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Outcomes after thoracic endovascular aortic repair in patients with traumatic thoracic aortic injuries—a single-centre retrospective review

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Summary
Background Blunt and penetrating traumatic thoracic aortic injuries constitute surgical emergencies that are attended with high mortality rates. Most patients do not survive long enough, post injury, to reach a hospital. On-site mortality rates may approach approximately 85%. Two main treatment options for blunt thoracic aortic injuries are open surgery and thoracic endovascular repair. Penetrating thoracic aortic injuries have a higher mortality than blunt trauma, with patients often only reaching the hospital in extremis. Thoracic endovascular repair is currently rapidly evolving as the standard of care for thoracic aortic injuries at many centres.
Methods This is a ten-years retrospective study during which data from December 2006 to December 2016 was collected, yielding 34 patients (30 blunt trauma, 4 penetrating trauma). These injuries were treated with thoracic aortic stent grafts at the Groote Schuur Hospital Vascular Unit, Cape Town. We assessed the technical and clinical outcomes.
Results The 30-day mortality rate was 5.8%, corresponding to 2 deaths both associated with the index trauma-related fatal strokes. The overall mortality rate was 11.8% (4/34): three deaths were due to major strokes and one death was related to pulmonary complications.
Conclusion Thoracic endovascular repair after traumatic aortic injury is associated with significantly lower procedural and post-operative mortality. The 30-day and overall mortality after thoracic endovascular repair in our unit is comparable to international standards. Even though there is a paucity of literature on penetrating traumatic aortic injury, thoracic endovascular repair has low peri-procedural adverse events and is safe in selected patients.

Keywords Blunt aortic injury · Aortic traumatic injury · Thoracic aortic injury · Blunt thoracic aortic injury · Penetrating thoracic aortic injury

Main novel aspects

- Despite resource limitations in an African setting, our results were comparable to international data.
- This is the first study in the sub-Saharan Africa to report a 10-year experience with thoracic endovascular repair for traumatic thoracic aortic injuries

Introduction

Blunt traumatic thoracic aortic injury (BTAI) caused by motor vehicle accidents and less commonly by other blunt thoracic trauma constitutes a surgical emergency. These injuries are often attended with high mortality rates. Two main treatment options for BTAI are open surgical repair (OSR) and thoracic endovascular repair (TEVAR). Penetrating thoracic aortic injuries (PTAI) generally have a higher mortality than blunt trauma, with patients often reaching the hospital in extremis. On-site mortality in both these cases approaches 85%. Currently TEVAR is rapidly evolving as the standard of care for thoracic aortic injuries

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(TAI) at many centres, primarily due to the lower mortality and morbidity rates compared to open surgery [1–4]. We only started performing TEVAR at Groote Schuur Hospital (GSH) from 2006.

The burden of civilian trauma in South Africa is absolutely devastating [5]. In 2007 the National Injury Mortality Surveillance System recorded 33,484 civilian trauma-related deaths, more than one-third of which were related to inter-personal violence, followed by road traffic injuries [6].

The first-reported case of BTAI was by the Italian anatomist Andreas Vesalius in 1557 [7], who identified aortic rupture as the cause of death in a patient thrown from a horse. Now with the availability of modern imaging technologies, BTAI, a life-threatening surgical emergency, is more easily diagnosed. The mechanism of injury is related to sudden horizontal or vertical acceleration–deceleration injury, and most cases are a result of motor vehicle accidents (MVA), pedestrians struck by vehicles (PVA) or falls [1–3]. Penetrating aortic injuries have an exceptionally high mortality rate. Regarding PTAI, gunshot wounds, un-recordable blood pressure on admission, and the need for emergency room thoracotomy are important predictors of high mortality [8].

Thoracic endovascular aortic repair (TEVAR) has evolved since the introduction of open surgical repair in 1959 [7], with the first description of TEVAR by Volodos in 1991 [9]. Open repair has been shown to be associated with a high peri-operative mortality and morbidity rate [3, 4]. The American Association for the Surgery of Trauma (AAST)-1 trial evaluated outcomes after open repair. The peri-operative and overall mortality rates were 15% and 31%, respectively [10].

Thoracic endovascular aortic repair (TEVAR) was a transformative advance in the treatment of BTAI and was first described for management of aortic injury by Michael Dake and colleagues in 1997 [11]. In 2008, the AAST-2 study was published. In this study, TEVAR was associated with significantly lower procedural and post-operative morbidity and mortality rates compared to open surgical repair [12]. The RESCUE trial showed infrequent major procedural and long-term device-related complications and no patients required aortic re-intervention or had neurologic complications after TEVAR. Overall mortality at 30 days and at 1 year was 8% and 12%, respectively [13].

Comparison between the two AAST studies in 1997 and 2007 showed a major shift in the diagnosis of the aortic injury, with the widespread use of CT scan and the almost complete elimination of aortography and transoesophageal echocardiography (TEE). The concept of delayed definitive repair has gained wide acceptance. This provides a window of opportunity to attend to critical issues and interventions, and more importantly to prognosticate before aortic repair. Endovascular repair has virtually replaced open repair. This paradigm shift has not only resulted in a major reduction in mortality and procedure-related paraplegia, but is also associated with a significant decrease of early stent graft-related complications [15]. A Meta-analysis of publications with open and stent graft repair cohorts was performed by Hoffer et al. to evaluate whether there was a difference in treatment effect with regard to mortality and paraplegia. Nineteen publications that compared the outcomes of 262 endograft repairs and 376 open surgical repairs were identified. The data support stent graft repair as a highly successful technique that may reduce mortality and paraplegia rates by half compared to open surgery and support endograft repair as first-line therapy for blunt thoracic aortic trauma [16]. The evolution of stent graft design over time has resulted in more conformable devices that are better equipped to accommodate severely angulated aortic arches, especially in young patients. Consequently, stent graft compression seen with earlier devices is less frequently reported nowadays.

A classification scheme for grading the severity of aortic injury has been proposed: type I (intimal tear), type II (intramural hematoma or intimal flap), type III (pseudo aneurysm) and type IV (rupture) [17]. The Society for Vascular Surgery (SVS) 2011 guidelines recommends expectant management with serial imaging for type I injuries, while types II to IV should be repaired. With the advent of high-resolution helical CT scanning for the diagnosis of suspected BTAI, identification of minimal aortic lesions has become increasingly prevalent. Approximately 10% of patients with BTAI experience minimal aortic injuries that result in focal intimal tears with no or little involvement of the media [18]. However, 21% of BTAI patients with minimal aortic injuries undergo TEVAR despite the clinical practice guidelines of the Society of Vascular Surgery to the contrary [19].

Several studies have shown favourable results after TEVAR for blunt thoracic aortic injury (BTAI). Here we report our 10-year experience with TEVAR for traumatic thoracic aortic injuries (TTAIs). There has been paucity of literature on TEVAR after penetrating thoracic aortic injury (PTAI). We believe that this study could produce data and stimulate further research that may be of real benefit to patients, including long-term outcomes, durability of stent grafts, and the use of stent grafts in the younger population, as well as CT angiography surveillance and exposure to radiation.

Our hypothesis is that TEVAR after TAI is associated with significantly lower procedural and post-operative morbidity and mortality. We postulated that the 30-day mortality after TEVAR, despite resource limitations in an African setting, will be comparable to international standards. The aim of the study is to assess the technical and clinical outcomes following TEVAR in patients with civilian trauma-related TAIs (TTAI).

Materials and methods

This is a single-centre one-year (June 2016–May 2017) retrospective descriptive study of all patients treated by the Vascular Unit at Groote Schuur Hospital in Cape Town, South Africa. Approval for this study was obtained from the Human Research Ethics Committee, Faculty of Health Sciences and University of Cape Town (REF: 635/2016). We included all patients aged over 18 years who were admitted to our Vascular/Trauma Units with TTAI confirmed on CT scan on admission who were treated with TEVAR from December 2006 to December 2016. Patients' demographics, clinical characteristics, imaging, bedside tests, laboratory tests, management, and follow-up data were extracted from the trauma registry, vascular registry and theatre registry. These were reviewed and the severity of aortic injuries were classified as: type I (intimal tear), type II (intramural hematoma or intimal flap), type III (pseudo aneurysm) or type IV (rupture) [21]. Intraoperative angiogram findings were obtained from the operation notes. The type of aortic injury was also noted. The arch type was recorded, measured as the vertical distance from the origin of the innominate artery to the top of the arch: type 1 (distance <1 common carotid diameter [CCA]), type 2 (between 1 and 2 CCA diameters) and type 3 (>2 CCA diameters) [22]. Arch anomalies were identified and recorded.

Results

Demographics and comorbidities

A total of 34 patients were enrolled into the study. There were 31 males (91.2%) and three (8.8%) females. The mean age of enrolled patients was 35.1 ± 11.5 years (range: 20–65 years). Twenty-six patients had no medical comorbidities as shown in Table 1. Nineteen patients did not know their HIV status. All HIV-positive patients were on treatment. HIV testing is not routinely performed on all patients and patient have to give consent for HIV testing. This coupled with the unwillingness of most patients to have an HIV test leads to fewer patients getting tested.

Presentation

At presentation, the mean pulse rate was 112 ± 20/minute and mean systolic pressure was 116 ± 25 mm Hg. The median Glasgow Coma Score (GCS) was 15 (range: 4–15). Eight patients were intubated either at the scene or upon arrival at the hospital. The average pH of patients on admission was 7.38 ± 0.06; minimum recorded pH was 7.23 and maximum pH 7.47. The frequency distribution of some biochemical variables (pH, lactate, Hb, creatinine) are as shown in Table 2.

Table 1 Demographics and comorbidities

Characteristics	*N* = 34
Age (years)	
Mean ± SD	35.1 ± 11.4
Median (range)	34 (20–65)
Gender	
Male	31 (91%)
Female	3 (8.8%)
Comorbidities	
Hypertension	3 (8.8%)
Diabetes	2 (5.9%)
Tuberculosis	1 (2.9%)
Epilepsy	1 (2.9%)
Cerebrovascular accident	0 (0%)
Paraplegia	4 (11.8%)
Smoking	14 (41.2%)
HIV status	
Positive	3 (8.8%)
Negative	12 (35.3%)
Unknown	19 (55.9%)

SD standard deviation, *HIV* human immunodeficiency virus

Table 2 Frequency distribution of biochemical variables

		pH	Lactate	Hb	Creatinine
N	Valid	28	23	33	28
	Missing	6	11	1	6
Mean	–	7.38	1.71	10.78	81.57
SD	–	0.06	1.87	2.18	29.82

Hb (g/dl); creatinine (Umol/L); lactate (mmol/L)

Mechanism of injury

Thirty patients sustained blunt trauma and 4 patients sustained penetrating trauma. In the blunt trauma group, 28 patients sustained motor vehicular accidents while 2 patients were involved in falls from a height. In the group of patients who sustained motor vehicular accidents (*N* = 28), seven were unrestrained drivers, four were motorcyclists (two with helmets on and two with helmet use information not documented), eight were unrestrained passengers and nine were pedestrians. In the group of patients who sustained injuries due to penetrating trauma, three were related to gunshot wounds and one was an iatrogenic injury sustained at thoracotomy (Table 3). Comparatively, penetrating trauma patients were younger, with a median age of 28 years (range 22–56) and had a median Injury Severity Score (ISS) of 17. The Injury Severity Score, an anatomical scoring system that provides an overall score for patients with multiple injuries, was calculated for each patient. Each injury was assigned an Abbreviated Injury Scale (AIS) score and was allocated to one of six body regions (head, face, chest, abdomen, extremities (including pelvis) and external). Only the highest AIS

Table 3 Injury proportions grouped according to mechanism of injury

Classification according to mechanism of injury	Count	Percent (%)
Blunt trauma	30	88.2
Motor vehicular accidents (MVA)	28	
Fall	2	
Penetrating trauma	4	11.8
Gunshot injuries	3	
Iatrogenic penetrating injuries	1	

Table 4 Comparison between blunt and penetrating trauma

Characteristics	Blunt trauma ($n=30$)	Penetrating trauma ($n=4$)
Age: median (range)	35 (20–65)	28 (22–56)
Gender		
Male	27	4
Female	3	0
GCS: median (range)	15 (4–15)	15 (In all four patients)
ISS: median (range)	33 (13–66)	17 (16–34)
Classification (extent of aortic injury)		
Grade I: intimal tear	0/30 (0.0%)	1/4 (25.0%)
Grade II: intramural hematoma	6/30 (20.0%)	2/4 (50.0%)
Grade III: pseudo-aneurysm	21/30 (70.0%)	1/4 (25.0%)
Grade IV: free rupture	3/30 (10.0%)	0/4 (0.0%)
Day of TEVAR: median (range)	2.0 (0–20)	13.5 (4–67)
ICU stay: mean ± SD	8 (±7.0)	2 (±5)
Primary endpoints		
30-day mortality	2/30 (6.7%)	0/4
Overall mortality	4/30 (13.3%)	0/4

ISS Injury Severity Score, *GCS* Glasgow Coma Score, *TEVAR* Thoracic Endovascular Aortic Repair, *ICU* Intensive Care Unit

score in each body region was used. The three most severely injured body regions have their score squared and added together to produce the ISS score. The ISS scores range from 1 to 75. If an injury is assigned an AIS of 6 (identifying an untreatable injury), the ISS score is automatically assigned 75. No grade IV aortic injuries were documented for penetrating aortic injuries. Table 4 compares characteristics of patients who sustained blunt vs. those who sustained penetrating trauma.

Imaging

Frontal chest x-ray was used as a screening tool for thoracic aortic injuries. Findings suggestive of thoracic aortic injury included widened mediastinum, obliteration of the aortic knob contour, left main stem bronchus depression, lateral displacement of the trachea and loss of the paravertebral pleural line. Twenty-two patients had a widened mediastinum and 12 patients had other suggestive findings. All patients

Table 5 Injury proportions grouped according to radiological findings

Classification scheme according to injury severity		
Grade I: intimal tear	1	2.9
Grade II: intramural haematoma	8	23.5
Grade III: pseudo-aneurysm	22	64.7
Grade IV: free rupture	3	8.8
Anatomical radiological classification schemes		
Arch types		
Type 1	28	82.4
Type 2	4	11.8
Type 3	2	5.8
Arch anomalies		
Bovine arch	3	8.8
Vertebral artery off the arch	2	5.9
Bovine arch and left vertebral artery off the arch	1	2.9

who had suggestive chest X-ray findings had CT angiography to diagnose and grade the injury. The commonest aortic pathology was a grade III aortic injury (64.7%) followed by grade II aortic injuries (23.5%). Only one patient (2.9%) had a grade I aortic injury and three patients (8.8%) had grade IV aortic injuries. Unsuitable anatomy, hemodynamic compromise requiring emergent surgery and inadequate proximal landing zone to allow for adequate seal are findings that may make candidates unsuitable for TEVAR but open surgery. The thoracic device sizing was selected based on the measurements from the thin-cut axial CT scans and the manufacturers' sizing recommendations. We found that 82.4% of our study population had a type 1 arch on CTA imaging. We found this to be very deceptive during catheter angiogram where young aortic arches were found to be more angulated than expected, resulting in challenging deployment of the aortic stent graft during TEVAR. Eighty-two percent (28/34) of our patients had a normal aortic arch and supra-aortic vessel configuration. The most common arch anomaly was a bovine arch (5/34 patients). Two patients had a left vertebral artery arising from the aortic arch between the origins of the left CCA and the left SCA. One patient had a bovine anomaly associated with an aortic origin of the left vertebral artery (Table 5).

Management

The initial management of these patients was done in close consultation with the vascular surgeon. Most of the times the vascular surgeon was in attendance during the initial management of these patients. Among patients who were referred to vascular surgeons and were candidates for TEVAR, none died while awaiting a TEVAR. However, data on mortalities in the trauma emergency room secondary to thoracic aortic trauma with or without other associated injuries were not collected in this study.

All TEVAR procedures were performed under general anaesthesia using a vascular C-arm in the operating room (OR). The average length of operation was 323 min (range: 85–700 min). Access was generally obtained via the femoral approach (groin cut-down with a contra-lateral femoral access sheath for imaging). Systemic heparinization was used in 82.4% (28/34) of patients prior to the deployment of the stent graft. These patients did not have any compelling contraindication to systemic anti-coagulation. Patients with ongoing haemorrhage or associated injuries such as brain injury were not anticoagulated. The left subclavian artery was intentionally covered in 47.0% of patients (16/34), with complete coverage in 23.5% (8/34). Only two (2/16) patients required revascularization. Four patients (4/16) had an anomalous arch configuration, three with a bovine arch and left vertebral artery coming off the arch and one with an isolated vertebral artery coming off the arch. None of these patients required revascularization. Two patients had a left carotid–LSCA bypass and both these patients had their left SCA intentionally covered. Three patients had a hybrid arch procedure: right common carotid–left common carotid bypass and a left common carotid–LSCA bypass. The proximal stump of the left CCA was ligated in these cases. Cases requiring a left CCA–LSCA bypass generally had an Amplatzer embolic plug (manufactured by St. Jude Medical, Plymouth, MN, USA) deployed in the proximal LSCA close to the aortic arch.

Seventy percent (24/34) of the thoracic aortic devices were 26 mm or less in diameter. Thirty-two (94.1%) of the TEVAR procedures were technically successful. One patient had a small type II endoleak via the left SCA. This was addressed immediately with a left SCA plug. One patient had an inner curve mal-apposition of the aortic stent graft (bird-beaking) which required no intervention. Seven patients had an additional vascular procedure based on radiological findings.

Outcomes

Upon admission, none of our patients had a neurologic deficit attributable to associated head injury. Four patients presented with trauma-related paraplegia, three of these patients had paraplegia secondary to radiologically confirmed spinal cord injury and one patient had pre-existing established lumbosacral radiculopathy (HIV related). No patient had a pre-interventional history of stroke.

The mean hospital stay was 23 ± 14.5 days (range: 7–65 days). The mean ICU stay was 7 days (range 0–28 days). The 30-day mortality rate was 5.8% (2 patients), all related to fatal major strokes. One of these strokes was secondary to a blunt left carotid dissection that was related to the initial trauma as witnessed on imaging. This was confirmed on post-mortem. One patient had an uneventful early post-operative course but developed a fatal major stroke on day 15 post TEVAR. We could not obtain a post-mortem report for the second patient. None of these strokes were related technically to the TEVAR procedure. The overall mortality rate was 11.8% (4/34): three deaths were secondary to fatal strokes and one death was secondary to pulmonary complications.

There was one recorded common femoral artery dissection. This was identified and repaired at the time of the TEVAR procedure. Six patients developed pneumonia. One patient developed renal failure requiring dialysis. Two patients developed groin wound infection. One patient developed a urinary tract infection. Three patients developed a stroke while in the intensive care unit. Two of the three were fatal strokes. One patient had a confirmed deep venous thrombosis. One patient developed a pulmonary embolism. One patient post TEVAR required a thoracotomy for evacuation of a massive mediastinal haematoma during the first 30 days. This patient had a persistent left main bronchus compression and failure to wean off the ventilator.

Surveillance imaging was performed at 1 month, 6 months, then annually post-TEVAR and reviewed. One patient had “bird-beaking” without stent graft compression after deployment, which was managed expectantly.

A total of 28 patients (82.36%) were available for late follow-up. The average duration of follow-up was 25 ± 23 months (range: 12–96 months). Six patients were lost to follow-up. One patient presented a few months later with a saccular aneurysm at the proximal landing zone extending into the distal arch. This patient had significant crowding of the supra-aortic

Table 6 Study endpoints

Primary endpoints		
30-day mortality		2/34 (5.8%)
Overall mortality		4/34 (11.7%)
Secondary endpoints		
Early complications (30 day)		12/34 (35.3%)
Pneumonia	6	
Renal failure	1	
Wound sepsis	2	
Urinary tract infection	1	
Deep Venous Thrombosis	1	
Pulmonary embolism	1	
Procedure-related complications		3/34 (8.8%)
Technical success		32/34 (94.1%)
Late complications (>30-day results)		
Clinical outcomes		1 arm claudication
Stent graft-related complications		1 saccular aneurysm at proximal landing zone
Technical success		32/34 (94.1%)
Re-operations		2/34 (5.8%)

Table 7 Comparison of survivors and non-survivors

Characteristics	Survivors ($n=30$)	Non-survivors ($n=4$)
Age (years): median (range)	34 (20–65)	32.5 (27–56)
Gender: male	27	4
ISS, median (range)	33 (13–66)	25 (16–31)
Ventilation	7	1
GCS, median (range)	15 (4–15)	15 (9–15)
Comorbidities	2HPT/DM, 1PTB, 20ther	1HPT
ICU stay, mean ± SD	7 (7.5)	6 (±6.9)
Renal failure	0	1
Day of TEVAR, median (range)	2.5 (0–67)	3.5 (2–5)
LSCA covered	14	0
LCCA covered	0	0
Inner curve mal-apposition of TEVAR device	1	1
Stent graft collapse/ compression	0	0
Leg ischemia	0	0

vessels. A hybrid arch procedure was performed, involving total arch debranching and translocation of the vessels to the ascending aorta with retrograde extension of the aortic stent graft. The patient developed a major post-operative stroke and demised. Following this case, we currently routinely occlude the proximal LSCA with an Amplatzer plug when we revascularize the LSCA.

No further device-related complications (stent graft migration, oesophageal or mediastinal erosion, stent graft sepsis, stent graft collapse or compression, stent fractures, etc.) were documented during follow-up in the remaining patients. Four patients died on late follow-up. Table 6 summarizes the study endpoints. Table 7 further compares the survivor and non-survivor patients' profiles.

Discussion

Since the introduction of commercially available aortic stent grafts, TEVAR has been increasingly used as a primary treatment option for BTAI due to its better outcomes compared to open repair [3, 12].

We retrospectively looked at the outcomes of TEVAR in TTAI (both blunt and penetrating) at a single centre. Our 30-day all-cause mortality was 5.8%, better than the 8% reported in the RESCUE trial and other studies. [12]. The overall all-cause mortality of 11.8% is reported in our series to date, noting that six of our patients were lost to follow-up (the regional births and deaths registry did not record deaths in these 6 patients). Follow-up is poor in post-trauma patients. This has been the case in other local studies [24].

The secondary endpoints in this review were the incidence of nonfatal adverse events related to the device and procedure and re-intervention rates. Delivery and deployment were successful in 94.1% of cases, lower than the 100% technical success rate reported in the RESCUE trial [13]. One patient had bird-beaking after deployment and one had a type I endo-leak managed with a left SCA plug. Forty-four percent (15/34) of patients had systemic and procedure-related adverse events, a very high rate compared to that quoted in the literature [13, 17]. Six of the fifteen patients had pneumonia which was managed medically. The incidence of post-operative atelectasis and pneumonia in patients undergoing non-cavitary surgery is reported to be 1% [25], however, one study [26] documented that 33% of trauma patients developed early onset pneumonia. Patients' HIV status did not seem to influence these septic complications. Only one patient who was HIV positive in our series had pneumonia. All three patients with HIV in our series were on treatment (HAART). The benefit of antiretroviral therapy in HIV-positive patients cannot be overemphasized.

Partial or complete coverage of the left subclavian artery was documented in 47.0% (16/34) of our patients. None of these patients developed significant arm ischemia. One patient developed non-disabling left arm claudication and was managed expectantly. This result is in keeping with reports of 41% [24], 58% [13] and 61% [25] of intentional left subclavian artery coverage. There was no reported paraplegia in our patients post-TEVAR, which is in keeping with low paraplegia rates reported in the RESCUE trial. Some studies have also reported a significant reduction in spinal cord injury from 8.7% with open surgery to 1.6% using TEVAR [12].

The Society for Vascular Surgery (SVS) 2011 guidelines suggest expectant management with serial imaging for type I injuries, while types II to IV should be repaired [19]. Only one patient (2.9%) with grade 1 aortic injury had TEVAR at our institution: a 23-year-old male with transthoracic GSW and a grade I aortic dissection of the descending thoracic aorta on CTA imaging. The decision was made by the operating vascular surgeon to perform a TEVAR. An intimal flap was identified with the use of intravascular ultrasound (IVUS). The RESCUE trial on the other hand selected 18% of patients with grade 1 aortic injuries for TEVAR [13]. Lee et al. [19] reported that 21% of BTAI patients with minimal aortic injuries undergo TEVAR despite these clinical practice guidelines.

Patients who had penetrating trauma in our series had more favourable results, with no deaths reported. This is probably due to natural selection, as these patients were younger, had low ISS scores and lower grades of aortic injuries associated with penetrating trauma. The time to TEVAR in this group of patients was longer, 13.5 days (range 4–67 days). Some studies have evaluated the timing of aortic repair and found improved survival among patients undergoing delayed repair [27].

The limitations of this study include its retrospective design, the period of follow-up to date and loss

of follow-up. Missing data are also a major issue. The author also acknowledges the low HIV testing rate in our patients.

Conclusion and recommendations

TEVAR after TAI is associated with significantly lower procedural and post-operative mortality. The 30-day and overall mortality after TEVAR in our unit, despite resource constraints in an African setting, is comparable to international standards. The morbidity associated with TEVAR is higher in our institution mostly due to pulmonary complications. Even though our sample size for PTAI was very small and no conclusion can be drawn from this, TEVAR has low peri-procedural adverse events and is safe in selected patients. From this audit, we recommend TEVAR for both blunt and penetrating thoracic aortic injury.

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Compliance with ethical guidelines

Conflict of interest N. Chinyepi, M.J. Motsumi and N. Naidoo declare that they have no competing interests.

Ethical standards This is a single-centre one-year (June 2016–May 2017) retrospective descriptive study of all patients treated by the Vascular Unit at Groote Schuur Hospital in Cape Town, South Africa. Approval for this study was obtained from the Human Research Ethics Committee, Faculty of Health Sciences and University of Cape Town (REF: 635/2016).

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