CLINICAL STUDY

Endovascular Removal of Fractured Inferior Vena Cava Filter Fragments: 5-Year Registry Data with Prospective Outcomes on Retained Fragments

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ABSTRACT

Purpose: To evaluate the safety and efficacy of attempted percutaneous filter fragment removal during retrieval of fractured inferior vena cava (IVC) filters and to report outcomes associated with retained filter fragments.

Materials and Methods: Over a 5-year period, 82 consecutive patients presenting with a fractured IVC filter were prospectively enrolled into an institutional review board–approved registry. There were 27 men and 55 women (mean, 47 y; range, 19–85 y). After main filter removal, percutaneous removal of fragments was attempted if they were deemed intravascular and accessible on pre-procedural computed tomography (CT), cone-beam CT, and/or intravascular ultrasound; distal pulmonary artery (PA) fragments were left alone. A total of 185 fragments were identified (81 IVC, 33 PA, 16 cardiac, 2 hepatic vein, 1 renal vein, 1 aorta, 51 retroperitoneal). Mean filter dwell time was 2,183 days (range, 59–9,936 d). Eighty-seven of 185 fragments (47%) were deemed amenable to attempted removal: 65 IVC, 11 PA, 8 cardiac, 2 hepatic, and 1 aortic. Primary safety outcomes were major procedure-related complications.

Results: Fragment removal was successful in 78 of 87 cases (89.7%; 95% confidence interval [CI], 81.3–95.2). There were 6 minor complications with no consequence (6.9%; 95% CI, 2.6–14.4) involving intraprocedural fragment embolization and 1 major complication (1.1%; 95% CI, 0.0–6.2), a cardiac tamponade that was successfully treated. The complication rate from attempted cardiac fragment removal was 12.5% (1 of 8; 95% CI, 0.3–52.7). Among patients with retained cardiopulmonary fragments (n = 19), 81% remained asymptomatic during long-term clinical follow-up of 845 days (range, 386–2,071 d).

Conclusions: Percutaneous removal of filter fragments from the IVC and proximal PAs is safe and effective overall, but attempted intracardiac fragment removal carries a higher risk of complication. Most residual filter fragments not amenable to percutaneous removal remain asymptomatic and may be monitored clinically.

ABBREVIATIONS

CI = confidence interval, HV = hepatic vein, IVC = inferior vena cava, PA = pulmonary artery, RA = right atrium, RV = right ventricle

In response to the growing number of inferior vena cava (IVC) filter–related complications, the United States Food and Drug Administration issued a safety communication in 2010 (1) alerting all physicians caring for patients with IVC filters to consider removing the filter as soon as protection from pulmonary embolism is no longer needed. Prolonged dwell time of IVC filters has been linked to a variety of complications, including filter migration, penetration through the IVC wall, viscus perforation, and filter fracture with possible component embolization. Filter fracture rates vary in the literature, ranging from 2% to 25% depending on filter type (2–7). In addition, fractured fragments can embolize into cardiac structures, which may cause tachyarrhythmia, hemopericardium, cardiac tamponade, and death (3,5,8–11).

Although many studies have focused on the removal of main IVC filter bodies, few studies have focused on the

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EDITORS' RESEARCH HIGHLIGHTS

- In patients with fractured filters, intravascular fragments that have not migrated into the heart or pulmonary arteries can be safely removed in the vast majority of cases.
- Cardiac tamponade occurred in 1 patient during attempted cardiac fragment removal; intracardiac retrieval is a complex procedure that is not without real risk.
- Most fragments that were not retrieved did not cause any significant sequelae during this study's follow-up.
- Radiation dose during complex retrieval was not studied. This should be kept in perspective during lengthy procedures (and may be worthy of future study) given the apparent benign course of unretrieved fragments.

removal of fractured and embolized filter fragments (5,7,8,12–14) and outcomes associated with indwelling filter fragments. The purpose of the present study was to evaluate the safety and efficacy of IVC filter fragment removal and to report outcomes from retained filter fragments not amenable to percutaneous retrieval.

MATERIALS AND METHODS

This study was performed with institutional review board approval. Over a 5-year period, 82 consecutive patients presenting with an embedded IVC filter complicated by fractured fragments were prospectively enrolled into a single-center registry, and no such patients were excluded. There were 27 men and 55 women (mean age, 47 y; range, 19–85 y). In all patients, IVC filtration was no longer needed at the time of retrieval. The indications for filter removal were the presence of filter-related complications (eg, filter fracture, component embolization, penetration, filter-related thrombotic events), the desire to treat symptomatic complications, and/or the desire to prevent future filter-related complications. More than 90% of the patients were referred from outside institutions, and more than half had undergone failed retrieval attempts at an outside hospital.

A total of 185 fractured filter fragments were identified among the 82 IVC filters encountered (**Fig 1**). The filters included retrievable and permanent types, and all are summarized in **Table 1**. The mean dwell time was 2,183 days (range, 59–9,936 d). A total of 62% of patients had clinically symptomatic filter-related complications from the main filter body and/or penetrating components such as pain and/or anxiety (**Fig 2**), and all had radiographically identified complications, including filter fracture with or without component embolization. The term "anxiety" in the present study was used to describe patient worry, nervousness, or unease regarding filter fragments and does not reflect the medical diagnosis of an anxiety disorder. The study endpoints were defined as follows: retrieval success (ie, complete filter fragment removal from the body) versus failure, major procedure-related complications, and long-term complications at clinical follow-up. All study data were collected by using case report forms within an electronic data capturing system (Project REDCap, Nashville, Tennessee) (15) including prospectively collected outcomes data on retained filter fragments.

All patients were evaluated in the interventional radiology clinic, where each patient gave informed consent to undergo filter removal and potential filter fragment retrieval. All procedures were performed percutaneously under moderate sedation or general anesthesia. General anesthesia was reserved for patients with severe pain related to filter penetration and/or severe underlying anxiety. All patients received intraprocedural therapeutic anticoagulation to minimize thrombotic risk per a previous protocol (16). Following removal of the main filter body, percutaneous removal of fragments was attempted if they were deemed accessible and intravascular on preprocedural computed tomography (CT), intraprocedural fluoroscopy, intravascular ultrasound (US), and/or cone-beam CT (DynaCT; Siemens, Munich, Germany). Removal of proximal pulmonary artery (PA) fragments was attempted, but subsegmental and peripheral PA fragments were left alone. Footplate filter fractures were excluded from the study as a result of their small size and inconsequential incorporation into the caval wall as previously reported (5,13).

For intracaval fragments, rigid endobronchial forceps (Lymol Medical, Woburn, Massachusetts) were used for attempted fragment retrieval. For intracardiac fragments, retrieval was attempted in the same procedure or in a follow-up procedure in conjunction with electrophysiology cardiologists. Cardiopulmonary fragments were approached with combinations of snares (EnSnare; Merit Medical, South Jordan, Utah; or Amplatz GooseNeck; ev3, Plymouth, Minnesota), various angled catheters, or a steerable introducer sheath (Agilis NXT Steerable Introducer; St. Jude Medical, St. Paul, Minnesota), and intravascular US (ACUSON AcuNav, Siemens) was used if needed. For cardiac cases, the following additional steps were taken: placement of radiolucent defibrillator pads, sterile preparation of the subxiphoid region for possible pericardial drain placement, and transvenous pacing apparatus if needed.

All procedural complications were classified according to established guidelines (17). All patients underwent routine clinical follow-up within 2–3 months to assess for post-procedural complications, and longer-term follow-up was conducted if needed for monitoring of indwelling fragments with particular attention to cardiopulmonary fragments. All statistics and confidence intervals (CIs) were calculated by using SPSS Statistics (version 21; IBM, Armonk, New York).

RESULTS

Based on imaging findings, 87 of 185 fragments (47%) were deemed intravascular and amenable to attempted removal: 65 in the IVC, 11 in the proximal PA, 8 cardiac, 2 hepatic, and 1 aortic. In this group, endovascular fragment removal