Percutaneous Endovascular Repair of Blunt Thoracic Aortic Transection

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Background: Untreated traumatic aortic transection carries a mortality rate higher than 85%. Standard therapy has been open repair via a left thoracotomy with systemic heparin and is associated with a high risk of paralysis. We reviewed our experience of endoluminal stent-graft repair for treatment of acute traumatic thoracic aortic transection.

Methods: Between February 2001 and February 2005, 11 patients sustaining severe blunt trauma with multiple injuries underwent acute endovascular repair for thoracic aortic transection with ‘off-the-shelf’ commercially available proximal aortic cuffs. No systemic heparin was used. Access to the aorta was obtained either through a femoral/iliac cutdown (n = 4) or percutaneously through the femoral artery (n = 7). Mean follow-up was 21 months (range, 3–49 months).

Results: Technically successful repair was achieved in 100% of patients, as determined by completion angiography demonstrating apposition of the stent-grafts to the aortic wall, normal perfusion of the aortic branches, and exclusion of the aortic transection without evidence of extravasation. None of the patients required secondary interventions, and there were no instances of death or paralysis. Patient follow-up, using computed tomography angiography, demonstrated durability of endovascular repair without evidence of endoleak, stent migration, or late pseudoaneurysm formation.

Conclusion: Adaptation and use of commercially available abdominal devices in the thoracic aorta has proven to be technically feasible. Urgent repair of traumatic aortic transection in the setting of blunt trauma can be transformed into a well-tolerated surgical intervention using endovascular techniques. Long-term durability of endovascular repair of traumatic thoracic transections remains unknown, but early and midterm results are promising.

Key Words: Aortic transection, Endoluminal repair, Stent-graft, Blunt trauma.

endovascular procedures used to treat traumatic aortic transections. All patients suffered multiple injuries, were involved in high-speed motor vehicle collisions or rapid deceleration events, and underwent endovascular repair for thoracic aortic transection in the acute setting.

Abnormalities seen on initial chest roentgenograms (Fig. 1) in the setting of blunt trauma (including widened mediastinum, obliteration of the aortic knob, tracheal deviation to the right, left hemothorax, depression of the left main stem bronchus, presence of a pleural or apical cap, widened paratracheal stripe, or fractures of the first rib or scapula) required further workup with a chest computed tomography (CT) scan. Thoracic aortic transection suggested by CT was confirmed in all cases with intraoperative aortography. Measurements of the proximal and distal neck length and aortic diameter, as well as location and extent of injury in relation to the origins of the arch vessels, were obtained using the aforementioned imaging modalities.

All procedures were performed in an operating room angi-suite, and the devices used to treat the transections consisted of commercially available endovascular aortic proximal extension cuffs (AneuRx, Medtronic/AVE, Santa Rosa, Calif; and Excluder, W.L. Gore & Associates, Flagstaff, Ariz). After the induction of general anesthesia, access to the aorta was percutaneously obtained via the common femoral artery (seven patients) or by cutdown on the femoral/iliac artery (four patients). A floppy tipped J-wire was then passed into the aorta under direct fluoroscopic guidance. An aortogram was obtained using steep left anterior oblique projection so as to open up the aortic arch. Arch anatomy and location of the aortic transection were noted. In those patients undergoing percutaneous repair, a 10F Perclose device was then placed over the area of transection and deployed without the use of chemically induced cardiac arrest or hypotension. An angiogram was obtained, and additional aortic extension cuffs were placed as required. Systemic heparinization was avoided in all cases.

In one patient, preoperative CT scan demonstrated the area of transection to be within close proximity to the left subclavian artery, from which the dominant vertebral artery took its origin. To ensure an adequate seal proximal to the transection in this patient, the left subclavian artery was transposed to the left common carotid artery before endovascular repair. The origin of the left subclavian artery was then covered with the stent-graft.

After endovascular repair, patients underwent CT angiography at 1 month after repair and at 6- to 12-month intervals thereafter. Mean follow-up of this patient cohort was 21 months (range, 3–49 months). This retrospective review was approved by our institution’s Institutional Review Board.

RESULTS

The average patient age in this study was 43 ± 14 years old (range, 20–73 years), with seven (64%) men and four (36%) woman. Our patients suffered multiple injuries including closed head injury, rib fractures with concomitant pulmonary contusion, extremity or pelvic fractures, and solid organ injury. The mean Injury Severity Score of this group of patients was 43 ± 13 (range, 25–66). The mechanisms of injury included high-speed motor vehicle collisions (nine patients), a fall from a three-story building (one patient), and a pedestrian versus automobile accident (one patient) (Table 1).

Endovascular repair was technically successful in 100% of patients, as determined by completion angiography at the time of the intervention (Fig. 2). These angiograms demonstrated apposition of the stent-grafts to the aortic wall, normal perfusion of the aortic arch vessels, and exclusion of the aortic transection without evidence of extravasation of contrast in all cases. No secondary interventions were required in this patient population.

Given the severity and variety of concomitant injuries, it may not be surprising that patient outcome seemed to be determined by the associated injuries present rather than the thoracic aortic transections. There were no procedure-related deaths, and no patient suffered paralysis secondary to spinal cord ischemia. Follow-up CT scans (Fig. 3) have demonstrated technically successful endovascular repair of the traumatic aortic transections. There has been no evidence of endoleak, stent migration, or late pseudoaneurysm formation throughout follow-up.

DISCUSSION

Thoracic aortic transection in the setting of blunt trauma is often a lethal event. Left untreated, mortality rates after these injuries are estimated to be approximately 85%.¹ Tra-
ditional open repair via a left thoracotomy and graft interpo-
sition has mortality rates as high as 28% and paraplegia rates 
secondary to spinal cord ischemia of up to 14%. Since the 
initial report describing endovascular treatment of thoracic 
aortic pathology with stent-grafts by Kato et al., several 
subsequent case reports have demonstrated the technical fea-
sibility of this technique. As the current report shows, we 
have demonstrated that acute aortic traumatic transection can 
safely and effectively be treated using ‘off-the-shelf’ com-
mercially available endovascular aortic proximal extension 
cuffs.

The setting in which these thoracic aortic transections 
occurred involved high-speed motor vehicle collisions in 
most cases. Indeed, these injuries to the thoracic aorta were 
not isolated but rather occurred in the setting of multisystem 
trauma. Unlike traditional open repair, endovascular treat-
ment of thoracic aortic transections obviates the need for 
systemic anticoagulation. The avoidance of systemic hepa-
rinization in this patient population suffering multiple inju-
ries, including long-bone or pelvic fractures and solid organ 
injury, is an important theoretical advantage of endovascular 
repair over open repair. Additionally, the more minimally 
invasive endovascular repair of these aortic injuries has the

<table>
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<th>Age</th>
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<th>Mechanism of Injury</th>
<th>ISS</th>
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MVC = motor vehicle collision; ISS = Injury Severity Score.

potential for significantly reduced iatrogenic blood loss in 
comparison to open repair. The importance of these advan-
tages in patients with multiple injuries, who are often hemo-
dynamically unstable, cannot be overstated.

Fig. 2. A Intraoperative angiogram demonstrating thoracic aortic 
transection. B Completion angiogram demonstrating coverage of 
tear with endovascular stent-graft.

Fig. 3. A Preoperative CT scan demonstrating thoracic aortic 
transection. B Follow-up CT demonstrating healing of tear, without 
evidence of extravasation or late pseudoaneurysm formation.
Whereas there are no commercially available devices designed specifically for the endovascular treatment of thoracic aortic transections, off-label use of commercially available abdominal aortic extension cuffs can be successfully used to treat these injuries. One of the main limitations of the use of abdominal devices for the treatment of thoracic aortic pathology has been insufficient device length for accessing the thoracic aorta via a femoral approach. Indeed, in our series, inadequate device length required a retroperitoneal iliac artery exposure to access the aorta in three cases.

Various measures can be undertaken to estimate the device length required to treat lesions of the thoracic aorta including measuring the distance from the sternal notch to the inguinal crease and using the preoperative CT scan to estimate vessel length. In our experience, these techniques accurately determined whether the device length would be sufficient. A cutoff of 61 cm (length of Excluder delivery system) was used to determine which lesions could be addressed percutaneously as opposed to those that required a retroperitoneal iliac cutoof. There were no conversions to an open approach after the initial decision had been made to proceed percutaneously. In the future, availability of commercial devices designed specifically for the treatment of thoracic aortic lesions will likely use longer delivery sheaths and will obviate the need to approach these lesions in a retroperitoneal fashion.

For the most part, the patient population suffering thoracic aortic transection in the setting of blunt trauma is younger than patients who develop aneurysmal degeneration or dissection of the thoracic aorta. The long-term outcome and durability of these endovascular devices has yet to be proven. In the meantime, extensive follow-up should include annual CT angiography. Whereas our mean follow-up was close to 2 years after the procedure, CT scans have demonstrated no evidence of endoleak, stent migration, or late pseudoaneurysm formation. However, the fact that these devices are placed within an otherwise normal aorta makes the occurrence of late complications seen after endovascular repair of abdominal aortic aneurysms less likely.

In the current report, we have demonstrated that commercially available endovascular aortic extension cuffs designed for use within the abdominal aorta can be used successfully to treat traumatic thoracic aortic transections. Our small series demonstrated technical success, safety, and midterm durability of these devices. Avoidance of systemic anticoagulation in the setting of patients with multiple injuries is one of the main advantages of the endovascular technique over open repair. Despite limitations of delivery system lengths, percutaneous repair of these lesions is possible in the majority of cases; however, whereas initial results are encouraging, close long-term follow-up is required until the durability of these devices can be demonstrated definitively.

REFERENCES