IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 18, Issue 5 Ser. 16 (May. 2019), PP 60-65
www.iosrjournals.org

Extra Anatomic Aortic Bypass Graft for Coarctation of Aorta with associated Cardiac Lesion

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***Abstract*:** *Coarctation of the aorta in an adult patient with associated cardiac anomaly often needs extra-anatomic bypass techniques. Among various techniques, the posterior pericardial bypass technique is commonly used,in which a Dacron conduit is anastomosed between the lateral aspect of the ascending aorta or conduit and the descending thoracic aorta posterior to the pericardium. Multiple surgical techniques have been described for the surgical treatment of adult patients with paraductal coarctation of the aorta and associated cardiac anomaly. Multiple options are, staged procedure using left thoracotomy and median sternotomy, correction of coarctation via catheter based technique along with median sternotomy, and single-stage simultaneous repair of lesions via sternotomy. We are reporting six cases of ascending aorta to descending aorta bypass without laparotomy or thoracotomy. This approach helps us to avoid surgical dissection in vicinity to the multiple colleterals and inflamed lesion and left thoracotomy which also causes bleeding from the collaterals, and to allow concomitant cardiac procedures to be performed.*

***Keywords*:** *Extra Anatomic Aortic Bypass Graft, Coarctation, Associated Cardiac Lesion, Dacron Conduit*

Date of Submission: 13-05-2019 Date of acceptance: 30-05-2019

I. Introduction

The coarctation of aorta (CoA) is a congenital disease in which outcomes were appreciably changed if surgical repair done in early childhood [1], showing noticeable improvement in the life expectancy and decreased morbidity of the patients [2]. Along with congenital coarctation, inflammatory diseases like Takayasu's arteritis are another main cause of aortic stenosis [3]. For correction of coarctation multiple surgical approaches have been described, but there are limited implication of these techniques [2].The surgical repair of coarctation in adults is challenging, as there are chances of heavy bleeding from large frailed significant colleterals and associated comorbid conditions such as hypertension and calcification present around the aortic wall [4], and other associated heart lesion such as aortic valve stenosis or regurgitation with dialated aortic root, atrial septal defect,patent ductus, ventricular septal defect etc [5]. There is significant high risk of developing paraplegia if surgery performed in adolescents, adults and also in recoarctations cases [6], especially where the collaterals poorly developed. The use of extracorporeal circulation (CPB) used during coarctation repair helps to maintain spinal cord perfusion during aortic clamping [7]. Thus, this study aims to describe our experience with the surgical correction of coarctation of aorta, along with addressing the concomitant cardiac anomaly in adult patients using extracorporeal circulatory assistance thus avoiding risk of paraplegia.

II. Background

With passage of time and improvement in surgical skills, multiple surgical techniques have been used for repair of coarctation of the aorta. The choice of procedure has been influenced, on one hand, by the trend at the time of presentation and on the other hand, by the presence of associated cardiac anomalies [8].Resection and end-to-end anastomosis – first developed by Gross et al., which is still widely used .In this procedure aortic arch and descending thorasic aorta mobilized and proximal and distal vascular clamps has been placed, and complete excision of narrowed portion of isthmus and coarctation part of aorta. Subclavian flap angioplasty – also known as the Waldhausen[4] procedure when subclavian artery is affected. Prosthetic patch aortoplasty – this technique was first used by Vosschulte[5] in 1957 and decribes the use of a prosthetic patch to enlarge the site of coarctation. Omeje et al first describe the extended resection and end-to-end anastomosis, technique in 1977[8]. Coarctation of the aorta in adulthood associated with other cardiovascular anomalies can be addressed on simultaneously via an extra anatomic bypass grafting technique with low morbidity and mortality [9]. The use of bypass graft for single-staged repair of coarctation of aorta along with treatment of a coexisting cardiac disorder is feasible, because the bypass graft between the aortic arch and descending aorta follows the route of the native aorta.[10]

III. Methods

We have taken six patients of coarctation of aorta with coexistent cardiac disorder from April 2014 to November 2018 via single staged approach. The age group was between 19 to 45 years. Out of six patients, four were men and two women. We retrospectively analyse the data of our patients and found six patients diagnosed with postductal aortic coarctation accompanied by a congenital or an acquired heart disease requiring repair, and underwent a single stage procedure through a median sternotomy. All of the patients underwent an extra-anatomic bypass from the ascending to descending aorta. All patients were evaluated by repeated 2-D Echo and cardiac CT Angiography. All 6 patients presented with systemic arterial hypertension and had used at least 1 antihypertensive medication. The coexistent cardiac disorders were severe mitral aortic stenosis in 4 patients and aneurysm of the ascending aorta with severe aortic regurgitation in 2 patients (55 and 50 mm in diameter). The last one patient also presented with severe aortic valve regurgitation, bicuspid aortic valve with moderate LV systolic dysfunction EF 35-40% and root dilation with small VSD. The below table 1 shows patient details with the procedure performed.

TABLE 1: Patient particulars- diagnosis and simultaneous procedure performed with ascending to descending Aortic Bypass Grafting

S.No.	Age in years	Sex	Diagnosis	Simultaneous Procedure Performed
1.	19	Male	Recurrent coarct with Aortic Stenosis (AS)	Aortic Valve Replacement (AVR)
2.	45	Male	Ascending Aortic Aneurysm with severe AR with small VSD	Bentall Procedure
3.	32	Female	Coarctation with AS	AVR
4.	35	Male	Coarctation with AS	AVR
5.	45	Male	Coarctation with AS	AVR
6.	23	Female	Coarctation with AS	AVR

Now, we have discussed below figure 1 with preoperative computed tomographic scan.

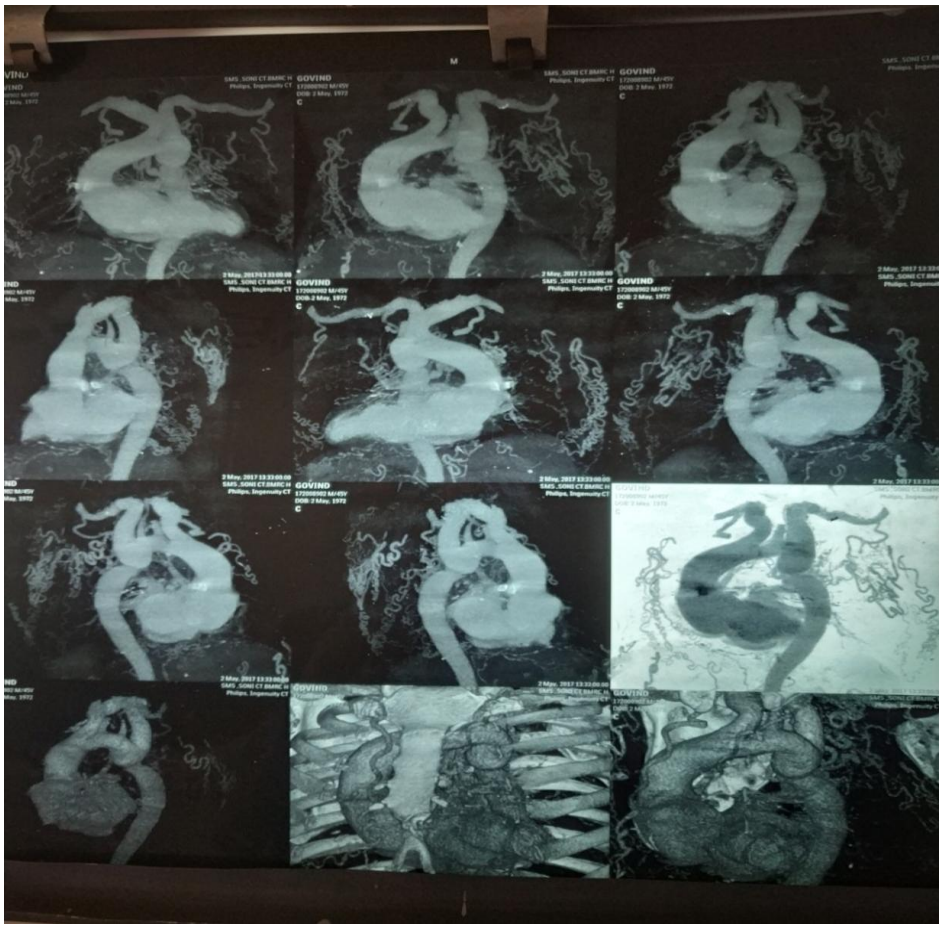

Fig 1. Preoperative computed tomographic scan shows aortic coarctation distal to the left subclavian artery in a patient with coexisting aneurysm of the ascending aorta.

3.1. Operative Technique

The surgical approach in all cases was by median sternotomy. Invasive monitoring was performed for following arterial pressures of both upper extremities via radial artery and one of the femoral arteries for lower extremities. SVC cannulation through right atrium we established cardiopulmonary bypass (CPB) through the right femoral artery artery, aided by 2-staged venous cannulation via IVC. Cardiac arrest was achieved in all cases with antegrade administration of blood cardioplegic solution. Prior to cross clamping the heart was retracted superiorly and the posterior pericardium was incised longitudinally exposing the descending thoracic aorta parallel to the phrenic nerve meticulously. Ryle's tube helped in identification of esophagus from possible injuries that may occur during the posterior pericardial dissections. The dacron tube grafts were anastomosed to the descending thoracic aorta in end-to-side fashion with the use of a side biting clamp. The graft was then clamped, de-aired carefully and positioned towards the ascending aorta for the proximal anastomosis. Now aorta was coss clamped and cardioplegia given. Then Bentall's procedure was performed and VSD closure was done. Proximal part of the graft was anastomosed to the ascending conduit of aorta. Then weaning from CPB was done. The below figure 2 provide us the view of ascending to descending aortic grafting along with Bentall procedure.

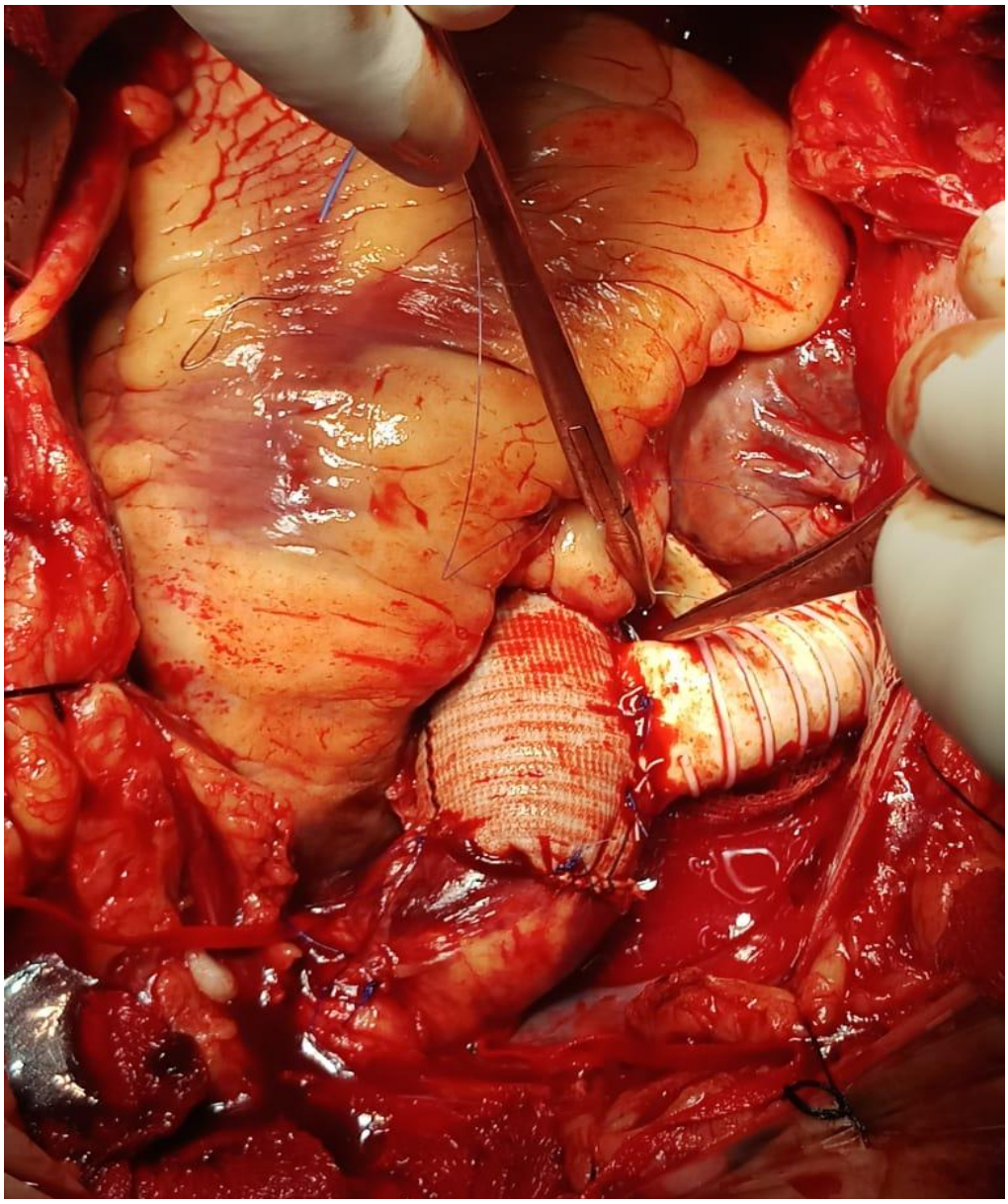

Fig 2. Intra-op image showing aortic bypass grafting from Ascending aortic conduit(Bentall) to distal descending aorta.

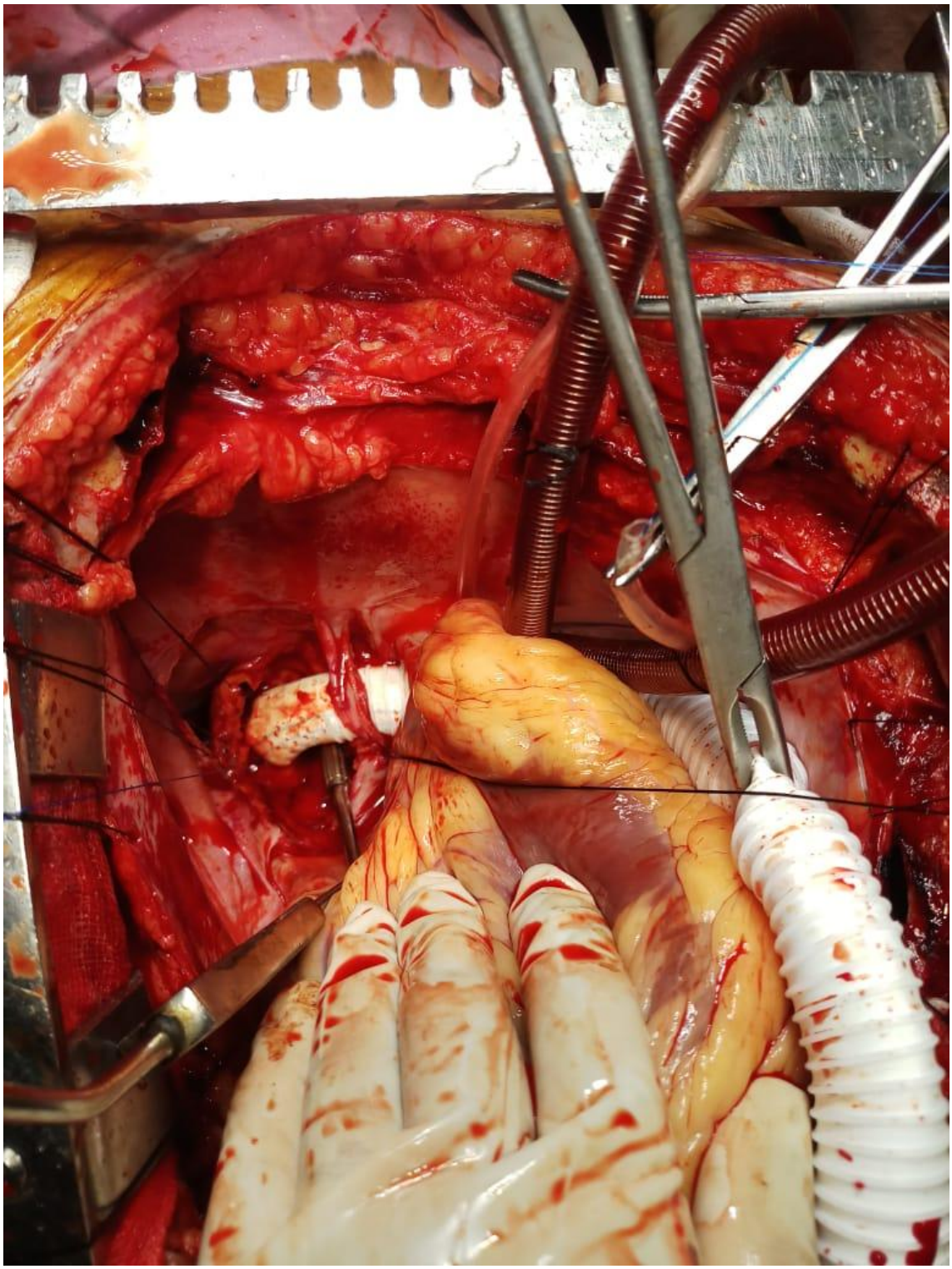

Fig.3 Intra-op image showing posterior pericardial reflection, bypass graft anastamosed to descending aorta.

Diagrammatic presentation showing Bentall procedure has been done along with Ascending to Descending Aortic bypass grafting. Proximal grafting is done with ascending aortic conduit and distal grafting is done at descending thoracic aorta bypassing the coarctation part of aorta.

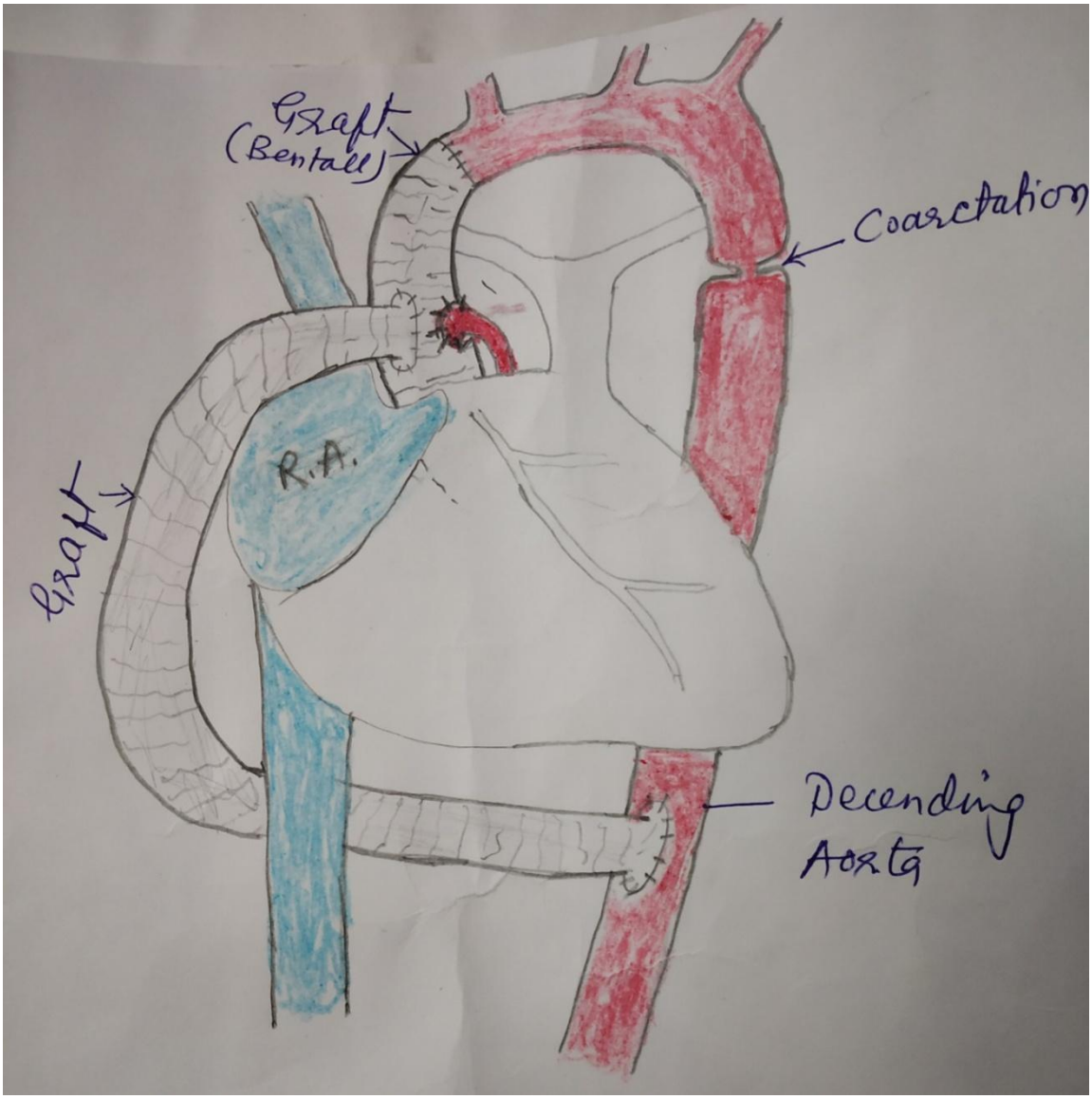

Fig 4: Image showing Bentall procedure with Ascending (conduit) to Descending Aortic Bypass Grafting

IV. Results and Discussion

In our study, there were 6 cases of coarctation with associate heart anomaly. Out of 6 patients, there were two early post-op mortality related to reduced ejection fraction of heart. In the remaining four patients, no procedure related morbidity was seen for surgical repair of coarctation using graft from ascending to descending aorta. Furthermore, intra-operative aortic gradient was measured in all patients via radial and femoral arteries. As a result, no residual gradient was noted. Also, none of them had undergone re-exploration for bleeding. There were no incidence of post op paraplegia and had no neurological findings. In addition, there was no esophageal injury and had no chylothorax. The average stay in ICU WAS 48±4 hrs and the mean hospital stay were 10±2 days. Moreover, follow-up was done in all 4 patients; the mean period follow-up was 5years±9 months. Serial follow-up was done by 2D Echo and CT scan for the patency of graft and function of prosthetic valve. However, there was no finding suggestive of graft stenosis, thrombosis and aneurysm formation. Long with it, serial BP measurement was also done during follow-up. Pre-op BP in right & left upper limb was 180/72 mmHg and during hospital stay was 146/80 mmHg and 132/72mmHg on single antihypertensive during successive examination.

This procedure provides opportunity to address both cardiac anomaly and co-arctation of aorta via a single incision, avoiding laparotomy and thoracotomy. This approach avoids risk of bleeding from collaterals present around the coarctation part of aorta and in the thorasic wall. It also avoids the risk of paraplegia. Therefore this procedure can be performed in selected patients with low morbidity and mortality, however, selection of patients for this surgical procedure should be individualized.

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