Acute dissection of the ascending aorta: first results of emergency valve sparing aortic root reconstruction


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Abstract

Objective: Acute dissection of the ascending aorta requires immediate surgical intervention. In this study, we report our first results with valve sparing aortic root reconstruction removing all the diseased tissues.

Methods: From August 1995 to December 2000, 22 patients with acute aortic dissection of the ascending aorta (Stanford type A) underwent valve sparing aortic root reconstruction. Their ages ranged from 20 to 76 years (52 ± 15, 68% males). Dissection was found in the ascending aorta (3 patients) or both in the ascending aorta and aortic arch (19 patients; 86%). Course and length of hospitalization, echocardiographic and clinical follow-up, complications and mortality were analysed.

Results: Mean cardiopulmonary bypass time was 212 ± 56 min (134–352 min), mean aortic cross clamp time was 157 ± 24 min (114–205 min). In patients undergoing additional arch replacement (n = 19), circulatory arrest was 35 ± 18 min (11–75 min). After reconstruction, intraoperative echocardiography showed aortic insufficiency (AI) grade 0 in 16 patients (84%) and grade 1 in three patients (16%). Stay in intensive care unit was 2.1 ± 0.7 days, and postoperative hospitalization was 21 ± 14.4 days. There were three perioperative deaths (14%). Mean post-operative follow-up was 18.4 ± 18 months (0.4–65.4 month). One patient died 10 months postoperatively. At follow-up, no patient suffered AI grade 2 or higher, and no reoperation for aortic valve failure was necessary. All patients presented with a favorable exercise tolerance being in New York Heart Association functional class I or II.

Conclusion: Valve sparing aortic root reconstruction in patients with type A dissection can be performed with acceptable intraoperative mortality and morbidity and excellent results during follow-up. The complete resection of the diseased aorta is particularly appealing. © 2002 Elsevier Science B.V. All rights reserved.

Keywords: Aortic aneurysm; Aortic dissection; Valves; Aorta; Reconstruction

1. Introduction

Acute dissection of the ascending aorta type A is a rare but life-threatening disease. Cardiac tamponade and possible acute aortic regurgitation require immediate surgical intervention. The standard technique consists of reconstruction of the aortic wall layers of the aortic sinus with gelatin–resorcinol–formaldehyde (GRF) glue or suture fixation, resuspension of the aortic valve commissures and supra-commissural replacement of the diseased ascending aorta with a Dacron graft [1]. Alternatively, replacement of the aortic valve, root and ascending aorta with a composite graft carrying a mechanical or biological valvular prosthesis can be necessary if the aortic root is severely impaired. Although both techniques achieve good early results with an acceptable mortality ranging from 10 to 20% [2–5], both approaches have limitations with regard to long-term morbidity. Composite graft replacement is accompanied by disadvantages of mechanical or biological valve prostheses, such as thromboembolic events and haemorrhage due to lifelong anticoagulation [6,7] or reoperations due to degeneration of biological valve substitutes [8]. Resuspension of the aortic valve and supracoronary aortic replacement leaves diseased aortic wall tissue in place, which may lead to redissection or aneurysm formation of the sinus of Valsalva and subsequent aortic insufficiency (AI) [9,10].

Recently, several aortic valve sparing operations for replacement of the ascending aorta have been developed to overcome the shortcomings of mechanical prostheses. David and Feindel described a valve-preserving technique with complete resection of the ascending aorta and reimplantation of the native valve into a Dacron tube [11]. This technique is perfectly suited for patients with acute type A dissection since the sinuses are frequently involved in the disease process and can be completely replaced by prosthetic material. However, the reimplantation technique is more...
demanding than the standard techniques and its application to extremely sick patients presenting with acute aortic dissection type A may be debatable. At our institution, we have used the reimplantation technique as reported by David and Feindel in over 160 patients presenting with aneurysm of the ascending aorta. Low mortality and good durability of the repair encouraged us to apply this theoretically ideally suited technique to patients presenting with acute type A dissection. In the present study we report our midterm results of 22 patients that were treated exclusively with the reimplantation technique for acute aortic dissection type A.

2. Methods and patients

2.1. Patients

Between August 1995 and December 2000, 144 patients were admitted to our institution with acute dissection type A. In 68 cases (47%), we replaced the ascending aorta with a supracoronary tube graft. Replacement of the aortic valve with a composite graft carrying a mechanical valve was applied to 52 patients (36%). Twenty-two patients (15%) were operated with the valve-preserving implantation technique as described below. This subgroup was analysed in detail. Patient demographics and clinical data of patients undergoing valve reimplantation are listed in Table 1. Diagnosis of acute aortic dissection type A was established by computed tomography scans and/or transoesophageal echocardiogram. Most patients were diagnosed in external hospitals and transferred to our institution for emergency surgery. Preoperative grade of AI were determined in 20 patients by transthoracic or transoesophageal echocardiogram, whose findings are listed in Table 2. The final decision for valve-preserving aortic replacement was made by the surgeon intraoperatively and did not depend on the presence of AI. Routine intraoperative control of aortic valve function was determined with transoesophageal echocardiography in 19 patients. Before hospital discharge and at follow up, valve function was re-evaluated using transthoracic colour Doppler echocardiography. Valve morphology as well as systolic and diastolic function were assessed in accordance with published criteria [12]. Aortic regurgitation was assessed semi quantitatively as follows: 0, none; I, minimal; II, mild; III, moderate; IV, severe. Infectious, thrombembolic, and bleeding complications were recorded as required by the guidelines of the American Association for Thoracic Surgery/Society of Thoracic Surgeons [13].

Aortic valve reconstruction, patients were anticoagulated with Coumadin or Aspirin (at the discretion of the individual surgeon) to prevent thromboembolic complications for 3 months. Thereafter, anticoagulation therapy was discontinued.

Patient’s performance was assessed either directly or in a telephonic interview with regard to the classification of the New York Heart Association (NYHA).

2.2. Surgical procedure

For detection of peripheral malperfusion during the procedure, the anaesthesiologist placed arterial lines in both radial arteries and one femoral artery. During the preparation for the procedure, one leg was also surgically prepped and draped in all patients for vein graft harvest if required. Prior to median sternotomy and pericardectomy, the left femoral artery was dissected for arterial cannulation in unstable patients with pericardial effusion. In stable situation, cannulation of the ascending aorta and the right atrium for extracorporeal circulation was undertaken. Cooling to a rectal temperature of 28–30°C was initiated and myocardial protection was conducted with repetitive doses of cold blood cardioplegia in an antegrade fashion after aortic cross clamping and transection of the ascending aorta above the commissures. After careful inspection, the decision for reconstruction of the aortic valve depended on the morphological appearance of the cusps and root geometry. Only valves without gross structural defects, calcification, severe cusp prolapse or asymmetric geometry were selected for reconstruction. In case of dissection of the root involving the commissures, the wall layers were readapted with GRF glue. The operative technique used was recently described by our group [14]. In brief, after assessing the suitability of valve reconstruction, excision of the coronary ostia and resection of aortic sinuses up to a remnant of 2–3 mm, as well as extensive

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Patients’ demographics and preoperative clinical dataa</th>
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<tbody>
<tr>
<td>Number of patients</td>
<td>n = 22</td>
</tr>
<tr>
<td>Gender</td>
<td>15 males, seven females</td>
</tr>
<tr>
<td>Age ± SD</td>
<td>52 ± 15 years (20–77 years)</td>
</tr>
<tr>
<td>Dissected aorta</td>
<td>Ascending aorta (n = 3)</td>
</tr>
<tr>
<td></td>
<td>Ascending aorta + arch (n = 19)</td>
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<tr>
<td></td>
<td>Cardiogenic shock (n = 6)</td>
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<td>Malperfusion (n = 6)</td>
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<tr>
<td>Co-morbidities</td>
<td>CAD (n = 1)</td>
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<td></td>
<td>Prior HTx (n = 1)</td>
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<td></td>
<td>Marfan’s syndrome (n = 2)</td>
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a CAD, coronary artery disease; prior HTx, heart transplantation in the patients’ history before acute dissection type A; SD, standard deviation.

<table>
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<tr>
<th>Table 2</th>
<th>Echocardiographic assessment of grade of AI</th>
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<tr>
<td>Grade</td>
<td>Pre-operative</td>
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<tr>
<td>A</td>
<td>I</td>
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<tr>
<td>0</td>
<td>9</td>
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external dissection and mobilization of the aortic root, followed. Prosthetic diameters were calculated from the diameter of the left ventricular outflow tract and the height of the aortic cusps. Practically, the annulus was sized with a Hegar dilator and the sinotubular junction with a valve sizer (St. Jude Medical®, St. Paul, MN, USA). Valve coaptation was considered ideal if 30–50% of the cusp area was involved after modification of the sinotubular junction. Proximal anastomosis was performed with 12 threads of 3-0 coated polyester fibre (Ethibond®, Ethicon Inc., Hamburg, Germany) used as a horizontal mattress suture placed circumferentially through the annulus underneath the valve. The valve cuff was then reimplanted into the Dacron prosthesis using three 4-0 polypropylene sutures (Prolene®, Ethicon Inc.). Utmost care was taken to achieve correct cusp geometry and sufficient height of commissural resuspension within the prosthesis. If necessary, dissected coronary artery ostia were reconstructed using GRF glue. Reimplantation of coronary ostia button into the Dacron graft completed the root reconstruction.

During aortic valve reconstruction, extracorporeal circulation was interrupted in all patients, the aortic clamp removed, and the arch inspected carefully for additional entry tears. Cold (15°C) antegrade cerebral perfusion for further brain protection was initiated. Depending on the expansion of the dissection, the diseased aortic wall was either reconstructed with GRF-glue (n = 3 patients) or removed and the arch replaced by a second Dacron prosthesis (n = 19 patients). In case of more extensive distal dissection, an elephant-trunk extension of the arch prosthesis into the proximal descending aorta was used (n = 2 patients) [15]. The proximal and distal Dacron tubes were then sewn together followed by careful haemostasis. Following completion of rewarming, weaning from extracorporeal circulation and completion of the operation was conducted in a routine fashion.

3. Results

3.1. Intraoperative findings and perioperative results

Intraoperative findings confirmed the diagnosis of aortic dissection type A in all patients. In 19 patients (86%), the entry side of dissection was found in the ascending aorta, typically 2–5 cm above the valvular commissures. In two cases, the entry site was located in the aortic arch, and in one patient an entry tear could not be identified. In all the 22 patients, the reconstruction of the aortic valve by reimplantation in a Dacron prosthesis was feasible. Nineteen patients (86%) were treated with additional partial or complete aortic arch replacement, and two patients (9%) received an elephant trunk extension into the dissected descending aorta. Further, additional procedures included coronary artery bypass graft (CABG) in one patient, surgical fenestration of the dissection membrane of the abdominal aorta in two patients, and Gore-Tex interposition grafting for dissected supraaortic arteries in two patients. Implantation of an aortic bifurcation-prosthesis, closure of an atrial secundum defect, femoro-femoral bypass grafting, and ligation of the left subclavian artery were each necessary in one patient. For arterial cannulation, the femoral artery was chosen in 12 patients, the ascending aorta in three patients and the aortic arch in seven patients.

Due to the time-consuming reconstruction technique, time of extracorporeal circulation [215 ± 56 min (134–352 min)] and aortic cross clamp time [157 ± 24 min (114–205 min)] were relatively long. Average circulatory arrest for patients with arch replacement was 35 ± 18 min (11–75 min). Stay in intensive care unit (ICU) was surprisingly short with 2.1 ± 0.7 days, and mean hospitalization time was 21 ± 14 days.

Perioperative mortality was 14% (three patients). One patient was initially treated with streptokinase for suspecting acute myocardial infarction in an external hospital. She was transferred to our institution for left heart catheterization and coronary angiography 3 days later and eventually diagnosed for acute aortic dissection Type A involving the main supraaortic arteries and the abdominal aorta. During immediate initiated transport to the OR, she was resuscitated prior to the establishment of extracorporeal circulation. After aortic valve reimplantation, replacement of the aortic arch, reconstruction of the supraaortic branches with GRF glue, ligation of the left subclavian and left vertebral arteries and implantation of a Y-prosthesis into the abdominal aorta due to peripheral malperfusion complicated the procedure. She died shortly after being transferred to the ICU for multiorgan failure. Another patient, diagnosed on the day of the procedure, died 4 days after an uneventful operation and early postoperative course due to massive cerebral oedema. A third patient, treated with replacement of the aneurysmatic abdominal aorta before, presented with abdominal pain to an external hospital. Computed tomographic (CT) scan of the aorta, the next day, revealed a type A dissection reaching from the aortic valve annulus to the abdominal graft. After aortic valve reconstruction and fenestration of the dissection membrane in the aortic arch, distal malperfusion required laparotomy showing severe ischaemia of the bowl. After additional fenestration of the proximal abdominal aorta, distal pulses were present again. However, diffuse bleeding and haemodynamic instability led to exitus in tabula.

One patient required reexploration of the mediastinum for bleeding postoperatively. The majority of the patients who underwent intraoperative echocardiographic control after aortic valve reconstruction showed no AI (84%), while more than trace AI (grade I) was not found in any patient (Table 2).

3.2. Follow up

Mean follow up time was 18.4 ± 18 months (0.4–65.4
months). One patient died 10 months postoperatively due to onset of ventricular fibrillation. Latest echocardiographic control revealed no significant AI. None had to be reoperated for AI, all patients presented with AI grade 0 or I. Compared to intraoperative and early postoperative echocardiographic findings, there was no significant decrease in valve function (mean grade of AI 0.16 versus 0.31). Results of last echocardiographic follow up are demonstrated in Table 2. Structural changes of the aortic leaflets were not detected.

During follow up, one patient received Coumadin after peripheral vascular grafting due to atherosclerosis. Seven patients received aspirin for various indications by their home physician. No patient had to be anticoagulated for cardiac reasons. No bleeding or thromboembolic complications have been reported.

At the latest follow up, all patients presented with a favourable exercise tolerance being in NYHA functional class I or II.

4. Discussion

In addition to the ongoing discussion of the proper treatment for the aortic root in patients with acute aortic dissection type A, the results of our study clearly demonstrate the feasibility of valve sparing aortic root reconstruction using the reimplantation technique. Acceptable hospital mortality and low morbidity paired with excellent midterm stability of the reconstructed valve may support the use of this surgical strategy as an alternative to established treatment forms.

Major advantage of the reimplantation technique is the almost complete resection of diseased aortic tissue, a clear advantage compared to supracommissural tube graft replacement. Although the mechanism of the development of secondary aneurysmatic dilatation of the aortic root after supracommissural replacement remains unclear and may be multifactorial, these aneurysms are the main reason for reoperations due to development of moderate to severe aortic regurgitation with an incidence of 25–45% [4,10,16,17]. In patients with structurally impaired aortic wall tissue such as Marfan’s syndrome and in those who had acute dissection with pre-existing annuloaortic ectasia on the basis of cystic medial necrosis, the incidence may be even higher and composite replacement has been recommended [4,18].

Dissection into the sinus of Valsalva represents a frequently observed feature. Gluing the sinus tissue with GRF glue and consecutive supracommissural aortic tube replacement, the most common surgical approach, may offer a relatively simple and quick operative treatment, but leaves diseased aortic tissue in place ignoring the underlying aortic wall pathology. Furthermore, tissue necrosis has been hypothesized despite the absence of histological proof in operations where GRF glue had been used [19]. Possible redisssection or aneurysm formation may bear a vital risk for the patient and may require further operation of the proximal ascending aorta.

Complete resection of all diseased tissue avoids these problems. The replacement of the aortic wall and the dissected ascending aorta with a composite graft carrying mechanical valve prosthesis represents an established surgical treatment with excellent results [20,21]. However, the lifelong need for anticoagulation with the risk for bleeding and possible thromboembolic events after mechanical valve replacement cause complications with an annual incidence of 2–4% as reported in the literature [6,7]. These complications can be avoided by the use of the valve-preserving reimplantation technique. After endothelialization of the suture lines, anticoagulation is not required. In a recent study, we reported a matched pair analysis of patients with ascending aortic aneurysm treated either with composite replacement or the valve sparing reimplantation technique. We observed no bleeding or thromboembolic complications in the latter group, although there were significantly more events in the first postoperative year after composite replacement [22]. In addition, absence of anticoagulation is particularly appealing in patients requiring additional surgery due to aneurysmatic transformation of dissected distal aortic segments.

Recently published studies have demonstrated the feasibility of valve sparing aortic root operations in acute aortic dissection type A. Graeter et al. based their decision making additional surgery due to aneurysmatic transformation of dissected distal aortic segments.

Reconstructive aortic valve surgery in emergency situations such as acute aortic dissection type A remains challenging. Prolonged operation time with expansion of aortic cross clamp and extracorporeal circulation time is a potential drawback for application of this technique. Also, a substantial experience with this technique in elective cases is required if application under emergency situations is carried out. However, it would be highly speculative to link the
prolonged procedure time to our observed perioperative mortality of 14%. Two of the three patients who died perioperatively presented to our institution with a delay of 1 and 3 days, respectively, after the onset of symptoms. Both patients were severely impaired by additional complications such as malperfusion. Although 22 patients represent a selected cohort with respect to aortic valve and root morphology, the high incidence of co-morbidities in survivors indicates a typical profile for patients with acute aortic dissection type A.

In conclusion, valve sparing aortic root reconstruction using the reimplantation technique in patients with acute aortic dissection type A is feasible in selected patients with morphologically intact valve cusps. Our midterm results show excellent valvular stability without an increased operative risk. Rare bleeding complications early postoperatively, freedom from anticoagulation as well as complete resection of diseased tissue is particularly appealing and represent unquestionable advantages to established methods. In our centre, the described reimplantation operation advanced to the procedure of choice in patients suffering acute aortic dissection type A with intact valve cusps and/or aortic tissue defects. Further long-term studies must prove whether these benefits will outweigh the potential risk for reoperation.

References


