Thoracic endovascular aortic repair in a case of grade III blunt aortic injury with aberrant vertebral artery origin

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ABSTRACT

Aberrant origin of the left vertebral artery (LVA) can pose a challenge during thoracic endovascular aortic repair. We encountered such a patient who was involved in a motor vehicle accident in whom computed tomography angiography revealed a grade IIIB blunt aortic injury with an anomalous origin of the LVA distal to the origin of the left subclavian artery. On-table aortography confirmed dominance of the LVA. Hence, an open left carotid-vertebral and then left carotid-subclavian artery bypass was performed, followed by thoracic endovascular aortic repair. The patient recovered well and was discharged home 3 days later. (J Vasc Surg Cases and Innovative Techniques 2019;5:235-8.)

Keywords: Thoracic endovascular aortic repair (TEVAR); Vertebral artery revascularization; Carotid-subclavian bypass; Carotid-vertebral bypass; Aberrant origin of left vertebral artery

Aortic transection secondary to blunt aortic injury is the second most frequent cause of death in a motor vehicle crash after head trauma.[1,2] Although this kind of injury was previously treated with thoracotomy, endovascular repair has become the treatment modality of choice. Because of the mechanism of injury at the aortic isthmus, the proximal flap often extends into the origin of the left subclavian artery (LSA), necessitating its coverage during thoracic endovascular aortic repair (TEVAR).[3] This can pose a challenge in the presence of an anomalous vertebral, subclavian, or carotid artery origin. A particularly rare scenario is the origin of a left vertebral artery (LVA) directly from the arch of aorta distal to the LSA, which occurs in up to only 3% to 4% of the population.[4,5] This case describes TEVAR in a patient with an atypical LVA arising directly from the arch of aorta distal to the LSA and entering the foramen transversarium of the seventh cervical vertebra. Informed consent for publication of case details and images was obtained from the patient.

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Author conflict of interest: none.

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The editors and reviewers of this article have no relevant financial relationships to disclose per the Journal policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

2468-4287

https://doi.org/10.1016/j.jvscit.2018.12.009

CASE REPORT

A 22-year-old man with no previous medical or surgical history presented to our hospital with a history of an unrestrained high-speed motor vehicle accident 8 hours earlier. On presentation, he was fully conscious, oriented, and hemodynamically stable. He sustained blunt chest trauma, right humerus fracture, and facial injuries. Initial chest radiography showed only bilateral mild lung contusions. It did not show any rib fractures, hemopneumothorax, or widened mediastinum. Because of the high-speed mechanism, we proceeded to a pan-computed tomography (CT) scan per trauma protocol, which revealed a grade IIIB aortic tear of the descending thoracic aorta with an anomalous aortic arch origin of the LVA distal to the LSA (Fig 1). At a multidisciplinary team meeting the following day, it was noted that the LVA was dominant and the right vertebral artery was stenosed in part of its course. It was therefore decided to proceed with open left carotid to LVA and left carotid to LSA bypass before TEVAR of the descending aorta. CT angiography also suggested that the direct reimplantation of the LVA onto the left carotid artery was not possible owing to the unusually short cervical portion of the preforaminal LVA because of its early entry into the foramen transversarium of C7 rather than of the C6 vertebra.

Surgery was performed on a semiurgent basis 48 hours after the injury. Through a transverse left cervical approach, the LVA was dissected in the root of the neck as it ascended toward the foramen transversarium of the C7 vertebra. After systemic heparinization with 5000 units of unfractionated heparin, an end-to-side right long saphenous vein graft was created between the left common carotid and LVA using 7-0 Prolene (Fig 2). Intraoperative Doppler assessment confirmed satisfactory flow. An ipsilateral carotid-subclavian bypass was then performed with a Dacron 8-mm graft using 6-0 Prolene (Fig 2). TEVAR was then performed with a 26- ×100-mm Conformable TAG stent (W. L. Gore & Associates, Flagstaff, Ariz), with no immediate complications.

Fig 1. Preoperative computed tomography (CT) angiogram showing aberrant origin of the left vertebral artery (LVA) distal to the left subclavian artery (LSA) and grade IIIB aortic tear.

Follow-up CT angiography on the second postoperative day confirmed patency of both carotid-vertebral and carotid-subclavian grafts (Figs 3 and 4). The patient was noted to have a left-sided Horner syndrome but otherwise made an uneventful recovery. He was discharged on the third postoperative day and prescribed lifelong aspirin 81 mg once a day. At 1 month and 6 months of follow-up, he remained well with no complications and complete resolution of the Horner syndrome.

DISCUSSION

Thoracic aortic injury as a result of blunt trauma was classified into four types by Gavant according to severity on CT angiography: type I (A and B), type II (A and B), type III (A and B), and type IV (total rupture).[6] Eighty percent of sufferers do not survive to make it to the hospital.[7] Whereas grade I can be managed conservatively, intervention is advised for the higher grades to prevent further complications. TEVAR has become the treatment modality of choice because of its lower morbidity and mortality compared with open surgery.[7,8] Direct aortic origin of the LVA is the most frequent anatomic variant of the vertebral artery, with a prevalence of 2.4% to 5.8%.[4,5] Most LVAs with aortic arch origin proximal to the LSA enter the foramen transversarium of the C4 or C5 vertebra. On the other hand, all LVAs that originate distal to the LSA enter at the foramen transversarium of the C7 vertebra,[4,5] as noted in our case.

Most TEVAR stents mandate a minimum of 20 mm of proximal seal zone for safe deployment.[9,10] To achieve this often necessitates coverage of the origin of the LSA in blunt aortic injury. Rangel-Castilla et al[11] have reported the outcomes of vertebral artery surgery for revascularization for posterior circulation ischemia. The most common complications reported are recurrent laryngeal nerve palsy, thoracic duct injury, transient ischemic attacks, and Horner syndrome. In a systematic review and meta-analysis, Rizvi et al[8] reported the "baseline risks" of adverse outcomes in patients who have TEVAR and LSA coverage as 6% arm ischemia, 4% spinal cord ischemia, 2% vertebrobasilar ischemia, 5% anterior circulation stroke, and 6% death. We did not find any report in the literature regarding TEVAR in patients with an aberrant LVA arising distal to the LSA. What is also unusual about this case is that it occurred in a patient with blunt aortic injury and not dissection or aneurysmal disease, the more common indications for TEVAR.

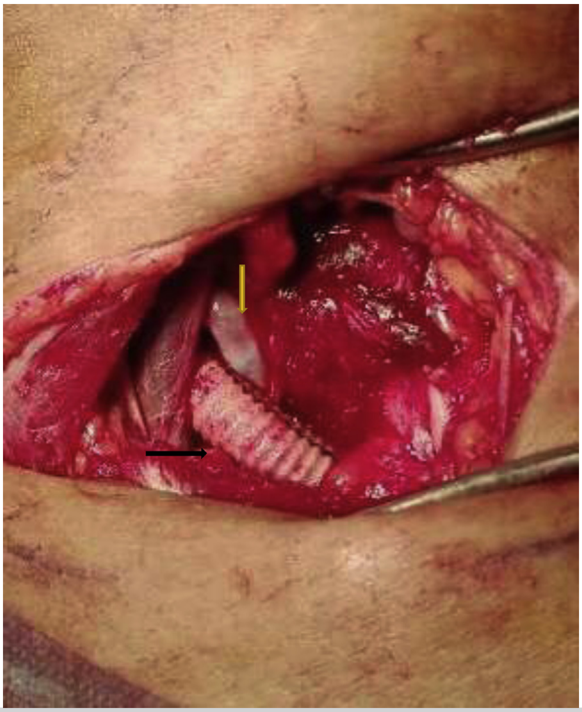

Fig 2. Left cervical exposure. *Black arrow,* Carotid-subclavian bypass; *yellow arrow,* carotid-vertebral bypass.

Ohkura et al[12] looked at vertebral artery anatomy from a registry of 214 patients who underwent aortic interventions for a variety of indications (but did not include blunt aortic injury). They recommended that in patients with high-risk anatomy, such as posterior inferior cerebellar artery termination, hypoplasia, or occlusive lesion on either side of the vertebral arteries, subclavian bypass should be performed. The series did not include any patients with arch origins of vertebral artery, however, in whom LSA bypass would not prevent posterior circulation ischemia.

Blumberg et al[13] have also described vertebral artery transposition to the carotid artery before performing TEVAR in a case of aortic dissection in which the LVA arose from aortic arch distal to the LSA in addition to

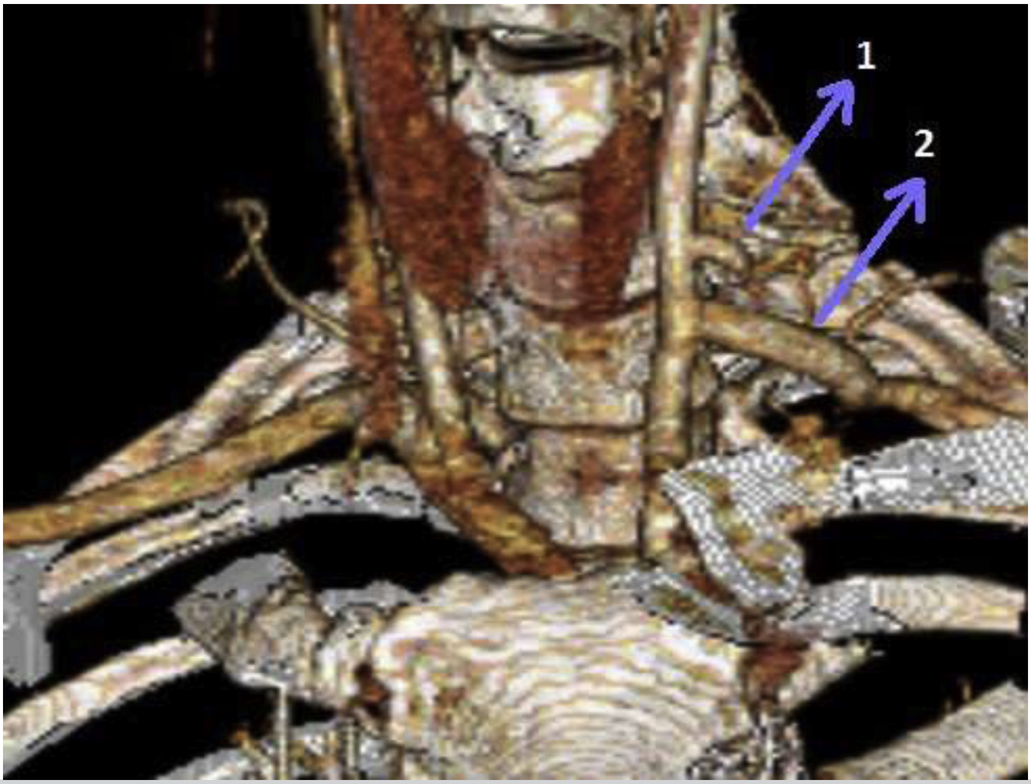

Fig 3. Follow-up computed tomography (CT) angiogram showing contrast material in carotid-subclavian bypass (*2*) and carotid-vertebral bypass (*1*).

bovine arch anomaly. In our case, however, it would not have been possible to perform a direct anastomosis of vertebral artery to common carotid artery owing to the unusually short cervical portion of the preforaminal vertebral artery because of its early entry into the foramen transversarium of C7 rather than that of the C6 vertebra.

The most common option for LSA revascularization is carotid-subclavian bypass performed with either autogenous or prosthetic material synchronously or after the TEVAR procedure.[14] The Society for Vascular Surgery practice guidelines recommend LSA revascularization in patients undergoing elective TEVAR with LSA coverage.[9] Conversely, the guidelines of the European Society for Vascular Surgery[10] recommend carotid-subclavian bypass in emergency settings only in patients with a dominant LVA or a coronary artery bypass with the left internal mammary artery where proximal seal zone requires stenting across the origin of the LSA. This report aimed to highlight the unusual anatomic scenario of the LVA arising from the aortic arch distal to the LSA and not the LSA proper. Both European Society for Vascular Surgery and Society for Vascular Surgery guidelines for LSA revascularization are in the context of the latter anatomic scenario and are therefore not applicable in this case, we would suggest.

We therefore advise that in patients with traumatic aortic tears undergoing emergency TEVAR and in whom a proximal landing zone will seal the origin of an aberrant dominant LVA arising from the aortic arch (proximal or distal to the LSA), vertebral artery revascularization should be performed before the TEVAR procedure. Furthermore, unlike in patients with a normal anatomic vertebral artery origin (in whom the LVA forms an important collateral through retrograde flow, preventing significant left arm ischemia), aberrant LVA origin is likely to increase the risk of left upper limb ischemia, necessitating concomitant revascularization of the LSA.

Fig 4. Computed tomography (CT) angiogram 1 day after stenting.

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Submitted Oct 27, 2018; accepted Dec 18, 2018.