Minimum 10-year follow-up of endovascular repair for acute traumatic transection of the thoracic aorta

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Objective: Thoracic endovascular aortic repair (TEVAR) for traumatic rupture of the descending thoracic aorta seems, in the short term, to be associated with better outcomes than open repair, but long-term data are lacking.

Methods: A review was conducted of a prospectively maintained database of patients who underwent TEVAR for traumatic rupture of the descending thoracic aorta in our unit, with a minimum 10-year follow-up. Follow-up computed tomography scans were performed at 1 week, 3 and 6 months, and annually thereafter. Particular attention was focused on device-related issues.

Results: Among the 53 patients, 17 had a minimum 10-year follow-up: mean age was 45.8 ± 17 years (range: 18-78 years); 4 were women. Mean follow-up was 11.6 years (range: 10.1-13.1 years). Technical success was achieved in 100% of cases. The distribution of the proximal landing zone was zone 2 in 4 cases, zone 3 in 13 cases. A case of inadvertent coverage of supra-aortic trunks occurred intraoperatively. An early proximal type I endoleak was successfully treated by proximal implantation of an additional second stent-graft. No perioperative death was observed, and none of the patients suffered transient or permanent paraplegia, or cerebral complication. After a minimum 10-year follow-up, all patients were still alive. Follow-up computed tomography scans did not reveal any stent-graft migration or collapse, or secondary endoleaks. However, we observed that the proximal and distal aortic neck dilated to some extent, as is the natural history of the thoracic aorta. This dilation was more marked in patients aged <30 years.

Conclusions: Our minimum 10-year follow-up study of endovascular repair for acute traumatic transection of the thoracic aorta demonstrated that the reduction in the operative mortality rate of TEVAR, compared with open repair, lasts over time, without any device-related issues. Longer-term follow-up is necessary to determine whether the thoracic aorta expansion continues and becomes clinically significant. (J Thorac Cardiovasc Surg 2015;149:825-9)

See related commentary on pages 829-30.

The treatment of traumatic transection of thoracic aorta has seen many changes over the past 20 years. Thoracic endovascular aortic repair (TEVAR) has been rapidly adopted as an alternative to the traditional open repair for treatment of these lesions. Two prospective observational studies from the American Association for the Surgery of Trauma (AAST), evaluating the management and outcomes of blunt thoracic artery injury studies, demonstrated a marked change in operative management, from exclusively open repairs (100%) in the early part of that period, to a majority of endovascular repairs (65%).[1]

This paradigm shift has improved the mortality rate in these patients, as demonstrated by the second AAST study[2]: 7.2% for endovascular repair versus 23.5% for open repair. Stent grafting has become the first-line approach for traumatic thoracic aortic transections. Although many early reports are overwhelmingly positive, concerns have been raised regarding the long-term durability of this approach in these young patients. Long-term follow-up data are clearly critical to assess the durability of TEVAR in this younger population of patients, who have longer life expectancies than patients with aneurysmal disease. Material failures, such as stent fractures and fabric fatigue, may become more significant during ensuing decades of follow-up. Because the aorta tends to dilate with age, smaller-sized devices appropriate at the time of implantation may lose their fixation over time. Therefore, evaluation of long-term device performance in this disease-specific condition is of high importance. The purpose of this study was to evaluate outcomes of endovascular repair of traumatic thoracic aortic rupture in our unit, with a minimum 10-year follow-up.

METHODS

Ethical approval was obtained from the scientific and research ethics board of our hospital.

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Abbreviations and Acronyms

AAST = American Association for the Surgery of Trauma
CT = computed tomography
LCCA = left common carotid artery
LSA = left subclavian artery
OR = odds ratio
TEVAR = thoracic endovascular aortic repair

Patients

A review of a prospectively maintained database of patients who underwent TEVAR for traumatic rupture of the descending thoracic aorta in our unit, with a minimum 10-year follow-up, was performed. Early and long-term outcomes were assessed. Diagnosis of aortic disruption was achieved by a preprocedural contrast-enhanced computed tomography (CT) scan of all patients.

Endovascular Repair

Suitable morphology for stent-graft placement requires a proximal aortic neck length of at least 20 mm between the ostium of the left common carotid artery (LCCA) and the tear. Measurements from preprocedural imaging data were used to select the appropriate diameter and length of the stent-graft. Devices were sized to be 10% to 20% greater than the minor axis of the aortic neck. This oversizing may have been greater in these patients, owing to the unavailability of small (<26 mm) thoracic devices at that time. All procedures were done with the patient under general anesthesia. Cerebrospinal fluid drainage was not used for any patient.

Patients were prospectively monitored by scheduled clinical observation and with contrast-enhanced CT, preoperatively, before hospital discharge, at 1, 3, 6, and 12 months, and annually thereafter. CT images were analyzed on a 3-dimensional workstation (Centricity, General Electric, Emporium, Pa). A comparison was made for each patient at each postoperative scan, and an annualized rate of change (mm per year) was calculated by dividing the difference in diameter (mm) by the number of intervening months and multiplying by 12. All measurements were then expressed as the mean ± standard deviation. The first postoperative scan at 1 month was considered the baseline, to try to negate the perioperative effect of the stent-graft on the neck. All aortic CT measurements were taken in a perpendicular plane using centerline reconstructions. Migration was defined as >5 mm movement of the stent-graft relative to the left subclavian artery (LSA), or any movement requiring a secondary procedure. Proximal and distal aortic neck diameter was measured 10 mm above and below the stent-graft in planes orthogonal to the aorta. The inner diameter of the aortic neck was measured on the major and minor axis.

Statistical Analysis

Categoric data are presented as counts (percentage); continuous data are presented as mean ± standard deviation, or median with interquartile range. Categoric variables were compared using a χ^2 analysis for normally distributed data, and the Fisher exact test for nonparametric data. Continuous data were analyzed using the Student *t* test. Statistical analyses were performed using SAS software (version 9.1; SAS Institute Inc, Cary, NC); $P < .05$ was considered significant.

RESULTS

Perioperative Data

At our institution, between January 2001 and January 2014, 53 consecutive patients underwent TEVAR for acute traumatic rupture of the aortic isthmus. Of these, 17 had a minimum 10-year follow-up. Median follow-up was 11.7 years (range: 10-13.2 years). Clinical follow-up data were available for all patients.

Patients included 4 women and 13 men, with a mean age of 45.8 ± 17 years (range: 18-78 years). The mean injury severity score was 36 ± 6. The grades of aortic injury were: grade 2 (intramural hematoma; n = 8); grade III (pseudoaneurysm; n = 7); and grade IV (free rupture; n = 2). The mean delay between the time of aortic disruption and endovascular treatment was 5.2 ± 7.8 days. No patients died during the interval between diagnosis and TEVAR, and no patients underwent open repair during the period of inclusion. Three endovascular devices were used: the Excluder Tag (W. L. Gore & Associates, Flagstaff, Ariz; n = 7); the Talent (Medtronic Vascular, Santa Rosa, Calif; n = 9); and the Zenith distal extension cuff (Cook Inc, Bloomington, Ind; n = 1). The distribution of the proximal landing zone was zone 2 in 4 cases, zone 3 in 13 patients. The LSA was covered in 4 cases.

In 3 patients, for whom the proximal aortic neck length was insufficient, the ostium of the LSA was deliberately covered. For 1 patient whose hemodynamic status was stable at the time of diagnosis, the landing zone was extended by prophylactic LSA to the LCCA transposition before endovascular repair. For 1 patient in whom the hemodynamic status was unstable at the time of aortic disruption, an LSA-to-LCCA transposition was secondarily performed to treat vertebrobasilar insufficiency (vertigo and drop attacks).

Median aortic neck diameter, at the time of stent-graft placement, was 21.5 mm (range: 16-31 mm), and median nominal device diameter was 28.4 ± 3 m (range: 22-40 mm), resulting in a mean oversizing of 25% ± 9%. The mean distal aortic diameter was 19.8 ± 4.5 mm. The mean stent-graft length was 104 ± 27 mm (range: 100-150 mm).

Clinical Outcomes

Perioperative results. Technical success was achieved in all cases. In 4 patients, for whom proximal aortic neck length was insufficient, the ostium of the LSA was deliberately covered. Intraoperatively, a proximal stent-graft migration occurred, totally covering the LCCA ostium. The stent-graft was pulled distally by traction, using an inflated low-pressure balloon, and re-established flow to the left common carotid artery. However, an excessive distal migration led to a proximal type I endoleak. This endoleak was successfully treated by a proximal implantation of a second stent-graft on the second postoperative day. No perioperative death was observed, and none of the patients suffered transient or permanent paraplegia, or cerebral complication.

Long-term results: Minimum 10-year follow-up. At a minimum 10-year follow-up, all the patients were still alive. None of them required open surgical conversion, or

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