Penetrating Vertebral Artery Pseudoaneurysm: A Novel Endovascular Stent Graft Treatment With Artery Preservation

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Vertebral artery injuries are rare, accounting for <1% of all vascular injuries.[1] Penetrating neck injuries secondary to gunshot or stab wounds are the most common causes of vertebral artery injury.[2–5] Approximately 1% to 6% of penetrating neck injuries result in a vertebral artery injury.[2–4]

Historically, blunt vertebral artery injury has been uncommon.[6] Recently, Inamasu and Guiot[7] concluded that among blunt trauma admissions, the incidence of blunt vertebral artery injury, estimated to be 0.20% to 0.77%, may be increasing. In two large case series on blunt cerebrovascular injuries, Biffl et al.[6,8] reported that motor vehicle crash is the most common mechanism of blunt vertebral artery injury.

Vertebral artery injuries can present as several different lesions. In a large case review of penetrating (91%) and blunt (6%) vertebral artery injuries, Mwipatayi et al.[5] found the spectrum of vertebral artery injuries to include the following: occlusion (44%), pseudoaneurysm (40%), arteriovenous fistula (AVF) (12%), and dissection (2%). Interestingly, blunt cervical trauma seldom causes pseudoaneurysm formation.[6–8] Biffl et al. used a blunt vertebral artery injury scoring system using five categories: grade I (49–53%) (intimal irregularity or small dissection/intramural hematoma), grade II (19–21%) (large dissection/intramural hematoma or intimal flap or intraluminal thrombus or hemodynamically insignificant AVF), grade III (6–8%) (pseudoaneurysm), grade IV (20–21%) (vessel occlusion), and grade V (0%) (transections or significant AVF).[6,8]

The management of vertebral artery injures depends on the extent of vessel damage. In general, vertebral artery lesions such as narrowing, occlusion, or mild intimal irregularity can be observed and the role of anticoagulation is not clear. Hemorrhage, pseudoaneurysms, and AVF can be managed surgically or angiographically using balloon occlusion or embolization.[1,9–13] Recently, covered stents have been investigated as a treatment modality for traumatically related injuries of the extracranial vasculature.[14–23] There are only three cases in the literature that document success with covered stents in the treatment of traumatic pseudoaneurysms of the vertebral artery.[18,22,23] We report the first documented case of a traumatic vertebral artery pseudoaneurysm, secondary to a gunshot wound, treated successfully with a Jostent (Abbot Vascular, Redwood City, CA) to preserve the vertebral artery. Approval was obtained from our hospital Institutional Review Board to use this stent graft for an off label use before the procedure. Additionally, we received Institutional Review board approval to retrospectively review and report this case.

Submitted for publication September 27, 2006.
Accepted for publication August 16, 2007.

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DOI: 10.1097/TA.0b013e3181589fb6

CASE REPORT

A 30-year-old man presented to our Level I Trauma Center with multiple gunshot wounds to the head, legs, left forearm, right buttocks, and left testicle. Upon arrival, the patient had a heart rate of 81 and blood pressure of 211/147 mm Hg. He was neurologically intact with a Glasgow Coma Scale score of 15. He reported numbness in his left forearm and hand and was found to have no weakness but decreased sensation in all aspects of his left hand. These findings were attributed to the gunshot wound to his left forearm. His diagnostic work up included a soft tissue computed tomography (CT) scan of his neck, which revealed multiple bullet fragments in close proximity to the left jugular vein and left vertebral artery at the level of C1–C2. The patient was considered to have a high probability of a vascular injury. Additional work up revealed no intracavitary injuries. However, his complex scrotal injury required operative management, including insertion of a suprapubic catheter for a complex urethral injury.

A diagnostic angiogram performed on admission demonstrated a small left vertebral artery pseudoaneurysm (4 mm) at the level of C2 vertebral body (Fig. 1). There was also a focal nonocclusive intraluminal thrombus in the distal left vertebral artery ~3.5 cm proximal to the origin of the basilar artery. In addition, there was a focal tortuosity and spasm just proximal to the area of the pseudoaneurysm. The uninjured right vertebral artery was found to be the dominant artery supplying the basilar artery.

Because of the intraluminal thrombus, focal spasm in the left vertebral artery, and absence of injuries precluding anticoagulation, the patient was started on systemic intravenous (IV) heparin therapy immediately after the initial angiogram. Consideration was given to placing a stent graft during the initial angiogram but there was concern about dislodging

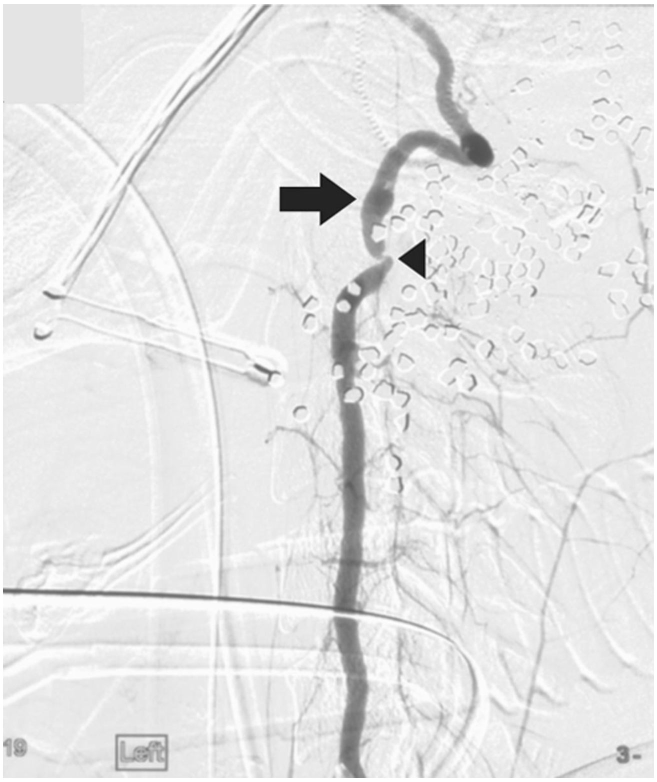

Figure 1. Initial angiogram shows a 4 mm pseudoaneurysm (*arrow*) proximal to a nonocclusive intraluminal thrombus and distal to a focal vessel spasm (*arrowhead*).

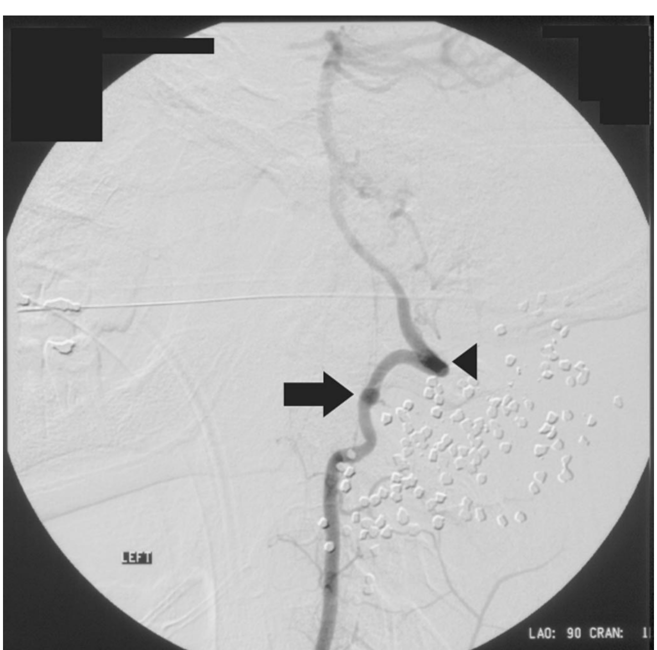

Figure 2. Second angiogram at 24 hours. The pseudoaneurysm (*arrow*) and residual clot (*arrowhead*) were still present. The focal spasm seen on day 1 had resolved.

Figure 3. Third angiogram at 1 week. The pseudoaneurysm (*arrow*) had increased to 6 mm. The original thrombus had resolved.

the thrombus and contributing to a stroke. After the initial angiogram, a follow-up brain computed tomography displayed no evidence of stroke. A repeat angiogram was scheduled in 24 hours to reassess the pseudoaneurysm for evidence of resolution, expansion, or thrombosis of the vertebral artery.

On follow-up angiogram 24 hours later, the spasm had resolved, the small residual clot was still present, and the pseudoaneurysm was unchanged (Fig. 2). The patient was maintained on systemic IV heparin for 4 days followed by 2 days of 75 mg/d oral clopidogrel and 325 mg/d acetylsalicylic acid. There were no changes in his clinical examination or complaints.

A third angiogram was performed on hospital day 7. The original thrombus had resolved but the pseudoaneurysm had increased in size from 4 mm to 6 mm (Fig. 3). It was felt that the vertebral artery could be preserved while excluding the pseudoaneurysm by placing a small stent graft.

The patient was given 150 mg oral clopidogrel and 300 mg acetylsalicylic acid 2 hours before angiography and was maintained on IV heparin drip during the procedure. The left vertebral artery was selectively catheterized and a 6-French sheath was advanced to the pseudoaneurysm. After angiographic confirmation, a 3 cm × 12 mm Jostent Graftmaster stent was placed across the pseudoaneurysm and was deployed to 14 atmospheres of pressure (Fig. 4). The Jostent is a balloon expandable covered stent used in the treatment of perforated coronary vessels. The stent graft contains an ultra thin layer of expandable polytetrafluoroethylene (PTFE) graft material sandwiched inside two stainless steel stents.

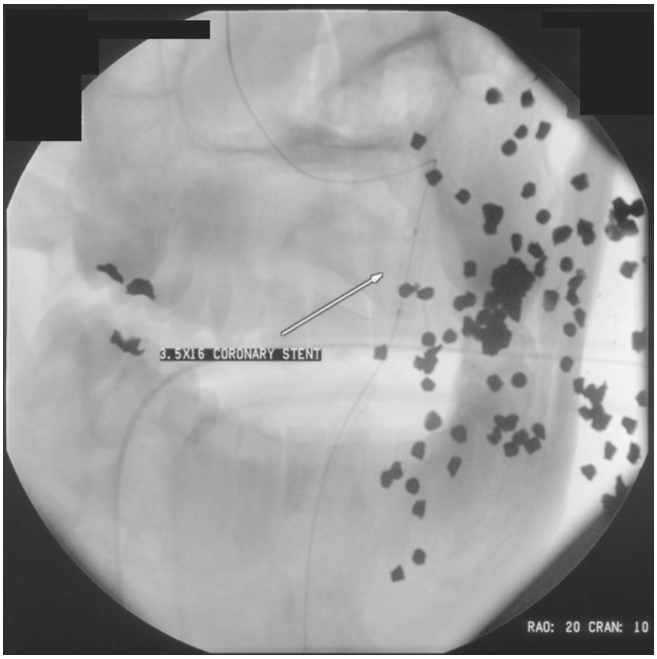

Figure 4. Confirmation angiogram. A 3 cm × 12-mm covered stent (*arrow*) was placed across the pseudoaneurysm.

Figure 5. Angiogram, after stent graft deployment. The lumen of the stent graft was patent as the pseudoaneurysm was successfully excluded. The vertebral artery was preserved.

Diagnostic angiography was performed after deployment and demonstrated complete resolution of the pseudoaneurysm (Fig. 5) and the lumen of the stent graft placed in the vertebral artery was patent with excellent flow. There was moderate spasm present at the proximal aspect of the stent and 50 μg of nitroglycerin was administered intra-arterially with complete resolution. The distal intracranial circulation was patent and normal. Upon awakening from general anesthesia, the patient was found to have no change in his neurologic examination.

Postoperatively, the patient was started on a regimen of 75 mg/d oral clopidogrel and 325 mg/d acetylsalicylic acid. However, because of the patient's scrotal injury, he developed gross hematuria and developed a symptomatic anemia necessitating blood transfusion. Therefore, clopidogrel and acetylsalicylic acid were discontinued 5 days after stent graft placement and for the remainder of his hospital course. No change in his neurologic examination occurred during his hospital stay and this patient did not follow-up in our out patient clinic.

Nine months after discharge, the patient sustained a gunshot wound to the right temporal brain, resulting in a right facial droop. The computed tomography scan of the brain at this time did not reveal any findings attributable to his prior vertebral artery injury. One year after stent graft placement, the patient was ambulatory, moving all four extremities and fluent. The patient continues to have left hand and forearm numbness secondary to the gunshot wound to his left forearm.

DISCUSSION

We describe a case of a 30-year-old man who presented with a high cervical traumatic vertebral artery pseudoaneurysm related to a gunshot wound to his neck. Because of the intraluminal thrombus and focal spasm, the patient was managed medically for 1 week before endovascular treatment. Vertebral artery pseudoaneurysms are often treated with angiographic balloon occlusion, sacrificing the artery proximal and distal to the pseudoaneurysm. Preservation of the vertebral artery with a covered stent (Jostent) was thought to be a reasonable alternative because covered stent grafts have been used in other types of extracranial cerebrovascular lesions.[16–23]

Management of vertebral artery injuries depends on the location and type of lesion. The vetebral artery can be divided into four parts: V1 (origin to C6 transverse process), V2 (C6 to C2), V3 (C2 and skull base), and V4 (intracranial).[5] As previously mentioned, surgical and angiographic intervention can be used to manage hemorrhage, pseudoaneurysms, and AVF.[1,9–13] However, surgical treatment can be difficult in distal vertebral artery lesions (V2,V3).[5] Instead, endovascular intervention has been shown to carry a lower risk of neurologic injury, low recurrence rate, and low morbidity when compared with surgical management of distal vertebral artery injuries.[5]

In our case, we choose to treat the vertebral artery pseudoaneurysm with a covered stent typically used for coronary arteries to help prevent pseudoaneurysm complications (vessel occlusion, AVF, rupture) and subsequent neurologic deficits or death. In the past, vertebral artery injuries were associated with a high mortality rate. In 1893, Matas[24] reported an 80% mortality rate in patients with traumatic vertebral artery injuries. Currently, the mortality rate for penetrating traumatic vertebral artery injuries is about 5%.[9]

The mortality associated blunt and penetrating vertebral artery injuries are similar. Biffl et al.[6,8] found that blunt vertebral arteries carry a 5% to 8% mortality rate, while 5% to 8% of the survivors suffer from severe neurologic deficits.

Advanced screening techniques via imaging have contributed to the decreased mortality associated with vertebral artery injuries perhaps due to earlier detection and treatment. In the past, computed tomographic angiography (CTA) and magnetic resonance imaging were considered less sensitive than catheter arteriography for screening vertebral artery injuries.[25] However, in 2004, CTA resolution greatly improved with the advent of the 16-slice multidetector CT coupled with 3D volume visualization.[26] The following year, Munera et al.[27] demonstrated that helical computed tomographic angiography (HCTA) could replace catheter arteriography for the initial evaluation of stable patients with penetrating neck injuries. Relatively recently, Eastman et al.[25] demonstrated the 16-channel, multislice CTA to be 96% sensitive in the detection of blunt vertebral artery injury. As imaging technology advances, screening vascular injuries will continue to become faster, safer, and more cost effective.

Covered stents have been used to treat vascular injuries including aneurysms (coronary, aortic, and peripheral vessels) and AVF (peripheral vessels).[28–30] Studies have shown stent graft treatment to be a safe and efficacious alternative to conventional surgical methods. In a recent subgroup analysis of stent graft treatment of peripheral aneurysms and vessel injuries, White et al.[30] found the Wallgraft Endoprosthesis (Boston Scientific Corporation, Natick, MA) to achieve similar 1-year patency rates to surgical repair but with less major morbidity and mortality. Although the Jostent is indicated for the treatment of perforated coronary vessels, it has been used successfully in the treatment of other types of traumatic vertebral artery injuries.[20–23] To our knowledge, this is the first documented case a traumatic vertebral artery pseudoaneurysm, secondary to a gunshot wound, treated successfully with a Jostent with preservation of the vertebral artery. Our case adds to the types of injuries that can be successfully treated with a covered stent.[14–23]

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