Obtaining Optimal Filter Placement

How imaging and technical skill ensure safe placement of an IVC filter.

BY MARK W. BURKET, MD

When compared to many other endovascular procedures, placement of an inferior vena cava (IVC) filter should be simpler, safer, and faster. This statement assumes that suitable devices are placed in appropriately selected patients, for appropriate indications, using the best access site, and with good technique. Two significant components of good technique are the accurate identification of a suitable location for deployment and the ability to release the filter accurately at that location.

Not surprisingly, knowledge of vena cava anatomy is essential for safe and accurate deployment. In almost all cases, the intended spot for filter placement is just caudal to the renal veins. This capitalizes on two key facts: first, should the device later become completely obstructed with clot, renal vein outflow is uncompromised; second, the IVC diameter is significantly smaller caudal to the renal veins, ensuring that filter diameter will be adequate to appropriately oppose the venous wall in almost all cases.

IMAGING THE IVC

Imaging the IVC is an integral part of filter placement. Although other venous access sites are sometimes used, the overwhelming majority of filters are placed after entering either the internal jugular vein or common femoral vein. Each site has its advantages and drawbacks. The percutaneous femoral access technique is very familiar to most operators. Before using this location, it is imperative to exclude the presence of an ipsilateral common femoral vein clot, typically by use of duplex ultrasound. A potential danger when using the femoral vein is inadvertent puncture of the adjacent femoral artery. Because candidates for IVC filters often are anticoagulated, there is significant risk of a bleeding complication. Once femoral puncture has been obtained, access to the IVC is almost always straightforward. Jugular access minimizes the risk of dislodging thrombus present in iliac veins, femoral veins, or the distal IVC. Although there is risk of inadvertent puncture of the carotid artery, this risk can easily be mitigated by performing vascular puncture

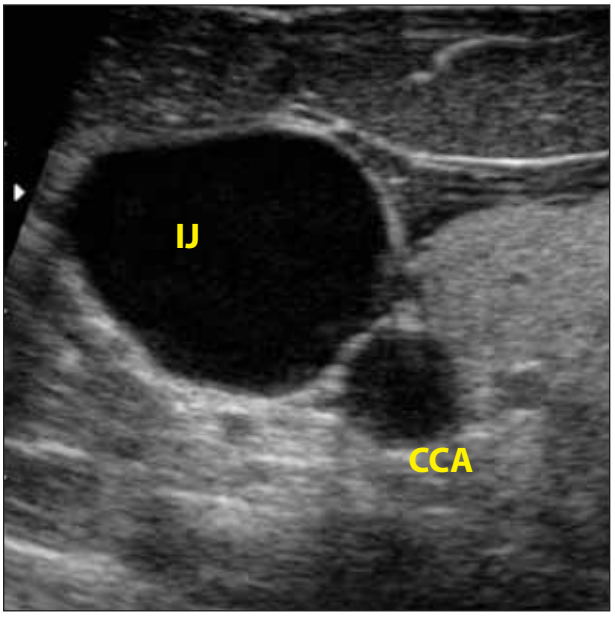


Figure 1. A transverse grayscale ultrasound image at the base of the neck, identifying the internal jugular (IJ) vein and the common carotid artery (CCA).

with the assistance of ultrasound imaging. In almost all cases, both the internal jugular vein and carotid artery are readily identified (Figure 1). After sheath placement, the guidewire generally passes easily into the IVC but on occasion will not exit the right atrium. When this occurs, an angled catheter, such as a multipurpose catheter, can be used to steer into the IVC.

Vena cava venography is an integral part of nearly all filter placement procedures. Radiographic imaging provides the necessary information to place the device safely and accurately. When the procedure is performed using femoral access, contrast injection through the sheath is helpful to evaluate for the presence of clot in the iliac veins. If thrombus is visualized, consideration should be given to changing the access site to avoid dislodgement and possible pulmonary embolism. Diluted contrast (50:50) provides sufficient imaging. In some cases, this femoral injection is also adequate to opacify the vena cava as well, precluding the need for additional imaging (Figure 2). In most femoral cases and in all jugular-approach procedures, imaging requires placing a catheter or specially designed dilator into the IVC. Multiple sidehole catheters are preferable, such as Uniflush (Cordis Corporation, Bridgewater, NJ), Omniflush (AngioDynamics, Queensbury, NY), or pigtail configurations. As mentioned, a 50:50 mixture of contrast and saline is adequate and reduces contrast volume.

The advantage to starting with a catheter is that it allows confirmation that the cava is suitable for a filter before opening the IVC filter package. Discovery of clot or an unusually large IVC may lead to a change in the type of filter selected, a different access site, or rarely, a decision not to place a filter. If a megacava is encountered, a Bird's Nest filter (Figure 3) is generally selected, which is adequate for diameters ≤ 40 mm. Because the chance of any of these is very low, manufacturers now provide delivery sheath/dilator combinations that allow accurate imaging and sizing of the IVC. These dilators have multiple sideholes and marker bands (Figure 4), which are used to measure caval diameter, ensuring that it falls within the accepted dimensions for use of a given device. The marker bands are spaced in such a way that if the IVC diameter is the same or less than the distance between markers, then the filter may be safely deployed. Use of the sheath/dilator combination eliminates the need for a separate catheter and streamlines the procedure.

If a dilator with marker bands is not used to size the IVC, some other method is necessary. Radiopaque marker tape placed under or on top of the patient has been used, but because it is not in the same horizontal plane as the IVC, magnification is always present, rendering the measurements inaccurate. A measuring tool inside the cava is the most accurate option. Catheters with marker bands are readily available and accurate. A simple, inexpensive, and universally available way to assess vessel diameter is to first measure the maximum width of the curve of the catheter that has been selected for venography. Nearly all trays come with some measuring tool: a small ruler, calibrated barrel of a marking pen, or centimeter markers on a scalpel handle. Typically, this dimension of the catheter will be approximately 15 mm. The catheter is then introduced to the desired position. It must be held in such a way that the loop is kept in the horizontal plane at the time of imaging. Caval width is then compared to catheter width, with no error introduced by magnification and no additional expense.

Contrast imaging of the IVC is qualitatively different from most vascular imaging. Typically, iodinated contrast is used to opacify the vessel of interest. In the case of filter placement, the cava is opacified to measure diameter and to check for thrombus, but negative contrast is often used to find renal vein inflow. That is, renal vein location is confirmed not by filling the veins with contrast but by observing where a stream of nonopacified blood enters into the cava. The appearance is analogous to a stream

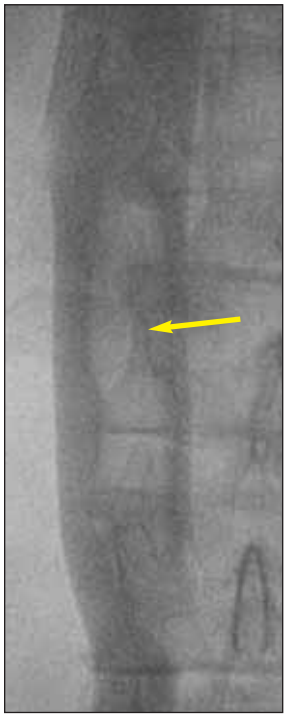
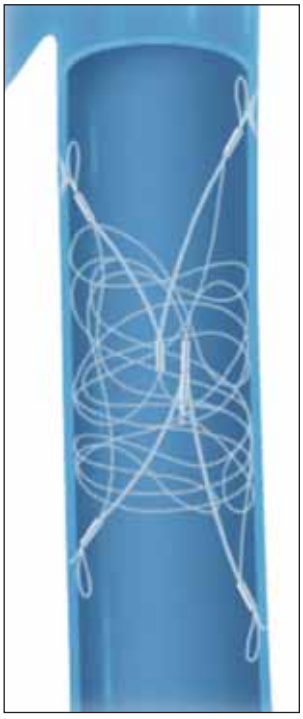


Figure 2. Opacification of the IVC with diluted contrast allows identification of a central luminal thrombus (arrow).



(Courtesy of Cook Medical.)

Figure 3. A Bird's Nest filter (Cook Medical, Bloomington, IN).

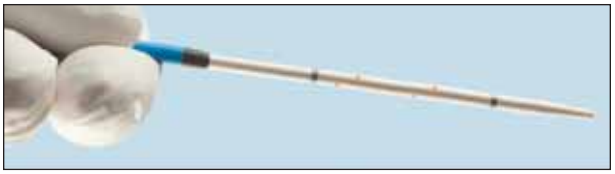

(Courtesy of Cook Medical.)

Figure 4. A sheath/dilator combination (Cook Medical). The 30-mm marker bands allow sizing of the IVC. Injection is performed through eight sideports.

with clear water entering into a river with muddy water. The filter will be placed caudal to this identified inflow. Positioning the end of the catheter at approximately L3 typically provides adequate imaging. Renal vein inflow will often be identified near the L1, L2 interspace. X-ray imaging of the IVC can be performed with either subtracted or nonsubtracted technique. Once images that allow identification of renal vein inflow have been obtained, the table on which the patient is lying should not be moved to eliminate the chance of a parallax error. If digital subtraction angiography has been used, bone images should be superimposed so that the operator can use bone landmarks to accurately place the filter.

FILTER PLACEMENT

After these steps, it is time to deliver the filter. Care should be taken not only to position the device at the proper level of the IVC but to center it carefully as well. Although some filter designs effectively prevent tilting within the vein, others can easily be slanted (Figure 5). This may decrease effectiveness in preventing pulmonary embolism. In the case of a retrievable filter, an inappropriate tilt may cause the recovery hook to touch the vessel wall. After the metal has become endothelialized, retrieval may be impossible. Techniques to avoid tilting vary with different filter types. Some can be partially deployed and then repositioned if needed before final release. With some, tilt can be minimized by placing slight tension on the delivery system just before placement.

Another design includes a curved wire at the tip of the "pusher" that is used to move the filter out of the sheath and into to IVC. If the alignment is not suitable, the sheath and pusher can be torqued before delivery to increase chances of coaxial delivery. Given the wide variety of filters that are now commercially available, the best strategy is for the operator to fully understand the selected system. The input of industry representatives is invaluable in this regard, as is a careful review of each device's Instructions for Use (IFU) included in the packaging. The IFU is typically also available online, allowing the operator to prepare in advance for the procedure.

The use of intravascular ultrasound (IVUS) for IVC filter placement is an alternative to contrast venography and device placement under fluoroscopy. Although any IVC procedure can be performed in this manner, this approach is especially helpful in select patient groups. In patients with severely impaired renal function, even the small volumes of iodinated contrast involved with typical deployment may be inappropriately risky. Severely morbidly obese patients may exceed the safe operational limit of angiographic tables; in these patients, standard C-arm fluoroscopy units may provide inadequate image quality, precluding bedside placement. A final group in which ultrasound-guided placement is well suited is the pregnant patient, in whom no fluoroscopy exposure is preferred.

The technique of ultrasound-guided IVC filter deployment has been well described.[1] This approach typically is accomplished using femoral vein access. Although a two-groin method, in which the IVUS catheter is inserted through one side and the filter deployment equipment through the other, has been described, the entire procedure can be accomplished using only a single venous puncture. Jugular access has also been used; however, fluoroscopy may be necessary to direct the guidewire out of the right atrium if it does not readily pass into the IVC. IVUS guidance for filter positioning is based on the fact that there are a series of reliable landmarks that give the

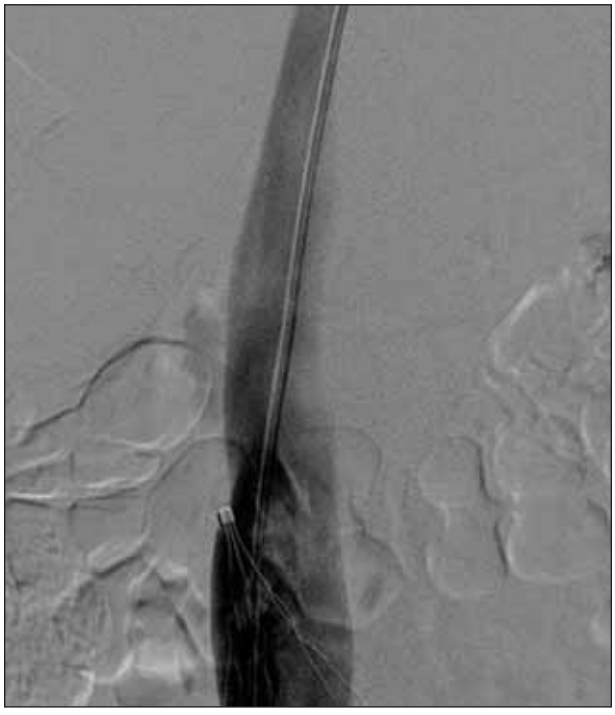


Figure 5. Suboptimal filter placement: the device is tilted in the IVC.

Figure 6. Duplication of the IVC. This image was obtained by simultaneous injection through right and left femoral sheaths.

operator confidence that the filter can be placed caudal to the renal veins. These landmarks include the right atrium, renal veins, right renal artery, and iliac vein confluence. The right renal artery has a distinct appearance as it passes posteriorly to the IVC, helping to confirm appropriate positioning. A delivery sheath with a radiopaque tip is used. Once the IVUS catheter is placed in the correct position, just distal to the renal veins, the delivery sheath is positioned such that the radiopaque tip is at the same level as the imaging portion of the IVUS catheter. This becomes apparent because the sheath tip causes significant degradation of the ultrasound image. When the catheter tip is just outside the sheath, the image will be optimal. As the sheath tip covers the imaging portion of the catheter, the image will worsen, confirming that the sheath tip is now just distal to the renal veins. The IVUS catheter is then withdrawn, and the filter delivery system introduced. The exact details of the procedure at this point depend on which access point, sheath, and filter system are selected. In general, however, the filter will be advanced until its tip is at the tip of the sheath. The filter delivery system will then be fixed, and the sheath retracted, deploying the filter. Correct positioning can be confirmed by cautiously advancing the IVUS catheter through the filter, establishing its relationship to the renal veins.

Although an exhaustive knowledge of vascular anatomy is not necessary for routine placement of an IVC filter, there are two anatomic details of which every operator should be aware. Neither is commonly relevant but in an isolated case could be crucial. The first is the presence of a duplicated IVC (Figure 6), estimated to be present in up to 3% of the population. In this context, IVC filter placement results in only ipsilateral protection against deep venous thrombosis-producing pulmonary embolus. So, for example, if a right-sided device is placed, a clot in the left leg may dislodge, pass up the left-sided IVC, continue into the confluence of right and left duplicate cavae, and proceed into the pulmonary artery. Recognizing this variant may be very tricky, especially if only right-sided venography is performed. If left-sided imaging is performed, it should be immediately obvious to the informed observer.

The second anatomic feature of which operators should be aware is the origin and course of the gonadal vein. A typical origin is in close proximity to the renal veins, with an initial course nearly parallel to the IVC. While this is largely irrelevant when placing filters from femoral access, there is a potential pitfall when using a jugular (or arm) approach. Inadvertently, the deployment sheath may be advanced into the gonadal vein when it appears under fluoroscopy to be properly positioned in the IVC. This can lead to a misplaced filter (Figure 7). The risk of this happening is increased if the sheath is advanced without first advancing a J-tipped guidewire.

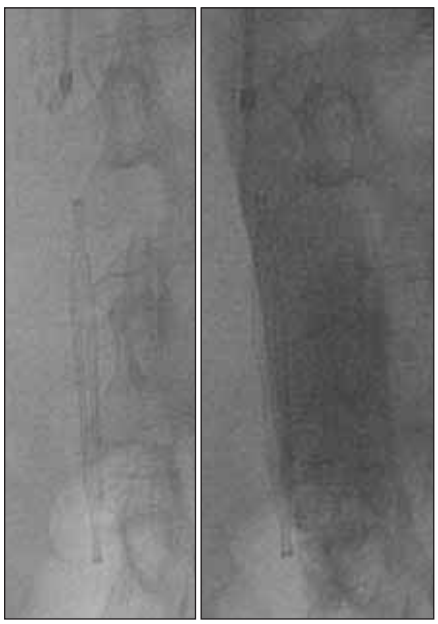


Figure 7. A filter inadvertently placed into the gonadal vein. The filter has not expanded and does not protect the IVC.

Occasionally, locations other than the IVC caudal to the renal veins may be selected for vena cava filter placement. Suprarenal placement may be preferred in pregnant patients.[2] Filter use in pregnant patients is also discussed in this issue on page 59. Although no filter has been designed for use in the superior vena cava, occasionally a clinical need arises for such an application (Figure 8).[3] In this situation, similar principles apply as in

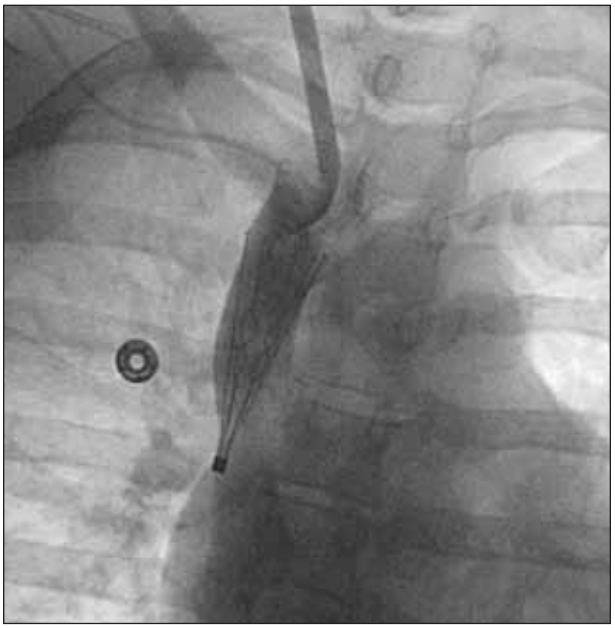


Figure 8. Filter placement in the superior vena cava.

the IVC. First, it is imperative to adequately image the superior vena cava. The diameter of this vessel typically is well within the sizing guidelines found in the IFU for each filter, but confirming this angiographically is always appropriate. Given the short length of this vessel, the margin for error in placement is less. For this application, delivery systems intended for femoral use should be selected when using jugular access and, conversely, jugular systems when using femoral access.

CONCLUSION

In summary, safe and appropriate placement of an IVC filter is generally a straightforward undertaking. A core of fundamental knowledge and technical skill is essential for consistently favorable results. ■

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