

## Retrievable Vena Cava Filters: Clinical Predictors of Retrieval

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### ABSTRACT

#### Objectives:

The purpose of this study is to: 1) quantify the rate of vena cava filter retrieval using single institutional data and 2) evaluate patient demographics and system-based practices that influence the placement and removal of a retrievable vena cava filter.

#### Methods:

This was a retrospective longitudinal analysis of a single institution's experience. The sample cohort consisted of patients undergoing filter placement between January 1, 2009 and May 31, 2010. For each patient, we gathered data regarding demographics and medical history and then reviewed the clinical course of the filter for a minimum of 100 days. Fisher's exact test and logistic regression were used to determine significance.

#### Results:

294 patients received retrievable filters. 28 patients (9.5%) had an attempt at retrieval. Factors associated with increased retrieval attempts included younger age, lower number of comorbidities, extremity hemorrhage on presentation, vascular surgery consultation, and no history of cancer. All patients with retrieval attempts were inpatients at time of removal or had documented follow-up appointments regarding filter management. Of the 266 patients with no retrieval attempts, only 31 had documented follow-up appointments for filter management. Of the 37 patients with temporary indications for a filter (i.e. short-term prophylaxis), only 7 patients had an attempt at retrieval; 11 patients had no attempt at retrieval despite never having developed DVT/PE or other long-term indication for anticoagulation.

#### Conclusion:

System-based practices influence the placement and removal of vena cava filters. This study identifies areas for systemic interventions to improve retrieval rates. Dedicated follow-up by interventional providers will likely help to improve retrieval rates, particularly in patients with temporary indications for the filter.

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## Introduction

Retrievable, or “optional,” vena cava filters are indicated to prevent massive pulmonary embolism (PE) in situations where anticoagulation is contraindicated or ineffective. Filters may be removed once contraindications resolve and anticoagulation is restarted or they may be left in place akin to permanent filters. All retrievable filters are approved for permanent use.

There have been numerous studies documenting the safety and efficacy of multiple brands of retrievable filters in preventing PE.<sup>1,2</sup> While useful for preventing PE in the short term, it is well established that both permanent and retrievable filters place the patient at risk for long-term complications, such as filter fracture, filter migration, deep venous thrombosis, caval stenosis/occlusion, and caval penetration. In general, once patients meet the criteria for filter removal, most attempts to retrieve the filters are successful.<sup>5,6</sup>

The utilization of vena cava filters has exponentially increased over the past few decades. In 1979, around 2,000 vena cava filters were placed nationwide; in 1999, around 49,000 vena cava filters were placed nationwide. However, despite increasing usage, it is noteworthy that only a minority of patients with retrievable filters have them removed, with published retrieval rates as low as 2.4–3.6%.

While there is no current guideline to suggest an appropriate rate of filter removal in a given population, it is evident that there are difficulties in identifying patients who are likely to become candidates for filter removal. The purpose of this study is to: 1) quantify the rate of filter retrieval using single institutional data and 2) evaluate patient demographics and system-based practices that influence the placement and removal of a retrievable filter.

## Material and Methods

### Study Design

A retrospective longitudinal analysis of a single institution’s experience with filter implantation and removal was conducted after IRB approval and in accordance with the Health Insurance Portability and Accountability Act (HIPPA). The derived sample population consisted of patients at our institution who

underwent vena cava filter placement between the dates of January 1, 2009 and May 31, 2010. To be included, the placement of the filter must have occurred at our institution. Patients were identified with our radiology inventory management database (Radiology Information System).

The sample population was sorted into two main groups: 1) those who had retrievable filters placed with eventual removal attempts (including failed attempts), and 2) those who had retrievable filters placed with no removal attempts. After compiling the groups, the clinical course of the filter was followed for a minimum of 100 days. This time period was chosen because most filter manufacturers recommend that the filters be removed, if possible, within 60–90 days after placement.

With each patient, we reviewed the primary indications for placement of each filter and gathered data regarding demographics and medical history and then reviewed the clinical course regarding the filter. The rates of filter placement per variable and the rates of successful filter removal per variable were subsequently calculated. Indwelling time for the retrievable filters was also recorded.

### Clinical Data

Patients who underwent IVC filter placement and removal during the study period were recorded into our database. Demographics included age, sex, race, and insurance status. Clinical data included: comorbidities recorded in accordance with the Charlson Comorbidity Index (CCI), history of malignancy, location of hemorrhage on presentation, filter type (permanent or retrievable), filter brand, indication for filter placement and removal, duration of filter implantation, location of filter implantation, and whether systemic anticoagulation was initiated on discharge. The referring physician, referring clinical service, and physician performing the filter placement were also recorded. The presence of scheduled follow-up appointments to consider filter retrieval was noted for groups 1 and 2.

### Statistics

We evaluated how each demographic variable and system-based factor affected the likelihood of filter retrieval.

Continuous variables were reported as means with standard deviation. Fisher's exact test was used to compare categorical variables. Logistic regression was used for age and CCI. Odds ratio was calculated for each variable as well. Statistical significance was considered with a two-tailed P value less than 0.05. All analyses were conducted using Stata 10 (Stata Corp. Texas).

## Results

We identified a total of 294 patients who received a retrievable vena cava filter over the studied time period. Of the 294 patients, 28 patients received a retrievable filter and underwent a removal attempt (referred to as Group 1); 266 patients a retrievable filter and had no attempts at removal (referred to as Group 2).

The main clinical indications for filter placement included: 1) documented PE and/or DVT in settings where anticoagulation was contraindicated or likely to lead to complications, 2) recurrence of PE or worsening of DVT despite anticoagulation or previous IVC filter, 3) prophylactic placement in high-risk preoperative patients and trauma patients without documented history of PE or DVT, and 4) situations where a new PE was judged to likely result in death, as in patients with limited cardiopulmonary reserve or a patent foramen ovale. Clinical indications for filter removal included: 1) no further need for indwelling filter, 2) suspicion for bacteremia or infected filter, and 3) complications from placed filter.

Of the 294 patients with retrievable filters, 28 patients (9.5%) had a removal attempt with an average indwelling time of 69 days. Of these 28 patients, 10 had the removal attempt as an inpatient, 10 had follow-up appointments scheduled with a procedural service prior to discharge, and the remaining 8 were eventually scheduled for removal by a phone call from the patient or referring physician.

Table 1 displays the characteristics of patients with an attempt at filter retrieval (Group 1) and patients without an attempt at filter retrieval (Group 2). Factors associated with increased retrieval attempts included younger age, no history of cancer, lower number of comorbidities, extremity hemorrhage on presentation, referral from the orthopedic surgery service, vascular surgery consultation prior to filter placement, and

scheduled follow-up appointments with a procedural service. Each additional point value on the CCI was associated with a lower chance of removal.

Of the 266 patients with retrievable filters but no removal attempts, 31 patients had scheduled appointments to discuss filter management. Of these 31 patients, 16 had indications to leave the filter in place and 15 patients were noncompliant with attending the follow-up appointments. 235 of 294 patients (80%) with retrievable filters had no documented follow-up plans with a procedural service to discuss filter management. Of note, this does include patients who died, transferred to palliative care, or became lost to follow-up (105 patients). These results are similar to that of a prior study, in which 70% of patients had no documented plans for removal.

## Discussion

We observed a low rate of filter retrieval in patients receiving a retrievable vena cava filter (9.5%). Our study reinforces that there are patient factors and system-based practices which influence whether or not there is an attempt at filter retrieval (seen on Table 1).

Younger age was associated with increased filter retrieval attempts. There are fewer comorbidities in this inherently healthier population. This is reflected by the CCI score, which was significantly lower in patients with a retrieval attempt. This suggests that there are less likely to be extenuating circumstances that prevent removal of a filter in a young patient. This has been previously demonstrated.

A history of cancer was associated with decreased filter retrieval attempts. While cancer itself is not a contraindication to filter removal, retrieval of the filter may be prevented by recurring thrombocytopenia from chemotherapy, ongoing DVT/PE, and advanced stages of cancer. This is concordant with prior studies.<sup>12,13</sup>

Being referred by orthopedic surgery was associated with increased filter retrieval attempts. The orthopedic service was typically involved when the indication for filter placement was temporary (i.e. prophylaxis). This included trauma and high-risk surgical procedures which temporarily immobilized the patient. In addition, extremity hemorrhage is typically more manageable than hemorrhage in other locations (e.g.

Table I: Characteristics of patients with an attempt at filter retrieval

Total Patients = 294				
Patient Characteristics	Group 1 N = 28	Group 2 N = 266	Odds Ratio (95% CI)	P Value
Age, mean (SD)	43.3 (16.3)	58.3 (16.9)	0.8a (0.7 to 0.9)	<0.0001
CCI, mean (SD)	1.8 (2.3)	5 (3.6)	0.7b (0.6 to 0.8)	<0.0001
Male Sex	12 (43%)	143 (54%)	0.7 (0.3 to 1.4)	0.32
Black Race	3 (11%)	26 (10%)	1.1 (0.3 to 3.9)	0.75
<b>Referring service</b>				
Medicine	9 (32%)	120 (45%)	0.6 (0.3 to 1.3)	0.23
Surgery	9 (32%)	92 (35%)	0.90 (0.4 to 2.1)	1
Neurology	0 (0%)	9 (3%)	0.5 (0.1 to 8.4)	1
Neurosurgery	2 (7%)	28 (11%)	0.7 (0.1 to 2.9)	0.75
Orthopedics	5 (18%)	4 (2%)	14 (3.6 to 56)	0.001
Ob/Gyn	1 (4%)	6 (2%)	1.6 (0.2 to 14)	0.51
Pediatrics	2 (7%)	0 (0%)	50 (2 to >100)	0.01
<b>Procedural Service</b>				
Vascular Surgery	9 (32%)	24 (9%)	4.8 (1.9 to 12)	0.001
Interventional Radiology	4 (14%)	16 (6%)	2.6 (0.8 to 8.4)	0.11
Infrarenal placement of filter	23 (82%)	239 (90%)	0.5 (0.2 to 1.5)	0.21
<b>Indication</b>				
Anticoagulation contraindicated	13 (46%)	172 (65%)	0.5 (0.2 to 1)	0.07
Failure of anticoagulation	7 (25%)	46 (17%)	1.6 (0.6 to 4)	0.31
Prophylaxis/Trauma	7 (25%)	30 (3%)	2.6 (1 to 6.7)	0.06
Tenuous cardiovascular status	1 (4%)	12 (5%)	0.8 (0.1 to 6.3)	1
Unknown	0 (0%)	7 (3%)	0.6 (0.1 to 11)	1
Intra-abdominal hemorrhage	2 (7%)	22 (8%)	0.9 (0.2 to 3.8)	1
Gastrointestinal hemorrhage	1 (4%)	45 (17%)	0.2 (0.1 to 1.4)	0.10
Brain/Spine hemorrhage	3 (11%)	60 (23%)	0.4 (0.1 to 1.4)	0.22
Extremity hemorrhage	4 (14%)	8 (3%)	5.4 (1.5 to 19)	0.02
Intra-thoracic hemorrhage	2 (7%)	8 (3%)	2.5 (0.5 to 12)	0.24
Follow-up with procedural service	28 (100%)	31 (12%)	426 (25 to >100)	0.0001
Anticoagulation on discharge	18 (64%)	136 (51%)	1.7 (0.8 to 3.9)	0.23
History of cancer	6 (21%)	114 (43%)	0.4 (0.1 to 0.9)	0.04
Anticoagulation on discharge	6 (21%)	114 (43%)	1.7 (0.8 to 3.9)	0.23
History of cancer	6 (21%)	114 (43%)	0.4 (0.1 to 0.9)	0.04

a — Per every additional 5 years of age.

b — Per every additional point on the CCI.

intracranial). As evidenced in our study, patients presenting primarily with an extremity hemorrhage were associated with increased retrieval attempts. This makes sense as patients with intracranial or gastrointestinal bleeds are unlikely to go back on anticoagulation.

In our study, the indication for filter placement did not have an association with an attempt at filter retrieval. Of interest, previous studies have demonstrated that filters

placed for prophylactic indications, such as before surgery or after trauma, are removed more frequently than for other indications.<sup>13,14,15</sup> This can be explained by the relatively short time frame these filters are required. In theory, every patient receiving a filter for prophylaxis should have it removed once the need for the filter resolves. On the other hand, it is also well known that trauma patients are frequently lost to follow-up, obviating the possibility of removal.<sup>16</sup>

For example, in our study, 37 patients had prophylactic indications for a filter, but only 7 patients had an attempt at removal. 3 patients died after filter placement, however the remaining 27 patients had no documented reasons to leave the filter in place or contraindications for removal. 9 patients were lost to follow-up at discharge; 18 patients continued to be seen within our health system but still had no documented reasons for leaving the filter in place. Of these 18, 11 never developed DVT/PE or other indication for long-term anticoagulation. The absence of a retrieval attempt in these patients implies that there was a lapse of appropriate follow-up to discuss filter retrieval. This validates the importance of strictly monitoring retrievable filters, especially in the trauma population and in patients receiving filters for prophylaxis.

Arranging for follow-up with a procedural service was the single most important factor for having a retrieval attempt. In our study, all patients with a retrieval attempt were either inpatients during both placement and removal of the filter, scheduled outpatient appointments with a procedural service at discharge, or eventually scheduled outpatient appointments with a procedural service by a referring clinician. While interventional radio-logists placed the majority of filters in our study, follow-up visits were not scheduled as often. When the vascular surgery service was consulted, the surgeon typically performed the procedure and followed the patient as an inpatient and outpatient.

In our study, retrieval attempts were not influenced by anticoagulation status at discharge. This is in contrast to prior studies where patients discharged with anticoagulation had significantly increased retrieval rates.<sup>12,18</sup> In many circumstances, if a patient can be started on anticoagulation safely, then a filter is not needed anymore and should be removed.

## Summary

It is evident that a large number of retrievable filters will become lost to clinical follow-up.<sup>17</sup> Multiple prior studies have demonstrated that follow-up with procedural services increased retrieval rates, especially in the trauma population.<sup>18,19,20</sup> This data supports the importance of follow-up visits following the placement of a filter. While the primary responsibility for filter management certainly belongs to

the procedural services, primary care physicians and other specialists can greatly serve patients by learning about vena cava filters and ensuring that patients have appropriate follow-up when these devices are in place.

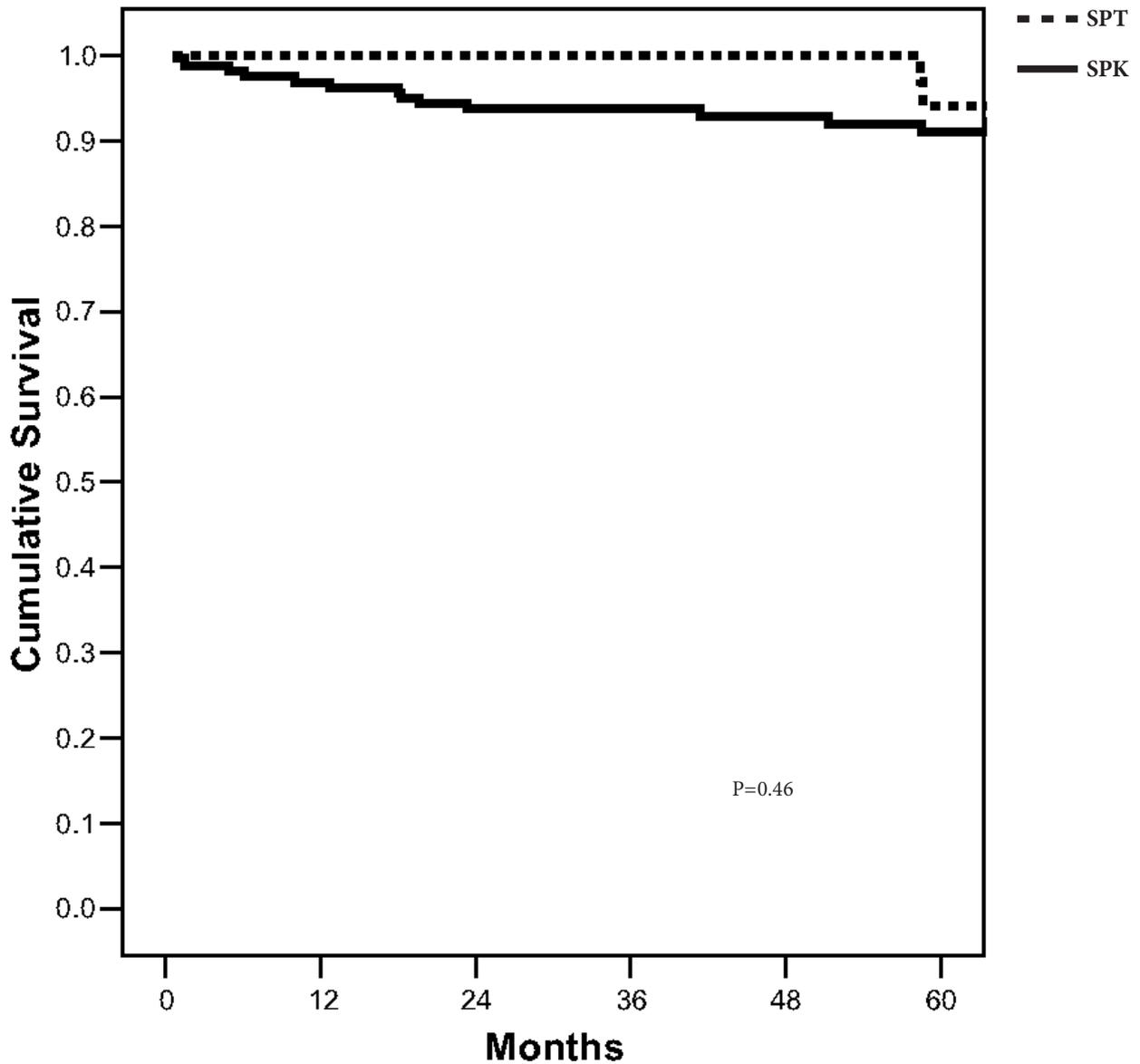
In 2010, and again in 2014, the FDA officially recommended that implanting physicians and clinicians responsible for the ongoing care of patients with retrievable vena cava filters consider removing the filter as soon as protection from PE is no longer needed.<sup>21,22</sup> In October 2013, the FDA suggested that the maximal benefit for filter removal occurred between 1 and 2 months after filter placement.<sup>23</sup> These recommendations, in addition to prior knowledge of poor retrieval rates, have spurred wide interest in developing new methods for better tracking patients and improving retrieval rates. There have been several reports demonstrating improved filter retrieval rates after implementing new databases and clinics to track patients.<sup>14,24,25,26,27</sup> For example, following creation of a dedicated outpatient filter clinic, one study demonstrated a retrieval rate increase from 29% to 60%. Furthermore, there is currently a large multicenter trial (PRESERVE) being run jointly by both the Society of Interventional Radiology (SIR) and Society of Vascular Surgery (SVS) which aims to further evaluate the placement and retrieval of filters.<sup>29</sup> It is apparent that there is still much work to be done to fully understand the safety profile and efficacy of vena cava filters.

There are several limitations to our study. Again, there is no “correct” rate of filter retrieval; many patients receiving filters may require them for a long period of time. Since all retrievable filters are approved for permanent use, we cannot determine the intent of the physician at the time of filter placement. Using a retrievable filter does not imply that there is a plan for future removal. The patients in this study came from a single tertiary care hospital, thus the results are not representative of healthcare delivery nationwide. Our online medical record does not document every interaction between patients and their physicians. It is possible that the patients chose not to have a filter removed or chose to have the filter removed at a different institution. In addition, there were a large number of patients who died or transferred to palliative care; removing a filter is not feasible in these cases.

In summary, we have observed a low rate of filter retrieval and identified factors associated with retrieval attempts. More importantly, this study demonstrates the importance of tracking filters and following up on patients with filters, especially those in the trauma population and/or receiving filters for prophylaxis. This is encouraging data for interventional radiology practices striving to improve

patient care by establishing consult services and clinics to follow patients for the long term. It is equally important to continue educating referring services about safe and proper use of vena cava filters.

Figure 1: Five year actuarial patient survival according to type of pancreas transplant (p=NS).



## Authors

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