Endovascular repair of a traumatic inferior vena cava injury after exploratory laparotomy

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ABSTRACT
The incidence of traumatic inferior vena cava (IVC) injury is infrequent but is associated with high mortality. No clear and current society-based guidelines are available to dictate the role of endovascular therapy. In the present case report, we have described a unique clinical presentation of a patient in extremis after emergent exploratory laparotomy who had experienced an IVC injury that could not be controlled with open surgery. The IVC injury was treated with an endovascular approach with a Core TAC endograft (W.L. Gore & Associates, Flagstaff, AZ). We have reported a technique for successful treatment of a complex IVC injury, with the aim of adding to the current body of literature supporting the use of endovascular approaches. (J Vasc Surg Cases Innov Tech 2022;8:694-7.)

Keywords: Endovascular; EVAR; IVC injury; Trauma

Traumatic injury to the inferior vena cava (IVC) is rare, with a prevalence of only 0.6% to 1% after blunt trauma and 0.5% to 5% after penetrating trauma.1,2 Although infrequent, mortality has remained high, both before arrival and at discharge, with mortality rates reported as high as 50%.3 Traditionally, open surgery has remained the standard of care for IVC injuries. A paucity of literature is available regarding the treatment alternatives, including conservative management.3 No clear society-based guidelines are available to dictate the role of endovascular therapy for IVC injuries.4-6

We have presented a unique, complex clinical situation in which an endovascular stent graft was used for traumatic injury of the IVC and described the innovative role of endovascular management of an IVC injury. The patient provided written informed consent for the report of his case details and imaging studies.

CASE REPORT
A 40-year-old man had arrived as a patient with priority 1 trauma after sustaining multiple gunshots to the chest, abdomen, and pelvis. Shortly after arrival, the trauma surgical team performed resuscitative thoracotomy and emergent exploratory laparotomy. The patient had also undergone spleenectomy, direct repair of enterotomies, and gastrotomy. A traumatic IVC injury within the suprarenal segment was noted. Abdominal packing was placed with particular attention to the retrohepatic space. Temporary abdominal closure was performed, and our mass transfusion protocol was continued. The patient was then transferred to the surgical trauma intensive care unit for continued resuscitation. Despite these repairs, the patient continued to have high sanguineous output from his abdominal wound (Table) and had become hemodynamically unstable at 7:12 AM the following morning. The patient had developed a noticeable hemoperitoneum and increasing drain output.

Thus, vascular surgery was consulted for recommendations for a presumed retrohepatic IVC injury in this hemodynamically unstable patient. The case was discussed at a multidisciplinary team meeting consisting of trauma/critical care surgery, vascular surgery, radiology, and cardiology/endovascular lead. The decision was made in the best clinical interest of the patient to take him emergently for an IVC venogram with possible repair of the suspected retrohepatic IVC. The decision was made to proceed to our institution’s semihybrid circulatory dynamics laboratory, which was activated at 7:34 AM the same morning. The massive transfusion protocol was continued, and the hemodynamics were supported with vasopressors.

At 7:52 AM, ultrasound-guided access of the right femoral vein was obtained, and an 8F sheath was placed. An IVC venogram was obtained using a power injector through a 5F Omni flush catheter. The initial venogram did not reveal any apparent blush within the retrohepatic IVC. The catheter was retracted, and an imaging series was obtained using undiluted contrast, which revealed substantial blush within the suprarenal IVC (Figs 1 and 2). Angiographic sizing of the IVC is complex, and the diameter of the IVC can vary with the respiration and hemodynamic status of the patient.7,8 An intravascular ultrasound (IVUS) probe (Eagle Eye platinum digital IVUS with third-generation peripheral probe and catheter; Philips Volcano, San Diego, CA) was advanced into the IVC, and measurements were taken at the proximal and distal sites of the IVC injury. Based on the size
discrepancy and the proximity of the injury to the renal veins, we
decided that the best option would be to use a Gore TAG 28.5-
mM/3.3-cm endograft cuff (W.L. Gore & Associates, Flagstaff,
AZ), which was approximately 12% larger than the maximum
diameter of the IVC measured using IVUS. The table was locked
and the screen marked with the locations of the renal veins and
IVC injury. A 20F Gore DrySeal sheath (W.L. Gore & Associates)
was exchanged, deployment was performed, and a completion
venogram was obtained, which showed tilting of the first cuff
with an incomplete seal and continued blush. The renal veins
were fully visualized and showed a sufficient landing distance
to support further endograft placement, and a second Gore
TAG endograft cuff (28 x 4.5 cm) was deployed, and a complete
seal was obtained. The completion venogram showed resolution
of the blush. The access site was closed using a monofila-
ment figure-of-eight cutaneous stitch with direct pressure for
10 minutes, and hemostasis was obtained.

A coagulation panel was ordered, and the patient was
returned to the trauma intensive care unit at 9:34 AM for further
resuscitation. The patient remained hemodynamically stable
overnight and was returned to the operating room for abdom-
inal washout the next day. The total operative case time was
55 minutes. At 2 weeks postoperatively, a follow-up computed
tomography scan showed no stent graft migration or extravasa-
tion around the stent graft. Subsequently, the patient was dis-
charged home after 1 week and advised to follow-up at
30 days at the vascular center. The patient received a 1-month
prescription for daily 75 mg clopidogrel and 81 mg aspirin,
with plans for continuing daily 75 mg clopidogrel for 6 months.

DISCUSSION
We found an endovascular approach repair IVC is
reasonable, given the lack of clear guidelines or extensive
literature in the setting of hemodynamic compromise.
The case we have described has demonstrated a multi-
disciplinary approach to stabilizing a critically ill patient
with a known traumatic injury to the IVC. At his initial
presentation, exploration and repair of the patient’s
visceral injuries were best performed with open surgical
exploration.

Suspected retrohepatic IVC injuries are surgically chal-
 lenging to control. The decision to proceed with
delayed endovascular repair stemmed from the nature of
the patient’s instability. In the setting of traumatic
cogulopathy, the risk of decompensation and further
hemorrhage outweighed the risks of re-exploration. Additionally, the placement of abdominal laparotomy
pads to tamponade could have disrupted the peritoneal
bleeding further and caused repeat bleeding in the setting of re-exploration. Likewise, the previous repair of the IVC was likely coupled with a second injury arising from the posterior wall of the IVC that could not be easily repaired conventionally.

**TIPS AND TRICKS**

Endovascular stent graft placement of the IVC should be performed after precise measurement of the IVC from IVUS. The IVC diameter can vary depending on the volume status, hemodynamic changes such as shock or sepsis, and the patient’s breathing pattern. Undersizing the covered stent graft or deploying undersized, covered stents can result in device embolization to the right atrium or right ventricle, myocardial damage, and pericardial effusion. Such embolization will occur explicitly when the patient’s volume status and hemodynamics resolve and the IVC has expanded to its average diameter. The diameter of the endograft should be moderately oversized, and most manufactures have recommended oversizing by 5% to 20%. In these complex clinical situations, we would recommend IVUS measurement during active resuscitation to best reduce the risk of undersizing the endograft. The length of the endograft should be long enough to cover the injury and yet not obstruct the renal veins, hepatic veins, or contralateral common iliac veins.

Although we achieved an excellent result with the present case, careful multidisciplinary case planning, appropriate device selection, angiography, and IVUS interpretation are essential. Follow-up computed tomography scans at 2 weeks demonstrated no apparent stent migration. Another limitation of this approach is the infection risk resulting from the placement of synthetic material in a contaminated surgical abdomen. Long-term, broad-spectrum antibiotics are recommended during admission. At the last follow-up, our patient had not demonstrated any clinical signs of infection.
CONCLUSIONS
We have reported our experience with stabilizing a critically ill trauma patient. Endovascular stent grafts are suitable for repairing a traumatic IVC injury as an alternative to open repair.

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