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Retrievable Inferior Vena Cava Filters Can Be Placed and Removed with a High Degree of Success: Initial Experience

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Abstract

Objectives—Evaluate the success rate of retrievable inferior vena cava filter (IVC) removal in a tertiary care practice.

Background—Retrievable IVC filters became readily available in the United States following Food and Drug Administration approval in 2003, and their use has increased dramatically. They represent an attractive option for patients with contraindications to anticoagulation who may only need short-term protection against pulmonary embolism.

Methods—All patients who had undergone placement of a retrievable IVC filter at Mayo Clinic between 2003 and 2005 were retrospectively reviewed to evaluate our initial experience with retrievable inferior vena cava filters at a large tertiary care center.

Results—During a three-year-period of time, Mayo Clinic, Rochester, MN placed 892 IVC filters, of which 460 were retrievable. Of the 460 retrievable filters placed (249 Günther Tulip®, 207 Recovery®, and 4 OptEase®), retrieval was attempted in 223 (48.5%). Of 223 initial attempts, 196 (87.9%) were initially successful and 27 (12.1%) were unsuccessful. Of the 27 unsuccessful initial retrieval attempts, 23 (85.2%) were due to the presence of significant thrombus within the filter and 4 (14.8%) were due to tilting and strut perforation. Of the 23 filters containing significant thrombus, 9 (39.1%) were later retrieved after a period of anticoagulation and resolution of the thrombus.

Conclusions—Retrievable IVC filters can be removed with a high degree of success. Approximately one in ten retrievable IVC filter removal attempts may fail initially, usually because of significant thrombus within the filter. This does not preclude possible removal at a later date.

Keywords

inferior vena cava filters; successful removal; venous thromboembolism

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INTRODUCTION

Venous thromboembolism (VTE), consisting of deep vein thrombosis (DVT) and pulmonary embolism (PE), is a relatively common condition associated with serious and costly outcomes.(1-5) Anticoagulation is the standard of care but is contraindicated in many patients. When anticoagulation is contraindicated or fails, inferior vena cava (IVC) interruption is a mechanical technique used to prevent potentially fatal migration of thrombus from the lower extremity veins to the pulmonary arteries. Initially accomplished by open surgical ligation or clipping, it is now easily and safely performed by percutaneous placement of caval filters proven to decrease the risk of pulmonary emboli.(6-8) IVC filter use has increased dramatically in recent years and it was estimated that approximately ¼ million per year currently would be placed. (9, 10) Historically, IVC filters were permanent devices associated with IVC occlusion and an increased risk of lower extremity DVT. (6) Reports on the long term patency of the IVC with a filter in place vary widely. Crochet reported patency of only 66.8% at 9 years with the Vena Tech LGM® permanent IVC filter versus Greenfield's report of 96% caval patency at 20 years with the stainless steel Greenfield permanent IVC filter. (11, 12) The presence of a permanent IVC filter has prompted some clinicians to treat patient with long term secondary prophylaxis with anticoagulation therapy in spite of the associated bleeding risk, cost, and inconvenience.

The main advantage of a retrievable IVC filter is it can be removed when it is no longer needed, thus sparing the patient the aforementioned risks of a permanent foreign body in the cava. Although they are not a new idea, retrievable caval filters became widely available in the United States following Food and Drug Administration (FDA) approval in 2003, and their use has become commonplace. There is a variable window of time during which a retrievable filter can be removed with a high likelihood of success. With time, some filters become more incorporated into the wall of the cava and may be difficult or impossible to remove percutaneously. Under some circumstances, retrievable filters may be left *in situ*. We describe our initial experience with retrievable IVC filters in a high volume tertiary care practice.

MATERIALS AND METHODS

Study design

A retrospective review of IVC filter placements and removal attempts was conducted at a single tertiary care institution in the north central United States (Mayo Clinic, Rochester, MN) for the period January 2003 through December 2005. All patients referred for IVC filter placement or removals were eligible for inclusion. The decision to place or remove a filter was at the discretion of the referring clinician. Standard informed consent was obtained prior to any procedure and was documented in the medical record. A computerized record search was conducted for patients who had consented for research and had IVC filters placed were selected for analysis. Clinical characteristics, demographics, indication for IVC filter placement and removal, type of IVC filter used, and complications were documented for these patients. The study was approved by the local Institutional Review Board.

Retrieval IVC Filters

Three brands of retrieval IVC filters were available during the study period. The Günther-Tulip® filter (Cook Medical Inc., Bloomington, IN) was the first available to us and was recommended for removal within approximately two weeks of placement. The Recovery® filter (Bard Peripheral Vascular, Tempe, AZ) was available for removal within a longer window of time (average of 60 days as described in Bard product literature) and was subsequently withdrawn from the market in September 2005. The OPTEASE® filter (Cordis, Miami Lakes, FL) was recommended for removal within approximately three weeks of placement and was not widely used in our practice. All procedures were performed in dedicated peripheral angiography suites under sterile conditions and fluoroscopic guidance by fully trained interventional radiologists experienced in the use of IVC filters and a wide variety of endovascular procedures. An inferior vena cavogram with iodinated contrast was standard procedure before placement or removal. The infrarenal IVC was the preferred location for placement. The brand of filter used was determined by operator preference. Either a femoral or jugular approach was used for deployment depending on the clinical circumstances of the procedure, the device, and at the discretion of the operator. If the patient was on anticoagulation therapy, it was not routinely suspended for either placement or retrieval. All removals of the Günther Tulip™ and Recovery® filters were performed via an internal jugular vein approach, as dictated by the design of the filter. A cavogram was performed prior to filter removal to assess caval patency, thrombus within the filter, and filter position within the cava. If significant thrombus was found within the filter, removal was not attempted at that time but was reconsidered after a period of anticoagulation to allow the thrombus to dissolve (figure 1 and figure 2). The Günther Tulip® filters were preferentially removed using a loop snare through a 10 French sheath (figure 3 and figure 4). The Recovery® filters were preferentially removed using the proprietary Bard Recovery Cone® removal device through a 12 French sheath.

Assessment of Outcomes

The clinical record was reviewed for basic patient demographic information, indication, and brand of retrieval filter placement. Filter removal was only attempted if the patient was specifically referred back for filter removal. The angiographic images and/or procedure report were reviewed as necessary in each case to determine outcome and potential causal factors including dwell time, retrieval success, and cause of failure.

Statistical Analysis

Data analyses (JM) were conducted using JMP (version 9.0.1, SAS Institute Inc, USA). Continuous variables were reported as means $\pm$ standard deviation, and were compared between groups using a two-sample t-test. Categorical variables were reported as percentages, and were compared between groups using Pearson's Chi-square test for independence. P value using the two-tailed alpha level of 0.05 was considered statistically significant.

RESULTS

We identified 892 IVC filters placed between January 2003 and December 2005 of which 460 patients received a retrievable filter. There were 256 males and 204 females who received a retrievable IVC filter. The mean age for men was 50.7 ± 17.3 years and 53.7 ± 18.9 years for women. The categorical indications published by the Society of Interventional Radiology for filter placement in our patients are in Table 1. (13)

Of the 460 retrievable filters placed, (249 Günther Tulip®, 207 Recovery®, and 4 OptEase®), retrieval was attempted in 223 (48.5%). Of 223 initial attempts, 196 (87.9%) were successful and 27 (12.1%) were unsuccessful. Of these 27 (15 Günther Tulip® and 12 Recovery®) unsuccessful initial attempts, 14 (51.9%) were males and 13 (48.1%) were females. The mean dwell time for successful removal of the Günther Tulip® IVC filter was 22.6 ± 5.5 days (range: 1-411) and 105 ± 5.8 days (range: 4-384) for the Recovery® filter. The 27 initial failures were due to significant thrombus in the filter in 23 (85.2%) and filter tilt and strut perforation in 4 (14.8%). There was no significant difference in retrieval failure rates when adjusting for age, gender, type of filter, indication for placement, or time until removal ($p=0.8$). All 4 patients who had unsuccessful removal of their filter due to excessive tilt and strut perforation had the Recovery® filter. Nine of the 23 patients (39.1%) who had filter removal aborted initially due to thrombus later underwent successful removal once the thrombus had resolved (figure 5).

DISCUSSION

Placement and retrieval of retrievable IVC filters can be performed safely with a high technical success rate in experienced centers. Given the inherent flexibility initially thought to be provided by retrievable filters in terms of treatment options (i.e. removing the filter or leaving it *in situ*), their use has increased relative to permanent filters. In our current practice, retrievable IVC filters inserted outnumber permanent IVC filters approximately 4 to 1.

Even though it is generally accepted that filters decrease the incidence of PE (14), unfortunately there is no strong evidence that permanent or retrievable filters decrease mortality.(6, 8, 28) There is ongoing concern about the inherent risks associated with retrievable IVC filters. Retrievable IVC filters have been associated with perforation into adjacent structures, such as the duodenum, ureter and aorta, strut fracture, and strut or filter migration to the heart or pulmonary arteries with adverse clinical outcomes. (15, 16), (17, 18, 29) These adverse outcomes include ventricular arrhythmias, cardiac tamponade, erosions into the spine, lumbar artery pseudoaneurysms, and even death (14, 15, 19, 20); all of which tempered the initial enthusiasm and led to a 2010 FDA warning statement regarding adverse events with long term use of retrievable IVC filters.(21)

These concerns have led to IVC filter design changes. The Recovery® filter (Bard Peripheral Vascular, Inc. Tempe, AZ) was not very robust, prone to tilting, and had no retrieval hook. It was withdrawn from the market in September 2005. It was replaced by the Bard G2® filter which was of similar overall design but with longer centering struts and

more secure anchoring hooks. The new design was meant to have improved stability and centering with fewer fractures. The G2® permanent filter was only approved as a permanent filter but it can be removed using the Bard Recovery Cone®. Subsequent designs include the G2® Express released in July of 2008, followed by the G2® X vena cava filter; the Eclipse™ filter design; the Meridian™ vena cava filter; and the newest Denali® filter design. The Cook Celect™ vena cava filter (Cook Medical, Bloomington, IN.) gained FDA approval as a retrievable device in April of 2009. It has a hybrid design with an easy to snare hook at the apex like the Günther Tulip® and a row of centering struts to help prevent tilt. Other IVC retrievable filters include the ALN Retrievable Vena Cava Filter (ALN Implants Chirurgicaux, Ghisonaccia, France) which was approved by the FDA in January of 2008, the Option™ Retrievable Vena Cava Filter (Rex Medical, L.P., based in Conshohocken, Pa) which was approved by the FDA in June of 2009, the OPTEASE® Retrievable Vena Cava Filter (Cordis Corporation, Bridgewater, NJ) which was approved by the FDA in February of 2010, and the Crux vena cava filter (Crux Biomedical, Menlo Park, CA) which was approved by the FDA in July of 2012. Filter designs continue to evolve. The goal is to have a filter that is effective, not prone to excessive tilting, strut perforation or fracture, and is easy to remove even after relatively long dwell times.

Even though physicians and patients alike are attracted to the idea of retrievable IVC filters; many are not removed once they have been implanted. This varies by local practice patterns. A recent retrospective single center study of 679 retrievable filters placed reported that only 58 (8.5%) filters were removed over an 8 year time period, while 608 (89.5%) retrievals were not attempted. Furthermore, of those patients who had an IVC filter placed, an astounding number of patients (n=78; 8.5%) had no mention of filter placement in their discharge summary, had no documented follow-up data at the study center (n=270; 30%), and had no mention of IVC filter placement during subsequent medical follow-up (n=360; 39%).(22) Another study reported that of 298 retrievable filters placed, only 11 (3.7%) of them were removed during a 3 year period of time. (23) Because of the aforementioned complications, it is paramount that patient follow up programs are in place at institutions that place retrievable IVC filters. The retrieval rate of IVC filters has been shown to significantly increase from 29% to 60% when a dedicated IVC filter clinic is established, however the number of failed retrieval attempts were similar. (24) These programs should monitor and assess the candidacy for filter removal and retrieve them as soon as clinically indicated. In addition, patients who receive a retrievable filter should receive a product card that details the type and brand of filter placed, date of placement, indication for filter placement, and expected dwell time.

Retrievable IVC filters have assumed a theoretical advantage in limiting long term thrombotic complications as they can be removed when no longer clinically indicated; thereby accounting for about half of all IVC filters placed during our three year study period. Our initial experience in attempting removal was 48.3% versus 47.7% when compared to a 197 patient multicenter experience. (25) Their successful removal rate was 85.1% with a failure rate in 14.9% patients versus our success of 87.9% with a failure rate in 12.1%. Their dwelling time for successful removal was comparable between their Günther Tulip filter of 11 days (range, 1-139 d) with our experience of 22.6 ± 5.5 days (range, 1-411 d) and 28 days (range, 6-117 d) compared to our 105 ± 5.8 days (range, 4-384 d) for the

Recovery filter. Interestingly, 50% of the retrieval failures in their study were the result of thrombus within the filter compared to 85.2% in our experience. Technical difficulties (tilted filter) were the cause of retrieval failure in the other half compared to our 14.8%. They experienced no significant difference in their retrieval failure rates between the Günther Tulip and Recovery filter (16.4% vs 9.5%, respectively) which was also comparable to our experience.(25) During our study period, retrieval failures were usually secondary to the presence of thrombosis and not due to filter tilting or technical failure. It is very rare that a filter is not successfully removed in our current practice. Of the 23 filters containing significant thrombus, 9 (39.1%) were referred back after a period of anticoagulation and underwent successful retrieval. The number of recovered filters could be significantly higher with closer follow up and this is an important issue in current practice.

More detailed societal and organizational guidelines may also provide an important role in improving patient follow-up care after IVC filter placement. The American College of Chest Physicians (ACCP) guidelines recommends placing IVC filters in patients with acute PE who have a contraindication to anticoagulation. (26) However, the ACCP currently provides limited recommendations regarding when an IVC filter should be retrieved, the length of anticoagulation advised prior to retrieval of an IVC filter, or timing of follow-up in patients who receive IVC filters.(26) Organizational guidelines have begun to recognize the importance of providing recommendations to physicians in follow-up of patients who receive IVC filters. For example, The British Society of Interventional Radiology has recently published a registry report providing commentary regarding the growth of IVC filter use, the potential consequences of IVC filter placement, the technical aspects and learning curves of IVC filter placement, and the procedures that should be in place to avoid the patient being lost to follow-up.(27)

As with any new technique or device, there is a learning curve. Operators have become increasingly comfortable with the deployment and removal of retrievable IVC filters. Catheter and guidewire techniques have been learned to successfully remove filters in technically challenging cases such as extreme tilt, inability to engage the apex of the filter, and deep strut perforation. These techniques include using a guidewire to direct the removal device over the filter apex, looping a guidewire through the struts just below the filter apex like a boot strap if the apex cannot be engaged, coaxial sheath systems for adherent penetrating struts, ballooning the filter off the wall of the IVC, grasping the filter with biopsy forceps, and laser extraction systems. In addition, experienced operators have increased awareness of the problems with these less robust retrievable devices prone to tilting, fracture, and migration which have tempered the initial enthusiasm over the inherent flexibility associated with retrievable IVC filter placement. It is our opinion that clinicians and operators from all disciplines who care for patients with or at risk for VTE should be slower to place, more careful to follow, and quicker to remove these devices.

Our study has several limitations. This investigation was limited to a single tertiary care center, which is predominantly white of non-Hispanic ancestry. Tertiary referral centers often care for patients with multiple complex comorbidities that may differ from community centers. In addition, since we had a small number of failures (27 out of 222 initial attempts), we may have insufficient numbers to meaningfully capture the true incidence of

complications associated with removing these filters across all variations in IVC filter type and duration of filter use. Other factors that may portend success of IVC retrieval include the multitude of variables associated with different anticoagulant protocols used prior to removal, patient clotting tendencies, retrieval techniques, and operator experience. Our findings may not be generalizable to other populations.

CONCLUSION

Retrievable IVC filters can be removed with a high degree of success. Approximately one in ten retrievable IVC filter removal attempts failed initially, usually because of significant thrombus within the filter. Importantly, this does not preclude possible removal at a later date. Referring clinicians and operators who place and remove retrievable IVC filters must be aware of the potential complications associated with these devices including tilting, perforation, fracture, and migration. Patients who receive retrievable IVC filters should be followed and assessed for filter removal as soon as clinically indicated.

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References

1. Spencer FA, Emery C, Joffe SW, Pacifico L, Lessard D, Reed G, et al. Incidence rates, clinical profile, and outcomes of patients with venous thromboembolism. The Worcester VTE study. *Journal of thrombosis and thrombolysis*. 2009; 28(4):401–9. [PubMed: 19629642]
2. Spyropoulos AC, Lin J. Direct medical costs of venous thromboembolism and subsequent hospital readmission rates: an administrative claims analysis from 30 managed care organizations. *Journal of managed care pharmacy : JMCP*. 2007; 13(6):475–86. [PubMed: 17672809]
3. den Exter PL, Hooijer J, Dekkers OM, Huisman MV. Risk of recurrent venous thromboembolism and mortality in patients with cancer incidentally diagnosed with pulmonary embolism: a comparison with symptomatic patients. *Journal of clinical oncology : official journal of the American Society of Clinical Oncology*. 2011; 29(17):2405–9. [PubMed: 21555690]
4. Heit JA, Silverstein MD, Mohr DN, Petterson TM, O'Fallon WM, Melton LJ 3rd. Predictors of survival after deep vein thrombosis and pulmonary embolism: a population-based, cohort study. *Archives of internal medicine*. 1999; 159(5):445–53. [PubMed: 10074952]
5. Silverstein MD, Heit JA, Mohr DN, Petterson TM, O'Fallon WM, Melton LJ 3rd. Trends in the incidence of deep vein thrombosis and pulmonary embolism: a 25-year population-based study. *Archives of internal medicine*. 1998; 158(6):585–93. [PubMed: 9521222]
6. Decousus H, Leizorovicz A, Parent F, Page Y, Tardy B, Girard P, et al. A clinical trial of vena caval filters in the prevention of pulmonary embolism in patients with proximal deep-vein thrombosis. Prevention du Risque d'Embolie Pulmonaire par Interruption Cave Study Group. *The New England journal of medicine*. 1998; 338(7):409–15. [PubMed: 9459643]
7. Athanasoulis CA, Kaufman JA, Halpern EF, Waltman AC, Geller SC, Fan CM. Inferior vena caval filters: review of a 26-year single-center clinical experience. *Radiology*. 2000; 216(1):54–66. [PubMed: 10887228]
8. Eight-year follow-up of patients with permanent vena cava filters in the prevention of pulmonary embolism: the PREPIC (Prevention du Risque d'Embolie Pulmonaire par Interruption Cave) randomized study. *Circulation*. 2005; 112(3):416–22. [PubMed: 16009794]

9. Stein PD, Kayali F, Olson RE. Twenty-one-year trends in the use of inferior vena cava filters. *Archives of internal medicine*. 2004; 164(14):1541–5. [PubMed: 15277286]
10. Smouse B, J A. Is market growth of vena cava filters justified? a review of indications, use, and market analysis. *Endovasc Today*. 2010
11. Greenfield LJ, Proctor MC. Twenty-year clinical experience with the Greenfield filter. *Cardiovascular surgery*. 1995; 3(2):199–205. [PubMed: 7606407]
12. Crochet DP, Brunel P, Trogrlic S, Grossetete R, Auger JL, Dary C. Long-term follow-up of Vena Tech-LGM filter: predictors and frequency of caval occlusion. *Journal of vascular and interventional radiology : JVIR*. 1999; 10(2 Pt 1):137–42. [PubMed: 10082099]
13. Recommended reporting standards for vena caval filter placement and patient follow-up. *Journal of vascular and interventional radiology : JVIR*. 2003; 14(9 Pt 2):S427–32. [PubMed: 14514858]
14. Vergara GR, Wallace WF, Bennett KR. Spontaneous migration of an inferior vena cava filter resulting in cardiac tamponade and percutaneous filter retrieval. *Catheterization and cardiovascular interventions : official journal of the Society for Cardiac Angiography & Interventions*. 2007; 69(2):300–2. [PubMed: 17191236]
15. Chandra PA, Nwokolo C, Chuprun D, Chandra AB. Cardiac tamponade caused by fracture and migration of inferior vena cava filter. *Southern medical journal*. 2008; 101(11):1163–4. [PubMed: 19088532]
16. Hann CL, Streiff MB. The role of vena caval filters in the management of venous thromboembolism. *Blood reviews*. 2005; 19(4):179–202. [PubMed: 15784297]
17. Ferris EJ, McCowan TC, Carver DK, McFarland DR. Percutaneous inferior vena caval filters: follow-up of seven designs in 320 patients. *Radiology*. 1993; 188(3):851–6. [PubMed: 8351361]
18. Durack JC, Westphalen AC, Kekulawela S, Bhanu SB, Avrin DE, Gordon RL, et al. Perforation of the IVC: rule rather than exception after longer indwelling times for the Gunther Tulip and Celect retrievable filters. *Cardiovascular and interventional radiology*. 2012; 35(2):299–308. [PubMed: 21448771]
19. Haddadian B, Shaikh F, Djelmami-Hani M, Shalev Y. Sudden cardiac death caused by migration of a TrapEase inferior vena cava filter: case report and review of the literature. *Clinical cardiology*. 2008; 31(2):84–7. [PubMed: 18257027]
20. Skeik N, McEachen JC, Stockland AH, Wennberg PW, Shepherd RF, Shields RC, et al. Lumbar artery pseudoaneurysm caused by a Gunther Tulip inferior vena cava filter. *Vascular and endovascular surgery*. 2011; 45(8):756–60. [PubMed: 22262118]
21. US Food and Drug Administration. Inferior Vena Cava (IVC) Filters: Initial Communication: Risk of Adverse Events with Long Term Use. <http://www.fda.gov/Safety/MedWatch/SafetyInformation/SafetyAlertsforHumanMedicalProducts/ucm221707.htm> Posted August 9, 2010
22. Sarosiek S, Crowther M, Sloan JM. Indications, complications, and management of inferior vena cava filters: the experience in 952 patients at an academic hospital with a level I trauma center. *JAMA internal medicine*. 2013; 173(7):513–7. [PubMed: 23552968]
23. Gaspard SF, Gaspard DJ. Retrievable inferior vena cava filters are rarely removed. *The American surgeon*. 2009; 75(5):426–8. [PubMed: 19445296]
24. Minocha J, Idakoji I, Riaz A, Karp J, Gupta R, Chrisman HB, et al. Improving inferior vena cava filter retrieval rates: impact of a dedicated inferior vena cava filter clinic. *Journal of vascular and interventional radiology : JVIR*. 2010; 21(12):1847–51. [PubMed: 21035356]
25. Ray CE Jr, Mitchell E, Zipser S, Kao EY, Brown CF, Moneta GL. Outcomes with retrievable inferior vena cava filters: a multicenter study. *Journal of vascular and interventional radiology : JVIR*. 2006; 17(10):1595–604. [PubMed: 17057000]
26. Kearon C, Akl EA, Comerota AJ, Prandoni P, Bounameaux H, Goldhaber SZ, et al. Antithrombotic therapy for VTE disease: Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. *Chest*. 2012; 141(2 Suppl):e419S–94S. [PubMed: 22315268]
27. Uberoi R, Tapping CR, Chalmers N, Allgar V. British Society of Interventional Radiology (BSIR) Inferior Vena Cava (IVC) Filter Registry. *Cardiovascular and interventional radiology*. 2013
28. Haut ER, Garcia LJ, Shihab HM, et al. The Effectiveness of Prophylactic Inferior Vena Cava Filters in Trauma Patients: A Systematic Review and Meta-analysis. *JAMA Surg*. 2013 Nov 6.

29. Andreoli JM, Lewandowski RJ, Vogelzang RL, Ryu RK. Comparison of Complication Rates Associated with Permanent and Retrievable Inferior Vena Cava Filters: A Review of the MAUDE Database. J Vasc Interv Radiol. 2014 Jun 10.10.1016/j.jvir.2014.04.016

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Figure 1.
Inferior vena cava filter with large thrombus burden extending within and below the filter.

Figure 2.
Inferior vena cava filter largely with thrombus resolved.

Figure 3.
Inferior vena cava filter being snared for removal.

Figure 4.
Removal of an inferior vena cava filter into sheath.

Figure 5.
Filter extracted from the inferior vena cava with fibrin on struts.

Table 1

Categorical indications published by the Society of Interventional Radiology for filter placement in our patients.

Indication for placement in 460 cases	Number of Patients
Contraindication to anticoagulation	220
Complication of anticoagulation	53
Prophylaxis without venous thromboembolism	156
Anticoagulation failure	20
Filter failure	1
In association with another procedure (such as thrombolysis, thromboembolectomy)	9

* Data was missing on 1 patient.