Long-Term Outcomes of Open Arch Repair After a Prior Aortic Operation: Our Experience in 154 Patients

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Background. **This study assessed the early and long-term results of arch operations performed after a prior aortic operation.**

Methods. **From 1994 to 2014, 154 consecutive patients (mean age, 59.7 years) underwent an aortic arch repair, after a previous aortic operation, at our institution. Antegrade selective cerebral perfusion was used in all cases. Chronic postdissection aortic aneurysm (87 [56.5%]) and degenerative aneurysm (43 [27.9%]) represented the most common indications for surgical intervention. A complete arch replacement was performed in 119 patients (77.3%), an associated root repair in 70 (45.5%), and the frozen elephant trunk technique was used in 55 (35.7%).**

Results. **Hospital mortality was 11.7% (n = 18). Postoperative permanent neurologic dysfunction occurred in 10 patients (6.4%). On multivariate analysis, cardiopulmonary bypass time (odds ratio, 1.02 per minute; p = 0.005) emerged as the only independent predictor of hospital death. Follow-up was 100% complete. The estimated survival at 1, 5, and 10 years was 79.6%, 69.9%, and 46.8%, respectively. Freedom from reoperation was 75.6% at 5 years and 54.6% at 10 years. Cox regression identified chronic postdissection aortic aneurysm (odds ratio, 4.2; p = 0.006) to be the only independent predictor of aortic reintervention. Late survival was comparable between degenerative aneurysm patients and the Italian population matched for age and sex (standardized mortality ratio, 1.9; p = 0.1). Longevity was reduced in patients operated on for chronic postdissection aortic aneurysm (standardized mortality ratio, 6.3; $p < 0.001$).**

Conclusions. **Arch operations after a previous open aortic repair can be performed with acceptable mortality and good long-term outcomes. Complete aortic resection did not increase hospital deaths and was associated with a low need for aortic reinterventions at follow-up.**

(Ann Thorac Surg 2017;103:1406–12)

Aortic arch operations are challenging, time consuming, and require experienced surgeons [1–5]. These features are even more pronounced if reopening the chest is necessary. Only meticulous surgical planning, adequate visceral and cerebral organ protection during the operation, and careful surveillance in the intensive care unit can minimize complications and decrease deaths [4–6]. The question is whether all of this effort contributes to the patient's longevity. This study assessed early and long-term results in a large cohort of patients undergoing open arch repair after a prior aortic operation.

Patients and Methods

Patient Characteristics

Medical records and available aortic data sets were reviewed to identify patients who underwent operations on the aortic arch after a previous aortic operation at Sant'Orsola-Malpighi Hospital (Bologna, Italy). Approval from the institutional review board was obtained. The study excluded patients who had previously undergone nonaortic operations such as coronary artery bypass grafting or mitral valve replacement or repair. Between 1994 and 2014, 154 consecutive patients underwent aortic arch operations after a previous open aortic procedure at our institution. The study cohort was a mean age of 59.7 ± 12. years, and 122 (79.2%) were men. An urgent/emergency reoperation was performed in 17 patients (11%), and 18 (11.6%) had already undergone at least one previous aortic redo procedure through a midsternotomy. The mean time elapsed from the last operation was 9.17 ± 7.62 years.

Patient demographics and previous aortic procedures are reported in Tables 1 and 2. In particular, 86 (55.8%)

Accepted for publication Aug 15, 2016.

Presented at the Poster Session of the Fifty-second Annual Meeting of The Society of Thoracic Surgeons, Phoenix, AZ, Jan 23–27, 2016.

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0003-4975/$36.00
http://dx.doi.org/10.1016/j.athoracsur.2016.08.090

Table 1. Patient Demographics

Variable	No. (%) or Mean ± SD (N = 154)
Males	122 (79.2)
Age, y	59.7 ± 12.1
NYHA class III-IV (n = 115)	17 (11)
Hypertension	113 (73.4)
Diabetes	8 (5.2)
Obesity	4 (2.6)
Smoking	52 (33.8)
COPD	11 (7.1)
Renal insufficiency	9 (5.8)
Peripheral vascular disease	10 (6.5)
Cerebral vascular disease	5 (3.2)
Coronary artery disease	16 (10.4)
Marfan	13 (8.4)
Chronic postdissection aneurysm[a]	87 (56.5)
Degenerative aneurysm	43 (27.9)
False aneurysm	19 (12.3)
Acute aortic dissection	4 (2.6)
Endocarditis	2 (1.3)
Urgent/emergency status	17 (11)
Redo >2	18 (11.7)
Years since last operation	9.2 ± 7.6

[a] Previously repaired for acute type A aortic dissection.

COPD = chronic obstructive pulmonary disease; NYHA = New York Heart Association Functional Classification.

Table 2. Previous Aortic Procedures

Variable	Frequency (%) (N = 154)
Aortic root procedure	86 (55.8)
Aortic valve + ascending aorta replacement	2 (1.3)
Aortic valve + ascending + hemiarch replacement	1 (0.6)
Aortic valve replacement + ascending aorta reduction	2 (1.3)
Ascending aorta reduction	1 (0.6)
Aortic valve repair + hemiarch replacement[a]	1 (0.8)
Aortic valve repair + ascending aorta replacement + arch stent	1 (0.6)
Aortic valve repair + ascending aorta replacement	7 (4.54)
David + hemiarch replacement	1 (0.6)
David + arch replacement + elephant trunk	1 (0.6)
Bentall	35 (22.7)
David	3 (1.9)
Bentall + hemiarch replacement	3 (1.9)
Bentall + aortic arch stent	1 (0.6)
Ascending aorta replacement (alone)	50 (33.1)
Partial or total arch replacement	18 (11.7)
Hemiarch replacement	5 (3.2)
Ascending + hemiarch replacement	10 (6.5)
Ascending + arch replacement	1 (0.6)
Ascending aorta replacement + aortic arch stent	1 (0.6)
Arch	1 (0.6)
Associated procedures	
CABG	9 (5.8)
Mitral valve repair	1 (0.6)
Atrial septal defect closure	1 (0.6)
Mitral valve plasty	1 (0.6)
Mitral valve + tricuspid valve plasty	1 (0.6)
TEVAR	1 (0.6)

[a] Hemiarch replacement: partial arch replacement without reimplantation of arch vessels.

CABG = coronary artery bypass grafting; TEVAR = thoracic endovascular aneurysm repair.

were aortic root procedures, 50 (33.1%) consisted of an ascending aorta replacement alone, and 18 (11.7%) were a partial or total arch replacement. Three patients who had previously undergone complete arch replacement required a second arch procedure because of graft infection, pseudoaneurysm of the aortic isthmus, and rupture of the proximal descending thoracic aorta. Main indications for the operation (Table 1) were chronic postdissection aortic aneurysm (CPDA) for residual aortic dissection after a previously repaired acute type A dissection in 87 patients (56.5%) and a degenerative aneurysm in 43 (27.9%).

Operative Technique

Various aortic procedures were performed according to the underlying pathology. A total arch replacement was performed in 119 patients (77.3%), with the elephant trunk used in 16 patients (10.4%) or the frozen elephant trunk (FET) technique in 55 (35.7%). The entire proximal thoracic aorta (root + ascending aorta + total arch) was replaced in 43 patients (27.9%). Associated cardiac procedures were performed in 19 patients (12.3%). The site of arterial inflow for cardiopulmonary bypass (CPB) was the right axillary artery in 62 patients (40.3%), the innominate artery in 30 (19.5%), the ascending aorta in 14 (9%), and the femoral artery in 48 (31.2%; Fig 1).

Antegrade selective cerebral perfusion (ASCP) was used in all cases. Our technique for ASCP has been previously described [6, 7]. Briefly, it involves moderate hypothermia (nasopharyngeal temperature of 26°C), bilateral hemisphere perfusion, and a cerebral flow rate of 10 to 15 mL/kg per minute, adjusted to maintain a right radial arterial pressure between 40 and 70 mm Hg. Monitoring devices included bilateral radial artery pressure catheters, nasopharyngeal and bladder temperatures, and regional oxygen saturation in the frontal lobes by means of near-infrared spectroscopy. The temperature of the cerebral perfusate was 1° to 2°C less than the core temperature (24° to 25°C).

After distal anastomosis, CPB was reinitiated in an antegrade fashion through the graft or axillary and innominate arteries when feasible. The mean CPB and cerebral perfusion times were 230.2 ± 73.9 minutes and 79.9 ± 39.2 minutes, respectively. Before chest reopening, 14 patients were placed on CPB, and 5 required deep hypothermic circulatory arrest. The surgical procedures and operative data are reported in Tables 3 and 4.