CLINICAL STUDY

Inferior Vena Cava Filter Retrieval: Effectiveness and Complications of Routine and Advanced Techniques

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ABSTRACT

Purpose: To investigate the success and safety of routine versus advanced inferior vena cava (IVC) filter retrieval techniques.

Materials And Methods: A retrospective review was performed of patients who underwent IVC filter placement and/or a retrieval attempt over a 10-year period. Retrieval technique(s), preretrieval computed tomography, preretrieval venography, and clinical/imaging follow-up for 30 days after retrieval were analyzed. Mean filter dwell time was 134 days (range, 0–2,475 d).

Results: Filter retrieval was attempted 231 times in 217 patients (39% female, 61% male; mean age, 50.7 y), with success rates of 73.2% (169 of 231) and 94.7% (54 of 57) for routine and advanced filter retrieval techniques, respectively. The overall filter retrieval complication rate was 1.7% (four of 231); complications in four patients (with multiple complications in some cases) included IVC dissection, IVC intussusception, IVC thrombus/stenosis, filter fracture with embedded strut, IVC injury with hemorrhage, and vascular injury from complicated venous access. The rate of complications associated with filter retrievals that required advanced technique was significantly higher than seen with routine technique (5.3% vs 0.4%; $P < .05$). Longer dwell time, more transverse tilt, and presence of an embedded hook were associated with significantly increased rates of failed retrieval via routine technique ($P < .05$).

Conclusions: IVC filters can be retrieved with a high overall success rate (98.2%) and a low complication rate (1.7%) by using advanced techniques when the routine approach has failed; however, the use of advanced techniques is associated with a significantly higher complication rate.

ABBREVIATIONS

AP = anteroposterior, CI = confidence interval, DVT = deep vein thrombosis, IVC = inferior vena cava

Indwelling inferior vena cava (IVC) filters that are no longer indicated for use should be assessed for retrieval in view of the risk of long-term IVC filter complications such as IVC thrombosis, IVC penetration, filter migration, deep vein thrombosis (DVT), and filter fracture (1,2). The desire to retrieve these filters has led to the development and adoption of various registries that have successfully increased the retrieval rate in many institutions (3,4). This trend has also led interventional radiologists to attempt IVC filter retrievals with increased dwell times, particularly in younger patients. Angel et al (2), in a systematic review of 1,715 removed filters, reported an average time to retrieval of 72 days; however, successful retrieval after a dwell time as long as 3,006 days has been reported in the literature (5,6). The success of retrieval attempts has been shown to decrease with prolonged dwell times, which further highlights the importance of frequent follow-up for reassessment of risk and consideration of filter retrieval (7,8).

Although a majority of filters can be removed without difficulty, there are several factors that increase the risk of filter retrieval failure, including embedded filter hook, severe tilt, caval occlusion, and filter penetration into the caval wall (9,10). Multiple studies have described advanced techniques for retrieval of these difficult IVC filters (11,12). A few studies have reported no or minor complications with IVC retrieval (11,13–17), but studies are lacking that have reported a comprehensive complication rate associated with attempted filter retrieval. We

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believe this information is a crucial component in the decision management for IVC filter retrieval attempts. The purpose of the present study is to retrospectively review our institutional experience with IVC filter retrievals during the past 10 years and to document the success rate and complications associated with routine and advanced retrieval methods.

MATERIALS AND METHODS

IVC Filter Placements and Retrievals

Institutional review board approval was obtained to review IVC filter placement and retrieval procedures performed at our institution from 2003 to 2013. Patient electronic medical records were reviewed for patient demographics and filter indication. Indications were categorized based on the 2006 Society of Interventional Radiology (SIR) consensus guidelines (18). IVC filter placement and retrieval procedure reports were reviewed for filter type, fluoroscopy time, venous access site(s), filter retrieval technique(s), and immediate intra- or postprocedural complications. Attempted filter retrieval techniques were classified as antegrade or retrograde based on filter type and venous access site (ie, internal jugular vein antegrade and femoral vein retrograde for all retrievable filter types except OptEase [Cordis, Bridgewater, New Jersey]). Nomenclature from Iliescu et al (12) was used as a standard reference for categorization of advanced filter retrieval techniques. In brief, a stiff wire-displacement technique functions to reorient a filter with significant tilt by passing a stiff wire between the filter apex and cava wall; this is closely related to dual-access technique, which uses a second venous access to externalize the distal end of the wire. Balloon displacement technique attempts filter realignment by inflation of an intravascular balloon placed adjacent to an embedded or tilted filter. Realignment technique incorporates an angled guiding catheter and loop snare to capture the filter hook for filter realignment and retrieval. The "sling" technique consists of a wire passed through the filter legs, then snared proximally and externalized through the sheath, creating a "sling" around the filter. The dissection technique uses rigid bronchoscopy forceps to directly release an embedded hook and/or penetrating struts. Patient chart and imaging records were reviewed as long as 30 days after the procedure for filter retrieval–related complications. Our general algorithmic approach to filter retrieval is to obtain a preretrieval venogram, attempt filter retrieval by routine technique, and then attempt retrieval by advanced techniques (in the same setting or at a later date with increased sedation) only if routine technique failed. We defined advanced retrieval technique as the use of any method other than standard venous access and snaring of the filter hook. We considered any clinically significant outcome related to the IVC filter retrieval procedure as a complication of retrieval. Clinically silent stenosis of the IVC or other subclinical angiographic changes of the vena cava were not considered complications. Patients who had permanent filters retrieved were excluded from analysis, as were patients who did not undergo a filter retrieval attempt as a result of the presence of filter thrombus on a preretrieval venogram. SIR clinical practice guidelines (19) were used for grading of complication severity.

Cross-Sectional Imaging Review

Computed tomography (CT) scans of the abdomen performed at our institution between filter placement and retrieval were reviewed by a single radiology resident who was blinded to filter outcome. Transverse tilt of the filter was measured from coronal reconstructions as the angle of the filter from the center axis of the vena cava. Anteroposterior (AP) displacement of the hook from the center axis of the vena cava and the height of the filter were measured from axial images. AP tilt was then calculated as $\Theta_{AP} = \tan^{-1}$ (hook AP displacement/filter height).

Embedded hook was defined by a lack of definite visualization of the vena cava or intravenous contrast medium outside the filter hook. Leg penetration was defined by the length of the leg with greatest penetration. Filter leg contact with structures adjacent to the vena cava was recorded. Penetration was then graded according to a previously described grading system (20).

Venographic Imaging Review

Frontal-projection preretrieval venograms for all IVC filter retrievals were reviewed by a single radiology resident who was blinded to filter outcome. Filter transverse tilt was defined as the angle between the axis of the filter and the axis of the vena cava. A standard vena cava axis was defined as a line connecting the horizontal bisect of the vena cava at the level of the filter hook and filter base. Embedded hook was defined as lack of definite visualization of contrast medium outside the filter hook; lateral projections (if obtained) were also reviewed for presence of embedded hook. Leg penetration was defined as visualization of greater than 3 mm of filter leg outside the vena cava.

Statistical Analysis

Statistical analysis was performed by using SPSS software (IBM, Armonk, New York). Differences in patient demographic and imaging characteristics between advanced and routine retrievals were comparatively analyzed by analysis of variance for variables with assumed normal distribution and homogenous variances based on the Levene test (age, days before filter retrieval attempt at the time of CT). Variables that showed significant heterogeneity of variances based on the