Title: Total Root Remodeling by Sleeve Technique for Aortic Regurgitation in Repaired Tetralogy of Fallot

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Abstract

We report a 15-year-old patient who developed aortic regurgitation (AR) primarily because of annulus dilatation late after definitive repair of Tetralogy of Fallot. Valsalva sinus dilatation was not remarkable enough for root replacement. For the purpose of total root remodeling, the Sleeve procedure was employed. This procedure not only reduced root diameters but also augmented commissure heights. With concomitant non-coronary cusp plication, AR was effectively controlled. As an alternative to root replacement, Sleeve may be a preferable postoperative option for patients with congenital heart disease who develop AR because of dilatation of the annulus or sino-tubular junction without significant dilatation of the sinus of Valsalva.

Introduction

The strategy of valve sparing aortic repair for aortic regurgitation (AR) in patients without severe root dilatation is controversial. We report total root remodeling by Sleeve procedure[1] in a young severe AR patient with severe annular dilatation but not severe sinus of Valsalva dilatation late after definitive repair of Tetralogy of Fallot (TOF).[2]

Case report

A 15-year-old male (height 168 cm, weight 47 kg, body surface area 1.5 m^2) had undergone one-stage repair of TOF at the age of 3 years. AR gradually worsened to severe, and the patient was referred to our hospital for surgery. Preoperative transthoracic echocardiography (TTE) showed leaflet malcoaptation and aortic root dilatation. Left ventricular end-diastolic and end-systolic diameters were 61 mm and 38 mm, respectively. As shown in Table 1 and Figure 1 (upper panel), the aortic annulus was severely dilated, but dilatation of the sinus of Valsalva and the sino-tubular junction (STJ) remained less than severe. Thus, the mechanism of AR was the outward tethering of cusps due to dilatation of the aortic root, mainly associated with annular dilatation. During surgery (Video 1), the aortic root and the area around the origin of both coronary arteries were carefully dissected. In total, eight mattress 4-0 sutures were placed at the level of the ventriculo-aortic junction in a circular fashion. Subsequently, a 28-mm artificial Valsalva sinus graft (Japan Life Line, Chiba, Japan) was placed using the Sleeve technique[1] to plicate the annulus by the bottom end of the graft. At the top end of the graft, the dissected native STJ end was sutured while slightly lifting the commissures up and letting the sinuses down in order to increase the commissure height and keep the coaptation point in the proper position. Central plication with three simple stiches was added at the non-coronary cusp to increase its effective height (Video 1). Cardiac arrest time was 116 minutes. Postoperative AR was traced by intraoperative trans-esophageal echocardiography (Video 2). As shown in Table 1 and Figure 1 (lower panel), the root was reshaped, and the effective heights in all three cusps were increased with sufficient coaptation. All three commissure heights increased post-operatively: The average commissure height was 18.6±1.2 mm before surgery, and 20.3±1.0 mm after surgery. The patient was discharged to home uneventfully on the thirteenth day after operation. TTE at 18 months after surgery showed mild AR. Both ventricular end-diastolic and end-systolic diameters were reduced (48 and 33 mm, respectively).

Comment

In terms of valve-sparing repair, the David or Yacoub procedures are highly established strategies. However, indication of root replacement for the patients with mild or moderate root dilatation is controversial. In contrast to the remarkable aortic annulus dilatation in the present case, the Valsalva sinus was not severely dilated enough to be resected. Therefore, the Sleeve procedure, which spares the Valsalva sinus and enables annuloplasty, STJ plasty and the prevention of ongoing root dilatation, was employed. Out of several annular stabilization techniques, such as external suture or band annuloplasty[3] and internal ring annuloplasty, we selected the Sleeve method in the present case for the purpose of remodeling the entire root, including the annulus. In the Sleeve procedure, reconnection of the coronary arteries is not required, and the suture lines are considerably shorter than those in root replacement, which should reduce aortic cross-clamp time and perioperative bleeding. Interestingly, commissure heights in this case were increased post-operatively. This may have resulted from the previously noted suture line at STJ or the longitudinal stretch of the inter-leaflet triangle caused by radial compression of the sinus of Valsalva by the graft. Increased commissure height contributes to maintaining a sufficient coaptation surface and to avoiding iatrogenic cusp prolapse induced by downsizing of the aortic root diameter. Long-term prognosis of the residual aortic regurgitation after the Sleeve procedure has not been fully understood, and close follow-up is necessary.

A certain subset of congenital heart diseases that exhibits ongoing dilatation of the aortic root resulting in AR has been reported.[4] For such patients with less than severe Valsalva sinus dilatation, the Sleeve procedure can be an effective option.

Figure legend

Figure 1 Pre- and post-operative multi-planar reconstruction image of each cusp by computed tomography at late diastole

The arrows indicate the effective heights. The horizontal lines correspond to the basal ring.

EH: effective height, GH: geometric height

Video legends

Video 1: Intra-operative video

Video 2: Echocardiograms and cardiac computed tomographies (3D images) before and after surgery

Table 1 Aortic root configurations before and after surgery

	Pre-operation	Post-operation
Aortic annulus, mm	38.3	27.6
Sinus of Valsalva, mm	41.0	28.1
Sino-tubular junction, mm	31.8	23.7

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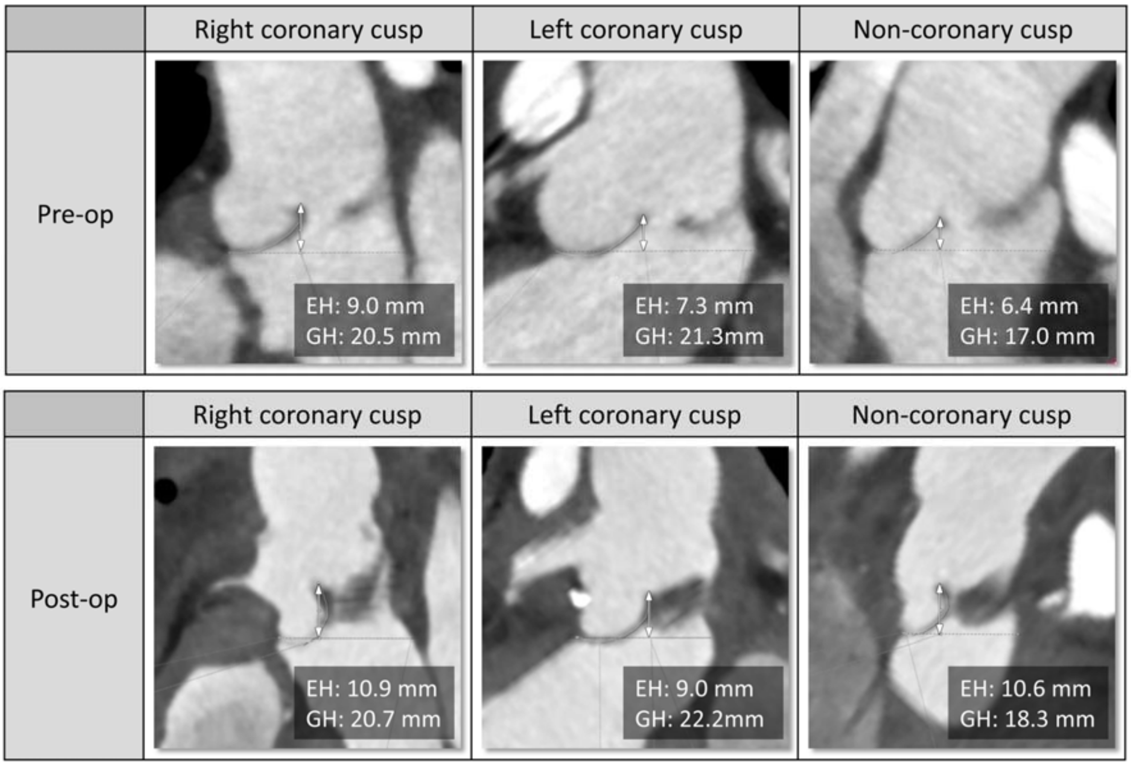
Figure 1



Right coronary cusp
Left coronary cusp
Non-coronary cusp
Pre-op
EH: 9.0 mm
GH: 20.5 mm
EH: 7.3 mm
GH: 21.3mm
EH: 6.4 mm
GH: 17.0 mm
Right coronary cusp
Left coronary cusp
Non-coronary cusp
Post-op
EH: 10.9 mm
GH: 20.7 mm
EH: 9.0 mm
GH: 22.2mm
EH: 10.6 mm
GH: 18.3 mm