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Improving the retrieval rate of inferior vena cava filters with a multidisciplinary team approach

Elica Inagaki, MD^a, Alik Farber, MD^b, Mohammad H. Eslami, MD^b, Jeffrey J. Siracuse, MD^b, Denis V. Rybin, PhD^c, Shayna Sarosiek, MD^d, J. Mark Sloan, MD^d, and Jeffrey Kalish, MD^b

^aDepartment of Surgery, Boston Medical Center, Boston, Mass

^bDivision of Vascular and Endovascular Surgery, Department of Surgery, Boston Medical Center, Boston, Mass

^cDepartment of Biostatistics, Boston University School of Public Health, Boston, Mass

^dSection of Hematology and Oncology, Department of Medicine, Boston University and Boston Medical Center, Boston, Mass

Abstract

Objective—The option to retrieve inferior vena cava (IVC) filters has resulted in an increase in the utilization of these devices as stopgap measures in patients with relative contraindications to anticoagulation. These retrievable IVC filters, however, are often not retrieved and become permanent. Recent data from our institution confirmed a historically low retrieval rate. Therefore, we hypothesized that the implementation of a new IVC filter retrieval protocol would increase the retrieval rate of appropriate IVC filters at our institution.

Methods—All consecutive patients who underwent an IVC filter placement at our institution between September 2003 and July 2012 were retrospectively reviewed. In August 2012, a multidisciplinary task force was established, and a new IVC filter retrieval protocol was implemented. Prospective data were collected using a centralized interdepartmental IVC filter registry for all consecutive patients who underwent an IVC filter placement between August 2012 and September 2014. Patients were chronologically categorized into preimplementation (PRE) and postimplementation (POST) groups. Comparisons of outcome measures, including the retrieval

Correspondence: Jeffrey Kalish, MD, Director of Endovascular Surgery, Boston Medical Center, 88 E Newton St, Collamore 5, D-506, Boston, MA 02118 (jeffrey.kalish@bmc.org).

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AUTHOR CONTRIBUTIONS

Conception and design: EI, AF, ME, JS, SS, MS, JK

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rate of IVC filters along with rates of retrieval attempt and technical failure, were made between the two groups.

Results—In the PRE and POST groups, a total of 720 and 74 retrievable IVC filters were implanted, respectively. In the POST group, 40 of 74 filters (54%) were successfully retrieved compared with 82 of 720 filters (11%) in the PRE group ($P < .001$). Furthermore, a greater number of IVC filter retrievals were attempted in the POST group than in the PRE group (66% vs 14%; $P < .001$). No significant difference was observed between the PRE and POST groups for technical failure (17% vs 18%; $P = .9$).

Conclusions—The retrieval rate of retrievable IVC filters at our institution was significantly increased with the implementation of a new IVC filter retrieval protocol with a multidisciplinary team approach. This improved retrieval rate is possible with minimal dedication of resources and can potentially lead to a decrease in IVC filter-related complications in the future.

Venous thromboembolism (VTE) is a potentially lethal disease that consists of both deep venous thrombosis (DVT) and pulmonary embolism (PE).¹ Anticoagulation is the standard first-line therapy for DVT and PE; however, placement of a retrievable inferior vena cava (IVC) filter is an alternative treatment option that provides temporary protection from potentially fatal PE in patients with a contraindication to anticoagulation.² Efficacy of the retrievable IVC filter remains unclear and continues to be a source of ongoing debate. A recent randomized clinical trial comparing the effectiveness of recurrent PE prevention using a retrievable IVC filter plus therapeutic anticoagulation with anticoagulation alone in patients with severe acute PE found that the use of a retrievable IVC filter together with anticoagulation did not reduce the risk of recurrent PE at 3 months.³ Unfortunately, this study did not include patients with contraindications to anticoagulation, rendering the data inapplicable to a large portion of patients who typically receive an IVC filter. Despite the limited evidence supporting long-term safety and efficacy,⁴ deployment of retrievable IVC filters has progressively escalated,⁵ with approximately 200% increase in use from 1999 to 2006.⁶ This rise is largely attributed to the liberalized use of retrievable IVC filters for prophylactic indications.^{6–9}

Although the theoretical advantage of retrievable IVC filters is the reduction in the long-term risks associated with permanent IVC filters, contemporary data from a systematic review of 37 clinical studies reported low retrieval rates ranging from 12% to 45%, with a mean retrieval rate of 34%.¹⁰ Given the known complications of permanent IVC filters, these patients,^{11,12} who may not have had IVC filters in the past, now face the possibility of complications related to permanent IVC filters. Between 2005 and 2010, 921 adverse events associated with retrievable IVC filters were reported to the U.S. Food and Drug Administration (FDA) through the Manufacturer and User Facility Device Experience database.¹³ Because of the growing concerns that these adverse events were associated with retrievable IVC filters left in situ for extended periods, the FDA released a statement in August 2010 recommending that all retrievable IVC filters be considered for filter retrieval once the risk of VTE has subsided.¹³

Recently, Sarosiek et al conducted a large retrospective review of IVC filter use at Boston Medical Center and found that only 8.5% of retrievable IVC filters inserted between August

2003 and February 2011 were successfully retrieved.¹⁴ In response, efforts to increase the retrieval rate of IVC filters have been targeted as a quality improvement project at our hospital. The purpose of our study was to create an operational and sustainable protocol at an academic medical center with minimal dedication of resources. We hypothesized that the implementation of this new multidisciplinary IVC filter retrieval protocol would increase the retrieval rate of appropriate IVC filters at our institution.

METHODS

Study design

A retrospective review of hospital medical records was conducted of all consecutive patients who underwent an IVC filter placement at Boston Medical Center between September 2003 and July 2012. Patients were identified with *Current Procedural Terminology* codes for IVC filter placement with manual review of the medical record. In August 2012, a new IVC filter retrieval protocol was implemented at our institution using a multidisciplinary team approach. Prospective data were then collected for all consecutive patients who underwent an IVC filter placement between August 2012 and September 2014. Extracted data included date of filter placement, indication for filter, filter type, specialty of operating physician, indwelling time, date of filter retrieval, and reasons for retrieval failure if filter retrieval was unsuccessful. The Institutional Review Board at Boston University School of Medicine approved this study, and the need for individual patient consent was waived because of the retrospective design.

During the study period, IVC filters were inserted and retrieved by physicians from multiple departments, including vascular surgery, interventional radiology, cardiology, and trauma surgery. The brand of filter inserted was at the discretion of the operating physician.

IVC filter retrieval protocol

Before August 2012, no standardized procedure was in place at our institution to track patients with IVC filters and to facilitate their retrieval. Therefore, a multidisciplinary task force, composed of representatives from vascular surgery, interventional radiology, cardiology, trauma surgery, and hematology, was established in August 2012. Through this task force, a new IVC filter retrieval protocol was designed to standardize the IVC filter retrieval process with the goal of improving the overall retrieval rate of IVC filters inserted at our institution. Four key elements were developed to augment the efficacy of this protocol. These included (1) patient educational pamphlets, (2) an additional IVC filter procedure form, (3) a centralized interdepartmental IVC filter registry, and (4) a dedicated administrative coordinator. The IVC filter retrieval process was initiated before filter placement with the education of patients or surrogates. All patients were given preprinted educational pamphlets that not only described the risks, benefits, and process of IVC filter placement and retrieval but also re-emphasized that most retrievable IVC filters should be removed once anticoagulation is tolerated or the risk for PE has abated. This pamphlet was reviewed with a family member, if available, or through an interpreter if the patient did not speak English. At the time of filter placement, the operating physician completed an IVC filter insertion form to document the indication for filter placement and estimated duration

of the IVC filter. Each IVC filter was categorized as *permanent* (no retrieval needed), *immediate* (retrieval in same hospital stay or <1 month), *short term* (retrieval in 1–6 months), or *long term* (retrieval in ≥6 months) on the basis of the clinical judgment of the operating physician. Furthermore, at the time of filter retrieval, the operating physician completed an IVC filter retrieval form to indicate whether the retrieval procedure was successful or to specify reasons for retrieval failure if it was unsuccessful. Information from these IVC filter procedure forms was collected on a centralized interdepartmental IVC filter registry, which is an access-limited database in Excel spreadsheet format (Microsoft, Redmond, Wash) that tracks all patients with IVC filters inserted at our institution from the time of placement until retrieval. A dedicated administrative coordinator updated this prospective registry and maintained active communication with other departments to navigate the patients through the retrieval process. At our institution, a pre-established vascular surgery coordinator took on these added responsibilities with negligible effect on her other duties.

Although patient follow-up methodology varied among departments, departmental coordinators contacted patients with retrievable IVC filters by phone and mail regarding their follow-up clinic and vascular laboratory appointments, and physicians, if necessary, evaluated these patients for appropriateness of future filter retrieval in their respective clinics. Standardized guidelines to determine suitability of patients for filter retrieval were established by the multidisciplinary task force, as was an algorithm for any necessary preretrieval clinic visits and imaging studies (Fig 1).

Outcome definitions

For the purpose of this study, we defined a *permanent* filter as a nonretrievable or retrievable IVC filter that was inserted into a patient for a permanent indication with no plans for future retrieval. An IVC filter that was inserted into a patient with the intent to be retrieved later and met the criteria for filter retrieval was categorized as *retrievable*. A retrievable IVC filter that was subsequently determined to remain in place permanently as the patient developed a permanent indication was classified as *deemed permanent* by an evaluating physician. An *expired* filter was a retrievable IVC filter inserted in a patient who died before IVC filter retrieval or follow-up evaluation. A *removed* filter was successfully retrieved, whereas a *technical failure* signified a retrievable IVC filter that could not be technically removed. A retrievable IVC filter in a patient who is pending follow-up evaluation with regard to the appropriateness of future filter retrieval was classified as *pending* (found only in the postimplantation group).

The primary outcome measure of IVC filter retrieval rate was calculated as a percentage of removed filters out of total retrievable filters. We also evaluated the rates of retrieval attempt and technical failure as secondary outcome measures. Rate of retrieval attempt was expressed as a portion of total retrievable filters that underwent a retrieval attempt. Finally, technical failure rate was defined as a percentage of technical failures among the total retrieval attempts.

Statistical analysis

Patients were chronologically stratified into preimplementation (PRE) and postimplementation (POST) groups by the date of IVC protocol implementation. Bivariate comparisons of clinical variables and outcome measures between these two groups were achieved by using the χ^2 test for categorical variables and the unpaired *t*-test for continuous variables. Comparisons of outcomes among immediate, short-term, and long-term filters were performed using logistic regression and one-way analysis of variance. *P* value < .05 was defined as statistically significant. Analyses were performed using SAS 9.2 (SAS Institute, Cary, NC).

RESULTS

During the study period, a total of 1275 patients underwent IVC filter placement at our institution. Thirty-six patients were excluded from the analysis because of incomplete medical records. The remaining 1239 patients were chronologically stratified into two groups, with 1088 patients in the PRE group and 151 patients in the POST group. A bivariate comparison of clinical variables is presented in Table I. The mean age of all patients was 55 ± 20 years, and no significant difference in age was observed between the two groups. Compared with patients in the PRE group, patients in the POST group were more likely to be nontrauma patients (*P* = .007) and to have an IVC filter placed by a vascular surgeon (*P* < .001). In addition, IVC filters were more likely to be inserted after a diagnosis of acute DVT or PE rather than for prophylactic indications in the POST group (*P* < .001).

Outcomes of all IVC filters are demonstrated in Fig 2. Of the 1088 IVC filters in the PRE group, 304 (28%) were inserted as permanent filters, whereas 784 (72%) were judged to be retrievable at the time of insertion. Of the 784 retrievable filters, 47 filters (4%) became irretrievable as the patients died before filter retrieval, and 17 filters (2%) were later deemed permanent, leaving a total of 720 retrievable filters (66%) at the time of the analysis. Likewise, of the 151 IVC filters in the POST group, 32 (21%) were inserted as permanent filters and 119 (79%) were inserted as retrievable filters at the time of insertion. However, among the 119 retrievable filters, 14 filters (9%) became irretrievable as the patients died before filter retrieval, and 31 filters (21%) were subsequently deemed permanent, resulting in a total of 74 retrievable filters (49%) at the time of the analysis. In contrast to the PRE group, a greater proportion of retrievable IVC filters in the POST group became irretrievable because of death of the patient (*P* = .01) or were later deemed permanent (*P* < .001). In the POST group, filters were deemed permanent for the following reasons: multiple disease burden (ie, malignant disease; *n* = 10), patient's refusal of retrieval (*n* = 9), recurrent VTE despite adequate anticoagulation (*n* = 6), inability to maintain therapeutic anticoagulation because of high bleeding risk (*n* = 5), and advanced age >80 years old (*n* = 1).

Outcomes of retrievable IVC filters are summarized in Table II. In the 720 retrievable IVC filters from the PRE group, filter retrieval was attempted in 99 filters (14%) and succeeded in 82 filters (11%), with median indwelling time of 119 days (range, 0–1882 days). Of the 99 retrieval attempts, 17 filters with median indwelling time of 115 days (range, 5–319 days) were not removed because of technical difficulties encountered during the retrieval

procedure, resulting in a technical failure rate of 17%. In the 74 retrievable IVC filters from the POST group, on the other hand, filter retrieval was attempted in 49 filters (66%) and succeeded in 40 filters (54%), with median indwelling time of 130 days (range, 8–664 days). Among the 49 retrieval attempts, 9 filters with median indwelling time of 113 days (range, 39–246 days) were unable to be retrieved, resulting in a technical failure rate of 18%. Open filter retrievals were not performed during either study period. At the time of analysis, 25 of 74 retrievable IVC filters (34%) in the POST group were pending further evaluation for the following reasons: likely to be lost to follow-up ($n = 13$), awaiting clinic visit ($n = 9$), and moved out of state ($n = 3$). Compared with the PRE group, a marked increase in the rate of retrieval attempt ($P < .001$) and a significant improvement in the retrieval rate ($P < .001$) were observed in the POST group. No significant difference in the rate of technical failure was found between the two groups ($P = .9$). Reasons for IVC filter retrieval failure are shown in Table III. For both groups, the most common reason for a failed retrieval attempt was a filter embedded in the wall of the IVC or other veins. No significant difference was seen between the two groups with regard to the reasons for IVC filter retrieval failure ($P = .5$). Further attempts at retrieval using adjunctive maneuvers were not made, and these filters were left in place as permanent filters. Finally, outcomes of retrievable IVC filters in the POST group stratified by categorization of immediate, short term, or long term are presented in Table IV. A notable decrease in rates of retrieval attempt from 92% in the immediate filters to 50% in the long-term filters ($P = .03$) was observed. Likewise, a significant decline in retrieval rates from 83% in the immediate filters to 38% in the long-term filters ($P = .03$) was also noted.

DISCUSSION

In response to the FDA's initial communication expressing the safety concerns of retrievable IVC filters left in situ for extended periods, much attention has focused on improving the retrieval rates to avoid long-term filter-related complications. In this study, we not only succeeded in significantly improving the retrieval rate of retrievable IVC filters from 11% to 54% but also demonstrated the feasibility of implementing a new IVC filter retrieval protocol at our institution. No difference in the rate of technical failure was detected between the PRE and POST groups, suggesting that the observed improvement in retrieval rate was due not to a decrease in the number of technical failures but rather to an increase in the number of retrieval attempts facilitated by the implementation of the new protocol. Our observed technical failure rates are most likely due to our longer indwelling time compared with those reported in the literature.^{10,15,16} As previously demonstrated by Rosenthal et al, a modification in the IVC filter retrieval protocol to shorten the indwelling time will presumably result in a lower technical failure rate.¹⁷ As in several other studies,^{15,18–20} the most common reason for a failed retrieval attempt at our institution was encountering a filter adherent to the wall of the IVC. No difference was seen between the two groups with regard to the reasons for IVC filter retrieval failure; however, the interpretation of this result is limited by the small sample size.

The primary outcome of this study parallels those from prior published studies,^{3,16,21–23} in which high retrieval rates were demonstrated in institutions with a wide range of dedicated patient tracking and outreach programs. Ko et al increased the retrieval rate from 37% to

84% by electronically tracking trauma patients with retrievable IVC filters and sending automated emails to the admitting physicians as reminders to proactively schedule filter retrievals for appropriate candidates.²¹ In addition to an IVC filter database, Minocha et al established a dedicated IVC filter clinic, resulting in a doubling of the retrieval rate from 29% to 60%.¹⁶ O’Keeffe et al presented a higher retrieval rate of 55% in trauma patients compared with a baseline retrieval rate of 19% in nontrauma patients by using arm bracelets or chart stickers to track trauma patients with a retrievable IVC filter and providing appropriate follow-up appointments.²² Sutphin et al improved the retrieval rate of retrievable IVC filters from a baseline of 8% to 40% with mailing of follow-up letters to the patients and referring clinicians and subsequently to 52% with automated scheduling of a clinic visit 4 weeks after IVC filter placement.²³ Finally, an impressive cumulative retrieval rate of 93% by 17 French centers participating in the Prevention of Recurrent Pulmonary Embolism by Vena Cava Interruption 2 (PREPIC2) trial was made possible by mandatory follow-up visit and filter retrieval at 3 months from the time of filter placement.³

Whereas the overall evidence linking the establishment of a dedicated patient tracking and outreach program and its favorable effect on the retrieval rate of IVC filter is strong, these previous studies were limited by the single disciplinary nature of the program,^{15,16,22,24–26} the inclusion of study subjects restricted to trauma patients,^{21,22,25–27} and the placement of IVC filters by a single department.^{15,16,23,24} To overcome these limitations, the IVC filter retrieval protocol presented in our study was designed and implemented through a multidisciplinary team approach, with all parties invested in improving the tracking of these filters. Unlike in prior studies, in which a single department assumed the sole responsibility for ensuring timely follow-up evaluations and filter retrievals,^{15,16,22,24–26} the vascular surgery coordinator provided follow-up reminders to all procedural services—vascular surgery, interventional radiology, and cardiology—and in response, each individual department coordinated scheduling of appointments and retrievals with their respective patients to maximize the likelihood for successful filter retrieval, as previously described by Karmy-Jones et al.²⁸ More important, the study subjects evaluated in the present study were not just limited to trauma patients^{21,22,25–27} or patients with IVC filters placed by a single department,^{15,16,23,24} but rather we included all patients with retrievable IVC filters inserted at our institution. Such individuals are highly representative of the population of patients seen by many urban tertiary academic medical centers in the country. Thus, because of the multidisciplinary nature of the IVC filter retrieval protocol and inclusion of all patients with retrievable IVC filters, our experience and results presented in this study have broad applicability.

To create a sustainable protocol in an urban academic medical center, locally available resources were fully used to design and to execute the new IVC filter retrieval protocol with minimal added cost. The centralized IVC filter registry was maintained on a database in Excel spreadsheet format on a pre-existing shared drive. As an alternative to hiring new personnel, an established vascular surgery coordinator took on added responsibilities to maintain the IVC filter registry and to facilitate follow-up appointments and filter retrieval procedures with other departmental coordinators and physicians. The IVC filter procedure forms are incorporated into the electronic medical records and allow easy integration into the daily workflow of operating physicians. Finally, rather than opening a separate,

dedicated IVC filter clinic, patients with retrievable IVC filters were divided among the procedural services and either were evaluated at their respective outpatient clinics or had their retrieval procedure directly scheduled.

This study has a number of limitations. First, the retrospective nature of the study makes our data susceptible to inherent biases of retrospective analyses. Second, the data are subject to poor documentation or lack of follow-up, especially in the PRE period. For example, our study demonstrated that a greater number of retrievable IVC filters in the POST group were later deemed permanent compared with those in the PRE group. However, this significant difference may be attributed to poor documentation or low follow-up rate in the PRE period, resulting in the under-reporting of filters later deemed permanent in this group. Next, because our data are single institutional, IVC filters retrieved at other institutions were not captured in our data analysis. In addition, a higher number of IVC filters were placed in trauma patients in the PRE group compared with the POST group. It is possible that this observation may represent a local phenomenon due to the fact that before the implementation of the IVC filter retrieval protocol, the trauma surgery service placed more IVC filters in trauma patients, and many of these were done for prophylactic indications. With the implementation of the protocol, the vascular surgery service absorbed this role from the trauma surgery service. Fewer filters were inserted for prophylactic indications, probably because of the review of indications for placement of IVC filters discussed by the multidisciplinary task force. Furthermore, another limitation in the implementation of the IVC filter retrieval protocol is that it does still require resources, albeit minimal, for an administrative coordinator to track all IVC filters, for various departmental staff to coordinate follow-up evaluations, and for physicians to fill out each IVC filter procedure form. Perhaps as electronic medical records become more sophisticated, reports can potentially be run to perform this tracking instead of manual entry, and reminder flags can facilitate communication regarding upcoming filter follow-up evaluations to the appropriate providers. Finally, long-term complication data were not presented in this study as only a limited amount of data was available at the time of the analysis.

CONCLUSIONS

Despite these limitations, this study has clinical relevance in this era of health care quality improvement. We demonstrated a significant improvement in the retrieval rate of IVC filters and validated the feasibility of implementing a sustainable IVC filter retrieval protocol with a multidisciplinary team approach at our institution. This improved retrieval rate was made possible with minimal dedication of resources and can potentially lead to a decrease in future IVC filter-related complications.

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Fig 1.

Algorithm for evaluation of the patient before inferior vena cava (IVC) filter retrieval. In addition to bilateral venous duplex examination, an evaluating physician may order a computed tomography (CT) venogram or an abdominal radiograph under certain circumstances. *DVT*, Deep venous thrombosis; *PE*, pulmonary embolism.

Fig 2. Outcomes of all inferior vena cava (IVC) filters in the preimplementation (PRE) group (September 2003–July 2012) and postimplementation (POST) group (August 2012–September 2014).

Table I

Clinical variables

Variables	PRE group (n = 1088)	POST group (n = 151)	P value
Age, years	55 ± 20	57 ± 17	.2
Trauma patient	526 (48)	55 (36)	.007
Indication			<.001
Prophylaxis for high-risk patient	485 (46)	40 (27)	
Acute DVT or PE	479 (45)	97 (64)	
Excessive clot burden	64 (6)	12 (8)	
Recurrent PE while on anticoagulation	34 (3)	2 (1)	
Filter type			<.001
Angiotech Option	115 (10)	46 (30)	
Bard Denali	0 (0)	40 (27)	
Bard G2X	21 (2)	1 (1)	
Bard Eclipse	210 (20)	44 (29)	
Cook Gunther-Tulip	45 (4)	17 (11)	
Cordis Optease	77 (7)	1 (1)	
Cordis Trapease	264 (24)	0 (0)	
Cook Bird's Nest	6 (1)	0 (0)	
Unknown	350 (32)	1 (1)	
Service			<.001
Vascular surgery	53 (5)	53 (35)	
Interventional radiology	717 (67)	90 (60)	
Cardiology	23 (2)	8 (5)	
Trauma surgery	278 (26)	0 (0)	

DVT, Deep venous thrombosis; *PE*, pulmonary embolism; *POST*, postimplantation; *PRE*, preimplantation.

Categorical variables are presented as number (%). Continuous variables are presented as mean ± standard deviation.

Table II

Outcomes of retrievable inferior vena cava (IVC) filters

Outcomes	PRE group (n = 720)	POST group (n = 74)	P value
Retrieval attempts	99 (14)	49 (66)	<.001
Removed filters	82 (11)	40 (54)	<.001
Indwelling time, days, median (range)	119 (0–1882)	175 (8–664)	.8
Technical failure rate ^a	17 (17)	9 (18)	.9

POST, Postimplantation; *PRE*, preimplantation.

Categorical variables are presented as number (%).

^aTechnical failure rate (%) = No. of technical failures/total No. of retrieval attempts × 100.

Table IIIReasons for inferior vena cava filter (*IVC*) retrieval failure

Reasons	PRE group (n = 17)	POST group (n = 9)	P value
Embedded in IVC/lumbar/renal veins	9 (53)	7 (78)	.5
Abnormal position of filter	4 (23)	0 (0)	
Protrusion of limbs out of IVC	2 (12)	0 (0)	
Thrombus present in filter	1 (6)	1 (11)	
Other	1 (6)	1 (11)	

POST, Postimplantation; *PRE*, preimplantation.

Categorical variables are presented as number (%).

Table IV

Outcomes of retrievable inferior vena cava (IVC) filters in the postimplantation (POST) group stratified by categorization of immediate, short-term, or long-term filters

Outcomes	Immediate filters (n = 12)	Short-term filters (n = 55)	Long-term filters (n = 8)	P value
Retrieval attempts	11 (92)	34 (62)	4 (50)	.03
Removed filters	10 (83)	28 (51)	3 (38)	.03
Indwelling time, days, median (range)	23 (8–269)	164 (10–664)	245 (21–270)	.05
Technical failure rate ^a	1 (9)	6 (18)	1 (25)	.4

Categorical variables are presented as number (%).

^aTechnical failure rate (%) = No. of technical failures/total No. of retrieval attempts × 100.