Retrieval rates of inferior vena cava (IVC) filters: are we retrieving enough?

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Abstract

Aims The aim of this study was to document retrieval rates of IVC filters in a single tertiary centre, before and after implementation of an IVC filter pathway, and to identify factors that may affect retrieval rates.

Methods This was a two phase study. In Phase 1, rates of IVC filter retrieval were collected retrospectively from June 2010 to June 2012. During Phase 2 an IVC filter pathway was developed and prospective data was collected from July 2012 to June 2014. Univariate analysis and Kaplan-Meier estimates were performed to determine the rate of IVC filter retrieval and to analyse factors contributing to retrieval rates.

Results 95 patients (39 Phase 1; 56 Phase 2) had an IVC filter inserted over a 4 year period. In Phase 1, of those eligible to have their filter removed, the 12-month retrieval rate was 63%, this improved to 100% in Phase 2. Following implementation of the IVC filter pathway (Phase 2) no patients were lost to follow-up.

Conclusions We have improved the rate of IVC filter retrieval in our institution by development of an IVC filter pathway. Rates of optional IVC filter retrieval in our experience are now higher than previously published figures.
from 12–45% (mean 34%). To improve the rate of IVC filter retrieval several institutes have implemented databases and clinics to follow up patients who have an IVC filter placed.7–9

In July 2012, the Departments of Vascular Surgery and Interventional Radiology at Wellington Hospital in conjunction with the Venous Thromboembolism Clinic developed a clinical pathway for patients who had an IVC filter placed in order to streamline timely retrievals.

The primary aim of this study was to document the retrieval rates of optional IVC filters at a tertiary centre, two years prior to developing an IVC filter clinical pathway (Phase 1) and two years following its implementation (Phase 2). The secondary aim was to analyse factors which may have influenced retrieval rates in Phase 1.

Methods

All IVC filters inserted by vascular surgeons or interventional radiologists during a consecutive 4-year period (1 June 2010 and 30 June 2014) in Wellington Hospital were identified via the clinical coding registry and confirmed by the picture archiving computer system (PACS). The New Zealand Health and Disability Ethics Committee’s (HDEC) review process advised that ethical approval was not required. This audit was registered and approved by Capital and Coast District Health Board.

In Phase 1, IVC filters inserted between the 1 June 2010 and 30 June 2012 were identified and studied retrospectively. During this phase multiple factors were investigated to ascertain if these contributed to retrieval rates. Factors studied were: acute versus elective procedures, medical compared to surgical referrals, vascular surgeons compared to interventional radiologists performing the IVC filter placement, written instructions for removal in the clinical notes or not, whether the patient had been referred from outside the Wellington catchment area or not, and normal working hours compared to after-hours procedures.

On the basis of the outcomes of Phase 1, an IVC filter pathway (Figure 1) intended to ensure strict follow-up of patients with IVC filters placed was then implemented in July 2012 and data was collected prospectively on all patients who underwent IVC filter placement from the 1 July 2012–30 June 2014 (Phase 2). Filter retrievals in Phase 2 were documented up until 30 August 2014.
Clinical and radiology records were reviewed to identify indications for IVC filter placement, procedural information and follow-up. Patients who had been referred for IVC filter placement from outside the Wellington catchment area, but within New Zealand were followed up on an individual basis to determine if the filter had been retrieved elsewhere. Filters placed from patients visiting New Zealand from overseas were excluded from analysis.

**Device description**—All IVC filters inserted in our institution during the study period were optional filters. The two types of filters used were the Celect Vena Cava Filter (Cook Medical, Bloomington, Indiana) or the G2 filter (Bard Peripheral Vascular, Tempe, Arizona). The choice of filter was at the discretion of the intervening physician performing the procedure.

**IVC filter placement**—Placement of IVC filters was under direct fluoroscopic guidance by either the right or left femoral vein approach. The caval filter was typically placed infra-renally and position prior to deployment was confirmed with a venogram.

**IVC filter retrieval**—When clinically appropriate (i.e. contraindication for anticoagulation had expired or the caval filter was no longer required) patients were referred for IVC filter retrieval. Retrieval was performed typically via cannulation of the right internal jugular vein. Under fluoroscopic guidance the filter was snared and removed.

**IVC filter pathway (Phase 2)**—In July 2012, an IVC filter pathway was implemented at our institution (figure 1). All patients with IVC filters placed were identified in a monthly report generated by the clinical coding unit and transferred to a dedicated vena caval filter database. This database was maintained by the nurses in the pre-existing venous thromboembolism (VTE) clinic.

Any patient who had an IVC filter in situ for greater than 6 weeks was then discussed with the VTE consultant and the patient was either followed up in clinic or via phone consultation, depending on the complexity of the case. The patient was then booked for retrieval, or if the filter was still clinically required the patient was booked for review when deemed clinically appropriate. The filter was declared permanent if the indication was likely to continue long-term or if the perceived risks of retrieval were greater than the filter remaining in situ.

**Statistical analysis**—Univariate statistical analysis was produced in R2 15.1 statistical package (R Institute, Vienna). Kaplan-Meier estimates (plots and 12-month retrieval estimates) were used to document accurate retrieval rates over the study period.

Patients that died or had their filter declared as a permanent device due to clinical circumstances, were censored at the applicable time during analysis. Phase 1 patients were censored at the end of that phase if they had not yet had their filter removed (to avoid any influence of the system changes made for Phase 2); Phase 2 patients were censored at the end of the study period if they had not had their filter removed. Statistical significance was set at a p value <0.05.

**Results**

95 patients had an IVC filter placed over the 4-year period. During Phase 1, 39 patients had an IVC filter placed; median (range) age was 67 years (31–87) and 16 were male. Patient characteristics and indication for filter placement are shown in Table 1.
Table 1. Summary of patient characteristics

<table>
<thead>
<tr>
<th>Demographic/clinical characteristics</th>
<th>Phase 1 (n=39)</th>
<th>Phase 2 (n=56)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years), Median (range)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>n, percentage</td>
<td>n, (percentage)</td>
</tr>
<tr>
<td></td>
<td>67 (31–89)</td>
<td>62 (18–93)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>16 (41%)</td>
<td>34 (60%)</td>
</tr>
<tr>
<td>Female</td>
<td>23 (59%)</td>
<td>23 (40%)</td>
</tr>
<tr>
<td>Indication for IVC filter placement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prophylaxis (total)</td>
<td>6 (15%)</td>
<td>7 (12.5%)</td>
</tr>
<tr>
<td>Trauma + previous DVT/PE</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Surgery (malignant) + previous DVT/PE</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Surgery (non-malignant) + previous DVT/PE</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Bleeding + anticoagulation reversed + previous PE/DVT</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Major trauma</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Therapeutic (total)</td>
<td>33 (85%)</td>
<td>49 (87.5%)</td>
</tr>
<tr>
<td>PE/DVT + active bleed (non-trauma or trauma)</td>
<td>15</td>
<td>23</td>
</tr>
<tr>
<td>Recurrent/extension DVT/PE on anticoagulation</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>PE/DVT + surgery (malignant or non-malignant)</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>PE/DVT + contraindication to anticoagulation or high risk for bleed</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Massive PE</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

DVT = deep vein thrombosis, PE = pulmonary embolus

Phase 1—Of the 39 patients who had an IVC filter placement in Phase 1, 15 underwent IVC filter retrieval, of which 14 were successful. Median (range) time from insertion to removal for this group was 97 (15–293) days.

Retrospective follow up analysis revealed that of the 24 patients that did not have their filter removed; five had their filter declared as a permanent device (and hence were not eligible to have their filters removed and were censored at the beginning of analysis), nine had died, two were booked for retrieval in the future, and eight patients were lost to follow up.

Of those who were eligible to have their filter removed, the Kaplan-Meier estimate of the 12-month retrieval rate was 63% (Figure 2). The two patients who had their filter booked for retrieval after the end of the study period did subsequently go on to have a successful retrieval procedure.

The eight patients that were lost to follow-up were subsequently contacted to determine if filter retrieval had been performed at another institution and if not their notes were reviewed and if appropriate, IVC filter retrieval was recommended.

Patients referred by a surgical specialty for insertion of an IVC filter had a significantly higher retrieval rate compared to those referred by a medical speciality (p=0.004) (Figure 3).

The 12-month Kaplan-Meier estimates of retrieval rates for those referred by a surgical specialty were 78% (95%CI 41–92) and 40% for those referred by a medical speciality (95%CI 0–67). IVC filters that were placed in an elective setting were significantly more likely to be removed compared to those placed acutely (p=0.04) (Figure 4): respective 12-month retrieval rates were 85% (95%CI 11–98) and 55% (95%CI 19–75).

The instruction that the filter is retrievable from the vascular surgeon or radiologist performing the IVC filter placement appeared to improve the rate of retrieval, although this difference was not significant (p=0.07) (Figure 5).
Figure 2. Kaplan-Meier curve showing time to filter retrieval for Phase One (n=34) and Phase Two (n=50) patients

Figure 3. Kaplan-Meier curve showing retrieval rates of filters in medical vs. surgical patients
There was no statistically significant difference between IVC filter retrieval rates of patients referred from the Wellington region compared to referrals from outside the region (p=0.6); insertion by a vascular surgeon compared to an interventional radiologist (p=0.6); or the timing of the procedure (p=0.5) (Table 2).

**Phase 2**—Of the 56 patients who had an IVC filter placed in Phase 2, 29 underwent IVC filter retrieval. Of those who did not have their filter retrieved 12 died, two had a planned retrieval procedure within the following month, three had their filter retrieval requested but not yet scheduled for retrieval at the end of the study period, three patients still had an ongoing temporary indication for filter placement and seven patients had their device declared as permanent. The Kaplan-Meier estimate of the 12-month retrieval rate of those eligible to have their filter retrieved was 100%.
Table 2. Comparisons of retrieval rates at 6 and 12 months for each variable studied in phase 1

<table>
<thead>
<tr>
<th>Variables studied</th>
<th>Retrieval rate (%) at 6 months (95% CI)</th>
<th>Retrieval rate (%) at 12 months (95% CI)</th>
<th>P-value*#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local DHB (n = 25) vs. Other DHB (n = 9)</td>
<td>46 (17–64) 26 (0–52)</td>
<td>65 (25–84) 56 (0–81)</td>
<td>0.6</td>
</tr>
<tr>
<td>Acute (n=25) vs. Elective placement (n=9)</td>
<td>24 (3–40) 85 (11–98)</td>
<td>55 (19–75) 85 (11–98)</td>
<td>0.04*</td>
</tr>
<tr>
<td>Interventional radiologist (n=15) vs. Surgeon (n=19) performing procedure</td>
<td>54 (11–77) 31 (4–51)</td>
<td>54 (11–77) 64 (25–83)</td>
<td>0.6</td>
</tr>
<tr>
<td>Normal hours (n=26) vs. After hours (n=8)</td>
<td>56 (26–74) 0 (0–0)</td>
<td>56 (26–74) 78 (0–96)</td>
<td>0.5</td>
</tr>
<tr>
<td>Plan for retrieval by interventionist (n=19) vs. No plan (n=15)</td>
<td>62 (27–80) 11 (0–29)</td>
<td>69 (34–86) 58 (0–84)</td>
<td>0.07</td>
</tr>
<tr>
<td>Medical (n=15) vs. Surgical referrals (n=19)</td>
<td>10 (0–27) 63 (28–81)</td>
<td>40 (0–67) 78 (41–92)</td>
<td>0.004#</td>
</tr>
</tbody>
</table>

*From log-rank test comparing Kaplan-Meier curve functions by group; Statistical significance p-value ≤ 0.05; DHB = district health board.

There was some evidence for a difference in rates of IVC filter retrieval between Phases 1 and 2 (log-rank test p=0.056 Figure 2). Median time to retrieval in Phase 1 was 7.4 months (95% CI 4.5, upper bound non-estimable), and in Phase 2 the median time was 4.1 months (95% CI 3.4, 6.9).

As the age and gender distributions were different for these two phases, a stratified analysis compared time to retrieval between phases while controlling for age group (<35, 35–54, 55–74, 75+ years) and gender, where the statistical evidence for any difference between phase was weaker (log-rank test $\chi^2$ (1 df)=1.1, p=0.30). Stratified Kaplan-Meier estimates by age group (figure not shown) suggested that Phase 2 retrieval times were not shorter in the largest age group (55–74) with some evidence for faster times to retrieval in the other age groups (<35, 35–54, 75+).

Discussion

We have demonstrated that by introducing an IVC filter pathway, it is possible for an increase in IVC filter retrieval rates to be achieved; moreover the pathway ensured that patients were not lost to follow-up and facilitated timely removal of IVC filters. Prior to establishing this pathway the Kaplan-Meier estimate of the 12-month rate of filter retrieval was 63% and although this rate was higher than previously documented figures (12–59%); it remained suboptimal. Following implementation of the pathway the Kaplan-Meier estimate of the 12-month rate of retrieval increased to 100%.

A recent large study that evaluated factors predicting challenging or failed retrievals found that prolonged dwell time of IVC filters significantly increased the chance that retrieval would be difficult or fail. Specifically filters left in place for greater than 90 days had a significantly higher risk of failed retrieval.11 Prolonged dwell time increased the chance of long-term complications associated with IVC filter placement and recommendations have been made previously for randomised control trials to assess the safety of retrievable IVC filters.12

There have been several proposed methods of improving the rate of IVC filter retrievals. Previously databases or registries have been used to ensure timely follow up of patients, as well as dedicated IVC filter retrieval clinics. Lynch et al., found that tracking patients via a prospectively collected database designed for patient follow-up, significantly improved the rate of IVC filter retrieval from 24% to 59%.7 A similar study found that IVC filter retrieval rates could be significantly improved from 16%
to 32% via implementation of an IVC filter registry. Another prospective study found that there was a significant improvement in retrieval rates of IVC filters when a dedicated clinic was instituted. This clinic was co-ordinated by a clinical nurse, who maintained the filter database and patients were only seen in the outpatient clinic if the procedure was predicted to be complicated.8,9

Prior to implementation of the IVC filter pathway in our institution, responsibility for the patient follow up and planning for IVC filter retrieval was left to the discretion of the referring clinician. This was because the indication for filter placement and therefore timing of retrieval was often related to the patient’s primary diagnosis. However, this responsibility for filter retrieval was not always clear and some patients were left with filters in situ, even when retrieval was indicated.

The multidisciplinary pathway now used in our institution incorporates several of the methods of follow-up previously described in the literature above. Figure 1 demonstrates the pathway; the major components of this were a database (which tracked all filters placed and retrieved), and review of individual cases by a specialist VTE physician. This method improved decision-making and ensured that timely follow up and filter retrieval occurred for all patients who underwent IVC filter placement.

During Phase 1 we investigated factors that may have contributed to rates of IVC filter retrieval. We found a statistically significant difference in IVC filter retrieval rates between those patients referred from a medical specialty compared to those referred by a surgical specialty (40% vs. 78% respectively, p<0.05). The lower rate of filter retrieval in medical patients may be related to the nature of their illness, however many of these patients did not appear to have formal review of whether or not filter retrieval was appropriate.

There was a statistically significant difference between patients who had their IVC filter placed in an acute setting compared to those placed electively (55% vs. 85% respectively, p<0.05) and although not statistically significant, the written instruction that the filter is retrievable from the vascular surgeon or radiologist performing the filter placement appeared to improve the rate of IVC filter retrieval. The other variables analysed did not impact upon retrieval rates of IVC filters. Given the above findings the need for a clearly documented plan for retrieval or review for consideration of filter retrieval, regardless of the patient’s primary medical or surgical problem, was thought to be necessary.

Failed retrievals commonly occur because of the filter tilting or embedding in the IVC wall, the risk of which increases with prolonged dwell time.10,11 Our overall rate of failed retrievals was 3.2%, which is similar to figures previously published.12 During the study period there was one patient in Phase 1 where the IVC filter retrieval was unsuccessful, with two independent attempts by different interventionalists. Filter retrieval was first attempted 308 days following placement and was unable to be retrieved because the filter “legs” were embedded in the IVC wall; a known complication of retrievable filters.13 During the second attempt (day 346), the filter hook was unable to be snared as it opposed the IVC wall. In Phase 2 there were two failed retrievals – the first was in a patient whose abdominal tumour was causing extrinsic compression to the IVC causing the hook of the filter to embed in the IVC wall and was therefore not able to be snared and retrieved. The second patient was from outside the Wellington region and subsequent retrieval was arranged in the patient’s home centre. At the time of retrieval the hook of the IVC filter was found to be projecting into a small venous tributary making retrieval difficult and risky – the filter retrieval was abandoned and the filter was declared permanent.

Review of the IVC filter pathway and database demonstrates that it is a feasible and effective modality for follow-up. Most patients could be followed up via phone consultation, especially those who were from outside the catchment area, whereas more complex cases, were reviewed in clinic.
Limitations of this study include the retrospective nature of the data collection and the relatively small patient cohort. Thus it is possible that some of the comparisons made for the Phase 1 data were underpowered for detecting important differences. A further limitation is that there may be an over- or under-estimation of the effect size and type II error when comparing the differences between the two phases, even allowing for sufficient statistical power. The ‘lost to follow-up’ group may have included patients with undocumented reasons for keeping the IVC filter in situ. The single centre design of the study is also a limiting factor however this information was important for identifying areas specific to our hospital where our the IVC filter insertion service can be improved.

**Recommendations**

Given the increasing use of IVC filters for prevention of PE when anticoagulation cannot be used, we strongly recommend implementation of an IVC filter pathway to ensure that timely retrieval of all optional IVC filters occurs. In New Zealand, it is important that retrieval messages are relayed to all the involved teams when patients are transferred between provincial and tertiary hospitals.

The IVC filter pathway that has been set up in Wellington Hospital includes a database that is managed by the VTE clinic nurses and a clinic appointment with a VTE specialist, dedicated to planning IVC filter retrieval in complex patients.

**Conclusions**

Rates of optional IVC filter retrieval in our experience were similar to previously published figures. We have demonstrated that retrieval of IVC filters can be limited by suboptimal rates of follow-up in the outpatient setting. Although a statistical improvement was not seen following the IVC filter pathway implementation, complete follow up of all patients has been observed.

**Competing interests:** Nil.

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