Simplified IVUS Technique for IVCF Placement

How to place an inferior vena cava filter at the ICU bedside.

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Inferior vena cava filters (IVCFs) prevent pulmonary embolism (PE) and its catastrophic sequelae. Although generally considered safe, permanent filters have been associated with iliofemoral and vena cava thrombosis,[1,2] and some investigators advocate their avoidance, especially in younger female patients.[3] The evolution of the temporary or retrievable IVCF now offers protection against PE in high-risk-patient populations, such as the multiple-trauma patients, while avoiding the potential long-term sequelae of a permanent filter.

Intravascular ultrasound (IVUS) is a minimally invasive, accurate method of interrogating the vena cava.[4-7] The ability to safely place IVCFs at the ICU bedside avoids the need to transport critically ill patients to the operating room or angiography suite with its associated risks and costs. Despite these advantages, the acceptance of IVUS-guided IVCF placement has been limited. The objective of this study was to evaluate the placement accuracy and retrievability of the Celect IVCF (Cook Medical, Bloomington, IN) placed at the ICU bedside under IVUS guidance in multiple-trauma patients.

METHODS

Between March 1, 2007, and January 1, 2009, 93 multiple-trauma patients underwent prophylactic placement of Celect IVCFs (Figure 1). Our original deployment technique involved two femoral vena punctures; however, a single-sheath IVUS-guided deployment technique was recently reported by Jacobs et al,[7] which we have used since March 2007. The technique utilizes a single femoral vena puncture, the Celect filter 9-F sheath, and a 260-cm 0.35-inch Glidewire (Terumo Interventional Systems, Somerset, NJ). The 9-F sheath is placed in the iliac vein, the IVUS catheter (Volcano Corporation, San Diego, CA) is introduced over the Glidewire, and the IVC is interro-

Figure 1. Celect IVC filter.

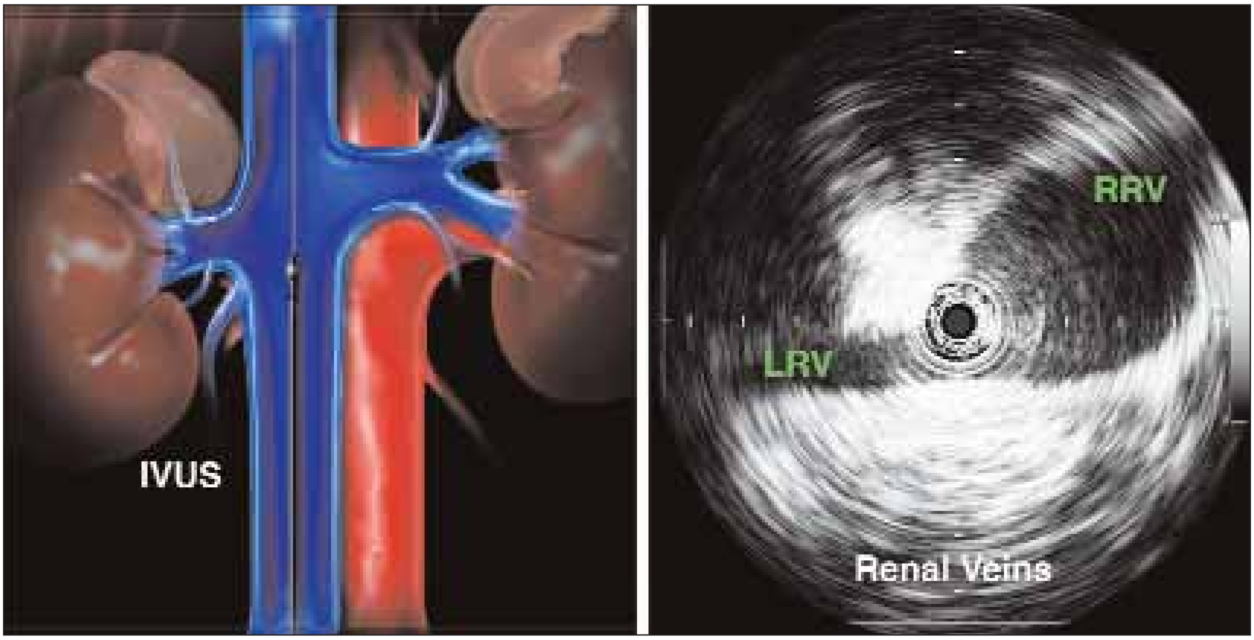

Figure 2. The IVUS catheter is placed at the level of the renal veins. LVR, left renal vein; RRV, right renal vein.

gated as previously described.[4] After the renal veins are identified (Figure 2), the filter introducer sheath is advanced until the radiopaque band covers the IVUS catheter, and the renal vein image loses its brightness (Figure 3). With the "gain" on the IVUS increased, the tip of the introducer sheath can be repeatedly passed over the IVUS catheter (while holding the IVUS catheter in place) to confirm the location of the sheath tip just below the renal veins. The introducer sheath is then held in place while the IVUS catheter and Glidewire are removed. The Celect filter is then advanced into the sheath until the distal marker reaches the Tuohy-Borst sidearm adapter (Cook Medical), identical to deployment under fluoroscopic surveillance. The tip of the filter (the hook) is now at the tip of the sheath (Figure 4). The filter introducer catheter is secured, the 9-F sheath is pulled back to the proximal marker (Figure 5), and the filter is released in the standard manner. Retrieval is identical to that for the Günther Tulip filter (Cook Medical).

Before filter retrieval, all patients underwent venous color-flow duplex ultrasound scanning of the lower extremities to rule out lower extremity deep vein thrombosis. All filter retrieval procedures were performed in the catheterization laboratory under sterile conditions, and a right jugular vein puncture was made under ultrasound guidance. The Cook filter retrieval system was used for retrieval. Before retrieval, vena cavography was performed to assess the Celect filter for trapped emboli or thrombus within the filter. A significant (> 25%) filter volume for trapped thrombus was considered a contraindication to filter removal. After retrieval, repeat vena cavography was performed to evaluate the IVC for contrast extravasation, intraluminal defects, or residual stenosis.

RESULTS

Ninety-three multiple-trauma patients underwent ICU bedside placement of retrievable Celect IVCFs. Eighty filters were placed via the right femoral vein and 13 via the left femoral vein. The mean (± SD) age of the patients was 44 ± 2 years (range, 17–71 years), and 51 (54.8%) were male. All patients sustained multiple-trauma injuries, and the mean ± SD Injury Severity Score was 28.5 (± 2.2). Eighty-five (91.4%) of the patients had blunt injuries from motor vehicle crashes.

Fourteen patients died of their injuries. One PE, documented by contrast-enhanced spiral computed tomography occurred. The PE was an "escape embolus" that was successfully treated with anticoagulation. Ninety-one (97.8%) IVCFs were placed without complications in the vena cava, as verified by postprocedure abdominal x-rays. One filter was misplaced in the right iliac vein while, another filter only partially expanded. These filters were uneventfully retrieved and replaced in the IVC within 48 hours. No procedural complications (ie, groin hematoma, femoral deep vein thrombosis) occurred.

Celect filters were in place a mean of 97 ± 2 days (range, 39–183 days) before retrieval. Eight Celect filters were not retrieved in patients who had continued contraindications to anticoagulation because of the severity

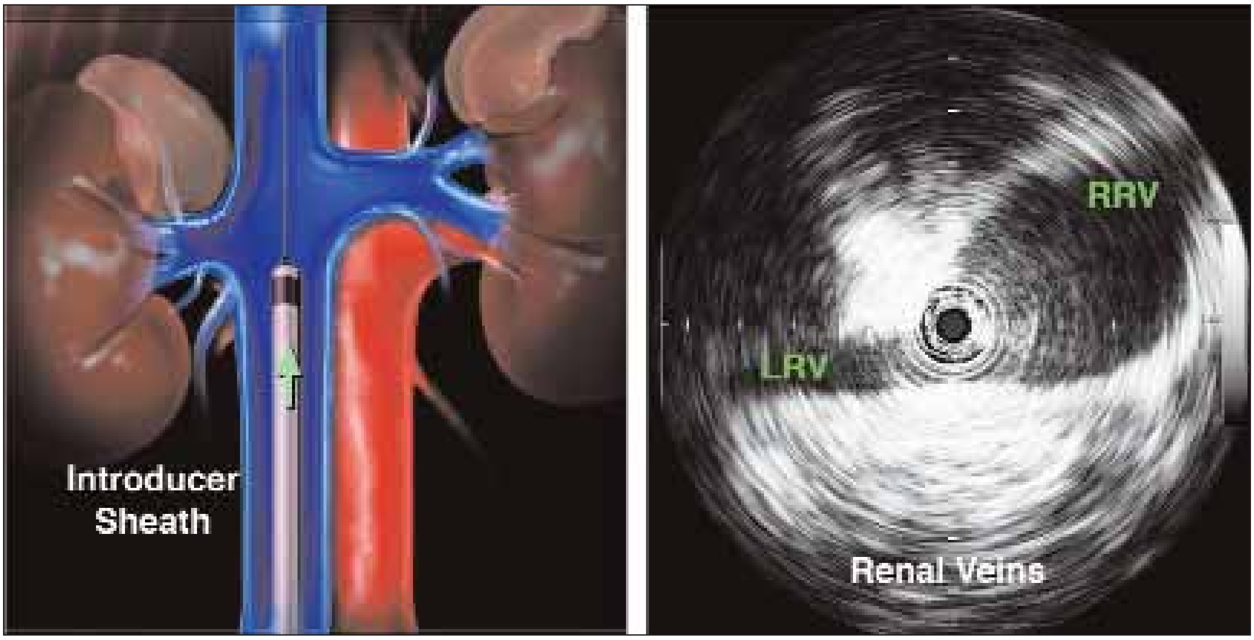

Figure 3. The filter introducer sheath is advanced until the radiopaque band covers the IVUS and the renal vein image loses its "brightness."

of their injuries, and seven patients were lost to follow-up. Filter retrieval was, therefore, attempted in 64 patients. Eighteen filters could not be retrieved due to filter tilting and/or prolonged indwell times: preretrieval vena cavography (compared against the long axis of the IVC) identified filter tilting (> 20°) in 10 filters, whereas the other eight filters had extended indwell times (range, 168–210 days). Retrieval attempts were unsuccessful due to the interventionist's inability to capture the filter hook because of excessive tissue ingrowth. Forty-six of the 93 filters (49.4%) were therefore retrieved. Only one retrieved filter had trapped thrombus identified by vena cavography at the time of retrieval, none had structural defects, and one Celect filter migrated (caudally, 2 cm). Postretrieval vena cavagrams demonstrated no contrast extravasation, intraluminal defects, or IVC narrowing.

DISCUSSION

Matsumura et al[8] initially reported the bedside placement of IVCFs guided by IVUS. With this innovative technique, the IVUS catheter identified the renal veins and filter landing zone. After removing the IVUS catheter, however, the filter was passed blindly over a stiff wire and the filter deployed. This initial technique has been used successfully, but the blind deployment of the filter made this technique potentially hazardous and inaccurate.

Our original "double-puncture" technique enabled real-time ultrasound scanning of the IVC and renal veins to ensure precise filter deployment.[9] Theoretical disadvantages of this technique are the two femoral vein punctures and the potential for access site femoral vein thrombosis. With the evolution of the single venous access method, the need for two sheaths required for continuous imaging of the filter system is eliminated, simplifying the procedure while reducing the risk of complications.

The filter deployment success rate with this single-puncture technique was 97.8%. Before using this bedside technique, Jacobs[7] recommended (and we concur) that fluoroscopic imaging be combined with IVUS early in the operator's experience. This allows the operator to correlate IVUS imaging of the IVC and localization of the renal veins with contrast venography as well as evaluate the accuracy of filter deployment after delivery sheath positioning, similar to what occurs when using the IVUS-guided technique alone. Confirmation of filter placement by bedside anterioposterior abdominal x-ray films to evaluate IVCF location and opening of the filter is part of our standard technique.

In this era of cost containment, new techniques must be examined. Historically, IVCFs have been placed in the radiology suite or operating room, and it was of interest to note the charge center differences at our hospital. The charges for IVCF insertion in our operating room were $5,783; the charges for insertion in the radiology suite were $4,744; and the charges for insertion at the ICU bedside were $4,920.[4] Although ICU bedside IVCF placement under IVUS surveillance was not the lowest hospital charge, because of the cost of the IVUS probe ($850), the ICU bedside placement saves on staff and resource

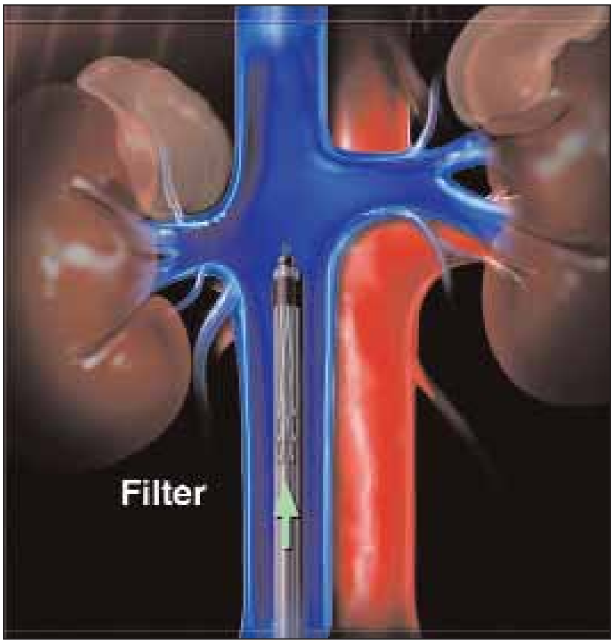

Figure 4. The IVUS catheter and Glidewire have been removed, and the Celect filter is then advanced into the sheath until the distal marker reaches the Tuohy-Borst side-arm adapter.

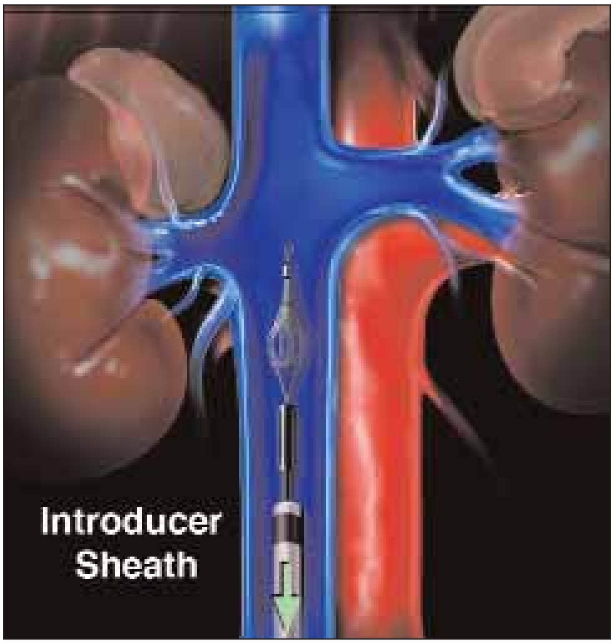

Figure 5. The filter introducer is secured, the 9-F introducer sheath is pulled back to the proximal marker, and the filter is deployed in the standard manner.

utilization, avoids transportation of critically ill patients to the operating room or radiology suite, and avoids the complications of contrast reactions and the risks of radiation exposure, items for which it is difficult to apply a dollar amount.

CONCLUSION

IVCF placement at the ICU bedside with this simplified IVUS technique in patients with multiple traumas is efficacious and safe, prevents pulmonary embolism, and serves as an effective bridge to anticoagulation therapy until venous thromboembolism prophylaxis can be initiated. Further investigation of this simplified bedside technique and the role of temporary IVCFs is warranted. ■

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