Endovascular repair of an actively hemorrhaging gunshot injury to the abdominal aorta

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Endovascular stents have had a limited role in the management of trauma and vascular emergencies involving active hemorrhage. We describe a patient with delayed rupture of the infrarenal aorta after intra-abdominal sepsis caused the breakdown of a primary aortic repair. A stent-graft repair was performed, as concomitant injuries did not allow anterior access to the aorta. This report describes the successful endovascular repair of an actively hemorrhaging penetrating abdominal aortic injury. Endovascular approaches to aortic injuries may be valuable in settings where a hostile abdomen precludes traditional open repair. (J Vasc Surg 2005;42:1007-9.)

Vascular injuries resulting in major arterial hemorrhage generally require open repair. In the extreme case of traumatic aortic hemorrhage in the presence of a hostile abdomen, endovascular approaches may be considered. We present a patient with multiple abdominal gunshot wounds who developed massive hemorrhage from the infrarenal aorta 2 weeks after initial laparotomy. After attempts at conventional repair were frustrated by severe visceral fibrosis, hemostasis was achieved with deployment of a covered stent over the affected aortic segment.

CASE REPORT

A 22-year-old man had three gunshot wounds to the left posterior flank. Abdominal plain x-ray films revealed two retained bullets, one in the right upper quadrant and a second to the left of the L3 vertebral body. At laparotomy, the injuries found were a 2-cm laceration of the superior mesenteric vein, a small shrapnel injury of the infrarenal abdominal aorta, a blast injury of the third portion of the duodenum, a through-and-through injury of the transverse colon, and multiple small bowel enterotomies. All bowel injuries were primarily repaired, as was the superior mesenteric vein. The aortic injury was stabilized with a side-biting clamp and then suture repaired with pledgets. The abdominal contents were temporarily covered with a sterile plastic drape.

On postoperative day 1, a planned re-exploration was performed. The third portion of the duodenum was resected, and a duodenojejunal anastomosis was performed. Several additional enterotomies were repaired. Subsequently, the patient became febrile and was thus explored again on postoperative day 3. Leakage of stool from the transverse colon injury was found. The area was resected and an ascending end colostomy created, leaving a long, blind distal segment. The abdomen was left open and covered with a vacuum-assisted closure device (VAC, Kinetic Concepts, Inc, San Antionio, Tex), which was changed every 3 days. Blood cultures from this period grew only coagulase-negative *Staphylococcus.*

Two weeks after the initial injury, the abrupt onset of massive abdominal hemorrhage and hemodynamic instability was noted. Arterial blood was seen issuing circumferentially about the matted viscera. Initially, direct pressure was applied to the abdominal contents, and the left retroperitoneal area was packed. An open repair of the aorta was attempted, but because of extensive adhesions and edematous viscera, there was no anterior or retroperitoneal access to the source of hemorrhage.

Arteriography was performed, which revealed extravasation of contrast from the anterior aspect of the aorta in the infrarenal segment (Fig 1, *A*). The appearance was consistent with that of a ruptured mycotic pseudoaneurysm.

Because we were unable to expose the aorta by using traditional operative approaches, an emergent endovascular repair was undertaken in the operating room, using the Zenith intravascular aortic stent-graft system (Cook Group Inc, Bloomington, Ind). A 10F sheath was placed into the left common femoral artery, and an 18-mm-diameter × 55-mm-long iliac extension limb was introduced through this. The device was deployed with proximal fixation just below the level of the renal arteries (Fig 1, *B*), resulting in cessation of hemorrhage. Mild residual filling of the aneurysm cavity was found on postdeployment angiography. This resolved after serial dilatation of the graft with a 20-mm balloon.

The patient remained critically ill for several months. He had intermittent fevers that responded to broad-spectrum antibiotic therapy. Multiple intra-abdominal fluid collections developed, including one adjacent to the aorta, which were treated with percutaneous drainage (Fig 2). A low-output duodenocutaneous fistula developed and was managed nonoperatively. The abdominal fascia and soft tissues underwent gradual staged closure.

The patient was discharged home after 3 months of inpatient care. Renal function was normal. One year after his initial injury, the patient returned in good condition for colostomy takedown. His recovery from this procedure was uneventful.

DISCUSSION

Blunt and penetrating injuries to the aorta are associated with a high mortality rate, and attempts at conventional open

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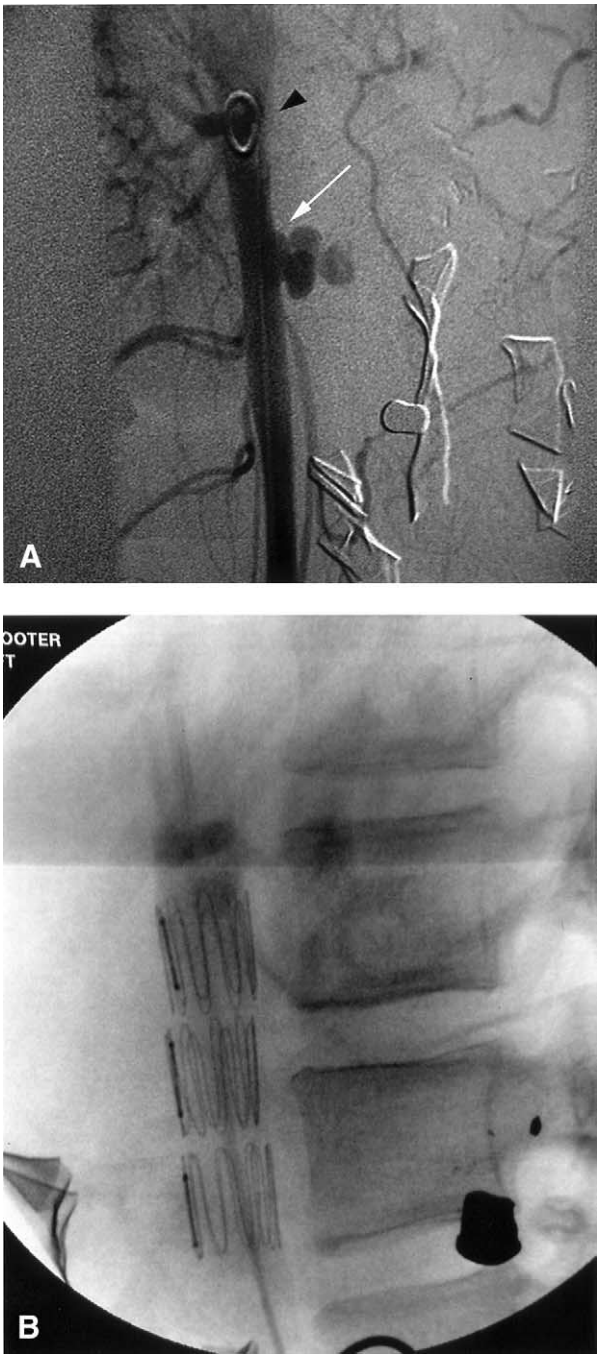

Fig 1. A, A lateral aortogram shows contrast extravasation from the anterior aspect of the infrarenal abdominal aorta *(white arrow)*. The tip of the pigtailed catheter is positioned at the level of the renal arteries *(black arrowhead)*, with two large lumbar vessels seen to arise inferiorly. **B,** A lateral completion image shows the aortic stent-graft extension cuff deployed at the level of the L2-L3 vertebral bodies.

repair are generally mandated.[1,2] This is particularly true in the presence of concomitant injuries or active hemorrhage, with or without hemodynamic instability. With rare exception, reports of endovascular repair of abdominal aortic injuries

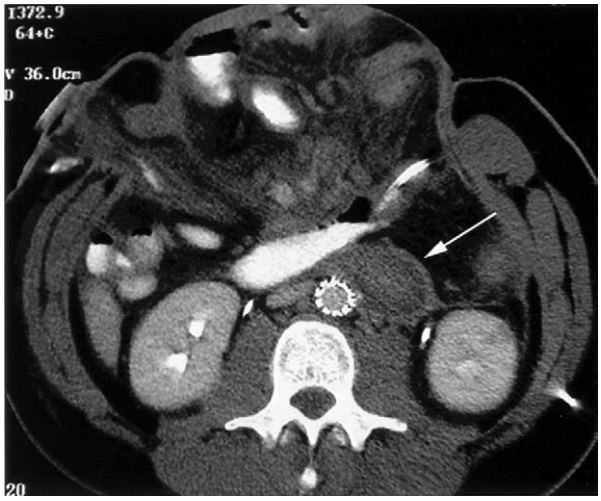

Fig 2. A contrast-enhanced computed tomography scan shows a rim-enhancing fluid collection *(white arrow)* adjacent to the endovascular prosthesis.

have thus far been confined to cases where pseudoaneurysms, traumatic arteriovenous fistulae, or dissections were treated with stent grafting in hemodynamically stable patients.[3-7] Scharrer-Palmer et al[8] reported the successful endovascular repair of an actively hemorrhaging infrarenal aortic rupture 6 days after blunt trauma, and there appears to be a growing role for endovascular therapy in the treatment of blunt thoracic aortic trauma.[9-11] In contrast to these reports, we describe the use of endovascular techniques to address delayed hemorrhage after penetrating aortic injury.

The presence of multiple concomitant severe visceral injuries played a central role in this patient's management. Although the aortic injury was primarily repaired, trauma to the large and small bowel resulted in intra-abdominal infection and probable mycotic degeneration of the vascular suture line. The extent of the injuries made abdominal closure impossible. The ensuing visceral fibrosis that occurred over a period of 2 weeks precluded open aortic repair at the time of delayed rupture, leaving an endovascular approach as the only option.

Traumatic pseudoaneurysms of the aorta can form weeks to years after penetrating injury. They are associated with a significant rupture risk, and such events are generally fatal.[12] Prophylactic endovascular exclusion of traumatic aortic pseudoaneurysms has been reported by two groups,[6,7] both of whom identified the lesions on surveillance imaging. Miller et al[12] have reported successful open repair of a ruptured aortic pseudoaneurysm after gunshot injury. Endovascular stent grafts have been used to treat penetrating atheromatous aortic ulcers in hemodynamically stable patients.[13,14] Aortic extension cuffs, which are similar to the iliac extension limb used in the present report, have been used to treat a ruptured thoracic aortic aneurysm.[15] Proximal endovascular balloon occlusion, which may have been a useful adjunct in this case, is a measure that

we have used to achieve temporary hemostasis in other patients with penetrating arterial injuries.

We have followed this patient for over a year. He has had no fevers or other indications of a stent-graft infection. This is despite the development of infected retroperitoneal fluid collections and an enterocutaneous fistula adjacent to the graft. The possibility of a latent infection remains, and it is known that endovascular graft infections can often have a delayed and nonspecific presentation.[16] Another caveat is that the long-term durability of endografts remains uncertain. For these two reasons, close follow-up of these patients, with serial imaging, should be performed whenever possible. Although we had planned to image this patient every 6 months, he did not comply with our instructions.

Given the long-term infection risk and durability concerns associated with endografts, open repair of aortic injuries remains the standard of care. Endovascular interventions may, at this point, best serve to stabilize patients in the short-term as a bridge to definitive open repair.

Our report is conceptually similar to another by Wyers et al,[17] who described endovascular stent-graft repair of an iatrogenic injury to the common carotid artery in a hostile neck. Though this case represents an extreme scenario, we believe that endovascular approaches can be highly favorable—and occasionally the only option—in the treatment of vascular injuries that occur in otherwise poorly accessible operative fields. Thus, we recommend that vascular surgeons associated with trauma centers be adequately trained in these techniques. As commercial endografts become more widely manufactured, we anticipate that it will be more feasible for trauma centers to have them available for situations similar to the one described here.

CONCLUSION

Endovascular approaches to aortic injuries may be valuable in settings where a hostile abdomen precludes traditional open repair. Even in the presence of active hemorrhage after penetrating trauma, such techniques can be lifesaving.

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