Gunshot wound causing penetrating injury to the inferior vena cava treated with open cell self-expanding stents

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ABSTRACT

Endovascular stents are predominantly utilized for intra-arterial interventions; however, their application in managing venous injuries, especially traumatic ones, lacks comprehensive guidelines and long-term outcome studies. This case report discusses the innovative deployment of an infrarenal inferior vena cava stent for a traumatic inferior vena cava injury after a gunshot wound in a polytrauma patient. This case aims to enhance the existing evidence on the feasibility and potential outcomes of endovascular stenting in traumatic venous injuries. (J Vasc Surg Cases Innov Tech 2024;10:101565.)

Keywords: Vascular trauma; IVC; Stent; Wounds; Gunshot

The inferior vena cava (IVC) can be compromised in 0.5% to 5.0% of penetrating abdominal traumas, presenting significant clinical challenges with mortality rates of ≤50%.[1] Prognosis largely depends on the injury's location, extent, and concurrent injuries.[2,3]

Traditionally, open surgical intervention, including venorrhaphy or ligation, has been the standard of care for penetrating IVC injuries.[4] Despite advancements in surgical techniques and perioperative management, these approaches remain linked to high morbidity and mortality.[5]

This report contributes to the sparse literature, providing insights into the selection, deployment, and complications associated with venous stenting in traumatic IVC injuries. It explores the critical differences in handling venous vs arterial stenting, emphasizing the challenges posed by the distensibility of veins compared with arteries. This analysis aims to highlight the potential complications associated with suboptimal stent selection, including stent migration, thrombosis, venous hypertension, and its morbidities.[6]

CASE REPORT

A 26-year-old man was admitted to the emergency department after multiple gunshot wounds. He arrived with systolic blood pressure ranging between 80 and 90 mm Hg, after receiving 4 U of packed red blood cells per emergency medical services personnel. Despite the hypotension, the patient was alert with a Glasgow Coma Scale score of 15.

A trauma assessment revealed a 1- to 2-cm wound in the right upper quadrant with protruded omentum and a positive Focused Assessment with Sonography for Trauma in bilateral upper quadrants. Additional punctate wounds with an ankle deformity were noted on the left lower extremity. Persistent hypotension prompted the initiation of a massive transfusion protocol.

The patient underwent an emergent exploratory laparotomy, and significant hemoperitoneum was evacuated, revealing a large nonexpanding right-sided retroperitoneal hematoma and suspected injury to the infrahepatic/infrarenal vena cava at the confluence. Four small bowel injuries were identified, requiring resection. After hemodynamic stabilization, a computed tomography angiography was performed for better characterization of the retroperitoneal injury, detecting small contrast blushes around the infrarenal IVC, indicative of a penetrating injury (Fig 1).

Twenty-four hours after the initial surgery, a decrease in systolic blood pressure raised concern for enlarging retroperitoneal hematoma. Given a known IVC injury on computed tomography scan, he was taken to the angiography suite for endovascular repair of the IVC. Through bilateral femoral vein access using 10F sheaths, a venogram revealed active extravasation from the infrarenal IVC at the confluence of the common iliac veins (Fig 2), making surveillance and tamponade unfeasible and open surgical intervention challenging. In addition, owing to the risk of occluding a unilateral iliac vein with a covered stent, we opted to place two open-cell self-expanding bare metal Medtronic (Dublin, Ireland) Abre 18 × 60-mm stents in kissing fashion in the bilateral common iliac veins extending into the IVC. This approach aimed to scaffold the vein confluence while maintaining vein patency. Subsequent imaging confirmed the cessation of contrast extravasation (Fig 3).

Subsequent surgeries involved posterior lumbar fusion, left tibia and fibula external fixation followed by open reduction internal fixation, and management of abdominal injuries including serial pancreatic debridement performed for partial

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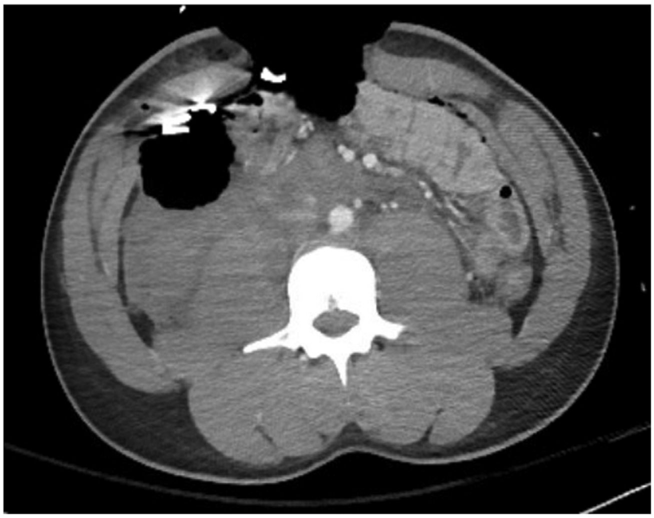

Fig 1. Preoperative computed tomography angiogram demonstrates a small blush of contrast at the injury level, suggestive of an inferior vena cava (IVC) injury.

Fig 2. Intraoperative Cavogram, shows contrast extravasation at the site of the inferior vena cava (IVC) injury indicating active bleeding.

necrosis and duodenal perforation identified on take back after bile staining noted, treated by resection and duodenojejunostomy. A left common femoral vein filling defect, nonocclusive, was detected 10 days postoperatively, leading to anticoagulation therapy. Subsequent imaging showed resolution of the defect, and the patient was discharged on anticoagulation. As of this report, the patient is alive with no complications from the IVC stent, which remains patent on imaging done approximately 2 months postoperatively. Patient consent has been obtained in written form for publication.

Fig 3. Poststenting intraoperative Cavogram displays the properly sealed inferior vena cava (IVC) injury after stenting, confirming successful intervention.

DISCUSSION

Traumatic injuries to the IVC comprise approximately 30% to 40% of penetrating abdominal vascular injuries and are associated with mortality rates of >50%, despite advancements in trauma medicine and surgical techniques.[7,8] The incidence of iatrogenic IVC injuries is increasing with the complexity of surgical procedures, notable during advanced intra-abdominal, laparoscopic, or spine surgeries, which persistently result in high morbidity and mortality.[9,10]

The deep positioning and incompressibility of truncal veins pose significant challenges for immediate control during open surgical repair, increasing the risk of mortality.[11] Additionally, the morbidities associated with ligating central veins include acute compartment syndrome of the lower extremities, post-thrombotic syndrome, and increased mortality and underscore the limitations of conventional surgical approaches.[12,13] As a less invasive alternative, endovascular stenting offers temporary and permanent solutions for controlling hemorrhage and decreasing surgical exposure and associated risks, thereby enhancing patient outcomes.[14]

Endovascular stent repair for venous injuries remains underdocumented and understudied, with existing devices primarily designed for arterial conditions.[15,16] Current reports predominantly detail the use of intraluminal balloon catheters as temporary measures to stabilize patients until venorraphy is conducted. Additionally, the deployment of covered stents is noted for effectively sealing vascular defects, offering rapid hemorrhage control, decreasing the likelihood of vascular dissection, and mitigating resultant coagulopathy.[17-19]

Covered stents offer immediate exclusion of the targeted vessel segment and offers superior long-term patency rates compared with bare metal stents.[20] However, their larger size can complicate handling and delivery, potentially causing occlusion of branch vessels, as well as increased risks of stent fracture and migration. Moreover, selective vein cannulation, including renal and hepatic veins, before stent deployment, significantly heightens the technical complexity of using covered stents for venous injuries.[16]

In this case, opting for Medtronic ABRE open cell self-expanding stents was essential owing to the injury's location at the confluence of the iliac veins, where using a covered stent would have risked compromising the contralateral vein. The ABRE stents successfully sealed the injury, as demonstrated on follow-up imaging, without obstructing adjacent vascular pathways. Furthermore, there was concern for infection owing to an intestinal injury close to the IVC. Covered stents, with their associated graft material, potentially could be seeded with bacteria from the intestinal injury, leading to stent infection. The use of the ABRE stent provided a safer alternative that is more resistant to potential infection.

Managing traumatic injuries to the IVC presents several challenges. First, the low-pressure nature of the IVC can complicate injury detection using conventional contrast imaging. Given the IVC's large diameter, selecting the appropriate stent size is crucial, with injuries at the confluence posing particular challenges owing to potential obstruction issues with covered stents.

The use of Medtronic Abre stents in this case was particularly effective owing to their specific design features. The distensibility of the Abre stents is well-suited for the low-pressure venous system, making extravasation less likely to occur and allowing for a secure seal of the injury. This adaptability ensures that the stents conform to the vessel walls, effectively sealing the injury site. These characteristics make Abre stents an excellent choice for managing traumatic IVC injuries, decreasing the risk of complications such as thrombosis and migration. Additionally, identifying critical branches like the renal and hepatic veins in cases of superior IVC injuries is difficult, often requiring the use of intravascular ultrasound examination for accurate visualization and intervention. Postoperatively, careful management with antiplatelet or anticoagulation therapy is essential to ensure stent patency and prevent complications.[21]

CONCLUSIONS

Current practices in venous stenting are largely extrapolated from experiences with arterial stenting, which may not always be applicable owing to the unique characteristics of the venous system, such as its distensibility, low-pressure system, and larger size. Confluence injuries can be managed successfully with open cell self-expanding stents in kissing overlap fashion if the injury is focal and not large.

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DISCLOSURES

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