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Contemporary management of chronic indwelling inferior vena cava filters

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Contemporary management of chronic indwelling inferior vena cava filters

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ABSTRACT

Objective: Despite increasing retrieval rates of the inferior vena cava (IVC) filter, less than one-third are removed within the recommended timeline. Prolonged filter dwell times may increase the technical difficulty of retrieval and filter-related complications. We sought to evaluate the contemporary outcomes of patients with chronic indwelling IVC filters at a tertiary care center.

Methods: A retrospective analysis was performed from August 2015 through August 2019 of all patients who were referred for removal of a prolonged IVC filter with a dwell time >1 year. Descriptive analysis was used to evaluate patients' characteristics and procedural outcomes, which were reviewed through electronic medical records. Data were expressed as median with interquartile range (IQR) or number and percentage, as appropriate.

Results: A total of 47 patients were identified with a median filter dwell time of 10.0 years (IQR, 6-13 years); 34 patients underwent IVC filter removal, and 13 patients refused retrieval. The median age of patients was 54.9 years (IQR, 42.5-64.0 years); the majority were female (57%) and white (53%). The most common indication for filter placement was high risk despite anticoagulation (49%), followed by venous thromboembolism prophylaxis (21%). The majority of patients were symptomatic (72%). If symptomatic, the most common reason for retrieval was IVC penetration (94%), and the chief complaint was pain (56%). Retrieval success was 97%, with a median length of stay of 0 days. The majority of retrievals were performed through an endovascular approach (97%). There was one postprocedural complication (3%).

Conclusions: Despite prolonged dwell times, IVC filter retrieval can be performed safely and effectively in carefully selected patients at a tertiary referral center. (J Vasc Surg: Venous and Lym Dis 2021;9:163-9.)

Keywords: Chronic IVC filter; Long-term IVC filter; IVC filter; IVC filter retrieval

The use of inferior vena cava (IVC) filters has increased in the past three decades. IVC filters are generally placed in patients with absolute or relative contraindications to anticoagulation or who have a high risk for development of recurrent venous thromboembolism (VTE)[1-3] as half of all filter placements are for prophylactic indications.[2] Retrieval of IVC filters is recommended once the risk of pulmonary embolism (PE) has resolved and the most significant clinical benefit from the filter has been achieved, which typically occurs within 90 days of implantation.[2,4] Consequently, filters are recommended to be removed within 90 days after placement. Despite this, less than one-third are removed within the recommended timeline.[3,5]

Many patients remain asymptomatic and rarely develop symptoms despite IVC-related complications.[6] In addition, increased dwell time is associated with increased retrieval difficulty and failure rates. Prolonged filter dwell times increase the technical complexity of retrieval and filter-related complications.[7] These complications include migration, embolization, thrombotic occlusion, filter tilt, perforation, and filter fracture and are more common with retrievable-type IVC filters compared with permanent devices.[8,9] In addition, failure to retrieve an IVC filter represents almost 20% of IVC filter-related litigations.[10] As a result, consensus on optimal management strategies of chronic (>3 months) indwelling IVC filters is lacking.

We sought to evaluate the contemporary outcomes of patients, both asymptomatic and symptomatic, with chronic indwelling IVC filters at a tertiary care center.

METHODS

Study population. After approval by our Institutional Review Board (#13282), a retrospective review of a prospectively maintained database at a single-institution

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tertiary referral center was performed from August 2015 through August 2019 of all patients referred for removal of a prolonged IVC filter with a dwell time >1 year. The Institutional Review Board has granted a waiver of patient informed consent for this retrospective review. This study was conducted in accordance with the Declaration of Helsinki. Demographics, comorbidities, and filter-specific, procedural, and postprocedural data were retrospectively reviewed. Indications for initial filter placement included high risk despite anticoagulation (including patients with a deep venous thrombosis [DVT] or PE at the time of filter placement), VTE prophylaxis (no DVT or PE at the time of placement), and inability to be anticoagulated (including patients with a DVT or PE at the time of placement).

Filter complications. Filter-related complications included migration (defined as the movement of the filter's position from its deployment site by >2 cm in either the caudal or cephalad direction), embolization (movement of the filter or any of its parts to a distant anatomic location), thrombotic occlusion, filter tilt (defined as tilting of the IVC filter axis compared with the IVC filter axis >15 degrees), penetration (movement of the IVC hooks or struts beyond the adventitia), perforation (filter strut or anchor extending >3 mm outside the wall of the IVC), and filter fracture (defined as loss of structural integrity of the filter by a break or separation).[9] Degree of filter strut perforation was graded by a system of Oh et al[11]: grade 0, all filter struts confined within the IVC lumen; grade 1, filter strut external but immediately adjacent to the IVC, likely to be representative of "tenting" of the IVC wall; grade 2, struts completely outside the IVC lumen, as demonstrated by a halo of retroperitoneal fat; and grade 3, struts adjacent to or inserting into an adjacent organ or retroperitoneal structure. Each filter was graded according to the highest graded strut.

Outcome. The primary outcome of the study was to evaluate the safety and feasibility of chronic indwelling IVC filter retrieval with a dwell time >1 year.

Removal technique. In our practice, for patients who are asymptomatic but have a filter-related complication noted on imaging, such as embolization, filter removal is recommended because of the potential for future complications. In patients who are asymptomatic and without a filter-related complication noted on imaging, the management algorithm is individualized according to the feasibility of retrieval and the patient's wishes and expectations. In patients with vena cava occlusion, recanalization and stenting may be performed.

In general, these procedures are done under general anesthesia or moderate conscious sedation. The right internal jugular approach is chosen with ultrasound-guided micropuncture venous access. The microsheath is then exchanged for a J-wire. Following this, either a Günther Tulip Vena Cava Filter Retrieval Set (Cook Medical, Bloomington, Ind) or a Bard Snare Retrieval Kit (Bard Peripheral Vascular, Tempe, Ariz) is used. Venography is performed to assess for the presence of any thrombus. Residual thrombus >30% is a contraindication to filter removal. Patients receive full-dose heparin intravenously before the procedure to minimize thrombus formation.

For more challenging cases, no universal process exists, and various options can be attempted. These include upsizing the sheath to a 16F sheath or using a 16F sheath within a 20F sheath. A hangman technique, which is a modified loop snare technique that creates a wire loop between the filter neck and the IVC wall, can be tried; this facilitates the release of embedded filter hooks.[12] To collapse the filter, a larger 16F sheath is gently telescoped over the entire retrieval kit to cause mobilization of the struts into the vena cava, ensuring that the loop wire is not pulled. More commonly, the hangman technique is omitted, and an attempt at filter retrieval is made using a Lymol endobronchial forceps (Lymol Medical Corp, Woburn, Mass).[13] A laser sheath can also be used with or without the forceps or a snare and acts as a thermal dissection tool to free the embedded filter.[14] Last, a TightRail Rotating Dilator Sheath (Spectranetics Corp, Colorado Springs, Colo) can be used. This is a sheath that contains inner circumferential blades around the tip. These rotating blades turn 287 degrees alternating clockwise and counterclockwise. As the blades rotate, the device's outer shaft remains stationary, decreasing the likelihood of device entanglement in the filter or IVC torsion.[15]

Completion venography is performed to assess for any perforation or residual filter fragment. Perforation may be tamponaded with a balloon catheter to occlude the vena cava temporarily. Filter fragments embedded in the caval wall or stuck in the spine are left in place. If a fragment has embolized, retrieval may be attempted with a snare.

Statistical analysis. Descriptive analyses were used to evaluate patients' characteristics and procedural outcomes through electronic medical records. All

ARTICLE HIGHLIGHTS

- **Type of Research:** Retrospective review of prospectively collected single-center institutional data
- **Key Findings:** In 47 patients with a median inferior vena cava filter dwell time of 10 years, 34 underwent filter retrieval and had a filter retrieval success rate of 97% with a median length of stay of 0 days.
- **Take Home Message:** Inferior vena cava filters can be safely and effectively removed despite long dwell times in selected patients at a tertiary care center.

statistical analyses were performed using SPSS 23 (IBM Corp, Armonk, NY). Data were expressed as median with interquartile range (IQR) or number and percentage, as appropriate. Univariate analysis used Pearson χ^2 test or Fisher exact test for categorical variables. A P value of $<.05$ was considered statistically significant.

RESULTS

During the study period, a total of 47 patients were identified with a median filter dwell time of 10 years (IQR, 6-13 years); 34 patients underwent removal of the IVC filter, and 13 patients refused retrieval. The median age of patients was 54.9 years (IQR, 42.5-64.0 years); the majority were female (57%) and white (53%). Comorbidities included a history of VTE (81%), hypercoagulable state (15%), hypertension (53%), diabetes mellitus (28%), hyperlipidemia (30%), chronic kidney disease (11%), and active smoking status (13%; Table I).

The filter types of the entire cohort can be seen in Table II. IVC filters removed included Günther Tulip (n = 16 [34%]), Celect (n = 8 [17%]), G2 (n = 6 [13%]), Greenfield (n = 5 [11%]), Simon Nitinol (n = 2 [4%]), Recovery (n = 3 [6%]), and Trapeze (n = 2 [4%]). The most common indication for filter placement was high risk despite anticoagulation (49%), followed by VTE prophylaxis (21%) and inability to be anticoagulated (17%). Of the overall cohort, the incidence of filter-related complications was as follows: filter fracture, n = 8 (17%); filter migration, n = 1 (2%); filter limb embolization, n = 3 (6%); filter tilt >15 degrees, n = 14 (30%); IVC penetration, n = 42 (89%); and IVC thrombus, n = 1 (2%). The most common grade of filter strut perforation was grade 3 (n = 31 [66%]). Most patients were symptomatic (72%) before removal. The most common reason for retrieval was IVC penetration (79%). If symptomatic, the most common chief complaint was pain (56%), typically in the abdomen or back.

The time from the first clinic visit or consultation until IVC filter removal was 34.0 days (median; IQR, 15.0-68.3 days). The overall retrieval success was 97% (Table III). Patients were generally discharged from the hospital on the same day of the procedure (n = 27 [79%]), and most were discharged home (94%). Two patients were discharged to an inpatient rehabilitation and an assisted living facility, respectively. The majority of retrievals were performed through an endovascular approach (n = 33 [97%]), and an interventional radiologist performed the majority of retrievals (n = 22 [65%]), followed by a vascular surgeon (n = 11 [32%]). One retrieval was done using a robotic surgical approach in combination with colleagues from the department of urology. One of the patients who underwent retrieval (1/34) developed a postprocedural complication (neck hematoma).

Table I. Patients' demographics and comorbidities

Total (N = 47)	No. (%)	Median (IQR)
Demographics		
Age, years		54.9 (42.5-64.0)
Male sex	20 (43)	
Race		
White	25 (53)	
African American	16 (34)	
Unknown	6 (13)	
BMI, kg/m^2		35.2 (27.2-41.7)
Preprocedural ASA class		
1	10 (21)	
2	0 (0)	
3	20 (43)	
4	2 (4)	
NA	15 (32)	
Comorbidities		
Current smoker	6 (13)	
Independent functional status	44 (94)	
History of VTE	38 (81)	
Hypercoagulable disorder	7 (15)	
Hyperlipidemia	14 (30)	
Chronic kidney disease	5 (11)	
Dialysis dependence	0 (0)	
Congestive heart failure	3 (6)	
Coronary artery disease	8 (17)	
Diabetes mellitus	13 (28)	
Hypertension	25 (53)	
Creatinine concentration, mg/dL		0.86 (0.76-0.99)
GFR, mL/min/1.73 m^2		86 (68.5-96.8)

ASA, American Society of Anesthesiologists; *BMI*, body mass index; *IQR*, interquartile range; *GFR*, glomerular filtration rate; *NA*, not available; *VTE*, venous thromboembolism.

DISCUSSION

This study demonstrates contemporary outcomes of chronic IVC filters and highlights the safety and acceptable retrieval success rates in select patients despite prolonged dwell times. All procedures in our experience were well tolerated and without postprocedural morbidity or mortality.

Prolonged filter dwell time is associated with device-related complications and increased retrieval difficulty.[11-14] The risk of filter-related complications and the development of patients' symptoms over time have to be weighed against the risk of retrieval, which many times requires advanced endovascular retrieval techniques or more invasive approaches. The decision-making in these cases is complex, and no clear guidelines exist on optimal management. Consequently, the management strategy is individualized and based on patients' wishes and expectations, procedural risks, and feasibility of retrieval. In our practice, patients who are asymptomatic but have a

Table II. Filter-related variable

(N = 47)	
IVC filter details	
Dwell time, years	10 (6-13)
Diagnosis at placement	
VTE	30 (64)
High risk for VTE	9 (19)
Recurrent VTE	4 (9)
Other	4 (9)
Indication for placement	
High risk despite anticoagulation (DVT or PE at the time of placement)	23 (49)
VTE prophylaxis (no DVT or PE at the time of placement)	10 (21)
Inability to be anticoagulated	8 (17)
Other	3 (6)
Missing	3 (6)
Filter type	
Günther Tulip	16 (34)
Celect	8 (17)
G2	6 (13)
Greenfield	5 (11)
Simon Nitinol	2 (4)
Recovery	3 (6)
Trapeze	2 (4)
Other/missing	5 (11)
Filter fracture	
No	39 (83)
Yes	8 (17)
Filter migration	
No	46 (98)
Yes	1 (2)
Filter limb embolization	
No	44 (94)
Yes	3 (6)
Filter tilt >15 degrees	
No	33 (70)
Yes	14 (30)
IVC penetration	
No	5 (11)
Yes	42 (89)
IVC thrombus	
No	46 (98)
Yes	1 (2)
Grade of strut perforation	
1	3 (6)
2	12 (26)
3	31 (66)
Not available	1 (2)
Symptomatic	
Yes	34 (72)
No	13 (28)
Reason for filter retrieval	
IVC penetration	37 (79)
IVC penetration and chronic abdominal pain	5 (11)
Chronic abdominal pain without IVC penetration	5 (11)
Other	4 (9)

DVT, Deep venous thrombosis; *IVC*, inferior vena cava; *PE*, pulmonary embolism; *VTE*, venous thromboembolism.
Categorical variables are represented as number (%) and continuous variables as median (interquartile range).

filter-related complication noted on imaging, such as embolization, are advised to undergo filter removal because of the potential for further complications. In patients who are asymptomatic and who do not have filter-related complications on imaging, the management algorithm becomes less clear and is individualized based on a patient's wishes, expectations, procedural risk, and feasibility of filter retrieval. The standard retrieval approach is based on the capture of the filter apex/hook with the coaxial collapse of the device into a sheath.[16] The success of standard retrieval techniques depends on the degree of filter-related complications, such as significant filter tilt, filter element embedment into the caval wall, or extracaval perforation of filter elements.[16] In the case of significant tilt, advanced techniques, such as the use of a curved inner sheath, can be used.[16] If the tip or hook of the IVC filter is embedded in the caval wall, a loop snare technique and rigid endobronchial forceps can be used.[16,17] The rigid endobronchial forceps is particularly useful for the dissection of fibrin of the filter apex to expose the filter hook.[16] Another technique that can be used in the case of significant filter strut incorporation into the caval wall is photothermal laser ablation, which obviates the need for shear force to release the filter from the caval wall and fibrin sheath.[14,16] In our practice, chronic indwelling filter removal is often amenable to removal with the use of one or a combination of these techniques.

Table III. Retrieval details

(n = 34)	No. (%)
Retrieval success	
Successful on the first attempt	32 (94)
Second attempt required	1 (3)
Not successful	1 (3)
Postprocedural complications	1 (3)
Length of stay, days	
0	27 (79)
1	1 (3)
2	3 (9)
3	3 (9)

Despite recommendations of timely removal and an increase in net filter retrieval rates, a minority are removed within the recommended timeline.[5,18,19] These high rates of nonretrieval may in large part be due to inadequate follow-up, which occurs in one-third of patients.[20,21] In a survey of patients' perspectives on IVC filter retrieval, the predominant response (69%) explaining lack of follow-up was unawareness of risks associated with keeping filters.[22] The same study found that only 23% of patients were aware that IVC filters could be retrieved, and 12% of patients were not even aware of having an IVC filter.[22] Furthermore, Mission et al[23] found that 21.6% of patients had no clear contraindications to filter removal. Several predictors have been identified for filter nonretrieval. Belkin et al[24] found longer time to follow-up and discharge to rehabilitation facility predictive of filter nonretrieval, whereas an indication for prophylaxis was protective. Siracuse et al[25] identified predictors of nonretrieval as age >80 years, acute bleed, current malignant disease, anticoagulation after filter placement, and history of PE or VTE. Other studies have corroborated older age as representing an increased likelihood of nonretrieval.[26-28] Although our study population was relatively young (55 years), it represents a select group of patients who presented for IVC filter retrieval consultation. As such, there is likely a large proportion of patients, perhaps older, who are never seen in such consultation and are therefore underrepresented in outcomes assessments.

There has been a decrease in the number of filter placements by surgeons with a corresponding increase in placement by interventional radiologists.[29] Furthermore, the majority of IVC filters are retrieved by interventional radiologists, something that was apparent in our study cohort as well.[30] Increased IVC filter dwell times are associated with increased filter-related complications as well as with increased filter retrieval difficulty and failure rate.[7] In addition to dwell time, pre-retrieval computed tomography can predict complicated retrieval in the presence of filter tilt >15 degrees, appearance of tip embedding, and visualized grade 2 perforations.[31] Other risk factors for complex retrieval include female sex and increased filter placement angle, whereas shorter dwell time, lower mean tilt, caudal migration, and less caval penetration are positive predictors of successful retrieval.[32-34] Despite an increase in retrieval complexity, the majority can be performed safely with use of endovascular methods, which was also the case in our series.[35] On occasion, an open surgical removal may be necessary because of its complications. However, such open operation may be performed with low mortality but nonetheless represents a major surgical procedure with the potential for significant morbidity.[36-38]

Approximately one-third of patients in our cohort were asymptomatic despite prolonged IVC filter dwell times. Several patients remained asymptomatic in midterm follow-up after unsuccessful retrieval, even in the setting of IVC filter-related complications such as significant strut penetration.[6,39] Warner et al[40] demonstrated, using Markov modeling, that leaving a previously placed IVC filter provides a 0.4 quality-adjusted life-year improvement over filter retrieval in the average patient. Optimal management strategies for chronic indwelling filters are lacking. Many physicians perform selective retrieval in such patients only in the presence of symptoms, which has been demonstrated to be associated with low morbidity and high success rates. Long-term data and additional comparative studies, particularly in asymptomatic patients managed conservatively, are desperately needed for the development of future management guidelines.

Limitations. This study is limited by its retrospective study design, which, despite a low number of missing variables, is subject to misclassification and selection bias. Despite overall favorable outcomes demonstrated, further studies are warranted to accrue information that can be used to evaluate risk factors for outcome variables evaluated. Given the single-institution nature of the study design, the results may not be generalizable to all centers. Furthermore, several patients had a prolonged filter duration (more than at least 1 year), but further information about the circumstances of filter placement could not be obtained because of placement at outside institutions. Despite listed limitations, this study describes a contemporary cohort of patients with generally long IVC filter dwell times who, when extraction was deemed feasible, had excellent postprocedural outcomes.

CONCLUSIONS

Despite prolonged dwell times, IVC filter retrieval can be performed safely and effectively in carefully selected patients at a tertiary referral center.

AUTHOR CONTRIBUTIONS

Conception and design: TI, PW, HN, SLM, SS, JL
Analysis and interpretation: TI, JL
Data collection: TI, PW, HN, SLM, JL
Writing the article: TI, PW, HN, SLM, SS, JL
Critical revision of the article: TI, PW, HN, SLM, SS, JL
Final approval of the article: TI, PW, HN, SLM, SS, JL
Statistical analysis: TI
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Overall responsibility: JL

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