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Case Report

Combined fenestrated/chimney thoracic endovascular repair for the treatment of blunt traumatic aortic injury: A case report

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ABSTRACT

Blunt traumatic thoracic aortic injury (BTAI) is an extremely serious medical condition with a high rate of associated mortality. Recent advances in techniques such as thoracic endovascular repair offer new opportunities to manage the critical BTAI patients in an efficacious yet less invasive manner. A 65 year-old-male suffered from multiple injuries after a fall, including BTAI in the aortic arch, which resulted in dissection of the descending thoracic-abdominal aorta and iliac artery, development of an intimal flap in the left common carotid artery, and dissection of the left subclavian artery. Based on the imaging information of this patient and our clinical experience, the combined treatment of fenestrated thoracic endovascular repair and a chimney technique was immediately planned to fully repair these dissections and moreover prevent further dissection of the branching vessels, additionally to ensure sufficient blood flow in the left subclavian artery and left common carotid artery. The intervention yielded satisfactory early outcomes. Follow-up assessment at six months reported no symptoms or complications associated with the stent-graft. Computed tomography angiography further confirmed adequate stent-graft coverage of the aortic injury.

Introduction

Blunt traumatic thoracic aortic injury (BTAI) is a life-threatening emergency. The majority of BTAI victims (about 80%) were not able to survive to reach a hospital and moreover the 24-h mortality after admission is high.[1] BTAI was traditionally managed by open surgery. With the rapid development of endovascular technique, the less invasive thoracic endovascular repair (TEVAR) was more frequently applied.[2] Here we report a case of BTAI managed by combination of fenestrated TEVAR and a chimney technique.

Case report

A 65-year-old male suffered from fall-related multiple injuries to the shoulder, right forehead, right chest, and right forearm, assessed via CT at a referring country hospital. CT analysis revealed mediastinal widening and suspected aortic dissection. The patient was then transferred to our regional hospital for further assessment and treatment. The patient was confirmed conscious with stable vital signs. Then emergency computed tomography angiography (CTA) was arranged, which revealed the presence of a BTAI within the aortic arch, resulting in descending aortic dissection, intimal flap formation within the left common carotid artery (LCCA), and left subclavian artery (LSA) dissection (Fig. 1). The aortic dissection involved the distal bilateral common iliac artery, the celiac trunk artery, and the superior mesenteric artery. In addition, both the left and right renal arteries extended from the true and false lumen, respectively. The patient also presented with pleural effusion, fracture of the right clavicle, fracture of the right 2, 4–7, 8–11, and 12 ribs, and a compression fracture to the second lumbar vertebra. The injury severity score ranked 38. After multidisciplinary discussions, management of the aortic injury was prioritized owing to its severity. Fractures were treated after aortic repair.

Though open repair strategies are commonly considered in patients undergoing such complex procedures, it was considered not safe or feasible in this polytrauma patient. The primary thoracic dissection originated from the distal LSA and was continuous with the LSA, but it was separated from the LCCA dissection. In order to fully repair these dissections and moreover prevent further dissection of the branching vessels, fenestrated TEVAR was

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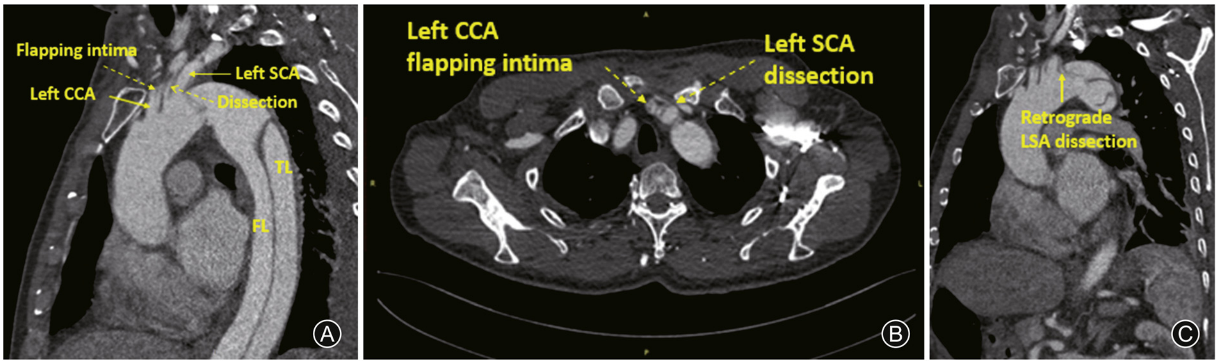

Fig. 1. Preoperative computed tomography angiography findings. (A) Imaging in the sagittal plane revealed damage associated with blunt aortic injury at the isthmus, an intimal flap in the LCCA, and dissection of the LSA. (B) The presence of an intimal flap in the LCCA and LSA dissection as viewed in the axial plane. (C) Dissection with LSA involvement as viewed in the sagittal plane. LCCA: left common carotid artery; LSA: left subclavian artery; FL: false lumen; TL: true lumen.

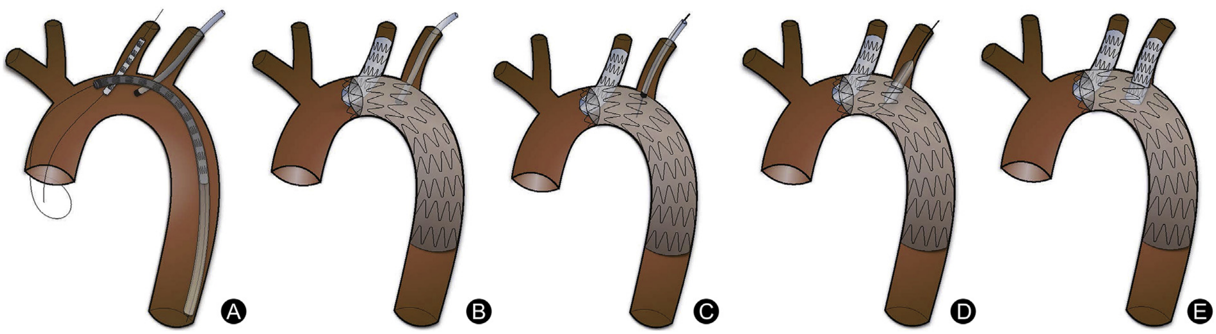

Fig. 2. Schematic diagram of technique. (A) The stent-graft and chimney stent were positioned in the aortic arch. (B) The stent-graft and chimney stent were released. (C) Fenestration was achieved via left subclavian artery. (D) A balloon dilatation catheter was used to enlarge the small hole. (E) The fenestration stent was inserted through the hole.

additionally employed to ensure sufficient LSA blood flow; while the LCCA was reconstructed via a chimney technique (Fig. 2).

Owing to differences in the diameters of the aortic arch and the descending aorta, Ankura™ thoracic stent graft (36-30 mm in diameter, 180 mm long, 10% oversizing; Lifetech Scientific Co., Ltd., Shenzhen, China) was applied in the descending aorta. The right femoral artery, LCCA, and the left brachial artery were first exposed in order to minimize the risk of medial brachial fascial compartment syndrome & associated access complications, and then the three arteries were respectively punctured and placed into a 6F, 10F sheath (Merit Medical System Inc., USA) and a 6F sheath in 55 cm length (Lifetech Scientific Co., Ltd., Shenzhen, China). The true lumen was next confirmed via aortogram, after which the first segment of the Ankura™ thoracic stent-graft was positioned via the right common femoral artery beyond the innominate artery origin with proximal seal extending into the undamaged portion of the aorta. The Fluency stent (12 mm in diameter, 40 mm long; C. R. Bard, Inc. Karlsruhe Germany) was then placed into the aortic arch via the LCCA. Stent positioning was again confirmed via aortogram, after which we sequentially deployed the Ankura™ thoracic stent-graft and the Fluency stent. The procedures of stent placement were conducted smoothly without difficulties.

Next, the Ankura™ thoracic stent-graft was fenestrated with the sharpened end of a V18 wire by turning the Fustar sheath in situ, after which this small hole was enlarged with a balloon dilatation catheter (INVATEC 6–120 mm, Medtronic, Inc, USA). The catheter was then exchanged for Amplatz wire (Boston Scientific Corporation, USA) and the Fluency stent (10 mm in diameter, 40 mm long) was inserted into the stent-graft, followed by stent-graft balloon dilatation. CTA assessment revealed good blood flow in the LSA and LCCA with no evidence of endoleak development (Fig. 3). In total, this operation lasted for 100 min. No significant difference in upper-extremity blood pressure was detected.

Following the TEVAR procedure, the patient remained intubated for one day. After extubation, the patient was assessed and no evidence of paraplegia or other neurological complications was detected. The patient thereafter underwent open reduction and internal fixation of the right clavicle fractures. On day 8 post-surgery, the patient was discharged.

At six months post-surgery, the patient returned for a follow-up assessment and reported no symptoms or complications associated with the stent-graft. CTA conducted at this time point further confirmed adequate stent-graft coverage of the aortic injury without any evidence of endoleak development (Fig. 4).

Discussion

BTAI is an extremely serious form of injury associated with rapid deceleration that affects 1.5%–2% of individuals and results in a high rate of mortality.[1] In total, approximately 80% of BTAI patients succumb to their injuries prior to arrival at a trauma center, and an additional 50% of those with success hospital access pass away within 24 h. BTAI has historically been treated via open surgery, although there have been reports of successful outcomes in patients subjected to conservative treatment and endovascular therapy. As the endovascular management techniques evolve, TEVAR-based treatment of BTAI is more and more frequently adopted. The open repair rates between 2007 and 2015 fell from 7.4% to 1.9%, whereas TEVAR-based repair rates rose from 12.1% to 25.7%. Endovascular repair strategies have been shown to be associated

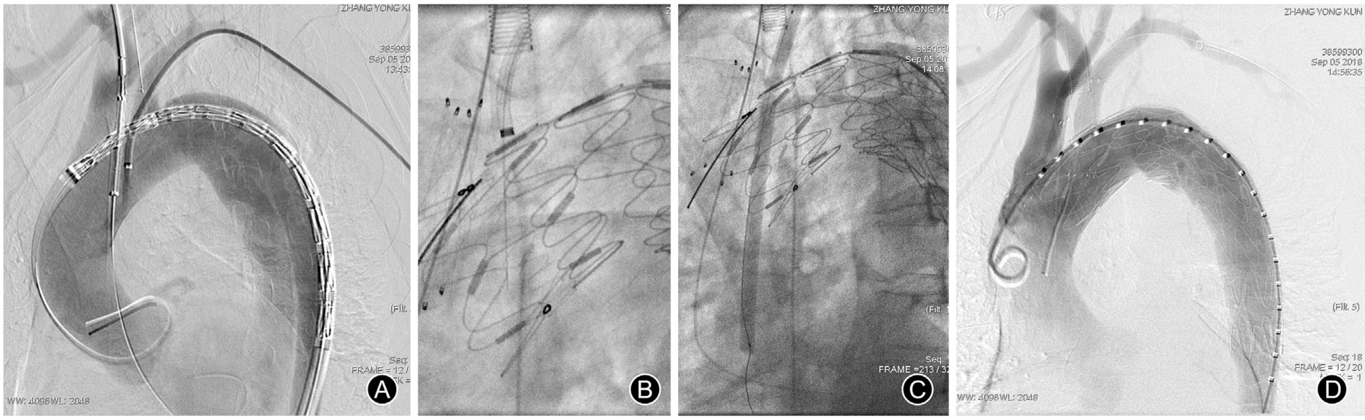

Fig. 3. Intraoperative findings. (A) The stent-graft and Fluency were positioned in the aortic arch under angiographic guidance. (B) Fenestration was achieved with V18 guide wire and a Fustar sheath. (C) A balloon dilatation catheter was used to enlarge the small hole in the ANKURA stent-graft. (D) Subsequent angiographic assessment revealed good patency of both the left subclavian artery and the left common carotid artery with no evidence of endoleak development.

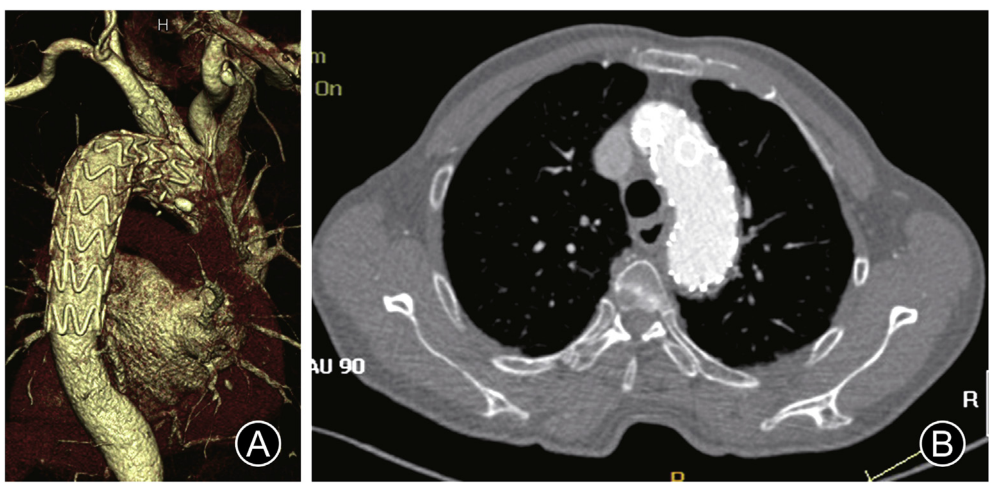

Fig. 4. Computed tomography angiography at six months post-surgery. (A) Three-dimensional CT image; (B) Axial image.

with reduced mortality rate, decreased length of hospitalization, and less complications such as acute renal injury.[2] Indeed, both single- and multi-center studies have demonstrated the efficacy of TEVAR-based repair as an approach to improve patient mortality and the incidence of procedure-related complications.[2,3] Though there were no randomized controlled trials to confirm these observations, clinicians have increasingly adopted endovascular approaches to manage BTAI based on the strength of large clinical series and cohort study-based meta analyses.[4]

Endovascular repair of the aortic arch remains challenging owing to the tight inner curve of this arch and supra-aortic branch involvement. When treating aortic isthmus injuries located distal to the origin of the LSA via a TEVAR approach, coverage of the LSA is often necessary, as a means of preventing endoleak formation. However, recent evidence indicates that LSA revascularization should be recommended for patients treated in this manner as revascularization of the LSA is associated with significantly reduced rates of perioperative stroke and spinal cord injury.[5] In the present case, the patient was diagnosed with an aortic arch BTAI that had resulted in dissection with retrograde LSA involvement and anterograde involvement of the distal aorta, and combined with the formation of an intimal flap in the LCCA.

By utilizing an adequate proximal sealing zone, it is possible to avoid the need to deploy the stent-graft within the curved region of the aortic arch. This is important, given that such deployment can lead to stent-graft migration and endoleak development. In this patient, LSA and LCCA reconstruction was essential in order to prevent subsequent stroke or left upper limb ischemia. Though open repair strategies are commonly considered in patients undergoing such complex procedures, open repair was considered unsafe or infeasible for our polytrauma patient. The incidence of successful repair and failure of endoleak was comparable by using the chimney technique in BTAI cases or patients with aortic arch diseases; however the latter may be able to tolerate the risk of endoleak but BTAI patients cannot.[6,7] There is evidence suggesting that fenestrated TEVAR is associated with better short- and mid-term outcomes relative to standard chimney graft-based techniques.[8]

In the present case, we utilized a combined approach: the LCCA was reconstructed via a chimney technique, whereas blood flow in the LSA was normalized through a fenestrated TEVAR approach using an Ankura™ thoracic stent-graft. The chimney technique allows for easy restoration of proper blood flow but can increase the risk of endoleak development, whereas in situ fenestration can extend the proximal landing zone in order to allow for better stent attachment to the aortic arch. In order to minimize the risk for stent migration or displacement, we inserted the stent into the branch artery and thereby reconstructed local blood flow in the present case.

The Ankura™ thoracic stent-graft was constructed specifically to treat cases of thoracic aortic dissection via an endovascular approach. It is available in a range of sizes (4 mm, 6 mm, and 8 mm with an optional taper), contains no main body suture in order to avoid the risk of developing type IV pinhole endoleak, surrounded by an e-PTFE membrane, and can be fenestrated with relative ease. Fenestration can further be supported using a Fustar sheath and V18 guide wire. CTA at 6 months follow-up of our patient showed that the aortic dissection repair was satisfactory without obvious leakage.

In conclusion, our use of a combined fenestrated TEVAR and chimney technique approach achieved good early outcomes in a patient with BTAI of the aortic arch without any incidence of procedure-related or neurological complications.

Funding

Nil.

Ethical statement

Informed consent has been obtained from the patient.

Declaration of competing interest

The authors declare no competing interest.

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