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Short-term results of left subclavian artery salvage in blunt thoracic aortic injury with short proximal landing zones

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ABSTRACT

Objective: Thoracic endovascular aortic repair (TEVAR) is the standard treatment of blunt thoracic aortic injury (BTAI). The concept of seal was derived from the treatment of aneurysms and has been adopted for BTAI. Given the location of injury in BTAI, left subclavian artery (LSA) coverage is sometimes necessary. In these often healthier aortas, a shorter proximal landing zone may be acceptable and beneficial in avoiding some complications. Current practice patterns vary, and long-term effects of LSA coverage remain unknown.

Methods: A single-institution experience with BTAI for TEVAR was examined from 2006 to 2017. The primary outcome was failure of sealing, endoleak, or persistent aortic injury on follow-up imaging. A centerline was used to measure the length of the landing zone, aortic diameter, and other parameters. Post-TEVAR computed tomography scans were examined for evidence of residual aortic injury.

Results: A total of 30 TEVARs were performed for BTAI. The mean age of the patients was 38.7 years (standard deviation [SD], 19.8 years), and 70% were male. The mean injury severity score was 36.75 (SD, 13.1). Treated patients had grade 2 (36.7%) or grade 3 (63.3%) BTAI. The LSA was salvaged in 23 cases and covered in 7 cases. The mean landing zone in LSA uncovered cases was 16 mm (SD, 10.4 mm). There were 15 patients (65%) who had a landing zone $<$20 mm, and 8 (35%) patients had a landing zone $>$20 mm. The mean landing zone in the seven covered cases was 1.8 mm (SD, 2.4 mm). Procedural success was 96% for the uncovered group and 100% for the covered group. On follow-up imaging, there was only one residual endoleak in all surviving patients (n = 25). Five patients did not have postoperative imaging, two (7%) of whom died of non-aorta-related issues.

Conclusions: TEVAR for BTAI in patients with short proximal landing zones of 10 to 20 mm as well as in select patients with landing zones of 5 to 10 mm appears to be safe and efficacious. The aorta demonstrates no residual injury after TEVAR, with the graft acting potentially more as a bridge to allow healing. Long-term issues regarding LSA coverage have been difficult to ascertain and to evaluate because of historically poor follow-up in this population of patients. However, potential issues with LSA coverage and revascularization may be avoided by preserving the subclavian artery even with shorter proximal landing zones. (J Vasc Surg 2018;■:1-6.)

Keywords: Blunt thoracic aortic injury; Left subclavian artery; TEVAR

Thoracic endovascular aortic repair (TEVAR) has been adopted as the optimal treatment strategy for blunt thoracic aortic injury (BTAI) in contemporary series. Compared with open repair, TEVAR has reduced the risk of stroke, spinal cord ischemia, and mortality in both aneurysms and traumatic injuries.[1-3] A frequent dilemma in treating the thoracic aorta is the issue of left subclavian artery (LSA) coverage and the need for revascularization to achieve an appropriate landing zone. Current society guidelines for BTAI recommend selective revascularization of the LSA.[4] Although this is a contentious topic, it is frequently encountered because aortic injury most commonly occurs at the isthmus, which is 10 to 20 mm from the LSA. For the treatment of aneurysmal disease, available devices have instructions for use that call for a minimum 20-mm proximal seal and thus place the LSA at risk. This concept of seal is derived from the treatment of aneurysms and has been adopted for treatment of BTAI. However, the natural history of BTAI, which is an acute injury, is likely to be different from the chronic degenerative process of aneurysmal disease, so the guidelines may not be entirely applicable.

Recent case reports and presentations have suggested that BTAI can be treated with shorter landing zones, but no study has addressed this hypothesis.[5,6] We aimed to show that accepting shorter landing zones without coverage of the LSA is safe and effective in the treatment of BTAI.

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METHODS

A retrospective analysis was performed using a database of thoracic aortic endograft procedures at a single institution from 2006 to 2017. The Institutional Review Board approved this study as exempt because of the retrospective and deidentified nature of the data (ID# 1121742). Informed consent was not required for this study. Patients were included in this study only if an endograft was deployed for the treatment of BTAI. Aortic injury grade was determined on the basis of the accepted classification system.[7,8] Patients with grade 2 injuries were selectively repaired, all patients with grade 3 injuries were repaired, and no patients with grade 4 injuries survived to the operating room (OR). The decision to cover the LSA was based on the surgeon's discretion. All procedures were performed in the OR using the GE OEC 9900 Mobile C-arm (GE OEC Medical Systems, Inc, Salt Lake City, Utah).

Demographics including age, sex, mechanism of injury, and perioperative risk factors such as survival indices were extracted from chart review. Preoperative and postoperative computed tomography (CT) angiograms were evaluated and measured on axial, coronal, and sagittal views as well as on TeraRecon 3D imaging software (TeraRecon, Foster City, Calif). Multiple measurements including length of injury, length of normal aorta distal to LSA, landing zone, and aortic diameters were obtained from both imaging modalities and assessed on the basis of standard reporting guidelines.[9] Aortic diameter was calculated as a mean of three measures obtained between the LSA and the start of the injury. Landing zones were measured as the distance from the LSA to the start of the injury including only uninvolved aorta. Procedural success, defined as exclusion of the injury without evidence of endoleak on completion, was the primary outcome. The time to the OR was calculated from first documentation in the emergency department to the in-room time in the OR. Postoperative CT scans completed within 30 days and during follow-up were examined for radiographic evidence of persistent aortic injury, pseudoaneurysm, or endoleak; this was the secondary outcome. Postoperative imaging was also used to measure the mean aortic diameter to compare it with the implanted graft size and to assess for dilation. All measurements and images were reviewed by two of the authors.

Statistical analyses were calculated for means and standard deviation for all measured variables. A confidence interval of 95% was used to express all variables. A Student *t*-test was used to assess continuous variables.

ARTICLE HIGHLIGHTS

- **Type of Research:** Retrospective cohort study
- **Take Home Message:** Of 30 thoracic endovascular aortic repairs performed for blunt thoracic aortic injury, the left subclavian artery was preserved in 23, with seal zone <20 mm in 15. Of 25 patients with imaging studies (<60 days in 23), only one had endoleak.
- **Recommendation:** These data suggest that some blunt thoracic trauma patients with short aortic neck and preserved left subclavian artery may do well with thoracic endovascular aortic repair in the short term.

RESULTS

A total of 30 patients with BTAI who underwent TEVAR were identified. The mean age was 38.7 years, and 70% were male (Table I). The calculated mean Injury Severity Score was 36.75, and the overall probability of survival was 73.7%. There were three mechanisms of injury, including motor vehicle accident (86.7%), pedestrian struck (10%), and fall (3.3%). There were 11 (36.7%) grade 2 and 19 (63.3%) grade 3 injuries repaired. There were no grade 1 injuries repaired, and no patient with grade IV injury made it to the OR. Mean time to OR was 75.6 ± 138.9 hours; two patients were transferred from outside hospitals, and the time to OR was significantly delayed. Two BTAIs were repaired 21 and 24 days after presentation because other severe injuries took priority. Without these outliers, the mean time to OR was 42.84 ± 47.12 hours.

Arterial access was obtained percutaneously 40% of the time compared with the cutdown approach. After 2013, 12 of 14 cases (85.7%) were completed percutaneously (Table II). Mean aortic diameter was 20 ± 2.5 mm and 19.71 ± 3.94 mm for the uncovered and covered groups, respectively. Mean graft diameter used was 24.4 ± 3.6 mm, and mean graft length was 106.8 ± 29.7 mm overall (Table II). The types of grafts used are listed in Fig 1.

The LSA was preserved in 23 cases (76.7%). The mean landing zone length in this group was 16 ± 10.4 mm using TeraRecon and 18.5 ± 11.1 mm using CT scan ($t = -1.01$; $P = .16$; Fig 2). There were 15 patients (65%) who had a landing zone <20 mm, and eight (35%) patients had a landing zone >20 mm (Fig 3). Of 23 patients, 14 (61%) were in the 5.1- to 15-mm range. Procedural success was 96% (22/23) overall. One patient had a type IA endoleak identified on postoperative imaging that required the patient to be taken back to the OR. The patient had a landing zone ≤10 mm, and so procedural success was 93% for <20-mm landing zones and 100% for >20-mm landing zones.

The LSA was intentionally covered in seven cases (23.3%). The mean landing zone in this group was 1.8 ± 2.4 mm using TeraRecon and 4.09 ± 5.3 mm using CT scan ($t = -1.65$; $P = .07$; Fig 2). All seven cases had landing zones <10 mm (Fig 3). Two patients in this group required extensions because of bird-beaking, but no arch vessels were covered unintentionally. Procedural success was 100%.