Original Article

Experience of endovascular repair of thoracic aortic dissection after blunt trauma injury in a district general hospital

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Background: Traumatic thoracic aortic dissection is uncommon in clinical practice; however, it is associated with high morbidity and mortality. Thoracic aortic dissection is usually caused by sudden deceleration resulting from a traffic accident or fall. Aortic injury after blunt trauma is a critical condition. This study reported the outcomes of endovascular repair of acute traumatic aortic dissection in patients at a district general hospital.

Methods: In this study, we retrospectively reviewed the clinical data of eight patients with acute traumatic aortic dissection after a blunt trauma who had undergone thoracic endovascular aortic repair (TEVAR) between January 2012 and December 2015 at a district general hospital in Taiwan.

Results: The median age of the patients was 49±22 years (range, 20–77 years), and 6 of the 8 (75%) patients were men. Five patients were involved in traffic accidents, and 3 patients had fallen from heights. The injury severity score (ISS) of the patients ranged from 17 to 66. In all patients, the aortic injury was located near the origin of the left subclavian artery (LSA). Four patients had seal ostium of subclavian artery, left. None of the patients developed paraplegia or lower extremity ischemia. Moreover, all patients had concomitant injuries, and no patients died postoperatively.

Conclusions: Endovascular repair is a rapid and minimally invasive therapy for patients with traumatic aortic injury and is associated with favorable technical results.

Keywords: Blunt trauma; traumatic aortic dissection; thoracic endovascular aortic repair (TEVAR)

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Introduction

Thoracic aortic injuries are associated with high mortality and are the second most common cause of death in trauma patients after intracranial hemorrhage (1). Thoracic aortic dissection is usually a result of sudden deceleration caused by a traffic accident or fall. The most common rupture location is the aortic isthmus (i.e., the region between the fixed aortic arch and mobile thoracic aorta) (1,2).

Thoracic endovascular aortic repair (TEVAR) is a rapidly evolving therapy for various thoracic aortic pathologies and involves the placement of an endovascular stent graft in the thoracic aorta from a remote peripheral location under imaging guidance. TEVAR is a less invasive option for managing traumatic injuries of the descending aorta in polytraumatized patients. Because TEVAR is less invasive and does not involve thoracotomy or use of heparin, it can be performed even in acutely injured patients without the risk of destabilizing pulmonary, head, or abdominal

Table 1 Basic status

Cases	Age (y)	Sex	Weight (kg)	Blood pressure (mmHg)	ISS score	Mechanism	Hospital stay (d)	ICU (d)
1	20	M	70	50/25	34	Traffic accident	40	20
2	35	M	107	73/53	66	Falling down	31	26
3	53	M	50	112/60	17	Traffic accident	23	7
4	77	F	72	119/58	20	Traffic accident	16	10
5	68	M	64	129/63	17	Falling down	17	7
6	37	M	77	147/97	28	Falling down	45	21
7	73	M	59	115/64	34	Traffic accident	52	23
8	26	F	75	137/85	29	Traffic accident	24	10

Figure 1 Coverage of the left subclavian artery was performed to achieve a satisfactory proximal sealing zone.

traumatic lesions. The goal of TEVAR is to reduce the risk of aortic rupture and subsequent fatal hemorrhage.

Methods

Patient demographics

This study was evaluated and approved by the institutional review board of our hospital. In this study, we retrospectively reviewed the clinical data of eight patients with traumatic thoracic dissection who had undergone TEVAR between January 2012 and December 2015 at the vascular surgery department of a district general hospital in Taiwan. All patients had undergone thoracoabdominal computed tomography angiography with an interval slice of 5 mm for evaluation of the entire aorta and possible accompanying injuries in other organ systems. None of the patients had undergone open surgical aortic repair for treating traumatic aortic injuries after TEVAR during the study period. All procedures were performed with the patients under general anesthesia. Cerebrospinal fluid drainage was not performed in any patient, and none of the patients had undergone cervical debranching before stent graft placement. In addition, medical history of the eight patients was reviewed. Data on demography and concurrent injuries were obtained, and the injury severity score (ISS) was calculated. Conformable GORE® TAG® Thoracic Endoprosthesis was used in all patients, and Perclose ProGlide® was used in selected patients. After discharge, the patients were followed up regularly.

Results

Preoperative and postoperative risks

The mean age of the patients was 49±22 years (range, 20–77 years). Of the eight patients assessed, six were men and two were women. All the patients had descending thoracic aortic dissection. All patients had a history of serious trauma and associated severe injury, with a high ISS (range, 17–66). Five patients had been involved in a traffic accident, and three patients had fallen from a height (*Table 1*).

All patients had undergone TEVAR; the endovascular stent graft was placed in the proximal part of the descending aorta. Coverage of the left subclavian artery (LSA) was performed in four patients to achieve a satisfactory proximal sealing zone (*Figure 1*); none of these four patients developed any complication (*Table 2*). None of the patients

Table 2 Operative data

Cases	Access	Seal**	Aorta (mm)	Stent-graft (mm)	Oversize (%)	Neck (mm)	Operation (min)	Blood loss*** (mL)	Blood transfusion (mL)
1	Right CFA	Seal	20	26	30	15	125	10	5,000
2	Right CFA	Seal	21	26	28	15	77	50	1,000
3	*Left CFA	Seal	23	28	22	15	100	50	1,000
4	Right CFA	Seal	31	34	10	15	105	50	2,250
5	Right CFA	Partial	27	34	26	15	164	20	1,000
6	*Left CFA	No	21	28	33	20	47	50	0
7	*Right CFA	No	30	34	13.30	20	50	30	500
8	Left CFA	No	24	31/26, 21/21	29	20	59	20	1,000

*, percutaneous puncture method with proglide; **, seal of ostium of subclavian artery, left; ***, blood loss from access during operation; CFA, common femoral artery.

Table 3 Associated injury

Organ	Number (%)
Head	6 (75.0)
Lung (hemothorax)	5 (62.5)
Multiple rib fracture	5 (62.5)
SAH	4 (50.0)
Liver	3 (37.5)
Spleen	2 (25.0)
Femur	2 (25.0)
Pelvis	2 (25.0)
L spine fracture	2 (25.0)
Facial bone fracture	2 (25.0)
Tibia	1 (12.5)
Fibula	1 (12.5)
Clavicle	1 (12.5)
T spine fracture	1 (12.5)
Scrotum	1 (12.5)
Gallbladder	1 (12.5)

SAH, subarachnoid hemorrhage.

developed paraplegia or left upper extremity ischemia and no patient had died postoperatively. All patients had concomitant injuries (*Table 3*). Closed head injury and subarachnoid hemorrhage were observed in 75% (6/8) and 50% (4/8) patients, respectively, with traumatic aortic injury. Five (62.5%) patients had multiple rib fractures and hemothorax. Liver injuries and spine fractures were observed in 37.5% (3/8), and spleen injury, pelvic injuries, femur bone fracture, and facial bone injuries were observed in 25% (2/8) of the patients. Perclose ProGlide® was used in three patients. We oversized 10–33% depending on the availability at the time of the trauma and manufacturer instructions. None of the patients died during hospital stay. Moreover, none of the patients showed signs of ischemia or loss of motor function at discharge or during follow-up.

Discussion

Traumatic thoracic aortic injuries are uncommon but severe and life-threatening clinical entities. Without appropriate treatment, up to 50% of the initial survivors die within the first 72 hours (3). Parmley and colleagues reported that 88% of the patients died during the first hour and 10% died within two weeks (4). Blunt trauma to the thoracic aorta typically occurs during a high velocity accident because of a combination of sudden deceleration and shearing of the relatively immobile aortic isthmus, which is located distal to the LSA and proximal to the third intercostal artery and is the junction between the relatively mobile aortic arch and the fixed descending aorta. Therefore, the isthmus is the most common location for rupture (50–70% of the cases), followed by the ascending aorta or aortic arch (18%), and the distal thoracic aorta (14%) (3,5). In our study, all patients (8/8, 100%) showed injury to the isthmus. Motor vehicle accidents are responsible for 96.7% of the thoracic aortic injuries, and blunt trauma caused by a fall are responsible for the remaining 3.3% of the injuries (6,7). In our study, 62.5% (5/8) and 37.5% (3/8) of the patients had experienced a traffic accident and a fall, respectively. The incidence rate of a fall from height was higher in the present study than in other studies.

Blunt aortic injury is the most common cause of death in trauma patients, with an overall incidence rate of 0.3% (8).

Thoracic aortic injury often goes undiagnosed, unless it is highly suspected by healthcare providers. Therefore, early triage of this condition is critical for survival. However, aortic injuries rarely occur in isolation, and no appropriate cutoff value is available for selecting an appropriate surgical strategy. The first comprehensive review on thoracic aortic injuries was published in 1958 by Parmley *et al*., who reported an out-of-hospital mortality of 86.2% in 275 cases (4). However, mortality associated with thoracic aortic injury has not reduced much in the last four decades despite considerable advances in prehospital management. In 1994, Williams *et al*. reported 75% mortality in patients with aortic injury secondary to blunt trauma caused by aortic transection or acute rupture (9). The course for natural progression of a transected thoracic aorta to subsequent rupture is unpredictable. Anxiety pertaining to such rupture is not unfounded, because although 25% of the patients arrive at the hospital on time, their prognosis remains poor, with nearly 30% of these patients dying within 6 hours and 50% of these patients dying within the first 24 hours (10,11).

Multiple organ injuries are frequently observed in patients with traumatic aortic injury, indicating that aortic injury rarely occurs as an isolated injury. Considering its nature, aortic injury is commonly associated with other organ injuries. Fabian *et al*. and Wahl *et al*. reported high incidence of multiple organ injuries in patients with traumatic aortic injury, such as closed head injury in 51% of the patients, intracranial hemorrhage in 24%, multiple rib fractures in 46%, pulmonary contusions in 38%, upper limb fractures in 20%, pelvic injuries in 31%, liver injuries in 22%, spine fractures in 4%, spinal cord injuries in 4%, and maxillofacial injuries in 13% of the patients (12-14). In our study, 75% (6/8) of the patients showed closed head injury and 50% (4/8) of the patients showed subarachnoid hemorrhage along with traumatic aortic injury. Five (62.5%) patients sustained multiple rib fractures and hemothorax. Liver injuries and spine fractures were observed in 37.5% (3/8) of the patients, and spleen injury, pelvic injuries, femur bone fracture, and facial bone injuries were observed in 25% of the (2/8) patients. The number of associated injuries reported in the present study was higher than that in other studies because of recent increases in the speed limit on roads, and consequently, higher vehicular speeds. Therefore, evaluating the severity of multiple injuries in these patients is critical and can be performed using ISS. In Fabian *et al.*, the mean ISS was 42.1 (12). In their study, all the patients had a history of serious trauma injury and high ISS (range, 17–66). Smith *et al*. found that on average, nonsurviving and surviving patients had 4 and 2 associated injuries (14). In the present study, none of the patients died during the hospital stay.

Endovascular repair for chronic infrarenal abdominal aortic aneurysms, introduced in the 1990s, is associated with a low complication rate, less operating time, and a high success rate. Moreover, it appears to be superior to open surgery because it is associated with minor operative trauma and because thoracic endografts have been used for managing blunt aortic injuries since 2001 (15,16). TEVAR is less invasive than conventional surgery. At present, TEVAR is an effective treatment option for treating patients with blunt thoracic aortic injuries (17,18). Because most injuries affect the aortic isthmus and because patients with traumatic thoracic aortic injuries have adequate proximal and distal landing zones, exclusion of an aortic tear with a stent can be performed rather easily. Our experience with traumatic thoracic aortic ruptures suggests that endovascular repair should be the method of choice, especially in unstable multi-trauma patients. TEVAR is associated with better postoperative recovery because it is a minimally invasive procedure that involves excision of an arterial puncture and does not involve creation of a large incision such as those created during thoracotomy, aortic cross-clamping, cardiac bypass, and single-lung ventilation. This in turn prevents major blood pressure variations and coagulopathy, which is advantageous in trauma patients with concomitant injuries, such as pulmonary contusion, in whom a thoracotomy wound could prolong recovery. Moreover, the lower intraoperative blood loss in TEVAR reduces the risks of ischemic events that may lead to spinal cord ischemia and paraplegia, ischemic bowel disease, or kidney failure. Thus far, no studies on endovascular repair of traumatic aortic injuries have reported a paraplegic complication (19). In the present study, we performed isolated TEVAR in eight patients and did not observe paraplegia or major complications. Thus, most severely ill patients admitted to hospitals can survive if they undergo emergency surgery. Because most patients have multiple injuries, evaluation of the severity of these injuries and estimation of survival probability is critical for determining the most appropriate surgical treatment. Moreover, because patients typically have multiple organ injuries, TEVAR, which is minimally invasive, can be performed in tandem with other surgical interventions. Systemic anticoagulation with heparin during TEVAR is rare or occasionally omitted; this is particularly beneficial in patients with concomitant intracranial or abdominal bleeding. In our case series, the timeline for

performing TEVAR varied among patients; however, in all patients, TEVAR was performed after treating the life-threatening injuries, which greatly affected the mortality rate.

The aortic isthmus is usually the rupture site in aortic thoracic injuries. Therefore, the distance from the LSA usually allows proximal stent graft fixation. The main challenge is the intentional coverage of the LSA, which is necessary to expand the proximal landing zone and to achieve an adequate seal. We observed complete occlusion in four patients and partial occlusion in the ostium of the LSA in 1 patient while performing TEVAR. None of the patients developed complications during follow-up. Most authors have reported the need for LSA revascularization only for specific indications, such as long aortic segment coverage, prior or concomitant infrarenal aortic replacement, hypoplastic right vertebral artery, patent left internal mammary artery graft, or functioning dialysis fistula in the left arm (20). None of the patients in the present study had indications for LSA revascularization and showed symptoms of subclavian steal syndrome or hand ischemia. A few studies have reported that intentional coverage of the LSA without revascularization is not associated with additional morbidity. However, most studies have reported higher incidence of postoperative arm ischemia and posterior circulation stroke in patients who undergo intentional coverage of the LSA compared with patients who do not undergo intentional coverage (21-24).

Our study has the following limitations. Our sample size was small. Because of constant advances in endovascular repair technologies and the low number of trauma patients undergoing this procedure at each center, following up these patients clinically and scientifically is crucial.

Conclusions

TEVAR is a relatively fast and safe method for treating patients with blunt trauma-associated thoracic aortic injuries and is in consistent with the principles of damage control.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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