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The Safety of Continuing Therapeutic Anticoagulation During Inferior Vena Cava Filter Retrieval: A 6-Year Retrospective Review from a Tertiary Centre

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Abstract

Purpose Assess the safety of inferior vena cava (IVC) filter retrieval in patients taking anticoagulation, compared to a non-anticoagulated cohort.

Materials and Methods Single-centre retrospective analysis of patients who underwent IVC filter retrieval between January 2012 and February 2018. Information about patient demographics, anticoagulation, tilt, major and minor complications was collected. Major complications were defined as: IVC injury from the filter retrieval, retained fragment of filter, filter fracture and filter embolisation. Minor complications were defined as: neck haematoma and puncture site infection.

Results Total of 357 patients (age 18–95, Male: 231) underwent IVC filter retrieval, comprising of Cook Celect Platinum, Cook Celect, and ALN-branded filters. Of these 182 patients were on anticoagulation and 175 patients were not on anticoagulation, based on the indication for the filter (thrombosis or prophylaxis) and at the discretion of the referring unit who were managing the anticoagulation. IVC filter retrieval was technically successful in 349 patients. Five major complications (1.4% of retrievals) were recorded and no minor complications (0% of retrievals). In the anticoagulation cohort, there were two major complications (1.1% of retrievals) both related to IVC injury. In the non-anticoagulated cohort, there were three major complications (1.7% of retrievals) relating to filter embolisation, IVC injury, and filter fracture.

Conclusions IVC filter retrieval is a safe procedure with a low complication rate. Being on anticoagulation does not increase the risk of a major complication or change the management of major complication compared with a non-anticoagulated cohort. IVC filter retrieval is safe to perform in patients currently taking prophylactic or therapeutic anticoagulation based on our cohort.

Level of Evidence Level 3, retrospective cohort study.

Keywords Interventional radiology · IVC filter · Anticoagulation · Complication · Haemorrhage

Introduction

Venous thromboembolism (VTE) is a prevalent condition that affects up to 0.5% of the population per year [1]. There is level 1 evidence to demonstrate that anticoagulation is suitable to prevent VTE in patients with deep venous thrombosis (DVT) [2]. Retrievable inferior vena cava (IVC) filters were designed to provide temporary prevention of pulmonary embolus in patients who cannot be anticoagulated and have or are at high risk of, VTE [3]. In addition, they are utilised in patients who sustain a pulmonary embolism whilst taking therapeutic anticoagulation [3].

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In these groups, anticoagulation should be commenced when safe to do so and the IVC filter may then be retrieved [4]. It has previously been suggested that the presence of an IVC filter may confer an increased risk of new additional DVT [5] and for this reason many haematologists choose to place patients on anticoagulation up until the IVC filter is removed. The relevance of these old data with respect to newer IVC filters is not clear [5]. This means that a high proportion of patients who are referred for IVC filter retrieval are still taking anticoagulation in the form of low molecular weight heparin (enoxaparin), vitamin K antagonist (warfarin) or a novel oral anticoagulant (NOAC). It is an accepted practice, that anticoagulation should be temporarily ceased prior to the filter being retrieved due to perceived risk of IVC-related complication during retrieval; however, the evidence to support this practice, either positively or negatively, does not exist, and exploring this forms the primary aim of this study.

Currently the safety of IVC filter retrieval while patients are on anticoagulation is based on consensus expert opinion rather than fact. The Society of Interventional Radiology (SIR) standards of practice document have set out guidelines for periprocedural management of anticoagulation. IVC filter retrieval is not specifically mentioned; however, venous interventions are considered moderate risk. The guidance is to reduce the International normalised ratio (INR) to less than 1.5, withhold therapeutic heparin for 1 day [6]. The addendum to this document also gives guidance on stopping NOAC for venous procedures [7]. The potential disadvantage to stopping anticoagulation is that this regime can be confusing for patients and booking staff and may lead to a cancelled procedure if the message has not been correctly interpreted. Also, medication crossover can lead to periods of subtherapeutic anticoagulation which in a high-risk population may expose them to VTE risk or propagation of a DVT being actively treated.

We therefore set out to investigate the safety of IVC filter retrieval in a cohort of patients on anticoagulation compared to a population not taking anticoagulation.

Materials and Methods

Institutional ethical board approval was obtained. A single-centre, retrospective review of patients who had undergone IVC filter retrieval at The Alfred Hospital (Melbourne, Australia) between January 2012 and February 2018 was carried out.

A list of all IVC filter retrievals between this period of time was obtained from the radiology information system (RIS). For each patient, the medical imaging, radiology reports and patient notes were reviewed via the Picture Archive and Communication System (PACS), RIS and electronic patient record (EPR), respectively.

The following pieces of information were collected and documented.

- Patient demographics (Age, Gender)—from EPR
- Date of insertion and retrieval (allowing calculation of dwell time) from RIS
- Tilt of filter at insertion and retrieval measured via angiographic images on PACS
- Anticoagulated or not anticoagulated—from EPR
- If on anticoagulation—the type, dose, date of last dose, and relevant coagulation profile if applicable—from EPR
- Retrieval attempts—from RIS
- Success of retrieval—from RIS
- Minor complications—from EPR
- Major complications—from EPR

All patients who underwent an attempted IVC filter retrieval were included in this study. The presence of therapeutic anticoagulation was at the discretion of the referring unit and based upon the indication and risk of VTE. We gave no instructions to cease anticoagulation unless it was anticipated that an advanced technique would be needed to be perform (e.g. known tilt > 15 degrees or previous failed attempt), in which case anticoagulation was ceased prior to the procedure at our instruction. Based on unpublished audit data, this is approximately 14% of retrievals. Anticoagulation was defined as a patient who was taking any of the following medications:

1. Warfarin
2. NOAC—apixaban, rivaroxaban or dabigatran.
3. Low molecular weight heparin—enoxaparin, dalteparin or tinzaparin.
4. Unfractionated heparin

During the period of this analysis, there were three different types of IVC filters that were retrieved: ALN vena cava filter (ALN Implants Chirurgicaux, Ghisonaccia, France), Cook Celect (Cook Medical, Bloomington, USA), and Cook Celect Platinum (Cook Medical).

Successful retrieval was defined as the filter being completely retrieved from the IVC. The procedure was unsuccessful if the filter was not retrieved. If the majority of the filter was retrieved; however, a fractured limb was left behind, this was considered a successful retrieval with major complication.

Complications were defined as ‘major’ or ‘minor’ based on whether the complication was likely to lead to a clinically significant immediate intervention. A literature search was able to identify common complications expected of this procedure [8].

Minor complications were defined as one of the following:

- Neck haematoma
- Neck infection

Major complications were defined as one of the following:

- IVC injury without haemorrhage, identified as intimal tear or pseudoaneurysm on venogram after retrieval.
- IVC injury with haemorrhage, identified as active extravasation of contrast on venogram after retrieval.
- Retained fragment of filter, identified as filter leg or arm left in IVC on fluoroscopy or venography after retrieval.
- Filter fracture, identified by either retained fragment (above), or upon inspection of filter after retrieval.
- Filter embolisation to the right atrium, right ventricle, or pulmonary artery, identified during live fluoroscopy at the time of retrieval.

If a patient had previously been taking anticoagulation but it was stopped as per the SIR consensus guidelines for anticoagulation, or if they were on warfarin but the INR was less than 1.5, they were considered to be not anticoagulated. If it was stopped for an insufficient period of time or INR remained greater than 1.5, then they were considered to be anticoagulated.

Dwell time of the filter was considered the time from insertion to retrieval of the filter in days. The tilt of the filter was measured using the angle measurement tool on PACS by placing a line centrally down the vertical axis of the IVC at the level of wall contact with the legs, and a line down the long axis of the filter [9].

IVC Filter Retrieval Technique

A standard technique was used for IVC filter retrieval. All procedures were performed in our angiography suite by trained Interventional Radiologists or advanced trainees (post-qualification fellowship) under direct supervision from an Interventional Radiologist. Intravenous anxiolysis (midazolam/fentanyl) was offered to patients who are assessed as being anxious prior to the procedure. Skin was prepared with 2% chlorhexidine/70% alcohol preparation and 10 mL 1% lidocaine administered to the skin and subcutaneous tissues overlying the right internal jugular vein. The right internal jugular vein was accessed under ultrasound guidance using either a micropuncture kit or an 18 Gauge vascular access needle (Cook Medical, Bloomington, USA). Most retrievals were performed using the Cook Medical Gunther-Tulip Retrieval Kit which consists of an 11-French telescoping vascular sheath, and this was introduced to the IVC over an 0.035" wire (260 cm fixed core with J-tip, Cook Medical). Retrievals of ALN-branded filters (ALN implants chirurgicaux) were performed with either the Cook Gunther-Tulip kit (for hooked ALN filters) or the ALN extraction kit (nor non-hooked filters). Cavography is performed in the AP plane with intravenous Iohexol (Omnipague 300, GE healthcare, Chicage, Illinois, USA), 15 mL diluted with 5 mL 0.9% saline to a total volume of 20 mL, with a hand injection at aiming to achieve a rate of approximately 15–20 mL/s. The use of an advanced retrieval technique has been required in 14% of retrievals in our institution (unpublished audit data). After retrieval, manual pressure was applied to the neck for 2 min and the patient placed sitting at 45° for 2 h. Patients were recovered in a nursing bay with observations of heart rate, respiratory rate, blood pressure, oxygen saturations, and neck venotomy wound site performed every 15 min for 2 h. After this time, if they were able to ambulate and tolerate oral intake, they were discharged into the care of a next of kin.

Study Endpoint

The endpoint for identifying a minor or major complication was considered the final piece of documentation when the patient was discharged after the IVC filter retrieval procedure. The radiology report, scanned radiology notes and patient discharge notes were reviewed for any immediate complications.

Statistics

Statistical analysis was performed using SAS software version 9.4 (SAS Institute, Cary, NC, USA). Continuous variables were summarised using mean (standard deviation) or median (inter-quartile range) where appropriate. Categorical variables were reported as counts and percentages. Comparisons between groups were made using the Student t test or Mann–Whitney U test as appropriate for continuous variables and Chi-square or Fisher's exact test for categorical variables. All calculated p values were two-tailed with $p < 0.05$ indicating statistical significance. Non-inferiority statistics were applied, significance level (alpha) was 5%, power 90% and percentage success in each group was deemed high.

Results

Between January 2012 and February 2018, 357 patients underwent attempted IVC filter retrieval. Of these, 349 patients had a successful IVC filter retrieval and eight patients had an unsuccessful retrieval due to filter adherence to the IVC. Of the unsuccessful retrievals, three were

anticoagulated and five were non-anticoagulated, but there were no complications.

The baseline characteristics of the study population demonstrated a mean age of 51 (range 18–95). The mean age in the anticoagulated group was 55 years whilst in the non-anticoagulated group was 47 years ($p < 0.0001$). The gender split was males: 231 and females: 156, with 67% males in the anticoagulated group and 64% males in the non-anticoagulated group ($p = 0.4$).

One hundred and eighty-two patients were considered to be anticoagulated at the time of retrieval. Four patients were taking warfarin at the time of retrieval; however, their INR was subtherapeutic (< 1.5); therefore, they were considered not anticoagulated. A total of 175 patients were included as part of the non-anticoagulated group.

In the whole cohort, no minor complications occurred (0%) and five major complications occurred (1.4%).

The results were then reviewed as two separate cohorts, non-anticoagulated and anticoagulated. In the non-anticoagulated group, of the 175 patients, three patients sustained major complications (1.7%) which were filter fracture, filter embolisation and IVC injury without haemorrhage (Fig. 1). In the anticoagulated group of the 182 patients, two patients sustained major complications (1%), $p = 0.66$, which were IVC injury with haemorrhage (Fig. 2). These results are summarised in Table 1.

The mean dwell time of the filters was 51 days (range 1–903 days). The median dwell time in the anticoagulated group was 161 days whilst in the non-anticoagulated group was 119 days, $p < 0.0001$. Of note, both the major complications in patients on anticoagulation were haemorrhage, and one of these patients had a prolonged filter dwell time of 609 days and was attending for a second attempt at retrieval due to an adherent filter with embedded hook.

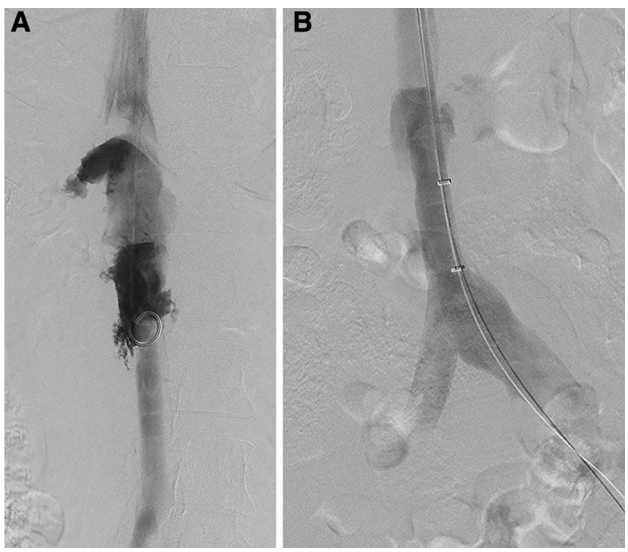

Fig. 1 **A** IVC injury and active bleeding post-caval filter retrieval, and **B** IVC pseudoaneurysm without bleeding post-filter retrieval

The median degree of tilt on retrieval in the anticoagulated group was 4.3 degrees (range 1.9–8.1) whilst in the non-anticoagulated group was 4.5 degrees (range 2.3–8.2), $p = 0.60$.

In the major complication subset of patients (Table 1), all patients had a dwell time of more than 156 days (range 156–903 days, mean 433 days).

Discussion

In any clinical procedure, patient safety is at the forefront of every decision that a clinician makes. Decisions are dictated by training, clinical experience and current evidence. As there is no current evidence regarding the safety of IVC filter retrieval while patients are on anticoagulation, there is a wide variability in current practice. At the moment, every case is a balance of risk versus benefit, with no real knowledge of the actual risk.

This study is to the authors knowledge, the first to assess the risk of anticoagulation in IVC filter retrieval and showed that regardless of the presence of anticoagulation, the overall risk of complication is extremely low and the groups are non-inferior in their outcome.

The considered advantage of stopping anticoagulation as per the guidelines from SIR is that the theoretical risk of a complication from acute haemorrhage may be easier to manage [7]. The disadvantage is that, for a small subset of patients taking anticoagulation for active VTE management, the risk of a complication from stopping anticoagulation may be higher than the risk of a complication from IVC filter retrieval itself [10]. In this subset, if a decision is made to stop anticoagulation, they may have to be bridged with unfractionated heparin which then requires hospital admission to manage perioperatively. Having a blanket rule to cease anticoagulation can also lead to cancelled procedures if there has been miscommunication either with a confused patient or with bookings staff. This leads to further potential costs to the hospital and patient, wasted angiography theatre and staff time, longer filter dwell times and prolonged periods of time before medications are restarted. Given there is no significant difference between the rates of complication regardless of anticoagulation status in this study, we suggest that continuing anticoagulation throughout the procedural period would be better for patient safety and resource utilisation.

There is already good evidence to show that IVC filter retrieval is a safe procedure [3]. Our results support this, with an overall major complication rate of 1.4% which is comparable to the literature. The rate of complications in both the non-anticoagulated and anticoagulated groups was

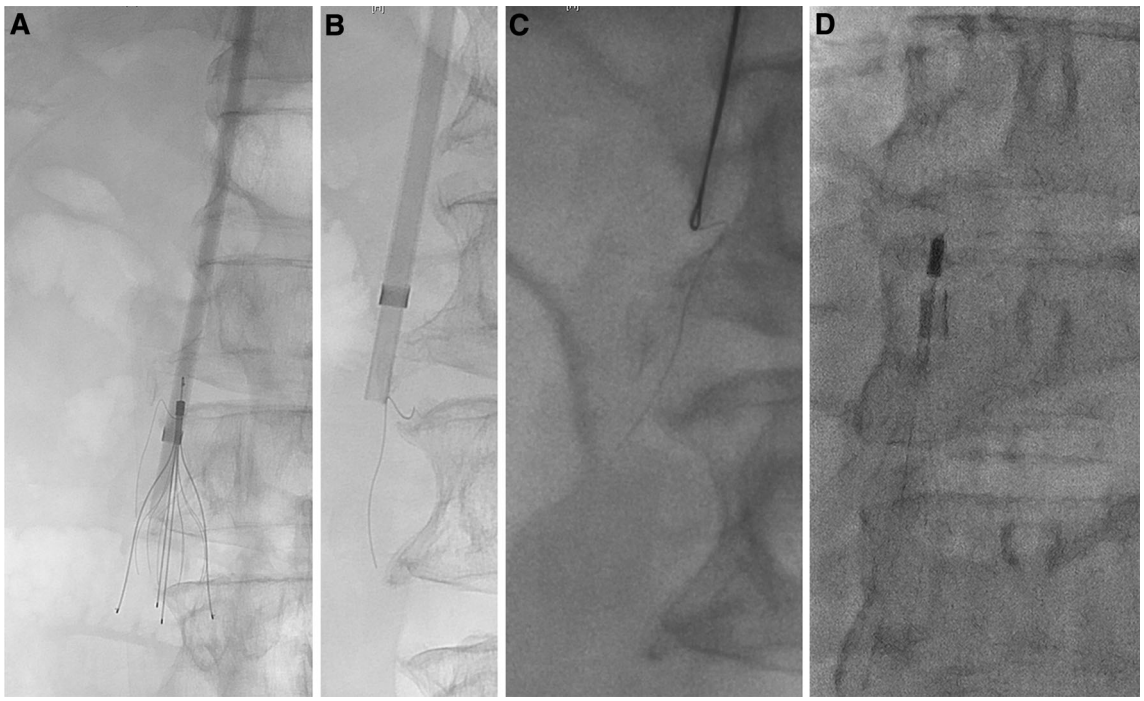

Fig. 2 **A** Filter arm position abnormal on screening prior to cavography **B** Arm is fractures and embedded upon filter retrieval requiring the arm to be snared separately (**C**). ALN filter embolised and wedged in the hepatic IVC during retrieval (**D**) but was snared in this location and retrieved

Table 1 Demographic of patients with IVC filter retrieval complications

Age	Gender	Anticoagulation	Dwell Time (days)	Filter tilt	Filter brand	Complications	Management
36	M	Rivaroxaban	609	10.1	Cook celect platinum	IVC injury with haemorrhage	Balloon tamponade for 5 min Bleeding ceased spontaneously Patient admitted and observed but no further treatment
70	F	Warfarin	203	8.7	Cook celect platinum	IVC injury with haemorrhage	Balloon tamponade for 20 min Patient admitted and observed but no further treatment
37	M	None	903	2.4	Cook celect platinum	IVC injury without haemorrhage	Balloon tamponade for 20 min Patient observed then discharged the same day
73	M	None	156	2.8	Cook celect platinum	Filter fracture	Filter fragment retrieved at same admission Patient observed then discharged the same day
60	M	None	298	17.1	ALN	Filter embolisation	Filter snared in the hepatic IVC and retrieved Patient observed then discharged the same day

not significantly different; however, the profile of complications is slightly different. The two major complications encountered in the anticoagulated group demonstrated haemorrhage, while none of the complications in the non-anticoagulated group demonstrated haemorrhage. Further management was required in two of the cases in the form of balloon tamponade [11]. It is interesting to note that while the anticoagulated patients both suffered from haemorrhage, they were able to be managed successfully via an endovascular approach without the need for surgery [11] or

transfusion and this challenges the entire reasoning for ceasing anticoagulation.

Current evidence suggests that prolonged dwell times increase the rate of complications [12], suggested by Desai et al. [13] to be 7 months or longer. In this study, the group taking anticoagulation during retrieval has a significantly longer dwell time than the non-anticoagulated group; however, both median times were lower than 7 months. Of the five patients with major complications, four had a dwell time longer than 7 months. Given the overall rate of complications in this study was extremely low, the difference in dwell times between groups will not significantly contribute to the rate of complication. However, it is clear that increasing dwell is likely to be a trend in IVC-related filter complications which supports prior literature.

Eight patients who were on anticoagulation required a repeat attempt at retrieval indicating that it was a challenging retrieval due to adherence and/or an embedded hook. Of those, one patient experienced IVC injury with haemorrhage. Historically based on these experiences our internal department protocol had been to stop anticoagulation for repeat attempts at retrieval where a more challenging retrieval is thus expected; however, the protocol will be reviewed in light of the study findings where the complication rate is low, and more literature is still needed looking at identifying at the relative risk of variable associated with retrieval difficulty. We acknowledge that the decision to cease anticoagulation in repeated or advanced retrievals during the study period introduces selection bias in that anticipated complicated retrievals will likely have had anticoagulation ceased; however, with the overall rate of bleeding complication being so low, this would have not changed the results.

In our study, the groups were reasonably well matched; however, we note that while the gender differential was similar, the patients in the anticoagulated group were significantly older. Placing this result in the context of the study, it is felt that the impact of this on the outcome is negligible.

While the overall number of retrievals in the study was relatively large, the limitations of such a study design are acknowledged. In addition to the selection bias, there are inherent difficulties with retrospective audits which would be solved with a prospective randomised study.

Conclusion

IVC filter retrieval is a safe procedure with a very low complication rate, and no significant difference in the complications rates between those taking anticoagulation and those not taking anticoagulation at the time of retrieval (i.e. these groups are non-inferior).

Our recommendation is to continue anticoagulation in those who are already taking it at the time of retrieval based on the data presented in this paper, however given the continued uncertainty around complex filter retrievals, more investigation will be needed to assess whether these results can be applied to this particular cohort of patients. Managing other factors such as prolonged dwell time is more likely to contribute to the risk of a major complication than the presence of therapeutic anticoagulation and thus attention should continue to focus on early retrieval of optional filters.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Consent for Publication For this type of study, consent for publication is not required.

Ethical Approval Approval was obtained by The Alfred Human Research and Ethics Committee prior to performing this study.

Informed Consent For this type of study, formal consent is not required.

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