Factors favoring retrograde aortic dissection after endovascular aortic arch repair

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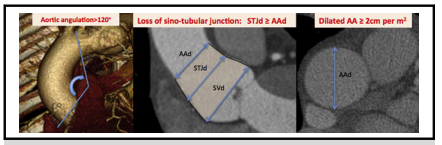
ABSTRACT

Objective: To assess factors predisposing patients to retrograde type A aortic dissection (RTAD) who have undergone hybrid aortic arch repair.

Methods: From 2001 to 2013, 32 patients underwent hybrid aortic arch repair in our department: 19 in zone 1 and 13 in zone 0. Among these patients, 6 experienced RTAD (18.7%): 3 in zone 0 (23%), 3 in zone 1 (15.8%). Preoperative computed tomography scans of these 32 patients were evaluated. A morphologic assessment of the aortic arch, ascending aorta, and aortic root was performed. Other potential risk factors were investigated. Binary logistic regression was performed to test for possible associations with RTAD.

Results: Five patients were successfully converted to open repair. Patients who had RTAD were similar to those who did not, across pertinent variables, including age, type of device, diameter of the ascending aorta, and presence of a bicuspid aortic valve (all $P > .1$). Incidence of RTAD was observed to be higher among women ($P = .034$), patients with stent-graft oversizing $\geq$10% ($P = .018$), and patients treated with a stent-graft of diameter >42 mm ($P = .01$). Aortic morphology analysis showed that an indexed aortic diameter of $\geq$20 mm/m^2 ($P = .003$); aortic root morphology, specifically loss of the sinotubular junction ($P = .004$); and presence of an aortic arch malformation ($P = .03$) were correlated with risk of RTAD. Two patients in the zone-0 group with severe angulation (>120°) between the ascending and the transverse aorta suffered RTAD.

Conclusions: The occurrence of RTAD after hybrid aortic arch repair is common. To prevent this complication, preoperative screening of the aortic arch, ascending aorta, and aortic root morphology is critical. (J Thorac Cardiovasc Surg 2015;150:136-42)



Aortic morphologic risk factors of retrograde dissection.

Central Message

The occurrence of RTAD after hybrid aortic arch repair is common. To prevent this complication, preoperative screening of the aortic arch, ascending aorta, and aortic root morphology (indexed aortic diameter of $\geq$20 mm/m^2 and presence of aortic arch malformation) is critical.

Perspective

Thoracic endovascular aortic repair is increasingly being applied to treat aortic arch lesions. But this approach can induce retrograde aortic dissection. Of a total of 32 patients who underwent hybrid aortic arch repair, with landing in zone 1 or zone 0, 6 experienced retrograde aortic dissection (18.7%). A morphologic assessment of the 32 preoperative CT scans was conducted. Excessive stent-graft oversizing (>10%), indexed aortic diameter of $\geq$20 mm/m^2, loss of sinotubular junction, aortic arch malformation, and being a woman were isolated as independent risk factors for retrograde dissection. Patients with such risk factors should either have open repair or hybrid aortic arch repair combined with prophylactic ascending aorta replacement.

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Currently, management of aortic arch aneurysm remains a clinical challenge. Given the complexity of open arch procedures, hybrid strategies involving transposition of the great vessel and endovascular stent-grafting are increasingly applied to treat aortic arch aneurysm.[1] Reductions in surgical trauma and procedural mortality and morbidity have been proposed as advantages of this novel technique.[2] But thoracic endovascular repair (TEVAR) implantation landing proximally in "zones 0 and 1," in particular, is associated with severe

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Received for publication Dec 6, 2014; revisions received March 22, 2015; accepted for publication March 29, 2015; available ahead of print May 1, 2015.

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0022-5223/$36.00

http://dx.doi.org/10.1016/j.jtcvs.2015.03.042

Abbreviations and Acronyms
CI = confidence interval
CT = computed tomography
RTAD = retrograde type A aortic dissection
TEE = transesophageal echography
TEVAR = thoracic endovascular repair

complications, such as retrograde type A aortic dissection (RTAD).[3-5] We report our institutional experience with a hybrid aortic arch operation, focusing particularly on predisposing factors of this devastating complication.

METHODS

From 2001 to May 2013, a total of 293 patients underwent TEVAR at our institution. Of these, 13 had TEVAR with a proximal aortic landing in "zone 0", and 19 in "zone 1," using the classification scheme proposed by Ishimaru.[6] A total of 11 patients who had undergone prior ascending aortic replacement were excluded.

Patient Demographics

The mean age of patients was 69.8 ± 8 years; 27 (84%) were men (demographics are shown in Table 1). Overall, 29 (91%) patients had an American Society of Anesthesiologists score of ≥3; 12.5% of patients had had a prior stroke; 34% had had previous myocardial infarction; 19% had chronic lung disease; 22% had peripheral vascular disease; and 50% had some history of smoking. Of these, 29 (91%) presented with aneurysmal disease of the aortic arch; 2 presented with chronic aortic dissection; and 1 presented with traumatic pseudoaneurysm. Three patients were treated after failure of prior TEVAR, and 16 patients (50%) underwent emergency surgery for aortic rupture.

Operative Strategy

A total of 32 patients received hybrid aortic arch repairs with a suitable proximal landing zone. For zone-0 repair, surgical repair involved the reimplantation of the aortic arch vessel using a 10-mm Dacron graft sewn to the native aorta just above the sinotubular junction. This procedure was performed without cardiopulmonary bypass, using a side-biting clamp. If exposure of the left subclavian was expected to be difficult through a median sternotomy, a pre-emptive transposition of the left subclavian to left common carotid artery was performed. After completion of the aortic arch debranching, a thoracic stent graft was deployed via a retrograde femoral approach during the same operative time. In 4 patients, stent-graft implantation was delayed until a later point during the same hospital stay. For zone 1, hemiarch debranching was performed by either a left carotid-subclavian transposition and carotid-to-carotid crossover bypass, or a sequential transposition of the left common carotid artery and of the left subclavian artery[7] (Figure 1).

During the same operative time, the stent-graft was deployed just distal to the brachiocephalic artery. Three thoracic stent-grafts were utilized: Gore Excluder (W.L. Gore & Associates, Flagstaff, Ariz) (n = 10; 31.3%); Gore TAG (W.L. Gore & Associates) (n = 7; 21.9%); and Medtronic Talent (Medtronic, Inc, Santa Rosa, Calif) (n = 15; 46.9%). Indications for each TEVAR were classified as degenerative aneurysm (including penetrating atherosclerotic ulcers) (n = 29; 90.6%), acute and chronic dissection (n = 2; 6.3%), or acute blunt traumatic aortic injury (n = 1; 3.1%). Intraoperative transesophageal echography (TEE) was not routinely utilized.

Follow-up

All patients underwent a control computed tomography (CT) scan at 7 days, at 1 month, at 6 months, at 1 year, and annually thereafter. The mean follow-up period was 29.9 months (range: 1.25-171.8 months).

Morphologic Assessment

Preoperative CT scans of these 32 patients were evaluated using OsiriX software (Mac app). A morphologic assessment of the aortic arch, the ascending aorta, and the aortic root was performed. Several measurements were made: ascending aortic diameter at 3 levels (ostium of the brachiocephalic trunk, half-length between the brachiocephalic trunk and the sinotubular junction, and sinotubular junction); sinus of Valsalva diameter; and the length between the aortic annulus and the origin point of the coronary arteries. Morphologic data were reported: bicuspid aortic valve; loss of sinotubular junction (an obliterated sinotubular junction was established when the sinotubular junction diameter was ≥ the ascending aorta diameter); malformation of the aortic arch (right-sided aortic arch, aberrant subclavian artery); and angulation between the ascending aorta and the transverse aorta (Figure 2).

Statistical Analysis

Statistical analysis was performed using SPSS (SPSS Inc, Chicago, Ill). Chi-square analysis, the Fisher exact test, and independent-sample *t* tests were performed for the univariate analysis. Binary logistic regression was utilized to identify factors that were independently associated with each outcome of interest.

RESULTS

From 2001 to May 2013, a total of 32 consecutive TEVAR procedures were performed at a single institution, with a proximal landing in zone 0 (n = 13) and zone 1 (n = 19). Six patients experienced RTAD (18.7%, with 95% confidence interval [CI] 8.89%-35.31%)—3 in zone 0 (23%), and 3 in zone 1 (15.8%).

Operative Characteristics, Detection, and Management of RTAD

Table 2 reports the clinical characteristics and management approach for the 6 RTAD cases. Patient 1 had RTAD originating adjacent to the origin of the inflow anastomosis of the bypass graft used for aortic arch debranching. Patient 2 suffered RTAD owing to an angiographic catheter tip abutting the carotid wall during a contrast injection; the dissection did not seem to be device related. Patients 3 and 4 both had a device-related dissection, based on findings at surgical repair (disclosing a tear adjacent to the proximal end of the endograft). With patient 5, RTAD was disclosed by TEE: a large tear proximal to the stent-graft was observed. Owing to her comorbidities, the patient was deemed unsuitable for surgical conversion and died of multiorgan failure. Patient 6 had an RTAD originating from the anastomosis between the brachiocephalic trunk and the left common carotid artery.

All cases were identified after surgery (range: 3-7 days), but none was intraoperatively disclosed. Patients 2, 3, and 4 were asymptomatic, and the RTAD was found, thanks to the