

Strut Penetration: Local Complications, Breakthrough Pulmonary Embolism, and Retrieval Failure in Patients with Celect Vena Cava Filters

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ABSTRACT

Purpose: To investigate strut penetration in patients with Celect filters, specifically local complications and association with breakthrough pulmonary embolism (PE) or retrieval failure.

Materials and Methods: A retrospective single-center study was conducted to evaluate patients who received Celect filters between January 2007 and May 2013. A total of 595 filters were placed during the study period. Primary indications included thromboembolic disease (93%) and primary surgical prophylaxis (7%). Complications and retrieval data were assessed by computed tomography (CT) and electronic medical records.

Results: A total of 193 patients underwent follow-up abdominal CT at a mean follow-up interval of 176.2 days (range, 0–1,739 d). The rate of strut penetration more than 3 mm outside the caval wall was 28.5% (n = 55). One patient had CT evidence of clinically major strut penetration (1.8%) with strut compression of the right ureter causing hydronephrosis. Indwelling filter time longer than 100 days was associated with strut penetration ($P < .001$). Age, sex, and history of thromboembolic disease were not associated with strut penetration ($P = .51$, $P = .81$, and $P = .89$). Sixty-three patients presented for follow-up CT pulmonary angiography at a mean of 128.1 days (range, 1–895 d). The rate of breakthrough PE was 12.7%. The overall retrieval success rate was 96.7% (n = 150). Strut penetration was not associated with breakthrough PE or retrieval failure ($P = .49$ and $P = .22$).

Conclusions: Although strut penetration is a common complication with Celect filters, there is no association with breakthrough PE or retrieval failure. CT evidence of local complications associated with strut penetration is rare.

ABBREVIATIONS

DVT = deep vein thrombosis, IVC = inferior vena cava, PE = pulmonary embolism

The recognized indications for inferior vena cava (IVC) filter placement by the Society of Interventional Radiology (SIR) include (i) deep vein thrombosis (DVT) and pulmonary embolism (PE) in patients who cannot receive anti-coagulation or in whom it has failed and (ii) PE prophylaxis

in certain high-risk patient populations (1). With the advent of retrievable IVC filters and expansion of prophylactic indications, filter use has experienced exponential growth in the past two decades (2,3). Between 1979 and 1984, 17,000 filters were placed in the United States. However, between 1985 and 2006, nearly 803,000 filters were placed, with 158,000 placed in patients without a history of PE or DVT, in part reflecting increasing liberalization with regard to filter indication (4). Despite increasing use, the reality is that most retrievable filters are not removed. Reported retrieval rates are consistently lower than 50%, with some as low as 15% (5,6). Longer indwelling times have been associated with increased complications (7).

In 2010, the United States Food and Drug Administration released a recommendation to remove retrievable filters as soon as the risk for PE resolves, citing IVC strut

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penetration in addition to other complications (8). However, strut penetration has been shown in several studies to be largely asymptomatic (9,10) and therefore may not represent an adverse event that warrants filter retrieval. The purpose of the present study was to identify local complications associated with strut penetration and determine any association between strut penetration and breakthrough PE or retrieval failure.

MATERIALS AND METHODS

An institutional review board–approved retrospective review was performed on all patients who received Celect filters (Cook, Bloomington, Indiana) at our institution between January 2007 and May 2013. All cases were performed by board-certified interventional radiologists or residents/fellows under direct supervision.

Procedure

IVC filter placement. Patients received weight-based antibiotic prophylaxis with 1 or 2 g cefazolin. Intravenous clindamycin 500 mg was administered in cases of documented allergy to cefazolin. Conscious sedation was administered intravenously. Jugular vein or femoral access was performed under ultrasound (US) guidance, and a venogram was obtained to evaluate IVC caliber, variant anatomy, presence of thrombus, and anatomic level of the renal veins. The filter deployment system was advanced over an Amplatz wire (Boston Scientific, Natick, Massachusetts), and the filter was deployed in the IVC under fluoroscopic guidance.

IVC filter retrieval. Conscious sedation was administered intravenously. Jugular vein access was performed under US guidance, and an IVC venogram was obtained to evaluate filter position and presence of thrombus. A hooked snare was advanced into the IVC, and the filter was removed. For more complicated retrievals, the snare–over–guide wire loop technique was used (11). Rigid endobronchial forceps (Bryan, Woburn, Massachusetts) were employed when conventional and snare–over–guide wire loop techniques failed (12).

Data Collection

All patients with Celect IVC filters placed during the study period were investigated. The electronic medical record system (EPIC, Verona, Wisconsin) was reviewed for patient demographics, filter indication, filter indwelling time, retrieval data, and clinical and imaging follow-up.

Imaging Analysis

All abdominal computed tomography (CT) images were jointly reviewed by two radiology residents. Strut penetration was defined in accordance with SIR practice guidelines for IVC filters (1) as a filter leg extending more than 3 mm beyond the IVC wall. All measurements

for strut penetration were performed in the axial plane. Filter tilt greater than 15°, thrombus, migration, and fracture were also assessed. All CT pulmonary angiography images were jointly reviewed by the same two radiology residents. Imaging findings consistent with acute PE included central low-attenuation filling defect within an opacified pulmonary arterial branch with or without expansion of the vessel. Mural or eccentric filling defects were considered chronic abnormalities (13). Earlier CT pulmonary angiography studies were reviewed when available to exclude the possibility of preexisting emboli.

Statistical Analysis

χ^2 tests and *t* tests were performed to compare categorical and continuous variables, respectively (Stata 13; Stata-Corp, College Station, Texas). Multivariate analysis was performed by using a multinomial logistic regression model. A *P* value less than .05 was considered statistically significant. Variables included strut penetration, age, sex, indwelling time longer than 100 days, and history of thromboembolic disease given the increasing use of filters for indications other than previous DVT/PE (14,15).

RESULTS

Twenty-six patients who received filters for primary prophylaxis underwent bariatric surgery (66.7%), with the remaining patients undergoing miscellaneous general or orthopedic surgeries (Table 1). Two bariatric surgery patients had filters placed in the immediate postoperative period. No filters were placed in the trauma setting, as our institution is not a level I trauma center. Technical success rate for placement was 100%. Fourteen filters (2.4%) were placed in the suprarenal IVC: 13 for thrombus in the infrarenal IVC and one for tumor invasion of the infrarenal IVC. Six filters were placed in the bilateral iliac veins for megacava (1.0%). The mean clinical follow-up time for all patients was 185.8 days (range, 0–1,991 d; Table 2). A total of 193 patients returned for abdominal CT follow-up, with a mean follow-up interval of 176.2 days (range, 0–1,739 d). IVC strut penetration was demonstrated in 55 patients (28.5%). Indwelling time longer than 100 days was associated with strut penetration

Table 1. Primary Indications for Filter Placement (N = 595)

Indication	Incidence
History of DVT	379 (63)
History of PE	177 (30)
Primary prophylaxis*	39 (7)
Bariatric surgery	26
General surgery	7
Orthopedic surgery	6
Trauma	0

Values in parentheses are percentages.

DVT = deep vein thrombosis.

*No history of thromboembolic disease.

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