



MASSACHUSETTS

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## Medical Policy

# Endovascular Stent Grafts for Disorders of the Thoracic Aorta

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### Policy Number: 233

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NCD/LCD: NA

### Related Policies

- Endovascular Stent Grafts for Abdominal Aortic Aneurysms, #[098](#)
- Wireless Pressure Sensors in Endovascular Aneurysm, # [306](#)

### Policy

#### Commercial Members: Managed Care (HMO and POS), PPO, and Indemnity Medicare HMO Blue<sup>SM</sup> and Medicare PPO Blue<sup>SM</sup> Members

Endovascular stent grafts for the treatment of thoracic aortic arch aneurysms<sup>1</sup> may be considered **MEDICALLY NECESSARY**.

Endovascular stent grafts using devices approved by U.S. Food and Drug Administration (FDA) may be considered **MEDICALLY NECESSARY** for the following conditions:

- Descending thoracic aortic aneurysms used according to FDA-approved specifications.\*
- Acute, complicated (organ or limb ischemia or rupture) type B thoracic aortic dissection.
- Traumatic descending aortic tears or rupture.

Endovascular stent grafts are considered **INVESTIGATIONAL** for the treatment of descending aortic disorders that do not meet the above criteria, including but not limited to uncomplicated aortic dissection.\*

Endovascular stent grafts are considered **INVESTIGATIONAL** for the treatment of ascending aortic disorders.

#### \*Endograft Placement

Endograft placement relies on nonaneurysmal aortic segments proximal and distal to the aneurysm and/or dissection for anchoring, and a maximal graft diameter that varies by device. For example, the Gore TAG® endoprosthesis is approved by the U.S. Food and Drug Administration (FDA) for ">2 cm non-aneurysmal aorta proximal and distal to the aneurysm" and an "aortic inner diameter of 23-37 mm." The Zenith TX2® device is approved by FDA for nonaneurysmal aortic segments "of at least

25 mm in length" and a "diameter measured outer wall to outer wall of no greater than 38 mm and no less than 24 mm."

**\*Uncomplicated Type B Aortic Dissection with Indication for Intervention**

Guidelines generally suggest medical management for most patients with uncomplicated type B aortic dissection. However, guidelines by the American College of Cardiology/American Heart Association (ACC/AHA) and Society of Thoracic Surgeons/American Association for Thoracic Surgery suggest that early, pre-emptive intervention may be considered in patients with uncomplicated acute type B aortic dissection who have high-risk features. The high-risk criteria suggested by ACC/AHA are: maximal aortic diameter >40 mm, false-lumen diameter >20-22 mm, entry tear >10 mm, entry tear on lesser curvature, increase in total aortic diameter of >5 mm between serial imaging studies, bloody pleural effusion, imaging-only evidence of malperfusion, refractory hypertension despite >3 different classes of antihypertensive medications at maximal recommended or tolerated doses, refractory pain persisting >12 hours despite maximal recommended or tolerated doses, or need for readmission. In patients with an indication for early intervention, guidelines suggest endovascular repair may be preferred for patients with suitable anatomy but who are at high risk for complications of open repair due to comorbidities.

**Prior Authorization Information**

**Inpatient**

- For services described in this policy, precertification/preauthorization **IS REQUIRED** for all products if the procedure is performed **inpatient**.

**Outpatient**

- For services described in this policy, see below for products where prior authorization **might be required** if the procedure is performed **outpatient**.

	<b>Outpatient</b>
<b>Commercial Managed Care (HMO and POS)</b>	This procedure is performed in the inpatient setting
<b>Commercial PPO and Indemnity</b>	This procedure is performed in the inpatient setting
<b>Medicare HMO Blue<sup>SM</sup></b>	This procedure is performed in the inpatient setting
<b>Medicare PPO Blue<sup>SM</sup></b>	This procedure is performed in the inpatient setting

**CPT Codes / HCPCS Codes / ICD Codes**

*Inclusion or exclusion of a code does not constitute or imply member coverage or provider reimbursement. Please refer to the member's contract benefits in effect at the time of service to determine coverage or non-coverage as it applies to an individual member.*

*Providers should report all services using the most up-to-date industry-standard procedure, revenue, and diagnosis codes, including modifiers where applicable.*

*The following codes are included below for informational purposes only; this is not an all-inclusive list.*

**The above medical necessity criteria **MUST** be met for the following codes to be covered for Commercial Members: Managed Care (HMO and POS), PPO, Indemnity, Medicare HMO Blue and Medicare PPO Blue:**

**CPT Codes**

<b>CPT codes:</b>	<b>Code Description</b>
33880	Endovascular repair of descending thoracic aorta (e.g., aneurysm, pseudoaneurysm, dissection, penetrating ulcer, intramural hematoma, or traumatic disruption); involving coverage of left subclavian artery origin, initial endoprosthesis plus descending thoracic aortic extension(s), if required, to level of celiac artery origin
33881	Endovascular repair of descending thoracic aorta (eg, aneurysm, pseudoaneurysm, dissection, penetrating ulcer, intramural hematoma, or traumatic disruption); not involving coverage of left subclavian artery origin, initial endoprosthesis plus descending thoracic aortic extension(s), if required, to level of celiac artery origin

33883	Placement of proximal extension prosthesis for endovascular repair of descending thoracic aorta (eg, aneurysm, pseudoaneurysm, dissection, penetrating ulcer, intramural hematoma, or traumatic disruption); initial extension
33884	Placement of proximal extension prosthesis for endovascular repair of descending thoracic aorta (eg, aneurysm, pseudoaneurysm, dissection, penetrating ulcer, intramural hematoma, or traumatic disruption); each additional proximal extension (List separately in addition to code for primary procedure)
33886	Placement of distal extension prosthesis(s) delayed after endovascular repair of descending thoracic aorta
33889	Open subclavian to carotid artery transposition performed in conjunction with endovascular repair of descending thoracic aorta, by neck incision, unilateral
75956	Endovascular repair of descending thoracic aorta (eg, aneurysm, pseudoaneurysm, dissection, penetrating ulcer, intramural hematoma, or traumatic disruption); involving coverage of left subclavian artery origin, initial endoprosthesis plus descending thoracic aortic extension(s), if required, to level of celiac artery origin, radiological supervision and interpretation
75957	Endovascular repair of descending thoracic aorta (eg, aneurysm, pseudoaneurysm, dissection, penetrating ulcer, intramural hematoma, or traumatic disruption); not involving coverage of left subclavian artery origin, initial endoprosthesis plus descending thoracic aortic extension(s), if required, to level of celiac artery origin, radiological supervision and interpretation
75958	Placement of proximal extension prosthesis for endovascular repair of descending thoracic aorta (eg, aneurysm, pseudoaneurysm, dissection, penetrating ulcer, intramural hematoma, or traumatic disruption), radiological supervision and interpretation
75959	Placement of distal extension prosthesis(s) (delayed) after endovascular repair of descending thoracic aorta, as needed, to level of celiac origin, radiological supervision and interpretation

## Description

### Thoracic Aortic Aneurysms

Aortic aneurysms are arterial dilations associated with age, atherosclerosis, and hypertension, as well as some congenital connective tissue disorders. The likelihood of significant sequelae from aortic aneurysm depends on the location, size, and underlying disease state. Left untreated, these aneurysms tend to enlarge over time, increasing the risk of rupture or dissection. Of greatest concern is the tendency for aortic aneurysms to rupture, with severe consequences including death. Another significant adverse occurrence of aortic aneurysm is aortic dissection, in which an intimal tear permits blood to enter the potential space between the intima and the muscular wall of the aorta. Stable dissections may be managed medically; however, dissections that impinge on the true lumen of the aorta or occlude branching vessels are a surgical emergency.

### Treatment

Indications for the elective surgical repair of aortic aneurysms are based on estimates of the prognosis of the untreated aneurysm balanced against the morbidity and mortality of the intervention. The prognosis of thoracic aortic aneurysm (TAA) is typically reported regarding the risk of rupture according to size and location (ie, the ascending or descending or thoracoabdominal aorta). While several studies have estimated the risk of rupture of untreated aneurysms, these studies have excluded patients who underwent surgical repair; therefore, the true natural history of thoracic aneurysms is unknown. Clouse et al (1998) performed a population-based study of TAA diagnosed in Minnesota, between 1980 and 1994.<sup>1</sup> A total of 133 patients were identified; the primary clinical endpoints were cumulative rupture risk, rupture risk as a function of aneurysm size, and survival. The cumulative risk of rupture was 20% after 5 years. The 5-year risk of rupture as a function of aneurysm size at recognition was 0% for aneurysms less than 4 cm in diameter, 16% for those 4 to 5.9 cm, and 31% for aneurysms 6 cm or more. Interestingly, 79% of the ruptures occurred in women. Davies et al (2002) reported on the yearly rupture or dissection rates in 721 patients with TAA.<sup>2</sup> A total of 304 patients were dissection-free at presentation; their natural history was

followed for rupture, dissection, and death. Patients were excluded from analysis once the operation occurred. Not surprisingly, the authors reported that aneurysm size had a profound impact on outcomes. For example, based on their modeling, a patient with an aneurysm exceeding 6 cm in diameter could expect a yearly rate of rupture or dissection of at least 6.9% and a death rate of 11.8%. In a previous report, these same authors suggested surgical intervention of a descending aorta aneurysm if its diameter measured 6.5 cm.<sup>3</sup>

Surgical mortality and morbidity are typically subdivided into emergency and elective repair, with a focus on the incidence and risk of spinal cord ischemia, considered the most devastating complication, resulting in paraparesis or paraplegia. The operative mortality of surgical repair of aneurysm of the descending and thoracoabdominal aorta is estimated at 6% to 12% and 10% to 15%, respectively, while mortality associated with emergent repair is considerably higher.<sup>1,4</sup> In elective cases, predictors of operative mortality include renal insufficiency, increasing age, symptomatic aneurysm, the presence of dissection, and other comorbidities (eg, cardiopulmonary or cerebrovascular disease). The risk of paraparesis or paraplegia is estimated at 3% to 15%. Thoracoabdominal aneurysms, larger aneurysms, the presence of dissection, and diabetes are predictors of paraplegia.<sup>5,6</sup> A number of surgical adjuncts have been explored to reduce the incidence of spinal cord ischemia, including distal aortic perfusion, cerebrospinal fluid drainage, hypothermia with circulatory arrest, and evoked potential monitoring.<sup>7,8,9,10</sup> However, the optimal protective strategy is still uncertain.<sup>11</sup>

This significant mortality and morbidity risks make definitive patient selection criteria for repair of thoracic aneurysms difficult. Several authors have recommended an individual approach based on balancing the patients' calculated risk of rupture with their anticipated risk of postoperative death or paraplegia. However, in general, surgical repair is considered in patients with adequate physiologic reserve when the thoracic aneurysm measures from 5.5 to 6 cm in diameter or patients with smaller symptomatic aneurysms.

### Thoracic Aortic Dissection

Aortic dissection can be subdivided into type A, which involves the aortic arch, and type B, which is confined to the descending aorta. Dissections associated with obstruction and ischemia can also be subdivided into an obstruction caused by an intimal tear at branch vessel orifices, or by compression of the true lumen by the pressurized false lumen. Type B aortic dissections are classified by acuity (termed as complicated or uncomplicated) and chronicity and are summarized in Table 1.

**Table 1. Aortic Dissection Acuity<sup>12,13</sup>.**

Category	Description
Uncomplicated	<ul style="list-style-type: none"> <li>• No rupture</li> <li>• No malperfusion</li> <li>• No high risk features</li> </ul>
Complicated	<ul style="list-style-type: none"> <li>• Rupture</li> <li>• Malperfusion</li> </ul>
High risk	<ul style="list-style-type: none"> <li>• Refractory pain</li> <li>• Refractory hyperfusion</li> <li>• Bloody plural effusion</li> <li>• Aortic diameter &gt;40 mm</li> <li>• Radiographic only malperfusion</li> <li>• Readmission</li> <li>• Entry tear: lesser curve location</li> <li>• False lumen diameter &gt;22mm</li> </ul>
Chronicity (time elapsed since the onset of symptoms)	<ul style="list-style-type: none"> <li>• Hyperacute (&lt;24 hours)</li> <li>• Acute (1 to 14 days)</li> <li>• Subacute (15 to 90 days)</li> <li>• Chronic (&gt;90 days)</li> </ul>

## **Treatment**

Type A dissections are usually treated surgically, while type B dissections are often treated medically, with surgery indicated for serious complications, such as visceral ischemia, impending rupture, intractable pain, or sudden reduction in aortic size. It has been proposed that endovascular therapy can repair the latter group of dissections by redirecting flow into the true lumen. The success of endovascular stent grafts of abdominal aortic aneurysms has created interest in applying the same technology to the aneurysms and dissections of the descending or thoracoabdominal aorta.

As noted, type A dissections (involving the ascending aorta) are treated surgically. There is more controversy regarding the optimal treatment of type B dissections (ie, limited to the descending aorta). In general, chronic, stable type B dissections are managed medically, although some surgeons have recommended a more aggressive approach for younger patients in otherwise good health. When serious complications arise from a type B dissection (ie, shock or visceral ischemia), surgical intervention is usually indicated. Endovascular intervention has supplanted open repair or medical management alone as first-line treatment for complicated type B aortic dissection as a result of accumulated data indicating reduced morbidity and mortality.<sup>14,12</sup>

## **Thoracic Aortic Rupture**

Rupture of the thoracic aorta is a life-threatening emergency that is nearly always fatal if untreated. Thoracic artery rupture can result from a number of factors. Aneurysms can rupture due to progressive dilatation and pressure of the aortic wall. Rupture can also result from traumatic injury to the aorta, such as occurs with blunt chest trauma. Penetrating injuries that involve the aorta can also lead to rupture. Penetrating ulcers can occur in widespread atherosclerotic disease and lead to aortic rupture.

## **Treatment**

Emergent repair of thoracic artery rupture is indicated in many cases in which there is free bleeding into the mediastinum and/or complete transection of the aortic wall. In some cases of aortic rupture, where the aortic media and adventitia are intact, watchful waiting with delayed surgical intervention is a treatment option. With the advent of thoracic endovascular aortic repair (TEVAR), the decision-making for intervention may be altered, because there may be a greater tendency to intervene in borderline cases due to the potential for fewer adverse events with TEVAR.

## **Thoracic Endovascular Aortic Repair**

TEVAR is an alternative to open surgery. It has been proposed for prophylactic treatment of aneurysms that meet criteria for surgical intervention, as well as for patients in need of emergency surgery for rupture or complications related to dissection. The standard open surgery technique for TAA is open operative repair with graft replacement of the diseased segment. This procedure requires a lateral thoracotomy, use of cardiopulmonary bypass, lengthy surgical procedures, and is associated with a variety of peri- and postoperative complications, with spinal cord ischemia considered the most devastating.

TEVAR is performed through a small groin incision to access the femoral artery, followed by delivery of catheters across the diseased portion of the aorta. A tubular stent graft composed of fabric and metal is then deployed under fluoroscopic guidance. The stent graft is then fixed to the proximal and distal portions of the aorta. Approximately 15% of patients do not have adequate femoral access; for them, the procedure can be performed using a retroperitoneal approach.

Potential complications of TEVAR are bleeding, vascular access site complications, spinal cord injury with paraplegia, renal insufficiency, stroke, and cardiopulmonary complications. Some of these complications are similar to those encountered with open repair (eg, paraplegia, cardiopulmonary events), and others are unique to TEVAR (eg, access site complications).

## **Outcome Measures**

Controlled trials of specific patient groups treated with specific procedures are required to determine whether endovascular approaches are associated with equivalent or improved outcomes compared with surgical repair. For patients who are candidates for surgery, open surgical resection of the aneurysm with graft replacement is considered the criterion standard for treatment of aneurysms or dissections. Some

patients who would not be considered candidates for surgical therapy (due to unacceptable risks) might be considered candidates for an endovascular graft. In this situation, the outcomes of endovascular grafting should be compared with optimal medical management. Comparative mortality rates are of high concern, as are the rates of serious complications such as the incidence of spinal cord ischemia.

## Summary

### Description

Thoracic endovascular aortic repair (TEVAR) involves the percutaneous placement of a stent graft in the descending thoracic or thoracoabdominal aorta. It is a less invasive alternative than open surgery for the treatment of thoracic aortic aneurysms (TAAs), dissections, or rupture, and thus has the potential to reduce the morbidity and mortality of open surgery. Endovascular stenting may also be an alternative to medical therapy for treating TAAs or thoracic aorta dissections.

### Summary of Evidence

For individuals who have type B (descending) thoracic aortic aneurysms (TAAs) who receive endovascular repair, the evidence includes nonrandomized comparative studies and systematic reviews. Relevant outcomes are overall survival (OS), morbid events, and treatment-related mortality and morbidity. The available nonrandomized comparative studies have consistently reported reduced short-term mortality and morbidity compared with surgical repair. Although these types of studies are subject to selection bias and other methodologic limitations, the consistency of the findings of equivalent or reduced short-term mortality and fewer early complications across populations with different characteristics supports the conclusion that thoracic endovascular aortic repair (TEVAR) is a safer procedure in the short term. The likely short-term benefits of TEVAR are mitigated by less favorable longer-term outcomes, but longer-term mortality appears to be roughly similar for patients undergoing TEVAR or open surgery. The evidence is sufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have uncomplicated type B (descending) thoracic aortic dissections who receive endovascular repair, the evidence includes randomized controlled trials (RCTs), systematic reviews, and retrospective cohort studies. Relevant outcomes are OS, morbid events, and treatment-related mortality and morbidity. In the INSTEAD trial there were no statistically significant differences between the endovascular and medical groups for overall survival at one year or at five years. At five years of follow-up, aorta-specific mortality (7% versus 19%) was significantly lower for endovascular versus medical treatment. In the ADSORB trial, there were significantly fewer events of the composite outcome of incomplete/no false lumen thrombosis, aortic dilation, or aortic rupture in the endovascular group in the per protocol analysis but the trial had several limitations and was not designed for mortality outcomes. An ongoing RCT (NCT02622542) is designed to compare 5-year all-cause mortality for best medical therapy alone versus best medical therapy with thoracic endovascular aortic repair for uncomplicated acute type B aortic dissection. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have complicated type B (descending) thoracic aortic dissections who receive endovascular repair, the evidence includes systematic reviews and nonrandomized comparative studies. Relevant outcomes are OS, morbid events, and treatment-related mortality and morbidity. Systematic reviews of the available nonrandomized comparative studies consistently indicate benefits in early morbidity and mortality with TEVAR relative to open repair, as well as similar or superior long-term survival outcomes compared to open repair or medical management alone. Although these studies carry inherent limitations and the interventions carry complication risks that do not completely overlap, the accrued evidence favors use of TEVAR over open repair in suitable patients. The evidence is sufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have traumatic descending aortic tears or rupture who receive endovascular repair, the evidence includes nonrandomized comparative studies and systematic reviews. Relevant outcomes are OS, morbid events, and treatment-related mortality and morbidity. Systematic reviews of the available nonrandomized comparative studies consistently indicate benefit in early mortality and similar or superior long-term survival outcomes with TEVAR relative to open repair, with low rates of complications requiring

reintervention with long-term follow-up. The evidence is sufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have ascending aortic disorders who receive endovascular repair, the evidence includes small case series. Relevant outcomes are OS, morbid events, and treatment-related mortality and morbidity. For patients with ascending aortic pathologies, including dissections, aneurysms, and other disorders, the evidence on the use of TEVAR is limited to small series that have assessed heterogeneous patient populations. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

## Policy History

Date	Action
10/2024	Annual policy review. Policy updated with literature review through July 1, 2024; references added. Policy statements unchanged.
5/2024	Clarified prior authorization table.
12/2023	Annual policy review. Policy updated with literature review through March 16, 2023; references added. Editorial refinements applied to evidence review sections on complicated type B aortic dissection and traumatic descending aortic tears or rupture. Evidence conclusions for these indications changed to sufficient based on guideline review. Policy statements unchanged. Policy guidelines updated.
8/2022	Annual policy review. Description, summary, and references updated. Policy statements unchanged.
6/2021	Annual policy review. Description, summary, and references updated. Policy statements unchanged.
7/2020	Annual policy review. Description, summary, and references updated. Policy statements unchanged.
6/2019	Annual policy review. Description, summary, and references updated. Policy statements unchanged.
10/2018	Annual policy review. Policy clarified. New investigational indications described. Effective 10/1/2018.
6/2017	Annual policy review. New references added.
7/2016	Annual policy review. New references added.
12/2015	Clarified coding information.
11/2015	Added coding language.
8/2015	Annual policy review. New references added.
9/2014	Annual policy review. New references added.
7/2014	Clarified coding information.
1/2014	Annual policy review. New medically necessary indications described. Effective 1/1/2014.
12/2013	Removed ICD-9 diagnosis codes 441.01, 441.03, 441.1, 441.2, 441.6, and 441.7 as the policy requires prior authorization.
11/2011-4/2012	Medical policy ICD 10 remediation: Formatting, editing and coding updates. No changes to policy statements.
5/2011	Annual policy review. No changes to policy statements.
4/2011	Reviewed - Medical Policy Group - Cardiology and Pulmonology. No changes to policy statements.
6/1/2010	New policy describing covered and non-covered indications. Effective 6/1/2010.
12/2009	Annual policy review. No changes to policy statements.
5/2008	Annual policy review. No changes to policy statements.

## Information Pertaining to All Blue Cross Blue Shield Medical Policies

Click on any of the following terms to access the relevant information:

[Medical Policy Terms of Use](#)

[Managed Care Guidelines](#)

## References

1. Clouse WD, Hallett JW, Schaff HV, et al. Improved prognosis of thoracic aortic aneurysms: a population-based study. *JAMA*. Dec 09 1998; 280(22): 1926-9. PMID 9851478
2. Davies RR, Goldstein LJ, Coady MA, et al. Yearly rupture or dissection rates for thoracic aortic aneurysms: simple prediction based on size. *Ann Thorac Surg*. Jan 2002; 73(1): 17-27; discussion 27-8. PMID 11834007
3. Coady MA, Rizzo JA, Hammond GL, et al. Surgical intervention criteria for thoracic aortic aneurysms: a study of growth rates and complications. *Ann Thorac Surg*. Jun 1999; 67(6): 1922-6; discussion 1953-8. PMID 10391339
4. Rectenwald JE, Huber TS, Martin TD, et al. Functional outcome after thoracoabdominal aortic aneurysm repair. *J Vasc Surg*. Apr 2002; 35(4): 640-7. PMID 11932656
5. Estrera AL, Miller CC, Huynh TT, et al. Neurologic outcome after thoracic and thoracoabdominal aortic aneurysm repair. *Ann Thorac Surg*. Oct 2001; 72(4): 1225-30; discussion 1230-1. PMID 11603441
6. Huynh TT, Miller CC, Estrera AL, et al. Thoracoabdominal and descending thoracic aortic aneurysm surgery in patients aged 79 years or older. *J Vasc Surg*. Sep 2002; 36(3): 469-75. PMID 12218969
7. Estrera AL, Rubenstein FS, Miller CC, et al. Descending thoracic aortic aneurysm: surgical approach and treatment using the adjuncts cerebrospinal fluid drainage and distal aortic perfusion. *Ann Thorac Surg*. Aug 2001; 72(2): 481-6. PMID 11515886
8. Safi HJ, Miller CC, Subramaniam MH, et al. Thoracic and thoracoabdominal aortic aneurysm repair using cardiopulmonary bypass, profound hypothermia, and circulatory arrest via left side of the chest incision. *J Vasc Surg*. Oct 1998; 28(4): 591-8. PMID 9786251
9. Safi HJ, Subramaniam MH, Miller CC, et al. Progress in the management of type I thoracoabdominal and descending thoracic aortic aneurysms. *Ann Vasc Surg*. Sep 1999; 13(5): 457-62. PMID 10466987
10. van Dongen EP, Schepens MA, Morshuis WJ, et al. Thoracic and thoracoabdominal aortic aneurysm repair: use of evoked potential monitoring in 118 patients. *J Vasc Surg*. Dec 2001; 34(6): 1035-40. PMID 11743557
11. Webb TH, Williams GM. Thoracoabdominal aneurysm repair. *Cardiovasc Surg*. Oct 1999; 7(6): 573-85. PMID 10519663
12. MacGillivray TE, Gleason TG, Patel HJ, et al. The Society of Thoracic Surgeons/American Association for Thoracic Surgery clinical practice guidelines on the management of type B aortic dissection. *J Thorac Cardiovasc Surg*. Apr 2022; 163(4): 1231-1249. PMID 35090765
13. Lombardi JV, Gleason TG, Panneton JM, et al. STABLE II clinical trial on endovascular treatment of acute, complicated type B aortic dissection with a composite device design. *J Vasc Surg*. Apr 2020; 71(4): 1077-1087.e2. PMID 31477479
14. Isselbacher EM, Preventza O, Hamilton Black Iii J, et al. 2022 ACC/AHA Guideline for the Diagnosis and Management of Aortic Disease: A Report of the American Heart Association/American College of Cardiology Joint Committee on Clinical Practice Guidelines. *J Am Coll Cardiol*. Dec 13 2022; 80(24): e223-e393. PMID 36334952
15. Food and Drug Administration Summary of Safety and Effectiveness. Valiant Thoracic Stent Graft with the Captivia Delivery System. 2014; [http://www.accessdata.fda.gov/cdrh\\_docs/pdf10/P100040S012b.pdf](http://www.accessdata.fda.gov/cdrh_docs/pdf10/P100040S012b.pdf). Accessed July 18, 2024.
16. Food and Drug Administration. Approval Order: Medtronic PMA P100040. 2018; [https://www.accessdata.fda.gov/cdrh\\_docs/pdf5/P050023S058A.pdf](https://www.accessdata.fda.gov/cdrh_docs/pdf5/P050023S058A.pdf). Accessed July 18, 2024.
17. Food and Drug Administration. Medtronic Announces Voluntary Recall of Unused Valiant Navion Thoracic Stent Graft System. Published February 23, 2021. [https://www.fda.gov/safety/recalls-market-withdrawals-safety-alerts/medtronic-announces-voluntary-recall-unused-valiant-naviontm-thoracic-stent-graft-system#:~:text=Medtronic%20plc%20\(NYSE%3AMDT\),the%20device%20until%20further%20notice](https://www.fda.gov/safety/recalls-market-withdrawals-safety-alerts/medtronic-announces-voluntary-recall-unused-valiant-naviontm-thoracic-stent-graft-system#:~:text=Medtronic%20plc%20(NYSE%3AMDT),the%20device%20until%20further%20notice.). Accessed July 18, 2024.



18. Upchurch GR, Escobar GA, Azizzadeh A, et al. Society for Vascular Surgery clinical practice guidelines of thoracic endovascular aortic repair for descending thoracic aortic aneurysms. *J Vasc Surg.* Jan 2021; 73(1S): 55S-83S. PMID 32628988
19. Abraha I, Romagnoli C, Montedori A, et al. Thoracic stent graft versus surgery for thoracic aneurysm. *Cochrane Database Syst Rev.* Jun 06 2016; 2016(6): CD006796. PMID 27265222
20. Makaroun MS, Dillavou ED, Kee ST, et al. Endovascular treatment of thoracic aortic aneurysms: results of the phase II multicenter trial of the GORE TAG thoracic endoprosthesis. *J Vasc Surg.* Jan 2005; 41(1): 1-9. PMID 15696036
21. Makaroun MS, Dillavou ED, Wheatley GH, et al. Five-year results of endovascular treatment with the Gore TAG device compared with open repair of thoracic aortic aneurysms. *J Vasc Surg.* May 2008; 47(5): 912-8. PMID 18353605
22. Fairman RM, Criado F, Farber M, et al. Pivotal results of the Medtronic Vascular Talent Thoracic Stent Graft System: the VALOR trial. *J Vasc Surg.* Sep 2008; 48(3): 546-54. PMID 18572352
23. Fairman RM, Tucheck JM, Lee WA, et al. Pivotal results for the Medtronic Valiant Thoracic Stent Graft System in the VALOR II trial. *J Vasc Surg.* Nov 2012; 56(5): 1222-31.e1. PMID 22832267
24. Matsumoto AH, Angle JF, Secic M, et al. Secondary procedures following thoracic aortic stent grafting in the first 3 years of the VALOR test and VALOR II trials. *J Vasc Interv Radiol.* May 2014; 25(5): 685-692.e5. PMID 24529546
25. Matsumura JS, Cambria RP, Dake MD, et al. International controlled clinical trial of thoracic endovascular aneurysm repair with the Zenith TX2 endovascular graft: 1-year results. *J Vasc Surg.* Feb 2008; 47(2): 247-257; discussion 257. PMID 18241743
26. Matsumura JS, Melissano G, Cambria RP, et al. Five-year results of thoracic endovascular aortic repair with the Zenith TX2. *J Vasc Surg.* Jul 2014; 60(1): 1-10. PMID 24636714
27. Sá MP, Jacquemyn X, Van den Eynde J, et al. Midterm Outcomes of Endovascular vs. Medical Therapy for Uncomplicated Type B Aortic Dissection: Meta-Analysis of Reconstructed Time to Event Data. *Eur J Vasc Endovasc Surg.* Nov 2023; 66(5): 609-619. PMID 37422209
28. Hossack M, Patel S, Gambardella I, et al. Endovascular vs. Medical Management for Uncomplicated Acute and Sub-acute Type B Aortic Dissection: A Meta-analysis. *Eur J Vasc Endovasc Surg.* May 2020; 59(5): 794-807. PMID 31899101
29. Brunkwall J, Kasprzak P, Verhoeven E, et al. Endovascular repair of acute uncomplicated aortic type B dissection promotes aortic remodelling: 1 year results of the ADSORB trial. *Eur J Vasc Endovasc Surg.* Sep 2014; 48(3): 285-91. PMID 24962744
30. Iannuzzi JC, Stapleton SM, Bababekov YJ, et al. Favorable impact of thoracic endovascular aortic repair on survival of patients with acute uncomplicated type B aortic dissection. *J Vasc Surg.* Dec 2018; 68(6): 1649-1655. PMID 29914833
31. Xiang D, Kan X, Liang H, et al. Comparison of mid-term outcomes of endovascular repair and medical management in patients with acute uncomplicated type B aortic dissection. *J Thorac Cardiovasc Surg.* Jul 2021; 162(1): 26-36.e1. PMID 31982125
32. Boufi M, Patterson BO, Loundou AD, et al. Endovascular Versus Open Repair for Chronic Type B Dissection Treatment: A Meta-Analysis. *Ann Thorac Surg.* May 2019; 107(5): 1559-1570. PMID 30481516
33. Thrumurthy SG, Karthikesalingam A, Patterson BO, et al. A systematic review of mid-term outcomes of thoracic endovascular repair (TEVAR) of chronic type B aortic dissection. *Eur J Vasc Endovasc Surg.* Nov 2011; 42(5): 632-47. PMID 21880515
34. Nienaber CA, Kische S, Akin I, et al. Strategies for subacute/chronic type B aortic dissection: the Investigation Of Stent Grafts in Patients with type B Aortic Dissection (INSTEAD) trial 1-year outcome. *J Thorac Cardiovasc Surg.* Dec 2010; 140(6 Suppl): S101-8; discussion S142-S146. PMID 21092774
35. Nienaber CA, Kische S, Rousseau H, et al. Endovascular repair of type B aortic dissection: long-term results of the randomized investigation of stent grafts in aortic dissection trial. *Circ Cardiovasc Interv.* Aug 2013; 6(4): 407-16. PMID 23922146
36. Leshnowar BG, Szeto WY, Pochettino A, et al. Thoracic endografting reduces morbidity and remodels the thoracic aorta in DeBakey III aneurysms. *Ann Thorac Surg.* Mar 2013; 95(3): 914-21. PMID 23245448
37. Andersen ND, Keenan JE, Ganapathi AM, et al. Current management and outcome of chronic type B aortic dissection: results with open and endovascular repair since the advent of thoracic endografting. *Ann Cardiothorac Surg.* May 2014; 3(3): 264-74. PMID 24967165

38. van Bogerijen GH, Patel HJ, Williams DM, et al. Propensity adjusted analysis of open and endovascular thoracic aortic repair for chronic type B dissection: a twenty-year evaluation. *Ann Thorac Surg.* Apr 2015; 99(4): 1260-6. PMID 25686670
39. Wilson-Smith AR, Muston B, Kamalanathan H, et al. Endovascular repair of acute complicated type B aortic dissection-systematic review and meta-analysis of long-term survival and reintervention. *Ann Cardiothorac Surg.* Nov 2021; 10(6): 723-730. PMID 34926176
40. Moulakakis KG, Mylonas SN, Dalainas I, et al. Management of complicated and uncomplicated acute type B dissection. A systematic review and meta-analysis. *Ann Cardiothorac Surg.* May 2014; 3(3): 234-46. PMID 24967162
41. Fattori R, Montgomery D, Lovato L, et al. Survival after endovascular therapy in patients with type B aortic dissection: a report from the International Registry of Acute Aortic Dissection (IRAD). *JACC Cardiovasc Interv.* Aug 2013; 6(8): 876-82. PMID 23968705
42. Gennai S, Leone N, Mezzetto L, et al. Systematic review and meta-analysis of long-term reintervention following thoracic endovascular repair for blunt traumatic aortic injury. *J Vasc Surg.* Aug 2023; 78(2): 540-547.e4. PMID 36754248
43. Harky A, Bleetman D, Chan JSK, et al. A systematic review and meta-analysis of endovascular versus open surgical repair for the traumatic ruptured thoracic aorta. *J Vasc Surg.* Jan 2020; 71(1): 270-282. PMID 31327611
44. 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.* Jan 2011; 53(1): 187-92. PMID 20974523
45. Scalea TM, Feliciano DV, DuBose JJ, et al. Blunt Thoracic Aortic Injury: Endovascular Repair Is Now the Standard. *J Am Coll Surg.* Apr 2019; 228(4): 605-610. PMID 30630086
46. Elkbuli A, Dowd B, Spano PJ, et al. Thoracic Endovascular Aortic Repair Versus Open Repair: Analysis of the National Trauma Data Bank. *J Surg Res.* Jan 2020; 245: 179-182. PMID 31421360
47. Yamaguchi T, Nakai M, Sumita Y, et al. Editor's Choice - Endovascular Repair Versus Surgical Repair for Japanese Patients With Ruptured Thoracic and Abdominal Aortic Aneurysms: A Nationwide Study. *Eur J Vasc Endovasc Surg.* Jun 2019; 57(6): 779-786. PMID 30837104
48. De Freitas S, Rossi MJ, Abramowitz SD, et al. Systematic review and meta-analysis of endovascular interventions for Stanford type A aortic dissection. *J Vasc Surg.* Nov 2021; 74(5): 1721-1731.e4. PMID 33592292
49. Vallabhajosyula P, Gottret JP, Bavaria JE, et al. Endovascular repair of the ascending aorta in patients at high risk for open repair. *J Thorac Cardiovasc Surg.* Feb 2015; 149(2 Suppl): S144-50. PMID 25218530
50. Roselli EE, Idrees J, Greenberg RK, et al. Endovascular stent grafting for ascending aorta repair in high-risk patients. *J Thorac Cardiovasc Surg.* Jan 2015; 149(1): 144-51. PMID 25312226
51. Appoo JJ, Hergert EJ, Pozeg ZI, et al. Midterm results of endovascular stent grafts in the proximal aortic arch (zone 0): an imaging perspective. *Can J Cardiol.* Jun 2015; 31(6): 731-7. PMID 25882336

## Endnotes

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<sup>1</sup> Based on expert opinion