Thoracic endovascular aortic repair for traumatic injuries of descending thoracic aorta

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Introduction
Traumatic transection of the descending thoracic aorta is a highly morbid injury. In aortic thoracic injuries, thoracic endovascular aortic repair (TEVAR) represents a less invasive alternative to open chest operation.
Patients and methods
This is a prospective study which included 15 patients presented to the Vascular Unit of Cairo University (Kasr Al aini Hospitals) in the period between June 2016 and April 2018. All patients underwent TEVAR for aortic pseudoaneurysms after the descending thoracic aortic injury. Procedures were performed with standard endovascular techniques. All data were collected included age, sex, mode of injury, associated injuries, timing of intervention, diameter and length of graft, site of access, and postoperative complications. Follow-up included computed tomography at 1 and 6 months.
Results
This study included 15 patients (10 of them men and five women) with a mean age of 28 years. Nine patients presented due to motor car accident, two patients after balloon dilatation of aorta due to aortic coarctation, and four patients due to fall from a height. All injuries were in the descending aorta distal to the left subclavian artery. The success rate was 100% at intervention without any complications.
Conclusion
TEVAR is an effective and safe management for the patients presented with traumatic injury of thoracic aorta.

Keywords:
endovascular repair, injury, pseudoaneurysm, thoracic aorta

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Introduction

Rupture of the descending thoracic aorta is one of the most life-threatening conditions of blunt chest trauma, about 80–90% of victims die immediately at the scene of the accident. If these patients were untreated, about 30% of the living patients will die within the first 24 h after admission [1,2].

Most of the injuries of the descending thoracic aorta occur in its proximal part and less commonly occur at the arch of the ascending aorta [2,3]. In addition to aortic injuries, most of the patients presenting with blunt trauma to the chest also have multiple extrathoracic injuries which may cause development of shock and coma more than that caused by aortic transection and pseudoaneurysms, which make the choice of managment for aortic injury repair critical [2,4,5]. In comparison with open surgery, endovascular interventions for thoracic aortic injuries are less invasive, with no single lung ventilation, no cardiopulmonary bypass, and no need for systemic anticoagulation, or aortic cross-clamping [4,5]. Although endovascular intervention was associated with significant low mortality than with open surgical repair, there is a risk for serious and dangerous complications that are related to the devices themselves and this leads to an urgent need for improvement in the available stent-graft devices [6].

Patients and methods

This is a prospective study which included 15 patients who presented to the Vascular Unit of Cairo University (Kasr Al Aini Hospitals) in the period between June 2016 and April 2018. Informed consent was applied to all patients before any intervention. All patients presented with blunt thoracic aortic injury. Computed tomography (CT) image was done at the presentation with analysis of the following data: (a) the proximal and the distal aortic neck that are suitable for stent-graft placement, (b) aortic diameters, (c) distance from the left subclavian artery (LSA), and (d) adequate

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vascular access for stent delivery. Associated extrathoracic injuries were also recorded in the study. All patients are evaluated preoperatively considering history taking, proper physical examination, and CT scan Echocardiography was carried out in some patients. During the procedure, the following data were also collected: the type of anesthesia, access site, length and diameter of the devices, coverage of LSA, timing of stent deployment, and technical success. Technical success was defined as complete exclusion of the aortic injury site, absence of an endoleak, and complete coverage of the ruptured site. During early postoperative period (<30 days), the following data were recorded: device-related systemic or local complications and procedure-related deaths. After the discharge of patients, regular follow-up was done at 1, 3, and 6 months. Follow-up included physical examination for any systemic or neurological abnormalities. CT scan was done at follow-up for device integrity or endoleak.

Statistical analysis

Categorical variables are used as counts (percentages) and continuous variables are described by using the means and the ranges. Statistical analysis were done using SAS statistical software (Cary, North Carolina, USA).

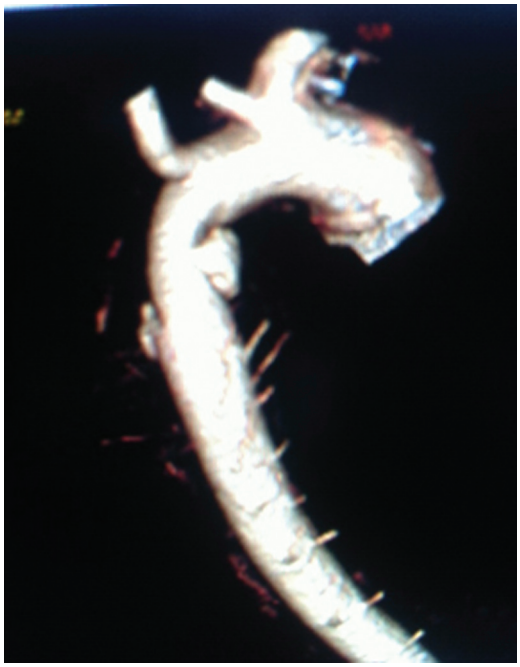
Results

This study included 15 patients, 10 (66.6%) patients were men and five (33.4%) were women (Table 1), with a mean of age 28 years (range, 22–34 years). All patients had contained aortic pseudoaneurysms in the descending thoracic aorta (Figs 1 and 2) due to blunt trauma, nine (60%) patients due to motor car accident, four (26.5%) patients due to fall from a height, and two (13.5%) patients presented after balloon dilatation of the aortic coarctation (Table 2). Regarding associated injuries, four patients had associated hemothorax; two patients were referred from other hospitals after laparotomy (one of them had duodenal injury in which repair was done and the other patient had splenic injury in which splenectomy was done); three patients presented with brain injury and disturbed conscious level; one patient presented by fractured humerus and chest pain; three patients had associated lung contusion, hemothorax, and pneumothorax; one patient presented after fall from a height (6th floor) by paraplegia and fractured pelvis and one patient had fractured femur and pelvis (Table 3).

Table 1 Demographic data of the patients

Male	10	66.6%
Female	5	33.4%

Figure 1



CTA of a patient presented by traumatic thoracic aortic pseudoaneurysm after blunt trauma.

Figure 2

CTA of a patient presented by traumatic thoracic aortic pseudoaneurysm after blunt trauma.

Table 2 Mode of injury

Mode of injury	*n* (%)
MCA	9 (60)
Fall from a height	4 (26.5)
Balloon dilatation of aortic coarctation	2 (13.5)

MCA, motor car accident.

Table 3 Associated injuries

Associated injuries	*n* (%)
Hemothorax	7 (46.6)
After laparotomy	2 (13.5)
Brain injury	3 (20)
Fractured humerus	1 (6.6)
Fractured pelvis	2 (13.5)
Fractured femur	1 (10)
Chest pain	1 (6.6)
Lung contusion	3 (20)
Paraplegia	1 (6.6)
Pneumothorax	1 (6.6)

Regarding the timing of intervention, in six patients, thoracic endovascular aortic repair (TEVAR) was done after 24 h of admission, three patients after 2 days, three patients after 3 days, two patients after 5 days, and one patient after 4 weeks of admission because the graft was not available. During the intervention, all procedures were done under general anesthesia. Right femoral access through open surgical exposure was used in 11 (73.4%) patients and left femoral access in four (26.6%) cases; in nine patients we used stent-grafts with a diameter of 22 mm and in six patients 24 mm diameter grafts were used (Fig. 3). All stent-grafts were implanted successfully in all 15 patients with a technical success rate of 100%. LSA was covered in three patients due to the proximity of the injury to the origin of LSA without symptoms of ischemia during the procedure or at follow-up. There were no endoleak, paraplegia, access site complications, or mortality during the procedure. Follow-up was done at 1, 3, and 6 months and computed tomography angiography (CTA) was done. One patient with duodenal injury died after 35 days due to the effect of the duodenal injury. There was no endoleak, stent migration, or access site complications at the follow-up.

Discussion

Aortic pseudoaneurysms may be caused by multiple reasons, iatrogenic injury, trauma, atherosclerosis, rarely infection, and by other causes [7]. In the study done by Sueyoshi *et al*. [8], 31.4% of thoracic aortic pseudoaneurysms was traumatic. In our study, nine patients due to motor car accident (60%), four (26.5%) patients due to fall from a height, and two (13.5%) patients presented after balloon dilatation of aortic coarctation.

Figure 3

Stenting of descending thoracic aorta with traumatic pseudoaneurysm without endoleak.

Any organ is susceptible to injury and these injuries include head injuries, intracranial hemorrhage, pulmonary contusion, long bone fractures, pelvic injuries, intraabdominal organ injuries, fracture of the spine with or without cord injury, diaphragmatic rupture, maxillofacial injury, and cardiac contusion. In a study done by Galli *et al*. [9], they recorded only three cases out of 42 cases with sole thoracic aortic injuries and much more commonly, it is associated with other organ injuries. Smith and Chang [10] found that patients who died had four associated injuries on average compared with two inpatients who survived. In a study done by Fabin *et al*. [11], they recorded a high incidence of multiorgan injuries. In our study, seven patients were associated with hemothorax, two patients presented after laparotomy, three patients had brain injury, paraplegia in one patient, lung contusion in three patients, pelvic fracture in two patients, and long bone fracture in two patients.

Regarding the timing of intervention, traditionally, patients presented by traumatic descending thoracic aortic injuries have been managed by open surgical repair either immediate or delayed repair which was converted to endovascular repair [12]. In a study done by Buz *et al*. [5], 50% of the patients presented by traumatic thoracic aortic injury underwent endovascular repair within 24 h of presentation. In this study, TEVAR was done in six patients after 24 h of admission, three patients after 2 days, three

patients after 3 days, two patients after 5 days, and one patient after 4 weeks of admission.

It is proved that TEVAR is an effective treatment option for blunt thoracic aortic injuries with a high technical success rate [13]. Buz *et al.* [5] reported that 40 patients presented after blunt traumatic thoracic aortic injury underwent TEVAR procedure with a 100% technical success rate [5]. In our study, TEVAR was done successfully in 15 patients presented after thoracic aortic injury with a technical success rate of 100%.

The use of TEVAR is rapidly expanding and with the experiences gained and devices improved, the trend seems to be pointing toward the improving outcomes and decreasing postoperative complications [14]. Recently, TEVAR has been proved to be the preferred management for traumatic descending thoracic aortic injuries in many centers due to the high significant reduction in perioperative morbidity and mortality [15]. In a study done by Burkhart and colleagues, neurological, access site complications or device collapse may cause a morbidity of between 3 and 36% of the patients and only one (2.5%) patient suffered from injury of external iliac artery which was treated surgically. No patient had endoleak or need conversion to surgical repair and with comparison to other studies using TEVAR the incidence of these complications were acceptable with a survival rate of 93.7% with only two deaths not related to the TEVAR procedure [16]. In a large retrospective study 106 patients who underwent TEVAR showed fewer complications and lower risk of hospital deaths in comparison to open surgery [17]. Another large meta-analysis reported the lower mortality and lower rate of spinal cord ischemia for the TEVAR group and reduced risk of graft and systemic infections [18]. In this study, there were no endoleak, paraplegia, access site complications, or mortality during the procedure. Only one patient with duodenal injury died after 35 days due to the effect of the duodenal injury. There were o endoleak, stent migration or access site complications at the follow-up.

Conclusion

TEVAR is an effective and safe modality of management for these patients who were presented with traumatic thoracic aortic injuries with lower incidence of mortality and perioperative complications.

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Conflicts of interest

There are no conflict of interest.

References

1 Fabian TC, Roger T. Sherman lecture. Advances in the management of blunt thoracic aortic injury: parmely to the present. Am Surg 2009; 75:273–278.

2 Burkhart HM, Gomez GA, Jacobson LE, Pless JE, Broadie TA. Fatal blunt aortic injuries: a review of 242 autopsy cases. J Trauma 2001; 50:113–115.

3 Neschis DG, Scalea TM, Flinn WR, Griffith BP. Blunt aortic injury. N Enhl J Med 2008; 359:1708–1716.

4 Demetriades D, Velmahos GC, Scalea TM, Jurkovich GJ, Karmy-Jones R, Teixeira PG, *et al.* Diagnosis and treatment of blunt thoracic aortic injuries: changing perspectives. J Trauma 2008; 64:1415–1419.

5 Buz S, Zipfel B, Mulahasanovic S, Pasic M, Weng Y, Hetzer R. Conventional surgical repair and endovascular treatment of acute traumatic aortic rupture. Eur J Cardiothorac Surg 2008; 33:143–149.

6 Demetriades D, Velmahos GC, Scalea TM, Jurkovich GJ, Karmy-Jones R, Teixeira PG, *et al.* Operative repair or endovascular stent graft in blunt traumatic thoracic aortic injuries: results of an American Association for the Surgery of Trauma Multicenter Study. J Trauma 2008; 64:561–571.

7 Whitehouse MJ, Galvin SD, Horrocks C, Mahon BD. Traumatic pseudoaneurysm of the aortic arch with aortovenous fistula. J Card Surg 2012; 27:609–610.

8 Sueyoshi E, Sakamoto I, Nkashima K, Minami K, Hayashi K. Viseral and peripheral arterial pseudoaneurysms. Am J Roentgenol 2005; 185:741–749.

9 Galli R, Pacini D, Di-Batolomeo R, Fattori R, Turinetto B, Grillone G. Surgical indications and timing of repair of traumatic rupture of the thoracic aorta. Ann Thoracic Surg 1998; 65:461–464.

10 Smith RS, Chang FC. Traumatic rupture of the aorta: still a lethal injury. Am J Surg 1986; 152:660–663.

11 Fabin TC, Richardson DJ, Croce MA, Smith SJ, Rodman G. Prospective study of blunt aortic injury. J Trauma Injury Infect Crit Care 1997; 42:374–383.

12 Rousseau H, Soula P, Perreault P, Bui B, Janne d'Othee B, Massabuau P, *et al.* Delayed treatment of isthmic aortic rupture of the thoracic aorta with endoluminal covered stent. Circulation 2009; 99:498–504.

13 Lachat M, Pfammatter T, Witzke H, Bernard E, Wolfensberger U, Kunzil A, Turina M. Acute traumatic aortic rupture: early stentgraft repair. Eur J Cardiothoracic Surg 2002; 21:959–963.

14 Yamane BH, Tefera G, Hoch JR, Turnipseed WD, Acher CW. Blunt thoracic aortic injury: open or stent graft repair? Surgery 2008; 144:575–580.

15 Nechis DG, Moainie S, Flinn WR, Scalea TM, Bartlett ST, Griffith BP. Endograft repair of traumatic aortic injury – a technique in evolution: a single institution's experience. Ann Surg 2009; 250:377–382.

16 Burkhart Z, Roberto C, Andrea K, Enrico M, Carlo S, Carlos E. Endovascular repair of traumatic thoracic aortic injury: Final results from the relay endovascular registry for thoracic disease. Ann Thoracic Surg 2014; 97:774–781.

17 Azizzadeh A, Charlon KM, Chen Z, Rahbar MH, Esterrera AL, Amer H, *et al.* An outcome analysis of endovascular versus open repair of blunt traumatic aortic injuries. J Vasc Surg 2013; 57:108–114.

18 Murad MH, Rizvi AZ, Malgor R, Carey J, Alkatib AA, Erwin PJ, *et al.* Comparative effectiveness of the treatment for thoracic aortic transection. J Vasc Surg 2011; 53:193–199.