Use of Noncontrast Computed Tomography of the Inferior Vena Cava for Real-Time Imaging Guidance for the Placement of Inferior Vena Cava Filters

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Abstract

Appropriate placement of an inferior vena cava (IVC) filter necessitates imaging of the renal veins because when an IVC filter is deployed its tip should be at or below the inferior aspect of the inferiormost renal vein. Traditionally, imaging during placement of IVC filters has been with conventional cavography and fluoroscopy. Recently, intravascular ultrasound has been used for the same purpose but with additional expense. Morbidly obese patients often exceed the weight limit of fluoroscopy tables. In addition, short obese patients are at risk of falling from narrow fluoroscopy tables. For such patients, computed tomography (CT) guidance is a viable alternative to conventional fluoroscopic guidance.

IVC placement was performed in the CT suite for two obese patients who exceeded the weight limits of the available fluoroscopy tables. In one case, a Vena-Tech filter (Braun Medical, Melsungen, Germany) was placed using CT fluoroscopy. In the second case, a Recovery (Bard, Murray Hill, NJ) filter was placed using intermittent limited z-axis scanning.

In the first case, the filter was placed below the level of the renal veins and above the confluence of the iliac veins, which is acceptable placement. In the second case, with refinement of technique, the filter tip was placed less than 1 cm below the inferiormost renal vein, which is considered optimal placement.

CT of the IVC precisely images the renal veins and can characterize their number and their confluence with the IVC. CT guidance is a viable alternative to fluoroscopic guidance for the placement of IVC filters in morbidly obese patients.

Keywords

- inferior vena cava
- computed tomography
- filterplacement-guidance
- deep vein thrombosis
- obesity

Appropriate placement of an inferior vena cava (IVC) filter necessitates imaging of the renal veins and characterization of their number and their confluence with the IVC. Imaging is desirable during filter placement to ensure that when an IVC filter is deployed, its tip is at or below the inferior aspect of the confluence of the inferiormost renal vein with the IVC. Placement of an IVC filter above the renal veins can lead to

thrombosis of the renal veins if an embolus is caught by the filter. Placement of the filter too far below the renal veins creates a dead space in the IVC above the IVC filter if an embolus is caught. A second thrombus can then form above the filter and subsequently embolize to the lungs.¹

Classically, imaging during placement of IVC filters is with conventional inferior vena cavography and fluoroscopy.^{2–4}

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However, some morbidly obese patients exceed the weight limit of fluoroscopy tables, which can be as little as 350 lb. In addition, short obese patients are at risk of falling from narrow fluoroscopy tables. For such patients, computed tomography (CT) guidance with or without the use of CT fluoroscopy is a viable alternative to conventional fluoroscopic guidance.

Methods

Case 1 (►Fig. 1a–d): A 59-year-old man with morbid obesity, weighing approximately 470 lb, was known to have a severe pulmonary embolus (PE) in addition to a large right lower extremity deep venous thrombosis (DVT). The patient exceeded the weight limit of the available angiography tables so CT was selected for guidance. A SomatomSensation Open 40-slice scanner (Siemens, Erlangen, Germany), a scanner with a nominal weight limit of 450 lb, was utilized. A preliminary scan was performed. The superior to inferior distance between the renal veins and the left femoral vein just above the saphenous vein (at the level of the femoral head) was measured. Five centimeter was added to this measurement to allow for the curvature of the iliac veins. Prior to its insertion into the venous system, the Vena tech LP filter (Braun, Melsungen, Germany), deployment sheath was

marked at this length with a Steri strip. Access to the left common femoral vein was then achieved using real-time ultrasound guidance.⁵ The patient's girth required a very long access system. An Accustick system (Boston Scientific, Natick, MA) was used. A 0.035 Amplatz wire was advanced through the Accustick outer catheter which was then exchanged for the deployment sheath. The sheath was advanced until the Steri strip marker was at the skin. The wire, sheath stiffener, and Steri strip were then removed. The patient was advanced into the gantry to a table position a few centimeters above that which was previously recorded to be at the level of the renal veins. The scanner was then set to fluoroscopy mode. The radio-opaque marker of the sheath tip was identified and then adjusted to be at a level well inferior to the renal veins because of the hypothetical risk of filter migration during this new technique. The sheath was held motionless and the filter advanced to its tip by advancing the pusher until its marker was at the valve of the sheath. The sheath was then withdrawn while the pusher was held motionless, deploying the Vena tech LP filter. A postdeployment scan was then performed to document the level of filter placement and its position relative to the renal and iliac veins.

Case 2 (►Fig. 2a–d): A 38-year-old man with morbid obesity, weighing approximately 370 lb and being approximately 5'6",

Fig. 1 (A) Axial image at the level of the renal veins from the preliminary CT. (B) Incremental axial CT fluoroscopy shows the tip of the sheath to be inferior to the renal veins. (C) Axial CT fluoroscopy shows deployed Venatech filter. (D) Two-centimeter thick coronal multiplanar reformatted image shows deployed Venatech filter with tip near to but inferior to the renal veins.

Fig. 2 (A) Axial image at the level of the renal veins from the preliminary CT. (B) Axial image shows the tip of the sheath to be inferior to the renal veins (note the excretion of contrast in the renal pelvi from a prior CT pulmonary angiogram). (C) Incremental axial CT shows deployed Recovery filter. (D) Coronal multiplanar reformatted image shows deployed Recovery filter with tip near to but inferior to the renal veins.

was known to have a severe PE in addition to a large left lower DVT. In addition to initiation anticoagulation, a filter was requested by the primary service. The procedure was performed in the same way as the first with several differences: the CT scanner used was a GE LightSpeed 4 (General Electric, Fairfield, CT) with a nominal weight limit of 350 lb, the same as the nominal weight limit of the angiography suite. The width of the CT table was 24" in contrast to the 18" width of the angiography table. CT was selected for guidance because of the concern that due to body habitus the patient might fall off the angiography table. Access to the right common femoral vein was selected in this case as the DVT was on the left. Intermittent scanning rather than CT fluoroscopy was utilized for guidance as fluoroscopy was not available. A G2 Recovery Filter (Bard, Murray Hill, NJ) was used. The tip of the sheath was positioned much closer to the renal veins.

Results

Renal venous anatomy was shown to be normal in both cases. In the first case, the filter was placed with its tip 3 cm below the inferior aspect of the inferiormost renal vein (►Fig. 1d). In the second case, the filter was placed with its tip 1 cm below the inferior aspect of the inferiormost renal vein (►Fig. 2d).

Discussion

There is precedence for using CT guidance for filter placement. Review of prior CT data before conventional IVC filter placement has been reported to be helpful in these studies.⁶⁻⁸ Advantages of CT review or guidance include ascertaining cross-section measurement of the IVC, the number and position of the renal veins, and the presence or absence on duplication of the IVC. Another advantage is that additional iodinated contrast media are not necessary for this technique. However, this could also be a disadvantage if undiagnosed thrombus within the IVC, such as tumor thrombus, is not detected. The focus of a recent paper by Hislop et al is CT planning for bedside intravascular ultrasound-guided placement of IVC filters.⁸ Our technique may be more expedient, as it combines planning and placement into a single procedure. As ►Fig. 1d and especially ►Fig 2d show, acceptable and even optimal placement can be achieved with this technique.

This technique has limitations and foremost among them is its novelty. A future study directly comparing CT-guided IVC filter placement to fluoroscopy-guided IVC filter placement will be necessary to compare the efficacy of the two techniques and to define what role, if any, CT guidance for IVC filter placement will have in the future.

Also important to note is that this technique has not been utilized for transjugular IVC filter placement. We chose to avoid the transjugular route of access because this would require that a guidewire be navigated through the right atrium into the distal IVC. CT guidance is not suited to this purpose; the heart moves too rapidly.

There may be a select group of obese patients with acceptable subcostal acoustic windows for adjunctive intra-procedural transthoracic echocardiography, which could be used to guide passage of a wire from the right atrium into the IVC in real time. Positioning of the filter could then be performed with CT guidance. Such a hybrid approach would avoid the complexity and expense of intravascular ultrasound while adding much of its advantage. This hypothetical technique could be attempted after greater experience with CT guidance for transfemoral IVC filter placement is accrued.

Conclusion

Real-time CT guidance using either CT fluoroscopy or frequent intermittent scanning is a viable alternative to conventional cavography and fluoroscopic guidance in patients who are morbidly obese.

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