

Outcomes and Direct Costs of Inferior Vena Cava Filter Placement and Retrieval within the IR and Surgical Settings

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ABSTRACT

Purpose: To compare the outcomes and costs of inferior vena cava (IVC) filter placement and retrieval in the interventional radiology (IR) and surgical departments at a tertiary-care center.

Materials and Methods: Retrospective review was performed of 142 sequential outpatient IVC filter placements and 244 retrievals performed in the IR suite and operating room (OR) from 2013 to 2016. Patient demographic data, procedural characteristics, outcomes, and direct costs were compared between cohorts.

Results: Technical success rates of 100% were achieved for both IR and OR filter placements, and 98% of filters were successfully retrieved by IR means, compared with 83% in the OR ($P < .01$). Fluoroscopy time was similar for IR and OR filter insertions, but IR retrievals required half the fluoroscopy time, with an average of 9 minutes vs 18 minutes in the OR ($P = .02$). There was no significant difference between cohorts in the incidences of complications for filter retrievals, but more postprocedural complications were observed for OR placements (8%) vs IR placements (1%; $P = .05$). The most severe complication occurred during an OR filter retrieval, resulting in entanglement of the snare device and conversion to an emergent open filter removal by vascular surgery. Direct costs were approximately 20% higher for OR vs IR IVC filter placements (\$2,246 vs \$2,671; $P = .01$).

Conclusions: Filter placements are equally successfully performed in IR and OR settings, but OR patients experienced significantly higher postprocedural complication rates and incurred higher costs. In contrast, higher technical success rates and shorter fluoroscopy times were observed for IR filter retrievals compared with those performed in the OR.

ABBREVIATIONS

CRNA = certified registered nurse anesthetist, IVC = inferior vena cava, OR = operating room, VTE = venous thromboembolism

Inferior vena cava (IVC) filter placement has seen a dramatic increase even though the prevalence of venous thromboembolism (VTE) has remained stable throughout the past two decades (1,2). In fact, it has been estimated that 2,000 filters were placed in 1979, 49,000 in 1999, and more

than 100,000 annually since the introduction of retrievable filters (2,3). Historically, IVC filter placement was initially performed almost exclusively by surgeons via a vascular cutdown approach in the operating room (OR), but advances in filter devices and percutaneous approaches have enabled the role of interventional radiologists as the dominant providers compared with vascular and trauma surgeons and cardiologists (4).

In an era of increasing health care costs and reduced payments, with a shift in reimbursement from fee-for-service to bundled care, it is paramount to provide cost-efficient patient care while maintaining the highest quality of the treatment provided (5). Although several studies have examined the clinical outcomes of IVC filter placement, there is a relative paucity of literature regarding the economic outcomes of filter use in the interventional radiology (IR) suite by radiologists and other settings by non-radiologists (6–8). Therefore, the purpose of the present study is to investigate the cost efficacy of outpatient IVC

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Table 1. Demographic and Clinical Characteristics of the IR and OR Cohorts

Characteristic	IR Placement	OR Placement	P Value	IR Retrieval	OR Retrieval	P Value
No. of procedures	91	51		146	78	
Age (y)*	59.6 ± 14.4	59.1 ± 15.7	.86	55.1 ± 14.6	54.3 ± 14.1	.70
Sex			.42			.36
Female	51 (56.1)	25 (49.1)		89 (58.9)	41 (52.6)	
Male	40 (43.9)	26 (50.9)		60 (41.1)	37 (47.4)	
Race			.31			.16
White	74 (81.3)	47 (92.1)		120 (82.1)	70 (89.7)	
Black	14 (15.3)	4 (7.8)		25 (17.1)	7 (8.9)	
Asian	1 (1.1)	0		1 (0.7)	0	
Other	2 (2.2)	0		0	1 (1.3)	
Comorbidity						
Neurologic disease	16 (17.6)	7 (13.7)	.55	27 (18.5)	9 (11.5)	.18
Cardiopulmonary disease	32 (35.1)	12 (23.5)	.15	27 (18.5)	20 (25.6)	.21
Hepatic disease	9 (9.9)	8 (15.7)	.31	9 (6.1)	1 (1.2)	.09
Renal disease	17 (18.7)	4 (7.8)	.08	14 (9.6)	11 (14.1)	.31
Gastrointestinal disease	7 (7.7)	7 (13.7)	.25	12 (8.2)	4 (5.1)	.39
HIV status	1 (1.1)	0	.45	3 (2.0)	0	.20
Cancer history	41 (45.0)	25 (49.0)	.65	53 (36.3)	15 (19.2)	.01
Cancer type			.64			.12
Nervous system	3 (7.3)	2 (8.0)		2 (7.6)	3 (20.0)	
Gastrointestinal	4 (9.7)	5 (20.0)		7 (17.0)	0	
Genitourinary	14 (34.1)	3 (12.0)		17 (18.9)	4 (26.6)	
Hematologic	7 (17.0)	1 (4.0)		10 (11.3)	1 (6.7)	
Lung	4 (9.7)	1 (4.0)		2 (15.1)	2 (13.3)	
Musculoskeletal	7 (17.0)	8 (32.0)		9 (16.9)	3 (20.0)	
Multiple	2 (4.8)	5 (20.0)		6 (3.7)	2 (13.3)	
Cancer stage			.44			.98
I	8 (23.5)	7 (29.2)		15 (36.7)	6 (42.9)	
II	4 (11.7)	5 (20.9)		5 (11.9)	1 (7.1)	
III	7 (20.6)	5 (20.9)		7 (16.7)	2 (14.3)	
IV	15 (44.2)	6 (25.0)		9 (21.4)	3 (21.4)	
Unknown	0	1 (4)		6 (14.3)	2 (14.3)	

Note—Values in parentheses are percentages.

OR = operating room.

*Data presented as mean ± half-range.

filter placement and retrieval performed by the departments of surgery, cardiology, and IR at a single tertiary-care center and to determine salient factors influencing the cost structures of the two providers.

MATERIALS AND METHODS

Study Design and Patient Populations

This retrospective cohort study was approved by the institutional review board and was performed with a waiver of informed consent. From January 1, 2013, to January 1, 2016, 142 IVC filter placement and 224 filter retrieval procedures were performed consecutively on an outpatient basis at a single tertiary-care academic institution. Inpatient procedures were excluded to avoid confounding factors such as comorbidities and confounding costs during the same hospital stay. Definitions recommended by the Society of Interventional Radiology (SIR) IVC filter placement and retrieval indication

guidelines (9) were used to classify patient cohorts. A contraindication to anticoagulation referred to the inability to be started on anticoagulation. A complication of anticoagulation referred to an adverse event encountered during anticoagulation. Of the 142 IVC filter placements, 91 were performed by interventional radiologists in the IR suite, and 51 were performed by vascular surgeons (n = 27) and cardiologists (n = 24) in a hybrid OR shared by both teams. Similarly, of the 224 filter retrievals, 146 were performed in the IR suite compared with 78 in the OR, 48 by vascular surgeons and 30 by interventional cardiologists. There was no statistical difference between the IR and OR cohorts in terms of age, sex, race, or comorbidities (Table 1).

Procedural Technique

Filter placements and retrievals in the IR suite were performed by an interventional radiologist or fellow supervised

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