Removal of Retrievable Inferior Vena Cava Filters with Computed Tomography Findings Indicating Tenting or Penetration of the Inferior Vena Cava Wall

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ABSTRACT

Purpose: To examine the feasibility and safety of removing retrievable inferior vena cava (IVC) filters with struts external to the IVC wall on computed tomography (CT) imaging.

Materials and Methods: This retrospective study included 64 IVC filter retrievals from 62 patients over a 5-year period. CT images obtained before retrieval were used to describe the various imaging characteristics of filter interactions with the IVC wall. Patient medical records were reviewed for filter type, results of filter removal with standard or nonstandard techniques, and complications.

Results: Filter struts outside the IVC wall were a common finding on CT with 55 (85.9%) filters showing some degree of perforation. Of 64 filters, 57 (89.1%) were removed successfully; 7 (10.9%) filters could not be removed because of incorporation of filter struts or tip into the IVC wall. Before retrieval, filter fracture was detected in eight (12.5%) cases, and IVC stenosis was present in three (4.7%) cases. No major complications occurred during any retrieval. Two (3.1%) cases were complicated by postprocedure abdominal pain. Both cases clinically resolved, and no abnormalities were detected on postprocedure CT.

Conclusions: The appearance of filter struts tenting or penetrating the IVC wall is a common finding on CT performed before filter retrieval. IVC filters with these findings can be removed safely and should not be a contraindication for IVC filter retrieval.

ABBREVIATIONS

IVC = inferior vena cava, PACS = picture archiving and communications system, PE = pulmonary embolism

Retrievable inferior vena cava (IVC) filters were introduced as an alternative to permanent filters to provide protection from pulmonary embolism (PE), while potentially decreasing the long-term risks associated with permanent IVC filters (1,2). The use of retrievable IVC filters has increased since retrievable filters were first introduced, and these filters generally have been shown to be relatively safe to deploy and retrieve (3,4).

Major complications associated with retrievable IVC filters are uncommon (5,6). Retrievable filters can fracture, migrate, become embedded in the IVC wall, and contain struts that perforate through the IVC wall, however (7–9). Hull and Robertson (10) examined the issue of filter strut perforation involving the Recovery filter (Bard Peripheral Vascular, Tempe, Arizona), which was withdrawn from the market in 2005. These investigators showed that leg perforation is associated with an increased incidence of strut fracture and migration. In addition to these complications, there are often concerns regarding the success and safety of removing filters with perforated struts. Remov-
ing filters with perforated struts raises potential issues of bleeding, injury to the IVC, and injury to surrounding structures. These potential issues cause some physicians not to remove IVC filters with perforated struts. This study examines the feasibility and safety of removing retrievable IVC filters with struts that are tenting or penetrating the IVC wall as seen on computed tomography (CT) imaging.

**MATERIALS AND METHODS**

After receiving institutional review board approval for this study, we retrospectively reviewed our procedure database and picture archiving and communications system (PACS) to identify patients who had an IVC filter removed during the period January 2003 to December 2008. During this time, 88 IVC filters were removed from 86 patients. Because CT performed before retrieval was used to identify and assess IVC perforation, 24 patients without a preretrieval CT study available for review on the PACS at our institution were excluded, leaving 64 filters removed from 62 patients.

There were 32 (51.6%) male patients and 30 (48.4%) female patients. The mean age was 39.8 years (range 17–73 years). Over the 5-year period, four different filter types were retrieved: 23 Recovery filters (Bard Peripheral Vascular) (35.9%), 30 G2 filters (Bard Peripheral Vascular) (46.9%), 8 Gunther Tulip filters (Cook Medical, Bloomington, Indiana) (12.5%), and 3 OptEase filters (Cordis Corporation, Bridgewater, New Jersey) (4.7%).

CT images obtained before retrieval were used to assess the integrity of the IVC filter, strut relationship to the IVC wall, and thrombus trapped in the filter. We were primarily interested in describing the various appearances these filters had before retrieval for categorization purposes and possible associations with complications. Because the imaging characteristics of IVC filter perforation are not always systematically described in the literature (8–10), we used CT images obtained before retrieval to classify IVC filter interactions with the IVC wall into four different grades (**Table 1**), as follows: grade 0, strut fully within the IVC lumen (**Figure 1**); grade 1, strut external but immediately adjacent to the IVC lumen (**Figure 2**); grade 2, strut completely outside the lumen, as shown by a halo of retroperitoneal fat (**Figure 3**); and grade 3, strut that contacts adjacent organs and retroperitoneal structures (**Figure 4**). Although the appearance of a grade 1 strut on CT is external to the IVC wall, it probably represents what is commonly termed “tenting” of the IVC wall rather than true penetration.

Every strut was identified, and each filter was classified by its maximum grade strut. Because we believed that each strut constitutes an individual risk for complication at retrieval, we also graded each individual strut such that a single filter may contain struts with multiple grades. This was done in addition to grading the entire filter because we were uncertain if a higher grade strut would impart a higher risk of complication. Grading an entire filter based only on maximum strut grade may mask complications associated with lower grade struts.

The success of IVC filter removal along with major and minor complications was recorded. The technique used for filter retrieval was noted. If postprocedure CT scans were obtained, these images and reports were reviewed for potential complications that may have occurred secondary to the IVC filter retrieval procedure.

**Table 1. Grading System for IVC Filter Interaction with IVC Wall**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
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<tbody>
<tr>
<td>0</td>
<td>Normal; filter strut confined entirely within IVC</td>
</tr>
<tr>
<td>1</td>
<td>Filter strut is immediately adjacent to external aspect of IVC wall likely reflecting tenting of IVC wall</td>
</tr>
<tr>
<td>2</td>
<td>Filter strut is entirely outside IVC lumen within retroperitoneum as evidenced by a “halo” of retroperitoneal fat around axially viewed strut</td>
</tr>
<tr>
<td>3</td>
<td>Filter strut interacts with adjacent organ outside of IVC*</td>
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* An “interaction” was defined as a strut touching, impressing, or perforating any other organ. Other organs included liver, bowel, aorta, lymph nodes, psoas muscle, and vertebral body.

![Figure 1. IVC filter interaction with IVC wall: grade 0. Note how all the struts are contained within the IVC lumen.](image-url)
RESULTS

The appearance of filter struts outside the IVC lumen was a common CT finding with 55 (85.9%) filters showing at least one strut external to the IVC wall on CT. When individual struts were evaluated, 56 (87.5%) of the filters contained grade 0 struts on CT images obtained before retrieval. Grade 1 struts were present in 45 (70.3%) of the filters. Grade 2 perforation was present in 38 (59.4%) of the filters, and grade 3 perforation was present in 26 (40.6%) of the filters. When each filter was graded according to maximum strut grade, 9 filters were classified as grade 0 (14.1%), 14 filters were classified as grade 1 (21.9%), 15 filters were classified as grade 2 (23.4%), and 26 filters were classified as grade 3 (40.6%) (Table 2). Table 3 summarizes the grading system applied to each filter strut in the individual filter types retrieved.

The mean filter dwell time was 172 days (range 13–490 days). Of the 64 filters in which removal was attempted, 57 (89.1%) were successfully retrieved. Seven (10.9%) filters could not be removed because of incorporation of filter struts or filter tip into the IVC wall. Some degree of strut perforation was apparent in 48 (84.2%) of the successfully retrieved filters and 7 (100%) of the unsuccessful retrievals. Nonstandard techniques were not tried in six of the seven unsuccessful retrievals either because this was early in our experience using these techniques or because of patient choice. Endobronchial forceps (rather than the standard Recovery Cone [Bard Peripheral Vascular] or snare) were needed to remove 17 (26.6%) filters because the tip of the filter was embedded in the IVC wall (11). Eight (12.5%) filter retrievals were referred to our institution after at least one prior attempt from outside.

Table 2. Grading of Each Filter Based on Maximum Grade Strut

<table>
<thead>
<tr>
<th>Grade</th>
<th>Number (Percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 0</td>
<td>9 (14.1%)</td>
</tr>
<tr>
<td>Grade 1</td>
<td>14 (21.9%)</td>
</tr>
<tr>
<td>Grade 2</td>
<td>15 (23.4%)</td>
</tr>
<tr>
<td>Grade 3</td>
<td>26 (40.6%)</td>
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Figure 2. IVC filter interaction with IVC wall: multiple grade 1 struts (arrows). These struts lie adjacent to the apparent external wall of the IVC and likely represent tenting of the IVC wall.

Figure 3. IVC filter interaction with IVC wall: grade 2 strut (arrow). The strut is entirely surrounded by retroperitoneal fat.

Figure 4. IVC filter interaction with IVC wall: grade 3 strut. Two struts (arrows) are within the lumen of the aorta.
institutions, and six (75%) of these referred retrievals required endobronchial forceps.

Filter fracture of one or more struts was seen in eight (12.5%) patients before attempted filter removal. All filters with fractured struts were successfully removed. IVC stenosis was seen in three (4.7%) cases on preprocedure cavo gram.

There were no major complications from removing the filters with struts tenting or penetrating the IVC wall. Two patients (3.1%) complained of postprocedural abdominal pain in the immediate filter removal time period. Noncontrast CT performed in the immediate postretrieval period revealed no cause for the pain, and the symptoms clinically resolved with no treatment. Both patients were discharged the day of the procedure.

**DISCUSSION**

Anticoagulation is the primary mode of treatment for PE and deep venous thrombosis (12). When anticoagulation has failed or is contraindicated in these patients, IVC filters have been accepted as a means to prevent the occurrence of PE (3). retrievable filters have emerged as an alternative to permanent filters in these patients who need short-term protection from PE. IVC filters have additionally been used as a prophylactic tool against PE in certain patient populations (3,13).

Retrieval of IVC filters is generally safe and seems to be associated with low morbidity and mortality even in anticoagulated patients (14). Retrieval failure and various complications seen at the time of removal, although uncommon, may occur, however. Failure to retrieve temporary filters may be linked to dwell time and tilting of the filter (15,16). Complications seen at filter retrieval have been well described and include fracture, tilting, and endothelialization of the filter (8,10,17,18).

The presence of filter struts external to the IVC wall is also a well-known phenomenon. Although these patients are often asymptomatic, the concern over these filters is heightened when the intent is for eventual retrieval. Previous case reports have described complications attributed to IVC wall perforation by filter struts (19–22). These reports do not directly address the issue of feasibility or safety in removing these filters, however. An additional issue arises when physicians deny patients the option of filter retrieval because of concerns for complications when struts are seen external to the IVC wall.

This study showed no major complications in retrieving filters containing struts outside the IVC wall. No extravasations were identified. The only postprocedure complications directly related to the procedure were two cases of abdominal pain that clinically resolved on their own.

Our study also shows that filter struts within the same filter can be expected to interact with the IVC wall in various ways. Most filters contain struts that remain within the IVC lumen (grade 0). Struts immediately adjacent to the external wall of the IVC reflecting tenting (grade 1), struts with full penetration of the IVC wall (grade 2), and struts interacting with adjacent structures outside the IVC wall (grade 3) are common observations, however. When filters are graded by maximum strut grade, our study finds that grade 3 filters were the most commonly encountered filter type.

The grading system we described was introduced as a descriptive tool to emphasize that IVC filter struts can interact with the IVC wall in various ways. Although this grading system is of uncertain clinical significance given the low rate of complications seen in our study, larger studies may reveal complications associated with particular grades. Individual filter types may be associated with certain grades, which may have implications for expected technical difficulty or complications associated with retrieval. Pathologic correlation with autopsy specimens may also be required to confirm findings seen on CT. The important finding in our study is that despite the various forms of severity seen with IVC filters interacting with the IVC wall, complications in retrieving these filters can be expected to be limited.

This study is limited in that it may not be generalizable because this is a single-institution experience. Also, our conclusions may be limited in regard to Gunther Tulip and OptEase filters because they represented only a small fraction of the filters used in our study. Although we conclude that it is generally safe to remove filters with struts perforating the IVC wall, further studies evaluating individual filter types in various clinical scenarios are needed.

In conclusion, our study suggests that IVC filter tenting and penetration through the IVC wall is a common finding on CT images obtained before retrieval and that retrieval of these filters is safe. We also show that IVC filters interact with the IVC wall in various ways. Future studies are
required to assess the clinical significance of these various grades of perforation.

**REFERENCES**


