Endovascular stent grafting for ascending aorta repair in high-risk patients

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Objectives: Standard treatment of ascending aortic pathology is open repair, but some patients are too high risk. Thoracic endovascular aortic repair (TEVAR) of the ascending aorta has been used as an alternative. Our objectives were to characterize patients, describe repair methods, and assess outcomes.

Methods: From 2006 to 2014, 22 patients underwent supracoronary ascending TEVAR for acute Type A dissection (n = 9), intramural hematoma (n = 2), pseudoaneurysm (n = 9), chronic dissection (n = 2), or aorta-cardiac fistula (n = 2). Mean age was 71 ± 13 years and the maximum proximal aortic diameter was 6 ± 1 cm. Devices were delivered via a transfemoral (n = 10), transapical (n = 7), or axillary (n = 5) artery approach. The proximal landing zone was at the sinotubular junction in 14 patients, mid to distal ascending aorta in 3 patients, and surgical graft from previous ascending repair in 5 patients. More than 1 device was used in 15 patients. Imaging and engineering analysis was performed for all patients.

Results: There were 3 hospital deaths (13.6%) (tamponade in 1 patient, bleed from left atrial fistula in another patient). One patient had partial occlusion of the left coronary artery requiring open conversion and died later from multiorgan failure. One patient required early open conversion for retained delivery system. There were 3 strokes, 2 myocardial infarctions, and 2 tracheostomies, but there was no new-onset renal failure. Median follow-up was 12 months. Six patients developed type 1 endoleak: 2 were treated endovascularly, 1 with open repair, 1 resolved, 1 refused treatment, and 1 is being watched. In 2 patients, initial TEVAR was performed as a bridge for ruptured high-risk dissection and were later converted to open repair. Reoperations also included removal of stent graft due to distal migration and repair of left ventricular pseudoaneurysm. There were 3 late deaths. Actual survival at 30 days, 1 year, and 5 years was 86%, 80%, and 75%, respectively.

Conclusions: Ascending TEVAR is a feasible alternative to medical therapy for repair of acute and chronic ascending disease in high-risk patients. Development of devices dedicated to treat ascending aortic pathology is needed to improve outcomes. (J Thorac Cardiovasc Surg 2015;149:144-54)

ACD

Video clip is available online.

Conventional treatment of ascending aortic aneurysm or dissection is open repair, but some patients are too high risk for this approach and may benefit from a less invasive alternative with thoracic endovascular aortic repair (TEVAR).[1-4]

Several studies have reported safety and effectiveness of TEVAR of the descending aorta, but the role of TEVAR for treating ascending aortic pathology is less well known. Only a small number of studies have described outcomes with this approach.[4-11]

Currently there are no commercially available endovascular devices specifically designed to treat the ascending aorta. Compared with TEVAR of the descending thoracic aorta, endovascular therapy for the ascending aorta is challenged by more complex pathology, hemodynamic characteristics, and anatomy. Despite these issues, we have used various endovascular devices to treat high-risk patients without other reasonable treatment options.

Objectives of our study were to explore the feasibility of TEVAR as an alternative to medical therapy for treating ascending aorta pathology in high-risk patients. Patients are characterized, outcomes are assessed, and recommendations for improvement are formulated based on imaging and engineering analysis.

PATIENTS AND METHODS

Patient Characteristics and Risk Factors

From 2006 to 2014, 22 patients underwent endovascular supracoronary ascending aortic repair at Cleveland Clinic. Presentation and indications for repair included acute Type A dissection (n = 9; 41%), acute intramural

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Abbreviations and Acronyms
CT = computed tomography
TEVAR = thoracic endovascular aortic repair

hematoma (n = 2; 9%), pseudoaneurysm (n = 9; 36%), and chronic dissection with aneurysm (n = 2; 9%). One patient presented with hemoptysis and heart failure due to a pseudoaneurysm to pulmonary artery fistula, and another presented with heart failure due to acute dissection of a chronic aneurysm that developed fistula into the dome of the left atrium. Mean age was 70 ± 13 years, 50% were men, and the preoperative mean maximum aortic diameter was 6 ± 1.0 cm.

Sixteen patients (73%) had a history of previous major cardiac or aortic operation and of these, 4 had multiple previous cardiac operations. All patients were considered too high risk for conventional open repair at the time of presentation. Additional patient details are summarized in Table 1.

Imaging analysis. Detailed imaging analysis was performed in all patients. Computed tomography (CT) scans were reviewed using 3-dimensional imaging software (Terarecon, San Mateo, Calif). Aortic and branch vessel diameter measurements were obtained at multiple landmarks. Length measurements were also taken from the highest coronary to the origin of brachiocephalic artery along 3 paths: the greater curvature, central line of flow, and the lesser curvature. These results are summarized in Table 2.

Presentation

Acute Type A dissection and intramural hematoma. All acute Type A dissection patients (n = 9; 41%) presented as an emergency. Of these, 4 patients (44%) had pericardial effusion, including 1 patient who refused blood transfusion for religious reasons. Four patients (44%) presented with moderately severe aortic insufficiency, whereas 3 patients (33%) had respiratory failure—1 already had tracheostomy in place at the time of presentation and the other 2 were intubated on arrival. Two additional patients presented with chest pain and intramural hematoma with a penetrating ulcer and were treated urgently (Figure 1). All patients in this group were deemed extremely high risk for open repair but had the potential for a reasonable quality of life if they were to survive the acute insult. Endovascular therapy was chosen over medical therapy for 1 of 2 reasons: they had favorable morphology believed to be amenable to definitive repair or they had unfavorable morphology that put them at immediate risk of death without mechanical treatment. The latter were treated with the understanding that the endovascular approach may serve as a bridge to later definitive open repair if their risk improved.

Ascending pseudoaneurysm. In contrast to patients with acute Type A dissection, 8 patients with ascending pseudoaneurysm presented in a stable condition, except for 1 who presented with hemoptysis, respiratory failure, and cardiogenic shock due to an 8.6-cm pseudoaneurysm with a fistula to the right main pulmonary artery in the setting of chronic dissection beyond a previous repair. All patients had a history of previous cardiac surgery and the mean interval to ascending TEVAR was 6.4 ± 5 years. Previous procedures included coronary bypass in 4 patients who developed pseudoaneurysm at the site of a proximal vein graft anastomosis. In the other 5 patients, the prior procedure included root and ascending aortic repair for dissection or aneurysm and aortic valve replacement (n = 4) or resuspension (n = 1). In these patients the pseudoaneurysm arose near the site of the distal graft anastomosis to native aorta (Figure 2).

Chronic dissection. Two patients presented with complications related to residual chronic dissection after acute Type A repair. Both patients had a small communication between the true and false lumen at the distal anastomosis of the ascending graft. One patient had persistent hemolysis without another source for anemia and required >30 units of blood transfused over a 4-month period with severe left ventricular dysfunction (ejection fraction, 10%-15%) without clear etiology. The other patient had growth of her arch by approximately 15 mm only 4 months following the initial emergency dissection repair (Figure 3). Ascending TEVAR was technically successful in the second patient, but the other required emergency conversion for a retained delivery system. The delivery system was removed under circulatory arrest and the stent graft was left intact.

Operative Details and Technique

Stent grafts were used in 21 patients (95%) (see Table 3). In 1 patient attempted stent graft delivery was aborted due to difficulty in crossing an existing mechanical aortic valve. This is the patient who presented with pseudoaneurysm after previous Type A repair and fistula from the aorta to pulmonary artery. The pulmonary artery and aortic defects were plugged with atrial septal closure devices and the aorta device was reinforced by a balloon-expandable stent in the ascending aorta.

All procedures were done under general anesthesia with heparin for anticoagulation. Device delivery was transfemoral (n = 10), transapical (n = 7), or through the axillary artery (n = 5). Transfemoral delivery was performed through a cut-down exposure of the common femoral artery and stiff wire access across the aortic valve. For transapical delivery, through and through wire access into the left subclavian artery was obtained using a snare technique. Axillary artery approach was performed through a 10-mm surgical graft conduit. In 1 patient with very severe left ventricular dysfunction due to untreated hypothyroidism, the device was deployed while the patient was on full cardiopulmonary bypass. In all others, hemodynamic displacement forces were reduced by rapid ventricular pacing during the device deployment. Transesophageal echocardiography was used in addition to fluoroscopic guidance. Completion angiogram was performed to assess coronary and brachiocephalic vessel patency, and to rule out endoleak. All patients were transferred to the intensive care unit intubated.

In patients who underwent ascending aortic stent grafting, 16 out of 21 patients had proximal landing zone in the native proximal aorta: sinotubular junction in 13 and mid to distal ascending aorta in 2 patients. In the other 5 patients, the proximal landing zone was a surgical graft from previous open ascending aortic repair. More than 1 device was used in 14 patients (64%).

Additional intraoperative procedures. Five patients had coronary artery access obtained during the ascending repair. In 2 patients, coronary intervention was planned: a clinically important circumflex artery stenosis was stented and a saphenous vein graft where pseudoaneurysm originated was coiled to avoid type 2 endoleak. In 3 others, wire access was obtained due to concern that the device would be deployed close to the origin.

Two patients required intraoperative open conversion to manage acute complications. In 1 patient who underwent transfemoral emergency TEVAR for acute Type A dissection, there was a partial occlusion of the left coronary artery by the stent graft. The patient was immediately placed on cardiopulmonary bypass support via cannulation of the femoral vessels. Initial attempts at balloon-facilitated repositioning was not successful. During hypothermic circulatory arrest, the stent graft was removed and the ascending aorta was replaced. This patient died on postoperative day 6 due to stroke and multiorgan failure. A second patient who required open conversion had chronic dissection after previous Type A repair. This patient had persistent hemolysis from a small entry tear at the distal suture line. The device was delivered from the left axillary artery. After deploying the stent graft, a portion of the delivery system was retained. Following multiple failed attempts at removal of the delivery system, the patient was placed on cardiopulmonary bypass support, cooled, and redo sternotomy was performed. Previous surgical graft was opened and the delivery system released. The remaining proximal end of the stent graft was secured with sutures and the aortotomy was closed.