Open versus endovascular repair for patients with acute traumatic rupture of the thoracic aorta

Ludovic Canaud, MD, Pierre Alric, MD, PhD, Pascal Branchereau, MD, Frédéric Joyeux, MD, Kheira Hireche, MD, Jean-Philippe Berthet, MD, and Charles Marty-Ané, MD, PhD

Objective: The study objective was to compare the outcome between open and endovascular repair of acute traumatic rupture of the thoracic aorta.

Methods: Seventy-five patients (mean age 38.6 ± 10.7 years) with an acute traumatic aortic rupture were referred to the Arnaud de Villeneuve Hospital between January 1990 and January 2010. Between January 1990 and December 2000, 35 patients (33 men, mean age 35.8 ± 11.3 years) underwent surgical repair using cardiopulmonary bypass. From January 2001, an endovascular approach was deliberately chosen; 40 patients (30 male, mean age 41 ± 10.1 years) underwent endovascular repair. The 2 groups were statistically comparable.

Results: The overall mortality rates for the surgical and endovascular groups were 11.4% (intraoperative mortality: 8.5%) and 2.5% (intraoperative mortality: 0%), respectively. The mortality rates related to aortic repair for the surgical and endovascular groups were 11.4% and 0%, respectively. In the surgical group, the morbidity rate was 14.2%: 4 cases of recurrent nerve palsy and 1 case of false anastomotic aneurysm were diagnosed at 52 months. In the endovascular group, the morbidity rate was 20%: 3 cases of intraoperative inadvertent coverage of supra-aortic trunks (requiring a secondary procedure in 2 cases after 1 and 2 years to revascularize the supra-aortic trunks), 1 proximal type I endoleak (requiring deployment of a second stent-graft at day 2), 2 stent-graft collapses in the first postoperative month (treated by open repair and explantation in 1 case and by the deployment of a second stent-graft in 1 case), 1 vertebrobasilar insufficiency after left subclavian artery coverage, and 1 intraoperative iliac rupture (surgically repaired). No cases of paraplegia or stroke were observed. The median follow-up was 7.7 (range, 0.4–15) years.

Conclusions: Compared with open repair, endovascular repair of traumatic thoracic aortic rupture is associated with a lower death rate but failed to reach statistical significance, most likely because of underpowering. These results prompt us to consider endovascular repair as the first-line therapy for acute traumatic rupture of the thoracic aorta, except in some rare but challenging anatomic situations. New stent-graft designs, sizes, and deployment systems could improve the results of endovascular repair in these indications. (J Thorac Cardiovasc Surg 2011;142:1032-7)

Open operative repair of a traumatic thoracic aortic rupture in the presence of other associated injuries correlates with significant mortality approaching 8% to 15%, despite significant improvements in intensive care.[1] Paraplegia rates of 2.3% to 14% remain high as the result of aortic thoracic crossclamping and prolonged distal hypoperfusion in polytraumatized patients, despite the use of circulatory assistance.[2] Moreover, these patients typically have other severe injuries, and the use of extracorporeal circulation, particularly the use of systemic heparinization, complicates the management of those associated injuries.

In 1994, Dake and colleagues[3] reported the first successful endovascular repair of thoracic aorta disease. Currently, stent-graft placement represents a valid option for thoracic aortic aneurysms and complicated type B dissections, especially for patients at high surgical risk.

Despite lack of level I evidence, endovascular treatment of traumatic thoracic aortic rupture is increasingly being used as the primary modality of therapy. The purpose of this retrospective and monocentric study was to evaluate outcomes of open and endovascular repair of traumatic thoracic aortic rupture.

MATERIALS AND METHOD

Institutional review board approval was obtained for the review of all patient records relevant to this study.

Patients

Seventy-five patients (mean age, 38.6 ± 10.7 years; range, 15–78 years) with an acute traumatic rupture of the thoracic aorta were referred to the Arnaud de Villeneuve Hospital between January 1990 and January 2010, 63 of whom were male (84%).

From the Department of Vascular and Thoracic Surgery, Arnaud de Villeneuve Hospital, Montpellier, France.

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Address for reprints: Ludovic Canaud, MD, Service de Chirurgie Vasculaire et Thoracique, Hôpital A de, Villeneuve, 191 av Doyen Gaston Giraud, 34090 Montpellier, France (E-mail: ludoviccanaud@hotmail.com).

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Abbreviations and Acronyms

AAST = American Association for the Surgery of Trauma
BT = brachiocephalic trunk
CT = computed tomography
LCCA = left common carotid artery
LSA = left subclavian artery

All patients admitted for blunt traumatic injury during that time were included. Diagnosis of aortic disruption was achieved by a preprocedural contrast-enhanced computed tomography (CT) scan of all patients. Subcategories of aortic lesions in the endovascular group and the open repair group were pseudoaneurysm (17 and 18, respectively), intramural hematoma (18 and 13, respectively), and free rupture (5 and 4, respectively).

To define the severity of trauma in the conventional surgical group and endovascular stent group, an anatomic scoring system, the injury severity score from 0 to 75, was used.[4]

Therapeutic Strategy

Between January 1990 and December 2000, all patients underwent surgical repair using cardiopulmonary bypass. From January 2001, an endovascular approach was deliberately chosen for all patients.

We aimed to perform surgical or endovascular repair soon after admission, unless severe associated injuries or complications restricted this policy. In 9 patients (endovascular in 6, surgical repair in 3), treatment was delayed for more than 5 days after trauma caused by septic state, major cerebral lesions, or severe pulmonary contusion (Table 1).

Surgical Approach

In all patients, surgical repair was performed using a standard left heart bypass driven with a Bio-Medicus pump (Bio-Medicus Inc, Eden Prairie, Minn). This circulatory support was inserted between the left atrium and the left common femoral artery. In the absence of associated bleeding injuries, a bolus of 0.5 mg/kg of heparin was given. The thoracic aorta was approached through a left posterolateral thoracotomy. The aorta was repaired with direct suturing or prosthetic graft interposition.

Endovascular Repair

Suitable morphology for stent-graft placement requires a proximal aortic neck length of at least 15 mm. Measurements from preprocedural imaging data were used to select the appropriate diameter and length of the stent-graft. Devices were oversized by 10% to 20% greater than the minor axis of the aortic neck to provide sufficient radial force for adequate fixation.

TABLE 1. Patient population and associated injuries

	Surgical group	Endovascular group	*P*
Gender (m/f)	33/2	30/10	.3
Age (y)	35.8	41	.4
Delay between trauma and treatment (d/median)	3.4 (0–28)	7.3 (0–30)	.08
ISS (median)	37 ± 5	34 ± 7	.6
Associated injuries			
Thoracic injuries (%)	94.2	92.5	
Cranial and spinal injuries (%)	42.5	37.1	
Abdominal injuries (%)	45.7	55	

ISS, Injury severity score.

All procedures were performed in the operating room under general anesthesia. All angiograms were performed through a 5F calibrated pigtail catheter (Cook Australia Pty Ltd, Queensland, Brisbane, Australia) placed percutaneously into the aortic arch via a brachial artery. A 260-cm, 0.035-inch Terumo guidewire (Terumo Medical Corporation, Tokyo, Japan) was placed under fluoroscopic control into the ascending aorta through a sheath in the common femoral artery; a 5F measuring pigtail catheter was advanced into the ascending aorta over the Terumo guide. This pigtail catheter was used to exchange the Terumo guide wire for a 0.035-inch-diameter Lunderquist (Cook Inc, Bloomington, Ind) to guide passage of the 22F to 24F sheath. In absence of associated bleeding injuries, a bolus of 0.5 mg/kg of heparin was given. Angiography was performed before stent-graft deployment. Stent-graft deployment was performed under fluoroscopic control. A control angiography was performed to confirm appropriate position of the device and exclusion of the aortic disruption. In case of endoleak after stent-graft deployment, the stent-graft was further expanded with a low-pressure balloon.

Follow-up surveillance was performed with serial CT scans at 1 week; at 3, 6, and 12 months; and annually thereafter. Outcomes were analyzed using Kaplan–Meier life-table analysis.

Statistical Analysis

Categoric data are presented as frequency (percentage), and continuous data are presented as mean + standard deviation or median with interquartile ranges. Comparison of continuous data was by the Student *t* test for normally distributed data and Mann–Whitney test for non-normally distributed data. Comparison of categoric data was by chi-square test for normally distributed data and Fisher exact test for non-normally distributed data.

RESULTS

Follow-up

No patients have been lost to follow-up, and all have completed each of their scheduled follow-up evaluations and CT scans.

Surgical Group

In our series, 35 patients (33 male; mean age, 35.8 ± 11.3 years) underwent surgical repair of a traumatic rupture of the thoracic aorta. The aorta was repaired with direct suturing in 13 patients (37%) and with a prosthetic graft interposition in 22 patients (63%). The intraoperative mortality was 8.5% (n = 3): these 3 patients had a free rupture of the aorta. The cause of the intraoperative mortality was irreversible cardiac arrest in all 3 patients. The overall mortality was 11.4% (n = 4). One patient died of acute respiratory distress syndrome on the sixth postoperative day. No patients experienced stroke or paraplegia.

The morbidity rate was 14.2% (n = 5): 4 cases of recurrent nerve palsy and 1 false anastomotic aneurysm diagnosed at 52 months and treated conservatively.

The median follow-up for survivors was 13 years (range, 9–20 years). During follow-up, no patient required a redo operation.

Endovascular Group

In our series, 40 patients (30 male; mean age, 41 ± 10.1 years) underwent endovascular repair for a traumatic rupture of the thoracic aorta. Technical success was obtained