Proposed Modification for Valve-Sparing Aortic Root Replacement

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Valve-sparing aortic root replacement (ARR) is the procedure of choice in young patients with aortic root aneurysm and preserved aortic valve leaflets; however, coronary ostial anastomoses remain an issue. Troublesome bleeding sometimes occurs during surgery, and in the long term, there is a risk of aneurysmal formation in the residual aortic wall of the ostial “button.” We describe a technique of valve-sparing ARR wherein each coronary button along with its flange of aortic tissue is implanted within the prosthetic graft used for ARR, thereby eliminating the risk of both immediate surgical bleeding and late coronary button aneurysms.

Valve-sparing aortic root replacement (ARR) has been described by David and Feindel [1] and Sarsam and Yacoub [2] and modified in various ways to improve physiology [3] or overcome technical issues [4]. One main drawback remains: native aortic tissue around the coronary ostia is left unsupported and this, especially in patients with inherited connective tissue disorders, is prone to aneurysmal dilatation [5], which may require future high-risk surgical intervention [6]. We describe a technique of valve-sparing ARR wherein the coronary ostia are reimplanted within the prosthetic aortic root to eliminate the risk of late coronary ostial aneurysmal formation.

Technique

A median sternotomy is performed and cardiopulmonary bypass is instituted. The ascending aorta is cross-clamped, and the heart is arrested using a combination of antegrade and retrograde cold blood cardioplegia. Repeat cardioplegia administration is by the retrograde route when the ostial buttons are unsupported.

The ascending aorta is transected 1 cm proximal to the cross-clamp, and the aortic root is dissected from the pulmonary artery. The coronary ostia are mobilized with a 5-mm rim of surrounding aortic wall. The outer aortic root is dissected from surrounding tissues to 2- to 3-mm below the aortic annulus. The coronary aortic sinuses are then excised, preserving the aortic valve leaflets and 4 mm of aortic wall at the base, immediately distal to the valve annulus.

Valve Reimplantation

Fifteen horizontal mattress sutures of pledgeted 2-0 braided polyester sutures are placed in the left ventricular outflow tract (LVOT) 2 to 3 mm below the aortic annulus and brought outside the aorta, taking care to preserve the integrity of the valve leaflets. Three pledgeted 4/0 polypropylene sutures are inserted in the apex of each commissure and guided through an appropriately sized synthetic sealed vascular graft to emerge at the distal end. The LVOT sutures are then passed through the graft proximal edge, and the graft is “parachuted” onto the annulus so that the entire native valve apparatus lies within the graft. The LVOT sutures are tied. The three 4/0 polypropylene sutures are then passed through the graft wall at the correct height and radial position and tied. The valve is tested for competence by filling the graft with a column of clear solution. The aortic sinuses are then sutured into the Hemashield graft with hemostatic running 4/0 polypropylene sutures, commencing at the nadir of each sinus and working upward, tying the suture to the suture from the adjoining sinus on the outside of the graft at the level of the commissure. Testing is once again performed to ensure a competent valve. 

Coronary Ostial Reimplantation

Circular orifices slightly larger than the main stems of the coronary ostia are created at the correct height and radial position in the graft. A horizontal mattress suture of 5/0 polypropylene is placed at the base of the left coronary button from inside to outside adjacent to the ostium. Both needles are brought into the graft through the orifice and are then brought out of the graft 1 mm from the lower margin of the orifice (Fig 1). The coronary buttons are then coaxed into the graft through the orifice. One needle is used to secure the button to the graft in a radial running suture with the in-to-out pass close to the ostial opening and the out-to-in pass just beyond the circumference of the button. After half of the anastomosis is completed in this manner, the second needle is picked up, the other half is completed likewise, and the suture is tied outside the graft. The same procedure is repeated for the right coronary ostium.
button. This method of anastomosis is perfectly hemostatic. In 20 years of aortic root replacements, we have never experienced bleeding from a coronary ostial anastomosis performed in this fashion. This is because intraluminal aortic pressure serves to appose the flange of aortic tissue onto the wall of the graft. Cardioplegia is then administered via the aortic root by distal occlusion of the graft to enhance myocardial protection and to confirm hemostasis of all proximal suture lines. The distal anastomosis is completed with continuous 4/0 polypropylene suture. Air is removed from the left heart, the aorta is unclamped, and the patient is separated from cardiopulmonary bypass.

Results
Using this technique, we have treated 28 patients with aneurysmal aortic roots secondary to connective tissue disorders. There was no early mortality and no reexploration for bleeding. Mean total postoperative blood loss was 264 ± 165 mL. All patients had a satisfactory postoperative course. Postoperative cardiac magnetic resonance imaging confirmed aortic valve competence and delineated the anatomy of the neoaortic root (Fig 2).

Comment
Valve-sparing ARR has been increasingly performed over the last two decades [1–4]. The rationale for this approach is to preserve the competent native valve leaflets, avoiding the risk of structural valve degeneration of bioprostheses and anticoagulation problems with mechanical valves. The procedure has undergone several modifications [3, 4].

There is evidence that such valve-sparing procedures are durable, and the advantages they offer over valve replacement are obvious, but leaving potentially aneurysmal aortic tissue unsupported, especially in connective tissue disorders, is intuitively and surgically wrong. This concern is justified by the high incidence of coronary ostial aneurysms in the residual aortic flange on routine imaging in these young patients [5], some of whom may require reoperation because of risk of thrombi, embolization, rupture, or compression [6]. This high incidence prompted us to adopt the approach of an internal implantation of the coronary ostia, which should abolish the risk of coronary artery aneurysms developing in residual periostial aortic wall. An additional advantage is the superb hemostatic property of this technique, as any increase in the intraluminal pressure in the aorta only serves to increase the blood-tightness of the anastomosis. Technically, these anastomoses are more demanding, but the advantages far outweigh the technical challenge and the slightly longer cross-clamp times required. Similar modifications to the coronary button anastomoses have been reported for ARR [7, 8], but not in valve-sparing ARR. This is particularly challenging in the context of valve-sparing techniques because of the large amount of suturing to be performed within the confines of the graft, placing the aortic valve leaflets at risk, but it can be accomplished with a degree of care and dexterity. The technique can be incorporated into any ARR procedure and will serve to improve long-term results and freedom from reintervention after such operations, especially in the presence of connective tissue disorders.

In conclusion, we describe a method of performing valve-sparing aortic root replacement, which has the advantages of excellent hemostasis and abolishes the risk of future coronary ostial aneurysms.
References


