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A systematic review of primary endovascular repair of the ascending aorta

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ABSTRACT

Objective: Endovascular repair of the ascending aorta is currently limited to patients at high surgical risk with aortic diseases originating above the sinotubular junction. A number of different endovascular technologies and approaches have been used, although no consensus exists regarding a standardized technique. To better understand real-world endovascular approaches to the ascending aorta, we performed a comprehensive review of the types of endovascular aortic stents and associated vascular access used in repair of the ascending aorta.

Methods: A search of the MEDLINE database was conducted from January 1, 1995, through January 31, 2017, with the search term "ascending aortic stent." Studies involving endovascular stenting in which the primary therapy was confined exclusively to the ascending aorta were included. Studies involving hybrid arch procedures and surgical replacement of the ascending aorta associated with aortic stenting were excluded. The type of aortic stent, underlying aortic disease, and surgical approach were recorded along with outcomes, need for reinterventions, and follow-up.

Results: A total of 46 publications that focused on primary endovascular repair of the ascending aorta were identified. Thirteen different aortic stent grafts of various designs were used in 118 total patients. The most commonly used device types were thoracic stents (n = 84 [71.2%]) along with abdominal cuffs (n = 13 [11%]) and custom-made grafts (n = 12 [10.2%]). The most commonly treated aortic disease was type A aortic dissection (n = 59 [50%]), followed by aortic pseudoaneurysm (n = 35 [29.7%]), aortic aneurysm (n = 6 [5.1%]), penetrating atherosclerotic ulcer (n = 5 [4.2%]), and acute aortic rupture (n = 3 [2.5%]). Femoral arterial access was used in 62.7% of patients (n = 74); transapical (n = 17 [14.4%]), carotid (n = 15 [12.7%]), and axillary (n = 8 [6.8%]) approaches were also used. The overall type I endoleak rate was 18.6% (n = 22), with 11 patients (9.3%) requiring reintervention. Other complications included all-cause mortality (n = 18 [15.2%]), conversions to open surgery (n = 4 [3.4%]), and cerebrovascular complications (n = 4 [3.4%]). Aorta-related mortality was 5% (n = 6), and average follow-up was 17.2 months.

Conclusions: Despite the absence of a dedicated aortic stent graft for the ascending aorta, patients with a range of ascending aortic diseases are being successfully treated by endovascular technologies. For optimal outcomes, patient selection is critical to align aortic anatomy with the limited device sizing options, and it should be reserved for patients at high surgical risk. (J Vasc Surg 2018;67:332-42.)

The ascending aorta represents the final frontier of endovascular therapy. Use of endovascular stent grafts in the abdominal aorta is well established and has evolved to become first-line therapy for intact abdominal aortic aneurysms.[1] With the immense success of endovascular interventions in the abdominal aorta, aortic stent grafts are now being applied to treat descending, arch, and ascending aortic diseases. The role of endovascular interventions in descending thoracic aortic disease has grown in recent years, and early results have demonstrated reductions in early death, paraplegia, renal insufficiency, cardiac complications, and length of stay compared with open surgery.[2] Branched stent grafts are being used in the aortic arch, and various adjunctive techniques, such as endoanchors, in situ laser fenestration, elephant trunk, and chimney graft techniques, continue to expand the applicability of thoracic endovascular aortic repair (TEVAR) in the aortic arch while preserving the patency of the great vessels.[3-5]

Wedged between the aortic valve, coronary ostia, and great vessels, the ascending aorta presents a formidable challenge in stent graft placement. Nevertheless, during the past 11 years, surgeons have been successfully treating patients endovascularly using various stent grafts and vascular approaches.[6] Originally arising out of necessity, stent grafting of the ascending aorta has up to this point been primarily used as a last-ditch effort to treat

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patients who are considered unfit candidates for open surgery.[7-9] Open surgery in patients with ascending aortic diseases often has very poor outcomes, and advanced age and medical comorbidities create prohibitive operative risk for many of these patients.[10] Despite these risks, early results for stenting of the ascending aorta are promising, and it continues to be applied for a variety of aortic diseases. Because of the early success of these interventions, there has been an evolution toward use of stent grafts to treat focal lesions of the ascending aorta, thus circumventing the need for cardiopulmonary bypass and open surgery. Various approaches have been used, although no consensus exists regarding a standardized technique. To better understand the landscape and outcomes of this rapidly evolving discipline, we performed a comprehensive literature review of the types of endovascular aortic stent grafts and the associated vascular access approaches used in endovascular repair of the ascending aorta. In presenting our findings, we attempt to evaluate the efficacy of the devices and tactics currently used in ascending aortic repair and comment on the importance of continuing to improve on the existing technology and techniques used to manage these patients.

METHODS

A search of the MEDLINE database was conducted from January 1, 1995, through January 31, 2017, with the search term "ascending aortic stent." Two separate researchers analyzed the data set to ensure accuracy and to capture all available studies. Manuscripts involving endovascular stenting of the ascending aorta in which the primary therapy was confined exclusively to the ascending aorta were included in the analysis. Cases in which stents were deployed in the aortic arch or descending aorta were excluded. Studies involving hybrid arch procedures and surgical replacement of the ascending aorta associated with aortic stenting were also excluded along with papers written in another language and papers for which only the abstract was available. The type of aortic stent, underlying aortic disease, and surgical approach were recorded along with patient outcomes, need for reinterventions, and follow-up.

RESULTS

The literature search yielded 779 publications in PubMed. Of these, a total of 46 publications that focused on primary endovascular repair of the ascending aorta were identified from the literature and included in the analysis. In one instance, two papers were published describing the same 15-patient cohort, one providing early outcomes and the other describing midterm follow-up. In this case, only the more recent manuscript was included in the analysis.[9,11] Fig 1 shows the results of the literature search according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement. Table I summarizes the number of patients and diseases managed for each manuscript included in the analysis.

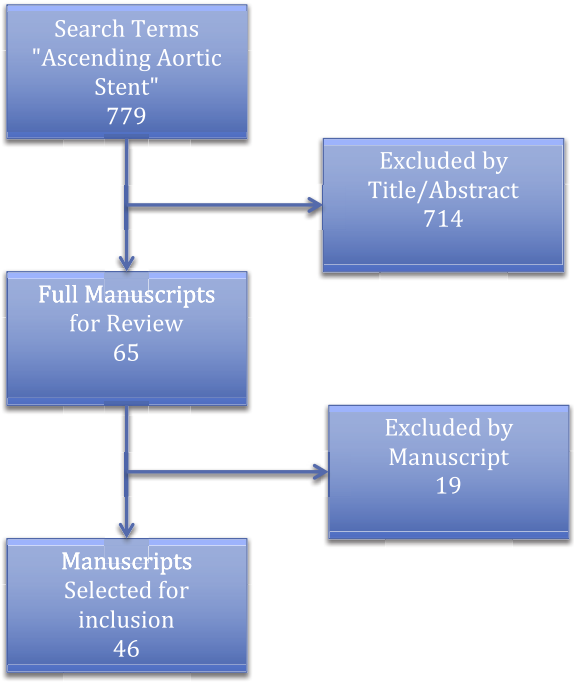

Fig 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow chart.

Stent graft design. A total of 118 patients were treated with 13 different aortic stent grafts of various designs. The most commonly used device types were thoracic aortic stent grafts (n = 84 [71.2%]), followed by abdominal aortic cuffs (n = 13 [11%]), custom-made stent grafts (n = 12 [10.2%]), stents of unspecified design (n = 8 [6.8%]), and thoracic endovascular cuffs (n = 1 [0.9%]). Custom-made stents included stents industry made to specific patient dimensions as well as off-the-shelf devices physician modified to conform to the ascending aorta. This most frequently involved device shortening to accommodate the short length of the ascending aorta. The most commonly used device was the Zenith TX2 Pro-Form endograft (Cook Medical, Bloomington Ind) with a total of 40 patient implants. An off-the-shelf Zenith ascending dissection device (Cook Medical) designed specifically for the ascending aorta was used in 15 patients. This was followed by the Gore TAG (W. L. Gore & Associates, Flagstaff, Ariz; n = 13) and Gore Excluder abdominal cuff (n = 12; Table II).

Aortic disease. Endovascular stenting of the ascending aorta was predominantly used to treat patients with acute type A aortic dissections (n = 59 [50%]) and aortic pseudoaneurysms (n = 35 [29.7%]). Other pathologic processes included ascending aortic aneurysm (n = 6 [5.1%]), penetrating atherosclerotic ulcers (n = 5 [4.2%]), aortic