Institutional report - Cardiac general

Long-term results of modified Bentall procedure using flanged composite aortic prosthesis and separately interposed coronary graft technique

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Abstract

We have selected the flanged composite aortic prosthesis and separately interposed coronary graft technique for the aortic root replacement over seven years. We sought to evaluate the long-term results of aortic root replacement with this technique. Between April 1996 and September 2003, 71 patients (mean age 46.1±12.9 years, 67.6% males) underwent aortic root replacement with this technique. Sixty-two patients had annuloaortic ectasia, and seven patients acute type A aortic dissection. Marfan syndrome was recognized in 35 patients. Two separate 8–10 mm knitted Dacron grafts were interposed between a valved composite graft and both coronary ostia to avoid kinking of coronary arteries. The early mortality rate was 4.2%. The actuarial survival rate was 93.9±3.0% at 5 years. The freedom from operation related complications was 86.7±4.1% at 5 years. No patients had anticoagulant-related hemorrhage, valve thrombosis, reoperation, graft thrombosis, or coronary pseudoaneurysm. The separately interposed coronary graft and the flanged composite graft technique is predictable and safe. Coronary pseudoaneurysm and graft thrombosis have been eliminated.

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Keywords: Aortic root replacement; Interposition graft technique; Flanged graft

1. Introduction

The surgical reconstruction of the aortic root with a valved composite graft was first reported by Bentall and DeBono [1]. This original Bentall method employed in situ circumferential suture lines around the coronary ostia then complete aortic wraparound to control bleeding. Tension within the perigraft space conveyed the significant risk of coronary separation, false aneurysm formation, and re-operation [2,3]. To avoid this problem, Cabrol et al. adopted interposition Dacron conduits to the coronary ostia with the new risk of graft thrombosis [4].

Currently, coronary button mobilization and direct re-implantation into the valved conduits superseded these modifications [5–10]. However, there are potential difficulties to avoid an acute coronary problem and late false aneurysm formation in the direct re-implantation technique [4,11]. We have, therefore, decided to anastomose two separate interposition grafts between both coronary ostia and composite graft with an exclusion technique to achieve low risk and predictable outcome of aortic root replacement [12]. We made a flanged composite graft using a Hemashield tube graft (Meadox Medicals, Inc, Oakland, NJ) and a mechanical aortic valve (St. Jude Medical, Inc, St. Paul, MN). A flange, the segment (8–10 mm in length) of the proximal end of the vascular graft was made for the implantation (Fig. 1). This study describes our 7-year experience of aortic root replacement with this technique and provides analysis of mortality and morbidity.

2. Material and methods

2.1. Patient characteristics

Between April 1996 and September 2003, 71 patients (48 males, 23 females; mean age: 46.1±12.9 years; range: 24 to 74 years) underwent aortic root replacement with the valve composite flanged graft and the two separate inter-position graft technique (Fig. 1). Medical records were reviewed retrospectively for patient demographics, preoperative symptoms, preoperative echocardiographic findings, operative procedures, and survival. Follow up was obtained by office visits and/or telephone interviews.

Indications for surgery were annuloaortic ectasia (AAE) in 62 patients (35 patients with Marfan syndrome), acute type A aortic dissection in six (four patients with Marfan syndrome), chronic type A aortic dissection in 10 (seven patients with Marfan syndrome), atherosclerotic aneurysm in one, and coronary pseudoaneurysm after original Bentall procedure in four. Marfan syndrome was present in 35 patients. Twenty-eight patients had a history of hypertension. Thirty-one patients had severe or moderate aortic valve regurgitation. The preoperative data are given in Table 1.

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2.2. Surgical technique

The cardiopulmonary bypass was instituted with ascending aortic cannulation and bicaval drainage. Femoral cannulation was performed in patients with aortic dissection, ascending aorta aneurysm extending to aortic arch, and emergency status and auxiliary artery for recent cases. Antegrade or retrograde cold blood cardioplegia was applied for the myocardial protection. Deep hypothermic circulatory arrest with retrograde cerebral perfusion (16°C) was applied in patients requiring concomitant transverse arch replacement.

After cross-clamping of ascending aorta, the aorta was completely transected at the sinotubular junction and distally 2 cm from the cross-clamp, then, aortic leaflets were removed. We have made coronary buttons with a 1.5 cm diameter cuff of aortic wall and anastomosed to the interposition grafts with the exclusion technique (sewing all layers of aortic wall) to avoid producing a pseudo-aneurysm (Fig. 1). We had used two 8–10 mm knitted Dacron tube grafts as the interposition graft.

We made a flanged composite graft in the operating room using a Hemashield tube graft (Meadox Medicals, Inc, Oakland, NJ) and mechanical aortic valve (St. Jude Medical, Inc, St. Paul, MN). A flange, the segment (8–10 mm in length) of the proximal end of the vascular graft was made for the implantation (Fig. 1). After we sized the aortic annulus for the prosthetic valve, we selected the tubular graft one or two sizes wider than the prosthetic valve. The mechanical valve was inserted into the graft and was fixed at the four corners to the graft with 2-0 Polyester sutures at the point 5–10 mm from the end of graft. Then, a continuous 2-0 Polyester suture was performed to anastomose the sewing cuff of the mechanical valve.

The composite valve graft was implanted by attaching the flange of the handmade composite valve conduit into the aortic annulus with pledgeted horizontal mattress sutures using a Hemashield tube graft (Dacron tube grafts as the interposition graft. The interposition grafts with the exclusion technique were removed. We have made coronary buttons with a 1.5 cm diameter cuff of aortic wall and anastomosed to the composite valve graft end-to-side with a continuous 4-0 polyfluoridevinyl suture. Two short separately interposed grafts resulted to attach to the composite graft in a slightly higher position. The distal anastomosis was performed to the transected aorta with a continuous 4-0 polyfluoridevinyl suture. Mean duration of aortic cross-clamp and cardiopulmonary bypass were 140 ± 17.5 and 219 ± 25.9 min, respectively.

For arch replacement, total circulatory arrest with retrograde cerebral perfusion is performed after coronary reconstruction. Concomitant procedure was summarized in Table 2.

2.3. Statistical methods

Results are presented as mean ± standard deviation. Cox proportional hazard regression analysis was used to assess risk factors as independent predictors of patient survival. Estimates for long-term survival or freedom from operation related complications were made by the Kaplan–Meier method. A P-value < 0.05 was considered statistically significant for all comparisons.

3. Results

3.1. Mortality

The early mortality was 4.2% (three patients). Cause of death was cerebral dysfunction, respiratory failure and

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number (%)</th>
</tr>
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<tbody>
<tr>
<td>Patient numbers</td>
<td>71</td>
</tr>
<tr>
<td>Male/female</td>
<td>48/23 (67.6%/32.4%)</td>
</tr>
<tr>
<td>Mean age</td>
<td>46.1 ± 12.9</td>
</tr>
<tr>
<td>Mean NYHA function class</td>
<td>1.8 ± 0.9</td>
</tr>
<tr>
<td>Marfan syndrome</td>
<td>35 (49.3%)</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>3 (4.2%)</td>
</tr>
<tr>
<td>Mitral valve insufficiency</td>
<td>3 (4.2%)</td>
</tr>
<tr>
<td>Low EF or FS</td>
<td>8 (11.3%)</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>5 (7.0%)</td>
</tr>
<tr>
<td>Respiratory dysfunction</td>
<td>6 (8.5%)</td>
</tr>
<tr>
<td>Renal dysfunction</td>
<td>4 (5.6%)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>28 (39.4%)</td>
</tr>
<tr>
<td>Marfan syndrome</td>
<td>35 (49.3%)</td>
</tr>
<tr>
<td>Prior cardiac operation</td>
<td>12 (16.9%)</td>
</tr>
<tr>
<td>Emergency</td>
<td>9 (12.7%)</td>
</tr>
</tbody>
</table>

NYHA, New York Heart Association functional class; EF, ejection fraction; FS, fractional shortening.
mediastinitis in each patient. There has been no early death since September 1999.

There has been one late death (1.4%). The cause of this late death was sepsis. This patient had complications with myelodysplastic syndrome and had taken prednisolone for immuno-suppression for 20 years after renal transplantation. One year later, after aortic root replacement, an infection of unknown origin caused sepsis and multi-organ failure and finally he died on the postoperative day. The actuarial survival rate was 93.9 ± 3% at 5 years (Fig. 2).

3.2. Postoperative complications

Seventeen patients had 31 postoperative complications. Five patients required surgical re-entry for excessive bleeding. One patient suffered from complete heart block requiring pacemaker implantation. Four patients suffered low cardiac output syndrome (LOS). Seven had respiratory failure requiring prolonged ventilation. Two required temporal renal support for acute renal failure but recovered completely. Cardiac tamponade in late phase was recognized in one patient and drained.

No patients had anticoagulant-related hemorrhage, valve thrombosis, re-operation, coronary event, and coronary pseudoaneurysm.

Freedom from operation related complications was 86.7 ± 4.1% at 5 years (Fig. 3).

4. Discussion

We have undertaken the interposition graft and the flanged graft techniques for 71 patients with aortic root disease over 7 years. The most important finding in this study is that the interposition graft and the flanged graft techniques are feasible and excellent long-term results can be achieved as reported in the direct button technique [12].

We believe that this technique has some advantages. The flanged valve technique can achieve the continuance of flexibility of the aortic annulus by avoiding the fixation of aortic annulus to the prosthetic valve ring. The flanged part of the vascular graft, as a strip over the proximal anastomosis, was used to attach to the aortic annulus by pledgeted mattress sutures. This decreases any bleeding problems from the proximal anastomosis and additional sutures for hemostasis can be easily applied for this strip [13,14].

No coronary event or coronary pseudoaneurysm formation indicates that the separately interposed coronary graft technique is reliable, while the incidences of pseudoaneurysm with the button technique were reported between 3.1% and 9% in other series [3,15]. Using excluded coronary buttons anastomosing to the interposition graft makes it less likely to pseudoaneurysm formation and excessive bleeding [4]. Especially in a situation of re-operation, the separate coronary graft technique enables safe re-attachment of the coronary ostium without tension. This coronary reconstruction without tension could contribute to the elimination of coronary false aneurysm in this series. There were concerns related to the long-term patency of these grafts and increased number of coronary events. We, however, showed that long-term mortality and morbidity related to the coronary events were eliminated. Compared to the Cabrol technique, separately interposed coronary grafts were remarkably shorter and physiological coronary flow can be provided through 8–10 mm grafts according to each coronary artery resistance.

The disadvantage of this technique is that it requires two more anastomoses between grafts and this is time-consuming. However, with a reliable myocardial protection technique, an excellent early result without peri-operative myocardial infarction can be achieved. We routinely use antegrade cold blood, delivered in a continuous fashion through a separately interposed coronary graft. This technique also prevents debris from entering the coronary circulation.

In summary, we have performed aortic root replacement with separately interposed coronary graft and the flanged composite graft in 71 patients. The advantage of this technique is low mortality and morbidity for up to seven years. Coronary pseudoaneurysm and graft thrombosis have not been observed. This technique is feasible as one of many modifications of the aortic root replacement.
References


