

# AORTIC VALVE SPARING TECHNIQUES AS DESCRIBED BY TYRONE DAVID AND MAQDI YACOUB

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## INTRODUCTION

In the past 15 years valve-preserving aortic replacement has evolved into an increasingly accepted alternative to composite replacement of aorta and valve in order to minimize the incidence of valve-related complications.

Two basically different principles of valve-preserving aortic replacement are currently used, and minor modifications have been proposed for both. Reimplantation of the native valve within a vascular graft has been shown to normalize aortic root dimensions and restore valve function<sup>1</sup>. Remodeling of the root was originally designed by Sarsam and Yacoub<sup>2</sup>, and it has been demonstrated to restore root geometry and improve aortic valve competence in a physiologic fashion<sup>3</sup>. The technique of aortic remodeling has been employed for more than 10 years and clinical results have been highly satisfactory<sup>4</sup>. Compared to the reimplantation procedure, remodelling has had the advantages of being less complex and time consuming.

## AORTIC VALVE SPARING - ACCORDING TO DAVID

This operation was developed to treat patients with aortic root aneurysm such as in Marfan syndrome. The three aortic sinuses are excised leaving 5 mm of arterial wall attached to the aortic annulus and all around the coronary artery orifices. Sizing the diameter of the graft to be used for reimplantation of the aortic valve is based on the average heights of the aortic cusps because this variable cannot be modified. Thus, a graft of diameter equal to the double of the average height of the cusps is used, usually from 28 to 34 mm. If the three aortic cusps have similar size, three equidistant marks are made in one of the ends of the graft to correspond to each commissure. If the cusps have different sizes, the spaces between those three marks should

reflect those differences. A small triangular segment is excised along the mark in the graft that corresponds to the commissure between the right and left cusps because that part of the aortic annulus is subtended by the muscular interventricular septum. Next, multiple horizontal mattress of 3-0 polyester sutures are passed from the inside to the outside of the left ventricular outflow tract, immediately below the aortic annulus. These sutures are placed in a single horizontal plane along the fibrous component of the left ventricular outflow tract and following the scalloped shape of the aortic annulus along the muscular component. If the fibrous portion is very thin, small Teflon felt pledgets are used in these sutures. The sutures are then passed from the inside to the outside of the tailored end of the Dacron graft. This suture line is important to reduce the diameter of the left ventricular outflow tract if dilated or to prevent future dilation if it is normal. Regardless, the most important aspect of it is the recreation of sharp sub-commissural triangles beneath the commissures of the non-coronary cusp. The aortic valve is placed inside the graft and the left ventricular outflow tract sutures are tied on the outside. The graft is cut in the length of 5 or 6 cm. The three commissures and the graft are pulled gently upward and each commissure is secured to the graft with a transfixing 4-0 polypropylene sutures from the inside to the outside of the graft but these sutures are left untied. These three sutures are pulled apart gently and the level of coaptation of the cusps and the level and alignment of the commissure are inspected. It is important to remember that the three commissures must be correctly aligned within the graft and the level where they are sutured in the graft will determine the shape of the reconstructed aortic annulus. Next, the three sutures are tied on the outside of the graft and one of the arms of the polypropylene suture is brought inside the graft and used to secure the remnants of the aortic sinuses and aortic annulus against the graft by passing the needle through the

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junction between aortic annulus and aortic sinus from the inside to the outside of the graft and back from the outside of the graft to inside at the level where the rim of the remaining aortic sinus lies. This suture line should be haemostatic and should remodel the aortic annulus into a smooth scallop-shape.

The aortic cusps are inspected and if the free margin of one cusp appears to coapt at a lower level than the other two, it should be shortened by plicating along the nodule of Arantii with a 5-0 polypropylene suture. If large fenestrations are present in the commissural areas, the free margin should be reinforced with a double layer of 6-0 or 7-0 Gore-Tex suture. Once all this is done, the upper level of the coaptation of the cusps must be within the reconstructed aortic root by at least 8 mm above the level of the aortic annulus.

The left and right coronary arteries are reimplanted into their respective neo-aortic sinuses. Valve competence can be assessed at this time by applying a clamp to the upper end of the graft and injecting cardioplegia under pressure. If there is no ventricular distension during this maneuver, it is unlikely that there is more than trace aortic valve insufficiency. The distal end of the graft is sutured to the ascending aorta.

It may be desirable to create neo-aortic sinuses in the reconstructed root. Darts can be placed in between the commissures to create neo-aortic sinuses. These plicating sutures should start at the centre of each sinus and extend above the level of the new sinotubular junction.

#### **AORTIC VALVE SPARING ACCORDING TO YACOB**

**Patient Selection/Choice of Technique:** Root remodeling surgery is performed in ascending aortic or root aneurysm whenever aorto-ventricular diameter is preserved (<30mm) and there is no evidence of connective tissue disease. It is important to realize that any reduction of root dimensions will automatically alter the complex relationship between cusp and root configuration and may lead to cusp prolapse. Regardless of the choice of operative strategy, it is of paramount importance to produce cusp configurations that are as close to normal as possible<sup>5</sup>. Remodeling is mostly used for tricuspid aortic

valves with a symmetric root. Subsequently, this policy has also been adapted for the anatomy of bicuspid aortic valves.

**OPERATIVE STEPS:** A transoesophageal echocardiogram will help to determine root dimensions and cusp configuration preoperatively. This is used to determine the diameter of the aorto-ventricular junction and look at cusp configuration.

While a transverse or limited sternotomy are options, a standard median sternotomy is preferred. Aortic and right atrial cannulations are used for connection to cardiopulmonary bypass. The aorta is opened by a longitudinal incision, and cardioplegia is given directly into the coronary ostia.

For optimal exposure, the aorta is completely transsected 5 to 10 mm above the commissures. Stay sutures are placed in order to facilitate mobilisation of the root. If aorto-ventricular junction is 29 mm or less, root remodeling is undertaken. Mobilisation of the aortic root down to the lowest point of the sinuses is an important step of the operation. A graft approximately 1 to 2 mm smaller than the diameter of the aorto-ventricular junction is selected. The height of the native commissures is eye-balled, and the respective incision in the graft is kept approximately 20% shorter than the estimated height of the commissure. It is always easier to simply extend the length of this incision that has to accommodate the commissure. The three tongues are cut in a configuration that resembles a sinus curve. Wide tongues will let the remodelled root bulge more, but may also contribute to secondary dilatation of the root in the long-term course. The graft is then sutured to the aortic root, carefully following the insertion line of the aortic cusps. Suturing is started in the center of the sinus and directed towards the commissures.

Assessment of the aortic valve, i.e. configuration of the cusps, is an important part of the procedure once the graft has been sutured in place. The reduction of sinus dimensions will lead to some degree of cusp prolapse. In addition, prolapse may be pre-existent or aggravated by the operation. Initially it was felt that only asymmetric cusp prolapse had to be corrected. Now, the approach of trying to normalize the configuration of all cusps and measure the effective height of each cusp, i.e. the



height difference between free margin and aortic insertion is taken<sup>5</sup>. An effective height of 8 mm measured with a calliper intra-operatively corresponds to a similar height on post-operative echocardiograms and will result in an almost normal configuration of the aortic cusps. In order to achieve this the free margin is shortened by plication sutures using 5/0 or 6/0 prolene. Re-implantation of the coronaries is done in a standard fashion. Finally, the aortic graft is trimmed to adequate length and anastomosed to the ascending aorta.

## RESULTS

From October 1995 to April 2006, 262 patients (mean age  $60 \pm 15$  years) underwent

root remodeling for aortic root aneurysm. Cusp pathology was additionally corrected in 158 patients (60.3 %). Follow-up was complete in 99%. Hospital mortality was 3.8% (10/262; elective surgery: 3.2 %; emergency surgery: 7 %). Freedom from AI > II was 91 % at 5 and 90% at 10 years. Eight patients required reoperation (5 replacements, 3 re-repairs). Freedom from reoperation was 96% at 5 and 10 years, freedom from valve replacement 98% at 5 and 10 years.

## CONCLUSION

Root remodeling leads to good reconstitution of aortic root and valve geometry if cusp geometry is corrected in addition.

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