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Trauma Admission CT as a Road Map for IVC Filters

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The objective of this study was to determine if admission abdominal/pelvic CT on trauma patients can be used as a novel method to evaluate the inferior vena cava (IVC) anatomy and facilitate potential IVC filter placement. Consecutive trauma admission CT's were reviewed. The potential landing zone for filters was determined by the IVC mid portion between the renal and iliac veins. The IVC landmarks were described anatomically using the thoracic and lumbar vertebral bodies as reference points. The IVC diameter and anatomic anomalies which would affect filter placement were also evaluated from the CT. The records of 610 Trauma patients were reviewed. There were 518 (84.9%) that had an admission CT, forming the basis of the study. The CT for 500 of 518 (96.5%) was of sufficient quality to accurately evaluate the IVC. The third lumbar location of the IVC was a safe landing zone in 476 of 500 (95.2%). Anatomic anomalies were present in 47 of 500 (9.4%). We had the following three conclusions. The admission CT in over 96% of trauma patients can be used to determine the IVC filter landing zone. The third lumbar region of the IVC was a safe landing zone in over 95%. Anatomical anomalies affecting IVC filter placement were revealed in 9.4%.

Key words: Inferior vena cava – Computed Tomography – Trauma – Inferior Vena Cava filters

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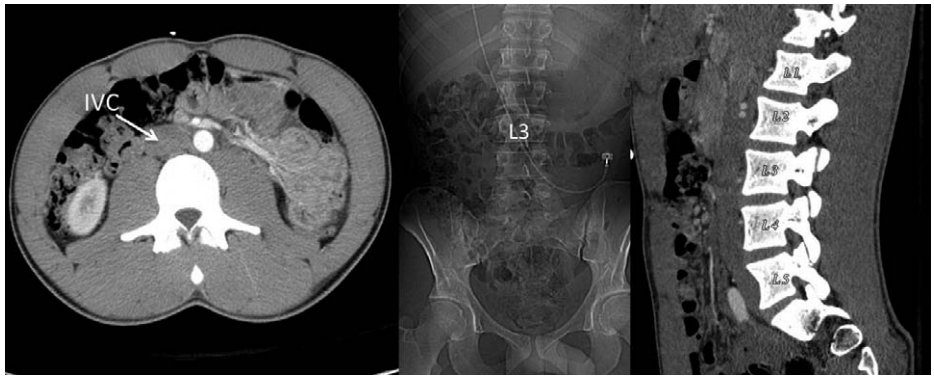

Fig. 1 Left: Axial CT of IVC at the L3 level. Middle: Scout view from CT with L3 indicated. The scout view can be cross-referenced with the axial images for localization. Right: Sagittal reformats can also be cross-referenced with the axial plane at L3.

Venous thromboembolism (VTE) and bleeding are both significant risk factors in trauma patients.[1–3] Trauma patients are difficult to treat; a balance must be established between the use of VTE chemoprophylaxis and the increased risk of bleeding. This balance is especially challenging for patients with traumatic brain injury, spinal fractures, spinal cord injury, or spinal surgery since these patients are simultaneously at a higher risk of developing VTE and at a higher risk for bleeding.[4,5] However, if the risk of VTE chemoprophylaxis is felt to be excessive for bleeding, prophylactic inferior vena cava (IVC) filters may be placed.[6] Trauma patients are also unique in that abdominal/pelvic computed tomography (CT) scans are frequently done upon admission to evaluate or determine injuries. The purpose of this paper is to determine if the admission abdominal/pelvic CT could be used as a novel method to evaluate the IVC anatomy and facilitate potential IVC filter placement.

Methods

We reviewed trauma admission abdominal/pelvic CTs to evaluate the IVC. All studies were performed on a 32-slice GE CT scanner (Fairfield, CT, USA). The potential safe landing zone for IVC filters was defined as the infrarenal IVC, as determined by the IVC midportion between the lowest renal vein and the bifurcation into the iliac veins. This location was described anatomically using the thoracic and lumbar vertebral bodies as reference points. This reflects the reference points that are commonly used when a venogram is obtained to determine a safe landing zone during IVC filter placement. In the study group, the IVC diameter was evaluated in the transverse direction from CT cross sectional imaging, again mirroring the diameter measurement revealed during a venogram. The admission CT was also used to determine anatomic anomalies, which would affect the planning and placement of IVC filters.

Results

The records of 610 consecutive Trauma Alert patients admitted to the Trauma Center at Kendall Regional Medical Center in Miami, Florida, were reviewed. Trauma Alert patients are determined by Emergency Medical Services from pre-established trauma criteria reflecting a high likelihood of life-threatening injuries. Of these 518 (84.9%) had an admission abdominal/pelvic CT, forming the basis of the study. The CT imaging of 500 of the 518 (96.5%) trauma alert patients who had an admission

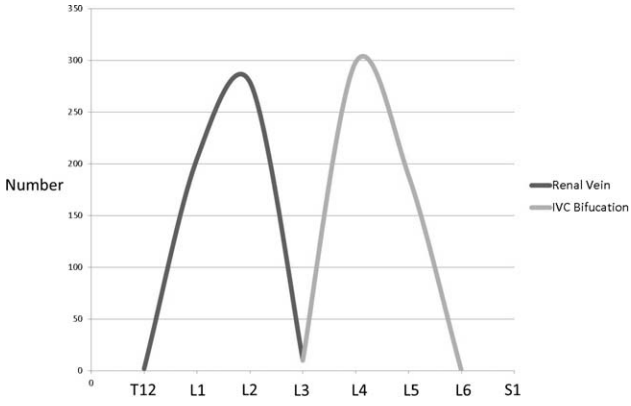

Fig. 2 Figure 2 depicts the location of the lowest renal vein and IVC bifurcation as it relates to the vertebral bodies, T12 = 12th thoracic vertebral body, L1–5 = lumbar vertebral bodies, S1 = sacrum.

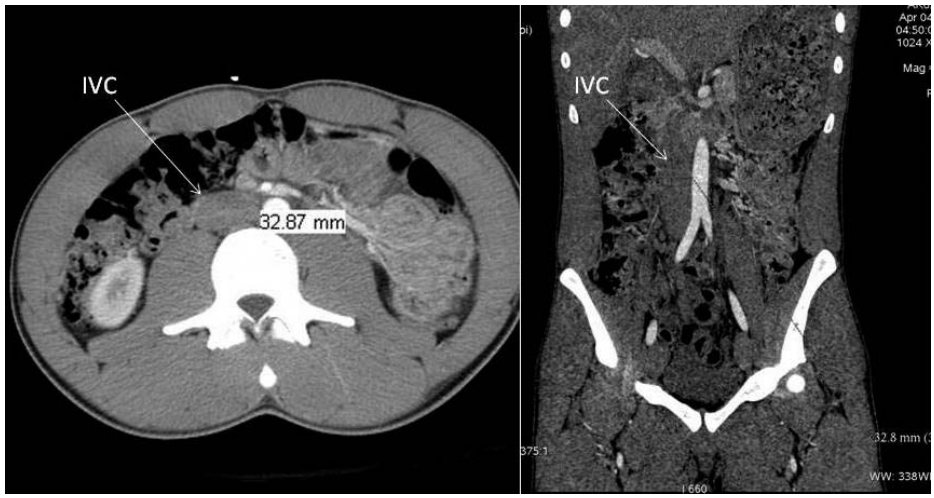

Fig. 3 Patient with giant IVC. Left: Axial CT at the L3 level, the IVC measures greater than 32 mm. Right: Coronal reformat of "Giant IVC."

CT was of sufficient quality to accurately evaluate the IVC. The common reasons for inability to use the admission CT to evaluate the IVC included patient movement, technical errors, patient positioning, and lack of scout images. The use of intravenous contrast was not necessary to identify the IVC and evaluate potential landing zones. The lack of intravenous contrast did not result in any of the 18 exclusions. The potential landing zone for an IVC filter is below the lowest renal vein and above the IVC bifurcation. This region is utilized because filters have the tendency to migrate caudally or cranially. The third lumbar location was a safe landing zone in 476 of 500 (95.2%) cases (Figs. 1 and 2). Anatomic anomalies affecting IVC filter placement were present in 47 of 500 (9.4%) cases (Figs. 3, 4, and 5).

Discussion

Traumatic injury is one of the leading causes of death worldwide. Common complications in trauma patients include bleeding, deep venous thrombosis, and pulmonary embolism. The challenge for clinicians is to balance VTE chemoprophylaxis with the risk of bleeding. In many traumatized patients such as those with traumatic brain injury, spine or spinal cord injury, or coagulopathy, the risk of bleeding is high and an IVC filter may be indicated.

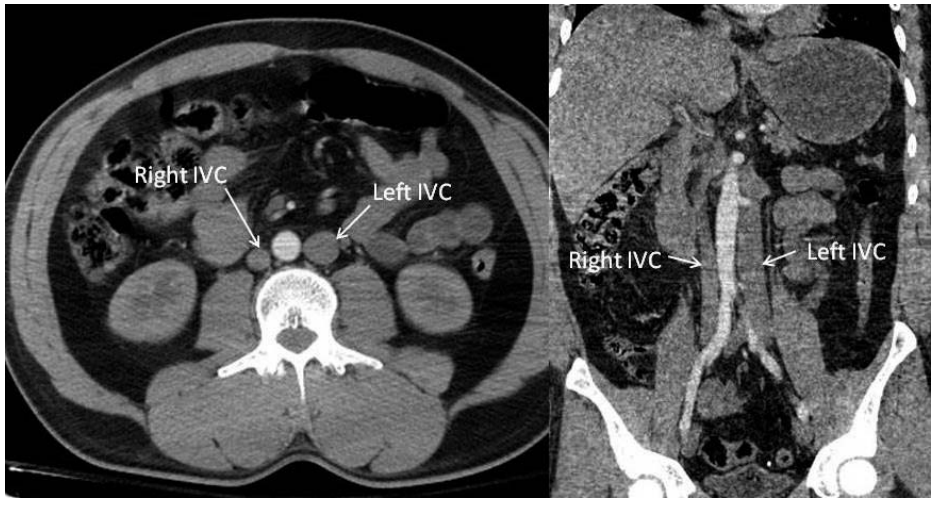

Fig. 4 Patient with duplicate IVC. Left: Axial CT shows right and left IVCs adjacent to the aorta. Right: Coronal reformats confirm the duplicated IVC.

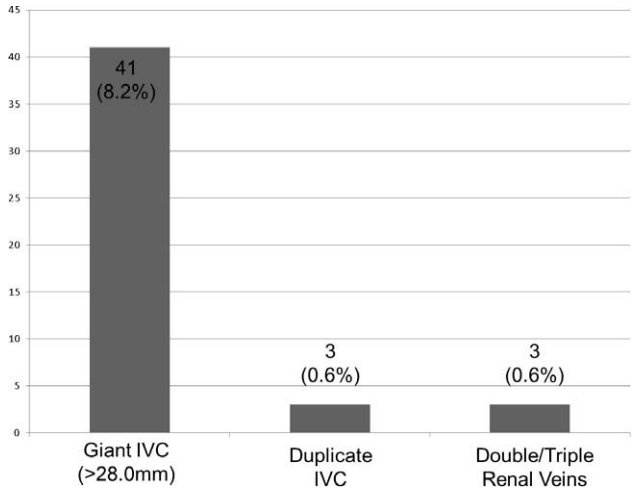

Fig. 5 Figure 5 reveals the frequency of IVC anatomic anomalies.

In developed countries an admission CT is commonly utilized in trauma patients to look for or define injuries. The purpose of this research was to determine if the admission abdominal/pelvic CT on trauma patients could be used to evaluate the IVC anatomy as a novel screening method to facilitate potential IVC filter placement.

In our study the majority of severely injured trauma patients had an admission abdominal/pelvic CT. The vast majority of abdominal pelvic admission CTs was of sufficient quality to analyze the IVC anatomy. CTs with or without intravenous contrast could be used with equal ease to evaluate the IVC. When utilizing an IVC filter it is normally placed infrarenal, as filters have the potential to migrate. Most filters are approved for use in IVCs with a diameter $\leq$ 28 mm.[7]

Our study found a number of anatomic anomalies that would impact the placement of an IVC filter. Most commonly we found that more than 8% of patients had a giant IVC (Figs. 3 and 5). Giant IVCs—defined as $>$ 28 mm in diameter—require special filters approved for use in these circumstances.

Another anatomic anomaly we encountered was duplicate IVCs (Figs. 4 and 6). This occurred in 3 of the 500 cases. There is potential for this to be overlooked during a routine venogram as only the IVC on the side of the venogram might be visualized. A duplicate IVC requires a change in treatment: An IVC filter must be placed in each of the 2 inferior vena cavae (Fig. 6).[8,9]

The final anatomic anomaly we encountered was double or triple renal veins. This anomaly was coupled with at least one circumaortic renal vein in each of the 3 cases. Such an anomaly is commonly missed with a venogram.[10] This presents potential problems during filter placement. If the filter is placed above one of the renal veins, the potential for thrombosis exists with resultant renal dysfunction. It would also be possible for an embolus to travel around an improperly placed filter. Another potential complication, if this anomaly is not recognized with the venogram, is placement of the filter at the level of the renal vein with malpositioning.[11,12]

There is also a potential advantage. Having preprocedure knowledge of the anatomy may lead to lower intravenous contrast use for those patients getting an IVC filter. Contrast-induced nephropathy

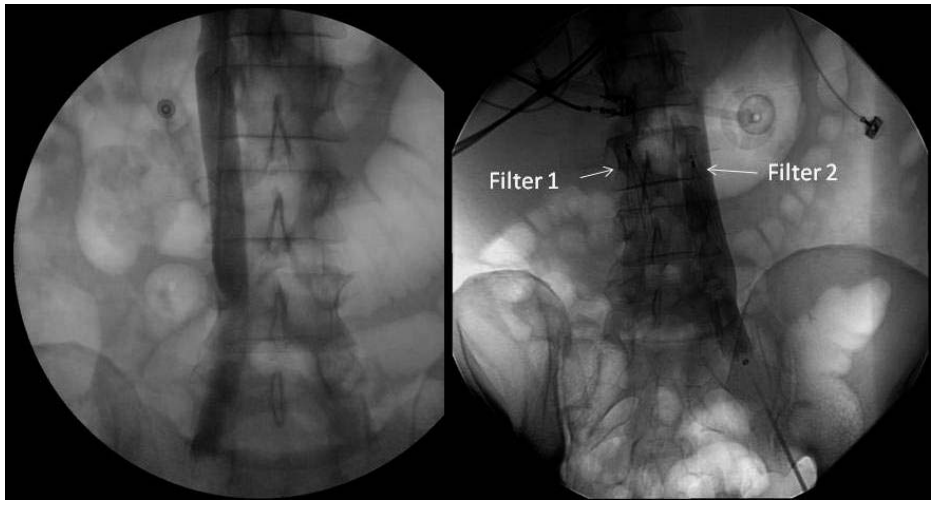

Fig. 6 Duplicate IVC. Left: Axial CT of duplicate IVC. Right: Coronal reformat of duplicate IVC.

occurs in approximately 5% of patients and goes up to 11% in diabetic patients with impaired renal function.[13–16] Although not specifically studied in this manuscript, at our institution IVC filter placement is frequently accomplished with 5–10 mL of intravenous contrast in high-risk patients.

There were several limitations of this study. This was a retrospective analysis and the possibility for selection bias exists. Our analysis is specific to trauma patients who had an admission abdominal/pelvic CT. Also, we only looked at the CTs for potential placement of an IVC filter and CTs were not compared to venograms, which limits our ability to provide either sensitivity or specificity analysis. Finally, this was a single institution study utilizing a high-quality CT scanner.

We conclude that a high quality admission abdominal/pelvic CT on more than 96% of trauma patients can be used to determine a potential IVC filter landing zone. High-quality CT scans may also have some advantages over the gold standard venograms in identifying anatomic anomalies. The third lumbar region of the IVC was a safe landing zone in more than 95% of patients. Anatomical anomalies affecting IVC filter placement were revealed in 9.2% of the trauma patients reviewed.

Acknowledgments

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