

Aneurysms After Coarctation Repair Associated With Hypoplastic Aortic Arch: Surgical Management Through Median Sternotomy

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Aneurysm development after repair of aortic coarctation is not a rare complication, but it is highly related to hypoplasia of the transverse aortic arch. The optimal management of such cases is not clearly established. We propose a single-stage transmediastinal re-repair using

moderate hypothermic cardiopulmonary bypass and antegrade selective cerebral perfusion.

(Ann Thorac Surg 2006;81:758–60)

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Aortic arch hypoplasia is highly related to aneurysm formation after coarctation repair and is frequently associated with intracardiac defects that may require surgical correction [1, 2].

We propose a single-stage corrective re-repair of these complex lesions through median sternotomy using antegrade selective cerebral perfusion and moderate hypothermia.

Technique

Between October 2002 and May 2004, 4 adult patients (mean age, 28.2 ± 8.4 years; range, 18 to 37) with pseudoaneurysm after coarctation repair and concomitant arch hypoplasia were surgically treated (Table 1). Aortic arch hypoplasia was defined as an arch diameter less than or equal to 0.9 times the aortic diameter at the level of the diaphragm. Three patients had undergone patch aortoplasty and one had a bypass graft. They were asymptomatic and pseudoaneurysm was detected at 15.75 ± 0.96 years (range, 15 to 17 years) after the initial repair operation at follow-up imaging (Fig 1A, 1B). Two patients had bicuspid aortic valve, and 1 of these patients had moderate aortic insufficiency.

According to the body surface area and the age of the patients, 3 of them had a dilation of the ascending aorta requiring replacement [3].

After endotracheal intubation with a double-lumen tube, the patient was positioned on the operating table supine with the patient's left arm stretched above the head with a pillow placed under the left shoulder. A standard median sternotomy was used in all patients. Cardiopulmonary bypass was instituted with a cannula for arterial return in the femoral artery and a venous

single two-stage cannula in the right atrium. Antegrade selective cerebral perfusion with moderate hypothermic circulatory arrest was utilized in all patients.

The left recurrent laryngeal nerve was identified and protected. The pseudoaneurysm and the descending thoracic aorta were exposed through the left pleural space with a downward gentle retraction of the left lung (Fig 2A). Distally the aorta was transected circumferentially below the level of the pseudoaneurysm and a gelatin-sealed vascular graft was implanted. As this suture line was completed, the cardiopulmonary bypass was restarted antegradely, permitting the evaluation of the distal anastomosis (Fig 2B).

The left subclavian artery was reimplanted in 3 patients; in 1 patient it was closed because the reimplantation was technically too demanding. Proximal anastomosis was then performed and, subsequently, the left common carotid artery and the innominate artery were reimplanted. Supraaortic vessels were reimplanted using separated graft technique in 3 patients and "en bloc" technique in 1.

The extent of the repair and the associated procedures performed are shown in Table 1.

There were no in-hospital deaths. No patients suffered from stroke or temporary neurologic dysfunction and no one required reoperation for bleeding. One patient had pneumonia.

Cardiopulmonary bypass mean time was 196 ± 44.9 (range, 161 to 261 minutes). The mean cross-clamp time was 146.3 ± 43.1 minutes and the antegrade selective cerebral perfusion time was 114.3 ± 29.7 minutes (range, 87 to 146 minutes). The mean duration of lower body ischemia was 63 ± 45 minutes.

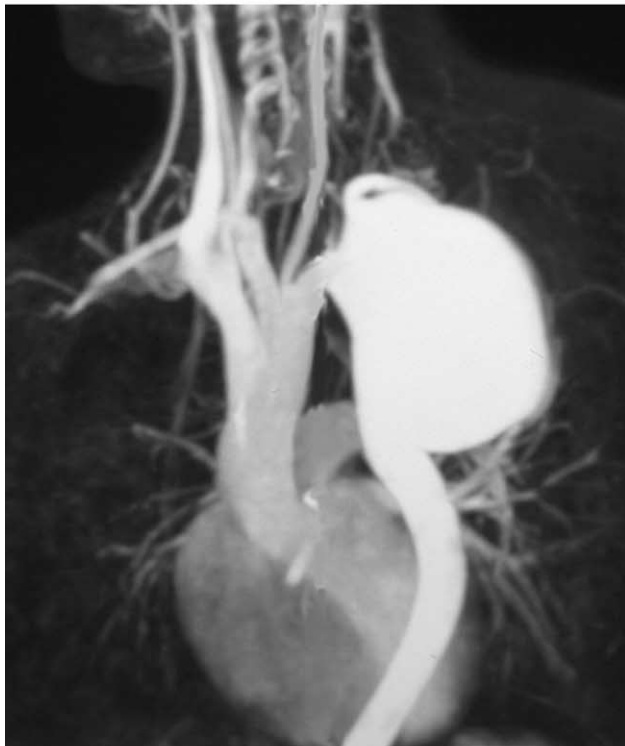
All patients were discharged from the hospital with antihypertension medications. Patients were followed-up for a mean duration of 10.50 ± 6.81 months. All patients underwent postoperative magnetic resonance or computed tomographic scan, which showed good results of the surgical correction.

Accepted for publication Nov 2, 2004.

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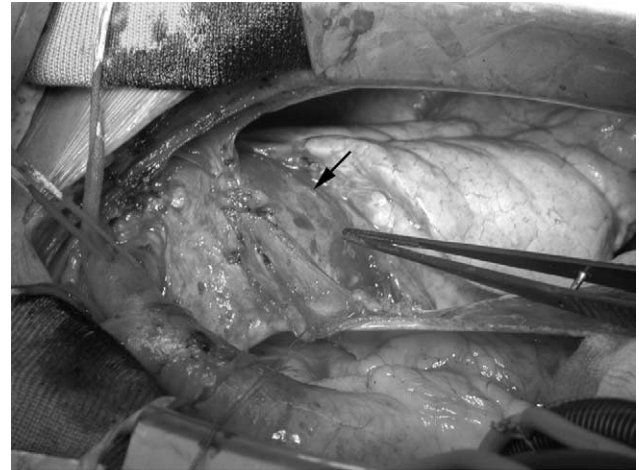


A



B

Fig 1. (A) Angiographic magnetic resonance image of large pseudoaneurysm involving the proximal and distal anastomosis of the aorta-to-aorta bypass graft (patient 1). (B) Angiographic magnetic resonance image of pseudoaneurysm involving the origin of the left subclavian artery associated with aortic arch hypoplasia in patient with previous patch aortoplasty repair (patient 4).



A



B

Fig 2. Intraoperative view through a median sternotomy approach. (A) Surgical exposure of the pseudoaneurysm (arrow) through the left pleural space by means of downward retraction of the left lung. (B) Visualization and evaluation of the distal anastomosis after cardiopulmonary bypass restarting.

Comment

Surgical repair of postsurgical complications in complex forms of coarctation has been associated with high mortality and morbidity, and an optimal treatment is not well established [4, 5]. This limited series confirms that good surgical results can be obtained in such a challenging group of patients using moderate hypothermia and antegrade selective cerebral perfusion.

These lesions are typically managed with the clamping technique through a left thoracotomy with or without some form of left heart or cardiopulmonary bypass.

Recently some authors have suggested deep hypothermic circulatory arrest as an appropriate technique to approach this difficult lesion, and they have reported very excellent results [6, 7]. Deep hypothermic circulatory arrest permits an accurate repair, avoids the risk of

Table 1. Extent of Repair and Associated Procedures Performed

Patient	Operative Date	Age (y)	Sex	Type of Initial Repair	Indication for Reoperation	Type of Reoperation	Outcome
1	Oct 23, 2002	37	F	Coarctation repair with bypass graft (1987)	Pseudoaneurysm, hypoplasia of the aortic arch	Arch and descending thoracic aorta replacement	Alive and well
2	Feb 18, 2004	25	F	Coarctation repair with patch aortoplasty (1988)	Pseudoaneurysm, hypoplasia of the aortic arch, and aneurysm of the ascending aorta	Ascending arch and descending thoracic aorta replacement	Alive and well
3	Oct 9, 2003	18	M	Coarctation repair with patch aortoplasty (1988)	Pseudoaneurysm, hypoplasia of the aortic arch, aneurysm of the ascending aorta	Ascending arch and descending thoracic aorta replacement, sinotubular junction remodeling, and subcommissural aortic annuloplasty	Alive and well
4	Aug 14, 2003	33	F	Coarctation repair with patch aortoplasty (1986)	Pseudoaneurysm, hypoplasia of the aortic arch	Ascending arch and descending thoracic aorta replacement	Alive and well

F = female; M = male.

clamp-related injuries, and provides adequate protection of the brain, spinal cord, and other organs. However, in cases of coexisting aortic arch hypoplasia, frequently associated with dilatary abnormalities of the ascending aorta and with intracardiac lesions, the lateral approach does not allow the performance of surgical maneuvers on the ascending aorta or the heart, or both.

We treated 4 patients with aneurysm or pseudoaneurysm at the site of coarctation repair and with a concomitant aortic arch hypoplasia. Successful anatomic repair was achieved in all patients through an anterior approach using antegrade selective cerebral perfusion and moderate hypothermia. There were no deaths, and none of the patients had a central neurologic deficit (stroke or spinal cord injury, or both).

We obtained the exposure of the descending thoracic aorta through the left pleural space with a gentle retraction of the left lung toward the patient's feet. In this manner we could easily reach the descending aorta down to T6-T8, allowing us to safely perform the distal anastomosis. However, in case of difficult exposure of the distal aorta, an additional left anterior thoracotomy could be made.

Exposure of the subclavian artery, especially if associated with a large aneurysm, can be technically challenging. In 1 patient, we decided to close the subclavian artery because the reimplantation was technically too demanding. This patient experienced neither symptoms nor functional deficits at the follow-up.

The risk of spinal cord ischemic injury is substantial when no distal perfusion techniques are used. In such cases, spinal cord protection can be achieved only with hypothermia, and for ischemic times shorter than 60 to 90 minutes, moderate hypothermia at 26°C nasopharyngeal appears to be adequate [8]. Our mean lower body isch-

emic time was 63 minutes, and no patient had evidence of neurologic deficits such as paraplegia or paraparesis.

In conclusion, this procedure should be considered as a suitable alternative for adult patients with aortic coarctation or with pseudoaneurysm at the site of the previous repair and a concomitant hypoplastic aortic arch. Excellent surgical results can be obtained in this technically challenging group of patients.

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