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Case Report: Aberrant Left Vertebral Artery Management in Traumatic Transection of the Aortic Isthmus

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ABSTRACT

Association of elective debranching and endovascular thoracic aortic repair (TEVAR) with aberrant left vertebral artery (AVA) revascularization and supra-aortic left carotid-subclavian bypass in post-traumatic pseudoaneurysm of the distal aortic arch are extremely rare procedures that can minimize unnecessary neurologic complications.

The patient was a 42-year-old man, stable, with a post-traumatic transection of the aortic isthmus, with origin of the AVA between the left common carotid artery (LCCA) and left subclavian artery (LSA). Preoperative planning and proper sizing of the stent grafts were evaluated by means of computed tomography angiography (CT scan) images. The patient underwent a hybrid procedure that included TEVAR with landing zone 2, covering the origin of both the AVA and LSA, and concomitant supra-aortic reimplantation of the AVA in the LCCA and left carotid-subclavian bypass combined with both ligation of the AVA and LSA proximally. Postoperative arteriography images confirmed the exclusion of the aneurysm and the patency of all arch vessels, including the AVA. No endoleak was reported.

INTRODUCTION

Despite standardization and technical progress in open surgical procedures, the management of traumatic distal aortic arch aneurysms remains a clinical challenge. Open surgery for aortic arch aneurysm repair in patients with polytrauma has significant morbidity and mortality. Alternative therapies like the use of thoracic stent-grafts for patients at excessive risk were introduced by Dake in 1994 [Dake 1998]. Many variations of debranching and hybrid procedures have been described and can be found in literature [Czerny 2012; Gottardi 2008]. Nowadays, the management of post traumatic distal aortic arch pseudoaneurysm is changing from open surgical repair to TEVAR. Thus, aortic distal arch repair with de-branching and TEVAR is evolving toward a first-line treat-ment option in high risk patients [Bavaria 2010]. It is now accepted that TEVAR is less invasive and has fewer complications and lower mortality than conventional operations [Zeeshan 2010]. Aortic rupture as a result of rapid deceleration is commonly located in the isthmic portion of the aorta, usually distal to the origin of the LSA. Post-traumatic aortic rupture has been described to have several pathological forms, including minor aortic wall injuries, aortic laceration, aortic pseu-doaneurysm, aortic intramural hematoma, and aortic complete transection. In surviving patients with isthmus transection, preoperative diagnosis is performed by multi-slice CT scan. Furthermore, CT scan is used as a diagnostic tool to exclude occlusive disease of supra-aortic branches and aorta-iliac axis and to predict arterial access for stent-graft insertion. The length and diameter of the intended proximal landing zone should allow for a sufficient proximal neck of at least 2 cm along the lesser curvature of the aortic arch [Czerny 2012]. CT scan also can diagnose the rare variations of supra-aortic vessels anatomy. The left vertebral artery usually originates from the LSA. The most frequent variations

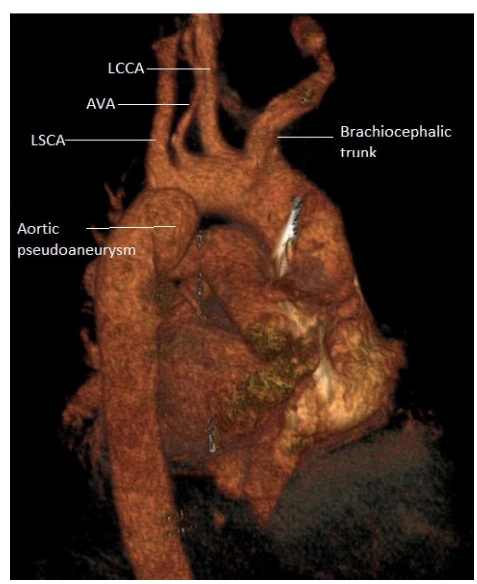

Figure 1. Posterior view. 3D Contrast-enhanced computed tomography scan of the chest demon-strating an acute traumatic transection of the distal aortic arch.

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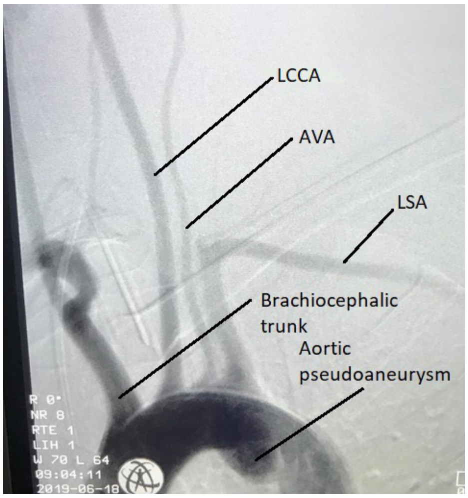

Figure 2A. Before stent-graft insertion. Intraoperative angiogram demonstrating pseudoaneurysm of the distal aortic arch and origin of AVA from aortic arch between LCCA and LSA.

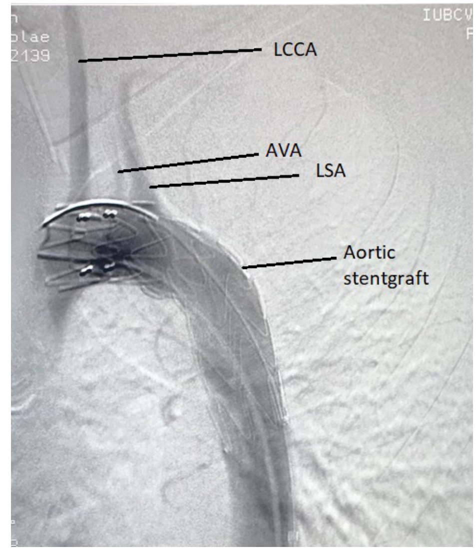

Figure 2B. After stent-graft insertion. Intraoperative angiogram revealed complete coverage of the pseudoaneurysm with no endoleak, brachiocephalic trunk and LCCA with normal flow, but delayed retrograde flow in the AVA and LSA.

involve the origin directly through the aortic arch, between the LCCA and LSA with an incidence of 4.1% [Karacan 2014] and do not cause functional implications for the patient [Shinohara 2018]. It is known that traumatic vertebral artery injury, although frequently asymptomatic, can have disastrous consequences of basilar territory infarction and death [Kim 2009]. In our opinion, in this particular situation, the use of thoracic stent-grafts with stent deployment covering the origin of AVA should include the relocation of AVA in the LCCA in order to avoid neurologic consequences.

CASE PRESENTATION

A 42-year old male patient suffered head and thoracoabdominal blunt trauma in a pedestrian acci-dent. At initial admission to a different hospital, the patient was conscious (Coma Glasgow Score 9), hypotensive, with severe dyspnea and signs of acute abdomen. After initial resuscitation, a tho-racoabdominal CT scan was performed revealing hemoperitoneum with splenic rupture, grade V-right renal pedicle avulsion, grade II-hepatic hematoma (according to the American Association for the Surgery of Trauma), with intraperitoneal and retroperitoneal hematoma, bilateral pulmonary contusion and laceration with minimal pleural effusion in the left pleural cavity and massive he-mopneumothorax in the right pleural cavity, multiple rib fractures and a blunt traumatic aortic in-jury with periaortic hematoma and pseudoaneurysm development at the level of the aortic isthmus and distal aortic arch. Also, the CT scan described an AVA and no brain injuries. Initial surgical management addressed the life-threatening abdominal and pulmonary hemorrhage. An emergency surgery performed exploratory laparotomy confirmed the previous findings and continued with right nephrectomy, splenectomy, anterograde cholecystectomy and liver packing for bleeding control. Minimal left pleurostomy with passive pleural drain and hemostatic right anterolateral thoracoomy were also performed for bilateral pulmonary laceration, resulting in ventilation improvement. After 24 hours, an additional abdominal surgery was performed for hemostatic control and removal of liver packs with complete postoperative recovery. Follow-up CT scan was performed two weeks later, showing stable dimension of the aortic pseudoaneurysm. The patient was referred to a tertiary cardiac center for further management. Following admission to our center, the patient was stable and transthoracic echocardiography found normal cardiac function without any valvular pathology. The CT scan revealed that the aortic pseudoaneurysm originated just caudally from the LSA, on the lesser aortic arch curvature (Figure 1) and had a maximum diameter of 4/5 cm. CT scan images were sent and processed by an outside service for preoperative planning and proper sizing of endografts. The evaluation recommended stent deployment with complete coverage of the AVA and LSA in the landing zone 2, in order to achieve an adequate sealing zone, followed by extra-anatomic rerouting of blood flow with subclavian-carotid bypass. There were no recommenda-tions regarding to the LVA. Open surgery was considered to have high risks because of the patient's associated recent traumatic pathologies and fragility of the patient's state. Doppler vascular echography of peripheral arteries found suitable artery for endograft procedures. After general anesthe-sia with invasive monitoring of blood pressure (right radial artery) and cerebrospinal fluid pressure via a peridural catheter, a Valiant Captivia VAMF2424C100TE covered stent was introduced via a 20F sheet into the right femoral artery (Figures 2A, 2B). Our method to insert the endograft has been previously described in detail [Stiru 2017]. Occipital transcranial cerebral oximetry was used to monitor intraoperative changes in regional cerebral blood flow and subsequent cerebral ischemia. After initial deployment distal to the origin of the LCCA, proper alignment and fixation were ob-tained with gentle ballooning of proximal

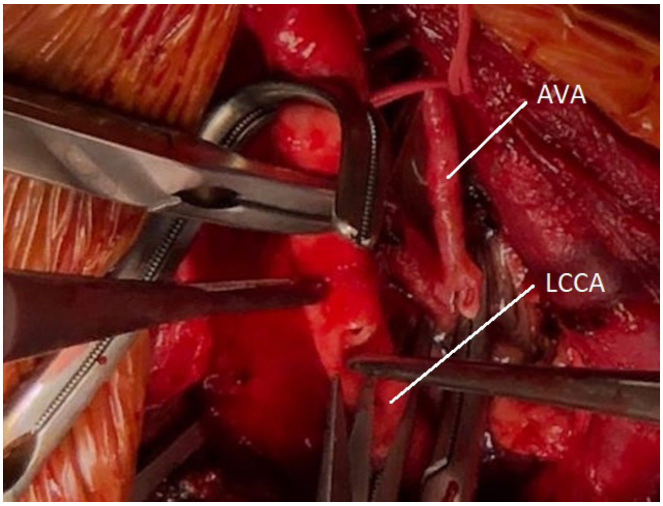

Figure 3A. Intraoperative view of AVA and LCCA before transposition.

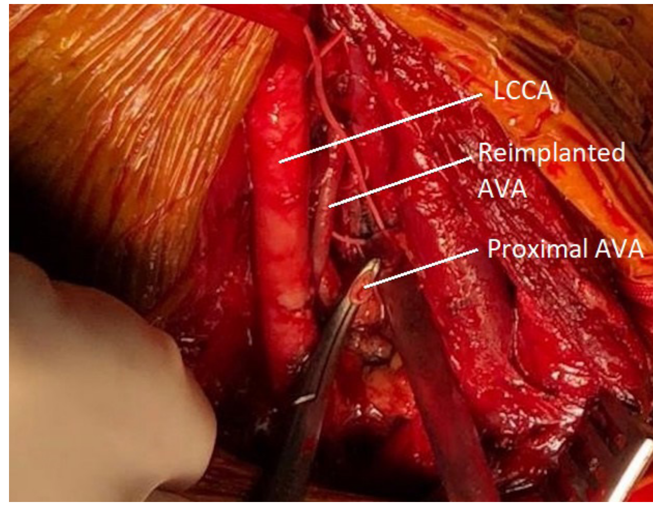

Figure 3B. Intraoperative view of AVA transposition of the LCCA end-to-side anastomosis. Pean clamp on the proximal AVA stump.

and distal ends of the covered stent. Aortography re-vealed complete coverage of the pseudoaneurysm with no endoleak, brachiocephalic trunk and left carotid artery with normal flow, but delayed retrograde flow in the AVA and LSA. Additionally, abnormal pulse oximetry, followed by nail and skin discoloration suggesting critical left upper limb ischemia revealed the necessity for limb revascularization. At the same time, no relevant sign of decrease of cerebral oximetry was noted. Via an "L"-shaped incision in the left supraclavicular fossa, the AVA was dissected and was transposed in the LCCA in a terminolateral fashion, fol-lowed by closure and ligation of the proximal AVA (Figures 3A, 3B). A left carotid-subclavian bypass with a No. 8-ringed ePTFE prosthesis was performed followed by closure and ligation of the proximal LSA. Final aortic arch aortography revealed complete exclusion of the pseudoaneurysm, absence of endoleak, complete covering of ruptures entry and normal anterograde flow from the LCA in the AVA and in the LSA via the carotid-subclavian bypass (Figure 4). The patient had an uneventful recovery without any signs of limb ischemia, transient or permanent neurologic injury and he was discharged from hospital on the 4th postoperative day. Three months after this procedure, 3D CT reconstruction revealed a good evolution, with normal flow in carotid-subclavian by-pass and left vertebral artery with no evidence of aneurysm expansion or endoleaks (Figure 5).

DISCUSSION

When patients are considered suitable for TEVAR with landing zone 2, several different treatments are developed for managing supra-aortic arteries. Surgical solutions include extra-anatomic rerout-ing of blood flow with left subclavian-carotid transposition, subclavian-carotid bypass, or simply ignoring subclavian revascularization [Czerny 2012; Gottardi 2008; Matsumura 2009]. Revascu-larization of the LSA may result in reducing the prevalence of left arm ischaemia, stroke, spinal cord ischaemia, endoleak, or mortality. [Sepehripour 2011]. There is no consensus regarding the management of the rare cases in which the AVA is located in landing zone 2. Most authors agree that preventing proximal endoleaks and preserving vertebral circulation is critical for success [Matsumura 2009]. Variations in the origin of the vertebral artery have been reported, among them, the most frequent being atresia or hypoplasia, duplication, loops, abnormal level of origin from the common carotid artery or from the aortic arch and abnormal level of entrance into the transversary canal (C7, C5, C4, or C3 instead of C6) [Heary 1996]. The present case report brings a traumatic transection with pseudoaneurysm of the distal aortic arch with the AVA from the aortic arch, be-tween the LCCA and LSA. The knowledge of this variant of the vertebral artery is essential for the correct planning and execution of the debranching TEVAR to avoid postoperative neurologic disorders. Stroke after TEVAR is a disastrous complication, and it can be caused not only by atheroem-boli from endograft deployment but also by poor protection of the vertebral artery [Yoshitake 2016]. Injuries of the vertebral artery in a minority of patients potentially can lead to fatal posterior circulation ischaemia [deSouza 2011]. Manipulation of the carotid and vertebral artery is associated with potential embolic risk and may cause cerebral embolization of atherosclerotic debris. Short total clamping of the LCCA to achieve the transposition of the AVA and the carotid-left subclavian artery bypass when contralateral cerebral perfusion circulation is efficient may not have significant cerebral morbidity [Sepehripour 2011]. However, surgical exposure of the AVA at any level all along its course in the neck usually is considered a great challenge. With knowledge of surgical anatomy and proper surgical technique, the AVA can be exposed and revascularization can be realized safely and reliably. Options for selective AVA revascularization in TEVAR with landing zone 2 should be individualized considering the surgical team's expertise and the possibility of evaluating the patency of the Circle of Willis's by intraoperative angiography of both vertebral arteries [Matsumura 2009].

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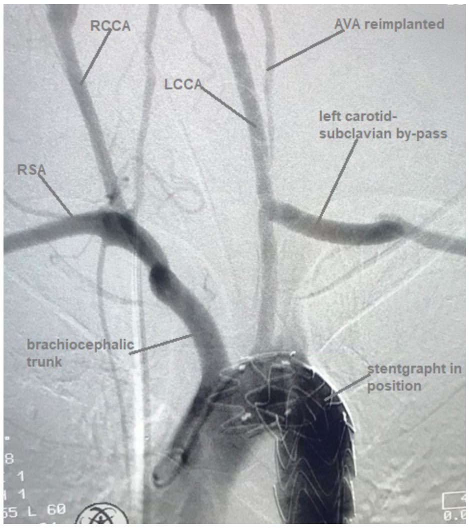

Figure 4. Angiography of postoperative stent-graft implantation in landing zone 2 with no endoleak. Angiographic appearance of a completed AVA to LCCA transposition and LSA to LCCA by-pass without contrast filling in the residual subclavian and vertebral stump.

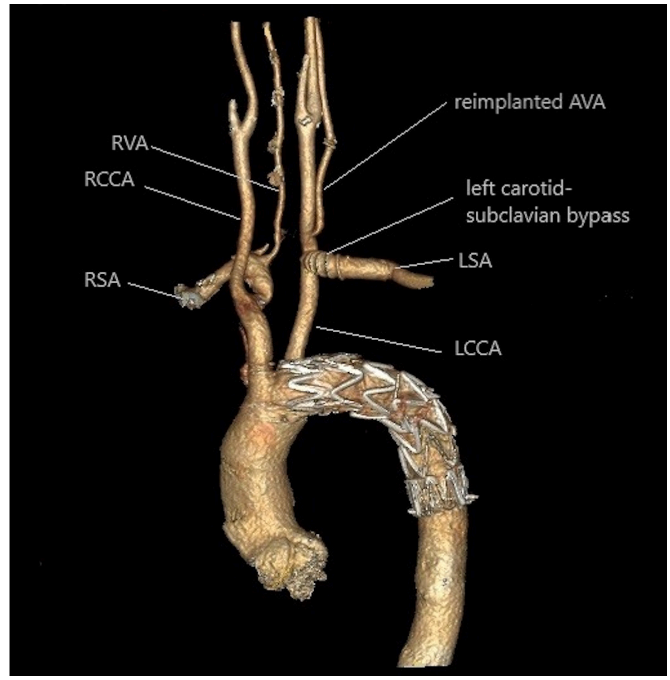

Figure 5. Multislice 3D reconstruction CT scan of the aortic arch after three months, showing the correct morphology of the aortic stent graft and patency of the carotid-subclavian bypass, graft, and AVA transposition.

We agree with the opinion that if the right vertebral artery is atretic or hypoplas-tic or if the Circle of Willis's angiography reveals an absence of posterior communication, the decision to revascularize the LSA with or without normal origin of the left vertebral artery is mandatory. We take into account transposition of the AVA in the LCCA mainly if the left AVA artery is not hypoplastic or if the Circle of Willis is incomplete. The confidence that the simple preservation of antegrade perfusion can supply posterior circulation and decrease the risk of posterior strokes may lead to unwanted accidents. In a similar case of the AVA, Moss and colleagues reimplanted the AVA directly in the LCCA with end-to-side anastomosis in the thoracic cavity [Moss 2013]. In our case, after stent deployment, we chose to perform after TEVAR the left cervical incision in the supraclavicular space, simultaneously debranching and bypassing the LSA to the LCCA. The AVA was transposed from a natural course on the dorsal side of the LCCA and it was reimplanted on the lateral side of the LCCA, where it was easier to make an end-to-side anastomosis. However, it is essential to determine the correct length of the AVA between LCCA anastomosis and the level of entrance into the transversary canal, as well as the correct length of the carotid-subclavian bypass. Last but not least, it must be kept in mind that incorrect routing may result in kinking or compres-sion. Nevertheless, results of these approaches and the impact of revascularization of the AVA re-main to be determined.

CONCLUSION

Appropriate management of AVA in hybrid TEVAR procedure with stent-grafts should minimize unnecessary neurologic complications and help with a more sustainable distal aortic arch repair.

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