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ORIGINAL ARTICLE

Effect of a dedicated inferior vena cava filter retrieval program on retrieval rates and number of patients lost to follow-up

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PURPOSE
We aimed to assess the efficacy of a dedicated inferior vena cava (IVC) filter retrieval program on filter retrieval rates and number of patients lost to follow-up.

METHODS
A dedicated IVC filter retrieval program began in July 2016. This consisted of tracking all patients with retrievable filters placed by interventional radiology (IR). At the time of filter placement, patients were scheduled for a retrieval consult in the IR clinic. Any missed appointments were followed up by a physician assistant. The program was overseen by a single IR physician. To assess this program's efficacy, we reviewed the records of all patients who had retrievable IVC filters placed by IR nine months prior to and nine months after program initiation. Demographics and clinical factors were then collected and compared. A P value of < 0.05 was considered statistically significant.

RESULTS
Prior to the program, 76 patients (31 males, 45 females; mean age, 64.2 years) had retrievable filters placed; 75% were placed due to a contraindication to anticoagulation. From this group, five filters were removed (6.6%), 42 patients were lost to follow-up (55.3%), 22 patients died (29.0%), and seven filters were deemed permanent by a physician after placement (9.2%). All five retrievals were successful and no complications were reported. After program initiation, 106 patients (59 males, 47 females; mean age, 58.8 years) had retrievable filters placed; 75.5% were placed due to a contraindication to anticoagulation. In this group, 30 filters were retrieved (retrieval rate 28.3%), 17 patients were lost to follow-up (16%), 23 patients died (21.7%), 28 filters were deemed permanent by a physician after placement (26.4%), and decisions were still pending in eight patients (7.5%). One patient (3.3%) had a minor complication during filter retrieval. Initiation of a filter retrieval program increased our retrieval rate (6.6% vs. 28.3%; $P < 0.001$) and reduced the number of patients with filters that were lost to follow-up (55.3% vs. 16%; $P < 0.001$).

CONCLUSION
Dedicated filter retrieval program is effective in increasing filter retrieval rates and decreasing the number of patients lost to follow-up.

The mainstay of venous thromboembolism (VTE) treatment is medical management with anticoagulants (1). Yet, many patients are not candidates for anticoagulation due to contraindications or to having experienced complications from anticoagulants. Additionally, some patients without VTE may benefit from pulmonary embolism (PE) protection during high-risk periods of immobility such as after significant trauma or after a neurosurgical procedure. These patients are commonly managed by the insertion of an inferior vena cava (IVC) filter, intended for the mechanical filtering of blood returning from the lower extremities to prevent life-threatening PE (2). Retrievable, or optional, IVC filters came into the market in the 1990s and are intended for patients with potentially transient contraindications to anticoagulation or a temporary risk of PE (3). There are many types of retrievable filters with various designs, all of which can function as permanent filters, if necessary. Despite an overall good safety profile, indwelling IVC filters can lead to a number of complications, including caval penetration, filter fracture, filter migration, and iliocaval

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thrombosis (2). The risk of filter-associated complications increases with longer dwell times (2, 4). Moreover, retrieval can become more difficult with longer dwell times (5). Multiple reports of complications related to indwelling IVC filters led to a 2010 communication by the Food and Drug Administration (FDA), recommending removal of IVC filters as soon as protection from PE is no longer needed (6). Thus, improving retrieval rates is a key patient safety goal. Unfortunately, retrieval rates have been historically poor without a dedicated retrieval program, ranging from 2% to 20% in the literature (7). As a result, multiple institutions have established dedicated programs to improve filter retrieval rates (8–14). The purpose of this report is to describe our institution's IVC filter retrieval program and its impact on the management of patients with retrievable IVC filters.

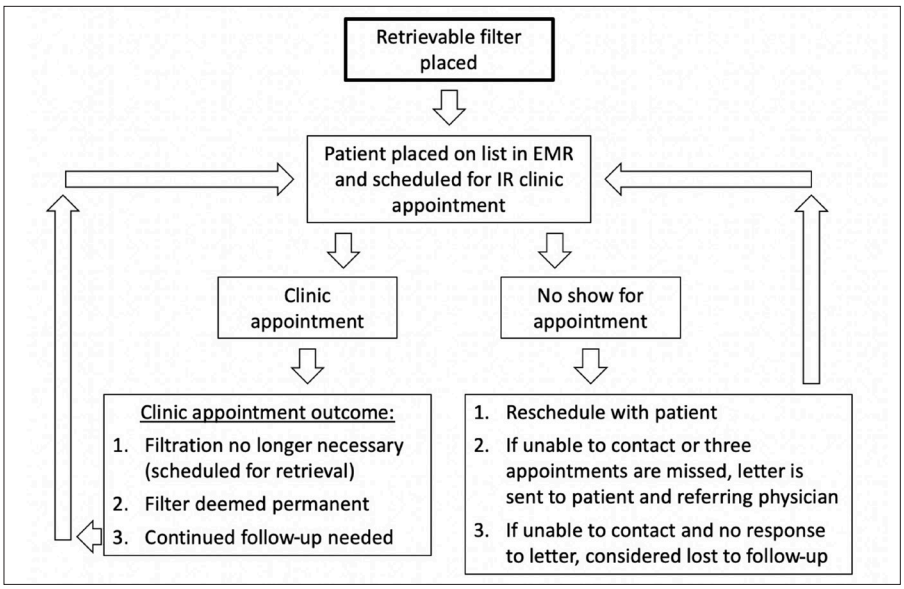

Figure 1. IVC filter retrieval program design.
EMR, electronic medical record; IR, interventional radiology.

Methods

The study was approved by the Institutional Review Board and was Health Insurance Portability and Accountability Act compliant.

A dedicated IVC filter retrieval program began in July 2016. A summary of the IVC filter retrieval program design is illustrated in Fig. 1. The program consisted of tracking all patients with retrievable filters placed by interventional radiology (IR). At the time of placement, a physician assistant (PA) scheduled the patients for a consult to discuss retrieval in the IR clinic. This appointment typically occurred between two and three months after placement. During the appointment a patient could be either scheduled for filter retrieval, recommended for continued follow-up, or a filter could be deemed permanent. If patients did not show up for the retrieval consult, a PA would contact them to reschedule. If the PA was unable to reach the patient after three attempts, a standard letter was sent to the patient's home address via mail and a message was sent to the referring physician via the institution's electronic medical record (EMR) that explained the importance of filter retrieval and provided the clinic's contact information. If the patient missed three scheduled retrieval consults, the same letter and message were sent to the patient's home address and to the referring physician, respectively. If there was still no response, the patient was considered lost to follow-up. A single IR physician oversaw the program.

A board-certified or board-eligible IR physician performed all IVC filter retrievals in the IR suite. Filter retrievals were most commonly performed utilizing a standard snare technique. If the standard snare technique was ineffective, advanced retrieval techniques, typically the loop snare technique or endobronchial forceps, were utilized during the same session.

To assess this program's efficacy, we reviewed the records of all patients who had retrievable IVC filters placed by IR nine months prior to and nine months after the initiation of the program (November 2015 through April 2017). Based on the date of filter placement, patients were divided into two groups: those who had a filter placed prior to the program initiation (i.e., before July 2016) and those who had a filter placed after the program initiation (i.e., after July 2016). These groups were mutually exclusive. The outcome of a patient's filter was classified into one of the following categories: retrieved, deemed permanent, lost to follow-up, expired, or decision pending. Table 1 contains a detailed explanation of these categories. Patient demographics and clinical characteristics were collected. Complications were classified according to estabilised criteria (2).

Main points

- IVC filter follow-up program improves filter retrieval rates.
- Procedural service placing IVC filters should be a driving force in IVC filter follow-up.
- Future research is needed to determine if filter retrieval decreases filter-related complication rate.

Statistical analysis

Descriptive statistics, e.g., means and standard deviation (SD), or median and range are presented for continuous variables, and frequency count and percentage are presented for categorical variables. Kruskal Wallis test was used to compare age between the two groups because age was not normally distributed. Fisher's exact test was used to compare gender differences between the two groups, and two-proportion Z-test was used in proportions comparison between groups for variables including the indication for placement, filter brand, and filter outcomes. A P value of < 0.05 was considered statistically significant.

Results

A total of 76 and 106 patients were included for review in the pre-program initiation and post-program initiation groups, respectively. Patient demographics, indications for filter placement, brand of filter, and filter outcomes are summarized in Table 2. Comparison of filter outcomes both before and after program initiation are illustrated in Fig. 2. There was a statistically significant difference in patient age between the groups with mean age of 64.2±15.4 years

Table 1. Filter categories based on a decision at the time of data collection

Filter category	Explanation
Retrieved	An IVC filter was successfully retrieved
Deemed permanent	A documented decision was taken by a physician or a patient to leave an IVC filter in place
Lost to follow-up	Prior to program initiation: No documented decision regarding an IVC filter and no intent to follow-up with IR in clinical notes
	After program initiation: A physician assistant was unable to reach the patient after three attempts or the patient did not show up for three scheduled retrieval consults
Expired	A patient died prior to a decision regarding filter retrieval
Decision pending	Prior to program initiation: Clinical notes mention an intent to follow-up with IR regarding filter retrieval
	After program initiation: A decision regarding filter retrieval has not been taken by the time of data collection

IVC, inferior vena cava; IR, interventional radiology.

Table 2. Patient and filter related parameters before and after program initiation

Parameter	Prior to program initiation	After program initiation	*P*
Number of patients with retrievable filters placed	76	106	
Age			
Mean±SD	64.2±15.4	58.8±14.2	0.008
Median (min, max)	65 (20, 90)	60 (26, 86)	
Sex, n (%)			0.048
Male	31 (40.8)	59 (55.7)	
Female	45 (59.2)	47 (44.3)	
Indications, n (%)			
Contraindication to AC	57 (75.0)	80 (75.5)	0.936
Complication of AC	9 (11.8)	8 (7.6)	0.337
Failure of AC	4 (5.3)	5 (4.7)	0.857
Severe CP disease	1 (1.3)	5 (4.7)	0.204
Massive PE with residual DVT	0 (0.0)	5 (4.7)	0.055
Prophylactic	5 (6.6)	3 (2.8)	0.219
Brand of retrievable filter, n (%)			
Denali (Bard Peripheral Vascular Inc.)	59 (77.6)	89 (84.0)	0.276
Celect (Cook Medical LLC)	12 (15.8)	14 (13.2)	0.624
Günther Tulip (Cook Medical LLC)	5 (6.6)	1 (0.9)	0.033
Denali (Bard Peripheral Vascular Inc.) and Celect (Cook Medical LLC)*	0 (0.0)	1 (0.9)	0.407
Filter category, n (%)			
Retrieved	5 (6.6)	30 (28.3)	<0.001
Deemed permanent	7 (9.2)	28 (26.4)	0.004
Lost to follow-up	42 (55.3)	17 (16.0)	<0.001
Expired	22 (29.0)	23 (21.7)	0.258
Decision pending	0 (0.0)	8 (7.5)	0.015

*Filters were placed in each common iliac vein in a patient with large inferior vena cava.
SD, standard deviation; AC, anticoagulation; CP, cardiopulmonary disease; PE, pulmonary embolism; DVT, deep venous thrombosis.

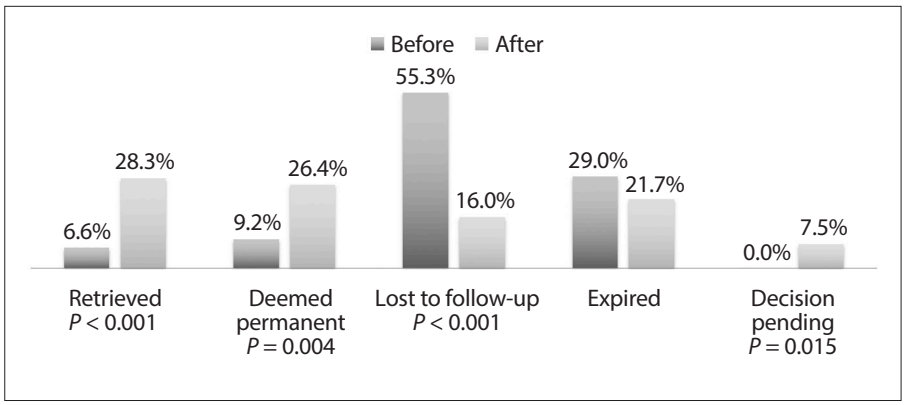

Figure 2. Comparison of filter categories before and after initiation of the program. *P* values are provided for the statistically significant changes.

(median, 65 years; range, 20–90 years) after program initiation and a mean age of 58.8±14.2 years (median, 60 years; range, 26–86 years) prior to program initiation ($P = 0.008$). The sex of the patients was also statistically significant between the two groups ($P = 0.048$). After program initiation, retrieval rates increased from 6.6% to 28.3% ($P < 0.001$). The proportion of patients lost to follow-up decreased from 55.3% to 16.0% ($P < 0.001$). There was a statistically significant increase in the number of filters that were deemed permanent after program initiation (9.2% to 26.4%, $P = 0.004$). Additionally, there was an increase in the number of patients classified as "decision pending" (0% to 7.5%, $P = 0.015$).

All patients scheduled for retrieval during their clinic appointments did present for their procedures. One retrieval procedure was aborted due to iliocaval thrombosis discovered on the pre-retrieval venogram. Given that actual retrieval was not attempted and the patient was asymptomatic, this filter was categorized as "deemed permanent". No major complications were encountered during retrievals either before or after program initiation. One minor complication (3.3%; puncture site infection; Society of Interventional Radiology category B) was noted in the post-initiation group. There were no minor complications recorded during retrievals in the pre-program initiation group.

Discussion

After their introduction and through the early 2000s, there was a dramatic increase in the number of filters placed (15, 16). Concerns for filter safety and efficacy has led to a reversal of this trend in recent years (5). As such, a cautionary approach to IVC filter utilization has been supported by the FDA as well as by the American Society of Hematology's Choosing Wisely Initiative (6, 17). Given these developments, there has been a growing interest in improving filter retrieval rates, which have been historically poor (7, 18). Moreover, prior studies have shown retrieval rates are depressed when the service responsible for filter placement is not involved in following the patients post-placement, which is still commonplace in IR (19). Therefore, multiple institutions have developed dedicated filter retrieval programs to improve patient care, showing that active follow-up uniformly improves filter retrieval rates (8–14). One effective way of improving retrieval rates appears to be the development of a patient tracking system aimed to decrease the number of patients lost to follow-up (20). For example, the establishment of one IVC filter clinic and tracking system resulted in an increase of filter retrieval rates from 30% to 60% (9). Similarly, Kalina et al. (11) and Ko et al. (8) developed filter registries, which led to improvements in retrieval rates from 15.5% to 31.5% and from 30% to 51%, respectively. Finally, Rottenstreich et al. (14) developed a multidisciplinary institutional protocol involving a tracking system and a physician education program, which also improved retrieval rates from 14.1% to 50%.

Before the initiation of our dedicated IVC filter retrieval program, IR did not directly follow the patients after placement but rather relied on the referring physicians to send the patient back when retrieval was indicated. This methodology resulted in low retrieval rates (6.6%) with more than half of patients being lost to follow-up (55.3%). By establishing a filter retrieval program, IR became the driving force in the follow-up of these patients. Anecdotally, the filter retrieval program also increased interactions and collaboration with referring physician, resulting in opportunities for educating them regarding the importance of filter follow-up and retrieval. This markedly increased filter accountability at our institution with a significant decrease in the number of patients lost to follow-up to 16%. The retrieval rate also increased four-fold to 28.3%. Improved retrieval rates were not due to improvements in the technical success of filter retrieval, given that technical success was 100% both prior to and after program initiation. Importantly, only one minor complication occurred during the entire study, confirming the overall safety of filter retrieval and supporting an active approach to patient follow-up. Despite pending follow-up in 9.2% of the patients in the post-initiation group, our filter retrieval rate remains low in comparison to other reports. This is due to the 21.7% of patients that died prior to filter retrieval and another 26.4% of patients in whom the filters were later deemed permanent. In addition, only a small proportion of the patients in our cohort received prophylactic filters in the setting of high-risk patients without evidence of VTE (pre-initiation, 2.8%; post-initiation, 1.4%). This is much lower than rates described in previous cohorts in which prophylactic use of IVC filters was a major indication (8,11,14). Certainly, this data raises an interesting question regarding our patient selection for placement of either a retrievable or a permanent filter. It is possible that a less costly permanent filter would have been a better choice for these patients. Implementation of decision-making algorithms for permanent versus retrievable filters have the potential to optimize patient selection (21). This will be an important avenue for future research.

It needs to be mentioned that there was statistically significant difference in demographics of our study groups, i.e., the mean age in the group prior to program initiation was 64.2 years versus 58.8 years afterward. In addition, there was statistically significant difference in gender distribution before and after program initiation, 40.8% males and 59.2% females versus 56.2% males and 43.8% females, respectively. Despite those differences, the indications for filter placement were not statistically significant between the groups, implying that the study populations were indeed similar. Even though younger patients in theory

have a higher chance of their filters being removed, we still believe that program initiation, rather than demographic difference, is the primary reason for higher retrieval rates. Apart from that, we did observe a statistically significant decrease in the placement of Günther Tulip (Cook Medical LLC) filters after program initiation (6.6% versus 0.9%). However, this is a smaller fraction of the filter types placed with the rates of more commonly placed filters remaining similar between study groups.

Our study has several limitations. First, all the data was collected in a retrospective fashion. Second, the results are from a single center. Third, a relatively short study period did not allow us to discuss the long-term effects of the program or identify significant filter-related complications in our study cohort. Undoubtedly, a future investigation into whether a filter retrieval program decreases filter-related complications would be worthwhile.

In conclusion, our data supports the effectiveness of a clinic-based, IR-driven IVC filter retrieval program in improving retrieval rates and lowering the number of patients lost to follow-up.

Conflict of interest disclosure

The authors declared no conflicts of interest.

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