Endovascular Stent-Graft Placement for Treatment of Traumatic Penetrating Subclavian Artery Injury

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Civilian vascular trauma has increased over the past decade with a concurrent surge in the use of firearms. Penetrating trauma accounts for approximately 90% of arterial injuries. These are often difficult to diagnose and treat.1,2 Early descriptions of the diagnosis and management of traumatic vascular injuries came from both military and civilian trauma surgeons.3,4

Trauma patients frequently have multiple injuries, complicating routine approaches to vascular repair. Acute subclavian artery injuries, which are now appearing more frequently in trauma centers as trauma care is regionalized, are especially difficult to treat because of the difficulty in obtaining adequate exposure even when the injury is isolated.5 Endovascular stent-graft placement offers a new and less invasive technique for the treatment of acute traumatic vascular injuries. We present a patient with traumatic disruption of the subclavian artery whose injury was successfully managed with an endovascular stent-graft.

CASE REPORT

A 22-year-old man suffered two gunshot wounds to the head in a gang-related shooting. The patient was brought into the emergency room with a Glasgow Coma Scale score of 4, heart rate 94, blood pressure 92/70 in left arm and 90/70 in right arm. There was no movement of his bilateral upper or lower extremities. Initial management included intubation and fluid resuscitation. On secondary survey, the patient had two gunshot entrance wounds: to the right postauricular and right parietal region. He had flaccid rectal tone and a pulseless left upper extremity. A trauma chest radiograph revealed a bullet projecting over the left shoulder, a left apical cap, and fluid in the left supraclavicular region.

After the chest radiograph was completed, the patient developed a left supraclavicular mass. The patient remained hemodynamically stable and was taken for a computed tomographic scan of the head and neck. The images revealed a small right temporal epidural hematoma without bullet penetration of the skull, multiple cervical vertebral fractures involving the spinal canal, and a soft tissue swelling in the left supraclavicular region.

The patient remained hemodynamically stable and underwent emergent arch aortography with selective left subclavian arteriography. This image showed extravasation of contrast medium from the left subclavian artery adjacent to the bullet consistent, with a through-and-through type injury (Fig. 1). The decision was made by the trauma and vascular surgeons and the interventional radiologists to attempt emergent endovascular stent-grafting of the injury.

Initially, a 5 French pigtail catheter was introduced through the left common femoral artery into the ascending aorta. After the aortogram, the pigtail catheter was exchanged for a 5 French Berenstein catheter to facilitate selective catheterization of the left subclavian artery. The left subclavian artery injury was visualized on arteriography, and a 0.035-inch angled tip guide-wire (Glidewire, Meditech, Watertown, Mass) was used to cross the injured area.

Then a 12 French, 80-cm long angiographic sheath was advanced over the guidewire and placed across the left subclavian artery injury. Next, a 12-mm diameter, 45-mm long Gianturco Z-stent (Cook, Inc., Bloomington, Ind) covered with polytetrafluoroethylene graft material (Impra, Inc., Tempe, Ariz) was loaded into the sheath and introduced under fluoroscopic guidance. Subsequently, to completely cover the injury, a similarly constructed 12-mm diameter, 60-mm long, stent-graft was deployed within the left subclavian artery overlapping the previous stent.

After placement of the stent-grafts, excellent flow was fluoroscopically apparent without evidence of extravasation of contrast medium (Fig. 2). Subsequently, a complete arteriogram of the left arm was obtained, which revealed a short segmental occlusion of the distal left brachial artery with excellent reconstitution of the radial, ulnare, and anular arteries. The previous pulseless left radial artery now had a palpable pulse. The patient left the angiographic suite in stable condition and was transferred to the intensive care unit. Seven weeks later, the patient underwent a C6–7 anterior cervical discectomy and fusion performed by the neurosurgery staff. Subsequently, the patient underwent tracheostomy secondary to his C4 quadriplegia and loss of accessory respiratory muscles. After a 3-month...
hospital stay, the patient was transferred to a spinal rehabilitation unit.

**DISCUSSION**

Surgical repair of traumatic subclavian artery injuries is technically demanding because of the anatomic position of the vessel and the propensity for concomitant injuries. Standard surgical exposure techniques involve median sternotomy, posterolateral and anterolateral thoracotomy, often with extrathoracic extension and “book” incisions. These large open operations may add to the overall morbidity and mortality of the trauma patient by prolonging recovery time or injuring adjacent structures. Thus, the development of endovascular stent grafts, initially proposed by Dotter, provides a new less invasive alternative for the repair of traumatic vessel injuries.

There are few data regarding endovascular grafts for acute subclavian artery injury repair. Even less is known about transluminally placed stent-grafts for the treatment of acute penetrating, noniatrogenic arterial injuries. Patel et al., in 1996, described the first series of patients who suffered penetrating subclavian artery injuries that were treated with endovascular stent-grafts. There were six patients in this series, five of whom had injuries related to penetrating noniatrogenic trauma. These five injuries consisted of four pseudoaneurysms and one arteriovenous fistula. Each patient was administered general anesthesia and was prepared and draped for both interventional and surgical repair in the operating room. Subsequently, they underwent successful endovascular repair through access gained through the ipsilateral brachial artery.

We present this case because there is no literature describing endovascular stent graft repair of a traumatic noniatrogenic penetrating subclavian artery transection with acute hemorrhage. Our case is unique because the decision to undergo endarterial repair was made within the angiographic suite within the first hour of the patient’s arrival to the emergency room.

There were several reasons for this decision. First, the patient suffered several vertebral bony injuries starting at the C4 level with an uncertainty of how extensive the spinal cord was damaged. The neurosurgeons and vascular surgeons believed that this injury would be further compromised if the patient was to undergo a wide exposure in the operating room potentially causing destabilization of the head and neck. Second, endovascular stent-graft repair was the most expeditious treatment, because the injury was readily demonstrated and easy endovascular access was available because the selective catheterization of the subclavian artery had already been accomplished. Introducing the stent-graft to cover the arterial defect took only an additional 20 minutes. The vascular surgeons were present for the entire procedure and had the operating room prepared in case the intervention did not work.

The patient underwent successful placement of his PTFE stent-graft by means of distal access through the ipsilateral left common femoral artery. The entire procedure was completed within 1 hour and 55 minutes. Upon follow-up, the patient has excellent patency as evidenced by Doppler at 3-month interval and, clinically, at 12-month interval with blood pressures of 110/70 right arm and 112/68 left arm.

The use of endovascular grafts for the management of penetrating subclavian artery injuries is an excellent alternative to surgical repair if the right conditions exist. These include a hemodynamically stable patient and experienced interventional radiology and vascular surgery teams. This less invasive approach is especially useful in trauma situations in which the patients have multiple injuries. Our approach had...
several advantages over standard operative repair. The procedure is quick, vascular access at a site remote from the primary injury obviates wide dissection in the region of the injured subclavian artery (which might have caused further neurologic compromise in our patient), and there is reduced need for general anesthesia. Although stent-graft repair for arterial trauma seems promising, more published cases and longer follow-up are necessary to evaluate the efficacy of this procedure versus that of standard surgical repair.

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