Early and Medium Term Results of the Sleeve Valve-Sparing Procedure for Aortic Root Ectasia

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Background. **The aim of this retrospective study was to evaluate our experience of using a simplified aortic valve sleeve procedure to treat aortic root ectasia and aneurysms with or without aortic regurgitation. In experienced hands, 2 aortic valve-sparing procedures, ie, Yacoub and David, have yielded excellent long-term results in the treatment of aortic root aneurysms, with or without aortic regurgitation. However, these techniques are demanding and not widely used. Recently, a new and simplified valve-sparing technique, named "sleeve procedure," has been proposed, and has yielded encouraging early results.**

Methods. **Ninety consecutive patients with aortic root aneurysms underwent sleeve procedures from October 2006 to October 2012. Follow-up data (clinical 100% complete and echocardiographic 93% complete) were acquired from our outpatient clinic or from the referring cardiologist.**

Results. **The mean age of the patients was 61.5 ± 12.5 years, 79% were male, 16 (18%) had a bicuspid valve, 3 had Marfan syndrome, and 2 had aortic dissection. Over a mean clinical follow-up of 34 ± 19 months, 2 patients died from noncardiac causes and 1 was reoperated on for the recurrence of aortic regurgitation. On follow-up echocardiography after a mean of 18 ± 9 months, aortic regurgitation was absent/negligible, mild or moderate in 62%, 37%, and 1% of patients, respectively, and the diameters of the annulus, Valsalva sinuses, and sinotubular junction were 27.3 + 2.2, 37.0 + 3.4, and 30.6 + 3.1 mm, respectively.**

Conclusions. **Our encouraging early and medium term results suggest that the sleeve procedure is a safe and effective aortic valve-sparing technique for the treatment of aortic root ectasia and aneurysm. However, longer follow-up is needed in order to draw definitive conclusions.**

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In the last 3 decades, aortic root aneurysms, with or without aortic regurgitation (AR), have been treated by means of so-called "valve-sparing procedures" [1, 2]; with these techniques the diseased aortic wall is resected and the aortic valve leaflets are spared. When type-I AR is associated, which is usually caused by the outward displacement of the valve commissures, excellent long-term results may be achieved by normalizing the ratio between the aortic annulus and sinotubular junction (STJ) [1–5]. The 2 techniques most often used are the remodeling (or Yacoub) and the reimplantation (or David) procedures, both of which require aortic root wall resection and coronary ostia reimplantation on a Dacron (DuPont, Wilmington, DE) tube graft. The Yacoub technique seems more physiologic [6] and is indicated when the aortic annulus diameter is normal and is expected to remain stable over time, such as in degenerative disease. By contrast, the David technique is thought to be indicated when the ventricular aortic-junction (VAJ) is dilated and in patients with genetic tissue disorders (such as Marfan or Ehlers-Danlos syndrome, etc) because it secures and stabilizes the VAJ over time [2]. Both operations are reproducible, though technically demanding and time-consuming. Recently, Hess and colleagues [7] described a simplified sparing procedure in which the sinuses of Valsalva are not removed but sheathed in a Dacron graft tailored as a "sleeve." This technique allows for the reduction and stabilization of the entire aortic root unit, leaving the coronary artery ostia intact, and has yielded encouraging medium term results.

In 2006 our group started to treat aortic root disease by means of a sparing procedure similar to that described by Hess and colleagues, but simplified [8]. We undertook the present study to analyze early and medium term results of our sleeve procedure to correct aortic root aneurysm, with or without AR.

Patients and Methods

From October 2006 to October 2012, 90 consecutive patients with aortic root ectasia or aneurysm, with and without AR, underwent the sleeve procedure at the Ospedali Riuniti in Bergamo, Italy (44 cases) and at the

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Ospedale A. Manzoni in Lecco, Italy (46 cases). Institutional Review Board approval was obtained for the retrospective review of the records. The sleeve procedure was performed in all patients with an aortic root diameter 50 mm or greater (or $\geq$ 45 mm if associated with an ascending aorta aneurysm), with or without AR.

For the purpose of the present study, we selected patients who had undergone surgery at least 12 months before the closing date (October 31, 2013). A final telephone follow-up interview was conducted within 1 month after this date.

Surgical Technique

All patients were operated on through a median sternotomy, under extracorporeal circulation and mild hypothermia (34°C). Cardiac arrest was obtained by inducing normothermic continuous retrograde blood cardioplegia. After aortic cross-clamping, the aorta was completely transected 1 cm above the STJ. The aortic root unit was then prepared by dissecting the surrounding tissues underneath the VAJ. Both coronary stems were left attached to the aortic wall and were partially mobilized to allow access to the VAJ. The surrounding tissue dissection was deep, especially when the VAJ was dilated and its diameter needed to be reduced. The grafts used were the Gelweave Valsalva (Vascutek, Renfrewshire, Scotland) and the CARDIOROOT (Maquet Group, Wayne, NJ). The appropriate graft size was determined by taking into consideration the degree of aortic incompetence and STJ and VAJ diameters (measured by Hegar dilator; Jarit Instruments, Hawthorne, NY). In principle, when dilatation involves the sinuses of Valsalva and the STJ while the VAJ is normal or close to normal, the aim is to normalize the STJ. The size chosen is therefore between 28 and 32 mm, according to the size of the patient, the degree of AR, and the dilatation of the Valsalva sinuses. When VAJ dilatation is present (we consider the VAJ to be dilated when it is $\geq$ 28 mm) the aim is to reduce its diameter. In such cases the graft primarily chosen is 28 mm, unless the sinuses of Valsalva are very dilated (ie, $>$ 60 mm) or asymmetric, in which case we choose a 30-mm graft.

The graft is then prepared by trimming the proximal collar into 3 small crescent shapes and making 2 "keyholes" of approximately 1 cm in diameter, partially surrounded by small radial incisions of about 2 mm, at the level of the coronary ostia, in order to surround the ostia without causing constriction (Fig 1). The graft is secured at the level of the AVJ by means of 3 "U" stitches (4/0 Prolene; Ethicon, Somerville, NJ) reinforced with a small pledget made from autologous pericardium. These 3 stitches are placed from inside to outside the ventricular outflow, just underneath the nadir of each aortic valve leaflet, then through the graft.

Once the graft is seated over the aortic root by knotting the 3 stitches, another stitch is placed at the level of the vertical slit of each keyhole, underneath each coronary artery. This is done to constrain and stabilize the AVJ and to avoid excessive bulging of the Valsalva sinuses (Fig 2).

The cusps are then suspended by means of 3 single "U" stitches (4/0 Prolene), placed just above each valve commissure and through the graft at the STJ level, in such a way as to preserve the correct intercommissural distance and height. Then the STJ is secured to the graft STJ by a running suture, using the same 3 4/0 Prolene stitches used to suspend the commissures redistributing the excess aortic wall regularly (Fig 3). The last step consists of suturing the distal portion of the Dacron graft to the ascending aorta (4/0 Prolene).

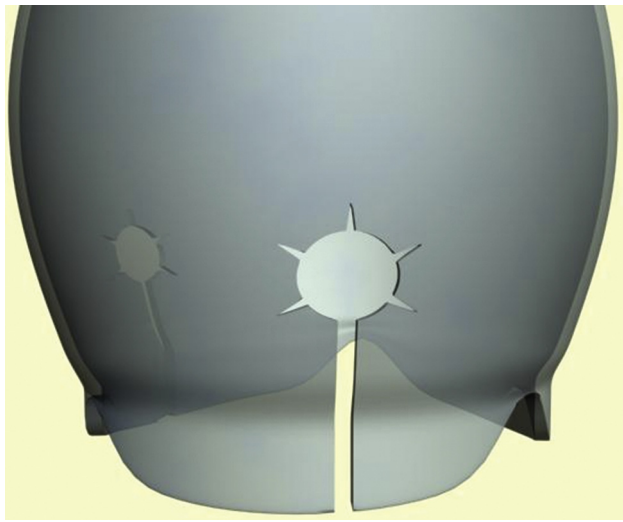

Fig 1. Graft preparation by trimming the proximal collar into 3 small crescent shapes and making 2 keyholes partially surrounded by small radial incisions.

Echocardiographic Follow-Up

Echocardiographic examinations were performed on discharge and on an annual basis. In this study the data were acquired from our database, outpatient clinic, and the referring cardiologist. Thus, we report the echocardiographic data collected on discharge and from the last examination available. Echocardiographic studies included the grade of AR on a scale from 0 to 4 (0 = none,

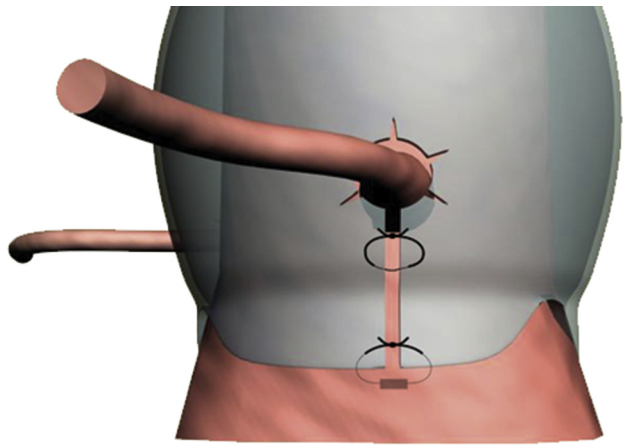

Fig 2. The graft is secured by a stitch at each nadir of the aortic cusp (lower suture). Another stitch is placed at the level of the vertical slit of each keyhole, underneath each coronary artery (upper suture).