Retrievable versus Permanent Caval Filter Procedures: When Are They Cost-effective for Interventional Radiology?

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PURPOSE: Because many retrievable inferior vena cava (IVC) filters are placed without ever being removed, placement of a retrievable device that is not removed incurs greater technical cost for the institution than a cheaper permanent filter (PF), with no clinical benefit for the patient and no additional professional or technical revenue for the interventional radiologist and institution. The purposes of this study are to identify patient characteristics associated with lack of removal of a retrievable filter (RF) and to develop a cost-effective strategy for placement of a retrievable IVC filter.

MATERIALS AND METHODS: A retrospective evaluation of 160 consecutive patients who underwent IVC filter placement with or without removal in our interventional radiology (IR) unit over a period of 31 months was performed. Patient characteristics were identified that were associated with lack of removal of retrievable IVC filters, and the cost savings were calculated in the event that a PF had been substituted for an RF in these patients.

RESULTS: A total of 160 consecutive IVC filters were placed during the study period. Of these, 42 (26%) were PFs and 118 (74%) were RFs. During the study period, only 27 of the 118 RFs (23%) were subsequently removed. Factors associated with lack of removal of an RF included patient age (P = .003), presence of ongoing malignancy (P = .04), and indication for filter placement (P = .01). Retrospectively, the use of retrievable devices only in the presence of two of the three selection criteria (ie, age <65 years, no ongoing malignancy, prophylactic indication) would have resulted in a net incremental benefit of $59,562 for the IR service.

CONCLUSIONS: The preferential use of retrievable versus permanent devices for filter placement is financially advantageous for an IR unit only if at least 41% of them are eventually removed. The use of clinical criteria to select device type allows significant cost savings.

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Abbreviations: IR = interventional radiology, IVC = inferior vena cava, PF = permanent filter, RF = retrievable filter

THE possibility to remove inferior vena cava (IVC) filters has long been appealing to physicians, especially in young patients with long life expectancy, when the presence of risk factors for venous thromboembolism is temporary, and in cases of bacteriemia or clinical suspicion of infected filter. In the past, temporary filters (ie, filters attached to a central venous catheter) have been used in many countries, but they were typically left in place for short periods of time (ie, <7 to 15 days) (1). In the past few years, retrievable filters (RFs) have become widely available worldwide and offer the additional advantage of optional retrieval and longer dwell times.

However, RFs are more expensive than permanent filters (PFs) and may result in increased expenses for interventional radiology (IR) services to place them (2). Also, publications have shown that insertion of an IVC filter provides little or no survival benefit in high-risk patient categories, especially when malignancy and/or suprainguinal venous thrombus are present (3). Hence, one could question why or when the higher cost of RFs is warranted in some patients.

From a financial point of view, reimbursement by third-party payers is the same for PFs and RFs. Therefore, placing PFs instead of retrievable devices could result in a larger net financial benefit (ie, reimbursements minus

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$$\textit{Net IR benefit} = \textit{Weighted average reimbursement} - \textit{Weighted average cost}$$

$$\text{Weighted average cost} = \sum_{i=1}^{n} \left(\textit{case mix}_i \times \textit{procedural cost}_i\right)$$

$$\text{Procedural cost} = (\text{Use rate of supplies} \times \text{Supplies cost}) + (\text{Labor cost} \times \text{Average procedure duration})$$

$$\text{Weighted average reimbursement} = (\textit{proportion paid}) \times \left(\sum_{k=1}^{m} \left(\textit{reimbursement mix}_k \times \textit{average allowable}_k\right)\right)$$

Figure 1. Cost calculation model. Assumptions of the reference case analysis (tested in sensitivity analysis): (i) supplies cost (eg, purchasing price of filter), (ii) use rate of supplies, (iii) procedure duration, (iv) case mix of filter *i*, (v) reimbursement mix of payer *k*, and (vi) proportion of procedures actually paid.

costs) for an IR service. However, in our experience, few of the RFs placed were actually removed. The present study was performed to identify circumstances in which RFs were not removed and to identify cost-effective strategies for placement of retrievable IVC filters.

MATERIALS AND METHODS

Study Design

This study was approved by our institutional review board and consisted of three steps. We gathered data by retrospectively reviewing all consecutive patients who underwent IVC filter placement and/or removal over a period of 31 months (January 2003 through August 2005) in the IR section of a tertiary academic hospital. Relevant cases were identified in our database and divided into three groups: (i) RFs placed and later removed, (ii) RFs placed and never removed, (iii) and PFs. For each case, clinical data were extracted from the patients' electronic medical and imaging records. Average costs were calculated with a modified existing cost-identification model (2) and then subtracted from average reimbursements (ie, weighted average of the allowable amounts from the six major third-party payers at our institution) to provide the average financial benefit per case for the IR section.

To address the fact that clinical data and cost may vary from study to study, and to assess the general applicability of our conclusions, a sensitivity analysis was performed. We recalculated the net benefit provided by each strategy over wide ranges of multiple parameters included in the cost analysis model. Because of the higher purchase price of RFs and the better financial return resulting from reimbursement of removal procedures, the financial benefit of PF placement for an IR unit is always between that of RF placement with removal and that of RF placement without removal. Hence, we sought to determine the removal rate at which RFs are equivalent to PFs in terms of net benefit to an IR service (ie, the "break-even" point).

In addition, we identified patients in whom ultimate filter removal is very unlikely based on clinical criteria that proved to be significant predictors in our experience. We then recalculated the net financial benefit that would have resulted for our IR service if we had followed these criteria beforehand to use permanent devices only in these patients.

Clinical Data

All IVC filter–related procedures performed during the study period were identified on our IR database. Each patient's electronic medical record and imaging studies were reviewed and we extracted patient age, sex, filter type, procedure type (ie, placement or removal), indication(s) for filter placement and removal, and presence and extent of malignancy. The degree of malignancy was assessed with the following scoring system: 0, no known malignancy; 1, remote history of malignancy (ie, the tumor has been resected curatively with no known recurrence to date); 2, known stable malignancy (ie, residual tumor is present but stable in size or has just been discovered and has not been treated yet or its treatment started <1 month earlier); and 3, progressing metastatic disease or local tumor recurrence in progress. Indications for filter placement included (i) documented pulmonary embolism and/or deep vein thrombosis in the presence of contraindication to or complication of anticoagulation, (ii) failure of anticoagulation to prevent extension or recurrence of pulmonary embolism or deep vein thrombosis, (iii) unstable cardiopulmonary status that would make any new pulmonary embolism likely lethal, and (iv) prophylactic preoperative filter placement with no proven pulmonary embolism or deep vein thrombosis. Indications for filter removal were classified as (i) need for filter no longer present, (ii) bacteriemia or clinical suspicion of infected filter, (iii) complication from filter (eg, IVC occlusion, filter migration), or (iv) other.

Cost Analysis Model

Procedural costs (ie, actual operating expenses for IR to place or remove each type of filter; Fig 1) were determined by calculating the expenses paid by IR to provide a given service, using the following formula (2):

$$\text{Procedural cost} = (\text{use rate of supplies} \times \text{cost of supplies}) + (\text{labor cost} \times \text{average procedure duration}) \quad (1)$$

The major part of supplies cost is determined by the purchasing price of the filter itself, which was collected from manufacturers (assumption 1). Labor cost includes the salaries of IR fellows, residents, nurses, and technologists (on the technical side) and the salaries of IR attending physicians (on the professional side). Labor costs vary with procedure duration, whereas supplies were assumed to be independent of time (ie, use rate of supplies is constant; assumption 2). For all filter devices, procedure duration was arbitrarily set at 30 minutes for filter placement (ie, angiography room time) and 45 minutes for filter removal (assumption 3).

After costs were calculated for each possible filter type and procedure, a weighted average cost was calculated according to the case mix observed in our study cohort: