

Treating Traumatic Thoracic Aortic Rupture

An overview of endovascular options for patients with blunt traumatic rupture of the thoracic aorta.

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Blunt traumatic rupture of the thoracic aorta usually occurs at the isthmus and is a life-threatening surgical emergency. Blunt traumatic rupture lesions are usually the result of a violent motor vehicle accident and are frequently associated with other life-threatening traumatic injuries (ie, pulmonary contusions, head injuries, fractures, injuries of the solid organs); thus, 80% of the subjects who experience aortic rupture die at the scene of the accident.¹ The management of patients who do reach the hospital remains a subject of controversy, both in terms of how the aorta should be repaired and the lapse of time between the traumatic injury and repair.²

THE STANDARD

Open surgical repair is the gold standard. The procedure consists of either simply suturing the aorta or clamp-and-sew repair, with the interposition of a prosthetic graft, sometimes using an adjunct to maintain distal aortic perfusion and limit the distal impact of aortic cross-clamping. The immediate outcome of surgical repair is disappointing. Operative mortality varies from 8% to 15%, depending on the severity of the associated traumatic injuries. Circulatory assistance reduces the incidence of medullary ischemia to 3%; however, it has the drawback of requiring systemic heparinization, thereby increasing the risk of fatal hemorrhage, particularly in patients with cerebral or pulmonary contusions.^{3,4}

TABLE 1. THEORETICAL ADVANTAGES OF ENDOVASCULAR TREATMENT

- Because the placement of a stent graft does not entail thoracotomy, the morbidity associated with single-lung ventilation decreases in trauma patients who often also have concomitant pulmonary contusions and fractured ribs.
- No circulatory assistance is needed, excluding systemic heparin treatment and thereby averting the hemorrhagic complications of open surgery in patients with multiple traumatic injuries.
- The placement of a stent graft does not require aortic cross-clamping, thus excluding the risk of distal visceral ischemia and reducing the risk of medullary ischemia. In theory, the risk remains because the intercostal arteries level with the stent graft are occluded, but the residual risk is limited because the spinal artery rarely arises from the aortic isthmus.
- Because an endovascular procedure is short and has only a minor physiological impact, it can be performed shortly after the traumatic injury, as soon as any other life-threatening injuries have been treated or in patients for whom conventional surgery is contraindicated.

POSSIBLE ALTERNATIVES

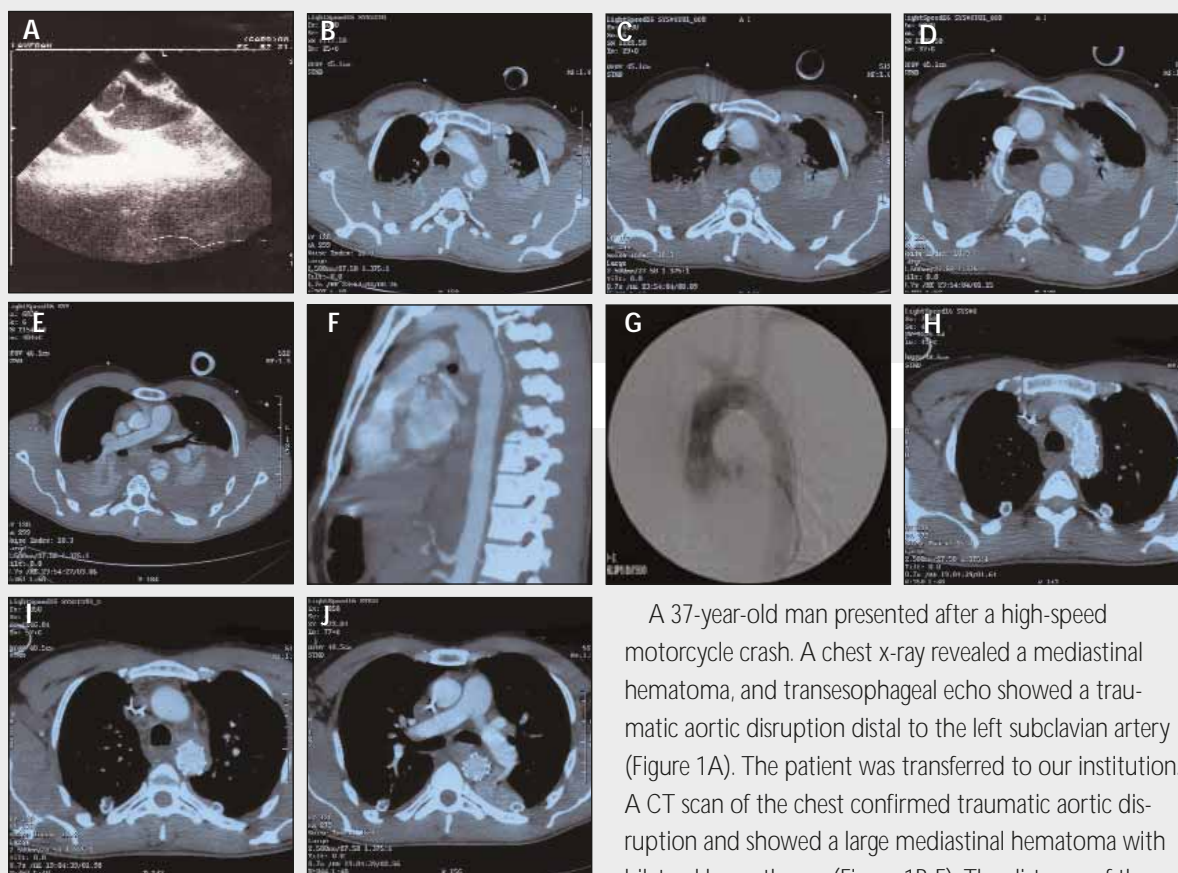
To avoid the complications of early surgery, some investigators have proposed delaying the procedure, subject to very careful surveillance of the patient's arterial pressure, although this approach is not entirely devoid of risk either because 2% to 5% of the patients have secondary rupture, in most cases within 1 week of their traumatic injury.⁵⁻⁷

Covered stent grafts can be used electively as a less-invasive method of treatment than standard surgical repair in patients with lesions of the descending thoracic aorta. Therefore, it was on the basis of the following underlying

logic that we applied this procedure to the treatment of blunt traumatic rupture to find a solution to the different controversies that fuel the debate on surgical repair (Case Report 1; Table 1).

The success of endovascular treatment is partly dependent on very careful evaluation of the anatomical conditions. Ideally, there should be 15 mm of healthy aorta proximal to the rupture site to ensure a satisfactory seal and exclude the false aneurysm. If the rupture is located near the ostium of the left subclavian artery, it is quite feasible to cover the artery and thus lengthen the proximal neck. When the left

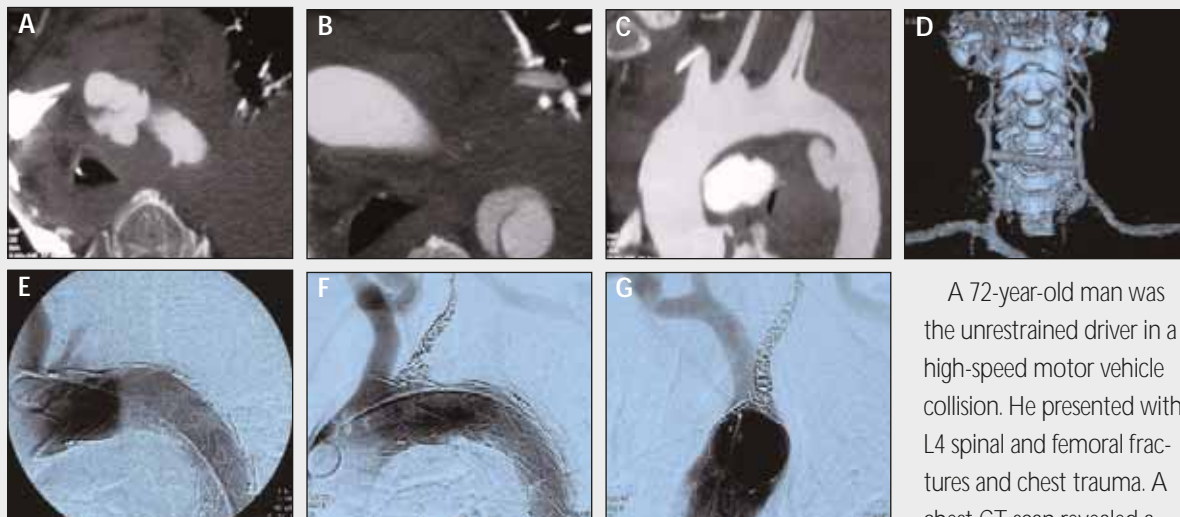
CASE REPORT 1



lesion from the left subclavian was 20 mm, and the diameters of the aorta proximal and distal to the lesion were 20 mm (Figure 1F). The patient developed hemorrhagic shock related to free aortic rupture and was taken to the operating room for stent graft placement. A 24-mm X 130-mm Talent stent graft (Medtronic, Inc., Santa Rosa, CA) was deployed distal to the left subclavian artery. A completion angiogram revealed complete exclusion of the aortic injury, with no extravasation (Figure 1G). A postoperative CT scan revealed satisfactory placement of the endograft, with no extravasation (Figure 1H-J). The patient was discharged to a rehabilitation center 1 month later and was asymptomatic at 1-year follow-up.

A 37-year-old man presented after a high-speed motorcycle crash. A chest x-ray revealed a mediastinal hematoma, and transesophageal echo showed a traumatic aortic disruption distal to the left subclavian artery (Figure 1A). The patient was transferred to our institution. A CT scan of the chest confirmed traumatic aortic disruption and showed a large mediastinal hematoma with bilateral hemothorax (Figure 1B-E). The distance of the

CASE REPORT 2



A 72-year-old man was the unrestrained driver in a high-speed motor vehicle collision. He presented with L4 spinal and femoral fractures and chest trauma. A chest CT scan revealed a

complex traumatic aortic arch disruption with contained aortic rupture distal to the left common carotid artery and isthmic laceration (Figure 2A-C). The patient was taken to the operating room for a hybrid treatment. We performed adjunctive cervical reconstruction including carotid-to-carotid bypass, left subclavian-to-carotid transposition, and proximal ligation of the left common carotid artery and the subclavian artery to facilitate the proximal attachment of the endograft in the aortic arch (Figure 2D). Two Talent stent grafts were deployed distal to the innominate artery. A completion angiogram revealed proximal type I endoleak (Figure 2E). The patient was administered beta-blocker therapy for blood pressure control until a coil embolization was performed a few days later (Figure 2F, G). The patient was discharged to a rehabilitation center 37 days later, and was asymptomatic at 6-month follow-up.

subclavian artery is covered, complications such as ischemia of the upper limb rarely occur, so there is no point in performing a subclavian-carotid transposition before the placement of the stent graft.⁸ In some cases of complex rupture involving the aortic arch, if the rupture is contained, a hybrid treatment is also feasible, but this can only be decided on a case-by-case basis (Case Report 2).

The immediate outcome of this type of treatment for blunt traumatic rupture compares favorably with that of conventional surgery;⁹⁻¹⁴ when observed 3 months after the procedure, the aortic wall is completely healed. This can be largely explained because (1) the aorta is usually healthy proximal and distal from the rupture site and the seal is satisfactory and free from type I endoleaks, (2) the rupture is always limited in length and very few intercostal arteries are likely to feed the false aneurysm, and (3) in most cases, a single stent graft is sufficient, thus reducing the risk of type III endoleaks.

Several factors can contribute to limiting the feasibility of endovascular treatment. Currently, any lesion that involves the aortic arch, proximal to the left subclavian artery, is a contraindication for the deployment of a stent graft in

patients who are hemodynamically unstable. Vascular access can be difficult if the femoral and iliac arteries are small in size or tortuous because the diameter and the stiffness of the stent graft deployment system remains a major obstacle. Lastly, it is also mandatory to have a complete inventory of stent grafts of all diameters to be able to treat the largest possible range of patients. Because aortic rupture is restricted to a single, short tear in most cases, one length of stent graft suffices, limiting the inventory required.

The real issue is the long-term future of these frequently young patients who are treated with stent grafts—they need very strict surveillance. We perform a thoracic CT scan 1 week after placement of the stent graft to check that the false aneurysm has been properly excluded. We then do regular CT scans and plain radiographs at various angles at 3 and 6 months, and yearly thereafter to check the satisfactory initial result and make sure that the stent graft remains in good condition. In our experience of 15 patients treated since June 2000, no late complications occurred, although this may be simply due to the fact that our follow-up is limited. Also note that long-term surveillance is equally mandatory for surgical treatment, which is not exempt from late

complications, such as false aneurysms, anastomotic stenosis, or infection of the prosthetic material that is burdened with a catastrophic prognosis.¹⁵

CONCLUSION

Endovascular treatment of traumatic rupture of the descending aorta can be performed safely with an immediate and short-term outcome that compares favorably with those in the literature for conventional surgery. Although some investigators¹⁰ reserve endovascular treatment for patients for whom surgical repair is contraindicated, the issue of whether the indication for stent graft placement should be extended to all patients presenting with blunt traumatic rupture of the thoracic aorta can be discussed. If the stent graft were to show any signs of failure during the follow-up period, a possible solution would be elective endovascular or surgical conversion in a safer setting. Studies should be undertaken to provide an answer to these issues. ■

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1. Parmley LF, Mattingly TW, Manion WC, et al. Nonpenetrating traumatic injury of the aorta. *Circulation*. 1958;17:1086-1101.
2. McLaughlin JS. The renegade fact. *Ann Thorac Surg*. 2002;73:1031.
3. Von Oppell UO, Dunne TT, De Groot MK, et al. Traumatic aortic rupture: twenty-year meat-analysis of mortality and risk of paraplegia. *Ann Thorac Surg*. 1994;58:585-593.
4. Jahromi AS, Kazemi K, Safar HA, et al. Traumatic rupture of the thoracic aorta: cohort study and systematic review. *J Vasc Surg*. 2001;34:1029-1034.
5. Pierangeli A, Turinetti B, Galli R, et al. Delayed treatment of isthmic aortic rupture. *Cardiovasc Surg*. 2000;8:280-283.
6. Fabian TC, Richardson JD, Croce MA, et al. Prospective study of blunt aortic injury. Multicenter trial of the American Association for the Surgery of Trauma. *J Trauma*. 1997;42:374-380.
7. Holmes JH, Bloch RD, Hall RA, et al. Natural history of traumatic rupture of the thoracic aorta managed non operatively: a longitudinal analysis. *Ann Thorac Surg*. 2002;73:1149-1154.
8. Dake MD. Endovascular stent-graft management of thoracic aortic diseases. *Eur J Radiol*. 2001;39:42-49.
9. Thompson CS, Rodriguez JA, Damaia VG, et al. Acute traumatic rupture of the aorta treated with endoluminal stent grafts. *J Trauma*. 2002; 52:1173-1177.
10. Marty-Ané CH, Berthet JP, Brancheau P, et al. Endovascular repair for acute traumatic rupture of the thoracic aorta. *Ann Thorac Surg*. 2003;75:1803-1807.
11. Orford VP, Atkinson NR, Thomson K, et al. Blunt traumatic aortic transection. *Ann Thorac Surg*. 2003;75:100-111.
12. Scheinert D, Krakenberg H, Schmidt A, et al. Endoluminal stent-graft placement for acute rupture of the descending thoracic aorta. *Eur Heart J*. 2004;8:694-700.
13. Melnitchouk S, Pfammatter T, Kadner A, et al. Emergency stent-graft placement for hemorrhage control in thoracic aortic rupture. *Eur J Cardiothorac Surg*. 2004;25:1032-1038.
14. Amabile P, Collart F, Gariboldi V, et al. Surgical versus endovascular treatment of traumatic thoracic aortic rupture. *J Vasc Surg*. 2004;40:873-879.
15. Kieffer E, Sabatier J, Goarin JP. Ruptures traumatiques de l'aorte thoracique. In: Kieffer E, ed. *Traumatismes artériels*. Paris, France: Editions AERC; 1995: 375-401.

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