ISSN: 2690-3164

Alamri M, et al. Int Arch Vasc Med 2026, 08:018
DOI: 10.23937/2690-3164/1710018
Volume 8 | Issue 1
Open Access

International Archives of Vascular Medicine

RETROSPECTIVE COHORT STUDY

Single Center Experience of Inferior Vena Cava Filters Retrieval and Associated Complications

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Abstract

Rationale and Objectives: Retrievable inferior vena cava (rIVC) filters are used to prevent pulmonary embolism in patients with contraindications to anticoagulation; however, retrieval rates remain low worldwide, increasing the risk of long-term complications. This study evaluates the impact of intervention radiologist follow-up documentation on filter retrieval rate, insertion indications, retrieval outcomes, dwell times, retrieval techniques, and complications at a tertiary center in Saudi Arabia.

Materials and Methods: This single-center retrospective observational study included 124 adult patients who underwent placement of (Option ELITE type) rIVC filters between 2018 and 2021. Data of retrieval recommendation in the procedure reports, retrieval attempts, dwell times, complications, were collected. Statistical analysis was performed using SPSS.

Results: The overall retrieval rate was 35.5% match the worldwide rate. Follow-up recommendation was present in 82% of procedure reports and was strongly associated with successful retrieval ($p < 0.001$). Mean dwell time was 98.8 days. Standard retrieval technique was successful in 88.4% of cases, while prolonged dwell times were associated with increased retrieval technique complexity. No major complications were observed.

Conclusion: Clear follow-up and recommendation of retrieval in the insertion report significantly improves retrieval rates. Early retrieval and structured follow-up systems from both intervention radiologists and primary physicians are essential to minimize long-term complications and enhance patient safety.

Keywords

Inferior vena cava filter, Retrievable inferior vena cava (rIVC), Dwell time, Complex retrieval techniques, Deep vein thrombosis, Saudi Arabia

Introduction

Retrievable inferior vena cava (rIVC) filter, prevent pulmonary embolism (PE) among patients with contraindications to anticoagulation. However, these devices, when left for prolonged periods, cause filter tilt, embedding hook, fracture, migration, or caval thrombosis [1,2]. To counter such risks, in 2010 and 2014, the U.S. Food and Drug Administration (FDA) issued safety alerts, recommending filter removal, immediately after no longer needed or the indication of insertion resolved [3].

Despite proposed recommendations, retrieval rates remain low. Data from national registries show as low as 15% retrieval rates among U.S. Medicare patients, with extended dwell times associated with caval thrombosis [4]. In 2020, a large systemic review metanalysis study found 34.4% estimation worldwide retrieval rate [2]. Emerging strategies, including, automated reminder system implementation through ML (Machine Learning), aids in prompting retrieval to enhance safety and efficiency of filter retrieval [2,5,6].

Citation: Alamri M, Alshehri O, Alamoudi O (2026) Single Center Experience of Inferior Vena Cava Filters Retrieval and Associated Complications. Int J Radiol Imaging Technol 08:018. doi.org/10.23937/2690-3164/1710018

Accepted: July 15, 2026 : **Accepted:** September 25, 2026 : **Published:** September 29, 2026

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However, scant data exists, regarding the usage of retrievable inferior vena cava (rIVC) filter, practices of retrieval, and barriers related to documentation in Saudi Arabia, given the need for quality improvement in the corresponding aspect. However, it is pertinent to understand the patterns of local practice to optimize follow-up systems, improve rates of retrieval, and reduce complications, that could easily be prevented. Hence, this research reviews Prince Sultan Military Medical City's (PSMMC), Riyadh, experience, during 2018 - 2021, regarding the focus upon indications of insertion, rates of retrieval success, related complications, and follow-up documentation influence on retrieval rates across Saudi Arabian Medical facilities.

Methods

This study was designed as a single-center retrospective study conducted at Prince Sultan Military Medical City (PSMMC), Riyadh, Saudi Arabia. Adult patients (≥ 14 years) who underwent placement of a retrievable inferior vena cava filter (Option, Argon Medical Devices) between January 2018 and December 2021 were included. The follow up of included patient electronic medical records extended until the study time, January 2023.

Exclusion criteria

The exclusion criteria of the study included patients younger than 14 years, those experiencing fatality before January 2023, patients receiving non–Option type filters, and those with incomplete medical records preventing assessment of outcomes.

Ethical considerations

Institutional Review Board (IRB) approval was obtained before data collection. Electronic health records were reviewed to extract information on patient demographics, indications for filter placement, filter retrieval attempts and techniques, dwell times, documentation of follow-up recommendations in the initial procedure report, and procedure-related complications.

Definition of follow-up documentation

Follow-up documentation was defined as the presence of explicit written recommendations in the initial interventional radiology procedure report mainly in two forms "IVC filter should be removed as soon as possible when no longer needed, follow up is recommended" or "IVC filter should be removed within 6 to 9 months as per hospital protocol". All documentation was entered by the performing interventional radiologist at the time of filter placement.

Definition of dwell time

Dwell time of the IVC filter refer to how long the filter stays in body.

Definition of complications

Complications included filter tilt (> 15°), embedded hook, migration (> 2 cm), fracture, caval perforation (> 3 mm beyond the caval wall), thrombosis involving the filter, and any retrieval-related adverse event. Moreover, retrieval technique was classified as standard retrieval technique (Snare technique) and advanced or complex retrieval technique (Tri loop-snare, Balloon-assisted, Laser sheath-assisted, or other nonstandard maneuvers).

Sample size

The minimum required sample size was calculated to detect a statistically significant association between follow-up documentation and retrieval success, assuming a two-sided α of 0.05, 95% confidence level, and an expected effect size based on prior literature, yielding 94 patients as the sample size.

Statistical analysis

Associations between retrieval recommendation in the report and filter retrieval were assessed using the Chi-square test. Results are reported as χ^2 values with corresponding degrees of freedom (df) and p-values. A p-value < 0.05 was considered statistically significant.

Results

Indications for filter placement

Table 1.

Retrieval outcomes

Of 124 inserted filters, 44 were successfully retrieved, yielding 35.5% (95% CI: 27.3-44.5%) retrieval rate.

Role of follow-up documentation

Procedure report Follow-up instruction of retrieval were included among 102 (82%) reports, where retrieval was likely during the presence of documentation ($p < 0.001$). Notably, none of the patients 22 (18%), lacking follow up recommendation for retrieval in reports, underwent retrieval. Retrieval was significantly more frequent among patients whose procedure reports included follow-up documentation compared with those without instruction documentation ($p < 0.001$). No filters were retrieved in cases lacking documented follow-up recommendations.

Table 1: Retrievable inferior vena cava (rIVC) filter indications.

Category	Indications for Filter Placement	Patients Number
1	Acute DVT with contraindication to anticoagulation	61 (49.2%)
2	Pulmonary embolism with inability to anticoagulate	29 (23.4%)
3	Prophylactic, either trauma or major surgery	26 (21.0%)
4	Prophylacti due to recurrent thromboembolic disease	8 (6.5%)

Dwell time

The mean filter dwell time was measured at 98.8 days (range: 15-247 days), where patients with < 50 days dwell time all showed successful retrieval through simple standard techniques, patients with > 50 days dwell time required likelihood of complex or advance retrieval techniques due to the tilting of filter mainly, embedded hooks, or early fibrotic incorporation.

A dwell-time threshold of > 50 days was used to indicate increased retrieval complexity, consistent with prior large systemic review metanalysis panel observation, demonstrating higher rates of filter tilt, hook embedding, and endothelialization beyond this period, leading to greater technical difficulty during retrieval.

Retrieval techniques

Standard retrieval techniques were successful among 39 (88.4%) patients, where complex retrieval techniques were required among 5 (11.6%) patients, at >50 days dwell time due to tilt and hook embedding.

Complex retrieval methods used

- Tri-loop snare: 2 patients
- Balloon-assisted retrieval: 2 patients
- Laser sheath–assisted retrieval: 1 patient

Complications

No major complications related to retrievable inferior vena cava (rIVC) filter insertion or retrieval were documented, including injury of the caval injury, fracture of the filter, or significant bleeding. However, transient pain, small access-site hematoma were found be rare among patients, which were usually resolved without an intervention.

Discussion

This study provides important insights into the use, follow-up recommendation, and retrievable inferior vena cava (rIVC) filter rate at Prince Sultan Military Medical City (PSMMC), Riyadh, Saudi Arabia. The results of the current study are consistent with global trends, with major filter placements for acute DVT or PE among patients, who may not receive anticoagulation. However, the notable proportion of prophylactic insertions reflects an opportunity to align local practice with international guidelines, which discourages the usage of routine prophylactic insertions, except across high-risk patients [2].

The overall retrieval rate remained almost similar to global estimates, reinforcing timely filter removal [2]. International registries, such as SAFE-IVC registry have reported wide variability across retrieval practices, with patients showing as low as 15% retrievable rates [4]. These comparisons highlight the inherent gap between guideline recommendations and real-world practice.

The research findings show strong linkage between retrieval instruction documentation and successful removal of filter. Patients with initial radiology reports containing explicit follow-up recommendations for removal showed higher filter retrieval rate, whereas none of the patients lacking this specific recommendation underwent retrieval. These results align with research studies that demonstrate the evidence of structured documentation and electronic reminders, which may double retrieval rates [2,4]. However, documentation absence in this research, likely reflects workflow issues, competing clinical priorities, and standardized reporting template lack. These factors are modifiable and offer enhanced improvement for treatment quality.

Prolonged dwell time was also strongly associated with retrieval difficulty. Filters left in situ for more than 50 days frequently required complex retrieval techniques, echoing earlier research demonstrating higher rates of tilt mainly, endothelialization, and hook embedding with extended implantation [2]. While the recommended dwell time for an Option Argon rIVC filter is within 175 days as per company, the FDA in a general advisory for all retrievable filters, suggested an optimal removal window of 29 to 54 days once the risk of pulmonary embolism has passed [2]. Despite successful complex retrievals, these approaches require additional expertise, containing increased complexity in procedures. Hence, the findings of the research highlight the importance of systematic follow-up and early retrieval within medical facilities.

Comparison with regional studies further support the research findings, where prior research studies conducted within Saudi Arabia, documented lower rates of retrieval, highlighting limitations across follow-up processes [7,8]. International literature also confirms wide interinstitutional variability, influenced by clinical workflows, operator experience, and surveillance systems [1,9-11]. Together, these findings emphasize upon the need for improvements within the system, to align recommendation guidelines and medical practices.

What this study adds

The study demonstrates a quantifiable follow-up documentation on retrieval success impact in Saudi tertiary, highlighting documentation quality, as a modifiable factor, which contributes to lower retrieval rates. This study provides local data, which supports the global call for structured follow-up systems, including electronic alerts and standardized reporting templates, thereby, offering region-specific evidence, prolonging dwell time that leads to using complex retrieval techniques.

Research limitations

1. The research design of the current study, limits causality determination between practices of documentation from no documentation and outcomes of retrieval.

2. Considering patient's medical records, still there is chance of some patients have undergone retrieval of filter at different hospitals, without system documentation, therefore, leading to underestimating rate of retrieval.

3. The research study includes the only available hospital supply (Option ELITE filters), which restricts medical institutes to adopt the usage of diverse filter models with distinct characteristics of retrieval.

4. The wide range of adult age influences decision-making upon filter retrieval, as clinicians may may leave filters intentionally specially older patients.

5. The research is a single-center study, where research findings are not generalizable within medical institutions possessing diverse populations of patients, clinical workflows, or practices of interventional radiology.

Conclusion

Retrievable inferior vena cava (rIVC) filters are an essential therapeutic option for patients, however, timely filter removal imposes significant challenges. In the current research, the filter retrieval was achieved across 1/3 cases, lacking documentation of follow-up, which emerges as a significant challenge. Prolonged dwell times increases complexity of filter retrieval, reinforcing early and properly planned filter removal. However, to improve research outcomes, the study recommends mandatory and structured plans of filter retrieval within radiology reports and automated reminder system implementation to reassess filter retrieval in due time, alongside enhancing co-ordination at multidisciplinary levels for consistent follow-up. Future research studies should evaluate system-level intervention effectiveness, for instance, standardized templates of reporting, automated alerts, and effective system of patient tracking, in order to improve rates of retrieval, while reducing the risk of medical complications.

Acknowledgment

The authors would like to thank the Interventional Radiology Department at Prince Sultan Military Medical City for their support in data collection. We also extend our appreciation to Saudi Society of intervention Radiology for accepting the abstract of this research to be presented in the annual meeting November 2023. Finally, we acknowledge the contributions of our colleagues and staff members who provided valuable input and guidance throughout the course of this research.

Conflict of Interest

The authors declare that they have no conflicts of interest related to this study.

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