Effectiveness of surgical interventions for thoracic aortic aneurysms: a systematic review and meta-analysis

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ABSTRACT

Objective: A systematic review and meta-analysis was conducted to evaluate the effectiveness of thoracic endovascular aortic repair (TEVAR) and open repair in patients with descending thoracic aortic aneurysms (TAAs).

Methods: PubMed, Ovid MEDLINE, Ovid Embase, EBSCO Cumulative Index to Nursing and Allied Health Literature, and Scopus were searched from each database's inception to January 29, 2016. We selected studies that compared the two approaches in adults with TAAs and reported 30-day mortality or procedure complications. Two reviewers independently extracted data, and conflicts were resolved by consensus. Random-effects meta-analysis was used to estimate odds ratios (ORs) and 95% confidence intervals (CIs). The main outcomes and measures were all-cause 30-day mortality, 30-day paraplegia or spinal cord ischemia, stroke, pulmonary complications, and length of hospital and intensive care unit (ICU) stay.

Results: Twenty-seven studies of moderate methodologic quality were included. TEVAR was associated with lower 30-day mortality in ruptured (OR, 0.58; 95% CI, 0.38-0.88) and intact (OR, 0.6; 95% CI, 0.36-0.99) aneurysms. Paraplegia or spinal cord ischemia (OR, 0.35; 95% CI, 0.2-0.61) and pulmonary complications (OR, 0.41; 95% CI, 0.37-0.46) were reduced in patients undergoing TEVAR, whereas a reduction in stroke risk was not statistically significant (OR, 0.89; 95% CI, 0.76-1.03). Pooled mean difference in length of hospital and ICU stay was lower for TEVAR by −5.17 days (95% CI, −7.77 to −2.57) and −5.89 days (95% CI, −9.65 to −2.12), respectively. Three studies showed that compared with open repair, a hybrid approach reduced hospital stay (pooled mean difference, −8.83 days; 95% CI, −14.37 to −3.29) and ICU stay (pooled mean difference, −3.17 days (95% CI, −5.54 to −0.97), with minimal evidence on other outcomes studied.

Conclusions: Observational evidence at high risk of confounding suggests that compared with open repair for TAA, TEVAR reduced risk of mortality, paraplegia, spinal cord ischemia, and pulmonary complications within 30 days of intervention. Patients undergoing TEVAR also had shorter length of hospital and ICU stay compared with patients undergoing open repair. (J Vasc Surg 2017;■:1-11.)

The thoracic aorta anatomically includes the ascending aorta, the aortic arch, and the descending thoracic aorta. Aortic disease, including the ascending and abdominal aorta, is among the 20 leading causes of death in the United States.[1] Thoracic aortic aneurysms (TAAs) are located in the descending thoracic aorta (35%), ascending aorta (40%), aortic arch (15%), and thoracoabdominal aorta (10%).[2] For the purposes of this review, the management of aneurysms of the descending thoracic aorta is the focus, including some studies that examine the thoracoabdominal aorta as well as the distal aortic arch. Defining aortic diameters in patients with TAAs is critical and typically performed by cross-sectional imaging, including computed tomography angiography, as diameter is the strongest predictor of rupture, with a reported mean aortic diameter of ruptured thoracoabdominal aortic aneurysms (TAAAs) of 6.1 cm.[3] Therefore, repair of TAAs is often recommended once these aneurysms have reached 5.5 to 6.0 cm. TAAs have an approximate overall incidence rate of 10.4 per 100,000 person-years.[4] Most patients with TAAs have no symptoms attributable to their disease at the time of diagnosis,[2] and therefore the diagnosis is often made when the patient is being evaluated for unrelated conditions. Yet, whereas most patients with TAAs are asymptomatic, most aneurysms will become symptomatic before they rupture.[5] Given its silent nature, the true incidence of TAA is therefore likely higher.[6] Current practice guidelines recommend early treatment of asymptomatic TAA once it is detected and a certain size diameter, usually 6 cm, has been reached.[7]

Originally performed with a standard "clamp and sew" technique,[8] open TAA repair has evolved with improved outcomes through the use of cardiopulmonary bypass

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and spinal fluid drainage.[2] Centers of excellence in this procedure report elective mortality and paraplegia rates as low as 4.8% and 4.6% for open TAA repair, respectively.[9] In contrast, national mortality rates before the introduction of endovascular technology were 22%.[10] Mortality rates after surgical treatment of ruptured TAAs are even higher, even though rates as low as 26% have been reported.[11] Data from multiple sources including single centers, industry-sponsored trials, and large national databases suggest that thoracic endovascular aortic repair (TEVAR) of isolated descending TAAs is a safe alternative to open surgery. TEVAR was first described as an alternative treatment in 1994,[12] and since then, multiple studies have compared open TAA repair with TEVAR. Regardless, multiple studies have suggested an improvement in early outcomes with TEVAR, whereas others have not.

Other studies have suggested a hybrid repair (a combination of open and endovascular approaches) in distal aortic arch aneurysms and TAAAs as a method by which to treat these complex aneurysms. The most common clinical scenario for this is when there is an inadequate landing zone for a stent graft in the proximal descending thoracic aorta. Therefore, a surgical procedure is performed first, most often with a left common carotid artery to left subclavian artery bypass or a left subclavian artery transposition.[13] Others have described extending the landing zone distally for stent grafts by performing bypasses to the visceral and renal arteries followed by stent grafting.[14] Still others have described performing a staged hybrid approach by performing the thoracic portion of the TAAA repair endovascularly and the abdominal portion with open surgery.[15] Although purely endovascular solutions are available in Europe, they are not currently available in the United States outside of the clinical trial. Clearly, the considerable variation in the management of these complex aneurysms suggests that no single approach has an absolute advantage over a different approach.

To evaluate the effectiveness of the different management paradigms in patients with TAAs, a systematic review and meta-analysis was performed comparing open and endovascular approaches as well as hybrid approaches on important perioperative outcomes, including mortality, paraplegia, pulmonary complications, and hospital and intensive care unit (ICU) length of stay.

METHODS

This systematic review and meta-analysis follows a priori determined inclusion criteria and is reported in adherence with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement.[16]

Eligibility criteria. Eligible studies were published in English and comparative (ie, compared any two interventions, including TEVAR, open repair, and hybrid surgery) in adult patients with TAA or TAAA. Aneurysms (or true aneurysms) were defined by current practice guidelines as permanent localized dilation of an artery, having at least a 50% increase in diameter compared with the expected normal diameter of the artery.[7] Only nondissected aneurysms were included in this systematic review, including degenerative or atherosclerotic and congenital aneurysms. Both ruptured and not ruptured aneurysms were included. Studies with other thoracic aortic diseases, such as acute or chronic aortic dissections, intramural hematoma, penetrating atherosclerotic ulcer, acute traumatic aortic injury, and pseudoaneurysms, were excluded unless a subgroup of outcomes for patients with aneurysms only was reported. Crawford (type IV) TAAAs, because they are limited to the abdominal aorta below the diaphragm, were also excluded.

Information sources. A comprehensive search of several databases from each database's inception to January 29, 2016, in any language, was conducted. The databases included Ovid Medline In-Process & Other Non-Indexed Citations, Ovid MEDLINE, Ovid Embase, Ovid Cochrane Central Register of Controlled Trials, Ovid Cochrane Database of Systematic Reviews, and Scopus. The search strategy was designed and conducted by an experienced librarian with input from the study's principal investigator. Controlled vocabulary supplemented with keywords was used to search for studies of management of TAAs. The actual strategy is available as an Appendix (online only).

Study selection and data collection. Two reviewers independently reviewed titles and abstracts of candidate studies. Disagreement on abstracts led to inclusion of the citation for full-text review. Included studies from this level were reviewed in full version by two reviewers independently. Any conflicts about the eligibility of the studies were solved by consensus of all reviewers. Data from included studies were abstracted in duplicate by two independent reviewers using a standardized form that was created using a web-based program (DistillerSR; Evidence Partners, Ottawa, Canada). Disagreement on data extraction was resolved by consensus of the two reviewers.

Outcomes. The primary outcome was 30-day mortality. Secondary outcomes were 30-day paraplegia, stroke, and pulmonary complications in addition to ICU and hospital length of stay. Data about iliac artery complications, need for tracheostomy, and estimated blood loss were collected when available; however, the data were inadequate to be included.

Risk of bias. Two reviewers independently assessed the risk of bias in the included studies using a standardized form based on the Newcastle-Ottawa Scale tool.[17] The