Journal of
Vascular Surgery
Venous and Lymphatic Disorders™

# Complications of indwelling retrievable versus permanent inferior vena cava filters

Tina R. Desai, MD,[a] Omar C. Morcos, MD,[a] Benjamin B. Lind, MD,[a] Nancy Schindler, MD,[a] Joseph A. Caprini, MD,[a] David Hahn, MD,[b] David Warner, MD,[b] and NavYash Gupta, MD,[a] *Skokie, Ill*

***Objective:*** **Retrievable inferior vena cava (IVC) filters are appealing because they are designed for either retrieval or long-term use. However, the long-term safety of indwelling retrievable compared with permanent filters is largely unknown. This study was undertaken to compare complication rates and types associated with indwelling retrievable and permanent filters.**

***Methods:*** **A retrospective review identified 1234 IVC filters (449 retrievable, 785 permanent) placed in 1225 patients from 2005 to 2010. Patients with retrievable filters removed electively were excluded, yielding 383 patients in whom retrievable filters were left in place. These patients with indwelling retrievable filters were compared with those with permanent filters with respect to demographics, comorbidities, survival, and complication rate and type. Differences in patient characteristics were tested with $\chi^2$, Fisher exact, and Wilcox rank-sum tests. Logistic regression was used to identify predictors of complications. Because there were differences in the characteristics of the patients with indwelling retrievable filters and permanent filters, an additional propensity score analysis was performed yielding 319 patients in each group.**

***Results:*** **Patients with indwelling retrievable filters were younger than those with permanent filters (mean age, 62 vs 75 years; $P < .0001$). Patients with indwelling retrievable filters had significantly more complications than those with permanent filters (9% vs 3.0%; $P < .0001$) after mean follow-up of 20 months (range, 0-86 months). Filter complications were categorized as thrombotic, device related, or systemic. While the most common complication type with both indwelling retrievable and permanent filters was thrombotic (4.4% vs 2.2%; $P =$ NS), device-related complications were significantly more common with indwelling retrievable filters compared with permanent filters (3% vs 0.5%; $P < .006$). Propensity score analysis demonstrated that even in the matched groups, indwelling retrievable filters were associated with significantly more complications than permanent filters (9.1% vs 3.5%; $P = .0035$).**

***Conclusions:*** **Indwelling retrievable IVC filters were associated with significantly higher complication rates than permanent filters. Both thrombotic and device-related complications were more common with retrievable filters. Long-term use of retrievable filters should be avoided, especially considering the younger population in whom they are placed. (J Vasc Surg: Venous and Lym Dis 2014;2:166-73.)**

While anticoagulation remains the primary method of prophylaxis and treatment for venous thromboembolism (VTE), interruption of the inferior vena cava (IVC) with a filter is useful when anticoagulation is contraindicated or when thromboembolism occurs despite the use of anticoagulation. IVC filter use is associated with a low periprocedural morbidity and mortality, and rates of filter use have doubled between 1998 and 2005,[1] especially with the introduction of retrievable filters, which may have contributed to liberalized indications for IVC filter use in the prophylactic setting.

From the Department of Surgery, Division of Vascular Surgery,[a] and Department of Radiology, Division of Interventional Radiology,[b] NorthShore University HealthSystem.

Author conflict of interest: none.

Presented at the Plenary Session of the 2013 Vascular Annual Meeting of the Society for Vascular Surgery, San Francisco, Calif, May 30-June 1, 2013.

Reprint requests: Tina R. Desai, MD, Department of Surgery, Division of Vascular Surgery, 9977 Woods Dr, Ste 355, Skokie, IL 60077 (e-mail: tdesai2@northshore.org).

The editors and reviewers of this article have no relevant financial relationships to disclose per the Journal policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

2213-333X/$36.00



http://dx.doi.org/10.1016/j.jvsv.2013.10.050

Based on their FDA approval as permanent filters, retrievable filters are appealing because they can be retrieved in the short term or left in place long term. However, the long-term safety of retrievable filters left in place is largely unknown. Reported complications of filters include filter migration, caval perforation, device fracture, and thrombosis (deep vein thromboembolism [DVT] or pulmonary embolism [PE]),[2,3] with reported rates of these complications ranging from 2% to 15%. Recent evidence suggests complication rates for long-term indwelling retrievable filters may be higher than for permanent filters,[4] and certain complications of retrievable filters may increase over time.[5] Overall, there is a lack of data directly comparing the long-term use of retrievable and permanent filters.

The current study was undertaken to compare complication rates and types associated with retrievable and permanent IVC filters in a multihospital health care system.

## METHODS

**Patients.** After obtaining approval of the Institutional Review Board, a retrospective review of the electronic medical records of all patients undergoing IVC filter placement at Northshore University HealthSystem was performed. Between January 2005 and December 2010, a total of 1234 IVC filters were placed in 1225 patients, including 449 retrievable filters and 785 permanent filters. Procedures were performed either in the operating room or in

the interventional radiology suite by vascular surgeons or interventional radiologists. Follow-up studies, including venous duplex, computed tomography scan, or venogram, were performed when clinically indicated. Of the 449 retrievable filters placed, 66 were retrieved electively and excluded from the primary analysis, yielding a group of 383 patients in whom retrievable filters were left in place (indwelling retrievable filter group). These patients were compared with 785 patients receiving permanent filters (permanent filter group). The patients with electively retrieved filters were excluded so that we could compare indwelling retrievable to permanent filters.

Patient demographic information, medical comorbidities, diagnosis and indication for filter placement, and number and types of complications were examined by a review of medical records and imaging studies. Patient complications were additionally categorized as thrombotic, device-related, or systemic, and these categories were also compared between patients with indwelling retrievable and permanent filters. Whether patients were anticoagulated or placed on antiplatelet therapy at any time after filter placement was also recorded. Patient survival was evaluated using the Social Security Death Index.

**Outcomes.** Symptomatic complication after IVC filter placement was the primary outcome measured. This included symptomatic thrombosis (recurrent DVT, IVC thrombosis, or recurrent PE), device-related complications (IVC perforation, filter migration, or filter fracture) causing pain that was not clearly associated with another cause, or systemic complications (hemodynamic instability, respiratory or cardiovascular compromise requiring pressor support or intensive care unit admission, myocardial infarction, stroke, or death within 30 days of procedure). Asymptomatic device-related complications were reported separately and consisted of incidental (asymptomatic) findings of device perforation, fracture, or migration noted on postfilter imaging studies. Elective IVC filter retrieval and patient survival and rate of freedom from complication were additional outcome measures.

**Statistical analysis.** All statistical analyses were performed with SAS software (SAS Institute, Inc, Cary, NC). The $\chi^2$ or Fisher exact test were used to compare patient characteristics/demographics between patients with indwelling retrievable filters and patients with permanent filters. For body mass index (BMI) and age, Wilcoxon rank-sum test was used to assess for any difference in median value between two filter groups. Logistic regression was used to predict the primary outcome variable of post-IVC filter complication comparing patients with indwelling retrievable filters and permanent filters. Univariate analysis was initially applied to screen potential predictors for complication with $P < .25$. Then, candidate models were developed based on the various selection methods, such as forward, backward, and stepwise selections. Confounders and interactions were checked. The adjusted odds ratio (OR) and confidence interval (CI) were calculated. The final multivariate logistic regression was determined by comparing several candidate models in terms of Akaike Information Criterion and parsimonious criteria. The final model has excellent discriminate ability for prediction (C-statistics $> 0.7$). Life-table survival analysis was utilized to compare survival rates and freedom from complications between patients with indwelling retrievable filters and permanent filters.

**Table I.** Patient demographics and comorbidities

| | *Retrievable filters (n = 449)* | *Permanent filters (n = 785)* |
|---|---|---|
| Age, years (range)[c] | 62 (14-97) | 75 (33-102) |
| Male | 220 (49) | 358 (46) |
| Female | 229 (51) | 426 (54) |
| Cancer[b] | 164 (36) | 350 (45) |
| Hypercoagulability[b] | 44 (10) | 41 (5) |
| Hypertension[b] | 221 (49) | 454 (58) |
| Diabetes[a] | 80 (18) | 184 (23) |
| Coronary artery disease[c] | 74 (16) | 241 (31) |
| Hypercholesterolemia | 138 (31) | 276 (35) |
| Previous history of DVT | 163 (36) | 257 (33) |
| Previous history of PE[b] | 108 (24) | 141 (18) |
| Recent operation[c,d] | 126 (28) | 150 (19) |
| Previous IVC filter | 5 (1) | 5 (0.6) |

*DVT,* Deep vein thrombosis; *IVC,* inferior vena cava; *PE,* pulmonary embolism.
Data are presented as number (%) unless otherwise indicated.
All diagnoses were recorded if identified in the medical record.
[a]Statistically significant ($P \leq .05$).
[b]Statistically significant ($P \leq .01$).
[c]Statistically significant ($P \leq .001$).
[d]Recent operation is defined as operation within 30 days prior to filter placement.

Because we noted significant differences in patient characteristics between the indwelling retrievable and permanent filter groups (Table I), an additional propensity score analysis was undertaken. We conducted the 1:1 propensity score matching using greedy match algorithm based on patient factors that we found different between filter groups: gender, hypertension, coronary artery disease, hypercoagulability, cancer, hypercholesterolemia, diabetes, BMI, recent operation, and previous DVT, PE, or IVC filter. Propensity matching yielded two groups (indwelling retrievable vs permanent filters; n = 319 in each group) in whom we did not find any significant difference in the above-mentioned factors. For comparison between matched filter groups, Wilcoxon signed rank or paired *t*-test was used to compare continue variables, and McNemar test was used to compare categorical variables. The marginal Cox regression model with robust sandwich estimator was used to compare survival curves between matched groups.

## RESULTS

Patient demographics and medical comorbidites of 449 patients with retrievable IVC filters and 785 patients with permanent IVC filters are described in Table I. Patients with retrievable filters were younger and had greater BMI compared to those with permanent filters. Those receiving