Endovascular stent grafting for ascending aorta diseases

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ABSTRACT

Objective: Conventional open surgery encompassing cardiopulmonary bypass has been traditionally used for the treatment of ascending aorta diseases. However, more than one in five of these patients will be finally considered unfit for open repair. We conducted a systematic review and meta-analysis to investigate the role of thoracic endovascular aortic repair (TEVAR) for aortic diseases limited to the ascending aorta.

Methods: The current meta-analysis was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. We investigated patients' baseline characteristics along with early (30 days/in-hospital stay) and late (beyond 30 days/in-hospital stay) outcomes after TEVAR limited to the ascending aorta and not involving the arch vessels. Separate analyses for case reports and case series were conducted, and pooled proportions with 95% confidence intervals (CIs) of outcome rates were calculated.

Results: Approximately 67% of the patients had a prior cardiac operation. TEVAR was performed mainly for acute or chronic Stanford type A dissection (49%) or pseudoaneurysm (28%). The device was usually delivered through the femoral artery (67%), and rapid ventricular pacing was used in nearly half of the patients. Technical success of the method was 95.5% (95% CI, 87.8-99.8). Among the early outcomes, conversion to open repair was 0.7% (95% CI, 0.1-4.8), whereas mortality was 2.9% (95% CI, 0.02-8.6). We estimated a pooled rate of 1.8% (95% CI, 0.1-7.0) for neurologic events (stroke or transient ischemic attack) and 0.8% (95% CI, 0.1-5.6) for myocardial infarction. Late endoleak was recorded in 16.4% (95% CI, 8.2-26.0), and 4.4% (95% CI, 0.1-12.4) of the population died in the postoperative period. Finally, reoperation was recorded in 8.9% (95% CI, 3.1-16.4) of the study sample.

Conclusions: TEVAR in the ascending aorta seems to be safe and feasible for selected patients with various aortic diseases, although larger studies are required. (J Vasc Surg 2017;■:1-15.)

Diseases of the ascending aorta, like acute type A aortic dissection, intramural hematoma, penetrating atherosclerotic ulcer, and chronic aneurysmatic dilation, have traditionally been treated with conventional open surgery through a median sternotomy and cardiopulmonary bypass, with the majority of them also necessitating circulatory arrest and deep hypothermia. However, 28% of these patients will be considered unfit for open repair.[1]

Thoracic endovascular aortic repair (TEVAR) has emerged as a potential alternative to emergency open surgical repair for acute aortic syndromes in selected patients. The feasibility of endovascular ascending aortic repair has been demonstrated in several case reports that used a variety of devices, all originally designed for the descending aorta.[2] TEVAR of the ascending aorta poses a challenge, mainly because of the curvature of the aortic arch, proximal fixation close to the aortic valve and coronary ostia, distal fixation that may impinge on the innominate artery, considerable hemodynamic forces, and risk of cardiac and aortic injury and retrograde aortic dissection. Some of the major complications of this procedure are novel, even to the endovascular specialists who are experienced in aortic endografting; these include perforation of the left ventricle, injury and dissection of the aortic root, and occlusion of the coronary arteries.[3]

Nearly all commercially available TEVAR devices are designed for the treatment of descending aortic disease. No device (except for Zenith Ascend TAA Endovascular Graft[4]; Cook Medical, Bloomington, Ind) has yet been specifically designed for the ascending aorta. To avoid the high risk of operation in patients with comorbidities or a previous cardiothoracic procedure, endografts in the ascending aorta may be a good alternative treatment. Safe and effective implementation of TEVAR in the treatment of ascending aortic diseases may be the solution for less invasive and efficient treatment.

The aim of this systematic review and meta-analysis was to investigate the clinical outcomes of endovascular repair limited to the ascending aorta and not involving the arch vessels. We explored the literature, in terms of both case series and case reports, concerning the mortality and morbidity, the complications, the access, and the techniques of the method.

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METHODS

Data collection

The meta-analysis was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. The following medical literature databases were systematically searched: MEDLINE, Scopus, Embase, Google Scholar, Ovid, and the Cochrane Library. A snowball process in the reference lists of the eligible articles was performed after retrieval of the relevant articles from search of the databases.

Search methodology, inclusion and exclusion criteria, and data extraction

We used the following Medical Subject Headings terms: ("ascending aorta" [All Fields] OR "zone 0" [All Fields]) AND ("thoracic" [All Fields]) AND ("endovascular" [All Fields]). We searched for all scientific papers, without gender or language restriction, until October 2016. We investigated studies focusing on TEVAR limited to the ascending aorta for all types of aortic diseases. Studies reporting on hybrid thoracic endovascular repair into the ascending aorta were excluded. Two authors (C.N.A., N.A.P.) independently extracted and analyzed the data, and final decision was reached by consensus.

Data extracted from eligible studies included the first author's name, study year, country in which the study was conducted, total number of patients, number of male patients, number of patients with prior cardiac/aortic surgery, indications for treatment, mean length of in-hospital stay (days), follow-up (months), inclusion and exclusion criteria, vascular access site (transfemoral, transapical, or through the axillary artery), type of anesthesia applied, type of anticoagulation used, type of endograft used, use of transesophageal echocardiography (TEE), and description of complications during follow-up.

We also extracted the number of patients with outcomes of interest, which were described as early and late. Early outcomes were defined as outcomes during the first 30 postoperative days[5] or in-hospital outcomes.[6-8] The majority of the studies included both of these definitions of early outcomes,[4,9-11] so we defined early outcomes as those occurring in 30 days or in-hospital outcomes and late ones as those happening beyond this period. Early (30 days/in-hospital stay) outcomes included the following: technical success; conversion to open repair; death; neurologic event; myocardial infarction; respiratory failure requiring tracheostomy, intubation, or prolonged ventilation; renal failure requiring dialysis; any arrhythmia; acute aortic insufficiency, mitral regurgitation, or both; and branch vessel occlusion. Late (beyond 30 days/in-hospital stay) outcomes included endoleak, death, and reoperation.

Statistical analyses

Data synthesis and treatment effects. The outcome rates in patients with TEVAR in the ascending aorta were estimated for each study and reported as the proportion of patients with the corresponding outcome among all patients with TEVAR in the ascending aorta. Values of the concomitant outcomes were subsequently appropriately calculated, expressed as proportions and 95% confidence intervals (CIs), and thereafter transformed into quantities according to the Freeman-Tukey variant of the arcsine square root transformed proportion. The pooled effect estimates were calculated as the back-transformation of the weighted mean of the transformed proportions, using Der Simonian-Laird weights of random-effects model and expressed as percentage proportions.[12] Two separate meta-analyses were conducted. The first derived pooled outcome rates, taking into account all case series (each case series participated with its own outcome rate) plus case reports (one outcome rate was calculated for all case reports). The second analysis derived pooled outcome rates only from case series (sensitivity analysis).

Heterogeneity, publication bias, and meta-regression analysis. A formal statistical test for heterogeneity using the I^2 test was performed. Publication bias was assessed using the Egger test for small-study effects as well as visual inspection of funnel plots. We used Stata statistical software version 14 (StataCorp LP, College Station, Tex) for the analyses.

RESULTS

Study characteristics. We identified 398 potentially eligible studies after a literature search. Review of the titles and abstracts evidenced that 211 articles were irrelevant. We also removed 11 articles because they were reviews and not original articles. A total of 176 articles were further evaluated. Finally, 36 articles were deemed relevant to be included in the systematic review. Among them, 13 were case series[2-11,13-15] and 23 were case reports.[16-38] However, because of overlapping population, we further excluded 6 articles, and finally 30 articles participated in the meta-analysis (Fig 1), corresponding to a total of 119 patients who underwent TEVAR in the ascending aorta.

Baseline study characteristics of the 30 eligible studies included in the systematic review (13 case series and 17 case reports) are presented in Table I for case series and in Table II for case reports. The included studies were published from 2000 to 2016. Of 119 patients included in our systematic review, 70 (58.8%) were male; 64 of 96 patients (66.7%) had already undergone a cardiac or aortic procedure or heart or lung transplantation, whereas there was no information concerning prior operations in 23 patients. There were 58 patients (48.7%) who received a TEVAR procedure in the ascending aorta because of acute or chronic Stanford type A dissection, 33 patients (27.7%) because of ascending aortic pseudoaneurysm, 4 patients (3.4%) because of intramural hematoma, 8 patients (6.8%)