.62) were better indicators of improved patient-reported overall QOL compared to LE pain (R = 0.54), and amount of daily ambulation (R = 0.37).

CONCLUSIONS: Use of PCD is strongly associated with patient-reported reductions in common lymphedema symptoms. The results also indicate a significant improvement in patient-reported level of daily ambulation and overall quality of life. Further studies are required by using objective clinical data to validate findings from this study.

Abstract No. 953

Preoperative evaluation of hyperinsulinemic hypoglycemia: the essentials of selective arterial calcium stimulation and hepatic venous sampling

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PURPOSE: 1) To discuss the pathophysiology, clinical presentation, diagnosis, and management of insulin secreting tumors. 2) To describe the role of non-invasive imaging techniques used to localize insulin secreting pancreatic tumors. 3) To review the pertinent anatomy of the pancreas, its blood supply, and venous drainage. 4) To discuss the indications, technique, and possible complications of the selective intraarterial calcium stimulation test for localization of insulin-secreting tumors.

MATERIALS: Insulinomas are the most common hormonally active pancreatic islet cell tumors and account for 70-75% of hyperinsulinemia cases [1]. Surgical resection is generally curative, however, preoperative localization can be challenging. Symptomatic insulinomas are often small, more than 90% are less than 2 cm in diameter [2], and can be difficult to localize with non-invasive imaging [1]. Furthermore, atypical imaging features can confound preoperative localization. In such cases, invasive localization using selective arterial calcium stimulation and hepatic venous sampling (ASVS), a highly sensitive and safe technique, may be utilized. ASVS has sensitivity of 84-96% for insulinoma localization, which is superior to non-invasive imaging [3, 4].


CONCLUSIONS: Arterial calcium stimulation and hepatic venous sampling (ASVS) is a highly accurate and safe localization method for insulin-secreting tumors. The success of invasive localization studies and results interpretation is dependent on the interventional radiologist’s understanding of the anatomy of pancreas, as well as the blood supply and venous drainage. Anatomic and technical considerations are reviewed.

Abstract No. 954

Splenic infarction following transsplenic access for portal venous intervention

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PURPOSE: 1. To characterize the typical appearance and temporal presentation of splenic infarction following transsplenic access. 2. To demonstrate how to best evaluate splenic infarction and highlight important associated findings. 3. To understand the clinical presentation, natural history, and management of postprocedure splenic infarction.

MATERIALS: Transsplenic access for portal venous intervention is being utilized more frequently. An IRB approved retrospective review comparing transsplenic and transelective access for portal venous system...
Interventions were performed for a separate abstract submission. In some cases in which transsplenic access was utilized, development of splenic infarction was noted on subsequent CT scans of the abdomen. The course of the postprocedure splenic infarctions is further detailed in this educational exhibit.

**RESULTS:** Isolated splenic infarcts were identified in 5 of 23 (22%) transsplenic cases. None of the cases had infarcts in other organs on pre- or postprocedural imaging. Infarcts appeared as new ill-defined, mixed density wedge-shaped lesions in the splenic periphery on postprocedure cross-sectional imaging. The time range in which these splenic infarcts were first identified on abdominal CT was between 1 and 31 days. Infarctions were best evaluated on portal or delayed venous phases, given the irregular arterial enhancing CT pattern of the spleen. No cases were associated with hemorrhage-related complications. No central splenic artery or splenic vein thrombi were noted. All of the infarcts resolved spontaneously without further complication within 2 weeks to 5 months. All patients maintained normal splenic function.

**CONCLUSIONS:** 1. Splenic infarcts can occur after transsplenic access for portal venous intervention. 2. The course of splenic infarcts is benign and does not necessitate follow-up with additional testing or interventions. 3. When postprocedure splenic infarcts are noted on imaging, associated hemorrhagic complications, central splenic artery abnormalities, or splenic vein thrombus should be assessed.

**Abstract No. 955**

**Transfemoral liver biopsy**

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**PURPOSE:** This educational exhibit aims to familiarize interventional radiologists with transfemoral liver biopsy (TFLB) as a viable alternative to percutaneous, transjugular (TJLB), or transcaval (TCLB) liver biopsy and to describe the technique used at our institution to achieve technical success.

**MATERIALS:** A transjugular approach is widely used in situations where a percutaneous liver biopsy is contraindicated, including patients with ascites or at increased risk of bleeding. Occluded jugular veins prohibits this approach, while acute cephalad angle of the hepatic vein origin due to congenital variation or posttransplant anatomic distortion can cause difficulty negotiating a stiffened cannula into the hepatic veins. Transcaval biopsy can provide an alternative in the setting of difficult hepatic vein anatomy. However, this approach places the patient at increased risk of retroperitoneal hemorrhage, particularly in patients on anticoagulation or with bleeding diatheses. In addition, transcaval biopsy does not allow for measurement of hepatic pressures or estimation of portosystemic gradient. Here, through a discussion of 6 recent cases, we briefly outline our technique for transfemoral transvenous liver biopsy.

**RESULTS:** Using standard Seldinger technique, the femoral vein is punctured and a long 10 Fr. braided sheath is placed in the IVC. Using a 5 Fr. multipurpose catheter, the right hepatic vein is cannulated and a stiff wire placed into the distal hepatic vein. Venography can be used to confirm proper position, and free hepatic and hepatic wedge pressure measurements can be made. A 14-G metallic cannula is then inserted into the RHV over the stiff wire positioned in the right hepatic vein. The wire is withdrawn, and the biopsy needle is advanced to the tip of the sheath. Four to six biopsies are taken, and the specimens are deposited into formalin and sent to pathology. The cannula and sheath are subsequently removed.

**CONCLUSIONS:** In patients who cannot undergo percutaneous liver biopsy, a transfemoral approach provides a viable option for liver biopsy in cases in which preprocedural evaluation has revealed an acute angle of the IVC and hepatic veins.

**Abstract No. 956**

**Recurrence patterns of varicose veins**

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**PURPOSE:** This exhibit will review the epidemiology, relevant anatomy, and pathophysiology of common recurrence patterns of varicose veins. The application of this knowledge provides a framework for the diagnostic evaluation of these patients, which will be discussed with a focus on the use of duplex ultrasound to identify the cause. Lastly, treatment strategies will be discussed including considerations specific to differing causal anatomy.

**MATERIALS:** Recurrence of lower extremity varicose veins after primary treatment is reported to occur in up to 60% of patients and should therefore be an expected complication. Thus, it is critical that physicians treating varicose veins are familiar with common patterns of recurrence, their manifestations on duplex sonographic imaging, and how to utilize this information to best proceed with further treatment. When recurrences occur at the same site of prior treatment they are likely related to technical failures, tactical failures, neovascularization, or some combination of the above. When occurring in a separate location, recurrences are related to either residual or new sources of incompetence.

**RESULTS:** Recurrence patterns of varicose veins will be presented using case-based examples to illustrate typical variations of recurrence including common appearances of technical failure, tactical failure, and new sources of incompetence such as accessory veins and perforators. A standard approach to duplex ultrasound examination or recurrent varicose veins will explained. Ablative therapies available for the management of recurrent varicose veins will also be discussed including thermal, chemical, and mechnochemical methods. Advantages and limitations of each modality will be discussed for specific clinical scenarios.

**CONCLUSIONS:** Recurrence of varicose veins after surgical and endovascular treatment is common. Understanding the most frequently observed causes and the relevant anatomy helps direct the sono-graphic evaluation which allows for optimal treatment planning.
Abstract No. 957

High-risk cardiac lead extraction: interventional radiology’s role in multidisciplinary care to improve patient outcomes

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1University of Colorado Denver, Aurora, CO

PURPOSE: We review the structure and experience of a single academic center’s multidisciplinary approach to high-risk lead extraction and interventional radiology’s role.

MATERIALS: The increased utilization of implantable cardiac devices over the past decade has led to an associated increase in lead-related complications necessitating removal. Lead removal may be complicated in the setting of infection, thrombus, scarring or other factors which increases the risk of cardiovascular injury that are associated with a high rate of morbidity and mortality. Institutional policy adopted in November 2016 established specific roles for specialists in electrophysiology, cardiothoracic (CT) surgery, interventional radiology (IR), cardiothoracic anesthesia, perfusion, and nursing. A high-risk lead extraction clinic was created to assess patient and lead-associated risk factors. Additionally, a multidisciplinary conference is held to discuss upcoming cases with all specialties represented for input on management, required equipment or additional personnel, and emergent response plan. Cases are performed in a hybrid OR suite and all participating teams are notified when a high-risk extraction is being performed and are immediately available to aid if needed.

RESULTS: Since the start of the program, procedures with 4 patients and a total of 8 leads involved IR assistance, 2 of which were scheduled to include IR. Lead ages ranged from 2 to 38 years old. 3 of the patient’s leads were removed due to infection and 1 due to lead failure. IR’s contribution to the procedures included mechanical thrombectomy, venoplasty, and lead removal with endovascular snares and forceps. In all cases, leads were successfully removed in their entirety without major complication. The study is limited by the number of available cases for review and short data collection period.

CONCLUSIONS: Structured multidisciplinary roles which include IR expertise and technical skill can improve the care of patients in high-risk lead extractions.

Abstract No. 958

Sclerotherapy as treatment of recurrent venous bleed from abdominal wall ulcers

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PURPOSE: Identify the source of hemorrhage in abdominal wall ulcers using ultrasound (US), computerized tomography (CT) and venography as diagnostic imaging tools. Understand the mechanism of action of foam sclerotherapy and the application of this endovascular technique to control venous hemorrhage caused by non-healing chronic abdominal wall ulcers.

MATERIALS: Recurrent bleeding from abdominal wall ulcers can be difficult to manage conservatively or surgically. Different conditions such as pyoderma gangrenosum or calciphylaxis may cause chronic non-healing ulcers that can erode into blood vessels causing significant hemorrhage that may require blood transfusions if not controlled.

RESULTS: Two patients (one with pyoderma gangrenosum and one with calciphylaxis) presented with non-healing chronic abdominal ulcers with recurrent hemorrhage that was difficult to control conservatively, required blood transfusions and had poor surgical options. Ultrasound (US) and computerized tomography (CT) of the abdomen were performed in both cases identifying that ulcerations eroded into abdominal wall veins causing recurrent bleeding. Interventional radiology was consulted for possible endovascular management. In both cases, intravascular access was obtained under US and fluoroscopy guidance and venograms were performed. Venograms identified the vessels coursing through the ulcer and foam sclerotherapy with sodium tetradecyl sulfate was performed causing obliteration of the vessel. There were no postprocedure complications and hemothasis of the ulceration was achieved in both cases. There was no further hemorrhage during the postprocedure follow-up.

CONCLUSIONS: Foam sclerotherapy is an efficient and minimally invasive technique to obliterate veins and control venous hemorrhage in non-healing chronic abdominal wall ulcers. Ultrasonography, computerized tomography and venography provide key information for source of hemorrhage identification and foam sclerotherapy planning.

Abstract No. 959

Thrombosed giant portal vein aneurysm: management and controversies

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PURPOSE: Identify the imaging characteristics of portal vein aneurysms and thrombosis. Describe potential mechanisms of portal vein thrombosis. Discuss the various approaches to access a thrombosed portal vein. Describe the devices utilized for thrombectomy and thrombolysis.

MATERIALS: Portal vein aneurysms account for 95% of all visceral venous aneurysms, are most commonly acquired, but also may be congenital. The risk factors for acquired portal vein aneurysms include primarily cirrhosis, portal hypertension, trauma and malignant portal vein thrombosis. Portal vein thrombosis is substantially more common in patients with chronic diseases such as cirrhosis and malignancy. The use of oral contraceptives has been reported to be associated with portal vein thrombosis. While most cases of portal vein aneurysms remain asymptomatic, intervention is often necessary in cases of thrombosis, compression of surrounding structures, or catastrophic hemorrhage.

RESULTS: A 25-year-old previously healthy woman on oral contraceptives presented with several weeks of epigastric pain with eating. MRI for
presumptive IBD demonstrated complete thrombosis of a giant portal vein aneurysm and the portal system, with thrombus extending into the SMV and splenic veins. A percutaneous transjugular ultrasound-guided approach was utilized to access the portal system. The Penumbra CAT 8 device was used for thrombectomy of the aneurysm, portal system and SMV. A TIPS was deployed to provide outflow. Pharmacomechanical thrombectomy followed by Fogarty embolectomy were then performed from the distal SMV through the TIPS with brisk prograde flow established. The patient’s symptoms subsequently resolved.

**CONCLUSIONS:** Mesenteric and portal vein thrombosis can be a very debilitating condition for patients. In this case, the unexpected finding of a giant portal vein aneurysm was likely a predisposing factor. Through a TIPS access, mesenteric and portal flow were completely restored, and the patient’s symptoms resolved. In addition, the aneurysm completely regressed at 6-month follow-up. While no consensus exists for optimal management and approach, newer tools are now available. Long term need for patency of TIPS remains unclear at this time.

**Abstract No. 960**

**Scrutinizing venous thrombus cases for malignancy: biopsy techniques**

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**PURPOSE:** Interventional radiologists must have a high suspicion for tumor thrombus while managing deep venous thrombosis (DVT) in patients with or without history of malignancy.

**MATERIALS:** The prompt detection of tumor thrombus is important as it influences thrombus treatment options and tumor staging. A high rate of re-thrombosis and an overall poor prognosis is associated with tumor thrombus. The interventional radiologist must have a high level of suspicion while treating DVT or tumor thrombus may be easily missed at initial presentation. We present a series of five unusual DVTs that were found to be tumor thrombi. This retrospective chart review was institutional review board (IRB) approved.

**RESULTS:** Case 1: 44-year-old male with history of recurrent left lower extremity DVT requiring pharmacomechanical thrombectomy, angio-plasty, and stenting on several occasions presented with worsening left lower extremity swelling. Aspirated clot was eventually found to have necrotic high-grade sarcoma. Case 2: 45-year-old male with refractory right common femoral DVT. Ultrasound-guided biopsy revealed intimal sarcoma. Case 3: 49-year-old male with Hodgkin disease in remission. Pre-liver transplantation vascular recanalization: UCSF institutional experience

**K Kinzer1, M Kohi2, E Lehrman3, J LaBerge4**

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**CONCLUSIONS:** Unexplained DVT recurrence or an unusual thrombectomy sample morphological appearance should alert the interventional radiologist to the possibility of intravascular tumor. In such cases, pathological analysis of the retrieved thrombus should be performed.

**Abstract No. 961**

**Single-session endovascular management of deep venous thrombosis: a pictorial guide**

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**PURPOSE:** 1. To review indications, procedural details and outcomes of endovascular management of deep venous thrombosis (DVT) in a single session. 2. To provide a case-based illustration of single session DVT lysis and thrombectomy for extensive ilio-femoral and ilio-caval DVTs.

**MATERIALS:** Over 600,000 patients are diagnosed with DVT every year in the U.S. In patients with extensive DVT, endovascular thrombolysis and thrombectomy is often performed. Endovascular treatment is often sought to improve symptoms, preserve valve function, decrease incidence of postthrombotic syndrome and improve quality of life. Traditionally, patients required overnight ICU stay for lytic infusion for large iliofemoral DVTs. However, in recent years single session treatment has become more frequent.

**RESULTS:** A case-based illustration of single session endovascular treatment of DVT will be provided. The exhibit will discuss preprocedure imaging, review of anatomy, procedural details, tips to avoid common pitfalls, postprocedural complications and appropriate clinical follow-up. Case illustration of single session treatment of extensive thrombus extending into the IVC and preexisting IVC filters will also be shown.

**CONCLUSIONS:** Single session endovascular pharmacological and mechanical DVT treatment is safe and effective. Thorough preprocedural planning, appropriate device selection and understanding of intraprocedural pitfalls is essential for successful treatment of DVT in a single session.

**Abstract No. 962**

**Pre-liver transplantation vascular recanalization: UCSF institutional experience**

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PURPOSE: 1. To review the role of transplant in the treatment of HCC, and bridging therapy as it relates to the role of radiology. 2. To discuss the consequences of portal vein thrombosis prior to liver transplantation, and review imaging findings in this diagnosis. 3. To review treatment options for recanalization of portal vein thrombosis pre-transplantation. 4. To discuss UCSF’s institutional experience with portal vein recanalization prior to transplantation.

MATERIALS: Portal vein thrombosis is often considered a contraindication to donor liver transplantation. Given the severe shortage of organs, complex work-up for transplant list placement, and long wait time once listed, the complication of portal vein thrombosis can be deadly. In recent years, IR has made strides in utilization of endovascular thrombectomy as a life-saving intervention. The purpose of this educational exhibit is to provide an overview of developments in IR-based recanalization prior to transplant and review our institutional experience. An institutional review was performed at UCSF Medical Center for patients who received vascular recanalization prior to liver transplantation. Data collected includes pretransplant labs, pre- and postthrombectomy imaging, posttransplant labs, and posttransplant outcome.

RESULTS: Thrombectomy performed using Angiojet with or without stent placement in 10 transplant-listed patients at UCSF to resolve pretransplant portal vein thrombosis. Of these patients, 7 made it to liver transplantation. All patients transplanted had successful immediate posttransplant outcomes. Patients are in varying stages of posttransplant timeline, as will be discussed in detail.

CONCLUSIONS: IR can play a vital role in patient optimization for transplantation. The long-standing contraindication of portal vein thrombosis for liver transplantation can be successfully circumvented through endovascular thrombectomy. Our institutional review demonstrates that this IR intervention can enable patients to receive transplanted livers, with excellent outcome. This highlights the broader role indicated for IR in pretransplant optimization and exemplifies the endless potential of the clinical utility for IR.

Abstract No. 963

Lessons learned in establishing a multidisciplinary consensus protocol for endovascular management of acute pulmonary embolism in a county hospital

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PURPOSE: 1. To discuss clinical scenarios and techniques for endovascular management for acute pulmonary embolism (PE). 2. To review the current evidence and guidelines pertaining to endovascular management of acute PE. 3. To present the challenges in establishing a multidisciplinary consensus protocol incorporating endovascular treatment for management of acute PE at a county hospital.

MATERIALS: Pulmonary embolism (PE) is the third most common cardiovascular cause of death in the United States. Nonspecific manifestations make PE difficult to diagnose. Compounded by lack of evidence based clinical practice guidelines, management of these patients is often delayed, leading to poor outcomes. With the recent advent of new devices and techniques, endovascular treatment is playing an ever increasing role in these clinical scenarios. The benefit of a multidisciplinary pulmonary embolism response team has also been established in the literature.

RESULTS: Endovascular management is indicated for acute massive and submassive PE. The exhibit will contain: A description of massive and submassive PE with case examples. An overview of techniques and devices including systemic and catheter-directed thrombolysis, ultrasound assisted catheter-directed thrombolysis, mechanical thrombectomy including Penumbra indigo, Angiojet and Angiovac with relevant literature review for outcomes and complications. Challenges of establishing a multidisciplinary protocol for early identification and management of patients likely to benefit from endovascular treatment.

CONCLUSIONS: Opportunities for improved outcomes in the management of PE are often missed due to a lack of consensus guidelines and limited referring clinician understanding of the options available for endovascular intervention. While a challenging process, establishing a multidisciplinary consensus protocol is paramount for improving outcomes in this patient population.

Abstract No. 1021

Median arcuate ligament syndrome: updating a controversial diagnosis

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PURPOSE: 1. Review the history and evolving perspectives of median arcuate ligament syndrome (MALS). 2. Discuss contemporary multidisciplinary approaches to MALS diagnosis and treatment. 3. Review multimodality imaging findings characteristic of MALS.

MATERIALS: Low insertion of the fibrous arch uniting the diaphragmatic crura over the aortic hiatus can extrinsically compress the celiac artery which can lead to abdominal pain referred to as median arcuate ligament syndrome (MALS). The compressive anatomy of the diaphragmatic crura on the celiac artery is thought to decrease flow resulting in a steal phenomenon, which can manifest as postprandial pain. Current literature supports the use of screening duplex ultrasonography followed by confirmatory CT or MR angiography. Laparoscopic and robot-assisted approaches are described as developing standards for treating MALS. Nevertheless, MALS is a rare entity and remains a diagnosis of controversy.

RESULTS: This exhibit will review the controversial history of MALS and examine the postulated theories on its pathophysiology. We also review contemporary algorithms in MALS diagnosis and treatment. We comprehensively characterize emerging trends of noninvasive imaging in the diagnosis of MALS and present pictorials highlighting characteristic findings seen on duplex ultrasonography and cross-sectional imaging.

CONCLUSIONS: Viewers of this exhibit will gain an understanding of current trends in MALS diagnosis in the context of its controversial history.
Abstract No. 964

Visceral artery aneurysms: a review of current techniques
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PURPOSE: After reviewing this exhibit, the reader should be able to recognize the options available for endovascular treatment of visceral artery aneurysms, including imaging findings, techniques, and differential applications.

MATERIALS: Visceral artery aneurysms (VAA) encompass intraabdominal arterial aneurysms affecting the celiac axis, SMA, IMA, and renal arteries. VAA include both true aneurysms and pseudoaneurysms, with degeneration of the arterial media the most common cause. While VAA are rare with an incidence rate of 0.1-0.2% detected at autopsy, they are potentially deadly, with a reported rupture rate of up to 22%. Importantly, the incidence of iatrogenic hepatic artery pseudoaneurysms has been increasing with the rise in interventional biliary procedures. VAA can be successfully managed by either a surgical or endovascular approach when they grow larger than 2 cm in diameter, thereby preventing aneurysm expansion and rupture. The majority of VAA can be treated via an endovascular approach.

RESULTS: A variety of options exist for the endovascular treatment of VAA. A technique can be employed within large arteries whereby coils are placed proximal and distal to the aneurysm, eliminating antegrade and retrograde flow while preserving end-organ perfusion. Covered stents provide a second option and are appropriate for vessels 6 mm or larger, with a risk of thrombosis of smaller vessels. A third option is coil occlusion of narrow-neck saccular aneurysms and stent-assisted coil placement of wide-neck saccular aneurysms, with occasional concomitant glue or thrombin injection. Finally, direct puncture and thrombin injection may be used in small peripheral pseudoaneurysms. Routine imaging surveillance is recommended following treatment to ensure complete response.

CONCLUSIONS: Several options are available for endovascular treatment of VAA. Choice of therapy is dependent on the location and size of the aneurysm. Imaging findings, techniques, and complications will be reviewed, with an emphasis on selection of appropriate management therapy in difficult cases.

Abstract No. 965

Review of imaging findings and management of aortic dissection variants
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PURPOSE: Limited intimal tears and minimal aortic injury are uncommon variants of aortic dissection. We aim to review the imaging findings and clinical management of these uncommon, but clinically important aortic lesions.

MATERIALS: Classic aortic dissection describes a tear in the aortic intima, which extends along the media creating a false lumen. Limited intimal tears and minimal aortic injury are less common dissection variants that may propagate to complete dissection if unrecognized.

RESULTS: Computed tomography angiography is the preferred modality for evaluating patients with suspected aortic pathology. With improvements in CT technology, limited intimal tears and minimal aortic injury are diagnosed more frequently. ECG-gating or Flash-gating the thoracic aorta is necessary to minimize motion artifact, which may lower sensitivity for subtle aortic lesions. Limited intimal tears are linear or stellate nontraumatic lesions that extend to the intima and underlying superficial media. This dissection variant is associated with Marfan’s disease and other collagen diseases. Minimal aortic injuries are secondary to blunt trauma and can present with intimal tears, intraluminal aortic thrombus or intramural hematoma. Depending on where these lesions occur in the aorta, treatment may involve surgical or endovascular repair.

CONCLUSIONS: Limited intimal tears and minimal aortic injury are aortic dissection variants that need to be recognized due to the risk of progression to complete dissection. Clinical management is similar to classic dissection.

Abstract No. 966

Overview of the endovascular management of type 2 endoleaks
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PURPOSE: 1. Provide background on the endovascular treatment of abdominal aortic aneurysms and their associated complications, with a focus on type 2 endoleaks. 2. Provide illustrative case-based examples of the various endovascular treatment options of type 2 endoleaks including transarterial, translumbar, and transcaval embolization.

MATERIALS: Treatment of abdominal aortic aneurysms (AAA) has undergone a rapid evolution towards endovascular treatment in the United States with 74% of all AAAs treated by endovascular aortic repair (EVAR) in 2010 due to significantly lower aneurysm-related mortality, decreased complication rates, and a shorter hospital stay for EVAR vs open surgical repair. However, EVAR is not without complications. The occurrence of endoleak (defined as persistent perfusion of the aneurysm sac outside of the stent graft) occurs in 25-35% of patients which necessitates lifelong imaging surveillance and is the predominant cause of higher reintervention rates in EVAR relative to open repair. Type 2 endoleak by patent aortic branch vessels is the most common subtype of endoleak.
RESULTS: Transarterial embolization is performed via arterial access through the inferior mesenteric artery or the lumbar artery when a continuous connection to the endoleak nidus is identified through the superior mesenteric artery or the iliolumbar artery, respectively. Translumbar embolization is performed through directly accessing the aneurysm sac by CT or fluoroscopic guidance and is often performed when no direct arterial connection is identified. Transcaval embolization is typically only used if there is a contraindication to both transarterial and translumbar access and involves accessing the aneurysm sac through the adjacent inferior vena cava.

CONCLUSIONS: Given the dramatic rise in the endovascular treatment of abdominal aortic aneurysms, management of the complications related to EVAR is paramount to avoid continuous enlargement of the abdominal aneurysm and associated AAA rupture risk. Many different techniques such as transarterial, translumbar, and transcaval embolization have been performed with success in the treatment of type 2 endoleaks.

Abstract No. 967

Imaging and management of complications from fenestrated and low-profile endovascular arterial repair grafts

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PURPOSE: This abstract will examine the emerging data involving new technologies in endovascular repair, namely new types of fenestrated grafts such as low-profile endovascular grafts, and to review imaging and management. The imaging findings in low-profile grafts will be compared to those of more traditional endovascular grafts, and challenges in diagnosis will be addressed. Furthermore, managing the complications that are characteristic of these grafts with be discussed and compared to complications and management in older grafts.

MATERIALS: Abdominal aortic aneurysm is a major cause of morbidity and mortality in the United States, resulting in nearly 10,000 deaths annually. For large and rapidly enlarging aneurysms, endovascular arterial repair is the standard of care. Exclusion criteria for treatment with endovascular repair have historically included a short segment of normal infra-renal aorta to anchor the cuff of the graft, and stenosed arterial access sites. Fenestrated grafts were developed to address aneurysms with a short segment of infra-renal aorta proximally. More recently, low-profile grafts have addressed the problem of vascular stenosis at access sites, which previously excluded up to 10% of AAA patients. Incraft (Cordis/Cardinal Health) and Ovation (Endologix) offer a 14F outer diameter profile. With these new technologies, there are new imaging findings of both normal and malfunctioning grafts, which the interventionalist must be familiar with.

RESULTS: Fenestrated and low profile grafts offer an opportunity for treating patients previously ineligible for treatment with endovascular arterial repair. Low profile grafts also utilize an O-ring at the cuff site, which decreases eccentric pressure on the vessel wall. These grafts can have pitfalls, however, and being familiar with these issues will help the interventional radiologist successfully provide the highest quality patient care.

CONCLUSIONS: Newer grafts have allowed for safe and effective treatment of patients previously ineligible for endovascular arterial repair. Interventional radiologists should be well versed in the imaging and management of these grafts and their complications, especially as they become more prevalent.

Abstract No. 968

Review of bronchial artery aneurysms

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PURPOSE: To briefly review the etiology, clinical presentation, and therapeutic management of bronchial artery aneurysms (BAAs) in an educational exhibit format.

MATERIALS: Incidence of BAAs is rare and detected in less than 1% of cases on bronchial angiography. BAAs can be intrapulmonary, mediastinal or both. Clinical presentation depends on size, location, and presence of concomitant disease. In general, the prognosis for BAAs is good, but early diagnosis and treatment are essential as aneurysm rupture may be catastrophic and life-threatening.

RESULTS: Etiology of BAAs is poorly understood. Bronchial arterial wall injury, focal weakening, and increased bronchial artery blood flow are proposed mechanisms for development of BAAs. BAAs are associated with chronic obstructive pulmonary disease, bronchietasis, hypertension and hyperlipidemia. Most BAAs are located in the mediastinum and diagnosed incidentally. In one review of 13 cases of BAA, sizes of BAA ranged from 5 to 30 mm; however, the size was not felt to be predictive of risk of rupture. Ruptured intrapulmonary BAAs are present with hemoptysis, while ruptured mediastinal BAAs are present with variety of symptoms such as chest or back pain. CTA usually demonstrates enlarged bronchial arteries, useful in differentiating mediastinal masses from aneurysms. Selective bronchial arteriography provides definitive diagnosis and allows for concomitant intervention. The pathologic process which leads to BAAs rupture is poorly understood. Because aneurysm size is an unreliable indicator for rupture, all BAAs should be considered for definitive treatment. Transarterial embolization (TAE) is favored over surgery as surgery is associated with high morbidity and mortality rates. Failure of TAE therapy may be related to enlarged bronchial arteries, tortuosity and collateral revascularization. Surgical treatment comprises bronchial artery aneurysm excision, bronchial artery ligation or lung resection.

CONCLUSIONS: Bronchial artery aneurysms are rare but potentially life-threatening entities. Therefore, all bronchial artery aneurysms should be considered for diagnosis and treatment, regardless of size or symptomatology.
Abstract No. 969

Endovascular rescue of traumatic renal artery injuries: a case series

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Purpose: To discuss feasibility, technical success and limitations of endovascular treatment for traumatic renal artery injuries.

Materials: Although traumatic injuries of renal arteries after deceleration and blunt abdominal trauma are rare, these injuries are being increasingly identified with widespread use of CT imaging in trauma patients. Traumatic occlusion, dissection and avulsion injuries of renal artery risk devitalized renal parenchyma. Suboptimal kidney salvage rates and high recurrent thrombosis have been reported with surgical revascularization. Several case reports and series have shown encouraging outcomes of endovascular treatment in maintaining arterial patency and salvaging kidney function.

Results: This exhibit discusses 6 patients presenting at level 1 trauma center who were found to have traumatic injury of renal artery. Two patients had complete cut off of the renal artery from traumatic dissection and recanalization could not be performed. Stent placement was performed in 4 of these 6 patients, balloon expandable stents were used. One patient had cut off of the anterior and posterior branches of the left renal artery, stents were placed in both branches. Follow-up CT and ultrasound imaging within one week showed good stent patency. Two patients had flow limiting dissections of the renal arteries and were treated with 5 mm diameter stents. Another patient had high grade stenosis of the right renal artery from a possible dissection and was treated with a 6 mm stent. Recanalization of lumen and reconstitution of arterial flow was achieved after stent placement resulting in satisfactory renal perfusion. Revascularization was performed as an emergency procedure if procedure could be performed within 6 hours from time of diagnosis. Anticoagulants were prescribed after stent placement if not contraindicated.

Conclusions: Endovascular treatment of traumatic renal injuries has demonstrated promising results in various reported case series. Stents can be placed to maintain patency if it is possible to traverse through arterial dissection/stenosed segment or to control bleeding. Patients may require anticoagulation to maintain stent patency. Alternatively, endovascular access allows for embolization of an avulsed renal artery stump.

Abstract No. 970

Drug-eluting balloons, stents, and bioresorbable vascular scaffolds in femoropopliteal arterial disease: overview of technology, applications, and review of literature

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Purpose: • Review the latest technology in drug-eluting stents (DES), drug-eluting balloons (DEB), and drug-eluting bioresorbable vascular scaffolds (DEBVS). • Present the latest trials in the safety, feasibility, and efficacy of DES, DEB, and DEBVS in femoro-popliteal (FP) vascular disease.

Materials: PAD continues to be a major public health burden with more than 200 million people affected worldwide. Innovations in endovascular management have progressed considerably since Charles Dotter conducted percutaneous transluminal angioplasty in 1964 with a rigid coaxial system. Modern day techniques have evolved into a wide variety of drug-eluting balloons, stents, and biodegradable scaffolds for FP revascularization. Drug-eluting technologies have shown superiority over conventional methods with higher rates of primary patency (PP) and lower rates of target lesion revascularization (TLR) and amputation.

Results: A plethora of devices exist in the market. Specifically, the exhibit will present: • All the available devices in a tabular format with description of product and FDA approval status. • The drugs used in the design of the DEB, DES, and DEBVS and information related to the drugs dosage, mechanism of action, and elution characteristics. • Potential complications related to the use of DEB, DES, and DEBVS. • Technical considerations while using DEB, DES and DEBVS in clinical practice. • Tabular description of all completed and ongoing randomized trials with outcomes.

Conclusions: Awareness of the most updated information regarding drug-eluting technologies with critical review of recent trials can help guide interventional radiologists effectively treat FP and maximize outcomes.

Abstract No. 971

Using U-turn catheter for ipsilateral, below-knee peripheral vascular disease treatment: a novel technique

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Purpose: • To familiarize Interventionalists with a novel technique for antegrade (AG) to retrograde (RG) conversion in treating infrapopliteal (IP) peripheral vascular disease (PVD), including discussion of complications.

Materials: Treating IP occlusive lesions using RG contralateral femoral access requires wire delicacy and the ability to push hard on the balloon for success. Conventional AG access can overcome these problems but has a greater complication rate than RG access, prevents aortoiliac inflow angiography and most closure devices are not approved for AG access (1). The following method addresses these problems.

Results: First, an IL RG vertical femoral puncture is performed. A wire is placed cephalad and an omni-flush or SOS is used for aortic angiography. In patients with minimal aortoiliac disease (AID), RG to AG conversion occurs by placing guidewire out the end of the catheter and pulling it down through the IL common iliac artery into the
Jumping in feet first: pearls and pitfalls of pedal artery access

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PURPOSE: The basics of pedal artery access technique will be presented in an image rich multimedia format. Patient evaluation, indications for pedal access, contraindications, and closure techniques will also be discussed.

MATERIALS: Retrograde pedal artery access has been traditionally used as a bailout technique for difficult critical limb ischemia. Similar to transradial access, retrograde pedal artery is now gaining popularity as a primary access due to patient comfort, decreased recovery time, and decreased bleeding risk compared to transfemoral approach.

RESULTS: Retrograde pedal access offers technical advantages and have been found useful to crossing chronic total occlusions that were unable to be crossed in antegrade approach. Transpedal approach has begun to be used more frequently as a primary approach for angioplasty, atherectomy, and stenting of lower extremities. Iliac lesions have even been found to be treated safely and effectively.

CONCLUSIONS: Retrograde pedal access is an effective means of treating peripheral vascular disease. This has traditionally been considered an advanced in difficult peripheral vascular technique. However, pedal artery access is quickly being adopted as a primary and sole access for peripheral vascular disease.

Abstract No. 974

Altering flow dynamics to reduce nontarget embolization during prostatic artery embolization: a technical review

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PURPOSE: Present a qualitative review of flow altering techniques used during prostatic artery embolization (PAE) to divert flow from extraprostatic anastomoses and prevent nontarget embolization.
MATERIALS: PAE is emerging as an effective, non-invasive treatment for symptomatic benign prostatic hyperplasia (BPH). Recently, several large review papers and meta-analyses have corroborated the efficacy of PAE for BPH in alleviating symptomatology. Due to the high variability of prostatic arterial anatomy, one of the risks associated with PAE is nontarget embolization through extraprostatic anastomoses with the potential for unwanted tissue necrosis. Here we describe intraprocedural techniques used to alter flow dynamics and reduce the risk of nontarget embolization.

RESULTS: Qualitative review of the literature three 3 techniques to alter flow dynamics to help ensure the safety of PAE. The primary reported method of altering flow dynamics is to insert coils and physically block flow through the dangerous extraprostatic anastomoses. The other two methods rely on inducing flow reversal through the extraprostatic anastomoses toward the prostate gland, thereby reducing the risk of nontarget embolization. One technique to redirect flow in PAE is via the infusion of vasodilators in the prostate artery. Dilatation of the downstream adenomatous vasculature results in decreased resistance thereby altering the pressure gradient such that blood now flows toward the prostate and away from the nontarget tissue. A recently described novel technique to prevent nontarget embolization is via the use of a balloon occlusion microcatheter to deliver the particles in the main prostate artery. Balloon occlusion or low-pressure embolization has the potential to prevent nontarget embolization by altering the pressure gradient such that extraprostatic flow is now redirected towards the lower pressure intraprostatic vasculature, reducing the chance of nontarget embolization. An additional benefit of balloon occlusion is to eliminate reflux into proximal nontarget vessels.

CONCLUSIONS: A variety of flow dynamic altering techniques may be successfully deployed during PAE to reduce the chance of nontarget embolization.

Abstract No. 975

The role of the acute gastrointestinal bleed protocol computed tomography angiogram in interventional radiology

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PURPOSE: 1) To review the indications and contraindications for partial splenic reduction (PSR). 2) To demonstrate the relevant anatomy and technical approaches, both transradial and transfemoral in various clinical scenarios through case presentations. 3) To list the major complications that may occur with this technique.

MATERIALS: PSR has traditionally been seen as an endovascular method in the treatment of trauma, splenic aneurysms, and splenic hemangiomas. However, its role has expanded in the treatment of hypersplenism from various etiologies that lead to thrombocytopenia and/or neutropenia and anemia. The etiology of thrombocytopenia include platelet sequestration, immune-mediated destruction, and/or decreased thrombopoietin levels. In order to improve platelet counts in patients, for example, with antiviral or chemotherapy induced thrombocytopenia, or myelodysplastic disorders, PSR should be strongly considered.

RESULTS: Through a case presentation, various clinical scenarios will demonstrate the utility of PSR. Preprocedural workup will be presented for each case in addition to a review of relevant arterial anatomy. PSR can be performed with various embolization agents which will be highlighted. The various clinical presentations include 1) Patient with myelodysplastic syndrome unable to receive intraarterial therapy for HCC given extreme thrombocytopenia; 2) Patient unable to receive further chemotherapy due to thrombocytopenia; 3) Isolated gastric varices secondary to splenic vein thrombosis. These cases

Abstract No. 976

Partial splenic reduction: the how, what, when, and why

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PURPOSE: 1) To review the indications and contraindications for partial splenic reduction (PSR). 2) To demonstrate the relevant anatomy and technical approaches, both transradial and transfemoral in various clinical scenarios through case presentations. 3) To list the major complications that may occur with this technique.

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Splenic artery embolization: case-based review of traumatic and nontraumatic pathology

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PURPOSE: The purpose of this poster is to illustrate the technique and application of splenic artery embolization. Specifically, we will demonstrate the myriad clinical scenarios amenable to splenic artery embolization including: trauma, aneurysms and pseudoaneurysms (pancreatitis and nonpancreatitis related), hypersplenism with pancytopenia, gastric variceal bleeding, and treatment of neuroendocrine metastases to the spleen. Through these illustrations, the user will gain a broader understanding of the technique, in particular proximal versus distal embolization of the splenic artery, as well as the myriad embolic agents utilized inclusive of: particles, coils, plugs, stents, and Gelfoam. The implementation of the transfemoral and the transradial approach to the splenic artery will also be highlighted.

MATERIALS: The technique of splenic artery embolization can be traced back to the late 1970s and 1980s. The evolution of this procedure from the utilization of autologous clot for splenic injuries to the myriad clinical applications at present day deserves special attention. Through a systematic review of 122 cases of splenic artery embolization performed at a single-institution over two decades an informative and illustrative group of cases was selected for presentation.


CONCLUSIONS: Teaching points: 1. Familiarity with the technical aspects and application of splenic artery embolization. 2. Appreciation for the myriad clinical scenarios amenable to splenic artery embolization. 3. Understanding the implementation of the various embolic agents for splenic artery embolization. 4. Elucidation of the transfemoral and transradial approaches to the splenic artery.
Abstract No. 979

Bariatric arterial embolization for the treatment of obesity: a review of clinical data

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MATERIALS: Obesity is a global health epidemic associated with many Conditions that significantly increase morbidity and mortality. Obesity can be managed through diet, exercise, drugs, and surgery. While surgical options often are more effective than other options in reducing weight, they are not without risks. Bariatric surgery contributes to weight loss in 4 patients after 6 months; Weiss et al. average of 9%

RESULTS: The fundus of the stomach is the section most involved in producing hormones controlling satiety and hunger. It is predominantly supplied by the LGA. In theory, LGA embolization causes sufficient ischemia to the fundus to lower ghrelin production, and can be tolerated due to collateral arterial supply. Gunn et al. performed a retrospective analysis of patients who underwent embolization for upper GI bleed. After 3 months, patients who received LGA embolization underwent a 7.3% weight loss versus a 2% weight loss in those who had other celiac axis branches embolized (p = 0.006). In a prospective study, Kipshidze et al. showed an average of 17% weight loss in 5 patients undergoing BAE. Syed et al. showed an average of 8.5% weight loss in 4 patients after 6 months; Weiss et al. average of 9% in 4 patients at 3 months. Syed et al. and Weiss et al. encountered superficial ulceration post embolization in 75% and 20% of patients, respectively. Ulcers resolved at 3 months in all patients. One episode of subclinical pancreatitis was also described by Weiss et al.

CONCLUSIONS: Current data supports BAE as a safe procedure for treatment of obesity. Further investigation in other populations of obese patients and long-term effects of this procedure are required.

Abstract No. 980

Transcatheter arterial embolization of abnormal neovessels in musculoskeletal conditions: a systematic review

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PURPOSE: Pain arising from musculoskeletal (MSK) conditions is a common and debilitating problem responsible for significant disability and reduced quality of life. Abnormal neovessels have been proposed as a potential source of pain in various MSK conditions (osteoarthritis, tendinopathies, enthesopathies). Recent literature has examined transarterial embolization (TAE) as a treatment option to relieve pain in these conditions. The purpose of this review is to examine current literature on clinical outcomes of TAE to treat MSK conditions, and comment on the feasibility of TAE to treat pain arising from various MSK conditions.

MATERIALS: Electronic databases were reviewed for clinical trials examining outcomes of TAE in adult patients suffering from painful MSK conditions. Prospective case series and randomized controlled trials were accepted. Six applicable full-text articles were examined by an individual reviewer. Data was extracted on age and sex of patients, duration of pain, duration and modality of conservative therapies, pain and functional scores evaluated by individual studies, the presence of abnormal neovessels, and adverse events of the TAE procedure. Data were subsequently analyzed primarily qualitatively.

RESULTS: Out of 77 screened studies, there were six applicable case series that reported on clinical outcomes of TAE to treat MSK conditions (knee osteoarthritis, adhesive capsulitis, lateral epicondylitis, and various tendinopathies and enthesopathies). All studies showed a statistically significant reduction of pain (visual analog scale) from baseline both rapidly after undergoing TAE and at all follow-up periods. All patients in all studies had confirmed abnormal neovessels and successfully underwent embolization with no major adverse events.

CONCLUSIONS: TAE is a potential novel therapy for MSK pain refractory to conservative management. It may be effective in treating pain from various MSK etiologies including osteoarthritis, adhesive capsulitis, lateral epicondylitis, and other tendinopathies. Larger studies and RCT would be beneficial to further assess the outcomes of this novel therapy.

Abstract No. 981

The wave of the future: covering level 1 trauma with CODE ANGIO

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PURPOSE: 1) To review the need for CODE ANGIO at level 1 trauma centers. 2) To present an overview of the multidisciplinary lean processes involved in CODE ANGIO at a level 1 trauma center to decrease IR response times.

MATERIALS: Over the last decade, there has been a progressive paradigm shift towards nonsurgical management of trauma patients. This has placed interventional radiologists at the forefront of trauma care since IR can provide precise and timely control of bleeding. Both the American College of Surgeons (ACS) committee on trauma and UK National Institute for Health and Care Excellence (NICE) have recognized the value of IR and have asserted the need for qualified IR to be
available within 30 minutes after the need for an intervention is established. To this end, CODE ANGIO was developed at a level 1 trauma center with a large geographical catchment. This process assures a fast system wide multidisciplinary response to the needs of the trauma patient.

**RESULTS:** CODE ANGIO, started in August 2014 at our institution, and can be initiated by trauma surgery, emergency radiology or interventional radiology following rapid interdisciplinary communication based on established indications (active extravasation on CT and hemodynamic instability). The response team includes IR, trauma, nursing and anesthesia, with the aim to have the team assembled and the procedure started by IR in 30 minutes or less.

**CONCLUSIONS:** This poster will outline the process of CODE ANGIO and our experiences over the last 3 years. The process starts with the initial activation of CODE ANGIO, assembly of a multidisciplinary team, assessment of the patient, and treatment by interventional radiology based on established indications and guidelines. This multidisciplinary lean approach in managing trauma care can improve communication between various departments in a coordinated effort to treat a patient in the acute trauma setting. CODE ANGIO is a lean multidisciplinary system wide response to trauma with IR being the core element. At our institution, CODE ANGIO has also been successfully employed for unstable patients with posttraumatic bleeding, decreasing turnaround and response times to nonsurgical interventions.

**Abstract No. 982**

**Recognizing, managing, and preventing complications of prostate artery embolization**

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**PURPOSE:** 1. Describe and illustrate the indications, procedure, and techniques of prostate artery embolization (PAE). 2. Present case-based discussions of PAE complications encountered in our institution’s experience. 3. Discuss the clinical presentation, imaging findings, management, prognosis, and prevention of these PAE complications.

**MATERIALS:** PAE has increasingly been performed at our institution for the relief of lower urinary tract symptoms associated with benign prostatic hyperplasia. In our experience, the procedure has a low incidence of adverse events; however, as the procedure grows in popularity, it is vital for the performing clinician to recognize, manage, and prevent PAE complications.

**RESULTS:** After an illustrated discussion of the PAE procedure, we present case-based discussions of PAE complications including vascular injury, acute urinary retention, hematuria, dysuria, urinary tract infection, and nontarget embolization (involving the bladder, bowel, and seminal vesicles). The clinical presentation, imaging findings, management, and prognosis of these complications will be reviewed. Strategies to reduce the incidence of these complications will also be addressed including the utilization of balloon microcatheters and selection of appropriate embolic agents.

**CONCLUSIONS:** PAE has shown great promise as an effective treatment for the lower urinary tract symptoms associated with benign prostatic hyperplasia at our institution. Given positive results in the literature, we are hopeful that PAE can provide a large number of patients with significant quality of life improvements. Now, more than ever, it is essential for interventional radiologists to understand the clinical presentation, imaging findings, management, and prevention of post-PAE complications.

**Abstract No. 983**

**A retrospective medicolegal analysis of jury verdicts and settlements involving endovascular coiling and embolization from 2000 to 2014**

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**PURPOSE:** Complications from endovascular coiling and embolization have potential for high morbidity as well as mortality and the possibility for litigation. We review medical malpractice litigation involving endovascular coiling and embolization to determine reasons for plaintiff’s to initiate litigation and to characterize legal outcomes.

**MATERIALS:** Using the WestlawNext database (Thomson Reuters, NY, NY), we analyzed the jury verdict and settlement reports of all publicly available federal and state court records for medical malpractice cases involving endovascular coiling and embolization. Cases that had litigious merit unrelated to endovascular coiling or embolization were excluded from analysis. A total of 15 cases were collected from 2000 to 2014 and reviewed.

**RESULTS:** Of the 15 cases, 53% involved radiologist and 40% involved neurosurgeons. The majority, 80%, involved embolization or coiling above the carotid arteries. The majority of cases involved targeted intervention of intracranial aneurysms, vascular malformations, or refractory posterior epistaxis. A third of the cases were in California and 13% were in Illinois. The average age of the plaintiff was 41 years-old (range, 6–97) and 67% were men. Of the 15 cases, 27% ruled in favor of the defendant, 47% for the plaintiff, 20% were settled, and the outcome of 1 case was confidential. The median and mean award for the plaintiff was $2.6 million and $5.2 million, respectively (range, $1.0–$23.4 million). The median and mean settlements were $150,000 and $1.5 million, respectively (range, $150,000–$4.2 million). Patient death occurred in 27% of the cases; of these cases, 75% resulted in settlement or in favor of the plaintiff.

**CONCLUSIONS:** Endovascular coiling and embolization offer distinct advantages to traditional open surgical procedures with improved mortality and morbidity. However, these technically difficult procedures are not without limitations and can result in medical malpractice...
lawsuits. Given the increased frequency of these procedures, it is important for interventionalist to understand the plaintiff’s alleged reason for malpractice and characteristics of the legal outcomes.

Abstract No. 984
Preoperative endovascular mesenteric skeletonization for unresectable metastatic carcinoid tumor: technique and initial results

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PURPOSE: Carcinoid tumors commonly present with metastasis to the mesenteric nodes, which can cause intestinal obstruction and ischemia, their main source of morbidity. Surgery is the only curative therapy for carcinoid patients; however, many have disease considered unresectable due to direct involvement of the superior mesenteric artery (SMA) branches. In these patients, we sought to improve surgical outcomes via arterial skeletonization of the SMA prior to surgical resection.

MATERIALS: After left radial access, the SMA was catheterized with a 6Fr guide catheter and angiogram was performed. Correlation between direct and prior CT angiography was done to identify which vessels were surrounded by tumor. Following balloon occlusion of the affected artery, patients were assessed for symptoms of ischemia and angiographic evidence of distal perfusion via collaterals. If patients tolerated occlusion, an endovascular plug was deployed in the affected artery; if not, the procedure was terminated. The next day, all patients underwent exploratory laparotomy and surgical resection of tumor and bowel.

RESULTS: At our institution, the procedure was performed 11 times on 10 patients (one patient received the procedure twice). 9 out of 11 procedures went to embolization, while the other 2 proceeded to surgery without plug deployment. None of the embryolized patients had postsurgical complications, while the other two patients developed complications including short bowel syndrome and ischemic colitis. Length of stay between embolized and non-embolized patients was equal, but readmittance within 30 days was 0% in the embolized group and 100% in the non-embolized group.

CONCLUSIONS: Our initial experience demonstrates feasibility and safety of deploying plugs within branches of the SMA prior to surgical resection and improved surgical outcomes. There was no correlation between extent of small bowel resected and embolization of the SMA branches. Palpation of the deployed plug assisted in surgical resection and accurate hemostasis. We have demonstrated that Pre-Operative Endovascular Mesenteric Skeletonization is a safe, practical procedure, which aids surgical resection of mesenteric carcinoid disease.

Abstract No. 985
Preoperative prostate artery embolization to reduce intraoperative blood loss during robot-assisted laparoscopic radical prostatectomy for prostate cancer

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PURPOSE: To assess the effect of preoperative prostate artery embolization (PAE) on estimated blood loss (EBL) during robot-assisted laparoscopic radical prostatectomy (RALRP) to treat prostate cancer.

MATERIALS: Four patients were prospectively enrolled in an FDA- and institutional review board-approved study (IDE G130237, ClinicalTrials.gov Identifier NCT02173522). Patients were aged between 45 and 79y, had biopsy-proven adenocarcinoma of the prostate and prostate size greater than 40g: exclusion criteria included active urinary tract infection, active cystolithiasis or prostatitis, previous pelvic irradiation or radical pelvic surgery, acute urinary retention, or baseline hemoglobin less than 8.0g/dL. PAE was performed 8 weeks prior to RALRP with follow-up visits 2 and 6 weeks following embolization. A complete blood count was obtained on the day of surgery prior to RALRP and estimated blood loss was collected during the procedure; patient hemoglobin and hematocrit were then assessed 24 hours after surgery.

RESULTS: Bilateral embolization was performed in 3 patients (75%) and unilateral embolization was performed in 1. Cystoscopy and proctoscopy at 2 weeks post PAE were normal in all patients. Prostate size decreased from 164, 103, 102 and 126g pre-PAE to 100, 60, 80 and 50g in each of the 4 patients at 6 weeks post PAE, respectively. Adverse events following PAE included dysuria in 3 patients (75%) and urinary urgency in 2 (50%). No intra or perioperative complications were encountered during RALRP. Estimated blood loss during RALRP was 120 mL in 2 patients and 100 mL in 2 patients, and corresponded to decreases in hematocrit in all 4 patients: 37.0, 39.5, 42.0 and 40.6% to 35.2, 35.9, 31.0 and 38.6%, respectively. On histopathologic examination, changes in response to embolization included foci of hemorrhagic necrosis, fibrosis and scarring; all foci of adenocarcinoma appeared unchanged compared to the samples collected during pre-PAE biopsy.

CONCLUSIONS: PAE is a safe and effective means of reducing prostate size prior to RALRP and decreasing intraoperative blood loss to less than half the typical volume without embolization.1 Embolization does not change the histologic features of carcinoma foci.

Abstract No. 986
Definitive treatment of pulmonary arteriovenous malformations: lessons from repeat interventions

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Definitive treatment of pulmonary arteriovenous malformations: lessons from repeat interventions
PURPOSE: Embolization of the inflow artery is the standard of care for the treatment of pulmonary arteriovenous malformations (AVMs). We describe three patients where previous treatment in this fashion had failed to treat the AVM.

MATERIALS: We present three patients for whom we were referred for repeat treatment of a pulmonary AVM through our Multidisciplinary Hemorrhagic Hereditary Telangiectasia clinic. All had persistent flow in their pulmonary AVM on CTA after coil embolization of their inflow artery, which measured 5–8 mm.

RESULTS: All three patients were taken to the interventional suite for repeat treatment. On catheter angiography, all patients had persistent flow in their pulmonary AVMs through previously coiled inflow vessels. We were able to reselect the previously treated artery with a microcatheter and traverse past the existing coil pack in two patients for repeat coil embolization of the nidus and inflow artery. For the third patient, we were able to re-embolize the inflow artery and nidus with Onyx. Follow-up CTA in all three patients demonstrated cessation of flow in the treated pulmonary AVMs at 1 month after treatment.

CONCLUSIONS: Definitive treatment of these patients’ pulmonary AVMs required not only treatment of the nidus as well as the inflow artery but was also due to the packing of the coils, when utilized. Although repeat treatment was feasible for these patients, this scenario makes treatment difficult or impossible. We advocate not only treating both the nidus and inflow artery, but also tightly packing of the coils when treating pulmonary AVMs.

Abstract No. 987

Onyx use in extracranial pathologies: a retrospective case review

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PURPOSE: Onyx is an embolic agent currently FDA approved for neurointerventional procedures such as in the treatment of aneurysms and arteriovenous malformations. Despite its limited indications, the agent’s off-label use in the treatment of extracranial pathologies continues to increase. To date, there has not been a single-center study assessing the safety and efficacy of Onyx in these indications. We present a retrospective case review of 64 cases treated at our center.

RESULTS: Among all 64 instances met our inclusion criteria. The incongruent number of cases compared to patients was secondary to multiple sessions for some patients. Such cases included: venous malformation, arteriovenous malformations, type 2 endoleaks, bronchobiliary fistula, and transgluteal rectal fistula. Technical success was achieved in 100% of cases. The clinical success rate was (98%). Among all 64 cases, only one complication had occurred with nontarget embolization of a renal pseudoaneurysm status post nephrectomy.

CONCLUSIONS: This study demonstrates the effectiveness of Onyx as an embolic agent that can be safely used beyond its limited FDA indication. Given the embolic agent’s success in neurovascular pathologies, we were able to show a wide breadth and variety of extracranial uses.

Abstract No. 988

Procedural factors associated with prostate artery embolization difficulty: a multivariate analysis

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PURPOSE: To determine factors which have a significant effect on prostatic artery embolization (PAE) procedure length, fluoroscopy time, contrast volume, and radiation dose through multivariate analysis.

MATERIALS: Retrospective analysis of 114 patients who underwent a total of 122 PAEs at a single site between April 2014 and May 2017 was performed. To reduce the effect of the procedural learning curve, the first 30 procedures of 152 were excluded from the analysis. Factors examined included, patient age, weight, and height; prior PAE, prior CT angiogram, subjective iliac tortuosity grade (SITG) (None, moderate, or severe), prostatic artery anatomy classification (PAAC) (types 1-5), presence of internal iliac artery atherosclerosis (IIAA), prostate volume, arterial access site, number of arteries embolized, and intraprocedural anastomotic embolization. Outcomes utilized as procedural difficulty surrogates included procedure time, contrast volume, fluoroscopy time, and radiation dose (dose area product DAP). Multivariate analysis with gamma and inverse Gaussian regression models were used for analysis with an alpha level of 0.05.

RESULTS: A severe SITG, moderate SITG, and the presence of IIAA were associated with a 56% (p < 0.001), 16% (p = 0.04), and 22% (p = 0.001) increase in procedure time, respectively. A severe SITG and the presence of IIAA were associated with a 54% (p = <0.001) and 25% (p = 0.006) increase in fluoroscopy time, respectively. A PAAC of 2 and 4 was associated with a 36% (p = 0.02) decrease in fluoroscopy time when compared to a PAAC of 1 bilaterally. A severe SITG was associated with a 23% (p = 0.03) increase in contrast volume. A PAAC of 2 and 4 was associated with a 38% (p = 0.02) decrease in contrast volume when compared to a PAAC of 1 bilaterally. A severe SITG was associated with a 47% (p = 0.004) increase in DAP.

CONCLUSIONS: Severe SITG, the presence of IIAA, and bilateral type 1 PAACs were all significantly related to an increase in metrics associated with PAE difficulty.
Abstract No. 989

Transcatheter arterial embolization for small bowel bleeding: clinical outcomes and prognostic factors for ischemic bowel damage

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PURPOSE: To assess the clinical outcome of transcatheter arterial embolization (TAE) in the treatment of small bowel bleeding and to determine the prognostic factor that affect ischemic bowel change.

MATERIALS: From January 2006 to April 2017, 68 patients (mean age, 57.5 years; range, 14–82 years) received TAE for the treatment of small bowel bleeding. We evaluated the rate of technical success, recurrent bleeding, major complication, and clinical success. The univariate analysis and logistic regression analysis were used to determine the prognostic factor for ischemic bowel change.

RESULTS: Technical success was achieved in 67 patients excluding one patient (98.5%). There were ten (15.2%) early recurrent bleeding and eleven (16.4%) major complication. All major complications were bowel ischemia or infarction. The number of embolized vasa recta was single in one patient (98.5%). There were ten (15.2%) early recurrent bleeding and eleven (16.4%) major complications. The univariate analysis and logistic regression analysis were used to determine the prognostic factor for ischemic bowel change.

CONCLUSIONS: TAE offers safe and effective hemostasis in patients with small bowel bleeding. To avoid ischemic bowel change after TAE, it is advisable to limit the number of embolized vasa recta to three or fewer.

Abstract No. 990

Interventional approach to traumatic hemorrhage with resuscitative endovascular balloon occlusion of the aorta

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PURPOSE: 1. Provide a review of resuscitative endovascular balloon occlusion of the aorta (REBOA), its major technical considerations, indications and contraindications. 2. Discuss steps to implement REBOA with illustrations and case examples in both the prehospital and trauma center settings.

MATERIALS: Hemorrhage is one of the leading causes of trauma mortality, accounting for up to 90% of all military-related trauma deaths. Of these, 67% are due to non-compressible truncal hemorrhage (NCTH). NCTH describes exsanguination from abdominal vessels, solid organs or the bony pelvis. Timely hemostasis is crucial until definitive management can be obtained in the operative or interventional radiology suite. Resuscitative thoracotomy (RT) with aortic cross-clamping has been standard therapy; however, REBOA provides a rapid, minimally invasive approach to NCTH with the potential to supersede RT, a highly morbid intervention.

RESULTS: REBOA, an emerging technique, will be described in detail with case illustrations. The 2017 Joint Trauma System Guidelines support use of REBOA for patients in hypotensive shock with blunt or penetrating injuries to the abdomen/pelvis. Briefly, intravascular occlusion of the aorta is achieved through a percutaneously deployed balloon. Vascular access is typically obtained through the femoral artery with a 7 Fr sheath and the balloon is directed to the site of hemorrhage to tamponade the vessel; bleeds of Zone 1 (between the left subclavian and celiac arteries) and Zone 3 (between the caudal renal artery and aortic bifurcation) are favored. The balloon is inflated with sterile saline and contrast, and then guided either by fluoroscopy, clinical response, or loss of contralateral pulse.

CONCLUSIONS: REBOA is an emerging technique in both the prehospital and in trauma centers. However, little is known about this potentially life-saving technique in the IR community. The procedure will be described in detail using case illustrations. As more centers including IR adopt REBOA, it will allow for more robust clinical trials to further investigate and innovate this life saving procedure.

Abstract No. 991

“Code blue in interventional radiology”: management of cardiac arrhythmias during pulmonary artery interventions

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PURPOSE: 1. Evaluate preprocedure cardiac risk of patients being considered for pulmonary artery angiography. 2. Describe preexisting arrhythmias or medically controlled arrhythmias and how they can be exacerbated during pulmonary artery angiography. 3. Recognize atrial fibrillation/flutter, bradyarrhythmias, heart block, ventricular tachycardia/fibrillation, PEA arrest and asystole. 3. Review ACLS management of the fatal arrhythmias.

MATERIALS: Pulmonary catheter angiography can be an important diagnostic and life-saving tool for entities such as massive PE or pulmonary hemorrhage. However, interventions involving the heart carry the additional risk of exacerbating or precipitating a fatal arrhythmia. Since patients receiving these interventions may already have conditions which predispose them to fatal arrhythmia (such as right heart strain or systemic hypotension), they are at increased risk. Therefore, the interventional radiologist should be familiar with these cardiac arrhythmias and their initial ACLS management.

RESULTS: 1. Pre-procedure evaluation: risk stratification, prior electro-physiological studies, prior outpatient medical management, recent stabilizing interventions including transcutaneous or transvenous pacing. 2. Unique risks of pulmonary angiography: Pathophysiology
of induction of arrhythmia during pulmonary artery catheterization and right heart block. 3. EKG patterns of heart block and other fatal arrhythmias. 4. ACLS review of the management of fatal arrhythmias.

CONCLUSIONS: Understanding cardiac arrhythmias in the setting of pulmonary catheter angiography and recognizing which patients are at increased risk is an important part of managing these often-critically ill patients. Reviewing ACLS for fatal arrhythmias is essential as the interventional radiologist will be responsible for the immediate management of any intraprocedural fatal arrhythmia.

Abstract No. 992

The urban legends of interventional radiology: can we handle the truth?

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PURPOSE: To review the literature that validates or refutes many of the fundamental assumptions underlying commonly performed procedures within interventional radiology.

MATERIALS: As with any specialty, there are certain fundamental concepts that underlie many commonly performed procedures within interventional radiology. These concepts are perceived to be so basic to practicing physicians that the understanding of their origin and the familiarity with their ongoing literature-based validity is often overlooked. Over time, these concepts have an experiential justification. This educational exhibit hopes to present the literature-basis to validate or refute several of these fundamental concepts.

RESULTS: As interventional radiologists, there are fundamental concepts that form the basis for much of the procedural work that is performed within our specialty. This exhibit will provide literature-based answers to the following questions among others: Is there a benefit to using smaller sheath sizes for arterial procedures? How long must a patient be NPO prior to receiving conscious sedation? How much time is needed for groin compression after femoral arterial access in order to achieve hemostasis? Is Gelfoam truly a temporary embolic agent? What is the appropriate tip position for a central venous access device?

CONCLUSIONS: As increasing numbers of individuals enter the field of interventional radiology, it is important to review the fundamental assumptions underlying many of the procedures we perform. By providing the literature basis for many of these concepts, it is hoped that both new and experienced interventional radiologists can gain a greater understanding of the tips passed along through the years.

Abstract No. 993

Pictorial essay and review of evidence for retrieval of intracardiac foreign bodies

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PURPOSE: We will provide a pictorial review of recommendations for the management of intracardiac foreign bodies (FOB).

MATERIALS: More frequent endovascular interventions lead to an increased risk of medical devices embolizing to the heart. Interventionalists who retrieve intracardiac FOB should be aware of the evidence for FOB retrieval before risking arrhythmia, valvular damage, or hemorrhage.

RESULTS: Intracardiac FOB may be free floating or embedded in the right or left heart with potential complications including thrombosis, embolization, malignant ectopy or infection. All symptomatic intracardiac FOB should be retrieved. However, only 20-30% of intracardiac FOB become symptomatic. For asymptomatic patients, the location of the FOB has historically predicted complications and therefore determined management. Four decades ago, Fisher & Ferryro advocated aggressive attempts to retrieve retained catheter fragments in the right heart after showing a 4-month mortality rate of 50% and a serious complication rate of 32%. However, recent studies advocated a more conservative approach including Gelbfish & Ascer who showed zero complications from filters in the right heart after 5-years. Based on historic data, the trauma literature recommended against retrieving right heart FOB or embedded intracardiac FOB. Instead, retrieval was advocated for FOB in the left heart or greater than 5 mm in size. As percutaneous techniques improve, the risk of intervention will decrease and the threshold to retrieve intracardiac FOB will be lowered. In fact, one metaanalysis of 151 patients advocated retrieving all intracardiac FOB regardless of symptoms or location.

CONCLUSIONS: All symptomatic intracardiac FOB should be retrieved. For the 70-80% of patients who remain asymptomatic, the trauma literature recommends against retrieving intracardiac FOB which are embedded in myocardium, located in the right heart, or smaller than 5 mm.

Abstract No. 994

On the “cutting edge” of wound care: what every interventional radiologist needs to know

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PURPOSE: 1) Review the basic science of wound healing. 2) Provide evidence-based wound care essentials that are crucial to IRs treating critical limb ischemia (CLI) patients from the perspective of podiatric wound care specialists. 3) Demonstrate the latest developments and future of this evolving field.

MATERIALS: Clinical outcomes in patients with critical limb ischemia (CLI) depend not only on endovascular restoration of macrovascular blood flow, but also on aggressive periprocedural wound care. Advances in wound care products and therapies have allowed the wound care specialist the ability to heal previously non-healing wounds, ultimately leading to fewer hospital admissions and fewer amputations. IR education about this area of CLI therapy is essential
to providing the best comprehensive care for CLI patients and maximizing the benefits of endovascular therapy. In addition, wound care knowledge facilitates participation in the multidisciplinary care these patients need.

RESULTS: We will provide a primer on the basic science behind wound healing. We will present the essentials of wound care using tables and case examples from a podiatric wound care specialist’s perspective. We will explore the most recent advances in the field of wound care by providing familiarity with recent advances in wound care products (amnion based, stem cell therapy, etc.). Last, we will familiarize the reader with new evolutions in podiatric surgical wound care techniques, such as the intraoperative use of near infrared fluorescent angiography for objective assessment of real-time peripheral tissue perfusion to accurately depict viable margins, detect suture-related perfusion constriction, and insure flap viability post transfer.

CONCLUSIONS: Knowledge of wound care is essential for the management of patients with CLI to not only increase positive postprocedural outcomes, but also to enhance inter-specialty interaction the multidisciplinary care needed for these patients. By increasing understanding of new therapies that stand poised to change the standard of care for non-healing wounds, the IR can stay on the “cutting edge” of the treatment of CLI.

Abstract No. 995

Transradial approach for noncoronary interventions: the experience of a small community-based hospital

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PURPOSE: Papers describing the relative success of transradial access (TRA) over transfemoral access (TFA) for interventional radiology procedures have been from large, high-volume centers. Thus far, there are fewer reviews of TRA from small, community-based hospitals. This presentation summarizes the experience with TRA within the interventional radiology department at our humble institution. A separate discussion of elderly patients (>70 years) is included, as this patient population has not been discussed in prior publications.

MATERIALS: We searched our institution’s dictation database for all transradial access procedures performed in a 2-year period since the first procedure was attempted. The electronic medical record for these patients was reviewed for data regarding gender, age, indication, patient comorbidities, catheter size, and subsequent in-house complications. Technical success was determined to be completion of the initially intended procedure without having to subsequently cross over to a transfemoral approach.

RESULTS: 100 procedures were initially considered for TRA. Only 1 case was contraindicated due to an inadequate Barbeau classification. Technical success was achieved in all but 2 patients. In the first, femoral artery crossover was necessary due to a radial loop variant. In the second, there was too much distance from the access site to the abnormality requiring treatment, and a longer catheter had to be ordered to treat this patient at a later time. Thus, there was a technical success rate of 98% (97/99) of attempted TRA procedures. This presentation: Reviews interesting procedures possible with TRA, presenting a relatively low complication rate. Discusses specific limitations to TRA and the few encountered complications which were specific to TRA. Discusses the success of TRA within an elderly subset of patients. Provides a comparison of fluoroscopy and intraprocedural time for each access method.

CONCLUSIONS: The success of TRA that is described at large, high-volume institutions can be mirrored in small, community-based settings. There is a broad range of procedures that may be performed transradially, with specific limitations imposed by both instrumentation and anatomy.

Abstract No. 996

Acute mesenteric ischemia: clinical evaluation, imaging work-up, and endovascular treatment

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PURPOSE: 1. Describe the clinical presentation and imaging findings of acute mesenteric ischemia and its subtypes. 2. Compare the surgical and endovascular treatment options for acute mesenteric ischemia. 3. Describe the procedural steps of mesenteric arterial thrombectomy. 4. Understand the complications and postprocedural care of patients who received endovascular treatment for acute mesenteric ischemia.

MATERIALS: Acute mesenteric ischemia is a serious and life-threatening diagnosis with high associated morbidity and mortality. Early imaging diagnosis and expedient endovascular treatment (when possible) is therefore vital to patient outcomes. Understanding the imaging findings and differentiating between the types of mesenteric ischemia is critical to choosing the correct treatment.

RESULTS: 1. Clinical presentation of acute mesenteric ischemia. 2. Imaging findings of acute mesenteric ischemia and differentiation from other acute bowel pathology. 3. Pictorial review of selected interesting cases. 4. Differentiation between acute mesenteric ischemia due to arterial occlusion, venous thrombosis, and systemic hypotension. 5. Preprocedure evaluation, arterial anatomic variants, indications and contraindications. 6. Procedural steps and thrombectomy options. 7. Complications, including related to arterial intervention, access site bleeding in the setting of concurrent systemic therapeutic anticoagulation, and surgical options for patients not candidates for endovascular intervention.

CONCLUSIONS: Acute mesenteric ischemia is a disease with high morbidity and mortality. Early clinical recognition followed by expedient imaging diagnosis and efficient endovascular treatment (when possible) is essential to achieving a good outcome. 2. The pathophysiology for acute mesenteric is multifaceted and has significant implications for subsequent treatment pathway. Therefore, recognition of these differences during diagnostic imaging is important. 3. Endovascular
thrombectomy is an excellent treatment option which is minimally invasive and is also useful for identifying additional thrombi/emboli not seen on computed tomography.

**Abstract No. 997**

**Acute pulmonary embolism: evolving endovascular technologies and the increasing role for interventional radiologists**

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**PURPOSE:** 1) Review the current therapeutic options available for acute pulmonary embolism. 2) Review the components and procedural details for available catheter-directed thrombolytic devices including ultrasound-assisted devices. 3) Discuss comparison studies between available therapeutic options and highlight controversy over treatment of submassive PE.

**MATERIALS:** Background: Acute pulmonary embolism is currently the third leading cause of cardiovascular death in the United States and causes an estimated 100,000 deaths annually. Anticoagulation is the recommended first line therapy, but additional treatments may be required in submassive and massive PE. Therapies include systemic chemical thrombolytics, mechanical thrombectomy, pharmacomechanical techniques including catheter-directed thrombolysis (CDT) using various suction/fragmentation devices, and now ultrasound-assisted, catheter-directed thrombolysis (USAT). Multiple studies have been performed examining the safety and efficacy of each method; however, few direct comparisons have been performed with these new technologies to date. These are now being published and the results will influence the future treatments of PE.

**RESULTS:** This exhibit will define submassive and massive PE and describe the current therapeutic options. An outline of the advantages and disadvantages of each option, as well as specific indications or contraindications will be provided. A bullet-point step-by-step narrative and simple pictorial model of the procedural details for the most common catheter-directed devices, such as USAT, will be provided. Lastly, a concise comparison will be made of the available options utilizing the most recently published data.

**CONCLUSIONS:** Various techniques and algorithms for treatment of submassive and massive PE will be reviewed with emphasis on procedural variables and relative efficacy.

**Abstract No. 998**

**Beyond tissue plasminogen activator: pearls and pitfalls in the modern management of acute limb ischemia**

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**PURPOSE:** 1) Review the pathophysiology and classification of acute limb ischemia (ALI). 2) Explore techniques such as conventional surgical balloon embolectomy, fibrinolytic infusion, ultrasound-enhanced lytic infusion, rheolytic thrombectomy, and aspiration thrombectomy. 3) Guide the reader through our protocol for patient selection, benefits, and potential complications of the various endovascular therapies. 4) Compare and contrast associated costs of current therapies. 5) Discuss pearls and pitfalls for increasing device effectiveness through case examples.

**MATERIALS:** Acute limb ischemia is associated with high rates of morbidity and mortality. Historically, catheter-directed thrombolysis has proven effective as standard of care in patients with early stage ALI. However, in practice the optimal endovascular therapy for ALI varies on a case-by-case basis, often depending on etiology, chronicity, clinical staging, anatomic location, and patient-specific factors. With the advent of new technology and an ever-increasing focus on healthcare costs, the treatment landscape of ALI is changing. It is imperative for IRs treating ALI to not only be well-versed in strengths and weaknesses of all available treatment options, but also to be able to delineate specific algorithmic endovascular approaches for ALI patient subclasses. What is best for the patient? The proceduralist? The healthcare system?

**RESULTS:** We provide an algorithm IRs can utilize to guide decision making in the treatment of ALI by: 1) Reviewing rationale for patient selection for different ALI endovascular devices currently on the market. 2) Comparing and contrasting mechanisms of action, benefits, and potential complications for each available therapy in table format. 3) Exploring procedural-associated costs of each technique. 4) Discussing Pearls and Pitfalls for increasing device effectiveness through case examples. 5) Depicting a decision flow chart to guide decision making in ALI treatment.

**CONCLUSIONS:** We explore the latest in ALI and provide an algorithmic up-to-date approach with case examples that IRs can utilize to guide cost-effective decision making in this dynamic landscape.

**Abstract No. 999**

**Implementation of a stroke endovascular thrombectomy program at a center without neuro-interventional radiology using monoplane fluoroscopy and with remote telefluoroscopy neurointerventional mentorship**

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**PURPOSE:** Endovascular therapy (EVT) has become the standard of care for selected ischemic stroke patients but access remains limited in part due to lack of neuro-interventionalists. We explored the feasibility of implementing an EVT program for acute ischemic stroke in a tertiary academic center without on-site neurointerventionalists, using monoplane fluoroscopy, and geographically remote telefluoroscopy mentorship from a neuro-interventionist.

**MATERIALS:** Three general interventional radiologists with a combined experience of 354 carotid angiography procedures over the past 10 years performed EVT, with the option of real-time mentorship from
an academic neuro-interventionalist using telefluoroscopy. Telefluoroscopy was securely networked using the Ontario Stroke network. Stroke neurologists were present for all cases. Patients were selected according to ESCAPE trial criteria. All cases were performed using a Covidien Solitaire stent and balloon occlusion catheter.

RESULTS: Between May 2 2016 and September 25 2017, 14 patients were treated with EVT for middle cerebral artery stroke. IV tPA was administered to 10/14 patients (mean door-to-needle time, 30.7 minutes). 1 procedure was aborted because of unfavorable aortic arch anatomy. Thrombectomy stent was successfully deployed in 13/14 cases. Average CT to puncture time was 30.5 minutes, puncture to reperfusion time was 27.6 minutes, and CT to reperfusion time was 54.1 minutes. Angiographic reperfusion scores were TICI 2b in 6/13, TICI 3 in 7/13. 90 days postprocedure, modified Rankin Scale score was ≤ 2 in 6/11 patients; 3 in 1/11 patient; 4 in 1/11 patients. 3/11 patients had died at 90 days, one where the procedure was aborted, one from a delayed procedural associated carotid dissection, and one from a delayed unrelated pneumonia.

CONCLUSIONS: In this program implementation experience, EVT performed by three general interventionalists with geographically remote telefluoroscopy mentorship from a neuro-interventionist and using monoplane fluoroscopy was feasible in a tertiary academic stroke center. Limited volume outcomes were similar to the ESCAPE trial.

Abstract No. 1000

Precision medicine for hepatocellular carcinoma: primary culture and patient-derived xenograft models from percutaneous biopsy samples as a foundation for identifying tumor-specific genetic vulnerabilities

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PURPOSE: Precision medicine may offer new avenues of therapy for patients with hepatocellular carcinoma (HCC) who have failed conventional treatments. The purpose of this study was to develop a precision medicine approach for HCC, using percutaneous biopsy samples to derive primary culture and patient-derived xenografts (PDXs) for identification of tumor-specific targetable vulnerabilities.

MATERIALS: Between 4/2016 and 9/2017, 16 embolotherapy naïve, non-transplant candidate patients with HCC were enrolled in this prospective clinical trial. Percutaneous 18G core biopsies of the dominant HCC were attained immediately prior to transarterial chemoembolization. Tissue processing techniques and culture conditions were compared and optimized for primary cell culture from biopsy specimens. Cultured cells were characterized using immunohistochemistry and flow cytometry. Biopsy cores from 7 tumors were implanted in nude mice for PDX generation. As a proof-of-principle for future application in patient-derived cells, a functional genomic screening assay using CRISPR/Cas-9 was assessed on immortalized HCC cell lines.

RESULTS: Primary cell culture was established in each of the 16 patients and successful expansion of malignant cells was achieved from two of these cultures. Plating efficiencies were significantly higher under hypoxic (5% O2) versus normoxic (21% O2) conditions. Cell characterization with immunohistochemistry confirmed positivity for pCEA, AFP, and glypican-3. Flow cytometry confirmed EpCAM tumor surface marker positivity. Successful engraftment and tumor growth was confirmed in two PDX mice with additional results pending. Implantation with Matrigel promoted more rapid flank tumor growth. Preliminary CRISPR/Cas-9 screening assay for targetable vulnerabilities in HepG2 and HuH-1 cell lines successfully identified novel putative drug target domains.

CONCLUSIONS: Percutaneous needle biopsy samples can provide sufficient tissue to establish primary cell culture and PDX for HCC, providing a foundation for a precision medicine approach to HCC. Functional genomic target screening with CRISPR/Cas-9 can augment conventional biochemical screening approaches for identifying putative drug targets.

Abstract No. 1001

Vascular anatomy considerations during transarterial embolization of external carotid artery

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PURPOSE: - Enumerate the current applications of extracranial embolization. - Review vascular anatomy of head and neck. - Review the extracranial- intracranial connections. - Review extracranial vascular supply of cranial nerves.

MATERIALS: In the last two decades, Embolization of external carotid artery (ECA) territory has been used in endovascular minimally invasive treatment of dural AV fistulas, epistaxis and transarterial chemotherapy for head and neck neoplasms. ECA branches are closely linked to intracranial arteries due to multiple embryological and genetic factors. Detailed knowledge of vascular anatomy, extracranial-intracrani al collaterals and cranial nerve vascular supply arising from ECA is essential to ensure safety and prevent potential neurological complications. In our exhibit, we explore the potential extra-intracranial collaterals and possible complications resulting from their embolization.

RESULTS: The extraintracranial anastomotic connections are usually not seen on routine catheter angiography, they open as collaterals when occlusion of a major intracranial artery happens or with increased pressure during embolization procedure. There are 3 main regions that form the major extra-intracranial pathways. 1- The orbital region- Internal maxillary 2 - The petrous-cavernous region 3 - The upper cervical region.

CONCLUSIONS: Trans arterial embolization of the ECA territory is proven as an established and important treatment for several head and neck conditions. Ample knowledge of the Extra- intracranial connections is important to avoid neurological complications.
Abstract No. 1002

**Fabrication of endothelial progenitor cell–seeded drug-eluting stents and in vitro evaluation**

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**PURPOSE:** Although the introduction of drug-eluting stents (DES) dramatically reduced the risk of neointimal hyperplasia, late stent thrombosis due to delayed endothelialization after implantation is a remaining problem. Recently, a great deal of research has been focused on alternative stent designs that have early endothelialization ability after implantation without losing antstenotic drug elution. In this study, we report a method for fabricating late-outgrowth endothelial progenitor cells (EPCs) seeded DES to facilitate early endothelialization after implantation and show early results of in vitro evaluation.

**MATERIALS:** EPCs were isolated from human adult peripheral blood and were expanded in vitro up to 8 passages. Cells were confirmed as late-outgrowth EPCs by flow cytometry analysis. Commercially available self-expanding abluminal side paclitaxel-eluting stents were seeded with EPCs by exposing them to a cell concentration of 2.1 million/ml under constant rotation around the stent axis for 6 hours.

**RESULTS:** The seeding procedure resulted in 51% coverage of the stent’s surface in un-crimped conditions and 24% coverage of the stent’s surface in crimped conditions, respectively. As confirmed by liquid chromatography–mass spectrometry analysis, 99% of the loaded paclitaxel was still available for elution after 6h seeding. When the EPC-seeded DES were placed on a fibrin matrix, the seeded EPCs formed a confluent layer on the struts and spread to the surrounding fibrin gel. When the EPC-seeded DES were placed on fibroblast containing-fibrin layers, the cells below the stent area died as confirmed by dead and alive staining.

**CONCLUSIONS:** These results indicate that i) EPCs can be successfully seeded to DES without losing the drug-eluting ability from the stent surface; ii) the seeded EPCs have proliferative ability for endothelialization of the vessel’s lumen. Therefore, EPC seeded DES may be a valid alternative therapeutic medical device combining early reendothelialization ability with antstenotic effectiveness of DES.

Abstract No. 1003

**Dialysis demystified: how to interpret the hemodialysis report for the interventionalist**

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**PURPOSE:** 1. Identify and understand basic terms related to hemodialysis function. 2. Demonstrate a familiarity with normal ranges for common hemodialysis function metrics. 3. Provide basic interpretation of a hemodialysis report. 4. Utilize abnormal values from a hemodialysis report to predict the source of malfunction in a hemodialysis fistula as it relates to treatment planning during intervention.

**MATERIALS:** Malfunction of hemodialysis arteriovenous fistulas and grafts are a common problem encountered by the interventional radiologist. It is not unusual for patients to present in referral with complaints of “high venous pressures” or “prolonged bleeding” and little additional history. Each hemodialysis session generates a detailed report of the treatment parameters that is entered into the medical record. These parameters can be used to predict the underlying problem and help guide the interventional radiologist in making treatment decisions in addition to the angiographic findings. Knowledge of how to interpret these findings will provide the interventional radiologist with a broader set of diagnostic tools and a reference point for targeted treatment.


**CONCLUSIONS:** URR: a measurement of how much urea was cleared during the procedure. Expressed as a ratio of the removed urea over the initial urea. Target is around 65% Kt/V: Clearance multiplied by time over the total body water volume. Kt/V is used to assess the adequacy of clearance. Target is greater than 1.2 Venous pressures: pressures > 200 mm Hg signify an outflow obstruction. Prolonged elevation of pressures can lead to bleeding, thrombosis, recirculation, and aneurysm formation. Arterial pressures: > 200 mm Hg can signify stenosis in the arterial anastomosis, juxta-anastomotic segment and extensive collateral vein circulation, which may cause thrombosis and inadequacy of HD. In addition, immaturity of the AVF may be as a result of these features. Blood flow: The average prescribed BFR in HD is 400 ml/min. Being unable to achieve this rate may represent either immaturity or high venous/arterial pressures.

Abstract No. 1004

**Recent trends in Medicare rates of nephrologic interventions by physician specialty, 2012–2015**

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**PURPOSE:** Interventional nephrology (IN) has emerged as a growing field in medicine as more nephrologists strive to perform procedures
for their patients, with an associated rise in IN training programs and dialysis access centers. While more remote procedural trends have been reported, the purpose of this study is to further characterize the most recent trends in IN/IR procedures by physician specialty over time.

MATERIALS: A query was performed on “Medicare Provider Utilization and Payment Data: Physician and Other Supplier” datasets for the years 2012 to 2015. Specifically, arteriovenous (AV) access and kidney biopsy codes were analyzed over this time period because they were the most commonly performed nephrologic procedures by radiologists. Stratification of physician specialty was performed, including radiology (IR/DR), nephrology, vascular surgery, general surgery, internal medicine, and all others.

RESULTS: 703,994 procedures were analyzed during this time frame. AV access procedures were most commonly performed by radiologists (49%), followed by nephrologists (23%), vascular surgeons (15%), then general surgeons (6%). There was a slight decline in the proportion of procedures performed by radiologists between 2012 and 2015 (51% to 49%; p<0.0001) and a small increase in the proportion performed by nephrologists (22% to 24%; p<0.0001), vascular surgeons (14% to 15%), and without change for general surgeons. A similar trend was found for declotting of hemodialysis AV grafts with a slight decline in the proportion performed by radiologists (43% to 41%, p=0.0001) and an increase performed by nephrologists (32% to 33%, p = 0.0005). Radiologists continue to perform the majority of kidney biopsies (60%) compared to nephrologists (30%). The proportion performed by radiologists has steadily increased (5.4% to 60%) while the proportion performed by nephrologists has decreased (32% to 30%).

CONCLUSIONS: Radiologists remain the dominant provider for interventions on AV access, although there is a slight decrease over this 4-year period with a slight increase performed by nephrologists. For kidney biopsies, however, radiologists have continued growth in the Medicare population.

Abstract No. 1005

Deployed interventional radiology in Afghanistan

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PURPOSE: To understand the opportunities and potential of interventional radiology (IR) in the deployed environment by outlining the experiences of an Army interventional radiologist while deployed in Afghanistan. To highlight the challenges of IR in becoming a staple in the combat environment and an established deployable specialty.

MATERIALS: There is currently no established role for IR as a unique subspecialty on the battlefield. Given the variety of surgical subspecialties, e.g., vascular and general surgeons, the skillset of the interventional radiologist was not viewed as a necessity within the deployed environment (1). However, by including basic IR capability within the deployed environment, interventional radiologists have the potential to reduce morbidity and mortality through use of minimally invasive techniques for the injured or ill patient.

RESULTS: One of the author’s experiences during deployment in Afghanistan highlights the importance of IR in the combat environment. Though deployed as a general radiologist, he was able to improvise with limited supplies and equipment: using one portable C-Arm, portable ultrasound machine, and one CT scanner, he performed a wide range of procedures, to include placing nephrostomy, cholecystostomy and chest tubes, as well as foreign body removal related to blast injuries, abscess drainage, and placement of ureteral stents. The challenges that limit the use of IR in the deployed environment are related to limited supplies, suboptimal resupply, and necessity and maintenance of imaging equipment.

CONCLUSIONS: IR has a long way to go toward becoming a mainstay in the deployed environment. Throughout the various conflicts the US military has experienced, the role of diagnostic radiology has expanded and been redefined, allowing for greater utility on the battlefield. As technology continues to advance and imaging modalities move farther into the battlefield, IR has the potential to become an important asset to military medicine in the combat environment.

Abstract No. 1006

Augmented reality in the interventional suite: what the interventionalist should know

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PURPOSE: 1. Review fundamental concepts of augmented reality (AR) as well as available optical head mounted display devices. 2. Discuss applications of AR to interventional radiology for intraoperative data display, image-guided intervention or simulative training. 3. Review practical considerations for how to incorporate this technology as well as the future implications it has for the field of interventional radiology.

MATERIALS: Augmented reality (AR) is an emerging technology that has helped drive innovative solutions in many industries, including medicine. Recent advances in computing hardware and increasing availability of wearable devices have made this technology feasible for use by radiologists, in particular interventionalists. To date, there has been limited discussion of the potential to enhance practice patterns and unique challenges that these devices present.

RESULTS: We review current applications of AR devices in interventional radiology. Available applications and on-going development pertaining to three facets are discussed: 1) Display of patient imaging, electronic medical record or adjunct resources, intraoperatively. 2) Three-dimensional projection of prior or current patient imaging to facilitate intervention. 3) Simulation training that can better prepare trainees in a safe and extensive manner. Finally, practical considerations of how to set up an AR environment including current limitations and impact to daily workflow are discussed.

CONCLUSIONS: Augmented Reality is an innovative technology that the interventional radiologist should be familiar with. Given the rapid technical advancement, AR devices have many imminent applications that can change how we practice as well as implications that may shape the future of interventional radiology.
Abstract No. 1007

Intellectual property in interventional radiology: simplified

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PURPOSE: 1. Describe USPTO definition of an invention 2. Understand what an IP disclosure is and the pros/cons of a provisional patent. What is “prior art?” 3. Understand the timing of the process, which is critical; when to file a disclosure and a provisional patent. 4. What is a patent application? We will describe its components and overall structure. 5. What happens after a patent is filed? We will describe the rebuttal process and the pros/cons of an international filing. 6. What happens after the patent is issued? What does a patent actually protect?

MATERIALS: Minimally invasive interventions are rapidly becoming the mainstay of patient care. Interventional radiology (IR) is uniquely poised at the forefront of developing new technologies to improve current interventions. Intellectual property (IP) is the basis for ensuring protection and licensing of these ideas. With the protections guaranteed from the United States Patent and Trademark Office (USPTO), intellectual property can become a powerful tool for healthcare professionals, including interventional radiologists. As novel devices or alternative interventions are discovered in clinical practice or the laboratory, these ideas must be preserved by law to ensure the rights of the inventor and to guarantee proper transition to clinical practice.

RESULTS: In a simplified cookbook fashion, our aim is to demystify the process of IP filing. IP in interventional radiology is critical; it can potentially lead to resources allowing new devices, new techniques and new catheters to reaching our patients. Understand the process may lead to greater innovation and advancements in IR; it is a requirement for “start-ups.” Each step of the process will be reviewed and examples will be provided.

CONCLUSIONS: Securing IP disclosure is the first step to ensuring novel ideas are protected. When on the forefront of new technologies, IP must be granted to secure rights for the inventor. By understanding the process of obtaining an IP, breakthroughs can be more rapidly integrated into clinical practice.

Abstract No. 1008

Developing a successful interventional radiology inpatient practice

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PURPOSE: Establishing a successful interventional radiology service is filled with many obstacles, most of which can be overcome with deliberate and focused efforts. For most interventional radiologists, success means being able to devote nearly 100% of professional time to the practice of interventional radiology. This exhibit will highlights the challenges in developing a successful inpatient IR service.

MATERIALS: Developing a successful interventional practice is more analogous to developing a surgical practice than a conventional radiology practice. It is a service that must always be available and does not lend itself to conventional radiology hours. The surgical practice, therefore, is the model on which the interventional practice should be patterned.

RESULTS: Since interventional procedures are relatively new and may not be performed at all in some institutions, establishing an interventional radiology practice requires implementation of change: change in referral patterns, in the concepts of referring physicians, in diagnostic algorithms, and in radiological colleagues as well.

CONCLUSIONS: The following areas must be addressed by the interventionalist who wishes to aggressively implement change: 1. development of an optimal environment, including technical and staffing considerations. 2. continuing educational activities for the interventionalist and staff to keep abreast of a rapidly developing field. 3. active education and dissemination of information to other physicians, including specialists and primary care physicians. 4. interaction with lay groups who may have interest in interventional procedures; establishment of admitting privileges if necessary. 5. establishment of reimbursement levels appropriate to the procedure and time involved. 6. involvement of hospital administration to support procedures of mutual benefit.

Scope of Interventional Radiology

1. Vascular
2. Pain
3. Oncology
4. Cross-sectional procedures

Abstract No. 1009

You know how to treat, but do you know how to tweet?

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PURPOSE: • To describe the characteristics of tweets which afford higher engagements • Describe the interventional radiology hashtag ontology, which may be used to drive engagement • Describe tips and tricks to help the IR twitter community maximize their Twitter® impact

MATERIALS: Twitter is an effective platform for communication, collaboration, and sharing of information and ideas both within a medical specialty and from a medical specialty to the general public. In order to fully utilize Twitter’s potential effectively, user engagement should be maximized. A recent study analyzing the AJNR twitter feed showed
that Tweets including a picture, hashtag and those published during morning hours were associated with higher user engagement rates (1). The purpose of this exhibit is to describe how institutional and individual Twitter feeds can drive meaningful user engagement and reach out to a wider audience. We will also define IR specific hashtags to be included in the IR Hashtag Ontology.

RESULTS: • The primary purpose of any professional social media based activity is meaningful user engagement. • Engagement is quantified by different Social Media Platform differently. Twitter, a popular social media platform for IRs, defines engagement as some kind of interaction with the Tweet. • Images should be increasingly used since they provide visual attraction to the users. Also, IR is an imaging-based specialty, and thus IR-related discussions are more engaging when images are included. • The IR Hashtag Ontology includes #IRad, #RadRes, #EmoryIR, #FilterFriday #FilterOUT among many others. • Hashtags help IRs follow their interest on Twitter and connect with fellow IRs and other specialty physicians • Tagging other Twitter users related to a common topic is a useful trick to increase engagement. • Twitter Analytics data is a free and powerful tool to monitor user engagement data for institutions and individuals. For example, the mean number of impressions and engagements over the past 6 months for @MountSinaiIR were 1790 and 5.8% respectively, while for @AlexCVIR were 680 and 6.0% respectively.

CONCLUSIONS: Individuals and Institutions can adopt the described strategies to increase user engagement on Twitter.

Abstract No. 1010

Is residency training pathway influenced by a Medical Student Interventional Radiology Symposium?

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PURPOSE: Given the evolution of interventional radiology (IR) as a distinct clinical specialty and stand-alone residency program, medical student engagement is paramount especially with the perceived lack of exposure early in medical training. Medical student IR symposia are effective means to educate students about IR. This survey aims to assess the symposium’s effect on past attendees by evaluating their residency training choices using a long-term follow-up survey. In addition, attendee exposure to IR during medical school is assessed.

MATERIALS: The Midwest IR Medical Student Symposium (MiMSS) is a regional symposium held annually from 2015-2017. The event is sponsored by seven regional academic institutions and includes faculty lectures, basic and advanced courses, simulation, and networking events. While pre- and postsymposium surveys are obtained, we developed a 15-question survey via Google forms sent to medical students who registered for the MiMSS in 2015, 2016, and 2017. The survey was distributed 6 months following the 2017 symposium.

RESULTS: 417 registrants were contacted, and 54 surveys were completed (13.5% response rate). Students from 20 medical schools responded including 47 medical students (12 MS2, 12 MS3, 23 MS4) and 7 current residents (6 PGY1 and 1 PGY2). 40% of students plan to apply to IR residency, 30% are undecided, and 19% expect to apply to DR residency. 100% of medical students attended IR symposia while less than 60% had exposure to both clinical rotations and shadowing experiences. Only 55% of students believed they had adequate exposure to IR. Limited responses from current residents indicated 71% of matched into IR residency and 29% matched into a DR residency. All residents attended the symposium and did IR rotations. 71% of residents believed IR exposure was adequate. Overall, 69% of the respondents said the symposium increased their likelihood of pursuing IR.

CONCLUSIONS: Follow-up survey to past attendees of a regional medical student IR symposium demonstrated a strong correlation with the symposium and future applying/matching in an IR or DR residency. This surprises, the most significant exposure to IR for medical students is the IR symposia, which is critical for outreach.

Abstract No. 1011

Role of interventional radiology in the opioid epidemic

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PURPOSE: Review the scope of the opioid epidemic. Review the diverse presentations of opioid epidemic to interventional radiology. Discuss how interventional radiologists can serve as catalysts in the care of these patients.

MATERIALS: Substance use disorder from opioids is a health care crisis in America affecting up to 2.1 million people, and approximately half a million Americans suffer from heroin addiction. Prescription opioids have contributed to a steady increase in opioid-related deaths. Drug overdose is the most common cause of accidental death in the US, accounting for approximately 52,404 deaths directly from overdose in 2015. Still more patients suffer medical consequences from this national emergency that routinely lead to diagnosis and treatment by interventional radiology. A host of medical complications can occur with opioid abuse ranging from abscesses anywhere in the body, pseudoaneurysms, venous disease requiring interventions, and chronic sequelae of infections such as organ failure and in some cases malignancy. The purpose of this article is to review the diverse role of interventional radiology in helping diagnose and manage medical issues arising from opioid abuse through a series of select cases.

RESULTS: In this educational abstract, we review select cases of patients with opioid abuse with different clinical and imaging manifestations and briefly describe interventional radiology procedures performed in these cases.

CONCLUSIONS: 1. Opioid epidemic in the United States is a national crises. 2. Interventional radiology has a unique role to play in diagnosing and treating these patients.
Abstract No. 1012

Interventional radiology: examining the digital footprint
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PURPOSE: Given that the visibility of interventional radiology (IR) is essential to the continued growth of the specialty, the purpose of this study is to examine trends in the online footprint of IR using data from Google searches.

MATERIALS: We collected Google Trends data from January 2004 to August 2017 for the search phrase “interventional radiology” (categorization: medical specialty). The resulting normalized time series data, called a search volume index (SVI), is reflective of an unbiased random sampling of google searches. We also performed comparison queries for “vascular surgery” and “internal medicine.”

RESULTS: U.S. IR searches peaked in January 2004 (SVI = 100) and then declined to the lowest point in December 2011 and December 2012 (SVI = 51). August 2017 had the highest SVI since March, 2006 (SVI = 83). The worldwide SVI has not rebounded as strongly (August 2017 SVI = 58). Vascular surgery (VS) search traffic also exhibits a nadir in December 2012 (SVI = 49), followed by recovery (August 2017 SVI = 100). Comparing VS to IR, SVI are similar from 2004 to 2017, though with a slight yet consistent edge in favor of VS: 162 of 164 months saw greater SVI in VS, with an average multiplicative factor of 1.5 ± .2 (P<.05). From December 2012 to December 2016, VS SVI increased by a factor of 1.4, IR by a factor of 1.3. As a control, SVI for internal medicine was examined: the SVI ratio for Decembers of 2012 to 2016 was 1.0.

CONCLUSIONS: The reasons for the decrease in IR search popularity in the early 2000s are likely multifactorial. One contributing factor could be the relative increase in other specialties offering overlapping services, causing a fraction of potential patients to investigate those specialties instead. While the specialty of interventional radiology has continued to advance, those victories in the interventional suite do not always translate into greater public awareness. Consistent investment in public relations may, however, make a difference, which may explain the substantial SVI rebound since 2012, and the stronger SVI rebound in the U.S. as compared to abroad.

Abstract No. 1013

Differences in open payments to physician specialties that perform interventional procedures. what does it mean?
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1FDA, Georgetown University, Gaithersburg, MD, 2N/A, Arlington, VA, 3Georgetown University Hospital, Washington, DC, 4N/A, Washington, DC, 6Georgetown University Hospital, Washington, DC

PURPOSE: The purpose of this analysis is to assess whether there are substantial differences in payments by Industry to physician specialties that perform interventional procedures.

MATERIALS: The Centers for Medicare and Medicaid Services (CMS) General Open Payments Data (Detailed Dataset for the 2016 Reporting Year from January 1, 2016 to December 31, 2016) were analyzed to assess relative payment information for fields that generally perform vascular interventional procedures. Specialties that include the key words “Interventional” or “Vascular” were primarily used to sort data. Data regarding the number of payments and annual payment total per specialty were calculated.

RESULTS: The specialty with the largest annual payment amount was “Cardiovascular Disease” with over 103 million dollars paid to individual physicians. In general, the Cardiology specialties (i.e., Cardiovascular Disease, Cardiothoracic Vascular Surgery and Interventional Cardiology) accounted for 84.09% of the total payments. Focusing only on declared Interventional Specialists, Interventional Cardiology accounted for the largest portion of payments (14.59%), whereas interventional radiology accounted for 4.78% nearing that for Interventional Pain Medicine, 3.45%. Vascular Surgery accounted for 7.31%.

CONCLUSIONS: There is wide variability in payments to physician specialties that may perform similar interventions and interesting questions are raised regarding the impact of these payments, including but not limited to whether there is an association with product use, research participation, and/or novelty of technologies.

<table>
<thead>
<tr>
<th>CMS Open Payments to Interventional Specialties</th>
<th>Payment Amount</th>
<th>Number of Payments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiovascular disease</td>
<td>$103,071,771</td>
<td>668,173</td>
</tr>
<tr>
<td>Cardiothoracic vascular disease</td>
<td>$28,276,979</td>
<td>71,074</td>
</tr>
<tr>
<td>Interventional cardiology</td>
<td>$27,578,412</td>
<td>173,887</td>
</tr>
<tr>
<td>Vascular surgery</td>
<td>$13,819,690</td>
<td>64,604</td>
</tr>
<tr>
<td>Vascular and interventional radiology</td>
<td>$9,029,270</td>
<td>22,214</td>
</tr>
<tr>
<td>Interventional pain medicine</td>
<td>$6,527,843</td>
<td>60,998</td>
</tr>
<tr>
<td>Vascular neurology</td>
<td>$695,418</td>
<td>3,018</td>
</tr>
</tbody>
</table>

Abstract No. 1014

Etiology of liver disease: impact on the incidence of portal vein tumor thrombosis in patients with hepatocellular carcinoma
A Mähringer-Kunz1, S Schotten2, F Meyer3, D Graafen4, S Koch5, C Dueber6, P Galle1, A Weinmann1, R Kloeckner1
1Johannes Gutenberg University, Mainz, Germany, 2Universitätsmedizin Mainz, Mainz, 3Mainz, 4Rheinland-Pfalz, 4University Medical Center Mainz, Mainz, RLP, 5Johannes Gutenberg University, Mainz, RLP, 6University Medical Center Mainz, Mainz, Rheinland-Pfalz, N/A, Mainz, Germany

PURPOSE: The presence of portal vein tumor thrombosis (PVTT) has direct impact on treatment options and is crucial for the prognosis of patients with hepatocellular carcinoma (HCC). The purpose of this study was to evaluate whether the etiology of the underlying liver disease has an influence on the incidence of PVTT.

MATERIALS: All patients with proven HCC treated in our tertiary referral center from 01/2005-01/2017 were extracted from our clinical registry.
Demographic parameters and the etiology of the underlying liver disease were documented. PVTT was diagnosed by contrast-enhanced CT or MRI in consensus reading by two board certified radiologists with extensive experience in oncologic abdominal imaging.

**RESULTS:** In total, 1341 patients with HCC were extracted from our clinical registry. The etiologies of HCC were the following: 497 (54.1%) alcohol, 291 (31.7%) hepatitis c, 131 (14.3%) hepatitis b, 95 (7.1%) cryptogenic liver cirrhosis, 77 (5.7%) NASH, 177 (13.2%) no underlying liver disease, 39 (2.9%) hemochromatosis, 18 (1.3%) autoimmune liver disease, and 16 (1.2%) other liver diseases. The three most common etiologies (alcohol, hepatitis b and c) were further analyzed, resulting in 919 patients. PVTT was present in 166 (33.4%) patients with alcoholic disease, 40 (30.5%) patients with hepatitis b, and 70 (24.1%) patients with hepatitis c. Therefore, the etiology had no significant influence on the incidence of PVTT (p = 0.719).

**CONCLUSIONS:** The etiology of the underlying liver disease has no significant impact on the incidence of PVTT in patients with HCC. As PVTT limits treatment options and is associated with a dismal prognosis, meticulous evaluation of cross-sectional imaging is mandatory, irrespective of the etiology.

### Demographic Data

<table>
<thead>
<tr>
<th>Etiology n (%)</th>
<th>No PVTT</th>
<th>PVTT</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcoholic liver disease</td>
<td>285 (35.3)</td>
<td>212 (39.7)</td>
<td>0.28</td>
</tr>
<tr>
<td>Hepatitis C</td>
<td>189 (23.4)</td>
<td>102 (19.1)</td>
<td>0.14</td>
</tr>
<tr>
<td>Hepatitis B</td>
<td>72 (8.9)</td>
<td>59 (11)</td>
<td>0.26</td>
</tr>
<tr>
<td>NASH</td>
<td>47 (5.8)</td>
<td>30 (5.6)</td>
<td>0.90</td>
</tr>
<tr>
<td>No liver disease</td>
<td>103 (12.8)</td>
<td>74 (13.9)</td>
<td>0.62</td>
</tr>
<tr>
<td>Cryptogenic liver cirrhosis</td>
<td>58 (7.2)</td>
<td>37 (6.9)</td>
<td>0.91</td>
</tr>
<tr>
<td>Hemochromatosis</td>
<td>26 (3.2)</td>
<td>13 (2.4)</td>
<td>0.81</td>
</tr>
<tr>
<td>Autoimmune</td>
<td>15 (1.9)</td>
<td>3 (0.6)</td>
<td>0.05</td>
</tr>
<tr>
<td>Others</td>
<td>12 (1.5)</td>
<td>4 (0.7)</td>
<td>0.30</td>
</tr>
</tbody>
</table>

### Abstract No. 1015

**Pilot implementation of augmented reality to enhance interventional radiology procedure planning**

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**PURPOSE:** To develop a workflow process of implementing augmented reality to enhance IR procedure planning

**MATERIALS:** Patient procedural anatomy is often difficult to interpret using two-dimensional (2D) images. Nevertheless, current medical procedures are planned using digital 2D images. In IR, precise placement of hardware is paramount for effective therapy. Localization and positioning of devices can be complex, particularly when planning the procedure from a 2D dataset. The use of 3D holograms may benefit interventional radiologists in orienting anatomy, optimizing the procedural approach, and avoiding potential complications.

**RESULTS:** We used Microsoft HoloLens and custom software to visualize and interact with 3D holograms of patient anatomy to enhance IR preprocedural planning. Pilot cases for four IR faculty members included cryoablation of an apical lung mass, Y90 radioembolization of liver metastases, liver abscess drainage, and RF ablation of a desmoid tumor in the foot. Cross-sectional images were visualized in actual 3D space using both surface- and direct volume-rendering techniques to obtain holographic 3D roadmaps of patient anatomy. The time required for generation of these 3D holograms was less than 60 minutes and 5 minutes for our surface- and volume-rendering approaches, respectively. Our surface- and volume-rendering approaches provided 3D holograms that were accurate to scale. Surface-rendering provided more target-specific views of patient anatomy and was more computationally efficient but required a greater degree of image preprocessing due to segmentation. Volume-rendering provided greater fidelity of image data but was much more computationally intensive, requiring remote processing and real-time wireless data transfer for viewing. All faculty members reported enhanced confidence in procedural anatomy with HoloLens utilization.

**CONCLUSIONS:** HoloLens provides a feasible workflow for introducing augmented reality into the IR practice. Enhanced spatial understanding enabled by augmented reality can provide the interventional radiologist improved confidence during treatment planning and execution.

**Abstract No. 1016**

**Contrast-enhanced ultrasound: a guide for the interventional radiologist**

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**PURPOSE:** Review available ultrasound contrast agents and their mechanism of action. Review clinical scenarios where contrast-enhanced ultrasound (CEUS) can improve diagnosis. Review clinical scenarios where CEUS can facilitate interventional radiologic procedures.

**MATERIALS:** Ultrasound is well established imaging modality for diagnosis and intervention. CEUS involves adding a microbubble contrast agent that allows detection of vascular perfusion. The value of using CEUS is that the agents can be used in patients with renal failure, CEUS scanning avoids ionizing radiation, the exams are portable, and images can be acquired in real-time.

**RESULTS:** Through a case-based approach, this educational exhibit will comprehensively review the indications, contraindications,
techniques, and applications of CEUS in interventional radiology practice to improve procedural success. Diagnosis of HCC can be made in patients with renal failure to potentially avoid biopsy. CEUS can evaluate for tumor thrombus in the situation of an indeterminate liver CT or MRI used for pre-TACE evaluation. For biopsy, CEUS can aid in finding the ideal target for biopsy to maximize diagnostic yield. Furthermore, when multiple masses are present, CEUS may help to differentiate lesions, and select an appropriate target for biopsy. When catheter drainage is performed, CEUS aids in selecting the ideal target for fluid evacuation. For liver and kidney ablation, CEUS can evaluate for residual malignancy, as well as delineate the burn zone.

CONCLUSIONS: Contrast enhanced ultrasound is a useful adjunct to sonographic imaging for diagnosis and intervention, and can place ultrasound on par with other contrast-enhanced cross-sectional imaging modalities, without the harm of nephrotoxicity and ionizing radiation.

Abstract No. 1017

An apples-to-apples comparison of radiation dose and image quality between flat panel computed tomography and multidetector computed tomography

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PURPOSE: To compare, using the same radiation dose and image quality metrics, flat panel CT (FPCT) to multidetector CT (MDCT) in the context of interventional radiology.

MATERIALS: A Siemens Artis zeego with FPCT was compared to a Siemens Definition Edge Sliding Gantry MDCT. Radiation dose was measured on the central axis of a cylindrical CT dosimetry phantom (30 cm diameter, 60 cm length). The noise power spectrum (NPS) and modulation transfer function (MTF) were measured using methods and software adapted from Friedman et al.[1] Slice sensitivity profiles (SSP) and contrast for PMMA were also measured. FPCT was acquired using standard organ programs, 5sDCT Body Care and 6sDCT Body (syngo DynaCT). The default Edge abdomen protocol was used for imaging, with CarekV (ref. kV = 120, Slider 7 or 9), B30f, B45f, and B70f kernels were used for reconstruction. MDCT scan length (17.5 cm) was set to image a volume that matched that in FPCT (16 cm).

RESULTS: MTF dropped more quickly at higher spatial frequency for MDCT than for FPCT. 6sDCT had lower noise than MDCT for comparable in-plane resolution. MDCT had narrower SSP, indicating higher z-axis resolution. Contrast was higher for MDCT, likely owing to scatter in FPCT given the large cone beam. Radiation dose was much lower for MDCT compared to FPCT. The table summarizes these results.

CONCLUSIONS: Radiation dose is much lower for MDCT compared to FPCT. Image quality is comparable, with MDCT having better z-axis resolution and contrast but slightly lower in-plane resolution for the same noise magnitude.

Abstract No. 1018

Current International Society for the Study of Vascular Anomalies (ISSVA) classification and its impact on management

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1MD Anderson Cancer Center, Houston, TX, 2University of Texas, Southwestern Medical Center, Coppell, TX, 3University of Texas Houston, Houston, TX, 4The University of Texas at Houston, Houston, TX, 5Mallinckrodt Institute of Radiology, St. Louis, MO

PURPOSE: • Vascular malformations overview • Nomenclature and previous classifications • Current classification with case examples • Management options

MATERIALS: Vascular anomalies, a group encompassing a wide variety of lesions related to errors in vascular development, remain both diagnostic and treatment challenges to treating physicians. The terminology used to describe and classify vascular anomalies is the key for proper diagnosis and treatment. The classification system established by the International Society for the Study of Vascular Anomalies (ISSVA) is the most widely accepted system which divides congenital vascular anomalies into two groups: (1) vascular tumors such as hemangiomas, and (2) vascular malformations.

RESULTS: The distinction between the two is based on histopathological assessment of increased cell turnover as well as clinical presentation. Vascular tumors, formerly classified as hemangiomas, are true neoplasms with pathologic cell proliferation. These tumors typically exhibit rapid postnatal growth with variable regression (ex NICH, RICH). Vascular malformations are comprised of abnormally formed channels that lack smooth muscle and show normal cell turnover. Vascular malformations are also congenital, but often go unnoticed at birth, never regress,
Abstract No. 1019

Clinical use of a True 3D imaging system to guide intraprocedural decision making in vascular interventional radiology procedures

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1Stanford University School of Medicine, Stanford, CA, 2Brigham & Women’s Hospital, Boston, MA

PURPOSE: By using case examples, the reader will learn about the utility of a True 3D interactive imaging system as it is used in real time to facilitate intraprocedural vascular IR decision-making.

MATERIALS: EchoPixel offers a True 3D, interactive virtual reality imaging system that allows for conversion of image dataset files from an intraprocedural Cone-beam CT or preprocedural CTA/MRA into a True 3D model. This 3D anatomic model is projected onto a 2-Space display system and viewed with stereo glasses. This allows an interventional radiologist to see patient specific vascular anatomy in an open 3D space. The user can then interact with the images by rotating, magnifying, and analyzing a selected anatomic area of interest. The True 3D system was used in the interventional radiology suite at a single institution on 17 patients over a span of 3 months. Selective cases are chosen to highlight the possible benefits of using this new and interactive technology.

RESULTS: True 3D visualization of vascular anatomy during an interventional procedure can be valuable in delineating complex anatomic relationships and guiding treatment. Two case examples are discussed: 1) True 3D imaging reconstructed from intraprocedural cone-beam CT demonstrated useful information regarding the origin of a miniscule vessel feeding a large right hepatic artery branch pseudoaneuysm in a patient with a large volume hemoperitoneum. No definitive vessel source was noted on DSA or preprocedural CTA. 2) True 3D imaging reconstructed from intraprocedural cone-beam CT helped to identify a rare variant of right hepatic artery origin. This imaging facilitated cannulation of the right hepatic artery in a patient undergoing right hepatic artery chemoembolization.

CONCLUSIONS: Interactive intraprocedural True 3D imaging may be a useful tool in defining vascular anatomy, delineating blood supply of neoplasms, and defining sources of extravasation by providing an explicit roadmap to guide treatment planning.

Abstract No. 1020

The promise of augmented virtual reality in interventional radiology

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PURPOSE: Interactive virtual reality (VR) represents the next generation of disruptive imaging technology. In this pictorial report, we illustrate the potential of VR in providing critical information to facilitate endovascular procedures.

MATERIALS: Current imaging technologies acquire volumetric data, but are limited by the flat, two-dimensional (2D) viewing of complex three-dimensional (3D) data. VR allows the operator to manipulate 2D images in an open 3D space, as if it were a real physical object, thus providing unequivocal spatial orientation and transforming the way an operator can visualize and interact with patients’ organs.

RESULTS: In this pictorial presentation, we will illustrate the role of VR in interventional radiology (IR) vis-à-vis three commonly performed procedures, including endovascular repair of visceral aneurysms, transarterial chemoembolization of liver tumors, and transjugular intrahepatic portosystemic shunt (TIPS). Using a VR medical visualization software system, VR images will be reconstructed using preprocedural contrast-enhanced computed tomography (CT), CT angiography (CTA), and intraprocedural cone-beam CT (CBCT).

CONCLUSIONS: In planning for complex endovascular procedures, tortuous vascular anatomy is often difficult to elucidate on 2D imaging. By displaying the information presently buried in 2D display systems, the VR environment presents a unique solution, one that will undoubtedly be valuable in the IR suite.

Abstract No. 1022

Comparison of magnetic resonance imaging and computed tomography for the detection of arterial venous malformations in hemorrhagic telangiectasia: initial results

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1UCLA, Los Angeles, CA

PURPOSE: Screening for AVMs in HHT is predominantly performed using CT, with limited knowledge about the role of MRI. We hypothesize that MR Angiography with Ferumoxytol can serve as an alternative to CT, without exposure to radiation, nephrotoxic contrast agents or gadolinium. In this feasibility study, we compare the technical quality and diagnostic accuracy of Ferumoxytol MR with contrast CT for pulmonary AVM detection.

MATERIALS: Full IRB approval and informed patient consent was obtained. Patients with pulmonary artery AVMs who had prior chest CT within 12 months underwent MRI of the chest and abdomen with Ferumoxytol at 3.0T at a dose of 4 mg/kg. Four independent radiologists reviewed MR and CT images to assess AVM location, AVM site, sac size, feeding artery diameter, draining vein diameter, sites of extra
Cryoablation of breast fibroadenoma 101

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1Hofstra Northwell School of Medicine, Manhasset, NY, 2Zucker School of Medicine at Hofstra/Northwell, Manhasset, NY, 3South Texas Radiology Imaging Centers, San Antonio, TX, 4Hofstra Northwell School of Medicine, Lake Success, NY

PURPOSE: This educational exhibit aims to instruct viewers on how to perform cryoablation of breast fibroadenoma (FA). By the end of the presentation, the learner will understand the technique, pathophysiology, optimal patient selection criteria and treatment efficacy (through a detailed literature review), and postprocedural follow-up related to the procedure.

MATERIALS: FAs are the most common benign breast tumor, occurring in up to 10% of all women. Although benign, FAs may be treated in the setting of pain, symptoms related to tumor size, interval growth, or patient anxiety. Cryoablation is a FDA approved treatment for FA. Cryoablation involves placement of a probe into a lesion to induce cell injury and apoptosis. Cryoprobes utilize the Joule-Thomson effect to create freeze-thaw cycles that result in direct and indirect cellular injury. Studies have shown volume reduction of 87% to 99% at 12 months for FAs measuring up to 4.2 cm, although FAs measuring less than or equal to 2 cm respond the best to treatment. In comparison to surgery, cryoablation can be performed on an outpatient basis with minimal scarring or patient anxiety. Cryoablation is a FDA approved treatment for FA.

RESULTS: Prior to the procedure, percutaneous biopsy should be performed for tissue diagnosis. For large lesions greater than 4.2 cm, the patient should be counseled for incomplete/slow response. For lesions close to the skin surface or pectoralis, saline is injected to create a thermal buffer between the lesion and skin/muscle. Local anesthesia is given. Under ultrasound guidance, the cryoprobe is percutaneously placed into the center of the FA along its longest axis. Two freeze-thaw cycles are used, with the length of the cycle tailored to the size of the lesion to ensure that the iceball envelops the lesion.

CONCLUSIONS: Cryoablation has emerged as a safe and effective alternative to surgery for the treatment of breast fibroadenoma, the most common benign breast tumor. Viewers will receive an up to date primer on performing cryoablation of breast fibroadenoma.

Abstract No. 1024

Microwave ablation: comparison of technologies

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1University of Miami, Miami, FL, 2University of Miami Miller School of Medicine, Miami, FL

PURPOSE: Microwave ablation (MWA) is gaining popularity due to facility of probe placement and speed of ablation. This is a retrospective analysis of MWA of 207 liver lesions in 132 patients using 5 different machines.

MATERIALS: In sequential MWA procedures machines were allocated randomly, including Acculis™ (Angiodynamics) n = 15, AMICA™ (Mermaid Medical) n = 53, MicrothermX™ (BSD Medical) n = 16, Evident™ and Emprint™ (Covidien) n = 63, Certus® (Neuwave) n = 61. MicrothermX™ uses a frequency of 915MHz the remainder 2450MHz. Predicted vs actual ablation size, consistency, complete response rate (CRR) and time to recurrence (TTR) were evaluated for each machine.

RESULTS: All ablations were successfully completed. Emprint overheated twice, AMICA stopped unexpectedly once, all self-limiting. In lesions treated with a single ablation (n = 138) total watts per ablation were lowest with Certus, 61.4 ± 27.5 (range, 30-140, n = 38), highest with Emprint, 96.8 ± 8.3 (range, 65-100, n = 36). Largest ablation zones were achieved with AMICA mean 16.2 ± 8.4 cm2. Larger ablation zones can be created with overlapping zones or multiple probes with Certus or MicrothermX. 70 lesions required overlapping zones (2 n = 54, 3 n = 16) with resultant mean area 17.9 ± 9.0 cm2. 8 ablations used multiple probes with resultant mean area 24.9 ± 18.9 cm2. The difference between predicted and actual ablation zone area was greatest with MicrothermX, mean 52.9 ± 29.5% predicted (range, 18.2-129.5 n = 16) and least with Emprint, mean 87.9 ± 26.4% predicted (range, 29.9-144.7 n = 36). SDev (predictability) was highest with Certus ± 32% n = 38, lowest with Acculis ± 22.7 perhaps due to low n = 9. CRR was highest with Certus 27/30 (90%) and lowest with AMICA 27/39 (69.2%). Lesion size was smallest with Acculis 1.8 ± 1.5 × 1.5 ± 1.1 cm and highest with AMICA 3.1 ± 1.5 × 2.7 ± 1.2 cm. TTR was lowest with MicrothermX 253.0 ± 186.8 n = 4 and highest with AMICA 384.0 ± 410.4 days n = 11. There was no difference in procedure duration, all means between 108-130 minutes.

CONCLUSIONS: MWA is fast, efficacious and safe. Knowledge of different machines can improve clinical outcomes. The promise of larger ablation zones for the treatment of larger lesions still requires additional maneuvers or combination therapy.
Abstract No. 1025

Ultrasound-guided phrenic nerve block for lung biopsy: a single-center experience

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PURPOSE: -Review the relevant anatomy and technique to perform a PNB. -Describe our single-center experience with PNB including complications and outcomes.

MATERIALS: CT-guided lung biopsy can be technically challenging due to diaphragmatic motion. Patient breath holding is often critical but inconsistent. US-guided phrenic nerve block (PNB) prior to biopsy causing reversible paralysis of the ipsilateral hemidiaphragm can limit respiratory motion throughout the case, especially in conjunction with moderate sedation. This can lead to improved outcomes and faster case times. PNB is a technically easy procedure that can be performed quickly and safely prior to lung biopsy. We will discuss the relevant anatomy, anatomic variations, potential complications, and techniques of PNB, along with our single-center experience.

RESULTS: PNB is performed in the CT Biopsy suite. With the patient supine, the neck ipsilateral to the biopsy target is evaluated with ultrasound, and the anterior scalene and sternocleidomastoid muscles are identified approximately 2 cm below the level of the cricoid cartilage. The phrenic nerve can often be identified as a rounded hypoechoic structure between the anterior scalene and sternocleidomastoid. Approximately 1-3 ml of buffered 1% lidocaine is injected adjacent to the nerve or in the expected location of the nerve. CT-guided lung biopsy then proceeds. In our series of 19 patients, there were no complications related to the PNB. Three patients (3/19; 16%) had a small pneumothorax related to the biopsy, none requiring a chest tube. Average nodule size biopsied was 12 mm (range, 6-38 mm), and 15/19 nodules biopsied were in the lower lung fields. There were 18/19 (95%) true positive results and 1 false negative (1/19, 5%) result.

CONCLUSIONS: PNB prior to CT-guided lung biopsy is a safe and technically straightforward tool that can use for technically challenging lung biopsies to limit respiratory motion. Random controlled trials should be pursued to further assess effects on overall case time, radiation dose and post biopsy complications.

Abstract No. 1026

Liquid biopsy in lung cancer: impact on diagnostic imaging and image-guided procedures

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PURPOSE: Review liquid biopsy and its use in lung cancer diagnosis. Discuss the impact on imaging and image-guided procedures in lung cancer.

MATERIALS: Lung cancer remains the leading cause of cancer deaths due to smoking and late stage presentations. Early and more accurate diagnosis can increase survival. Currently, routine clinical and low-dose CT screening is used for identification of suspicious lung lesions warranting biopsy and PET-CT. This allows for early diagnosis, staging, molecular analysis and targeted therapy. Unfortunately, false negative biopsies and PET-CT findings can occur, and some lung lesions are unnameable to biopsy. Research in lung tumor microenvironment has identified specific and unique tumor associated signaling factors and cells that enter the blood from lung cancer. New non-invasive techniques called liquid biopsies can detect these elements, particularly circulating cell-free tumor DNA (cfDNA), once in the bloodstream. This exhibit reviews the use of liquid biopsy in lung cancer and its effect on diagnostic imaging and interventional procedures in the future.

RESULTS: The lung tumor microenvironment has signaling factors and tumor associated cells that enter the blood and reflect disease progression and metastatic potential. Of the known cells and factors, short DNA fragments of cfDNA secreted from normal and/or apoptotic lung cancer cells have shown to be accurate tumor biomarkers in liquid biopsy. Techniques to analyze cfDNA include forms of polymerase chain reaction (PCR) and next generation sequencing (NGS). Recent clinical data showed that a novel cost-effective NGS technique can detect and analyze various stages of lung cancer based on low levels of cfDNA in the blood of patients. This could serve as a non-invasive test for screening, diagnosis, molecular analysis and treatment response in lung cancer. Imaging with CT and PET-CT would still be necessary to localize disease and plan surgical or radiation treatments. CT-guided lung biopsies would likely be reserved for equivocal cases given the potential complications.

CONCLUSIONS: Liquid biopsy using cfDNA can serve as a non-invasive test for early clinical screening, diagnosis, staging and treatment of lung cancer.

Abstract No. 1027

Ultrasound-guided percutaneous lung biopsy

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PURPOSE: Ultrasound (US)-guided lung biopsy is a well-established commonly performed diagnostic procedure. The aim of our study was to evaluate the diagnostic outcomes and safety profile of US-guided lung biopsies.

MATERIALS: We retrospectively reviewed all US-guided lung biopsies performed in our institution over a 2-year period to determine the diagnostic accuracy and complication rates associated with this procedure. All biopsies were performed on an outpatient basis by a single experienced interventional radiologist using a GE Logiq P9 ultrasound machine. Prior to the biopsy all patients underwent thoracic computed
Population-based analysis of percutaneous liver biopsies: complications, utilization, and predictors of outcomes

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Purpose: Percutaneous liver biopsies are important tools for the diagnosis of parenchymal disease and focal liver lesions. Data regarding utilization and outcomes for these procedures are generally limited to retrospective series from high volume centers. The purpose of this study was to establish population-based measurements for percutaneous liver biopsy procedure complications and their risk factors.

Materials: Using administrative data from all inpatient and outpatient hospital encounters in California (2009-2011), patients undergoing percutaneous liver biopsies were identified. The demographic characteristics of this patient cohort as well as risk factors for complications were analyzed.

Results: 37,416 percutaneous liver biopsies were performed in 34,188 patients during the study period. Co-morbidities included alcohol abuse (9.5%), viral hepatitis (28.1%), coagulopathy (5.4%), and obesity (6.4%). Biopsies were performed across 342 hospitals, with yearly procedural volumes ranging from 1 to 524. Of the 19,759 patients who underwent biopsies as outpatients, 342 patients (1.7%) had unscheduled hospital visits within 7 days of the procedure, with a median length of stay of 4 days (range, 0–29 days). Postbiopsy hemorrhage was identified following 2.8% of biopsies, and 1.2% of patients required blood transfusions within 30 days of the biopsy. The all cause 30-day inpatient mortality rate for outpatient biopsies was 0.6%. History of coagulopathy and hypertension were significantly associated with both postbiopsy hemorrhage (OR 1.00 [1.08–1.1] and 1.04 [1.03–1.05], respectively) and 7-day unscheduled hospitalization (OR 1.02 [1.01–1.03] and 1.03 [1.01–1.03], respectively).

Conclusions: Percutaneous liver biopsies are a commonly performed procedure with low complication risks. These population-level estimates should help establish patient and physician expectations as well as societal guidelines for complication rate thresholds.

Implications of the Liver Imaging Reporting and Data System (LI-RADS) 2017 update on loco-regional treatment for hepatocellular carcinoma

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Purpose: • Discuss the relevance of the LI-RADS 2017 update on loco-regional treatment of HCC • Explain the implications of the update on loco-regional treatment decisions for non-treated lesions • Weigh the differences between LI-RADS 2017 and the mRECIST criteria, and the consequences on loco-regional treatment decisions for treated lesions

Materials: LI-RADS is a system used for the assessment and reporting of hepatic lesions in patients at risk of hepatocellular carcinoma. It is updated frequently to reflect accruing evidence and evolving literature. The recently updated CT and MR algorithm and its impact on local-regional treatment for HCC, including salient case examples, is the focus of this exhibit.

Results: Recent updates have been made to the LI-RADS criteria for both non-treated and treated lesions, with various implications. New criteria and expansion of the LR-M category were added, with clarification of peripheral arterial enhancement and emphasis that it should favor a malignancy but is not specific for HCC. A new LR-TIV category replaces LR-5V, highlighting that tumor thrombus is not specific for HCC. Other modifications include the optional use of ancillary features and more clear guidelines on how to apply them, the addition of ultrasound visibility as an ancillary feature, and an adjusted definition of threshold growth, with a new time restriction of under 24 months. These modifications each impact management decisions, including loco-regional treatment. With respect to the implications for treated lesions, there
has been further development of the LR-treated designation and a new 
algorithmic chart which clarifies categorization. Among the modific-
tions, LI-RADS now offers guidance on delineating treatment-related 
changes from suspicious findings of recurrent or residual disease. This 
will further be discussed and compared with mRECIST.

**CONCLUSIONS:** LI-RADS 2017 has added multiple new modifications 
which provide clarity of several decision branches for the categoriza-
tion of non-treated lesions, and addresses the response assessment 
of treated lesions. These modifications affect management decisions, 
in particular, use of loco-regional treatment and outcome assessment.

**Abstract No. 1030**

**Feasibility of 3D ultrasound and ultrasound contrast to 
better quantify and visualize intra-tumoral distribution of 
infused therapeutics (percutaneous ethanol injection): 
a bench-top phantom study**

**D Christensen**, **W Monsky**, **J Stringam**

**PURPOSE:** Percutaneous injection therapies are versatile and cost-ef-
fective with current and future applications. However, therapies such as 
percutaneous ethanol injections (PEI) have a high rate of residual 
and recurrent tumor, limiting efficacy. This may in part be due to the 
inhomogeneous, non-predictable pattern of distribution of the infused 
therapeutic and poor visualization with 2D ultrasound. The purpose of 
the study was to determine if 3D ultrasound (Logic E9 with VNav, GE 
and iU 22 with × 6-1 probe, Philips) could be used to determine volume 
and patterns of distribution when an infusion is mixed with ultrasound 
contrast and infused into tissue using a Bernadino needle and a needle 
with a 3 cm porous shaft (Twin Star Medical).

**MATERIALS:** Bernadino and porous needles were used to inject Lum-
ason ultrasound contrast agent (Bracco) mixed with either 100% ethanol 
or methylene blue into ex vivo porcine muscle. 10 infusions of 5 mL and 
10 mL were performed with each needle at 5 mL/min. 3D ultrasound 
segmentation of the infused demonstrated the volume and pattern of 
distribution. The muscle was then bisected along the needle and the 
ablation zone or methylene blue distribution measured.

**RESULTS:** 3D ultrasound allowed visualization of patterns of infusate dis-
tribution, including linear/ellipsoid with the porous needle and bilobar/
spherical with the Bernadino needle. The differences in volume between 
quantity injected, amount calculated with 3D segmentation of the images, 
and volume of ablation or methylene blue measured on x, y and z planes 
were not statistically significant with the Bernadino needle. (p = 0.14, p = 0.069, p = 0.912). Measurements of the porous needle 
infused volume were significantly different (p = 0.0001). With this needle, 
there was greater tracking along tissue fascial planes making segmenta-
tion-based volumetric and actual measurements more difficult.

**CONCLUSIONS:** The use of 3D ultrasound contrast agent mixed with 
therapeutic allows more comprehensive visualization of tissue and 
infused infusate. 3D injection visualization may improve tumor abla-
tion and limit disease recurrence by ensuring the therapeutic is distrib-
uted across the entire tumor volume at the time of therapy.

**Abstract No. 1031**

**Thermoembolization, a fundamentally new and powerful 
direction in locoregional oncologic therapy: first results 
from an in vivo swine model**

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**PURPOSE:** To assess in vivo feasibility of thermoembolization, a new transarterial technique, using a swine model.

**MATERIALS:** 10 outbred swine of 40-50 kg were divided into two groups, 
control (n = 5) and experimental (n = 5). Experiments were conducted 
using 1 mL of ethiodized oil as a control embolic agent or 400 µL of ther-
moembolic agent, dichloroacetyl chloride, 2 mol/L dissolved in ethio-
dized oil, delivered between 100 µL, ethiodized oil leading and 500 
µL trailing, in a segmental branch of the hepatic artery under fluoroscopic 
guidance. At 24 h postprocedure, animals were anesthetized for a non-
contrast CT scan followed by euthanasia and necropsy. Tissue samples 
were obtained for histology and mass spectrometry imaging.

**RESULTS:** Stasis occurred within seconds of treatment in the exper-
imental group and this persisted over 24 h whereas it was not reached 
in the control group. On post treatment CT, the control group gener-
ally showed diffuse attenuation throughout the treated segment of the 
artery, whereas in the experimental group the thermoembolic material 
was detected primarily in the precapillary vessels. At necropsy small 
punctate areas were observed on the liver capsule of the experimental 
group. Histologically, necrosis in the control group was not identified 
whereas in the experimental group coagulation necrosis was evident, 
frequently reaching several hundred microns from the vessels. Pres-
ence of the reaction product matching the vascular distribution was 
confirmed on mass spectrometry imaging by the presence of a peak at 
m/z 126 corresponding to the dichloroacetate molecule.

**CONCLUSIONS:** Early studies in thermoembolization are extremely promising. Coagulation extending several hundred microns from the 
treated vessel with such a small amount of material (0.8 mmol) war-
rants further investigation of the new method. Delivery must be opti-
imized and application in a tumor model will be reported in due course.

**Abstract No. 1032**

**Improved drug targeting to liver tumors following 
 intraarterial delivery using ferumoxytol and Lipiodol: 
preclinical study in a rabbit liver tumor model**


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**PURPOSE:** Ferumoxytol, an ultrasmall superparamagnetic iron oxide 
(USPIO) approved by the FDA as an iron replacement therapy has been
extensively investigated as an intravenous MR contrast agent in recent clinical practice. Based on its natural characteristics as a nanoparticle, we evaluated the feasibility of a novel drug delivery system combining Ferumoxytrol and Lipiodol to improve the selective intraarterial (IA) drug delivery to an experimentally induced hepatic tumor.

**MATERIALS:** This animal study was approved by our Institutional Animal Care and Use Committee. Fourteen NZW rabbits with VX2 liver tumors were treated with IA injection of four different agents through the hepatic artery: doxorubicin alone (group A, n = 3), doxorubicin/Lipiodol (group B, n = 3), doxorubicin/Ferumoxytrol (group C, n = 4), and doxorubicin/Ferumoxytrol/Lipiodol (group D, n = 4). In all animals, T2-weighted MR scans were performed just before and 7 days after TACE to confirm Ferumoxytrol retention in the tumors, and CT scans were added in group B and D immediately after TACE to confirm intratumoral Lipiodol retention. Serum liver transaminases were measured to evaluate acute liver injury. All the animals were euthanized at day 7 post-TACE for evaluating tumor viability by pathological examination.

**RESULTS:** The proportion of viable tumor cells were 65.3% in group A, 7.9% in group B, 29.2% in group C, and 2% in group D, which showed a significantly better therapeutic efficacy than any other group (the p-values were less than 0.05 by Mann-Whitney test). Though the peak serum transaminases levels were markedly elevated in all groups at early phase post-TACE, they were rapidly normalized in 7 days after TACE. All animals survived over the follow-up period without mortality.

**CONCLUSIONS:** The drug delivery system developed using Ferumoxytrol and Lipiodol showed better drug targeting and therapeutic effect when it is used for IA delivery to liver cancer. As Ferumoxytrol has been already approved for IV administration by FDA, this promising result warrants further investigation for potential clinical use in TACE.

**Abstract No. 1033**

**Antitumor effect of intraarterial delivery of doxorubicin-albumin nanoparticle loaded lipid microbubbles combined with ultrasound-targeted microbubble activation on VX2 rabbit liver tumor model**

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**PURPOSE:** To explore antitumor effect of intraarterial (IA) delivery of doxorubicin-albumin nanoparticle loaded lipid microbubbles combined with ultrasound-targeted microbubble activation (DMB/US) in rabbit VX2 liver tumor model.

**MATERIALS:** With institutional Animal Care and Use Committee approval, 25 rabbits bearing VX2 liver tumors were divided into 5 groups: IA DMB/US (group A, n = 6), Intravenous DMB/US (group B, n = 6), IA bland MB/US (group C, n = 5), IA doxorubicin/US (group D, n = 5), and Untreated control (Group E, n = 5). The delivered doxorubicin dose in group A, B, and D was the same as 1 mg. To assess tumor volume, volume inhibition rate (VIR), and Apparent diffusion coefficients (ADC) value, magnetic resonance image was performed at baseline and day-7 after the delivery. After the completion of follow-up imaging, pathological specimen was obtained to assess estimated viable tumor volume.

**RESULTS:** Group A showed the lowest mean tumor volume and the highest VIR at day-7 after delivery among the all groups (p < 0.05). ADC values in group A and B were significantly increased after the delivery (p < 0.05). The estimated viable tumor volumes were 433.47 mm³ for group A, 1010.52 mm³ for group B, 2451.12 mm³ for group C, 2004.86 mm³ for group D, and 2269.13 mm³ for group E.

**CONCLUSIONS:** The novel drug-delivery system developed using doxorubicin-albumin nanoparticle loaded lipid microbubble with activation of microbubble by clinical US probe can result in better antitumor effect when it is used for IA delivery to liver cancer. The results of this study warrant further investigation of this potential clinical treatment of advanced liver cancer.

**Abstract No. 1034**

**Intra- and extrahepatic collaterals: what you need to know for locoregional therapy**

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**PURPOSE:** To review common intra and extrahepatic collateral pathways that may be present or develop in candidates for intraarterial therapy with transhepatic arterial chemoembolization (TACE) or Yttrium-90 (Y90) radioembolization.

**MATERIALS:** Intra-arterial interventions such as TACE and Y90 are increasingly being performed for both primary and metastatic hepatic tumors. Patients who undergo TACE/Y90 with large tumors or multiple rounds of treatment may develop extrahepatic collateral supply, which can result in treatment failure. Collateral vessels arising from the hepatic arteries can also supply extrahepatic organs in the gastrointestinal tract resulting in ulceration. We review common collateral pathways, and describe identification strategies, treatment regimens and risk profile based on location.

**RESULTS:** Common collateral pathways include the inferior phrenic, internal mammary, intercostal, accessory gastric, and falciform artery. Additionally, we will review intrahepatic collateral cases from the right/left hepatic artery watershed region, cases sharing flow from native and accessory hepatic branches. Less common scenarios will be reviewed as well. In each case description, the angiographic findings of the collateral pathway and treatment course are highlighted along with posttreatment complications when present.

**CONCLUSIONS:** When unidentified, collateral pathways can result in treatment failure or avoidable toxicity. Understanding these common scenarios can improve identification and clinical outcomes while limiting risk.
Abstract No. 1035

DAXX mutation is an independent predictor of hepatic progression free survival after transarterial embolization of neuroendocrine liver metastases

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PURPOSE: To determine the prognostic value of DAXX mutation status and hepatic progression free survival (HPFS) after transarterial artery embolization (TAE) of neuroendocrine liver metastases (NLM).

MATERIALS: This is an Institutional Review Board approved single-institution study and included consecutive patients with NLM treated with TAE between 2014-2017. Patients with biopsies from other sites or no mutation analysis, or analysis performed > 1 year prior to TAE were excluded. Biopsy specimens underwent genetic analysis using an institutional multi-gene assay. Patient and tumor data were collected including prior treatment, tumor grade, primary site, tumor burden, functional status to identify confounders. Hepatic progression free survival was performed measured from the time of TAE to first evidence of hepatic progression on follow-up imaging or death. HPFS was estimated using Kaplan-Meier method. Cox regression was used to assess effect of covariates and multivariate analysis was performed using backward selection with cutoff of p<0.1 to select predictors.

RESULTS: Exclusions. The median time between biopsy and TAE was 0.4 months (range, 0 to 11.8 months). There were 10/47 (21%) patients with DAXX mutation. Liver tumor burden was defined as <25% (n = 15, 32%), 25-50% (n = 16, 34%), or greater than 50% (n = 16, 34%). There were 11 (23%) grade 1, 22 (47%) grade 2, and 14 (30%) grade 3 tumors. There were 19/47 (40%) patients with pancreatic primary. DAXX mutation was associated with shorter HPFS (hazard ratio [HR] = 9.03, p = 3.2 × 10^-5, confidence interval [CI] = 3.20-25.46). The median HPFS was 277 and 106 days in DAXX wild type and DAXX mutant patients, respectively (p<0.001). Grade (HR = 3.29, p = 6.4 × 10^-4, CI = 1.66-6.53) was also associated with shorter HPFS. Tumor type (HR = 2.06, p = 0.052, CI = 0.99-4.25) and MEN1 mutation status (HR = 1.94, p = 0.095, CI = 0.89-4.23) were marginally associated shorter HPFS. On multivariate analysis only DAXX mutation status (HR = 6.56, p = 0.028, CI = 1.22-35.18) and tumor grade (HR = 2.18, p = 0.041, CI = 1.03-4.59) were significant predictors of HPFS.

CONCLUSIONS: This study demonstrates that DAXX mutation in NLM patients undergoing TAE is an independent predictor of HPFS.

Abstract No. 1036

Assisted needle guidance using smart see-through glasses

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PURPOSE: Accurate needle placement largely depends on physicians’ visuospatial skills in CT-guided interventions. To reduce the reliance on operator experience and to enhance accuracy, we developed an augmented reality (AR) system using smart see-through glasses to facilitate and assist bedside needle angle guidance.

MATERIALS: The AR system was developed using Unity and VuforiaTM SDK. It displays the planned needle angle on the ODG R-7 (Osterhout Design Group, San Francisco, CA) smart glasses’ see-through screens in real-time based on the glasses orientation. The displayed angle is always referenced to the CT table and independent from the physical orientation of the glasses. The see-through feature allows the operator to compare the actual needle and the planned needle angle continuously. The glasses’ orientation was tracked by its built-in gyroscope. The offset between the embedded gyroscope and the glasses’ display frame was precalibrated. A quick one-touch calibration method between the glasses and CT frame was implemented. Hardware accuracy and guidance accuracy was evaluated using commercial multi-modality interventional anthropomorphic phantoms (CIRS, Norfolk, VA).

RESULTS: In the first test, an 18-G biopsy needle was inserted in the phantom and scanned with CT. The measured angle in the CT scan was set on the glasses. We took a snapshot from the lens and compared the needle vector and guideline in the saved snapshot. The hardware accuracy was within 0.98 ± 0.85 degree for ten trials. In the second test, a planned needle angle from CT was set on smart glasses’ screens. Users inserted the needle guided by the smart glasses. After each insertion trial, a CT scan was acquired and the inserted needle’s angle was compared with the planned angle in CT images. The accuracy of the guidance was within 1.33 ± 0.73 degree for ten trials.

CONCLUSIONS: Smart glasses can provide accurate guidance for needle-based interventions with minimal disturbance of the standard clinical workflow.

Abstract No. 1037

Pretreatment imaging of patients undergoing Yttrium-90 radioembolization: what to look for

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PURPOSE: 1. Review important and relevant findings on cross-sectional, nuclear medicine and corresponding angiographic imaging findings in patients undergoing planning for Yttrium-90 (Y-90) radioembolization of hepatic tumors. 2. Recognize imaging findings predictive of an elevated lung shunt fraction (LSF). 3. Understand the importance of these imaging findings to risk-stratify patients and guide treatment.

MATERIALS: Liver tumor response to Y-90 therapy depends on multiple factors including tumor type, tumor vascularity, and LSF. In addition to quantifying lesion size, location, and radiation dosimetry, pretreatment cross-sectional imaging can be used to predict elevated LSF. Elevated LSF increases the risk of nontarget lung irradiation and radiation pneumonitis, and reduced delivery of effective radiation dose results in decreased progression-free and overall survival.
RESULTS: - Describe CT and MRI findings predictive of elevated LSF, including early hepatic vein opacification, hepatic vein tumor thrombus or occlusion, and tumor hypervascularity. - Demonstrate normal pattern of uptake on planar and SPECT/CT Tc-99m MAA scintigraphy. - Review patterns suggesting the presence of lung, GI, or other extra-hepatic activity. - Review methods to calculate LSF with Tc-99m MAA scintigraphy using geometric means (GM) obtained by drawing regions of interest around the liver and both lungs. LSF = GMLung/(GMLung + GMliver). - Correlate DSA images of tumor type, vascular patterns and shunting with cross-sectional and nuclear medicine images. - Illustrate embolization of extra-hepatic vascular supply prior to Y-90 treatment.

CONCLUSIONS: 1. Y-90 radioembolization requires appropriate planning and evaluation of LSF. 2. Radiologists should be aware of cross-sectional imaging findings that predict elevated LSF. 3. Hepatic arterial injection of Tc-99m MAA followed by nuclear scintigraphy confirms the presence of extra-hepatic pulmonary or GI shunting. 4. LSF greater than 20% is often a contraindication to Y-90 therapy. 5. Aberrant vessels and/or extra-hepatic vascular supply to suspected GI shunts should be emoblized to minimize risk of reflux.

Abstract No. 1039

Increased Y-90 microspheres delivery to hepatocellular carcinoma and less collateral damage of the hepatic parenchyma using selective Gelfoam embolization

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PURPOSE: Present a novel technique to spare liver parenchyma and increase target dose to hepatic tumors during TARE-Y90.

MATERIALS: Transarterial radioembolization using Y-90 (TARE-Y90) technique involves intraarterial delivery of microspheres to treat liver tumors. The microcatheter positioning may occasionally treat tumors through proximal hepatic arteries that also include distal arterial branches that supply uninvolved liver tissue. In some situations, it is not possible to avoid nontargeted delivery of Y-90 microspheres to the uninvolved liver tissue. We describe Gelfoam embolization of distal non-tumor arterial branches to spare exposure of liver parenchyma to radioembolization and increase target dose to the proximal arterial tumor branches.

RESULTS: A single-institution review from January 2015 to September 2017 were analyzed retrospectively. A total of 143 patients with hepatocellular carcinoma who underwent TARE-Y90 were reviewed. 4 patients were identified where a pretreatment arteriogram was performed that showed distal non-tumor arterial branches with multiple proximal tumor branches. On the day of TARE-Y90, arterial branches distal to the tumor were temporarily embolized with Gelfoam prior to TARE-Y90 to reduce the entry of Y90 microspheres to uninvolved liver tissue. Analysis of SPECT/CT was used to compare the volume of liver 99m Technetium macroaggregated albumin (MAA) uptake to the volume of Y90 microsphere uptake. All cases demonstrated no significant uptake in the non-tumor liver cells and increased dose to the tumor as compared to prior Technetium MAA scans. The mean percentage of the treated liver volume that was spared from Y90 exposure was 64%. No complications occurred. 1 patient demonstrated 100% tumor necrosis after transplant and 1 patient demonstrated 75% tumor necrosis on 1-month follow-up CT. The other 2 cases have not had their follow-up imaging yet. There was no reflux of Gelfoam into the proximal hepatic arterial tumor branches.

CONCLUSIONS: Gelfoam embolization of distal non-tumor arterial branches in combination with TARE-Y90 is a promising technique to spare liver parenchyma exposure to Y90 microspheres and increase delivery of Y90 microspheres to tumor.

<table>
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Abstract No. 1039

Same-day Y-90 radioembolization: clinical, logistic, and financial considerations

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PURPOSE: To discuss clinical, logistic, and financial considerations of performing single versus multi-session Y-90 radioembolization.

MATERIALS: While performing single-session Y-90 radioembolization enhances central IR tenets such as increased patient access, multi-specialty collaboration, decreased time-to-treatment, and improved overall patient care. Our experience at a large academic center can delineate some of the clinical, logistic, and financial considerations of offering this therapy. While all hospitals may not be able to offer this procedure, we hope to delineate the workflow, discuss our clinical experience, and describe the economic pitfalls to this clinical offering for more widespread consideration.

RESULTS: Clinical considerations: Some biologically aggressive tumors are better served by single-session treatments versus the inbuilt delay of a multi-session approach, due to rapidity of progression. Logistic considerations: To support this offering, a center would need to have a nuclear medicine and an IR department in close proximity (ideally within one building), where a patient can be transferred between the two rooms/departments after a single stick and not need multiple sticks, which would be equivalent to a multi-session in terms of patient experience. Financial Considerations: Due to Medicare/CMS rules, a facility cannot bill for both components (two episodes) of this procedure if performed in a single setting. To this end, it is best to bill for the dose administration (CPT-36246, 36247). Additional reimbursement can be obtained if coiling of any vessels
in the treatment path is necessary; however, revenue will be lost on the additional components such initial percutaneous access, vessel selection, and closure (if used). Additional considerations: Reduced patient cost (one trip instead of two), and increased patient satisfaction. Financial cost of possible room idle time between mapping and treatment, whether the patient travels to NM or gets a portable scan in the room.

**CONCLUSIONS:** Our experience at an academic center has shown that there are very specific clinical, workflow, and financial considerations to take into account before widespread adoption.

**Abstract No. 1040**

**99 percentiles: evaluation and optimization of the prognostic utility of the lymphocyte-to-monocyte ratio in patients with hepatocellular carcinoma treated with radioembolization**

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**PURPOSE:** To evaluate and optimize the prognostic utility of the lymphocyte-to-monocyte ratio (LMR) in patients with hepatic cell carcinoma (HCC) treated with radioembolization (RE).

**MATERIALS:** From 1/2010 to 1/2016, a total of 501 patients with HCC underwent treatment with RE, of whom 398 patients (age: 65.9 ± 9.9 years, female: 21.1%) had recent pretreatment calculable LMR. The median (IQR) LMR for the cohort was 1.8 (1.2-2.4). The LMR predicted OS in the prediction of overall survival (OS) was then calculated separately in single percentile increments from 1 to 99. The optimal predictive percentile cutoff for the LMR was determined to be the lowest of the 99 p-values generated after correcting for multiple comparisons using the Bonferroni method. After determining this optimized LMR percentile cutoff, the technique of propensity score matching (PSM) was employed to match patients in the upper and lower percentile groups in a 1:1 ratio at this optimized percentile cutoff.

**RESULTS:** The median (IQR) LMR for the cohort was 1.8 (1.2-2.4). The median (95% CI) OS across the cohort was 14.8 (13.0-16.6) months. Of the 99 LMR percentile cutoffs, 83 (83.8%) were found to be significant predictors of OS. Thirty (30.3%) remained significant predictors of OS after correcting for multiple comparisons. The LMR predicted OS with the greatest significance at the 60% threshold (LMR ≥2.8, HR: 0.55, 95% CI: 0.42-0.73, p<0.001). Matching in a 1:1 ratio yielded two well-balanced groups of 145 patients. The post-PSM OS was again seen to be more favorable in patients with an LMR ≥2.8 (HR: 0.28, 95% CI: 0.11-0.72, p = 0.008). Multivariate analysis demonstrated improved OS in the following subgroups: ECOG 0 (p = 0.001), ALBI grade 1 (p<0.001), unilobar tumor distribution (p = 0.002), absence of portal vascular invasion (p<0.001), absence of metastasis (p = 0.04), AFP ≤400 (p = 0.003), and LMR ≥2.8 (p = 0.003).

**CONCLUSIONS:** The LMR appears to have prognostic utility in patients with HCC treated with RE with a 60-percentile cutoff appearing optimal in this cohort. This finding lends credence to the idea that inflammatory markers, in addition to liver function and tumor burden, may be of interest in the clinical management of patients with HCC undergoing treatment with RE.

**Abstract No. 1041**

**Response analysis of advanced HCC treated with Y90 measured by RECIST, mRECIST, and WHO criteria**

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**PURPOSE:** We present 9-year experience of a single-center practice of treatment response after Y90 radioembolization in patients with advanced HCC measured by RECIST, mRECIST and WHO criteria.

**MATERIALS:** Retrospective analysis of all patients treated with Y90 TheraSphere for advanced HCC was done from 2008 to 2016 at Detroit Medical Center. Of 96 patients 70 had data available for calculating the response at any time point from the first month follow-up after the treatment through the 24th month. The response to the Y90 treatment was calculated by using RECIST, mRECIST and WHO criteria. The data analysis was performed using SPSS software package with Chi-Square and Fisher exact tests.

**RESULTS:** Of 70 patients with HCC undergoing treatment with Y90 TheraSphere embolization, partial or complete response was noted in 25 (35.7%) by RECIST, in 29 (41.4%) by mRECIST, and 10 (14.3%) by WHO criteria. Each method demonstrated a statistically significant difference from the others (p = 0.015 for RECIST vs mRECIST, p < 0.001 for RECIST vs WHO, and p = 0.014 for mRECIST vs WHO). Progression was noted in 19 cases (27.1%) by RECIST, 15 (21.4%) by mRECIST, and 12 (17.1%) by WHO criteria. The difference in measuring the progression was statistically significant between RECIST, mRECIST, and WHO criteria (p < 0.001 criteria). 21 patients were stage B, 48 were stage C, and 1 was stage D according to Barcelona Clinic Liver Cancer staging (BCLC). Barcelona score showed no significant relation with tumor response when measured with RECIST (p = 0.831), mRECIST (p = 0.064) or WHO (p = 0.438) criteria. History of Sorafenib chemotherapy did not demonstrate a significant relationship with response measured by any of the three methods. 52 patients (74.3%) were male and 18 (25.3%) were female. The mean age of the patients at diagnosis was 63.7 ± 8.0 years. The mean tumor burden was 30.6% with a standard deviation of 22.9.

**CONCLUSIONS:** Our study shows clinical benefit of Y90 treatment in advanced HCC comparable to data available in literature. It is useful to realize that response rates may vary depending on the criteria being used. In our study it ranged between 14.3% (WHO) and 41.4% (mRECIST).
Abstract No. 1042

Radioembolization and peptide receptor radionuclide therapy as treatment of metastatic neuroendocrine tumor to the liver

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PURPOSE: To determine long-term safety and efficacy of combined treatment of 90Y glass microsphere radioembolization (RE) with peptide receptor radionuclide therapy (PRRT) in patients being treated for metastatic neuroendocrine tumor (mNET) to the liver.

MATERIALS: A single-institution retrospective analysis from 1995 to 2017 was performed for patients with mNET. Patients with mNET to the liver who received either PRRT alone, RE alone or both PRRT + RE combined treatment were included. Eighty-four patients were identified and then stratified into treatment groups PRRT alone (n = 30), RE alone (n = 38), or PRRT + RE combined (n = 13), excluding patients who had received TACE or MIBG treatments. Kaplan-Meier survival curves were plotted from time of diagnosis and from time of 1st treatment. Mean survival from time of 1st treatment was then calculated and then pairs compared to each other using T-test analysis.

RESULTS: The most common primary mNET sites were small bowel (48 of 81), pancreas (12 of 81), rectum (11 of 81), lung (4 of 81), or unknown (6 of 81). The 5-year Kaplan-Meier survival rate for the entire cohort (n = 81) from time of diagnosis was 77.9% and the 10 year survival rate was 42.4%. The 5-year survival rate from time of 1st treatment for the entire cohort was 39.7% with 0% living past 5 years post 1st treatment date. Five-year survival rates for PRRT alone was 28.4% with a mean survival of 61.8 months, for RE alone was 48.2% with a mean survival of 40.3 months and for PRRT and RE combined was 41.5% with a mean survival of 49.6 months. T-test analysis showed a statistically significant (p = 0.036) increase of 21 months survival on average from date of 1st treatment with combined PRRT + RE over PRRT alone, and a statistically insignificant (p = .251) increase of 12.2 months when compared with RE treatment alone. PRRT treatment alone and RE treatment alone showed no difference in average length of survival from date of 1st treatment when compared to each other.

CONCLUSIONS: There is limited data in literature for combined PRRT and RE treatment for mNET due to the rare nature of NETs. Our data, although small in sample, size adds to this growing body of work. Our findings suggest that patients undergoing additional interventions. There were no reported complications.

Abstract No. 1043

Transvaginal pelvic interventions: a road less traveled

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PURPOSE: To determine the safety and efficacy of ultrasound-guided transvaginal procedures in female patients with pelvic pathologies.

MATERIALS: A retrospective review of consecutive female patients with pelvic pathologies undergoing ultrasound-guided transvaginal pelvic aspiration, drain placement or biopsy between August 2013 and August 2017 was performed. Patient characteristics, imaging and pathology results, and follow-up clinic notes were reviewed. Technical success was defined as the ability to perform an aspiration, collect samples for biopsy or place a drain. Clinical success was defined as a diagnostic pathology sample from a biopsy or resolution of symptoms related to the indication for aspiration/drain without the need for additional interventions.

RESULTS: A total 25 patients were included; median age was 47 range, 23-74). The most common presenting pelvic pathologies for aspiration/drain placement were tubo-ovarian abscess and pyosalpinx whereas a pelvic mass in the setting of known primary malignancy was the primary indication for biopsy. Of the 25 patients, 11 underwent biopsies, 13 underwent aspirations, and one patient underwent drain placement. The overall technical success rate was 96% (24/25). Of the biopsies, 10/11 (91%) were technically successful and all were diagnostic on pathology. All 13 aspirations were technically successful. Of these 13 patients, two required additional drain placement due to re-accumulation and one underwent surgical management. The remaining one patient underwent successful drain placement without additional interventions. There were no reported complications.

CONCLUSIONS: Ultrasound-guided transvaginal procedures are a safe and effective option for the management of pelvic pathologies. This approach may be an alternative to the more frequently utilized transluminal approach which is often more painful and requires CT guidance with resultant radiation exposure.

Abstract No. 1044

Retrospective evaluation of Denver shunts: outcomes, complications, and effect of revisions and repairs

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PURPOSE: Published studies show a variance in the complication rate with Denver Shunts ranging from 6% to over 20%. Peritoneal lavage and/or revision and repair are thought to extend the utility of the shunts. To independently evaluate these prior reports, we performed a retrospective review of all Denver Shunt procedures performed at our institution.

MATERIALS: Review of imaging and medical charts was performed for all Denver Shunt cases and other associated interventions performed by Radiology at a large academic institution from 2012 to 2017. Patient demographics, diagnosis/indication, fluoroscopy time, labs, technique used (concurrent paracentesis and/or lavage), subsequent shunt-related interventions and associated indications were reviewed.
RESULTS: A total of 55 patients had Denver Shunts performed upon them (49% male; average age 61). The average preprocedure platelets were 187. Paracentesis and peritoneal lavage was performed in 71% and 27% of the cases. The mean postprocedure platelets were 92, representing an average of 48% drop in the preprocedure platelet level. Of those patients tracked, the average long-term platelet returned to or above the preprocedure platelet level. Of the 55 patients, 30 of the patients had some subsequent interventions (55%) with the first intervention occurring at an average of 125 days after the placement. Thirteen (24%) of the Denver Shunts were ultimately removed. Seventeen (31%) had interventions of the Denver Shunt without removal of the shunt. The vast majority of interventions were for non-functioning Denver Shunts. Only a small fraction of the interventions were for infection (5%) or disseminated intravascular coagulation (DIC, 5%).

CONCLUSIONS: In our series performed at a large academic center, the majority of Denver Shunts placed required a subsequent intervention, often for non-functioning, and about a quarter were removed. Only a small fraction of shunts were treated for infection or DIC. Almost one-third of Denver Shunts could be intervened upon without their removal.

Abstract No. 1045

Diagnosis in biliary tissue sampling: how well do we do?
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PURPOSE: Biliary tissue sampling is usually performed by obtaining duct brushings or fine needle aspirate for cytologic analysis. Brushings are sometimes indeterminate or inaccurate in the diagnosis of biliary tract pathology. Endobiliary shave biopsy using an atherectomy device has been utilized in some centers. Shave biopsy provides tissue for histologic analysis and may provide more definitive diagnosis. While initial cost is higher than brushings, it may lead to fewer repeat procedures for diagnosis. The purpose of this study is to analyze pathology data from biliary sampling procedures performed at our institution to assess whether shave biopsy is an effective method of initial biliary tract sampling.

MATERIALS: Appropriate IRB approval was obtained. We retrospectively reviewed all pathologic specimens performed for biliary sampling data collected at our institution between September 1994 and April 2017. 574 specimens from 420 different patients were analyzed.

RESULTS: Sixty-four (18%) brushings were classified as atypical, but no repeat sampling was performed for definitive diagnosis. Fifty-six (9.8%) patients underwent repeat intervention for diagnosis, with a maximum of 5 repeat procedures in one patient. Seven patients undergoing brushings/FNA had false negative results, with positive malignancy on surgical pathology. An additional 5 were classified as “atypical” on brushings, but subsequently had surgically proven malignancy. Twelve specimens were obtained using shave biopsy. Four of 12 yielded a diagnosis of malignancy, three of which had previously negative or non-diagnostic brushings. The remainder were negative for malignancy, and none were classified as non-diagnostic. There were no false positive results for either sampling method.

CONCLUSIONS: The data suggests bile duct brushings are a suboptimal method of determining bile duct pathology. Shave biopsy may decrease or eliminate the need for repeat intervention in appropriately selected patients, thereby decreasing time to diagnosis, patient anxiety, and cost. A cost analysis is warranted, and further analysis may reveal the appropriate patient population for the primary use of this technique.

Abstract No. 1046

Description of technique and initial feasibility of fully percutaneous, image-guided cholecysto-enteric anastomosis using a lumen apposing stent
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PURPOSE: Internal gallbladder drainage via endoscopic ultrasound-guided placement of a lumen apposing stent is gaining rapid popularity as a therapeutic option in high-risk patients with acute cholecystitis. As opposed to percutaneous cholecystostomy with external catheter placement, internal drainage may be more desirable to patients. The purpose of this study is to describe an image-guided, fully percutaneous technique for internal gallbladder drainage using a fully covered lumen apposing stent, and to assess its initial feasibility and safety in a porcine model.

MATERIALS: Procedures were performed on four, 30kg female white pigs under general anaesthesia and endotracheal intubation. A percutaneous transhepatic puncture under ultrasound and fluoroscopic guidance was performed through-and-through the gallbladder and into the stomach. After accessing the stomach, a guide-wire was placed over which a 12Fr sheath was advanced with its tip placed in the stomach. A 10-mm lumen apposing stent (AXIOS, Boston Scientific, Marlborough, MA) was delivered through the sheath and the distal flange was deployed in the gastric lumen under fluoroscopic and ultrasound guidance. The sheath was pulled back and the proximal flange deployed in the gallbladder. Contrast was injected to confirm placement and evaluate for leakage. The cholecysto-enteric anastomosis was examined by endoscopy, laparoscopy, followed by necropsy.

RESULTS: Technical success was 100% (4/4). Procedure times progressively decreased with experience and minor improvements in technique. Procedure times were 43, 27, 21 and 18 minutes. Contrast injection demonstrated free flow through the stent with no cholecysto-enteric anastomotic leakage. On necropsy, appropriate stent position was confirmed with good apposition of the gallbladder and stomach, without injury to surrounding structures.

CONCLUSIONS: Image-guided, fully percutaneous internal gallbladder drainage via a lumen apposing stent is feasible in a porcine model, and
may be an attractive alternative to both endoscopic ultrasound-guided stent placement or external cholecystostomy tube drainage. Further animal survival studies are planned both to refine the technique, and study periprocedural outcomes.

Abstract No. 1047

The efficacy of percutaneous intraductal radiofrequency ablation followed by dual stent placement for malignant biliary hilar obstruction

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PURPOSE: To evaluate the clinical efficacy of percutaneous intraductal radiofrequency ablation (RFA) followed by dual stent placement for advanced malignant biliary hilar obstruction.

MATERIALS: Between September 2013 and August 2015, ten patients with malignant biliary hilar obstruction who underwent percutaneous intraductal RFA followed by dual stent placement were included in this retrospective study. The technical success, clinical success, procedure-related complications, stent patency, and survival duration after treatment were investigated.

RESULTS: Percutaneous intraductal RFA followed by dual stent placement was successful in all patients; the technical success rate was 100%. There were no major complications identified. After procedure, serum total bilirubin levels were notably normalized, therefore percutaneous transhepatic biliary drainage (PTBD) catheter was removed successfully in 8 patients, the clinical success rate was 80%. Four patients with stent dysfunction associated with tumor ingrowth/overgrowth underwent repeat procedure of PTBD or secondary stent insertion. Mean stent patency and survival duration were 233.8 ± 35.6 days (95% confidence interval (CI), 164.0–303.5 days) and 387.2 ± 114.6 days (95% CI, 162.6–611.8 days), respectively.

CONCLUSIONS: Percutaneous intraductal RFA combined with dual stent placement for advanced malignant biliary hilar obstruction is a safe and feasible palliative treatment option.

Abstract No. 1048

Thoracic duct embolization techniques

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PURPOSE: 1. To illustrate a variety of techniques used to access the lymphatic system to perform thoracic duct embolization (TDE) through the presentation of a series of cases 2. To review the risks, outcomes and complications of TDE

MATERIALS: Thoracic duct disruption may lead to chylothorax, chylous ascites or plastic bronchitis. Conservative treatment of tube drainage and total parenteral nutrition is successful in 16-75% (1). Failed conservative treatment has historically been treated via surgical ligation, pleurodesis/pleurectomy or pleuroperitoneal shunt creation. TDE is a minimally invasive alternative to thoracic duct ligation for the treatment of lymphatic leaks.

RESULTS: We present a series of cases to illustrate three methods of lymphatic access used in TDE: 1) ultrasound-guided nodal contrast injection with cisterna chyli opacification and subsequent percutaneous transabdominal access to the cisterna chyli, 2) direct ultrasound-guided transcervical thoracic duct puncture, and 3) percutaneous transvenous retrograde access at the junction of the thoracic duct with the left internal jugular vein. We will show pediatric and adult cases of varied etiologies and cases which required more than 1 attempt for successful TDE. Presented cases will include a 49-year-old male with HIV and Kaposi’s sarcoma with extensive lymphadenopathy and involvement of the mediastinum and lungs, leading to recalcitrant chylothoraces and a 39-year-old male with congestive heart failure secondary to Adriamycin induced cardiomyopathy, presenting with plastic bronchitis. Finally, we will discuss the risks, outcomes and complications of TDE.

CONCLUSIONS: Thoracic duct embolization is a technically challenging but safe and effective treatment for chylos leaks and plastic bronchitis. Knowledge of different approaches for thoracic duct/lymphatic access may increase success in performing this historically challenging procedure.

Abstract No. 1049

Comparison of interstitial transpedal magnetic resonance lymphangiography and conventional lymphangiography for the diagnosis of traumatic lymphatic leakages

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PURPOSE: To compare the diagnostic yield of interstitial transpedal MR-lymphangiography (tMRL) and conventional lymphangiography (cL) in traumatic lymphatic leakages.

MATERIALS: 15 patients with chylous effusions (m/f:9/6; mean age 59 years) referred for lymphatic intervention due to traumatic leakages underwent preinterventional tMRL at 1.5T with interstitial pedal injection of a gadolinium contrast agent and intranalonal cL with ethiodized oil. cL was performed under general anesthesia. For tMRL conscious sedation was necessary in only one case. Indications for intervention were: chylothorax n = 10, chylascites n = 5. Contrast-enhanced images were independently evaluated regarding depiction of major anatomical structures (retroperitoneal lymphatics, cisterna chyli, thoracic duct [TD]) [i.e., technical success], detection of leakage, a possible access site for lymphatic intervention and anatomical variations by a blinded radiologist. Detection rates were compared between both modalities.

RESULTS: All cL and tMRL examinations were well tolerated without complications. All cL and 13/15 tMRL were technically successful. In two tMRL contrast did not ascend above pelvic lymphatics. Retroperitoneal lymphatics were visible on all cL and 13/15 tMRL. A cisterna chyli
was detected in 9/15 cases on cL and in 8/15 cases on tMRL. The TD was visible in 11/15 cL and 9/15 tMRL. Interestingly, in two cases tMRL demonstrated a cisterna chyli and a TD not visible on cL. The leakage site was confidently identified in all cL and in 10/15 tMRL. In two additional cases the leakage site was suspected on tMRL which was later corroborated by cL. An access site for lymphatic intervention was identified on 13/15 cL and 10/15 tMRL. Anatomical variations were seen on 9/15 cL and 8/15 tMRL examinations. All cL and 13/15 tMRL were considered clinically helpful.

**CONCLUSIONS:** Interstitial transpedal MR-lymphangiography is a useful tool in the diagnostic work-up of traumatic lymphatic leakages and can be employed to gain information on relevant anatomy and to guide further treatment without the need for ethiodized oil injection. However, conventional lymphangiography remains to be the gold standard in the work-up of traumatic lymphatic leakages.

**Abstract No. 1050**

**Role of percutaneous transthoracic lung biopsy for evaluation of lung infection in patients with hematological malignancies: a single-center 8-year analysis**

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**PURPOSE:** To report the yield, safety, and imaging prognosticators of success of percutaneous transthoracic lung biopsy (PTLB) in patients with leukemia and myelodysplastic syndromes (MDS) with suspicion of pulmonary infections.

**MATERIALS:** This retrospective, single-institution retrospective analysis included 77 patients (54 male, mean age 57 years) submitted to 81 PTLB between December 2007 and January 2016. Patients were referred to PTLB to rule-out pulmonary infection. PTLB were done under CT-guidance using a co-axial technique. Diagnostic success was classified in respect microbiology diagnostic yield (MDY) or any specific diagnosis (including MDY). Univariate analysis was performed to identify imaging predictors of MDY in respect: presence of airspace disease, surrounding ground-glass opacity, subsolid lesion, lesion cavitation, lesion calcification, presence of pleural effusion, lesion size, lesion lobe location. Complications were classified accordingly to SIR standard guidelines.

**RESULTS:** Specimen acquisition were done using fine needle aspirates (n = 24 PTLBs), core biopsy samples (n = 6 PTLBs) or a combination of both (n = 51 PTLBs). Successful MDY was achieved in 28 (34.5%) of the PTLB. Any specific diagnosis was achieved in 52 (64%) of the PTLB. Complications occurred in 7 (8.6%) of the 81 PTLBs, with 6 (7.4%) being graded as minor complications (pneumothorax, n = 3; hemoptysis managed conservatively, n = 2). One patient (1.2%) died of respiratory insufficiency due to hemoptysis during PTLBs procedure. On univariate analysis of imaging characteristics performed in 80 PTLBs, predictors of successful MDY were presence of airspace disease (p = 0.03) and lesion size > 2 cm (microbiology diagnostic yield, 11.8% vs 39.7%, ≤ 2 cm vs > 2 cm, respectively; p = 0.03).

**CONCLUSIONS:** PTLB is a useful alternative for diagnostic evaluation in patients with leukemia and MDS with suspicion of pulmonary infection. Physicians should be aware of the inherent risks associated with this procedure on this especially susceptible patient population.

**Abstract No. 1051**

**The complexities of a simple device: the percutaneous enteric tube**

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**PURPOSE:** 1. Describe the basic types of percutaneous enteric catheters including gastrostomy, jejunostomy and gastrojejunostomy, with attention to device-specific indications. 2. Provide tips for challenging catheter placement. 3. Establish an enteric tube assessment strategy and develop device-specific guidelines for exchange and removal. 4. Guide to maintenance of difficult tubes.

**MATERIALS:** Gastrostomy, jejunostomy and gastrojejunostomy tube placement are common interventional radiology consults. While such cases do not typically demand the extensive preprocedural planning required by many Interventional procedures, careful choice of device and placement strategy can have implications on catheter maintenance and impact future treatment options. While routinely requested for enteric nutritional support, there are less common indications for enteric tube insertion the Interventionalist should also be familiar with. Such indications, such as bilioenteric limb decompression in a gastric bypass patient, may be urgently required.

**RESULTS:** This educational exhibit will present the following: 1. A description of percutaneously inserted enteric tubes with special attention to their functional and practical differences. 2. A review of appropriate indications for different types of enteric tubes, highlighting those which may require more immediate attention. 3. Methods for success with difficult placement. 4. Step by step guide for assessment and manipulation of an existing enteric tube.

**CONCLUSIONS:** Maximizing patient and technical considerations can decrease not only complications but also the general nuisance such devices are commonly fraught with. Furthermore, familiarity with techniques for placement of catheters in patients with less favorable anatomy allows the Interventionalist to provide this minimally invasive procedure to a greater proportion of what is commonly the most frail of patient populations. In all cases, an open discussion with the consulting team regarding the clinical scenario and treatment plan are necessary to optimize patient care.
**Abstract No. 1052**

**Photothermal-mediated local heating suppresses stent-induced granulation tissue formation in rat esophagus**

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**PURPOSE:** Current therapeutic strategies are insufficient for suppressing stent-induced restenosis. The effects of photothermal (PT)-mediated local heating on suppressing stent-induced granulation-tissue formation in the rat esophagus were investigated.

**MATERIALS:** Self-expandable metallic stents (SEMSs) were coated with branched gold nanoparticles (BGNPs) to enable PT-mediated local heating. Fifty-two rats subjected to BGNP-coated SEMS placement were randomly divided into four groups of 13 rats each. Group A received control treatment. Groups B, C, and D received local heating at 50, 65, and 80 °C, respectively. Three rats in each group were sacrificed after heating; the remaining ten rats were sacrificed 4 weeks after stent placement. The effectiveness of local heating was assessed by comparing the results of histopathological examination.

**RESULTS:** Stent placement and local heating were successful in all rats. Eight rats were excluded because of stent migration (n = 5) and death (n = 3). HSP70 expression was gradually increased in a heating dose-dependent manner. Granulation-tissue formation-related variables were significantly higher in group A than in groups B, C, and D (all p < 0.001). HSP70 and TUNEL expressions were significantly lower in group A than in groups B, C, and D (all p < 0.001). Epithelial-layer number and αSMA and HSP70 expression in group D was higher than in groups B and C (all p < 0.05). Ki67 and BrdU expression were more prominent in group A than in groups B, C, and D.

**CONCLUSIONS:** PT-mediated local heating suppresses granulation-tissue formation after stent placement in the rat esophagus; moderate heating is a promising approach for preventing stent-related granulation-tissue formation.

**Abstract No. 1053**

**Percutaneous radiologically inserted push-gastrostomy tubes versus per-oral pull gastrostomy tubes: which is best?**

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**PURPOSE:** Percutaneous gastrostomies are inserted by IR using the classic push gastrostomy (RIG) or the per-oral pull gastrostomy (POG) techniques. The RIG method involves gastropexy sutures and serial dilatation of the tract. The POG technique delivers the gastrostomy via the oral cavity, with a benefit of being able to insert a larger caliber tube and avoiding the use of gastrostomy sutures. No formal standards exist for gastrostomies but case series in the literature report technical success rates ranging between 95-100%, with a low rate of minor complications (15%) and a rate of major complications of approximately 5%. The objective of this study was to compare our rates of minor and major complications between both procedures.

**MATERIALS:** All gastrostomy insertion procedures from January 2017 to May 2017 performed at McGill were audited. Procedure reports and fluoroscopy data were collected on PACS. Data collection in the electronic patient charts ensued for the identification of complications. Timing of gastrostomy suture removal in the RIG group was also recorded. Standard statistical comparison of both groups.

**RESULTS:** A total of 48 gastrostomies were included, with 12 (25%) POG and 36 (75%) RIG techniques. Average fluoroscopy time of 514 seconds and 164 seconds were recorded for the POG and RIG technique, respectively. 100% technical success rate was achieved in both groups, with zero 30-day mortality. Less than 10% of patients developed minor complications, which included pain and minor skin infection. Approximately 4% of patients, all of which were in the POG group, developed a major complication, primarily rectus sheath hematomas. Minor complications occurred more frequently in the RIG group and were independent of the timing of gastrostomy removal.

**CONCLUSIONS:** Both percutaneous gastrostomy techniques demonstrate a high technical success rate with overall lower complication rates compared with published literature. The POG technique was found to involve greater fluoroscopy time and a higher risk of major complications. Further analysis is being conducted to assess long-term complications related to both tubes.

**Abstract No. 1054**

**Think outside the spine: percutaneous cementoplasty for the management of symptomatic extraspinal lesions**

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**PURPOSE:** 1. Review the indications and rationale for performing extraspinal cementoplasty. 2. Describe techniques for image-guided percutaneous cementoplasty of flat and long bones with the use of case examples. 3. Discuss current literature evaluating clinical efficacy of cementoplasty.

**MATERIALS:** The role of interventional radiology is ever increasing in the management of symptomatic bony lesions, generally bone malignancy or traumatic fracture refractory to conservative therapy. It is postulated that percutaneous cementoplasty (PC) provides pain relief through 1) stabilization of the fracture from microscopic and/or macroscopic motion, 2) nerve damage from exothermic polymerization of poly-methyl-methacrylate (PMMA) and 3) neurotoxicity from the unpolymerized monomer. Percutaneous injection of PMMA, in
conjunction with radiation or thermal ablation, has been demonstrated to significantly reduce pain in up to 96% of cases. And while vertebroplasty has become a widely utilized tool for the management of spinal lesions, the experience with PC in long and flat bones is limited.

RESULTS: The exhibit will review clinical indications and procedural concerns when evaluating patients for PC. Candidates should be appropriately screened and thoroughly educated on the risk/benefits and potential outcomes of the procedure. Institutional techniques to optimize clinical success will be outlined with an emphasis on needle positioning and adequate PMMA injection. The exhibit will highlight cases of malignant and non-malignant bony lesions in extraspinal locations such as the sternum, femur, humerus, and pelvis. Lastly, a brief discussion of the current literature evaluating the clinical efficacy of cementoplasty will be preformed.

CONCLUSIONS: Percutaneous cementoplasty for extraspinal lesions has been demonstrated to provide significant palliation of refractory pain and therefore should be maintained in the interventionalists' armamentarium when approaching complex pain.

Abstract No. 1055
Real-time displayed radiation dose monitoring system in computed tomography fluoroscopy and its impact on radiation dose

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PURPOSE: CT fluoroscopy procedures involve high radiation dose exposure with deterministic effects being most prevalent. Awareness of radiation dose during these procedures is critical in protecting patients and medical staff. Several standard radiation protection measures are available in most interventional radiology labs. We present our experience with solid state real time radiation monitoring to further reduce medical staff exposure doses, allowing them to modify their intra-procedural behavior in real time, in order to further reduce radiation doses.

MATERIALS: Digital solid state detectors were used to collect radiation exposure doses, placed at different body or phantom positions. A phantom study was performed to determine the relationship of detector positioning on scatter radiation detected. The operator phantom was exposed in three angles; parallel, perpendicular, and 45 degrees relative to the CT bore while scanning another phantom acting as the patient in the CT table. This study was replicated with two interventional radiologists carrying solid state detector at the waist and the shoulder during 32 real time procedures for “real life” results. Patients’ DLPs were recorded.

RESULTS: The phantom study showed that scattered radiation dose strongly depends on physician position relative to the gantry. The scattered dose rates vary 1.56 to 6.76 mSv/h for parallel phantom position, 6.63 to 11.12 mSv/h for 45-degree position; 7.05 to 11.11 mSv/h for perpendicular position. The “real life” study showed no significant difference between wearing the detector at the shoulder or the waist. There was no difference in patient dose.

CONCLUSIONS: Real-time solid state detector measurement of scatter radiation during CT fluoroscopy-guided procedures can further minimize radiation exposure doses to the operator alongside standard radiation protection measurement. Detector placement at the waist vs shoulder did not have significant impact on measured doses.

Abstract No. 1056
Computed tomography–guided percutaneous ethanol sympatholysis of the sympathetic ganglia for primary hyperhidrosis

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PURPOSE: After completing this educational exhibit, you should be able to: 1. Define primary hyperhidrosis. 2. Discuss the pathophysiologic rationale for percutaneous sympatholysis. 3. Illustrate the steps involved in CT-guided percutaneous ethanol sympatholysis.

MATERIALS: Primary hyperhidrosis (PH) is defined as excessive production of sweat by eccrine sweat glands that substantially hampers normal daily activities. PH results from dysregulation of the sympathetic automatic nervous system. Percutaneous CT-guided ethanol sympatholysis disrupts the nerve fibers of the paraspinal sympathetic ganglia supplying the affected body region and is an effective treatment for craniofacial and axillary-palmar hyperhidrosis. This exhibit details the procedure of percutaneous CT-guided sympatholysis using ethanol for the treatment of PH.

RESULTS: 1. Perform preprocedure neurologic exam to assess for Horner syndrome. 2. Perform prone position CT of thoracic spine. Identify and mark treatment levels and determine the safe needle trajectory. 3. Using CT guidance, advance a 22-gauge spinal needle to the bilateral superolateral edges of the targeted level(s). 4. Inject 1 cc of buffered 1% lidocaine through each needle. 5. Repeat neurologic exam to assess for Horner syndrome. 6. If no new neurologic deficits are observed, proceed by injecting 1.5 cc of absolute ethanol into each needle. 7. Outpatient postprocedural care often requires oral opioids for 1–days. 8. Follow-up after at least 2 weeks to assess for response to treatment.

CONCLUSIONS: 1. Hyperhidrosis is characterized by excessive sweating that substantially hampers normal daily activities. 2. The location of the thoracic sympathetic ganglia is the superolateral aspect of the thoracic vertebral bodies. 3. Treatment of PH can be achieved with CT-guided percutaneous sympatholysis of the sympathetic ganglia with ethanol.

Abstract No. 1057
Were VCF patients at higher risk of mortality following the 2009 publication of the vertebroplasty sham trials?

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1. Hyperhidrosis is characterized by excessive sweating that substantially hampers normal daily activities. 2. The location of the thoracic sympathetic ganglia is the superolateral aspect of the thoracic vertebral bodies. 3. Treatment of PH can be achieved with CT-guided percutaneous sympatholysis of the sympathetic ganglia with ethanol.
PURPOSE: Balloon kyphoplasty (BKP) and vertebroplasty (VP) are associated with lower mortality risks than nonsurgical management (NSM) of vertebral compression fractures (VCF) (Ededin 2015). VP versus sham trials published in NEJM 2009 (Kallmes 2009, Buchbinder 2009) sparked controversy over the effectiveness of VP, leading to diminished referral volumes (Hirsch 2016). This diminution in volume ran counter to trends in utilization of percutaneous interventional procedures for pain, making the association with publication of these trials very likely (Manchikanti 2016a; Manchikanti 2016b). We hypothesized that this lower national utilization of augmentation could lead to a greater mortality risk for VCF patients.

MATERIALS: BKP/VP utilization was evaluated for VCF patients in the 100% U.S. Medicare dataset (2005-2014). Survival and morbidity were analyzed by the Kaplan-Meier method and compared between NSM, BKP, and VP using Cox regression with adjustment by propensity score and various patient/clinical factors.

RESULTS: 2,129,769 VCF patients were identified (n = 297,228 BKP and 135,129 VP). BKP/VP utilization was 20% in 2005, peaked at 24% in 2007-2008, and declined to 14% in 2014. Adjusted mortality risk for VCF patients was 4% greater in 2010-2014 versus 2005-2009 (p < 0.001). Overall VCF mortality risk was 85.1% at 10 years. The BKP and VP cohorts had a 19% (95% CI: 19%-19%; p < 0.001) and 7% (95% CI: 7%-8%; p < 0.001) lower propensity-adjusted 10-year mortality risk than the NSM cohort, respectively. The BKP cohort had a 13% lower adjusted 10-year mortality risk than the VP cohort (p < 0.001). BKP/VP had longer length of stay (LOS) but higher discharge to home rates (odds ratio vs. NSM: BKP 2.27, VP 1.86; p < 0.001 for both) than NSM. VP had longer LOS and lower rate of discharge to home than BKP.

CONCLUSIONS: Changes in referral/treatment patterns following the publication of the 2009 blinded VP trials led to lower BKP/VP utilization. In turn, the five-year period following 2009 was associated with elevated mortality risk in VCF patients. These findings provide insight into the implications of shifts in treatment patterns and associated mortality risks for VCF patients.

Abstract No. 1058

Efficacy of euthermic discolysis with Ho Laser in treatment of radicular pain

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PURPOSE: The aim of this study is to provide the efficacy of euthermic discolysis with Ho Laser in the treatment of disc protrusions by means of pain relief and functions.

MATERIALS: Fifty-six patients (35 males, 21 females, av. age: 51.2) with cervicobrachiagia or sciatic pain due to cervical or lumbar contained discal herniation (PFirrmann grade 1-3) were selected for treatment with percutaneous disc decompression by means of Ho Laser YAG Discolux® (Techlamed, ITA). Diagnosis was confirmed by MRI and EMG in all patients. All procedures were performed under fluoroscopic guidance and with local anesthesia. Eighteen-gauge Chiba needles were used to insert the laser fiber. Clinical evaluation, assessment of pain by means of a 11-point visual analogue scale (VAS, 0-10) and of functions by means of the Oswestry disability scale (ODI 0-50) was performed at baseline and at 6 months after the procedure. The use of painkillers was also evaluated.

RESULTS: A total of 59 intervertebral discs (35 cervical, 24 lumbar) on 56 patients were treated. Baseline pain was 7.54 ± 1.4, baseline ODI was 58.4%. At 6 months, pain was 2.8 ± 2.3 (p < 0.01), while ODI was 19.3%. No complications arose. 75% of patients stopped painkillers, 20% reduced the uptaking, 5% were still on analgesic drugs.

CONCLUSIONS: From our preliminary study, the treatment of contained discal herniation with Euthermic Discolysis with Ho Laser is an optimal therapy for symptomatic patients showing a good reduction of pain and a good increase of functions.

Abstract No. 1059

Applications of contrast-enhanced ultrasound in pediatric interventional radiology: an early experience retrospective review from a large single-center academic institution in the US

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PURPOSE: To describe applications of contrast-enhanced ultrasound in a variety of interventions performed in pediatric patients.

MATERIALS: An IRB-approved, HIPAA compliant retrospective review of 38 procedures was performed in which contrast-enhanced ultrasound (CEUS) was used either for adjunctive or intraprocedural imaging. Outcomes measured were how CEUS impacted 1) the planning of a case, 2) the course of a case or 3) delineated the success of a case. Interventions in which CEUS was utilized included biopsy of solid organ, intramuscular and osseous lesions, upper extremity venography, renal angioplasty, cholangiography, percutaneous cholecystectomy and biliary drainage catheter placement, abscess drainage and sclerotherapy.

RESULTS: The utility of CEUS in interventions was analyzed in 19 male and 19 female patients of mean age 9 years range, 10 days-21 years). Five biopsies of the liver, 1 biopsy of an intramuscular lesion, and 1 biopsy of a renal lesion were performed following CEUS which showed indeterminate or Type III enhancement kinetics; in all but 1 case, pathology was concordant with CEUS findings. Cholangiography using CEUS was performed for evaluation of biliary stenosis and confirmation of intraluminal position in 2 patients, aiding safe replacement of a percutaneous transhepatic biliary drain (PTBD) in one patient and placement of a new percutaneous cholecystostomy in the other. Postangioplasty CEUS demonstrated technical success (improved renal perfusion) in 5 patients. Real-time upper extremity CEUS venography was performed in 2 patients, corresponding with fluoroscopic venography. Finally, CEUS was used to outline venolymphatic malformations and abscesses in 10 patients, correlating well with fluoroscopic imaging results.

CONCLUSIONS: CEUS is an increasingly applicable modality in pediatric imaging due to its lack of ionizing radiation and safety of contrast agents. In our institution, we found it to be effective for preprocedural
planning, image-guidance during procedures and monitoring therapeutic success after an intervention. CEUS should be embraced as a new tool in the pediatric interventional arsenal and will likely shape the future of the field.

Abstract No. 1060

Incorporating data collection into the interventional radiology clinical workflow

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PURPOSE: We describe the design, development, and implementation of a centralized clinical research database that integrates with the normal interventional radiology (IR) clinical workflow and includes data from clinic visits, procedure reports, and patient reported outcomes.

MATERIALS: Although the process of data collection is one of the most arduous tasks in clinical research, it is also one of the most essential. The majority of data collection is done retrospectively from clinical documents that have no standardized format. This is not only time consuming, but also leads to poor quality data due to the heterogeneity of these documents. Standardized data collection results in much higher quality data, but also requires that data entry be done during or shortly after the clinical encounter. Unfortunately, most standardized collection methods are not integrated with the existing clinical workflow. Instead, these methods require duplicate data entry by the provider and are therefore rarely used. To deal with these challenges, we designed a clinical research database that integrates with the existing IR workflow to collect data from clinic visits, procedure reports, and patient reported outcomes.

RESULTS: Our clinical database of venous interventions collects data from three sources: clinic visits, patient surveys, and procedure reports. In clinic, providers use a server based user interface to collect standardized clinical information and automatically generate a clinic note for the EMR. Similarly, IR fellows create procedure reports from highly structured templates that push a copy to the EMR and also store a parsed copy in our database. Patient quality of life surveys are completed in clinic on a tablet or sent via email at regular intervals. Data from these surveys go directly to the database and are available for use in future clinical notes. These collection methods integrate with the current IR workflow and do not require duplicate data entry on the part of the provider, leading to higher quality and larger quantity of clinical research data.

CONCLUSIONS: To ensure quality and quantity of clinical research data, methods of collection should be integrated into the existing clinical workflow.

Abstract No. 1061

MIPS action plan for interventional radiologists

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PURPOSE: 1) Review the Merit Based Incentive Payment System (MIPS). 2) Explain how interventional radiologists (IRs), practices, and administrators can maximize Medicare reimbursement under the MIPS.

MATERIALS: In 2015, Congress passed MACRA, a revolutionary bill which established two new payment models for physician reimbursement for the care of Medicare patients: Merit Based Incentive Payment (MIPS) and Advanced Alternative Payment Models (APMs). CMS expects that over 96% of physicians will be utilizing the MIPS track. This exhibit will review major components for MIPS as it pertains to IRs including guidelines for eligibility, options regarding levels of participation, IR-specific performance categories, and reporting mechanisms. Additionally, it will provide a specific roadmap on what IR practices need to do to earn maximum reimbursement based on the metrics specified in MIPS.

RESULTS: To maximize reimbursement in MIPS, IR practices must earn full points in three measurable metrics—Quality, Advancing Care Information, and Clinical Improvement Activities. This exhibit will explain the rating criteria for each category and will delineate key steps that IR practices can take to meet these targets. Specific IT requirements including EHR will be reviewed. Furthermore, it will explain how participation in the National Radiology Data Registry (NRDR) IR Registry can help fulfill reporting requirements for MIPS as well will help IRs to improve safety and quality in their practice.

CONCLUSIONS: MACRA has officially come into effect in 2017 and it is imperative that interventional radiologists (IRs) understand and implement the various components of the legislation to be compensated for their work and continue to help patients in the years to come.

Abstract No. 1062

The utilization of “big data methodology” to better understand practice patterns

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PURPOSE: The research objective is to apply “big data methodology” to a novel software system to better understand key performance indicators (KPI) at a single academic center.

MATERIALS: IR is a complex field in constant evolution and as such requires an intricate system for management. Understanding factors that affect volume and practice profitability are useful for improving department efficiency. With the advent of EMR, the data now available for analysis has grown exponentially; however, institutions have discovered that they are “data rich, but information poor.” Over the years, numerous management tools have been developed to meet the demands of the expanding field. These traditional tools are often flawed in that they cannot process the large volume data in an expeditious manner or convert complex metrics to yield meaningful insight. Tableau is a data software solution designed specifically to improve the usability of big data sets by focusing on speed and data visualization, allowing patterns and trends to be more easily recognized by placing them in a visual context.
RESULTS: Tableau software was introduced to analyze the IR departmental data with the goal of better understanding operations and to gain meaningful insight about practice patterns. The KPIs that were measured included: procedure duration, access times, total procedure volumes, referring physician practice patterns, and indications for procedures. A total of 25,640 unique patient records were analyzed over a 15-month period. 1. When evaluating 4 representative IR procedures, total procedure duration was not found to be correlated with operator’s experience. 2. Over 40% of the total procedure volumes were dominated 4 ICD-10 codes: ESRD, dependence of hemodialysis, liver cell carcinoma and malignant neoplasm of the prostate. 3. The mean wait times for various IR procedures were analyzed and the median wait time is 6.9 days. 4. The top 4 referring providers were identified.

CONCLUSIONS: Big data information is underutilized often owing to the inability to readily manipulate and interpret data. New software systems can assist in the analysis and provide meaningful insight that can alter practice patterns and allow critical decision makers to appropriately allocate resources.

Abstract No. 1063
Development of a patient status dashboard for expediting patient care and quality improvement

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PURPOSE: We aim to describe the development of a real-time interactive dashboard for tracking outpatient case status within our interventional radiology practice. This enables physicians and schedulers to identify delayed patients and expedite their care. Moreover, it facilitates tracking of delays and causes of delay for future practice and quality improvement. We will describe the development, implementation, and outcomes of this outpatient delay dashboard.

MATERIALS: Patient case delay is a common issue among interventional practices, which leads to patient dissatisfaction and room downtime. Many of these practices use electronic medical records (EMRs) to manage patient care and track case status. EMRs enable the collection of patient information and data into a central repository, but are often inflexible. Accessing and manipulating big data like this is often difficult, especially in a rapid manner for real-time applications.

RESULTS: We assembled a cross-disciplinary team composed of physicians, nursing coordinators, information technology development, and EMR support staff. This team identified a list of data necessary for tracking outpatient case progress and potential causes for delays. A scheduled extract of this information from the Clarity reporting database underpinning our Epic EMR was created, allowing automatic retrieval of daily case information. Using custom Python code this data was ingested into a separate PostgreSQL database. A real-time web dashboard was implemented using the Django web application framework, enabling our staff to record accurate case delays and document delay reasons. Finally, statistical analysis tools were created to help identify common delay reasons and areas for improvement.

CONCLUSIONS: Leveraging the vast amount of data within our EMR, we successfully implemented a patient status dashboard, with a focus on improving patient centered care through the real-time identification of and prompt response to patient case delays. Future work will focus on using this data to identify common causes of delays and focused quality improvement efforts to minimize these delays.

Abstract No. 1064
Impact of a multidisciplinary fibroid center on diagnosis, management, and treatment of women with benign gynecological conditions

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PURPOSE: Uterine fibroids are the most common tumors of the female pelvis. Treatment options are multidisciplinary, and successful treatment can be impacted by other gynecologic conditions, such as adenomyosis and endometriosis. The Stanford Fibroid Center (SFC) is a multidisciplinary clinic wherein three subspecialty physicians jointly counsel patients on treatment options. This study assessed the effect of this multidisciplinary approach on diagnosis, management and treatment.

MATERIALS: A retrospective review of the volumes of pelvic magnetic resonance imaging (MRI), and surgical and interventional radiology (IR) procedures from July 2008 to July 2017 assessed evaluation and treatment prior to and after establishing the SFC in April 2013, including assessment of the 569 consecutive patients seen at SFC. All patients had a pelvic MRI prior to discussing treatment options with a team including a gynecologist, interventional radiologist, and body MRI radiologist.

RESULTS: After establishing the SFC, the volume of pelvic MRIs performed to evaluate benign gynecologic conditions increased by 300% (527 studies; 11.2/mo. vs 186 studies; 3.7/mo.) with patients from the SFC directly accounting for 323 (70%) of those studies. SFC patients underwent 386 procedures, including surgery (173; 30.4%), uterine artery embolization (UAE) (130; 22.8%), and MR-guided focused ultrasound (20; 3.5%). UAE volume increased 162% (33.6/yr. vs 20.7/yr.) as did surgical volume (246%; 5.7 cases/mo. vs 2.3 cases/mo.). Compared to ultrasound alone, MRI altered the diagnosis in 193 women (33.9%) with adenomyosis (136; 23.9%), endometriosis (72; 12.6%), and/or endometrial polyps (12, 2.1%) being the three most common secondary diagnoses. These additional diagnoses resulted in surgery being chosen more often (63/193, 32.6%, p = 0.08) and UAE significantly less often (22/193, 11.4%, p<0.001).

CONCLUSIONS: Implementation of a multidisciplinary approach including the use of routine pelvic MRI for women with fibroids and related conditions significantly impacted diagnoses and management, providing a benefit to both patients and clinical services.
Abstract No. 1065
Clinical utility of thromboelastography in pediatric intervention
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PURPOSE: To inform interventional radiologists regarding the clinical utility of thromboelastography.

MATERIALS: A recent resurgence of interest in thromboelastography (TEG) necessitates at the very least a basic understanding of the test's results as more surgical services adopt TEG in their postoperative bleeding protocols. Ideally, the interventionalist should understand the potential for TEG to provide accurate, critical guidance in his/her own preprocedural planning or postprocedural management of complex coagulopathic patients. A series of clinical scenarios are provided to illustrate the utility of TEG in pediatric intervention.

RESULTS: TEG analyzes time to initiation of clotting (r-time), time to achieve a certain level of clot strength (k-time), rate of clot formation (alpha angle), maximal clot strength (MA), and lysis 30 and 60 minutes after MA (Ly30 and Ly60). This reasonably quick test offers a comprehensive and dynamic analysis of the clotting profile, demonstrating the degree of anticoagulation or platelet blockade and identifying states of hypercoagulability or hemophilia, excessive fibrinolysis, or DIC. The format of results in both number and graph form allow both quick and comprehensive analysis.

CONCLUSIONS: The cause of bleeding in patients with complex coagulopathies such as those with cirrhosis, leukemia, sepsis, recent surgery, or major trauma can be difficult to determine due to multiple factors involved. TEG sheds light on these complex situations and can play a critical role, for example in determining whether to proceed with surgery/intervention or first correct a coagulopathy. As this test gains popularity, it is incumbent upon the interventionalist to understand TEG results and to consider implementing the test in the management of coagulopathic patients.

Abstract No. 1066
Beyond the catheter: essential nutrition education for our patients
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PURPOSE: Learning objectives: 1. Describe the best nutritional guidelines for treating many disease entities we see as IR physicians, such as obesity, diabetes, hypertension, vascular disease and cancer. 2. Explain how “food is medicine” 3. Detail varying disease incidence around the world 4. Review the literature and recommendations regarding optimum food choices

MATERIALS: As IR physicians and providers, we treat patients with common disease entities such as obesity, diabetes, vascular disease, hypertension, and cancer. We perform procedures and see patients in a clinic setting. Consequently, we have an opportunity to educate our patients on current dietary recommendations, which will have a direct impact on their health.

RESULTS: The traditional western diet is contributing to numerous common diseases. Extensive research has shown that a whole food, plant based diet is able to prevent, treat, and often reverse chronic disease. We will present scientific data regarding the best dietary guidelines for multiple disease entities. Current lifestyle recommendations, resources for non biased information on dietary research, and an IR clinic model which incorporates these educational tools will be described.

CONCLUSIONS: As clinical physicians who specialize in minimally invasive procedures, we see patients who suffer from obesity, diabetes, hypertension, vascular disease, and cancer. Many of these diseases are increasing and reaching epidemic proportions. Employing nutrition education in our clinical practices provides patients an opportunity to improve their overall health as well as their more immediate problem. Encouraging a whole food, plant based diet has been shown through numerous scientific studies to prevent, suspend, and reverse these diseases. Sharing this data with our interventional radiology patients will help their overall well-being.
Follow-up for percutaneous drains placed by interventional radiology: a quality improvement initiative

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PURPOSE: SIR quality improvement guidelines for percutaneous drainage recognize the importance of appropriate clinical follow-up and timely catheter removal. Lack of interventional radiology involvement after drain placement at our institution led to suboptimal care. We instituted a two-step quality improvement program that involved the use of existing tools within the electronic medical record. The goal was to evaluate if the intervention reduced the drain survival time (drain placement to removal), increased the percentage of drains removed by interventional radiology (IR), and reduced the percentage of drains lost to follow-up.

MATERIALS: We performed a retrospective review of all percutaneous drains for abscess placed by IR between 1/1/2016 and 7/1/2017 at our tertiary care hospital. Patient demographics and removing service as well as drain survival time, location, size, and revisions were recorded for pre- and postintervention groups. Statistical analysis was performed using a chi-square test for proportions. Kaplan-Meier survival analysis was conducted for drain survival time and compared using a log-rank test.

RESULTS: There were no significant differences in age or sex between the preintervention (n = 294) and postintervention (n = 153) groups. The median drain survival time decreased from preintervention (15 days, 95% CI = 12.5-17.5) compared with the postintervention group (11 days, 95% CI = 8.2-13.8). The percentage of drains removed by IR increased from 21.8% to 30.9% (p = 0.035), while the percentage lost to follow-up decreased from 13.9% to 7.9% (p = 0.063). Drain size and rate of revisions were equal between the two groups (p = 0.19). Kaplan-Meier survival analysis showed earlier drain removal in the postintervention group (log-rank p = 0.05).

CONCLUSIONS: The utilization of a SP tool significantly increased the nurses’ confidence in their ability to address the concerns/needs with NESHP during IR procedure. Contrary to our hypothesis, utilization of the SP did not have a significant difference on the overall satisfaction by the patients; both groups rated excellent overall satisfaction.

Early experience with wearable imaging technology for diagnostic ultrasound and ultrasound-guided procedures

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PURPOSE: Our purpose is to establish feasibility of augmented reality technology in IR. There is a need for more effective and ergonomic methods of image-guided procedures. Traditionally, the ultrasound screen is placed across from the physician, directing attention away from the patient and procedural field in order to view images. This study describes our experience using head-mounted wearable technology, namely Google Glass, Epson BT-200, and Microsoft Hololens for diagnostic ultrasound and ultrasound-guided procedures.

MATERIALS: With the Google Glass setup, Zonare ultrasound images are transmitted to a Microsoft Surface Pro tablet via a Startech video capture cable and wirelessly transmitted to the Google Glass. This was used during 2 ultrasound-guided regional nerve block procedures. With the Microsoft Hololens setup, Zonare ultrasound images are
transmitted to a Microsoft Surface Pro Tablet via an Epiphan AV.io HD device and wirelessly transmitted to the Microsoft Hololens. This was used with diagnostic fetal ultrasound, ultrasound-guided percutaneous renal transplant biopsy, and contrast-enhanced ultrasound-guided percutaneous liver biopsy. With the Epson BT-200 setup, ultrasound images acquired via a Philips Lumify ultrasound probe are transmitted to a Samsung Galaxy Tab S2 tablet and wirelessly transmitted to the Epson BT-200. This was used with echocardiography and RF ablation.

RESULTS: Google Glass-assisted ultrasound-guided regional nerve blocks were technically successful without complication. Limitations include small field-of-view and inability to use both eyes to assess depth perception. Microsoft Hololens-assisted diagnostic fetal ultrasound, ultrasound-guided percutaneous renal transplant biopsy, and contrast-enhanced ultrasound-guided percutaneous liver biopsy were technically successful without complication. Limitations include latency up to 1-2 seconds. Epson BT-200-assisted echocardiography was technically successful without complication. Limitations include connectivity only to Android operating systems.

CONCLUSIONS: Our experience with head-mounted wearable technology has been safe, technically successful, with improved ergonomics, ease of use, and adequate image quality.

Abstract No. 1071

Budd-Chiari syndrome: diagnosis and management strategies for the interventional radiologist

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PURPOSE: 1. To review the pathophysiology and diagnostic imaging findings of Budd-Chiari syndrome (BCS). 2. To review management strategies available to the interventional radiologist including hepatic vein recanalization and both transjugular and direct intrahepatic portosystemic shunts. 3. To review potential complications of these interventional management strategies.

MATERIALS: BCS is defined as a hepatic venous outflow obstruction. This may be primary (obstruction due to an internal venous process) or secondary (due to extrinsic venous invasion or compression). There are multiple etiologies for BCS including myeloproliferative disorders, coagulopathies, drugs and congenital abnormalities. Initial presentation is variable ranging from asymptomatic to fulminant hepatic failure.

RESULTS: We will provide an overview of the clinical and radiological findings of BCS. Additionally, we will discuss potential treatment strategies the interventional radiologist should be aware of including medical, endovascular and surgical options. Through the use of illustrative case presentations, we will provide an overview of therapeutic techniques including transjugular and direct intrahepatic portosystemic shunts (TIPS and DiPS) as well as hepatic vein recanalization. Specific focus will be directed at when to perform these procedures in the context of complex anatomical considerations and variable degrees of hepatic venous obstruction. Finally, we will review common treatment complications and relevant monitoring/management strategies.

CONCLUSIONS: We provide an illustrative overview of BCS including relevant diagnostic imaging/clinical considerations as well as a review of multiple management techniques including DIPS, TIPS and hepatic vein recanalization.

Abstract No. 1072

Transsplenic transjugular intrahepatic portosystemic shunt for cavernous transformation of the portal vein: tips and tricks

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PURPOSE: Transsplenic transjugular intrahepatic portosystemic shunt (TS-TIPS) is a novel technique, which involves complex recanalization of the chronically occluded (cavernous transformation) portal vein and placement of TIPS. Success of the procedure depends on several important and critical technical factors. We would like to share our experience of TS-TIPS to discuss in detail critical clinical and technical factors as well as follow-up protocol.

MATERIALS: Cavernous transformation of the portal vein is a sequelae of chronic portal vein thrombosis observed in patients with portal hypertension and cirrhosis. For these patients requiring liver transplant; very limited high-risk and poor outcome surgical options are available. Recanalization of the portal vein with TIPS placement (TS-TIPS) leading to long-term patency of the portal vein is an attractive alternative allowing end to end portal vein Anastomosis during the liver transplant.

RESULTS: TS-TIPS is relatively novel and technically challenging. We plan to discuss pertinent points in clinical evaluation and imaging studies (triple phase CT scan or MRI) and indications for TS-TIPS. We will discuss in detail (with images and graphics) critical technical steps: 1) selection of the splenic vein for ultrasound-guided access 2) splenic venous access tools 3) evaluation of splenic venogram 4) portal vein recanalization technique and tools 5) targeting of the intrahepatic portal vein through transhepatic route 6) access across the portal vein and placement of TIPS and venoplasty of the portal vein 7) closure of splenic access 8) potential complications and their solutions 9) follow-up intervention / imaging protocol.

CONCLUSIONS: In this educational exhibit we will use images and graphics to comprehensively discuss indications, preprocedure labs and imaging evaluations, basic and critical technical details, complications and their solutions as well as follow-up protocol for TS-TIPS.
Abstract No. 1073

Percutaneous mesocaval shunt placement for variceal bleeding: a case series

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PURPOSE: Patients with recurrent variceal bleeding secondary to portal hypertension have limited options when they are not candidates for TIPS or liver transplant due to portal vein occlusion. Percutaneous mesocaval shunt placement is a technique that has been described for these patients, but long-term data are limited.

MATERIALS: From November 6, 2013 to September 21, 2017, seven patients (ages 41-81, M:F 2:5) received percutaneously placed mesocaval shunts for variceal bleeding secondary to portal vein occlusion. All seven patients had a Gore Viatorr stent graft (Gore Medical, Flagstaff, AZ) placed from the IVC to the splenic vein or SMV. Technical success (angiography, pressure gradient), clinical status (recurrence of symptoms, MELD score), and complications (bleeding, infection, encephalopathy) were recorded.

RESULTS: At the time of stent graft placement, the mean portosystemic gradient was 15.3 (SD = 4.2). The mean baseline MELD score was 9.9 (median = 12.2, SD = 4.1). The technical success rate was 100%. The mean postprocedure MELD score was 9.7 (median, 9.8; SD, 3.4). No patients had recurrent bleeding or infection. One patient developed encephalopathy attributed to substance abuse and non-compliance with lactulose regimen.

CONCLUSIONS: Percutaneous mesocaval shunts may provide a viable therapeutic option in the setting of refractory variceal bleeding in patients who are not candidates for TIPS or liver transplant. We present seven patients who underwent technically successful stent graft placement with a primary patency rate of 71%. Two patients required shunt revision and the primary assisted patency rate was 100%. The mean postprocedure portosystemic gradient was 4.5 (SD = 5.2). The mean postprocedure MELD score was 9.7 (median, 9.8; SD, 3.4). No patients had recurrent bleeding or infection. One patient developed encephalopathy attributed to substance abuse and non-compliance with lactulose regimen.

Abstract No. 1074

Transcudate total portal diversion via transjugular portosystemic shunt creation: a case series

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PURPOSE: To retrospectively describe safety and symptom control in patients requiring transcudate transjugular portosystemic shunt (TCPS) creation. This technique was utilized in subjects with variceal bleeding (VB) and main portal vein thrombosis (mPVT) refractory to recanalization. A series of 3 cases will be presented and a review of the literature.

MATERIALS: Three patients required TCPS over a 6-month interval (10/2015 3/2016) at a single transplant center which performs an average of 100 TIPS per year. The medical record, imaging, and labs were reviewed. Shunt indication, MELD, ALBI score, etiology of liver disease, complications, patency, fluoro time, and follow-up symptomology were evaluated. Complications were graded using Common Terminology Criteria for Adverse Events (CTCAE) Version 4.0.

RESULTS: Portosystemic shunts were indicated in all patients due to medical and endoscopic refractory VB. All patients had chronic occlusion of the portal vein with attenuated or cavernous intrahepatic branches. MELD scores ranged from 1017 with ALBI grades A2 (2) or A3 (1). Liver disease was secondary to alcoholic cirrhosis, hepatitis C cirrhosis, and systemic lupus erythematosus. One patient had a remote splenectomy preventing antegrade portal access, one had a thrombosed stent graft abandoned in the main portal vein during an unsuccessful outside institution TIPS attempt, and the third developed cavernous transformation at the portal inflow confluence. Fluoro time ranged from 20.7 to 170 minutes. There were no perioperative adverse events. Durable VB resolution was achieved in 2 patients. One patient had two readmissions for recurrent VB at 10 and 41 days post TCPS creation (CTCAE 3). Both VBs resolved after revision angioplasty. The patient remains asymptomatic 4 months after most recent revision. All TCPS were patent on follow-up imaging 3 to 43 days postprocedure. None of the subjects developed hepatic encephalopathy or change in baseline liver function.

CONCLUSIONS: TCPS was well tolerated and resulted in durable primary and assisted control of variceal hemorrhage. This technique should be considered in select patients with main and intrahepatic portal vein occlusion when TIPS creation methods fail.

Abstract No. 1075

Precise iliac venous stent placement using fluoroscopy alone in May-Thurner syndrome

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PURPOSE: We describe a unique iliac venous stent landing technique in patients with confirmed May-Thurner syndrome (MTS) using fluoroscopy alone.

MATERIALS: 56 consecutive patients (mean age, 45; 82% female) with MTS were treated by venous stenting. By rotating the image intensifier, strict AP fluoroscopy was obtained, so that the image was centered over the appropriate lumbar vertebra spinous process (SP) and each pedicle was equidistant from the SP. Live AP fluoroscopy and DSA were used. The unsubtracted fluoroscopy visualized the lumbar bony landmarks, whilst the DSA roadmap facilitated precise deployment. The cephalad stent was deployed to the right of the appropriate lumbar vertebra spinous process, but not as far to the right as the medial margin of the right pedicle of the same vertebra. The stent length depended on biplanar venography lesion length. Intravascular
ultrasound (IVUS) was not used in any case. The position of the stent relative to the bony landmarks was analyzed using postprocedure CT venogram. Linear regression was used to identify explanatory variables. Wilcoxon signed rank test and Spearman’s correlation coefficient were reported.

RESULTS: The IVC consistently lay between a lumbar vertebra SP and right pedicle. A median 28 mm (SD ± 5 mm) right of the SP and 2 mm (SD ± 5 mm) left of the right pedicle. In all cases, the right common iliac artery (RCIA) was located to the left of the IVC. Age (R2 = 0.08), acute/chronic presentation (R2 = 0.07) and malignancy (R2 = 0.1) had weak effects on the IVC position. Positive linear correlations were found between stent position and the lumbar vertebrae SP (R = 0.63, P = 0) and pedicle (R = 0.5, P< 0.01) on CT. The median stent position lay against the IVC and the RCIA position did not differ pre-post (P = 0.1). Mean primary patency was 5.4 years estimated (4.4–6.5 years 95% CI).

CONCLUSIONS: The position of the IVC appears to lie between the spinous process and right pedicle of the appropriate lumbar vertebra. This may allow accurate stent placement using fluoroscopy without IVUS. A technically satisfactory result can be obtained: the stent lying beyond the point of maximal compression by the right CIA. Our study shows that this technique is feasible and reproducible.

Abstract No. 1076

Survival benefit of TACE in combination with irradiation stent placement in patients with hepatocellular carcinoma and portal vein tumor thrombosis

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PURPOSE: For patients with advanced hepatocellular carcinoma (HCC) and portal vein tumor thrombosis (PVTT), the survival benefit of transarterial chemoembolization (TACE) remains modest. This study aimed to investigate whether TACE in combination with irradiation stent placement could prolong the survival in patients with HCC and PVTT.

MATERIALS: From January 2011 to December 2016, patients with HCC and PVTT underwent TACE combined with irradiation stent placement between May 2008 and April 2017. Clinical records were reviewed to guide long-term management of venous occlusive disease. Despite this proliferation, little is known regarding factors associated with venous stent patency or malfunction. The purpose of this study is to examine factors associated with venous stent malfunction for iliocaval occlusive disease.

RESULTS: The median follow-up period was 12.1 months (0.6–51.6 months). Overall primary and secondary cumulative patency rates at 12 months were 70.0% and 97.8%, respectively. In univariate analysis, patients with DVT risk factors (HR = 8.43, P = 0.039), greater number of deployed stents (HR = 1.45, P = 0.022), greater combined stent length (HR = 1.06, P = 0.004), and stent extension into the common femoral vein (HR = 3.13, P = 0.024) had significantly higher risks of stent malfunction. Antplatelet use following stenting predicted significantly improved stent patency at follow-up (HR = 0.23, P = 0.007). In multivariate analysis, antplatelet use remained significantly associated with primary stent patency (multivariate HR = 0.32, P = 0.046).

CONCLUSIONS: Iliocaval venous stent malfunction was significantly increased in patients with DVT risk factors, greater number of deployed stents, greater overall length of stented segments and extension of stents into the common femoral vein. Administration of antplatelet medication was a significant predictor of venous stent patency. Further investigation of the mechanisms involved in venous stent thrombosis will be important to guide long-term management of venous occlusive disease.

Abstract No. 1078

Types of portosystemic shunts and indications for interventional radiology–guided embolization

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Abstract No. 1079

Electrified conductive vascular sheath to facilitate embedded inferior vena cava filter removal with radiofrequency: a feasibility bench study

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PURPOSE: To define the feasibility of delivering radiofrequency (RF) cutting energy to tissue via a customized vascular sheath with goal of facilitating removal of an embedded IVC filter.

MATERIALS: A bench model was established to simulate tissue response to cutting energy deposition delivered via a custom RF sheath. The RF sheath was fabricated by modifying a 12 Fr Flexor Guiding Sheath (Cook Medical Inc., Bloomington, IN). The marketed vascular sheath contains an embedded coil the length of the shaft for rigidity and is connected to a radiopaque metal ring at the distal tip. The metal components are conductive with 450 Ohm resistance. The conductive ring at the distal tip of the sheath and the proximal end of the embedded coil were physically exposed. The free end of the coil was connected to a Bovie generator (Aaron 2250, Bovie Medical, Purchase, NY). RF grounding pads were placed at the bottom of a 15 × 20 × 15 cm container filled with 1.5L of normal saline. A chicken breast was immersed. The compression force dropped from 10N to 6.2, 6.9, 3.8 and 3.5N after applying 50W, 100W, 150W and 200W, respectively. The diameters of the cut were 2.5, 3.5, 3.9 and 4.2 mm for the 12Fr sheath used while the depths of the cuts were 2.0, 3.0, 5.5 and 6.4 mm, respectively.

RESULTS: Major indications for portosystemic shunt include medical refractory hepatic encephalopathy, variceal hemorrhage and presurgical planning for intraabdominal surgery. We will demonstrate our institution’s experience with IR-guided embolization for spontaneous and post TIPS portosystemic shunt. We will also review current literature regarding patient selection, technique and possible complications.

CONCLUSIONS: IR-guided embolization of portosystemic shunts includes a wide spectrum of safe and feasible therapeutic procedures to improve hepatic encephalopathy, variceal hemorrhage and decrease hospitalizations when utilized in appropriately selected patient population. Varying guidance modalities and techniques may be applied.

Abstract No. 1080

Retrieval of permanent inferior vena cava filters: multicenter analysis of efficacy and safety

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PURPOSE: Permanent inferior vena cava filters (pIVCF) are effective in preventing pulmonary embolism (PE) in patients with acute deep vein thrombosis (DVT) when anticoagulation has failed or is contraindicated. However, pIVCF can result in device-related adverse events (AE) or potentially permanent anticoagulation when no longer indicated; in these cases, pIVCF retrieval may be considered. We aim to evaluate the efficacy and safety of pIVCF retrieval; we hypothesize that pIVCF can be safely retrieved with a high rate of technical success.

MATERIALS: In this multi-center study, pIVCF retrievals performed between 9/1/11 - 8/31/17 were retrospectively reviewed. Filter types, dwell time, use of advanced techniques, technical success, procedural AE rate, and procedural fluoroscopy time (FT) were evaluated. The relationship between pIVCF type, dwell time, use of advanced techniques, and AE rate was evaluated with multivariable logistic regression. Significance was determined at p<0.05.

RESULTS: 44 pIVCF retrievals were performed at 3 academic medical centers. Filters included: 22 (50%) Greenfield, 11 (25%) TrapEase, 6 (15.6%) Simon Nitinol, 5 (11.4%) VenaTech LP. Technical success of retrieval was 97.7% (43/44). Median dwell time was 4186 days (range, 5–12500). Median FT at retrieval was 24.4 minutes (range, 1.7–114.1). Advanced techniques were used in 40/44 retrievals (90.9%). Methods included: reversed curved catheter/lopped wire 21 (49%), endobronchial forceps 21 (49%), and excimer laser sheath-assisted photothermal ablation 19 (44%). The AE rate was 13.6% (6/44), 5 minor (11.3%), 1 major (2.3%); AE were not associated with pIVCF type (p = 0.53), dwell time (p = 0.96), or use of advanced methods (p = 0.99).

CONCLUSIONS: Permanent inferior vena cava filters can be safely and effectively retrieved, independent of dwell time, and can be considered in cases of device-related AEs or when a pIVCF is no longer indicated. Advanced retrieval methods are required in the majority of cases, thus referral to experienced centers for management and successful retrieval may be beneficial.
Abstract No. 1081

Forceps first: cost analysis of reusable endobronchial forceps as a primary technique for uncomplicated inferior vena cava filter retrieval

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PURPOSE: The use of rigid endobronchial forceps for advanced Inferior Vena Cava (IVC) filter retrieval is a safe and efficacious technique, with high technical success rates and complication rates comparable to other methods. We present a comparison of the immediate and projected costs for reusable endobronchial forceps versus traditional snares as the first line device in routine IVC filter retrieval.

MATERIALS: Unit costs of a selection of snares (Atrieve [Argon], Gooseneck Snare [Covidien], ONE Snare [Merit], Multi-Snare [Braun]) were combined with the cost of a Cook 14F Sheath to calculate the single and per-25 procedural costs. These costs were compared with the unit cost of reusable 4162s Endobronchial Forceps (Lymol) combined with the cost of a Cook 14F Sheath and the estimated cost of endobronchial forceps sterilization/reprocessing.

RESULTS: Projected cost of IVC filter retrieval with endobronchial forceps is estimated at $4850 per 25 procedures. This is inclusive of the one-time $650 cost of the Lymol forceps, $164 per Cook 14F Sheath, and $4 processing cost per procedure. Cost analysis for snares retrieval includes an additional $98 per procedure to account for the use of Cook 9F Sheath (no processing cost). Projected costs for snares retrieval per 25 procedures is as follows: $11,825 Atrieve snare ($375/unit cost), $10,125 Gooseneck snare ($307/unit cost), $9,700 One snare ($290/unit cost), and for $8,575 Multi snare ($245/unit cost). Further analysis demonstrates the following number of procedures required for cost of snares to surpass the initial cost of the endobronchial forceps system: Atrieve snare 2.1, Gooseneck snare 2.7, One snare 3.0, and Multi snare 3.7.

CONCLUSIONS: Once a minimum number of procedures are performed, significant cost savings are achieved with the use of endobronchial forceps for uncomplicated IVC filter retrieval. Cost savings are further increased with increased procedural volume. For this reason, we advocate the use of endobronchial forceps as a primary modality for IVC filter retrieval in the hands of experienced users.

Abstract No. 1082

Peri- and postprocedural complications in patients undergoing C-arm computed tomography-guided balloon angioplasty of the pulmonary arteries

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PURPOSE: To evaluate potential complications of C-Arm computed tomography (CACT)-guided balloon angioplasty of the pulmonary arteries (BPA).

MATERIALS: Overall, 266 consecutive interventions in 67 patients (42 females, mean age 66 ± 13 years) were included. Selective CACT was acquired prior to the intervention for guidance and to select appropriate balloon size based on the measured vessel diameter. Complications during and after the procedure, the need for further interventions and the impact on outcome were assessed.

RESULTS: Overall, 235 interventions were conducted without any complications (88.3%). Minor complications not requiring additional treatment occurred during or after 29 procedures (10.9%), including 3 focal dissections of the targeted pulmonary artery (1.1%), 4 cases of pulmonary hemorrhage (1.5%), 1 case of reperfusion edema (0.4%), 10 cases of postinterventional short-term hemoptysis (3.8%) and recurring cough in 4 patients during a total of 11 interventions (4.1%). Altogether, only 2 cases of major complications requiring additional treatment were reported (0.8%): 1 case of pulmonary hemorrhage treated with epinephrine inhalation to induce hemostasis (0.4%) and 1 case of atrial tachycardia induced during catheterization, subsequently requiring a cardiac pacemaker (0.4%). No patient died due to peri- or postinterventional complications.

CONCLUSIONS: Using CACT-guidance, the peri- and postprocedural complication rate in BPA is significantly below the given numbers in published data, where severe reperfusion edema and pulmonary artery perforation each are reported in up to 7% of patients, as well as an up to 3.4% periprocedural mortality.

<table>
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<th>Retrieval Method</th>
<th>Unit Cost, $</th>
<th>Cook 14F Sheath Cost, $</th>
<th>Cook 9F Sheath Cost, $</th>
<th>Reprocessing Fee/ procedure, $</th>
<th>Cost/25 Procedures $</th>
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Abstract No. 1083

Acute and chronic thrombus: using thrombus age to guide therapy

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PURPOSE: 1. Overview the biochemical change a thrombus undergoes separated into four distinct stages. 2. Discuss stage specific therapy including systemic and catheter-directed therapies.

MATERIALS: Venous thrombosis is a morbid and common clinical condition worldwide. Our current treatment options are most successful in the acute thrombus, which is comprised of fibrin and erythrocytes, making current therapies effective in treatment. However, research has demonstrated that venous thrombus evolves, with complex changes resulting from the interplay between cytokines, coagulation factors, leukocytes and other factors. Chronic thrombus is more resistant to current treatments, and is more cellular with a fibrotic collagenous framework. Understanding the biochemistry of an aging thrombus will allow us to adapt our therapies, optimize outcomes, and explore novel treatments for chronic thrombus.

RESULTS: The evolution of thrombus can be broken into four distinct stages: induction, acute fibrin dominant, intermediate, and chronic connective tissue dominant. During the acute stage, the thrombus is made primarily of platelets and RBCs with a loose network of fibrin. In this phase, anticoagulation and CDT is most effective. In the intermediate and chronic connective tissue stages, the thrombus becomes more organized with a network of collagen and leukocytes and becomes increasingly resistant to anticoagulation therapy. The majority of therapies are directed at the acute thrombus, including heparins, VKAs and novel NVOAs. CDT is reserved for patients with extensive thrombus and patient’s with cardiovascular and neurovascular compromise. Compressive Doppler US is both sensitive and specific in the detecting of DVT, and can sometimes differentiate between acute and chronic thrombus, although this is difficult with most imaging modalities.

CONCLUSIONS: The aging thrombus evolves through several stages, with therapies most effective during the acute phase. While subtle imaging findings can help to differentiate between acute and chronic thrombus, additional imaging techniques should be explored to more reliably differentiate between the two. Novel therapies targeting chronic thrombus should be an area of future research.

Abstract No. 1084

The benefits of transradial arterial access in prostate artery embolization

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PURPOSE: 1) Consider the use of transradial access (TRA) for prostate artery embolization (PAE) through a case example 2) Understand features of TRA that facilitate PAE 3) Understand the equipment that can be used to perform TRA PAE

MATERIALS: Although PAE procedures have been classically performed via transfemoral access (TFA), little research has been performed in the use of transradial access (TRA) as an alternative. TFA has limitations in certain patient populations. Problems with hemostasis, congenital or acquired bleeding disorders and highly anticoagulated patients have increased risks using a femoral access site. Patients with existing back pain and spinal deformities have limitations that are problematic to gain femoral access. In obese patients, overlying subcutaneous tissue may make it difficult to establish access from the groin as well. TRA permits hip flexion, enabling free movement and allowing maximum comfort and immediate ambulation. In addition, TRA facilitates rapid access to the downgoing internal iliac arteries, potentially trimming procedure time.

RESULTS: The patient is a 66-year-old male with benign prostatic hypertrophy and severe lower urinary tract symptoms (International Prostate Severity Score of 30 with severe quality of life impairment) and a recurrent need for an indwelling Foley catheter for urinary retention. Given prostate mass of 210 grams, the patient was not a candidate for transurethral resection of the prostate. He did not want to undergo open prostatectomy and opted for prostate artery embolization. He underwent bilateral prostate artery embolization using a 125 cm 5 French angled catheter and a 150 cm 2.0 French microcatheter. Approximately ½ vial of 100-to 300-micron spherical particles were injected into each prostatic artery. The patient experienced symptom improvement in the first few weeks postprocedure.

CONCLUSIONS: TRA serves as a feasible approach to PAE. It can be an invaluable tool among certain patient populations allowing many benefits such as increased patient comfort and early ambulation.