Mid-Term Outcomes of Repair of Coarctation of Aorta With Hypoplastic Arch: Extended End-to-side Anastomosis Technique

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The optimal surgical repair technique for coarctation associated with aortic arch hypoplasia (CoA-AAH) in neonates and infants is controversial. This study evaluates our current strategy using extended end-to-side anastomosis under selective cerebral and myocardial perfusion in treating this group of patients. Through a retrospective review, we analyzed the outcome of 87 infants who underwent surgical repair of CoA-AAH from January 2004 to December 2015. Patients with functional single ventricle were excluded. There were no early mortalities, and 4 patients (4.6%) experienced early complications. Eighty-five patients (97.7%) were followed up during a mean duration of 6.1 ± 3.53 years. There were 2 late mortalities (2.3%) and 3 reintervention (3.5%) of the aortic arch. Ten-year overall survival and freedom from reintervention for the entire cohort was 97.7% and 96.3%, respectively. At last follow-up, 4 patients (4.5%) showed a peak velocity greater than 2.5 m/s across the repair site. Seven patients (8.2%) were hypertensive. Our strategy with extended end-to-side anastomosis under selective cerebral and myocardial perfusion is safe and effective for repairing CoA-AAH in neonates and infants. Concomitant repair of associated cardiac anomalies can be done without added risk. Mid-term results are excellent with low rates of mortality, reintervention, and late hypertension.

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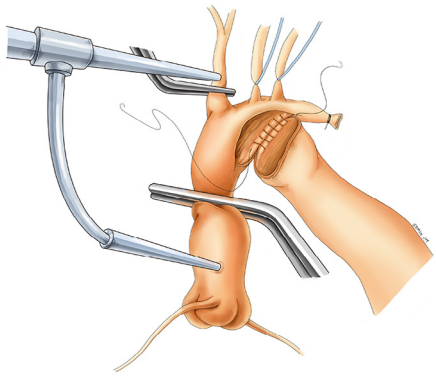

Illustration of coarctation repair with extended end-to-side anastomosis technique.

Central Message

Extended end-to-side anastomosis is a safe and effective surgical technique for the repair of neonatal and infantile coarctation associated with aortic arch hypoplasia.

Perspective Statement

Neonatal and infantile coarctation associated with aortic arch hypoplasia presents significant challenges to surgeons, and there is still no consensus about the ideal surgical repair technique. Our experience with extended end-to-side anastomosis technique demonstrates excellent mid-term result with low rates of mortality, restenosis, reintervention, and late hypertension.

INTRODUCTION

Since the first report on the surgical repair of coarctation in 1945,[1] surgical management of this congenital anomaly has significantly improved. Neonatal and infantile coarctation associated with aortic arch hypoplasia (CoA-AAH), however, still presents significant challenges to the surgeon as these patients are more prone to recurrent stenosis after repair.[2] Although the general agreement is to achieve complete relief of arch obstruction to prevent recoarctation, there is still no consensus about the ideal surgical repair technique. Furthermore, AAH is often combined with intracardiac anomalies.[3] The relative benefits of 1-stage repair are still debatable, and many centers prefer a staged approach for concurrent intracardiac anomalies.[4] More recently, conflicting studies have been reported on the relation between aortic arch geometry and late hypertension.[5,6]

Since 2004, our institute has adopted the extended end-to-side anastomosis (EESA) technique under selective cerebral and

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myocardial perfusion (SCMP) through a median sternotomy for all neonates and infants with CoA-AAH. In case of concurrent cardiac anomaly, 1-stage repair approach was taken. In this study, we review our overall experience with this strategy, with a special focus on mid-term outcomes and geometry of the arch.

MATERIALS AND METHODS

Study Population

Through a retrospective review of the Seoul National University Children's Hospital surgical database, we identified infants less than 1 year of age who underwent surgical repair of CoA-AAH from January 1, 2004 to December 31, 2015. The diagnosis of AAH was made according to the criteria set by Moulaert and colleagues.[7] The proximal transverse arch was considered hypoplastic when the external diameter was 60% or less of that of the ascending aorta. The limit was 50% or less for the distal transverse arch and 40% or less for the aortic isthmus. Patients with single ventricle physiology were excluded from this cohort.

All patients were treated by a single surgeon using an EESA technique under SCMP.[8] Along with the repair of CoA-AAH, concurrent repair of associated cardiac anomalies was done in 1 stage. Perioperative data including patient demographics, echocardiograms, operative notes, perioperative hemodynamics, and associated morbidity and mortality, were collected. Postoperative echocardiogram evaluations were performed just before discharge. After discharge, all patients were regularly studied by Doppler echocardiograms and blood pressure measurements. If possible, blood pressures from all 4 limbs were also measured to monitor for pressure gradients between the right arm and a lower extremity. Significant findings were defined as (1) 20 mm Hg or greater blood pressure gradient between the right arm and a leg, or (2) 2.5 m/s or higher estimated peak velocity across the anastomosis site was found on echocardiogram. If recurrent stenosis was suspected, computed tomography (CT) or cardiac catheterization was performed to evaluate the degree of stenosis. Reintervention was considered when patients showed (1) symptoms such as significantly lower leg blood pressure, (2) persistently high (> 3.0 m/s) or consistently increasing pressure gradient on echocardiography, or (3) significant stenotic lesions on CT. The reintervention method was decided through the discussion of a multidisciplinary discussion.

Surgical Technique

After median sternotomy, atrial cannula is inserted at the innominate artery (Fig. 1). Whenever possible, bicaval cannulation is used for effective venous drainage and rapid patient temperature control. Under cardiopulmonary bypass, the descending thoracic aorta and arch vessels are extensively dissected and fully mobilized. After cooling the patient to 28°C, an additional small cannula is inserted at the aortic root for myocardial perfusion. The technique of SCMP has been described by us previously.[8] With the initiation of SCMP, the proximal part of the ascending aorta and innominate artery is clamped, and the arch vessels are snared down. After dividing the isthmus and proximal descending aorta, all ductal tissue is excised including the ductus arteriosus. A longitudinal incision is made at the lesser curvature of the aortic arch. The proximal descending aorta is slightly beveled, and an end-to-side anastomosis is made as proximal as possible to bypass the isthmus and most of the hypoplastic arch. The whole procedure is done under a beating heart while maintaining coronary and brain perfusion. After anastomosis, all clamps and snares are removed, and cardiopulmonary bypass is increased to full support. If the patient has an associated intracardiac anomaly, the myocardial perfusion cannula is used to deliver cardioplegia and stop the heart.

Aortic Arch Geometry and Systemic Blood Pressure Analysis

Blood pressures were adjusted into percentiles based on age and height percentile.[9,10] As there is no reference of South Korean population at this time, we used the data from the National Institutes of Health of America and World Health Organization. Patients were considered hypertensive if either systolic or diastolic blood pressure percentile (BPP) was above the 95th percentile for age and height.

If postoperative CT was available, the repaired arches were classified as a roman, crenel, or gothic shape based on the images (Fig. 2). The height and width of the arch was measured from the

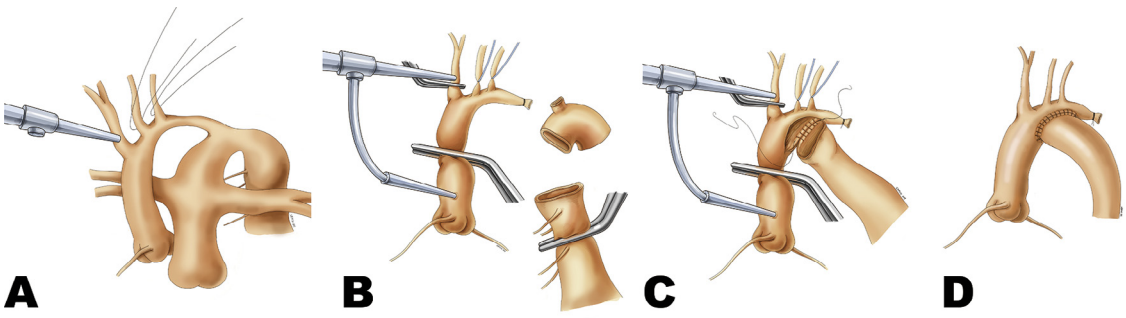

Figure 1. (A) An atrial cannula is inserted at the innominate artery to maintain cardiopulmonary bypass during extensive dissection. (B) An additional cannula is inserted at the aortic root, and all ductal tissue is excised under selective cerebral and myocardial perfusion. (C) A longitudinal incision and anastomosis is made at the lesser curvature of the proximal aortic arch. (D) Completion of the end-to-side anastomosis technique for aortic arch repair. (Color version of figure is available online.)