Aortic Root Reimplantation in a Patient Who Underwent an Arterial Switch Operation

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Neo-aortic insufficiency associated with root enlargement following an arterial switch operation is a serious late complication. To achieve successful surgical correction of this condition, multiple factors should be considered, including the individual patient’s anatomy, the challenging nature of the redo procedure, and the patient’s young age. However, limited publications have described the use of valve-sparing techniques for the treatment of neo-aortic insufficiency associated with root enlargement following an arterial switch operation. Herein, we report our recent experience of a valve-sparing aortic root procedure with ascending aorta and hemiarch replacement despite the presence of a discrepancy in leaflet size and nearby severe adhesions.


Case report

A 17-year-old male patient presented with severe aortic insufficiency associated with aortic root aneurysm. Seventeen years previously, the patient underwent an arterial switch operation (ASO), ventricular septal defect (VSD) closure, and side-to-end anastomosis of the distal aorta at 32 days after birth for the treatment of Taussig-Bing anomaly, subpulmonary VSD, and juxtaductal coarctation of the aorta. At the age of 9 years, the patient underwent an additional Nuss operation to treat pectus excavatum. At that time, a computed tomography (CT) scan showed neo-aortic root dilatation (34.4 mm) and mild-to-moderate aortic insufficiency was observed on echocardiography. On a follow-up CT examination performed at the age of 16 years, the neo-aortic root was further dilated to a maximal diameter of 55.1 mm (Fig. 1A). At the current evaluation, follow-up echocardiography showed severe aortic insufficiency and an enlarged aortic root with a maximal diameter of 54 mm (Fig. 1B). Therefore, an elective operation was planned. On the preoperative CT images, the coronary anatomy was Yacoub type A [1]; the left coronary artery originated from the left coronary sinus and the right coronary artery from the right sinus (1LCx; 2R), and the left coronary artery traveled behind the neo-aortic root, heading between the roots of the neo-aorta and the neo-pulmonary artery (Fig. 2).

As the aortic valve leaflets seemed amendable, the use of a valve-sparing root reimplantation technique was planned. Intraoperatively, the great arteries were located side-by-side and the neo-aortic root was se-
verely enlarged. After the redo sternotomy, cardiopulmonary bypass (CPB) was established through cannulation at the ascending aorta and right atrial appendage, and then the patient was cooled to the target nasopharyngeal temperature of 25°C. After aortic cross-clamping, antegrade del Nido cardioplegia was directly delivered through the coronary ostia (650 mL via the left main ostium and 350 mL via the right coronary ostium). During cooling the root procedure was performed, which included dissection of soft tissue around the aortic root down to the annulus level, resection of the aneurysmal root tissue, and trimming of the commissural parts and coronary ostia. The left coronary ostium was significantly small. At the nasopharyngeal temperature of 25°C, aortic clamping was released, the ascending aorta was further resected up to the proximal aorta, and then distal anastomosis of the aorta was performed with the use of a 24-mm Hemashield graft (Boston Scientific Corp., Natick, MA, USA) under total circulatory arrest. Then, full CPB was reestablished with a side arm of the graft, which was followed by root reimplantation with a 28-mm Hemashield tube graft (Boston Scientific Corp.). Six basal sutures were made using non-pledgetted 2-0 Ethibond (Ethicon, Cincinnati, OH, USA) thread, and 3-0 Prolene was used for the main hemostatic sutures. Plication sutures on the free edges of the non-coronary and right-coronary cusps were added to improve coaptation, and 2 coronary buttons were implanted into the graft (Fig. 3). The total circulatory arrest, cardiac ischemia, and CPB times were 11 minutes, 166 minutes, and 188 minutes, respectively.

Intraoperative transesophageal echocardiography showed no residual aortic insufficiency, with fair ventricular function. The patient was weaned from CPB with low-dose inotropic support. The immediate postoperative vital signs were stable and consciousness was restored 2 hours after the operation. Gradual increments of the serum lactate level and several intermittent episodes of non-sustained ventricular tachycardia, however, were observed starting...
Fig. 3. Intraoperative photographs of coronary re-implantation. (A) Left main coronary arterial reimplantation was performed (yellow arrow) before right coronary artery (yellow star) anastomosis. (B) A schematic illustration shows the course of the left coronary artery around the aortic root.

3 hours after surgery. The serum troponin-I level checked at postoperative 6 hours was markedly elevated compared to the immediate postoperative value. Transthoracic echocardiography was conducted immediately and revealed a regional wall motion abnormality in the left anterior descending artery territory. An emergent re-operation was performed under the suspicion of left coronary ostium stenosis. Immediate coronary arterial bypass surgery involving greater saphenous vein grafting to the left main coronary artery was undertaken. Central extracorporeal membrane oxygenation (ECMO) was applied to reduce the cardiac workload and to maintain coronary blood flow. As the cause of perioperative ischemia was uncertain intraoperatively, postoperative coronary angiography was conducted, and showed stenosis of the proximal left coronary artery (70%) but with fluent filling in the distal part (Fig. 4). We extrapolated from these results that the proximal left anterior descending artery wall behind the aortic annulus was wrinkled by the posterior basal stitch of the root reimplantation, which resulted in luminal stenosis of the proximal left anterior descending artery. No further intervention, however, was planned considering the adequate and rapid filling of the left anterior descending artery distal from the stenotic point. The patient’s cardiac function was restored without further interventions, and accordingly, the patient was weaned from ECMO successfully on the fifth postoperative day and discharged from the hospital following treatment for heart failure. On the latest echocardiographic examination, which was performed 8 months after surgery, there was mild central aortic insufficiency and the left ventricular ejection fraction was restored to 29%, with markedly improved subjective symptoms (New York Heart Association grade I).

Fig. 4. Postoperative coronary angiography demonstrated luminal stenosis of the proximal left anterior descending artery (arrow), which was suspected to have been pressed by the basal stitch during root reimplantation.

Discussion

ASO has become the surgical procedure of choice for repair of dextroposition of the great arteries (d-TGA) without significant stenosis in the left or right ventricular outflow tract since its first successful use by Jatene and his colleagues in 1975 [2,3]. Although clinically significant neo-aortic insufficiency associated with root enlargement following ASO is known to be relatively uncommon, it is a serious late complication that requires surgical correction when it shows a progressive course [4,5]. However, the majority of patients who require reoperation after ASO are young, and the Bentall procedure requires lifelong anticoagulation. For this reason, valve-sparing root replacement procedures may be more desirable...
if feasible [6]. However, a limited number of cases have reported employing valve-sparing techniques for the treatment of neo-aortic insufficiency associated with root enlargement following ASO. This may be attributable to the challenging nature of the procedure in redo cases requiring complex reimplantation procedures in the presence of adhesion around the aortic root. These cases are even more challenging because of the need to manipulate the previously reconstituted coronary ostia and adjust the discrepant aortic valve cusps. In the present case, the well-preserved valve cusps, without tearing or calcifications, allowed a valve-sparing procedure to be performed despite the presence of a discrepancy in leaflet size, and valve-sparing reimplantation with additional cusp plication sutures was performed to correct the neo-aortic insufficiency.

In patients with anomalous origin of the coronary artery, a full understanding of the coronary courses is a prerequisite for achieving a successful outcome. In the present case, the left anterior descending artery originated from the left main stem behind the aortic annulus and tightly ran along the annulus in its proximal segment. Basal sutures during root reimplantation seemed to damage this segment, which caused external left anterior descending artery stenosis. The coronary event that occurred in the present case underscores the importance of paying particularly careful attention and having a thorough understanding of coronary anatomy when performing root reimplantation surgery in patients who have undergone ASO.

In conclusion, we report a case of valve-sparing neo-aortic root reimplantation in a patient who underwent ASO due to d-TGA, in whom the clinical course was complicated by coronary artery stenosis. Although root reimplantation seems feasible in such cases, meticulous attention should be paid to the coronary anatomy to prevent potential coronary injury during the root reimplantation procedure.

**Conflict of interest**

No potential conflict of interest relevant to this article was reported.

**References**