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Retrievable inferior vena cava filters can always be removed using "fall-back" techniques

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Objective: **Retrievable inferior vena cava filters (IVCFs) left in place for a prolonged period can lead to complications including filter migration, fracture, and caval thrombosis. "Fall-back" techniques for IVCF retrieval that can be used when standard snaring is unsuccessful have been recently described. The purpose of this study was to analyze how incorporation of these new techniques affected the outcomes of IVCF retrievals at our institution during the past 5 years.**

Methods: **Data were collected of all patients undergoing IVCF removal by vascular surgeons at a tertiary academic medical center between 2009 and 2013, including demographics and procedural and filter characteristics. A standard technique of snaring the retrieval hook was attempted first in all cases; if this was unsuccessful, a number of fall-back techniques were employed, including the use of endoscopic graspers, 18F sheaths, and snaring a second wire below the collar of the filter to collapse it into the sheath.**

Results: **IVCF retrieval was attempted in 275 patients; 3 were excluded intraoperatively because of thrombus in the filter. Most filters (97%) were Günther Tulips (Cook Medical, Bloomington, Ind); 70% had been placed prophylactically before bariatric surgery. A total of 268 filters (98.5%) were retrieved successfully, 213 (79%) by standard snaring and 55 (21%) with fall-back techniques. In patients undergoing fall-back techniques, technical success was achieved 100% of the time. The median time since insertion was significantly longer in the fall-back group (173 days vs 83 days; $P < .0001$). Four intraoperative complications occurred; fractured wires embolized to the right atrium or pulmonary artery and were successfully removed endovascularly. The majority of the procedures (80%) were performed under sedation in both groups.**

Conclusions: **Incorporation of fall-back techniques may allow 100% technically successful and safe removal of retrievable IVCFs and is especially useful in removing filters with prolonged dwell time. (J Vasc Surg: Venous and Lym Dis 2015;3:364-9.)**

Venous thromboembolism affects 1 per 1000 people in the United States each year and is associated with significant morbidity and mortality.[1] Systemic anticoagulation is the first-line treatment in the majority of patients. Inferior vena cava filters (IVCFs) should be considered when anticoagulation is contraindicated or ineffective as recommended by the latest practice guidelines of the American College of Chest Physicians.[2] Since the first successful permanent filter was described by Greenfield in 1973, several filter designs have been developed.[3] The long-term outcomes of IVCFs have been extensively studied and reported in the literature. IVCFs left in place for prolonged periods may increase the risk of deep venous thrombosis, caval thrombosis, filter migration, fractures, and erosion into adjacent structures.[4,5] Retrievable IVCFs were developed to avoid some of these long-term complications. The Günther Tulip (Cook Medical, Bloomington, Ind) was the first retrievable filter approved by the Food and Drug Administration in 2003.[6]

Unfortunately, the majority of retrievable filters are not removed. A recent meta-analysis reported retrieval rates ranging from 12% to 45% (mean, 34%). Loss to follow-up and continued risk of pulmonary embolisms were the most common reasons for not removing the filter.[7] The reported technical success of filter retrieval is 82% to 98%.[7] Filter tilt and adherence to the caval wall are the most common reasons for retrieval failure[7]; when standard snaring of these filters is unsuccessful, various advanced techniques can be used. Multiple "fall-back" techniques for removal of tilted and embedded filters have been described in the literature with variable rates of success.[8-12] The purpose of our study was to analyze how incorporation of these new techniques affected the outcomes of IVCF retrievals at our institution during the past 5 years.

METHODS

Patients. A retrospective chart review was performed of all patients undergoing filter removal between January 2009 and December 2013 at a tertiary academic medical center. Demographic characteristics, including age, gender,

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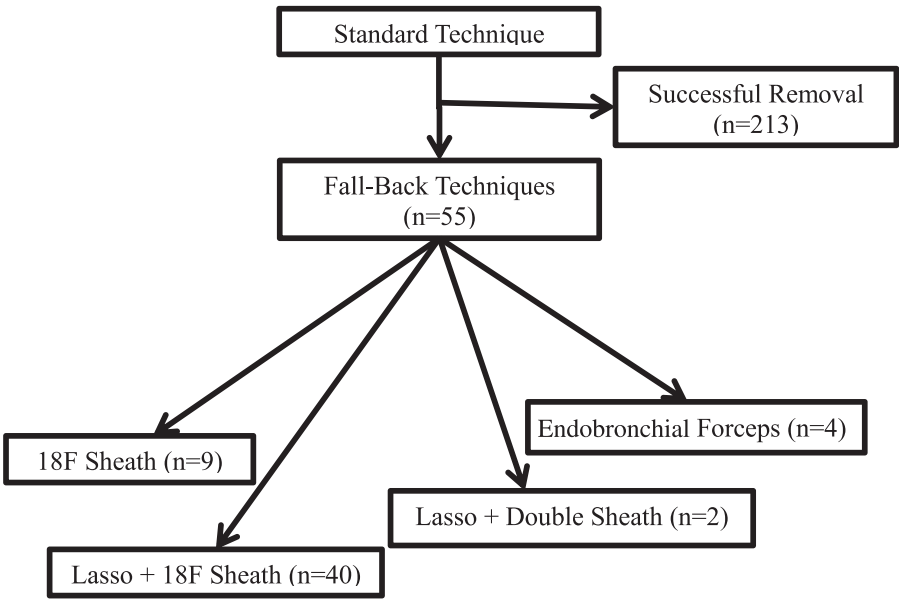

Fig 1. Filter retrieval techniques.

and indication for IVCF placement, as well as procedural characteristics, including procedure time, filter indwelling time, technique used, and type of anesthesia, were collected. Data collection and analysis were conducted in accordance with the University of Pennsylvania Institutional Review Board. The waiver of informed consent and Health Insurance Portability and Accountability Act waiver of authorization were approved by the Institutional Review Board committee.

Retrieval algorithm. All patients were evaluated by a duplex ultrasound examination for the presence of a deep venous thrombosis before any attempt at filter removal. In all cases, intraoperative venography or intravascular ultrasound was used before filter removal to exclude the presence of clot. Retrieval was aborted if any clot was seen within the filter. The standard snaring technique was first attempted for all patients. If this failed, one or more of the fall-back techniques were attempted, as described next. The choice of fall-back technique was determined by the surgeon performing the procedure.

Techniques. Several fall-back techniques were used (Fig 1). In the standard technique, an 11F Cook Performer introducer sheath was inserted through the right internal jugular vein. An EnSnare device (Merit Medical, South Jordan, Utah) or Amplatz GooseNeck snare (Covidien, Mansfield, Mass) was used to capture the hook of the filter, and the filter was then pulled up into the sheath. In cases in which the filter was successfully snared but could not be collapsed into an 11F sheath, it was switched over the wire for an 18F Cook Large Check-Flo Performer introducer sheath to increase the rigidity of the retrieval system.

In cases in which the filter hook could not be snared, the "lasso technique" was attempted. An exchange-length Bentson wire (Cook Medical) and a snare catheter were inserted through an 18F sheath and passed through separate interstices of the filter (Fig 2, *A*). The wire was snared with an EnSnare device, forming a lasso under the filter collar (Fig 2, *B*). The filter was then collapsed by pulling up the lasso mechanism and advancing the sheath over it while ensuring that the filter hook was inside (Fig 2, *C-E*). In some instances, the 18F sheath collapses on itself or "accordions"; in these cases, the lasso technique was used with coaxial sheaths, which consisted of an 18F sheath inside a 22F Cook Extra-Large Check-Flo Performer introducer sheath (Fig 3). In the infrequent cases in which the lasso technique failed, endobronchial forceps were used for removal (Fig 4).

Statistics. Statistical analysis was performed with Stata software (release 13; StataCorp LP, College Station, Tex). The Student *t*-test was used to compare continuous variables. The χ^2 test was used to compare categorical variables.

RESULTS

A total of 275 patients were taken to the operating room for IVCF retrieval between 2009 and 2013. Characteristics of the patients, indications for filter insertion, and type of filter used are summarized in Table I. Women constituted 63% of the cohort, with an average age of 45 years. The Günther Tulip was the most common filter and was used in 97% of patients. In our series, 70% of filters had been placed prophylactically before bariatric surgery. The patient's body mass index was not taken into account when retrieval technique was selected. Three patients were found to have a clot in their filter on venography or intravascular ultrasound, and retrieval was aborted. Of 272 attempted retrievals, 268 filters (98.5%) were successfully removed. All filters were removed during initial