Comparison of David V valve-sparing root replacement and bioprosthetic valve conduit for aortic root aneurysm

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Objective: Valve sparing root replacement (VSRR) is an attractive option for the management of aortic root aneurysms with a normal native aortic valve. Therefore, we reviewed our experience with a modification of the David V VSRR and compared it with stented pericardial bioprosthetic valve conduit (BVC) root replacement in an age-matched cohort of older patients.

Methods: A total of 48 VSRRs were performed at our institution, excluding those on bicuspid aortic valves. We compared these cases with 15 aortic root replacements performed using a BVC during the same period. Subgroup analysis was performed comparing 16 VSRR cases and 15 age-matched BVC cases.

Results: The greatest disparity between the VSRR and BVC groups was age (53 vs 69 years, respectively; $P < .0005$). The matched patients were similar in terms of baseline demographics and differed only in concomitant coronary artery bypass grafting (2 VSRR vs 7 BVC patients; $P = .036$). None of the VSRR and 3 of the BVC procedures were performed for associated dissection ($P = .101$). Postoperative aortic insufficiency grade was significantly different between the 2 groups ($P = .004$). The cardiopulmonary bypass, crossclamp, and circulatory arrest times were not different between the VSRR and BVC groups (174 vs 187 minutes, $P = .205$; 128 vs 133 minutes, $P = .376$; and 10 vs 13 minutes, respectively; $P = .175$). No differences were found between the 2 groups with respect to postoperative complications. One postoperative death occurred in the BVC group and none in the VSRR group. The postoperative length of stay and aortic valve gradients were less in the VSRR group (6 vs 8 days, $P = .038$; 6 vs 11.4 mm Hg, $P = .001$). The intensive care unit length of stay was significantly less in the VSRR group (54 vs 110 hours, $P = .001$).

Conclusions: VSRR is an effective alternative to the BVC for aortic root aneurysm. (J Thorac Cardiovasc Surg 2014;148:2883-7)

Since the original description of the use of a mechanical valve conduit for replacement of the aortic valve and ascending aorta by Wheat and colleagues[1] and then Bentall and De Bono,[2] an evolution of aortic root surgery has resulted in a movement to preserve the valve during root replacement. Patients requiring aortic root replacement for aneurysmal disease have historically been treated by complete excision of the aneurysm and valve, followed by replacement with a composite valve conduit (biologic or mechanical) or homograft aortic root. David and Feindel[3] and Sarsam and Yacoub[4] described techniques for valve sparing root replacement (VSRR), with multiple subsequent iterations for use in patients with aortic root aneurysms requiring aortic root replacement. Preservation of the native valve could avoid the potential complications related to the use of mechanical or bioprosthetic tissue valves, including freedom from anticoagulation and the theoretical risk of structural valve deterioration.

Accordingly, VSRR is an attractive treatment of aortic root aneurysm with a normal aortic valve for the initiated surgeon. Although technically more demanding, excellent early and late outcomes after VSRR have been reported.[5] Very few published reports comparing modern VSRR and bioprosthetic valve conduits (BVCs) are available. Therefore, we reviewed our experience with a modification of the David V VSRR and compared it with stented pericardial BVC root replacement in an age-matched cohort of older patients.

METHODS

From March 2003 to December 2012, 70 patients underwent VSRR by 1 surgeon (J.S.I.). Of these 70 patients, those with bicuspid aortic valves (n = 22) were excluded. For the remaining 48 patients (12 women and 36 men), the age range was 21 to 77 years. We compared these 48 VSRR procedures with 15 BVC procedures performed with the Carpentier Edwards Pericardial valve (Edwards Lifesciences Corp, Irvine, Calif) during the same period and by the same surgeon (J.S.I.). In the VSRR group, the etiology of the aortic root aneurysm was degenerative in most patients (n = 43) and aortic dissection in 5. Of the 15 BVC patients, the indication for surgery was degenerative disease in 12 and dissection in 3.

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Abbreviations and Acronyms
BVC = bioprosthetic valve conduit
NYHA = New York Heart Association
VSRR = valve sparing root replacement

All patients had aortic root aneurysmal disease that met standard size criteria (ie, >5.0 cm diameter or >2 times the size of a normal aortic segment) for resection. However, the greatest disparity between the 2 groups was patient age. Therefore, the 15 BVC patients were matched by age with 16 of the older VSRR patients. Data were collected prospectively as a part of our institutional participation in the Society of Thoracic Surgeons database and retrospectively from a review of the medical records for additional information not obtained prospectively. The preoperative patient characteristics are listed in Table 1, and the intraoperative variables are listed in Table 2.

The institutional review board of the Medical University of South Carolina approved the present study and waived the need for individual patient consent.

Operative Technique

VSRR was performed as described previously.[7] In brief, cannulation for cardiopulmonary bypass was obtained by way of the ascending aorta and right atrial appendage. Cardiac arrest was achieved with a combination of antegrade and retrograde cold blood cardioplegia. After transection of the ascending aortic aneurysm, the aortic valve was inspected for pathologic features that might preclude its preservation. When the valve was deemed acceptable for preservation (nonsclerotic without obvious large fenestrations or other imperfections), the aneurysm was excised, leaving a 5- to 8-mm rim of aortic tissue around the native valve and around the coronary ostia. Next, horizontal mattress sutures were placed circumferentially under the aortic valve annulus from inside to out and across an appropriately sized Dacron graft (Hemashield; Meadox Medicals, Oakland, NY; and Dacron; DuPont, Wilmington, Del). Graft sizing was achieved by adding 11 mm to the Hegar dilator-sized annulus (2.5-mm allowance for aortic wall thickness on either side of the outflow graft [5 mm total] and 6 mm for billowing of the neosinus graft). The Dacron graft was seated such that the valve was contained within the graft. The sutures were tied with an appropriately sized Hegar dilator gently placed across the aortic valve (to prevent overplication of the graft and constriction of the annulus and left ventricular outflow tract) and cut. The valve was then attached to the wall of the Dacron graft using running polypropylene suture followed by reimplantation of the coronary arteries in anatomic fashion. After re-establishment of arterial continuity, the patients were warmed and weaned from cardiopulmonary bypass.

The stented pericardial BVC was performed by first excising the native aortic leaflets and fashioning coronary buttons in the usual manner. Everting pledgeted mattress sutures were placed circumferentially around the annulus. The valve conduit was then constructed using running horizontal mattress sutures to affix an appropriately sized pericardial valve within a Dacron graft approximately 10 cm long. Root replacement proceeded as usual.

Statistical Analysis

The variables compared included demographic data, preoperative risk factors, intraoperative measures, and postoperative outcomes. The normality of the continuous variables was evaluated using the Kolmogorov-Smirnov statistic, and between-group comparisons were performed using the Student t or Mann-Whitney U test, as appropriate. Fisher's exact test was used to examine categorical variables. All tests were performed using SPSS 22 (SPSS Inc, Chicago Ill).

RESULTS

Patient demographics, operative characteristics, and early postoperative outcomes are summarized in Tables 1, 2, and 3, respectively. The greatest disparity between the VSRR and BVC groups was age (55 vs 69 years, respectively; $P < .0005$). Therefore, the 16 oldest VSRR patients were matched by age with the 15 BVC patients. These patients were similar in height, weight, sex, and race and differed only in the use of concomitant coronary artery bypass grafting (2 VSRR and 7 BVC; $P = .036$). Within the 31-matched patients, the indication for surgery was dissection in no VSRR patient and 3 BVC patients ($P = .224$). In the VSRR group, 11 patients were in New York Heart Association (NYHA) class I or II and 5 were in NYHA class III or IV preoperatively. In the BVC group, 4 patients were in NYHA class I or II and 11 were in NYHA class III or IV preoperatively. At 1 year postoperatively (approximate, given scheduling of follow-up visits), 100% of the VSRR group (n = 14, 2 were lost to follow-up) were NYHA class I, and in the BVC group, 13 were NYHA class I or II and 1 was in NYHA class III (Figure 1). The cardiopulmonary bypass, crossclamp, and circulatory arrest times were not different between the VSRR and BVC groups (174 vs 187 minutes, $P = .205$; 128 vs 133 minutes, $P = .376$; and 10 vs 13 minutes, respectively; $P = .175$). No differences were found with respect to postoperative complications. One death occurred in the BVC group and none in the VSRR group. Two permanent strokes occurred in the BVC group and none in the VSRR group. The intensive care unit length of stay was significantly shorter in the VSRR group (54 vs 110 hours; $P = .001$), as was the overall postoperative length of stay (6 vs 8 days; $P = .038$). The cause of immunocompromise in the VSRR patient was treatment of ulcerative colitis. The reasons for previous surgery in the VSRR group were endocarditis in 1 patient and ascending aorta replacement for aneurysm in 1 patient. The reasons for previous surgery in the BVC group was pulmonary autograft dilation after Ross in 1 patient, previous root replacement with a St Jude conduit in 1 patient, and previous repair of traumatic descending aortic tear in 1 patient (Table 1). The reasons for prolonged length of stay included pulmonary embolus in 1, pneumonia in 3, stroke in 1, atrial fibrillation in 1, and reoperation for bleeding in 1. The transvalvular gradients were lower in the VSRR group (6 vs 11.4 mm Hg; $P = .001$; Figure 2). Postoperative aortic insufficiency was graded as none in 7, trace in 3, mild in 5, and not recorded in 1 VSRR patient. It was graded as none in 14 and not recorded in 1 BVC patient.

DISCUSSION

In older patients, the perceived risks of VSRR might appear to outweigh the benefits of this technically challenging procedure. The results of the present study

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