# Long-term survival after composite mechanical aortic root replacement: A consecutive series of 448 cases

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**Objective:** To determine the effect of different etiologies on the outcome and mortality after mechanical composite aortic root/ascending replacement.

**Methods:** From February 1998 to June 2011, 448 consecutive patients (358 men, age, 52.8 ± 12.3 years) underwent composite mechanical aortic root replacement. Of these 448 patients, 362 (80.8%) were treated for degenerative/atherosclerotic root/ascending aortic aneurysm (287 men, age, 53.0 ± 12.1 years), 65 (14.5%) for emergent acute type A aortic dissection (49 men, age, 51.0 ± 13.1 years), and 21 (4.7%) for active infective endocarditis (20 men, age, 46.5 ± 13.6 years); 15% (n = 68) were reoperative or redo procedures.

**Results:** The overall hospital mortality after composite root/ascending replacement was 6.7% (n = 30). It was 3.9% (n = 14) after elective/urgent aneurysm replacement, 20.0% (n = 13) after emergency repair for acute type A aortic dissection, and 14.3% for active infective endocarditis (n = 3). The overall 1-year mortality—as a measure of operative success—was 5.2% (n = 19) after elective/urgent degenerative/atherosclerotic root/ascending aortic aneurysm repair, 21.5% (n = 14) after emergency repair for acute type A aortic dissection, and 14.3% (n = 3) after active infective endocarditis (degenerative/atherosclerotic root/ascending aortic aneurysm vs acute type A aortic dissection, $P = .03$; degenerative/atherosclerotic root/ascending aortic aneurysm vs active infective endocarditis, $P = .08$; acute type A aortic dissection vs active infective endocarditis, $P = .8$). Long-term survival was 88.3% at 5 years and 72.2% at 10 years, with a linearized mortality rate after 30 days of 2.5%/patient-year. Long-term survival after surgery for acute type A aortic dissection and active infective endocarditis was 72% and 72.3% at 5 years and 64.9% and 62% at 10 years, respectively, with a linearized mortality rate of 2.6%/patient-year for acute type A aortic dissection and 3.7% for active infective endocarditis. Survival after composite root replacement after the first year paralleled that of an age- and gender-matched population, regardless of the etiology. Women appeared to have less favorable longevity.

**Conclusions:** Composite root replacement remains a versatile choice for various pathologic features with excellent longevity and freedom from reoperation and should be strongly considered if conditions for valve-sparing repair are less than perfect. (J Thorac Cardiovasc Surg 2013;145:S41-7)

Bentall and De Bono originally described their technique for complete replacement of the aortic valve and ascending aorta in a patient presenting with free aortic regurgitation in 1968. They used a mechanical composite graft—consisting of a no. 13 Starr cage-ball valve attached to a crimped Teflon tube—for aortic root replacement with reattachment of the 2 main coronary arteries. Nine years later, in 1977, Kouchoukos and colleagues[1] published their initial experience of 25 cases using coronary buttons. The Button-Bentall became one of the most significant refinements of the classic procedure.[1] In 1996, Bachet and colleagues[2] were the first to report an extensive experience of more than 200 patients, demonstrating the superiority of the Button-Bentall and its successful use for various etiologies.

In the early 1990s, Galla and colleagues,[3] introduced the BioBentall—a home-made composite graft manufactured intraoperatively using a stented bioprosthesis—enabling root replacement in patients deemed unable to take anticoagulants. The BioBentall provided excellent long-term survival and very low rates of thromboembolism, bleeding complications, and reoperation.[4,5]

During the past decade, valve-sparing procedures have progressively been recommended for aortic root repair, especially in younger patients. Excellent patient survival and durability of aortic valve function in highly selected patients with root aneurysm and normal or near-normal aortic valve leaflets has been reported, particularly with the reimplantation technique.[6-8] The excellent clinical

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**Abbreviations and Acronyms**

ADA = acute type A aortic dissection
AIE = active infective endocarditis
CVA = cerebrovascular accident
LMR = linearized mortality rate
R/AsA = degenerative or atherosclerotic aortic root/ascending ectasia/aneurysm

outcome in selected patients and the lack of a need for anticoagulation generated increasing interest in extending the indications for valve-sparing procedures.[9,10] Increasing reports have emerged on extensive aortic valve repair even of bicuspid valves with a calcified raphe.[11]

Recently, Urbanski and colleagues[5] reported the successful use of composite grafts with oversized biologic valves, particularly in patients with a small native annulus (<23 mm). They suggested the biologic valve composite graft as an alternative for younger patients because of the ease of reoperative replacement of the biologic valve in the rare case of deterioration.[5]

The objective of the present analysis was to provide benchmark data from the largest contemporary single-center experience of mechanical composite aortic root replacement.

## METHODS

A review of the institutional database—of more than 1200 aortic root procedures—disclosed 448 consecutive patients who underwent isolated mechanical composite aortic root replacement from February 1998 to June 2011. The indications for surgery were pathologic features affecting the aortic valve in the presence of root/ascending aorta disease. These included degenerative or atherosclerotic aortic root/ascending ectasia/aneurysm (R/AsA), acute type A aortic dissection (ADA), and active infective endocarditis (AIE) of a native/prosthetic aortic valve. Patients requiring concomitant full arch repair were excluded (n = 26) to allow for objective comparison of root procedures. The institutional review board approved the present research, and additional patient consent was not required.

### Patient Demographics and Indication for Surgery

A total of 448 patients (mean age, 52.8 ± 12.3 years; range, 18-88 years) underwent mechanical composite aortic root replacement with a single conduit type (size, 21-29 mm; ATS Medical, Minneapolis, Minn). Of these patients, 362 were treated for R/AsA, 65 for ADA, and 21 for AIE. Aortic valve dysfunction was observed in 438 of the patients (98%) and was isolated stenosis (10%) or regurgitation (57%), or a combination of both (31%). The clinical characteristics of all patients are listed in Table 1.

### Indications for Root/Ascending Replacement

**Patients with R/AsA.** Most patients underwent surgery for various aortic valve pathologic entities combined with root/ascending ectasia or aneurysm (n = 352, aneurysm in 270 and ectasia in 82). Ten patients presented with an aneurysm strictly limited to the aortic root. Two patients underwent aortic root replacement after valve repair was unsuccessful. One patient underwent initial valve replacement and supracommissural ascending replacement, which resulted in distortion of the coronary ostia, warranting complex root revision. Finally, 42 patients (12%) had undergone previous cardiac surgery. Of those, 26 (62%) had undergone previous aortic surgery.

**Patients with ADA.** A total of 65 patients underwent emergency surgery for ADA. Patients with iatrogenic dissections (n = 6) were excluded owing to the confounding nature of the initial surgery. Eleven patients had undergone previous aorta-related surgery. Two patients had aortic type A repeat dissection at the root level (one bicuspid and one tricuspid) after previous aortic valve-sparing repair with supracommissural ascending replacement. One had undergone previous supracommissural ascending replacement, required reoperative root repair (valve-remodeling, Yacoub), experienced annulus perforation, and, eventually, received a mechanical composite graft at his third reoperation. Three patients had previously undergone isolated supracommissural ascending replacement (1, 3, and 4 years before their aortic root dissected). Five patients had undergone previous aortic valve replacement and their aorta dissected late at 2, 6, 13, and 15 years after the previous surgery. One patient experienced annulus perforation 12 years after redo aortic valve surgery.

**Patients with AIE.** A total of 21 patients underwent urgent surgery for AIE of the aortic valve. A native aortic valve was present in 7 patients, and 14 patients had prosthetic valve endocarditis. A root abscess was found in 7 (native in 4 and prosthetic in 3). Previous endocarditis had occurred in 3 (all prosthetic), and concomitant mitral valve endocarditis was found in 2 patients. Of the 21 patients, 16 (76%) had undergone previous aortic valve and/or ascending aortic replacement. One patient had undergone a Bentall procedure 5 years previously to redo mechanical composite root replacement for a pseudoaneurysm involving the right coronary button. The patient also required mitral valve repair at reoperation.

### Surgical Technique

**Cannulation.** Arterial cannulation was direct—either by the ascending aorta (n = 240) or the proximal arch (n = 97)—in 75%. In 1 case, primary cannulation of the carotid artery was used. The femoral artery was used in 51 patients (11%). This was by preference of the surgeon in 24 (47%), for emergency arterial access in 13 (25.5%), because the aneurysm included the aortic arch with no direct cannulation site available in 12 (23.5%), or because of a previous reoperative sternotomy in 2 (4%).

**Temperature management and cerebral protection.** Surgery was usually performed with mild-to-moderate hypothermia (30°C) with an average minimal core temperature (bladder) of 29.3° ± 6°C. In 370 patients (83%), the distal ascending aorta was clamped during completion of the distal anastomosis (R/AsA, 314 [87%]; ADA, 36 [55%]; and AIE, 20 [95%]).

In 30 patients (7%), antegrade selective cerebral perfusion was established as an adjunct to hypothermic distal circulatory arrest, and open distal anastomosis was performed (R/AsA, 13 [3.6%]; ADA, 17 [28%]; AIE, 0 [0%]), with a mean temperature of 23.9°C ± 5°C. Cannulation for antegrade selective cerebral perfusion was unilateral in 11 or bilateral using a perfusion catheter in the left carotid artery in 19, as previously described. Hypothermic circulatory arrest without antegrade selective cerebral perfusion was used in 48 (11%).

**Aortic root replacement.** The Button-Bentall procedure as modified by Kouchoukos[12] was performed in all patients, using 1 type of mechanical composite conduit (ATS Medical). The mean prosthesis size was 25 ± 2 mm (range, 21-29 mm).

**Partial aortic arch replacement.** A total of 74 patients underwent concomitant partial aortic arch replacement because of involvement of the proximal aortic arch in the aneurysm or dissection (R/AsA, 46 [13%]; ADA, 26 [40%]; and AIE, 2 [9.5%]). In these cases, the concavity of the aortic arch was resected, leaving the convexity of the transverse arch, including the origin of the supraaortic vessels.

**Concomitant procedures.** Coronary artery bypass grafting was performed in 58 patients (13%), with an average of 1.8 bypass grafts (range, 1-5 grafts) per patient. Mitral valve surgery was undertaken in 35 patients (replacement in 14 and repair in 21). Nine patients underwent