# Endovascular Aortic Repair for Thoracic Aortic Injuries

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## ABSTRACT

Traumatic aortic injury (TAI) or aortic transection is the second most common cause of death after blunt trauma. The conventional management approach towards a thoracic aortic injury is open thoracotomy and surgical repair; however, there is a recent increase in the trend towards the use of endovascular approach in this regard, particularly in the developed countries. We here report the cases of two young healthy male patients presenting in emergency department with thoracic aortic injury, following a road traffic accident (RTA). Thoracic endovascular aortic repair (TEVAR) was planned for both patients, as open repair was risky owing to other systemic injuries. Aortic stent graft was deployed just below the origin of the left subclavian artery in one patient, while it partially covered the left subclavian in the other. End runs showed good position of the graft with perfusion of aortic branches and exclusion of flow to the transection. Both patients had an uneventful recovery with no episodes of cerebrovascular accident (CVA) or paraplegia. Our study gives an insight into the recent trends of endovascular aortic repair (EVAR) becoming the mainstay treatment for TAIs. As far as we know this is the first reported successful case series of thoracic endovascular stent graft deployment for blunt thoracic aortic trauma in Pakistan. We recommend education and further teaching of surgeons to acquire expertise in this novel approach.

**Key Words:** *Traumatic aortic injuries. Endovascular. Aortic repair.*

## INTRODUCTION

Traumatic aortic injury (TAI) or aortic transection is the second most common cause of death after blunt trauma.[1] Its mechanism has been attributed to the intricate combination of the anatomy of organs in body cavities and the nature of the impact. In aorta, the greatest strain occurs at isthmus, the junction of fixed and mobile parts of this vessel.[2] In order of frequency, rupture occurs at the aortic isthmus, the ascending aorta, the aortic arch, the distal descending aorta, and the abdominal aorta. The rapid deceleration force from trauma necessary to tear aorta often leads to other organ injuries. Associated injuries have been reported in 90% of patients with aortic transection, with 24% of them requiring an intervention before aortic repair.[3] The most common cause of TAI is blunt trauma related to motor vehicular accidents, responsible for 16% to 23% of all motor vehicle fatalities. Other non-vehicular impacts causing sudden deceleration and stress can also lead to transection. As expected, this injury is associated with high mortality at the scene.[4] In patients with TAI, beta blockers are used to control the blood pressure and modify the left ventricle systolic ejection dynamics. Open surgical repair with interposition graft has been the traditional treatment of blunt traumatic aortic rupture for a long time. Early open repair or delayed repair, after managing other more life-threatening injuries, has also been reported. However, patients for delayed repair remain at risk of rupture. Open repair also requires anticoagulation, which in the presence of associated injuries in thoracic, abdominal and cranial cavities poses further risks. Open repair has, therefore, been reported to be associated with a significant mortality risk ranging from 24% to 42% as per a 30-year retrospective series.[5] Because of these considerations, interest in less invasive, and less traumatic methods of repair has been developed over the last 2 decades. Early reports of safety of thoracic endo-vascular aortic repair (TEVAR) using stent graft dates back to 1994, and in 1997, reports suggested that it was technically feasible to perform stent graft repair in acute rupture of the descending thoracic aorta. Results of several other clinical studies have shown successful emergency repair of acute thoracic aortic disease by endovascular stent grafting.[6] Blunt trauma related to road traffic accidents (RTAs) and other causes is commonly seen in all emergency departments of Pakistan. The incidence of TAI is unknown as diagnosing this condition requires high level of suspicion and quick diagnostic imaging. Endovascular stenting for aortic pathology has been slow to come to Pakistan due to lack of expertise and non-availability of stent grafts.

Here, we present the first two cases of TAI successfully treated with TEVAR in Pakistan.

## CASE REPORT

**Case 1:** A 36-year healthy male presented to emergency department 3 hours after an RTA. He was the driver of a car which had direct frontal collision with a tree with major trauma over his frontal region. At presentation, he had a Glasgow coma scale (GCS) of 8 with grade 1 shock. There were some scalp and facial lacerations. There was no active external bleeding, FAST scan was

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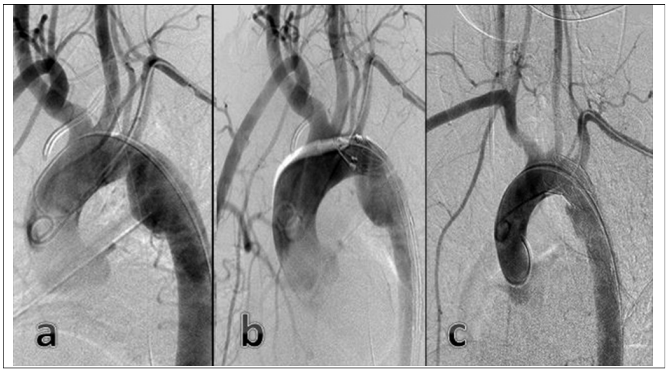


**Figure 1:** (a) Showing initial DSA run with aortic pseudoaneurysm distal to left subclavian artery. (b) Showing aortic stent graft being advanced through the aorta. (c) Showing a fully deployed aortic stent graft.

negative for any abdominal free fluid. He had a haemo-pneumothorax on right side of chest. Patient was Intubated because of head injury and low GCS, and basic resuscitation was carried out as per advanced trauma life support (ATLS) protocol. A right chest drain was inserted in which 300 ml blood came out initially. Chest X-ray (CXR) revealed a widened mediastinum, raising suspicion of a TAI along with multiple rib fractures and a flail chest. Computed tomography (CT) confirmed non-extravasated aortic transection just below the level of origin of left subclavian artery (Figure 1). Head CT showed multiple hemorrhagic contusions in bilateral cerebral hemispheres with surrounding oedema requiring no further neurosurgical intervention. TEVAR was offered for aortic transection as open repair was associated with a high risk due to parallel injuries. Since the stent graft was not available in Pakistan, patient was kept in intensive care unit (ICU) and his blood pressures were maintained at the required levels until the arrival of the graft. His GCS improved but he required mechanical support due to slow recovery from the head injury. TEVAR was performed under general anesthesia. Left brachial artery was percutaneously accessed and pigtail catheter was placed in the aortic arch. Right femoral artery was approached with open surgical access; and wire and catheter were advanced up and across the dissection into the aortic arch and ascending aorta. A 30 x 100mm Medtronic® Valiant Stent Graft was advanced into aortic arch and digital subtraction angiography (DSA) was used to identify aortic arch branches. Landing zone was identified and stent graft was deployed. End run showed good position of the graft with perfusion of aortic branches and exclusion of flow to the transection (Figure 1). Brachial artery sheath was removed and femoral access was closed surgically. The patient was shifted back to ICU to be kept under close monitoring. CT angiography was carried out after surgery at 2 weeks and 3 months. It showed the stent graft to be placed just below the origin of left subclavian artery, which was well perfused and no leak of contrast or dissection from aorta was noted. He was found stable at 6 months follow-up period.

**Case 2:** A 27-year healthy male presented in the emergency department 6 hours after an RTA. He was a bike rider that got hit by a van over the right side of his body. He presented with a GCS of 12 and minor lacterations over the thigh. CT head was normal. CXR showed fractionally displaced ribs over the right side. Trauma series identified fractures of humerus, femur and fibula of the right side. CT scan showed a psuedoaneurysm just below the origin of left subclavian artery. Patient was stabilised in ICU. TEVAR was planned for the next day. Stent graft was successfully deployed; however, partial coverage of left subclavian artery was also done to secure a better landing zone for graft. End run showed good perfusion of aortic branches, exclusion of flow to the transection and a well perfused left upper limb. Postoperatively, patient remained stable with no episode of transient ischemic attack (TIA), paraplegia or left arm weakness. CT aortogram on the third postoperative day showed complete resolution of psuedoaneurysm. Patient remains stable till date. Repeat imaging will be done after 4 weeks from the time of surgery.

## DISCUSSION

The traditional treatment of blunt aortic injury was early diagnosis and open operative aortic repair. Contrast aortography was the gold standard test for diagnosis, but now CT angiogram is widely available, non-invasive and quick investigation; and hence, has replaced aorto-graphy. Early open aortic repair was associated with complications including prolonged ventilator support and neurologic morbidities like cardiovascular accidents. On the other hand, delayed repair, as compared to early open repair, was associated with a significant risk-adjusted survival benefit, regardless of the presence or absence of major associated injuries according to major trauma surgery trial.[7] However, the reported 30-day mortality rates after open surgical repair of TAIs are still between 15% and 50%. Over the last couple of decades, thoracic endovascular repair has revolutionised the therapy of descending aortic pathology. This therapeutic approach has been successfully applied for the treatment of blunt TAI. The 30-day mortality with TEVAR for TAI, as reported by RESCUE trial in 2013, showed an all-cause mortality of 8%, with aortic injury-related mortality of only 4%.[7] Aortic transections occur mostly at the level of the aortic isthmus and in the absence of adequate proximal landing zone, left subclavian artery may need to be covered. The reported incidence of left upper extremity symptoms or stroke after covering subclavian artery is around 0-15.8%. However, a recent study in 2015 reports no appreciable neurological sequalae following TEVAR with subclavian coverage, rendering it as a safe procedure.[8] The data on the need for revascularisation of subclavian following TEVAR is scarce. Paraplegia is the most serious complication of

open or endovascular management of blunt TAI with a reported incidence of 2.3% to 25.5%. This is due to the coverage of the aortic branches to spinal cord. The risk of paraplegia, however, is significantly lower in endovascular procedure when compared with open surgery. A meta-analysis of endovascular *versus* open repair for TAI augments this notion via a comparison of 215 patients treated with endograft placement *versus* 333 with open repair. The risk of postoperative paraplegia was considerably lower with stent-graft repair (OR, 0.32; 95% CI, 0.1-0.93; P=.037).[9] Other complications of endovascular treatment include stroke (1.2%), stent collapse and recurrent laryngeal nerve damage, with morbidity ranging 3% to 36%. Access site complications can also occur and are more common with percutaneous approach.[9] Endoleak is another complication associated with endovascular stent grafting. The incidence of early and late endoleak after endovascular treatment has been reported as 4.2% and 0.9%, respectively.[9] The two major trials – VALOR and VALOR II – concluded that the most common reason for secondary procedures following TEVAR was type I endoleak.[10] The trials also concluded that the rates of secondary procedures following TEVAR have been reduced in recent years. This can be attributed to the development of improved delivery systems and enhanced surgical expertise. There are currently ongoing trials on the role of glucocorticoids on the prognosis of TEVAR. Furthermore, another recent multi-centered trial evaluating the second generation thoracic endoprosthesis with 6-33% oversizing capacity and allowing better maneuverability of stent grafts inside the aorta demonstrated considerable promise of this treatment modality in TAIs.[11] In one of our patients, there was a good landing zone below the left subclavian artery origin and; hence, the perfusion of left arm was not occluded, while it was partially covered in other patient. No stent-related neurological deficit or access-site complications were seen in both of our patients. Due to high technical success, low mortality and low complication rates, endovascular stenting for aortic transection is now the primary treatment modality in many centres around the world. Because of lack of expertise and non-availability of stent grafts, this treatment was not available in Pakistan until recent times.

Our report gives an insight into the recent trends of EVAR becoming the mainstay treatment for TAIs. We recommend education and further training of surgeons to acquire expertise in this novel approach.

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