VASCULAR AND ENDOVASCULAR TECHNIQUES

Peter F. Lawrence, MD, Section Editor

Outcomes in the emergency endovascular repair of blunt thoracic aortic injuries

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Thoracic aorta blunt injury (BAI) is a highly lethal lesion. A large number of victims die before obtaining emergency care. Thoracic endovascular aneurysm repair (TEVAR) is a less invasive method compared with open surgery and may change protocols for BAI treatment. This retrospective study was developed to evaluate the potential issues about thoracic endografting in the management of these patients. Twenty-seven patients with a BAI underwent aortic stent grafting. Intervention was preceded by the treatment of more urgent associated lesions in nine cases. In-hospital mortality was 7.4%. No paraplegia or ischemic complications developed because of the coverage of the left subclavian artery. In one case (3.2%), a type I endoleak was detected, proximal endograft infolding in two cases (7.4%) and endograft distal migration in further two cases were detected during follow-up (6-110 months). Thoracic endovascular aneurysm repair of BAI showed encouraging results in terms of perioperative mortality and morbidity. Concerns still remain about the potential mid- and long-term complications in younger patients. (J Vasc Surg 2013;58:832-5.)

Blunt trauma of thoracic aorta (BAI) represents the second leading cause of death after cranial injury. Although the incidence is only 0.5% of all traumas, it is extremely important due the high mortality rate ranging between 75% and 90% of cases.[1] Open surgery has been, principally, the only therapeutic option with a mortality rate between 18% and 28%, and a risk of stroke and spinal cord ischemia in up to a 19% of cases.[2,3]

Thoracic endovascular aneurysm repair (TEVAR) is an attractive alternative. According to Hoffer and Demetriades, TEVAR can decrease perioperative mortality rate and spinal ischemia of 50% and 5%, respectively.[4] Despite these satisfactory results, TEVAR suggests a new array of procedure-related complications analyzed in this retrospective study.

METHODS

From 2001 to 2011, 27 patients (22 males and five females, ranging in age from 20 to 69 years) were admitted to the Rome and Latina Emergency Care Unit for BAI. They had an injury severity score (ISS) of 40.9 ± 15.2; 7 (26%), they were hemodynamically unstable with a mean Glasgow Coma Scale of 11.4. On computed tomographic scan, the aortic diameters at the landing zones were 22 ± 1.8 mm (proximal) and 21.8 ± 1.5 mm (distal).

The aortic trauma was a partial transmural rupture in 18 cases, a segmental dissection with intramural clot in three, and a false aneurysm in six cases; a periaortic hematoma in 14 and a hemothorax in four were detected. Concomitant injuries were diagnosed in 25 patients (92.5%); in five cases (18.5%) the evacuation of a cerebral hemorrhage was required and in four (14.8%), the treatment of associated spleen rupture or vertebral fracture was also required before performing aortic stent graft repair.

In eight cases (29.6%), drainage of the associated hemothorax was performed together with aortic endografting just after stent graft deployment. Nineteen patients received emergency treatment within a mean interval of 6 ± 2.5 hours (Fig 1); nine were operated as soon as the more severe associated lesions were safely resolved (within 14 ± 6 hours). The associated injuries and their repair modalities are listed in Table I. All patients were operated under general anesthesia; no spinal fluid drainage was performed. A controlled hypotension was maintained during stent graft deployment.

The devices implanted were Zenith TX1 or TX2 (William Cook, Bjaeverskov, Denmark) in 4 patients, TAG or C-TAG (W. L. Gore and Associates, Flagstaff, Ariz) in 5, Valiant (Medtronic Endovascular System, Santa Rosa, Calif) in 9, Valiant-Captivia (Medtronic Endovascular System) in 8, and Talent (Medtronic Endovascular System) in 1.

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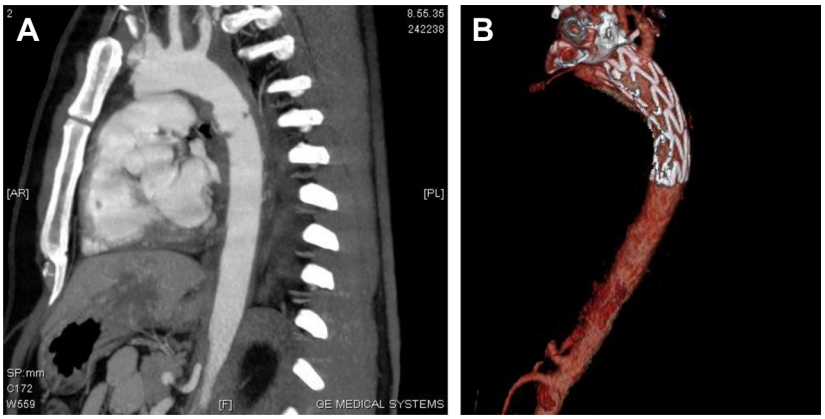

Fig 1. A, Traumatic lesion of aortic isthmus in a 21-year-old man. **B,** Emergency endovascular treatment.

Table I. Concomitant injuries and timing of treatment

Concomitant injury	*No.*	*Timing of treatment*
Head injuries/skull fractures	5	B
Cerebral hemorrhage	1	A
Bone fractures	3	B
Vertebral	1	B
Pelvic	5	A
Limbs	13	A
Cardiopulmonary	4	A
Lung contusion	17	A
Hemothorax	8	C
Kidney	2	A
Spleen	3	B

A, After aortic repair; *B,* before aortic repair; *C,* concomitant aortic repair.

The stent graft diameter ranged from 22 mm to 28 mm. The average thoracic graft oversizing was between 15% and 20%; the graft covered length was between 150 and 220 mm (two grafts were implanted in two cases of aortic dissection). The origin of the left subclavian artery (LSA) was intentionally covered in four patients. Computed tomographic angiogram (CTA) control was performed before hospital discharge, at 6 months, and yearly for the first 2 years and every 2 years thereafter.

RESULTS

Technical success was obtained in all cases; related mortality was nil. Two patients died because of disseminated intravascular coagulation and multiorgan failure, for a total inhospital mortality of 7.4%. No patients suffered paraplegia, neurologic disorders, or ipsilateral arm ischemia attributable to left subclavian artery coverage. An unrelated stroke occurred at 72 hours after the BAI repair. Procedure-related complications included one iliac artery dissection treated by a stent deployment and three groin hematomas treated by drainage. In one case (3.2%), a type I endoleak, attributable to an acute aortic angle (90°), required an adjunctive endografting.

During the follow-up ranging from 6 to 110 months (median 66.9), three patients were lost and 22 were in good condition. In four patients (mean age 38.7 years), complications were detected. In two patients (7.5%) (at 6 and 60 months), an endograft infolding and, in another two (7.5%) (at 18 and 24 months), an endograft migration were detected by routine CTA (Table II). All these cases required an adjunctive stent graft implantation (Fig 2), and no further complications arose in successive follow-ups (12-60 months). Subsequent computed tomography controls showed good results in all patients. A survival curve describing Kaplan-Meier overall survival is shown in Fig 3.

DISCUSSION

BAI of thoracic aorta is burdened by high mortality. This explains the low number of cases in each series and the difficulties in carrying out prospective analysis of prognosis and results in its treatment.

In 2009, data was published in the National Trauma Databank on 3000 U.S. patients with BAI associated with head trauma in 31% of cases and major trauma of the abdomen and pelvis in 29% and 15%.[5] The literature data shows patients with BAI with an average ISS[6] > 40, and this corresponds with an ISS of 40.9 ± 15.2 in our patients. TEVAR, associated with lower morbidity compared with open surgery,[7] has been indicated as a valuable option to improve the outcome of BAI. Although its primary technical success rate is 100%, the mid- and long-term outcome of TEVAR is limited by several problems.

Most younger patients have small aortic diameters and a narrow angle of arch. In addition, the arterial compliance of these younger patients may lead to a change in thoracic aortic diameter greater than 10%-20% during cardiac cycle, and this may cause an incorrect stent graft sizing. Reassessment of the oversizing, which is at present recommended in the instructions for use, is considered appropriate in the treatment of the aneurysmatic pathology, elaborating suitable indications in the treatment of trauma of the thoracic aorta, especially in the young.

Table II. Mid- and long-term complications after TEVAR

Patients	*Patient 1*	*Patient 2*	*Patient 3*	*Patient 4*
Type of complication	Infolding	Infolding	Graft migration	Graft migration
Age	22 years	23 years	41 years	69 years
Weight	65 kg	71 kg	80 kg	83 kg
Preoperative proximal aortic diameter	21.4 mm	22.4 mm	23.7 mm	23.8 mm
Graft diameter	26 mm	26 mm	28 mm	28 mm
Type of graft	Captivia	Gore Tag	Zenith Cook	Zenith Cook
Aortic diameter at the time of complication	21.8 mm	22.9 mm	24.2 mm	29 mm
Time of complication at follow-up	6 months	60 months	18 months	24 months
Pathology	Partial transmural rupture	Dissection	Dissection	Pseudoaneurysm
Clinical presentation	Asymptomatic	Asymptomatic	Asymptomatic	Asymptomatic

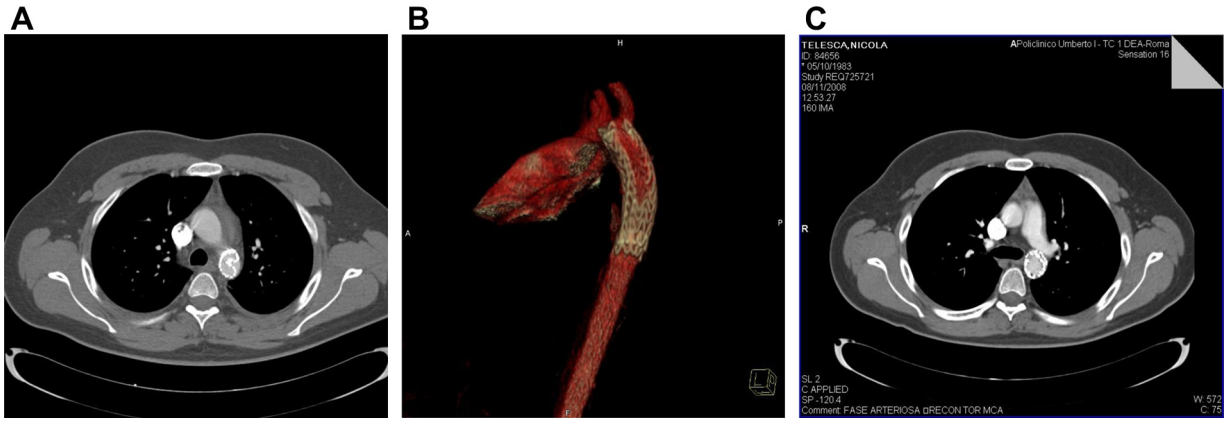

Fig 2. A, A 5-year computed tomographic angiogram (CTA) control that shows an infolding of thoracic aorta endograft. **B,** Three-dimensional reconstruction of the infolding of thoracic aorta endograft. **C,** Endovascular treatment by an adjunctive cuff of the infolding of the endograft depicted in **(A)** and **(B)**.

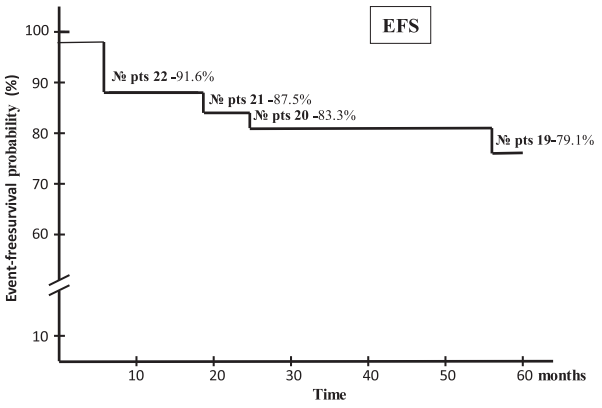

Fig 3. Kaplan-Meier curve for event free survival (*EFS*). Patients lost to the follow-up were censored (n = 3).

The optimal oversizing of the endograft deployed for BAI treatment should be no more than 10%. To obtain a good distal sealing, conical and more conformable endografts should be available. The employment of suboptimal devices and an incorrect oversizing of the stent graft may explain the distal migration and the infolding of the endografts that occurred in four cases. This suggests the need for a lower oversizing and more adaptable stent grafts for different conformations of the aortic arch. Incorrect oversizing is conditioned also by the availability of the endografts in emergency. In our series, no ischemic complications occurred after coverage of the LSA suggesting a selective indication to preemptive LSA revascularization.

The most appropriate timing of the endovascular BAI repair is still controversial. The question is whether to defer the urgency related to the aortic trauma to first stabilize the patients' conditions. The choice of a delayed treatment is suggested by the results of two large prospective studies of the American Association for the Surgery of Trauma[8] on conventional and endovascular treatment.[9] Most of our patients were treated as an emergency in the light of the signs of impending rupture, whereas in the remaining cases, BAI repair was performed as soon as the associated more severe injuries had been safely managed. This approach was chosen to avoid the risk of possible complete rupture as the patients' conditions were stabilizing.

Our strategy is consistent with data of the American Association for the Surgery of Trauma multicenter study, which reported an incidence of 8.8% of thoracic aorta

rupture before the planned surgery.[10] A deferred treatment of BAI should be reserved for patients with major trauma and/or with serious comorbidity to stabilize their conditions before aortic repair. Although in our series, all device-related complications occurred in the first 5 years, long-term durability of endovascular grafts is unknown, and TEVAR repair of BAI may be burdened with a number of late complications. For this reason, careful surveillance of relatively young patients is necessary.

CONCLUSIONS

Endovascular repair of BAI has proved to be available and a safe alternative to open surgery in terms of mortality and morbidity. Despite the early encouraging results, some concerns still remain about the mid- and long-term results. The main issues of these procedures are related to the frequent small size and acute angle of the aortic arch in younger patients.

Concerns about the outcomes of endovascular repair are particularly crucial in younger patients. They must undergo lifelong surveillance to detect early complications, which in most cases may be treated by an endovascular approach.

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