



Endovascular management of acute thoracic aortic emergencies

Acute emergencies involving the descending thoracic aorta, such as traumatic aortic disruption (TAD), ruptured descending thoracic aneurysm (RDTA), complicated type B dissection (cTBD), have been particularly challenging for aortic surgeons. Many patients do not survive the initial event, and are never afforded the opportunity to undergo surgical repair. Emergent open operative repair of the descending thoracic aorta, the traditional gold standard, is a formidable undertaking with significant operative mortality and morbidity. These are some of the most difficult and highest risk procedures performed by vascular surgeons.

Since the approval of the first thoracic endograft in 2005, thoracic endovascular aortic repair (TEVAR) has quickly become the treatment of choice for elective thoracic aortic aneurysm repair. It was not long before the "off-label" use of TEVAR for a wide variety of conditions, both elective and emergent, was reported. The expanded use of TEVAR has resulted in a decrease in both operative mortality and morbidity for patients with a wide variety of aortic pathologies. In addition, hospital length of stay is usually less following TEVAR, especially if the procedure is done using a totally percutaneous technique.

KEYWORDS: TEVAR; thoracic aorta emergencies

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The use of TEVAR in the emergency setting requires a level of commitment and logistics that

not all institutions can provide. Appropriate inventories of endografts, as well as full-time availability of a hybrid endovascular suite and team, are required. In addition, open surgical back-up is required. These resources may not be available in all centers, particularly those with low TEVAR volumes. In 2011 we reported our single center experience of 44 consecutive patients undergoing emergent TEVAR for descending thoracic aortic catastrophes over a three-year period [1].

During that time no patient required emergent open repair of the descending thoracic aorta. The technical success rate was 100%, with 84% survival and a procedure related complication rate of 20%. These results compare favorable to those seen with open surgical repair.

Endograft technology has improved remarkably since then, along with the skills of the surgeons performing these procedures. The use of TEVAR for both elective and emergent conditions involving the descending thoracic aorta has increased dramatically. This brief review describes the current state of the art for the treatment of emergency conditions involving the descending thoracic aorta.

Traumatic aortic disruption

Open surgical repair of TAD is associated with an operative mortality approaching 30%

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and a paraplegia rate of up to 16% [2-5]. Most patients have multiple injuries, and are not medically fit to undergo a major open vascular reconstruction. Many patients have associated heart and/or lung injuries, making the prospect of an open repair via a thoracotomy unattractive.

The limitations of early thoracic endografts, such as limited graft sizes, poor delivery systems, and stiff grafts that did not conform to the contour of an otherwise normal aorta, have been largely overcome. As a result, the vast majority of TAD is now being repaired using commercially available thoracic endografts.

Numerous retrospective reviews describing the repair of TAD using TEVAR have demonstrated technical success rates approaching 100%, with 30-day mortality less than 10%. The incidence of paraplegia is near zero and other complications are both infrequent and are usually easily managed [2,6-8]. Although follow up has been relatively short, the development of late endoleaks and other complications is uncommon.

Two recent prospective, nonrandomized, multicenter trials report a 100% technical success rate and 92% 30-day survival using commercially available thoracic endografts for the treatment of TAD [9,10]. None of the deaths were device or procedure related, and no patients developed paraplegia or suffered a cerebral injury related to the procedure.

The major limitation of TEVAR for TAD is the location of the injury in relation to the origin of left subclavian artery. Many patients (up to 60%) still require complete or partial coverage of the left subclavian artery, although most (more than 90%) do not require subclavian artery revascularization. Because of the low incidence of spinal cord ischemia when TEVAR is done for TAD, cerebral spinal fluid drainage is not required. The Society for Vascular Surgery Clinical Practice Guidelines now recommend TEVAR in favor of open surgical repair for the treatment of TAD [11].

Ruptured descending thoracic aneurysm

Just as TEVAR for elective thoracic aneurysm repair rapidly gained acceptance as the treatment of choice, TEVAR for RDTA has quickly gained popular acceptance. By 2007 more than half of RDTA were repaired using TEVAR [12]. The results of TEVAR for RDTA repair also mirror that of elective aneurysm repair, with

TEVAR demonstrating a significant decrease in mortality, morbidity and hospital length of stay.

Open repair of RDTA has a reported mortality rate of 25% to 45% [13-15]. Several recent studies comparing TEVAR to open repair for RDTA show unadjusted mortality rates for TEVAR of 18% to 23% [12,16,17]. The incidence of paraplegia was also less than that seen with open repair. As with TEVAR for TAD, coverage of the left subclavian artery is often necessary. Because these patients are usually unstable, pre-operative subclavian revascularization is not performed.

Despite being older and having a greater burden of associated comorbidities than patients undergoing open repair, patients undergoing TEVAR are more likely to be routinely discharged home following surgery [16]. Interestingly, small hospitals had worse results compared to large hospital for open repair, but not for TEVAR [16]. This suggests that emergent TEVAR may be particularly well suited for smaller centers not having a large experience with open thoracic aneurysm repair.

Complicated type B aortic dissection

While the role and benefits of TEVAR in the treatment of TAD and RDTA are well defined, its efficacy in the treatment of aortic dissection is less clear. In the acute period the most common indications for TEVAR are cTBD with rupture and cTBD with end organ malperfusion.

When treating cTBD with rupture, the primary entry site and the ruptured segment both must be covered by the endograft. Technical success rates of 100% with no operative deaths have been reported [18]. This compares favorably to historic mortality of 50% for open surgical repair [19].

When performing TEVAR for malperfusion associated with cTBD, the primary entry site must be covered in order to increase flow in the true lumen and facilitate thrombosis of the false lumen. Stenting of branch vessels is sometimes required. Technical success rates of 100% with 99% survival have been reported [20].

Less frequent conditions

TEVAR has been used to treat a variety of other less common emergent conditions involving the descending thoracic aorta. Hemorrhage from a penetrating aortic ulcer is treated similarly to RDTA. Mycotic aneurysms [21], aorto-esophageal fistulae, [8] and aortobronchial fistulae [22] have been successfully treated using TEVAR.

At this point TEVAR should be considered as a temporizing measure for these infectious conditions, although there are isolated reports of successful long-term treatment with TEVAR.

In conclusion, TEVAR has become the technique of choice for the treatment of a wide

variety of emergent conditions involving the descending thoracic aorta. The same benefits seen with elective TEVAR are observed in the emergent setting. As endograft technology continues to evolve and improve, the role of TEVAR in the emergency setting will continue to expand.

REFERENCES

- Mitchell ME, Rushton FW Jr, Boland AB *et al*. Emergency procedures on the descending thoracic aorta in the endovascular era. *J. Vasc. Surg.* 54, 1298-1302 (2011).
- Demetriades D, Velmahos GC, Scalea TM *et al*. Operative repair or endovascular stent graft in blunt traumatic thoracic aortic injuries: results of an American Association for the Surgery of Trauma Multicenter Study. *J. Trauma.* 64, 561-570 (2008).
- Cowley RA, Turney SZ, Hankins JR *et al*. Rupture of thoracic aorta caused by blunt trauma. A fifteen-year experience. *J. Thorac. Cardiovasc. Surg.* 100, 652-660 (1990).
- Ott MC, Stewart TC, Lawlor DK *et al*. Management of blunt thoracic aortic injuries: endovascular stents versus open repair. *J. Trauma.* 56, 565-570 (2004).
- 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.* 42, 374-380 (1997).
- Martinelli O, Malaj A, Gossetti B *et al*. Outcomes in the emergency endovascular repair of blunt thoracic aortic injuries. *J. Vasc. Surg.* 58, 832-835 (2013).
- Marone EM, Kahlberg A, Tshomba Y *et al*. Single-center experience with endovascular treatment of acute blunt thoracic aortic injuries. *J. Cardiovasc. Surg. (Torino).* 54, 123-131 (2013).
- Echeverria AB, Branco BC, Goshima KR *et al*. Outcomes of endovascular management of acute thoracic aortic emergencies in an academic level 1 trauma center. *Am. J. Surg.* 208, 974-980 (2014).
- Farber MA, Giglia JS, Starnes BW *et al*. TAG 08-02 clinical trial investigators, Evaluation of the redesigned conformable GORE TAG thoracic endoprosthesis for traumatic aortic transection. *J. Vasc. Surg.* 58, 651-658 (2013).
- Khoynezhad A, Azizzadeh A, Donayre CE *et al*. RESCUE investigators. Results of a multicenter, prospective trial of thoracic endovascular aortic repair for blunt thoracic aortic injury (RESCUE trial). *J. Vasc. Surg.* 57, 899-905 (2013).
- Lee WA, Matsumura JS, Mitchell RS *et al*. Endovascular repair of traumatic thoracic aortic injury: clinical practice guidelines of the Society for Vascular Surgery. *J. Vasc. Surg.* 53, 187-192 (2011).
- Kilic A, MD, Shah AS *et al*. Trends in repair of intact and ruptured descending thoracic aortic aneurysms in the United States: a population-based analysis. *J. Thorac. Cardiovasc. Surg.* 147, 1855-1860 (2014).
- Schermerhorn ML, Giles KA, Hamdan AD *et al*. Population-based outcomes of open descending thoracic aortic aneurysm repair. *J. Vasc. Surg.* 48, 821-827 (2008).
- Barbato JE, Kim JY, Zenati M *et al*. Contemporary results of open repair of ruptured descending thoracic and thoracoabdominal aortic aneurysms. *J. Vasc. Surg.* 45, 667-676 (2007).
- Girardi LN, Krieger KH, Altorki NK *et al*. Ruptured descending and thoracoabdominal aortic aneurysms. *Ann. Thorac. Surg.* 74, 1066-1070 (2002).
- Gopaldas RR, Dao TK, LeMaire SA *et al*. Endovascular versus open repair of ruptured descending thoracic aortic aneurysms: a nationwide risk-adjusted study of 923 patients. *J. Thorac. Cardiovasc. Surg.* 142, 1010-1018 (2011).
- Jonker FH, Verhagen HJ, Lin PH *et al*. Outcomes of endovascular repair of ruptured descending thoracic aortic aneurysms. *Circulation.* 121, 2718-2723 (2010).
- Minami T, Imoto K, Uchida K *et al*. Clinical outcomes of emergency surgery for acute type B aortic dissection with rupture. *Eur. J. Cardiothorac. Surg.* 44: 360-364 (2013).
- Trimarchi S, Nienaber CA, Rampoldi V *et al*. IRAD Investigators. Role and results of surgery in acute type B aortic dissection: insights from the International Registry of Acute Aortic Dissection (IRAD). *Circulation.* 114, 1357-1364 (2006).
- Shu C, Fang K, Luo M *et al*. Emergency endovascular stent-grafting for acute type B aortic dissection with symptomatic malperfusion. *Int. Angiol.* 32, 483-491 (2013).
- Heneghan RE, Singh N, Starnes BW. Successful emergent endovascular repair of a ruptured mycotic thoracic aortic aneurysm. *Ann. Vasc. Surg.* 29, 843 (2015).
- Canaud L, D'Annunzio T, Ozdemir BA *et al*. Combined endovascular and surgical approach for aortobronchial fistula. *J. Thorac. Cardiovasc. Surg.* 148, 2108-2111 (2014).