

Different strategies for simultaneous repair of aortic coarctation and associated cardiac diseases in adult patients

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Abstract

Background: Coarctation of aorta and associated cardiac disease is complex medical situation. Both requires correction either simultaneous or in stages. A distinct approach is vital in order to bring down the perioperative mortality and morbidity.

Objective: To study the different strategies for simultaneous repair of aortic coarctation and associated cardiac diseases in adult patients.

Materials and Methods: We have operated three patients with coarctation associated with other cardiac diseases, who were treated by various surgical approaches. Developments in endovascular technology over the past decade may potentially reduce the morbidity from open surgical repair. However, some cases are unsuitable for endovascular repair, and open surgical techniques continue to play a part in the management of these patients. Coarctation and associated diseases were treated in a single stage by an ascending-to-descending bypass ($n = 2$). One patient underwent a two-stage operation for his treatment.

Result: Postoperative recovery of all the three patients was uneventful. Their ICU parameters were within acceptable limits. All the three patients showed negligible gradients of blood pressure between the upper and lower extremities and discharged within 8 to 9 days. They showed postoperative CTscan suggestive of normal functioning graft without any leak or aneurysm.

Conclusion: In spite of the progress in the development and popularization of endovascular techniques, surgical intervention is becoming a more preferable option for the treatment of coarctation accompanied by cardiac diseases. Two-stage and single-stage (extra-anatomical bypass) procedures are the alternative techniques that are performed depending upon the experience of the surgeons in the center; however, we prefer the single-stage (simultaneous) technique.

KEY WORDS: Cardiopulmonary bypass, descending thoracic aorta, noncoronary sinus aneurysm

Introduction

Aortic coarctation surgery may be considered a well-established procedure in pediatric congenital heart surgery.

But, the technique gets complex in adults mainly owing to the occurrence of associated abnormalities. As of now, there is no consensus about how to approach such cases. According to some reports, it is recommended that coarctation ought to be treated initially, while in other studies, it is proposed that cardiac lesions must be treated before coarctation repair.^[1-3] As the patients are subjected to two different surgical techniques, the perioperative morbidity and mortality risks are elevated in the two-staged repair techniques. Moreover, the patients, in the long-term, can show distress as two separate skin incisions are made.

In this study, we assessed the surgical procedures carried out on three patients who underwent aortic coarctation

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accompanied by cardiac lesions. They presented to us with cardiac symptoms. Clinical examination revealed discrepancies in their pulses of upper and lower extremities. So, they were further investigated with computed tomography (CT) thorax for clinical correlations.

Materials and Methods

We carried out a retrospective analysis of the patients who had been operated for aortic coarctation with associated cardiac disease between January 2014 and July 2015.

Patient-1

An 18-year-old male patient came with dyspnea on exertion (DOE) at moderate work, and we found there was difference in pressure of both the extremities. On detailed workup, his echo findings were bicuspid aortic valve, aortic annulus 30 mm, ascending aorta 69 mm, severe aortic regurgitation (AR), dilated left ventricle (LV) size, and concentric LV hypertrophy.

His CT findings suggested grossly dilated aortic root and ascending aorta, LV hypertrophy, severe postductal coarctation of aorta, multiple mediastinal posterior chest wall, and paravertebral and intercostal collaterals on either side bypassing coarctation with collaterals channels [Figure 1A].

Patient-2

A 23-year-old male patient presented with New York Heart Association stage 3. His 2D echo findings suggested mitral valve prolapse with severe mitral regurgitation, bicuspid aortic valve with moderate AR, and severe juxtaductal coarctation.

His CT scan findings suggested bicuspid aortic valve, dilated aortic root and mild dilated ascending aorta, severe juxtaductal aortic coarctation, multiple mediastinal and posterior chest walls, and paravertebral and intercostal collaterals on either side bypassing coarctation with collaterals channels [Figure 2A].

Patient-3

A 58-year-old female patient showed complaints of DOE and New York Heart Association stage 3. Her 2D echo findings stated severe aortic stenosis with severe LV dysfunction with moderate AR and coarctation (juxtaductal).

Her CT scan findings suggested bicuspid aortic valve, severe juxtaductal aortic coarctation, and postcoarctated descending thoracic aorta (DTA) that was mildly dilated. Aneurysmal outpouching was seen from noncoronary sinus [Figure 3A].

The central venous pressure and two invasive arterial pressures (right radial and left femoral arteries) were monitored for all the patients.

The first case was treated with a two-stage procedure. He presented with ascending aortic aneurysm, dilated root, and severe AR. So, he required a root replacement. For ascending to descending aorta, bypass proximal anastomosis was difficult as we were in a learning curve. This patient underwent left posterolateral thoracotomy and graft no. 14 mm was kept from the arch of aorta (distal to subclavian artery) to DTA [Figure 1B]. The gradient between the extremities was negligible [Table 1]. The chest was closed and the patient shifted to intensive care unit (ICU). Once the patient was stabilized, on the fourth postoperative day, the patient was taken for Bentall procedure. This was carried out with routine

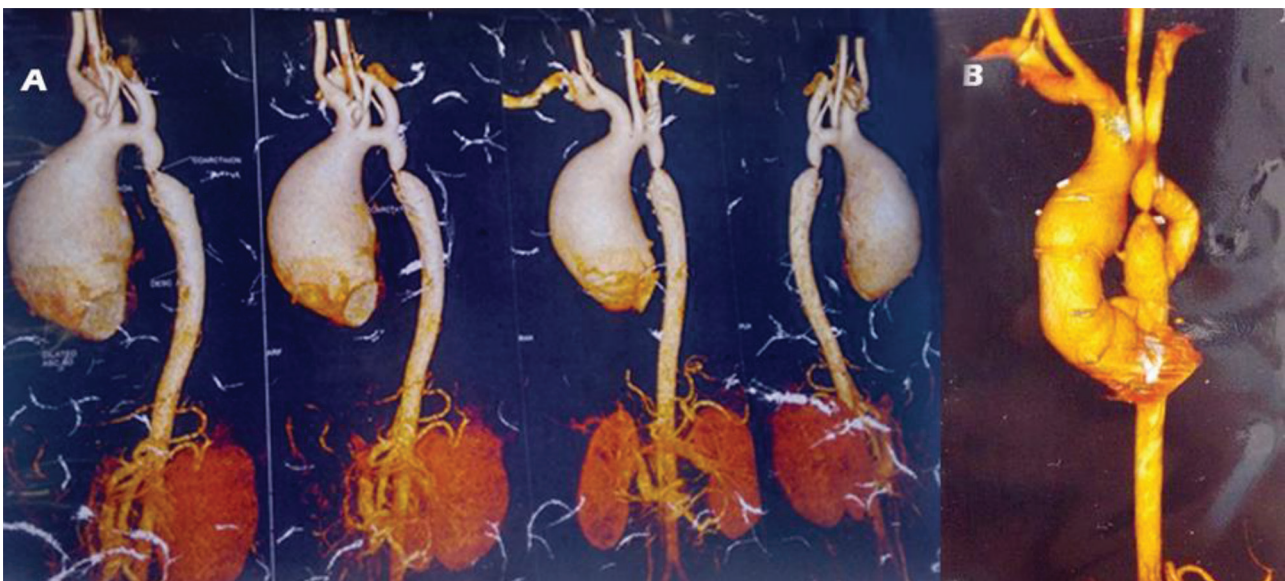


Figure 1: Pre- (A) and postoperative (B) contrasts of CT thorax of patient 1.

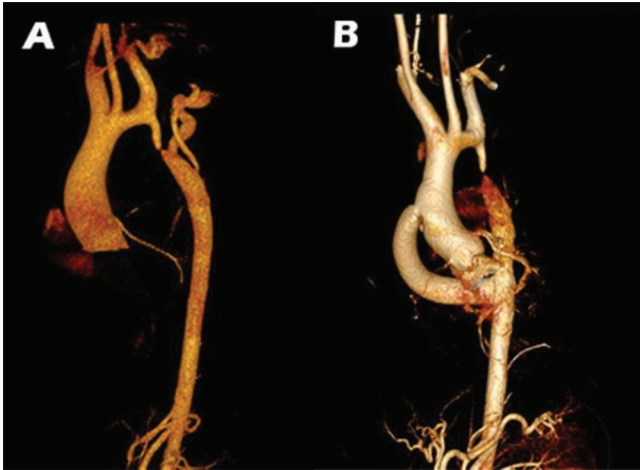


Figure 2: Pre- (A) and postoperative (B) contrasts of CT thorax of patient 2.

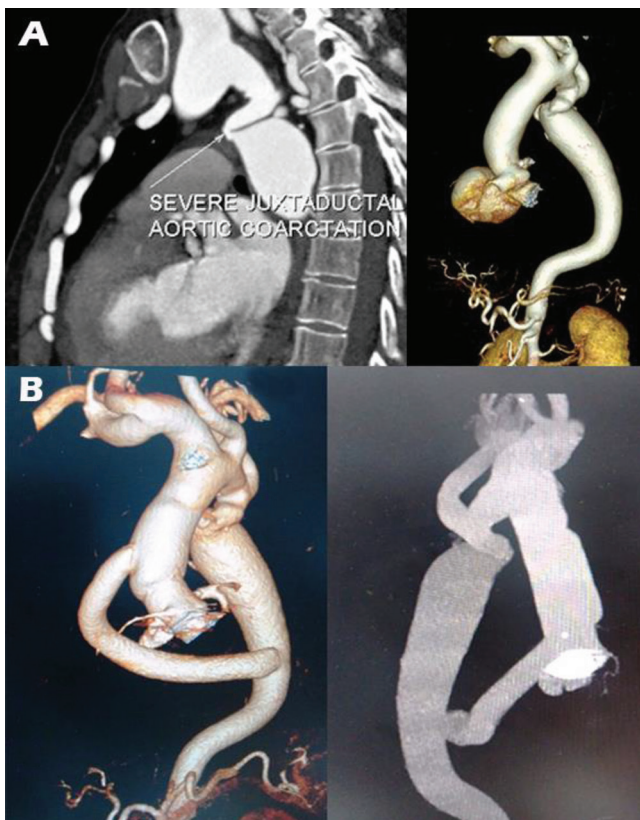


Figure 3: Pre- (A) and postoperative (B) contrasts of CT thorax of patient 3.

right atrium and ascending aorta cannulations, so that distal perfusion was well maintained. The second and third cases were treated with single-stage procedures. We carried out right atrium, ascending aorta annulations, and right femoral artery cannulation, so that distal perfusion was maintained [Figure 4].

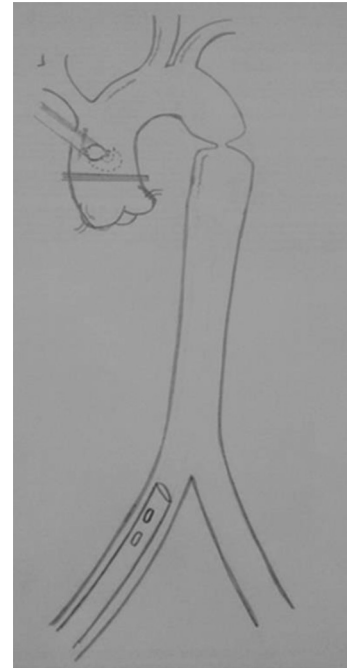


Figure 4: Cannulation strategy.

The second patient underwent double valve replacement, and the third patient underwent aortic valve replacement and repair of noncoronary sinus aneurysm with double velor Dacron patch. In both the patients, after the establishment of cardiopulmonary bypass (CPB) and aortic cross clamp (ACC), the heart was retracted and the postpericardium above the DTA opened. Graft no. 18 mm was anastomozed with DTA (side-biting clamp). The graft was passed behind the inferior vena cava (retrocavally), clamped, and kept in pericardium. After that, cardiac lesions were addressed. Once ACC released and cardiac activity resumed, proximal anastomosis of graft to ascending aorta was done by side-biting clamp. The patients were weaned from CPB and the femoral cannulas removed.

The advantage of this technique is that it decreases the perioperative morbidity. We found this technique was, to some extent, relatively easy, because site of coarctation is not handled directly (especially, adult cases were large collaterals present around the coarctation site). As the perfusion of lower body is maintained, we can deal with cardiac lesions with efficacy.

Result

In patient-1, we planned a staged procedure for this patient. The first stage was an off pump procedure. Although extubation was done after 4 h, we kept the patient in ICU for an observation. During the second stage, the CPB time was 225 min and ACC time 200 min. The blood loss was 500 mL (from both the stages), ventilatory support for 12 h, ICU stay for 3 days, and hospital stay for 8 days.

Table 1: Postoperative course details of all the three patients

	Patient 1		Patient 2	Patient 3
	I	II	I	I
CPB (min)	—	225	270	259
ACC (min)	—	200	215	167
Bleeding (mL)	350	150	700	200
Ventilation (h)	4	12	17	14
ICU stay (days)	4	3	3	3
Postoperative hospital stay (days)	12	8	10	8

CPB, cardiopulmonary bypass; ACC, aortic cross clamp time; ICU, intensive care unit.

Table 2: Pressure (mm Hg) charts of all the three patients

	Patient 1		Patient 2	Patient 3
	I	II	I	I
Preoperative upper limb	170/100		174/94	160/90
Preoperative lower limb	90/50		94/66	88/50
Postoperative upper limb	123/53	120/70	128/72	130/74
Postoperative lower limb	103/47	126/76	130/74	124/72

In patient 2, we planned a single-stage repair for this patient. The CPB time was 270 min, ACC time 215 min (includes 18 min of TCA time), blood loss 700 mL, ventilatory support needed for 17 h, ICU stay for 3 days, and postoperative hospital stay for 10 days.

Patient 3 showed noncoronary sinus aneurysm. The CPB time was 259 min, ACC time 167 min, and blood loss 200 mL. She needed ventilatory support for 14 h. Her ICU stay was for 3 days and hospital stay after surgery for 8 days. The details are summarized in Table 1.

On invasive monitor, there was no gradient between the upper and lower extremities in the postoperative periods [Table 2]. All the patients were discharged from the hospital within 8–9 days.

In patient 1, the postoperative 2D echo showed that fair LV function with Gmean 6.76 mm Hg, coarct segment Gmax 15 mm Hg, and concentric LV hypertrophy. While CT scan showed that ascending aorta graft appeared patent, no e/o anastomotic leak or pseudoaneurysm formation was seen at anastomotic site. LV hypertrophy was present [Figure 1B].

In patient 2, the echo report suggested aortic and mitral prosthesis in situ, Gmax 11 mm Hg at stenosis with left ventricular end-diastolic diameter/left ventricular end-systolic diameter as 52/30 mm and left ventricular ejection fraction as 60%. His CT scan showed that 18-mm Gore-Tex graft from ascending to DTA appeared patent with mild right pleural effusion [Figure 2B].

In patient 3, the postoperative echo study suggested that aortic signal Gmax of 38 mm Hg, LA 36 mm, and mild LV dysfunction. Her follow-up CT scan showed patent PTFE graft from ascending to DTA bypassing the coarcted segment. No residual outpouching of noncoronary sinus aneurysm was seen [Figure 3B].

All the patients were followed up for a period of 3–18 months. At the follow-up, physical examinations and echocardiography revealed patency of the grafts. There were no significant gradients between the extremities, graft-related complications, or reoperations.

Discussion

Coarctation of DTA is generally present in childhood. However, the significant number of patients will present in later stages in life. Liberthson *et al.*^[4] noted that 10% of the patients presented with thoracic coarctation after the age of 40 years. The incidence of other cardiovascular disorders (aortic aneurysm, simple valvular disease, and ischemic heart disease) is as high as 69% in patients surviving more than 20 years.^[5]

Operating on the cardiac defect without addressing the significant coarctation may have led to significant underperfusion of organs distal to the coarctation to leaving left ventricle with severe pressure load because of late hypertension and congestive heart failure.^[6,7] It is the opinion of many authors that simultaneous repair of both the problems would be the only curative procedure.^[8,9] Surgical repair of two pathologies with combined thoracotomy and sternotomy incisions simultaneously in the single-stage procedure could increase postoperative pain, lungs issues, and cosmetic problems.^[9] We have operated two patients by median sternotomy, simultaneously addressing both the problems in single stage.

Arterial cannulation and perfusion of both the ascending aorta and femoral arteries should be used to avoid underperfusion distal to the coarctation [Figure 4]. These maintain blood supply and adequate perfusion pressure in intercostal

arteries. So, spinal cord ischemia and other neurological complications are avoided. We have done anastomosis of graft to DTA with side-biting clamp and have not encountered any complications.

Coarctation when associated with aneurysm, coarctation repair is done first, and 1–5 weeks after the coarctation, the aneurysm repair is done.^[10] This helps in controlling blood pressure, bleeding, and aortic cannulation. Simultaneously, circulation and perfusion pressure distal to coarctation is maintained. In the first patient, we bypassed coarctation segment through left posterior lateral thoracotomy and number 14-mm graft sutured ascending aorta to descending aorta [Figure 1B]. As we were in a learning curve, after 5 days of the procedure, we performed Bental procedure in same patients by median sternotomy. However, we can operate such cases in single stage. In 1980, Vijayanagar *et al.*^[11] described the technique of ascending aorta to descending aorta bypass by placing the graft to the left margin of the heart. Powell *et al.*^[12] described a modification of this technique, which routed the graft around the right margin of the heart to avoid damage to higher vessels and phrenic nerve.

There are two different positions of graft in relation to inferior vena cava.^[13] The antecaval approach avoids the compression of the pulmonary veins and inferior vena cava, which could possibly happen in the retrocaval approach. In contrast, the retrocaval approach helps easy dissection during reoperation. Difficulty in the control of bleeding could arise with the retrocaval approach.^[14] Kinking and stenosis might occur with long grafts.

Conclusion

We conclude that coarctation of the DTA with concomitant cardiac lesions can be safely and efficaciously repaired simultaneously when patients present in adulthood. As shown in previously reported series^[9,12] and in our three patients, a number of various cardiac pathologies may be treated with a single-stage repair. We believe that the best approach, minimizing morbidity and mortality is with median sternotomy only, allowing safe access for the repair of cardiac lesion on cardiopulmonary bypass, with concurrent transpericardial ascending aorta to descending thoracic aortic bypass.

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