

Routine Inferior Vena Cava Filter Retrieval: A Cost Minimization Analysis of Loop Snare Versus Rigid Endobronchial Forceps-Assisted Retrieval Techniques

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Abstract

Background: Routine inferior vena cava filter retrieval is a common procedure that can be accomplished with different techniques. Simple loop-snare retrieval is common; however, snares are single use, and many seemingly routine retrievals require more advanced techniques. Rigid endobronchial forceps retrieval is an effective advanced approach with the ability for the forceps to be sterilized and reused for multiple procedures. The purpose of this study was to compare the cost-effectiveness of snare versus forceps inferior vena cava filter retrieval techniques at a single institution.

Methods: This study is a cost minimization analysis based on an institutional review board-approved, single-center, retrospective review of all inferior vena cava filter retrievals from January 2019 to April 2021. Routine inferior vena cava filter retrieval techniques were categorized as loop-snare-only retrieval, forceps-assisted after unsuccessful snare retrieval, and forceps-only retrieval. Total equipment cost for each technique was determined.

Results: Seventy-seven successful routine inferior vena cava filter retrieval procedures were performed at our institution during the study period (63 loop-snare-only retrieval, 8 forceps-assisted after unsuccessful snare retrieval, and 6 forceps-only retrieval). There were no technical failures. Forceps-only retrieval was the most cost-effective technique with per-procedure equipment cost of loop-snare-only retrieval, forceps-assisted after unsuccessful snare retrieval, and forceps-only retrieval techniques of \$434.30, \$556.55, and \$221.98, respectively. Average equipment cost for the 77 retrievals over the study was \$430.46. Had all retrievals been performed using the forceps-only retrieval technique, average equipment cost per retrieval would have decreased by \$208.48, for a total cost savings of \$16 052.72.

Conclusion: Utilization of forceps-only retrieval technique for all routine inferior vena cava filter retrievals would result in a meaningful cost savings compared to standard loop-snare-only retrieval and forceps-assisted after unsuccessful snare retrieval techniques.

Keywords: Venous thromboembolism, IVC filter retrieval, loop-snare, endobronchial forceps, cost minimization analysis

Introduction

Venous thromboembolism (VTE) is a significant cause of morbidity and mortality. Although anticoagulation is a first-line therapy, inferior vena cava filters (IVCFs) remain a mainstay in therapy for patients with VTE who have contraindications to or have failed anticoagulation.¹⁻³ The IVCFs were originally placed with the intention of long-term use; however, in 2010, the Food and Drug Administration (FDA) released a recommendation that IVCFs should be removed as soon as medically appropriate. This recommendation was reiterated by the FDA in 2014 and more recently has been reflected in current practice

guidelines made in collaboration with multiple medical societies.^{4,5} These recommendations have been the major driver of increasing IVCF retrievals.

The use of a simple loop snare is among the most common IVCF retrieval techniques. Due to the number of patients with chronically indwelling IVCF now undergoing filter retrieval, there have been significant advances in retrieval techniques. Although effective in many routine IVCF retrieval procedures, the use of a loop snare has the drawback of being single use.^{6,7} Additionally, advanced techniques are often required following loop-snare technique failures.⁶⁻⁹ Rigid endobronchial forceps (EF) retrieval

Cite this article as: Swietlik JF, Steiner Q, Laeseke PF, Eifler A. Routine inferior vena cava filter retrieval: A cost minimization analysis of loop snare versus rigid endobronchial forceps-assisted retrieval techniques. *Imaging Interv.* 2022;2(2):15-18.

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Received: January 31, 2023 **Accepted:** March 07, 2023 **Publication Date:** April 7, 2023



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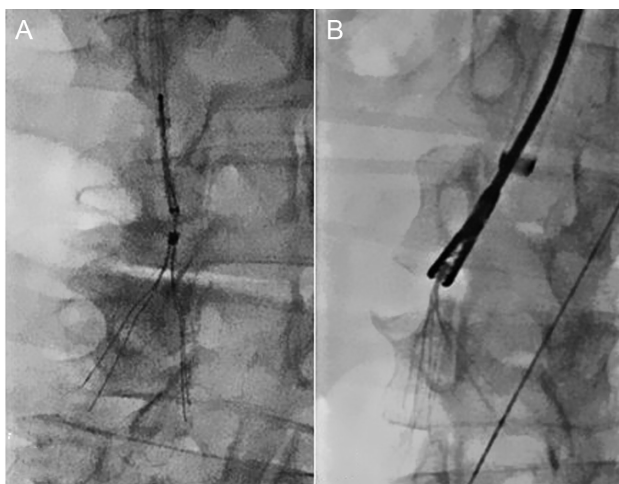


Figure 1. Routine IVCF retrieval can be accomplished with different techniques. Simple loop snare retrieval (A) is a common approach. However, EF retrieval (B) is a new technique with increased application for IVCF retrieval with the added advantage that they can be sterilized and re-used for multiple procedures.

has been developed for use in chronically embedded IVCFs. EF have also been used during routine IVCF retrieval cases after standard techniques have failed.⁶⁻⁸ EF can be sterilized and reused for multiple procedures. Given the increase in retrieval rates, it has become increasingly relevant to consider the financial implications of the varying retrieval techniques, but data evaluating the cost of IVCF retrieval techniques are currently lacking. The purpose of this study was to compare the cost-effectiveness of EF only versus simple loop-snare techniques for simple IVCF retrievals at a single institution.

Materials and Methods

Institutional review board approval was obtained to perform a retrospective review of all routine IVCF retrievals performed during a 27-month period (January 1, 2019 to April 30, 2021) at a single institution. Epic HealthLink (Epic Systems Corporation, Verona, WI, USA) was queried using procedure codes for all IVCF retrievals. A total of 94 procedures were identified. Chronic

Main Points

- Although anticoagulation is first-line therapy for venous thromboembolism (VTE), inferior vena cava filters (IVCF) remain a mainstay in therapy for patients with VTE who have contraindications to or have failed anticoagulation. With current recommendations for IVCF removal as soon as medically appropriate, IVCF retrieval remains a common procedure for an Interventional Radiologist.
- Rigid endobronchial forceps (EF) retrieval was developed for use complex filter retrieval, however as familiarity with EF increases their use has been adapted to routine IVCF retrieval cases. EF have potential for decreased costs for routine IVCF retrieval cases as they can be sterilized and reused for multiple procedures.
- In this cost minimization analysis EF retrieval was the most cost-effective IVCF retrieval technique, and utilization of EF retrieval technique for all routine IVCF retrievals could result in meaningful cost savings.

(>12-month dwell time) and complex filter retrievals (defined by pre-procedural imaging findings) were excluded. A total of 77 routine IVCF retrieval procedures were included for review. The procedures were subcategorized based on retrieval technique. Routine IVCF retrieval techniques were categorized as loop-snare-only retrieval (SR), forceps-assisted after unsuccessful snare retrieval (S+F), and forceps-only retrieval (FR). An institutional procedural database was reviewed for all 77 cases. Procedural equipment for all cases were recorded, and a standard procedural equipment setup was created from the most used equipment for each technique. Total equipment cost for the standard procedural equipment of each technique was calculated based on product-specific company prices. The EF used for filter retrieval can be autoclaved between cases for repeat use in multiple procedures. Therefore, an estimated per procedure cost was calculated for inclusion in the study. For the purpose of this study, the EF was given a conservative shelf life of 2 years based on potential wear and tear, as well as the theoretical risk for the EF to be misplaced or lost. In review of the current study period, 75 IVCF retrievals were completed over a 2-year period. Hence, a per procedure cost of \$14 was calculated based on the total cost (\$1050) divided by the procedures completed within a 2-year timeframe. All other equipments used were of single use, and the included cost was based on company prices. Cost analysis was then performed comparing the varying retrieval techniques. Chart review was completed for each case to determine procedural technical success and procedural complications. Technical success was defined as complete removal of the IVC filter. Procedural complications were based on the Society of Interventional Radiology (SIR) adverse event classification.⁹

Results

Seventy-seven successful routine IVCF retrieval procedures were performed at our institution during our period of study (63 SR, 8 S+F, and 6 FR). Technical success was 100% for all procedures. Table 1 summarizes the cost of the procedural equipment for each technique. Forceps-only retrieval was the most cost-effective technique with a per procedure equipment cost of \$221.98, compared to \$434.30 for SR and \$556.55 for S+F. Average equipment cost for the 77 retrievals over the study period was \$430.46, for a total cost of \$33 145.42 for the 27-month period. Had all retrievals been performed using the FR technique, average equipment cost per retrieval would have been decreased by \$208.48 for a total cost savings of \$16 052.72 over the 27-month period (see Table 2 for summary of the cost comparison of retrieval techniques). This potential cost savings represents 48% of the total procedural equipment cost.

Discussion

This study demonstrated that the primary use of EF for routine IVCF retrieval procedures allows for a procedural cost reduction compared to a snare-loop retrieval technique. Additionally, given that in IVCF retrieval cases where standard snare-loop retrieval fails, EF may be needed to achieve technical success, and primary use of EF would eliminate cost of using both techniques. The equipment cost reduction per retrieval is substantial and can be impactful when extrapolated over time. This cost savings becomes increasingly meaningful with the increasing number of IVCF retrievals that are being performed annually throughout the United States.

Table 1. Summary of Equipment Cost

Snare-Only Technique	Snare + Forceps-Assisted Technique	Forceps-Only Technique
Micropuncture set (\$27.00)	Micropuncture set (\$27.00)	Micropuncture set (\$27.00)
Amplatz wire (\$45.20)	Amplatz wire (\$45.20)	Amplatz wire (\$45.20)
Pigtail flush catheter (\$22.28)	Pigtail flush catheter (\$22.28)	Pigtail flush catheter (\$22.28)
10 Fr Check-Flo catheter (\$68.00)	10 Fr Check-Flo catheter (\$68.00)	12 and 14 Fr dilators (\$10.50)
EnSnare (\$271.82)	EnSnare (\$271.82)	16 Fr check-flow catheter (\$103.00)
	14 Fr dilator (\$5.25)	Rigid endobronchial forceps (\$14 per use)*
	16 Fr check-flow catheter (\$103.00)	
	Rigid endobronchial forceps (\$14 per use)*	
Total cost: \$434.40	Total cost: \$556.55	Total cost: \$221.98

Except rigid endobronchial forceps price, all other prices are listed as vendor list price.

*Rigid endobronchial forceps price is an estimation of per case cost as described within the "Materials and Methods" section.

Table 2. Cost Comparison of Retrieval Techniques

Retrieval Technique	Average Total Cost	Cost Comparison to Primary Forceps Retrieval	Number of IVC Filter Removal Procedures Completed	Potential Cost Savings of Forceps Retrieval
FR	\$221.98	—	6	—
SR	\$434.30	+\$212.32	63	\$13 376.16
S + F	\$556.55	+\$334.57	8	\$2676.56
Total			77	\$16 052.72

FR, forceps-only retrieval; S + F, forceps-assisted after unsuccessful snare retrieval; SR, snare-only retrieval.



Figure 2. Rigid endobronchial forceps are shapeable and allow for direct grasping of the filter apex. They were originally adapted for advance IVCF retrieval techniques; however they can be applied to routine filter retrieval and their ability to be re-used for multiple cases allow for potential procedural cost savings.

Chronic indwelling IVCFs have potential complications including filter fracture, device migration, organ penetration, IVC thrombosis, and increased deep vein thrombosis (DVT) risk.^{7,10,11} In 2010, the FDA issued a recommendation that all IVCFs be removed as soon as medically appropriate and that physicians who place IVCF ensure appropriate management of retrieval.⁵ This recommendation has led to an increase in IVCF retrievals, including complex retrievals due to chronically indwelling and embedded IVCF. Increased IVCF dwell times have been demonstrated to increase IVCF retrieval failure.^{8,12} The large patient population with chronic indwelling IVCF requiring complex retrieval led to a need for development of new retrieval techniques, including the EF.⁷⁻⁹ The EF can be advanced through a large-caliber venous access sheath (Figure 1: add in picture of forceps). The EF is used to grasp the filter hook, and then, the sheath is advanced over the EF while appropriate tension is kept on the EF which forces the IVCF to collapse into the sheath. The IVCF can then be removed through the sheath. The EF can be used for blunt dissection of embedded filter hook if needed, and the curvature of the EF can be manipulated to reach a tilted and embedded filter when necessary.^{6,7} As proceduralists have become more experienced and skilled with EF, their use has expanded beyond complex IVCF retrievals. The EF have potential benefits when used in routine IVCF retrieval cases.

The current study demonstrated a meaningful potential equipment cost savings (Figure 2) when primarily using EF retrievals for all routine IVCF retrievals. Although the current study demonstrated 100% technical success and no complications with the use of FR, future studies over a larger cohort are required to evaluate technical success and procedural complication rates.

The current study has multiple limitations. The single-institution retrospective design of this study may limit its application. Additionally, the EF retrieval technique is user dependent. Proceduralists who perform IVCF retrievals may have less familiarity with the EF and be less proficient than those in the current study, which might impact the widespread application of EF. However, as proceduralists complete greater numbers of complex IVCF retrievals, the use of EF will become more ubiquitous. At the study institution, the EF can be autoclaved at no direct cost to the department; however, this may not be the case at other institutions which may decrease the potential cost savings. Although this study demonstrates a potential equipment cost savings from the use of a primary EF technique for all routine IVCF retrievals, further studies are needed to determine any differences in fluoroscopy time and radiation exposure (both to patient and physician) compared to standard snare-loop techniques.

Conclusion

Primary utilization of FR for all routine IVCF retrievals could result in a meaningful cost savings compared to current standard techniques.

Ethics Committee Approval: Given the retrospective nature and patient anonymity of the study, ethics committee approval was not required.

Informed Consent: This study was performed under a waiver of informed consent by the IRB.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – J.F.S., A.E.; Design – J.F.S., P.F.L., A.E.; Supervision – J.F.S., P.F.L., A.E.; Materials – J.F.S., A.E.; Data Collection and/or Processing – J.F.S., Q.S., A.E.; Analysis and/or Interpretation – J.F.S., Q.S., P.F.L., A.E.; Literature Review – J.F.S., Q.S.; Writing – J.F.S., Q.S., A.E.; Critical Review – J.F.S., Q.S., P.F.L., A.E.

Declaration of Interests: J.F.S, Q.S., and A.E. have no conflict of interest to declare. P.F.L. has research grants from Siemens Medical and HistoSonics; is a paid consultant for Ethicon, HistoSonics, and Elucent Medical; and is a stockholder in Elucent Medical, McGinley Orthopedic Innovations, and HistoSonics, Inc.

Funding: This study received no funding.

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