removed due to the presence of residual thrombus (n=3), occlusion of the IVC (n=3) but also because of severe tilt or migration (n=17). 279 patients with filters died due to co-morbidities, the majority due to cancer. 375 patients still have their filters in situ.

Conclusion: The majority of filters had an absolute indication. Complications after filter placement were frequent (35.4%) but there was a low rate of breakthrough PE and the majority of the complications are clinically insignificant. Our retrieval rate was 83.0%. This may be lower than expected because of higher rates of severe tilt and local migration.


10:36 AM Abstract No. 4

Retrieval of permanently-embedded IVC filters and description of the laser-assisted sheath technique: Radiographic-histopathologic correlation

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Purpose: To evaluate the safety and effectiveness of removing permanently-embedded IVC filters. To describe the laser-assisted sheath technique. To elucidate the pathophysiology of chronic filter implantation via histologic analysis of retrieved specimens.

Materials and Methods: An IRB-approved retrospective study was performed on all patients who underwent filter retrieval from 10/2008 to 10/2009 in our department. Inclusion criteria were patients diagnosed with a permanently-embedded filter (adhered to the IVC and refractory to standard retrieval methods), no longer requiring filtration, who underwent attempted filter removal using alternative methods. All specimens were sent for histology including Elastic Van Gieson (EVG) staining.

Results: Ten consecutive patients with embedded filters underwent attempted retrieval. There were 6 men and 4 women (mean age 47.6 y, range 28-84). Indications for retrieval were symptomatic chronic IVC occlusion with associated edema, caval and aortic penetration, and/or acute PE from caval thrombosis. Retrieval was also performed to reduce risk of complications from long-term filter implantation and to eliminate the need for lifelong anticoagulation. The majority of filters had an absolute indication of removing IVC filters with struts that perforate the IVC wall. This study examines the feasibility and safety of removing IVC filters with struts that perforate the IVC wall on CT imaging.

Materials and Methods: This IRB approved, retrospective study included 64 attempted IVC filter retrievals from 62 patients over a 5 year period. Pre-retrieval CT was used to describe the various imaging characteristics of filter struts as they appeared to perforate the IVC wall. Filter struts were graded using the following CT-based grading system: Grade 0 = no perforation, Grade 1 = struts external but immediately adjacent to the IVC lumen, Grade 2 = struts completely outside the lumen as demonstrated by a halo of retroperitoneal fat, Grade 3 = struts that contact adjacent organs/retroperitoneal structures. Patient medical records were evaluated for filter type, results of filter removal, and complications.

Results: Grade 1 strut perforations were seen in 45 cases (70.3%), Grade 2 perforations were seen in 38 (59.4%) cases, and Grade 3 perforations were seen in 26 cases (40.6%). Nine patients (14%) had no strut perforations. Patients in this study had the following filters: Recovery (n=23), G2 (n=30), Gunther Tulip (n=8), and Optease (n=3). Average filter dwell time was 172 days (range 13-490 days). Fifty-seven of the 64 filters (89.1%) were removed successfully. Seven (10.1%) filters could not be removed because of incorporation of filter struts or tip of filter into the IVC wall. Seven (100%) of the failed retrievals and 48 (84.2%) of the successfully retrieved filters demonstrated some degree of strut perforation (p=NS). Prior to retrieval attempt, filter fracture was detected in 8 cases (12.5%) and IVC stenosis was present in 3 cases (4.7%). No major complications occurred during any retrieval or retrieval attempt. There were 2 cases complicated by immediate post-procedure abdominal pain. Both clinically resolved and no abnormality was detected on CT performed within 2 hours of the procedure.

Conclusion: IVC filter struts perforating the IVC wall is a common finding on CT. IVC filters with strut perforation can be removed safely and this should not necessarily be a contraindication for IVC filter retrieval.

11:00 AM Abstract No. 6

An in vitro study of clot-trapping efficiency of retrievable IVC filters

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Purpose: To evaluate the clot-trapping efficiency of current retrievable inferior vena cava (IVC) filters using an in-vitro model.
Materials and Methods: The IVC was modeled using 25.4mm inner diameter flexible, vinyl tubing and saline solution. To better simulate flow, iliac and renal veins (19.1mm inner diameter) were built into the circuit. Five inferior vena cava filters were studied-- Günther-Tulip (Cook Inc., Bloomington IN), Celect (Cook Inc, Bloomington IN), OptEase (Cordis Endovascular/Johnson & Johnson, Warren, NJ), G2 (Bard Peripheral Vascular, Tempe, AZ) and Option (Rex, Conshohocken, PA) in the infra-renal position. Two water pumps were used for a constant IVC flow of 4.6 L/min. The pressure inside the IVC was 8 mm Hg. Emboli (Surfiofoam, Johnson and Johnson, Warren, NJ) of pre-determined sizes (5x5x5mm, 3x3x4mm or 2x2x2mm) were inserted into the iliac veins. Each filter was tested 10 times per embolus size and the capture efficiency and position within the filter was recorded.

Results: As the clot size increased, the capture efficiency of each filter did not necessarily improve. The smallest clots passed through the center of the tube whereas bigger clots often traveled along the inner walls of the IVC. For the smallest-sized clots (2x2x2mm), the Celect and OptEase filters captured 10 out of 10 clots where as the G2 filter captured only 5 out of 10 (p=0.001). For medium clots (3x3x4mm), the Celect filter captured 10 out of 10 clots whereas the Tulip filter captured 6 out of 10 (p=0.002). The in vitro clot-capturing efficiency of all filters was uniform (10 out of 10) for the biggest clot size (5x5x5mm). The OptEase filter captured clots both inside and outside its wire struts.

Conclusion: Clot size significantly affects the efficiency of IVC filters. The Cook Celect filter was found to have the highest clot-trapping ability across all clot sizes in an in-vitro model.

11:12 AM

Abstract No. 8

Retrievable inferior vena cava filters used as permanent devices in cancer patients


Purpose: To compare clinical outcomes and complication rates of retrievable (RIVCF) and permanent (PIVCF) inferior vena cava filters placed in cancer patients.

Materials and Methods: A retrospective cohort study of 816 consecutive cancer patients who received IVC filters from January 2002 to July 2006 was conducted following IRB waiver of authorization. 721 patients (88.4%) received PIVCF and 95 (11.6%) received RIVCF. Filters deployed included Simon-Nitinol (n=502), Trapease (n=145), Venatech (n=33), Greenfield (n=36), Birds Nest (n=2), Gunther Tulip (n=96) and Recovery (n=2). Indications for filter placement included perioperative prophylaxis in patients with documented history of pulmonary embolism and/or DVT, contraindication to anticoagulation, failure of anticoagulation, as well as complication of anticoagulation. IVC filter related complications including IVC thrombosis (defined as any clot in and/or around the filter as well as caval occlusion), recurrent pulmonary embolism (rPE) as well as new and/or worsening deep venous thrombosis (DVT) were analyzed.

Results: Patients presented with deep venous thrombosis (n=473), pulmonary embolism (n=150), pulmonary embolism and DVT (n=101), IVC thrombus (n=21) as well as with high risk for pulmonary embolism without recent thromboembolic disease (n=71). The mean duration of follow-up in patients receiving ongoing filtration with PIVCFs and RIVCFs was 476 and 421 days, respectively. Ninety-three (96.9%) RIVCFs remained in situ and were not removed. 2.8% of PIVCF recipients experienced rPE versus 6.3% for RIVCF recipients. IVC thrombosis among PIVCF recipients occurred at a rate of 11.4% versus 9.5% in the RIVCF group. The only statistically significant difference was in new and/or worsening DVT found in 13.8% of PIVCF recipients versus 5.2% of RIVCF recipients (p=0.15).

Conclusion: Preliminary analysis suggests that RIVCF can be used as permanent devices in patients with cancer.