Is size-reducing ascending aortoplasty with external reinforcement an option in modern aortic surgery?

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Abstract

Objective: Enlargement of the ascending aorta is often combined with valvular, coronary, or other cardiac diseases. Reduction aortoplasty can be an optional therapy; however, indications regarding the diameter of aorta, the history of dilatation (poststenosis, bicuspid aortic valve), or the intraoperative management (wall excision, reduction suture, external reinforcement) are not established. Methods: In a retrospective study between 1997 and 2005, we investigated 531 patients operated for aneurysm or ectasia of the ascending aorta (diameter: 45—76 mm). Of these, in 50 patients, size-reducing ascending aortoplasty was performed. External reinforcement with a non-coated dacron prosthesis was added in order to stabilize the aortic wall. Results: Aortoplasty was associated with aortic valve replacement in 47 cases (35 mechanical vs 12 biological), subvalvular myectomy in 29 cases, and CABG in 13 cases. The procedure was performed with low hospital mortality (2%) and a low postoperative morbidity. Computertomographic and echocardiographic diameters were significantly smaller after reduction (55.8 ± 9 mm down to 40.5 ± 6.2 mm (CT), p < 0.002; 54.1 ± 6.7 mm preoperatively down to 38.7 ± 7.1 mm (echocardiography), p < 0.002), with stable performance in long-term follow-up (mean follow-up time: 70 months). Conclusions: As demonstrated in this study, size reduction of the ascending aorta using aortoplasty with external reinforcement is a safe procedure with excellent long-term results. It is a therapeutic option in modern aortic surgery in patients with poststenotic dilatation of the aorta without impairment of the sinotubular junction of the aortic valve and root.

Keywords: Aortic surgery; External reinforcement; Ectasia

1. Introduction

Ectasia of the ascending aorta is defined as a disproportional dilation of all three layers of the aortic wall beginning at the aortic annulus up to the inominate artery. The main underlying reasons are known as atherosclerosis, or collagen disorders, such as cystic medial necrosis or Marfan's disease [1—3]. Depending on the underlying pathomorphology the indication of surgical repair is commonly given at a diameter between 45 and 55 mm or when other complications such as dissection or rupture have occurred [4]. Until today the widest spread surgical therapy is the replacement of the dilated sections with or without additional replacement or reconstruction of the aortic valve [5].

However, by the Law of Laplace, the risk of further dilation and rupture increases with the rising diameter.

2. Patients and methods

In a retrospective study between 1997 and 2005, we investigated 531 patients operated for aneurysm or ectasia of the ascending aorta. The diameter was measured between 45 and 76 mm using both computertomography and transthoracic echocardiography preoperatively. Out of this entire cohort 50 patients (9.4%) underwent size-reducing ascending aortoplasty. The maximum diameter of the ascending aorta in this group was measured between 45 and 65 mm without dilatation of the sinotubular junction and normal values in the...
area of the aortic arch. Only eight patients suffered from reduced left ventricular function with an ejection fraction (EF) below 50%.

2.1. Operative details

All procedures were performed with the typical access using a median sternotomy. Extracorporeal circulation, thereafter, was established and cold crystalloid cardioplegia in form of Bretschneider’s solution was applied. All procedures were done in moderate hypothermia (30 °C). The main operation, i.e. aortic valve replacement, was then carried out: 35 patients received mechanical valves, 12 biological. Twenty-nine patients underwent additional subvalvular myectomy, 13 more patients received additional coronary bypass grafting. The pressure gradients of the aortic valve were between 0 and 95 mmHg (mean 63 ± 21 mmHg), valve orificium area between 0.4 and 2.8 cm² (mean 1 ± 0.5 cm²). In two patients already former cardiac surgery had taken place. Fourteen patients showed natively bicuspid valves.

The entire operation duration was between 130 and 315 min (mean 213 ± 74 min), the cross-clamp time was between 39 and 138 min (mean 99 ± 24 min).

Reduction aortoplasty was carried out using a longitudinal incision with subsequent resection of an oval wall segment at the maximal convexity of the ascending aorta as described by Robicsek and Thubrikar [6]. The aortic wall was closed with 4-0 Prolene double running sutures. Besides this external reinforcement with a non-coated dacron prosthesis was added in order to stabilize the aortic wall (Fig. 1).

The main pre- and intraoperative characteristics of all patients are shown in Table 1. Fig. 2 shows additionally the comparison of computertomographic and echocardiographic diagnosis for the widest diameter of the ascending aorta.

2.2. Follow-up and statistical analysis

Complete follow-up data were available in 31 patients with a mean interval of 59 months.

Descriptive measures are given as mean values with the standard error of the mean (SEM). Comparisons between groups were performed using the $X^2$-test or with Student’s $t$-test, as appropriate. A $p$-value ≤ 0.05 was considered to be statistically significant.

<table>
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<tr>
<th>Variable</th>
<th>n</th>
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<tbody>
<tr>
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<tr>
<td>Sex</td>
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<td>2</td>
</tr>
<tr>
<td>Biological aortic valve replacement</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

3. Results

There were four cases of immediate perioperative death within 30 days in the entire study group. The patients died either due to massive hemodynamic instability on the basis of a SIRS in the early postoperative course or due to severe pulmonary infection. The intraoperative courses had mainly run uneventful without severe catecholamine therapy.

In only two cases with preoperatively known reduced EF further circulatory support at the attempt of reducing the extracorporeal circulation was necessary. Stay on ICU respectively intermediate care unit was between 1 and 44 days (mean 4.4 ± 7.8 days). Prolonged ventilation due to impaired pulmonary function was needed in three cases. The entire duration of ventilation was between 0 and 170 h (mean 16.2 ± 31.9 h). One patient developed transient neurologic

![Fig. 1. External wrapping by reinforcement with a non-coated, cut-open Dacron prosthesis (A–C), normal diameter in the area of the aortic arch.](https://academic.oup.com/ejcts/article-abstract/31/4/614/394894)

![Fig. 2. Comparison of the widest preoperative diameters (mm) as estimated from transthoracic echocardiography (TTE) and computertomography (CT).](https://academic.oup.com/ejcts/article-abstract/31/4/614/394894)
Reduction aortoplasty could lead to a significant reduced diameter of the ascending aorta from 55.8 ± 9 mm down to 40.51 ± 6.2 mm as measured by CT scan. The echocardiographic values were 54.1 ± 6.7 mm preoperatively down to 38.7 ± 7.1 mm. Figs. 3 and 4 show the plot as well as the statistical significance concerning the long-term reduction of the aortic diameters with both measurements in the postoperative course.

In no case was a clue for valvular dysfunction observed; one patient showed chronic dissection as an incidental finding and was scheduled for re-operation.

4. Discussion

It has been a widespread accepted opinion that surgical repair in ectasia or aneurysm of the ascending aorta should be recommended on the base of the current diameter. Both normal values and pathologic changes, including also the morphologic character, however, depend on a variety of reasons. Under physiologic circumstances the size of the ascending aorta is significantly correlated to the body surface area (BSA) and the patient’s age [7]. Nowadays, there is general agreement that surgical intervention is indicated in adults at a diameter of 55 mm for degenerative aneurysms but in Marfan’s diseases or those with family history even at smaller values between 45 and 50 mm, especially in cases of size progression [8]. For these special entities and relatively large diameters, there seems to exist no other alternative than the replacement of the ascending aorta with or without aortic valve replacement.

In many other cases, especially in concomitant ectasia due to poststenotic or insufficient dilation on the basis of aortic valve disease serious efforts have been made to preserve the native aorta. The underlying rationale is to leave the endothelium-lined aorta where it is and to reduce the degree of surgical invasivity. In the debate of aortic annuloplasty versus ascending aorta replacement issues of indication, the risk of a wider operation with prolonged cross-clamp times and increased risk of bleeding on the one hand as well as late complications on the other hand seem to be most important [9].

The major concern, however, is the long-term follow-up with special regard to survival and redilatation. In our series we could present a complete long-term follow-up in 13 patients including 6 years. The freedom from cardiac-related death in this group was 100%. These results are congruent to the report of other groups, such as Polvani and colleagues or Bauer and colleagues [10—12]. A current view from the literature in concern of redilatation shows different results lasting from an incidence between 0 and 25% [10—13]. The reasons for this maybe seen almost in all cases of homogenous patient populations suffering from different origins of valve disease, and sometimes small number of cohorts.

There is general agreement that patients with ascending aortic aneurysm having a diameter more than 60 mm should not undergo reduction aortoplasty [14]. Regression analysis could already show that the risk of redilatation is significantly increased, when the diameter oversteps 55 mm [10]. Many authors see the cutoff at this point [10—13]. Our current series shows in this context that reduction aortoplasty might be useful even in greater diameters, if the aortic wall quality is acceptable as judged by the surgeon.

Another important aspect is the immediate postoperative diameter of the ascending aorta, i.e. the significance of size reduction. It has become a common concept to perform at least a reduction with the aim to receive a postoperative diameter below 40 mm. Our results show that even in the long-term follow-up no significant further dilation has taken place.

The limitations of the study should be seen in the relatively small number of patients in whom complete and long-term follow-up was available, besides that the investigation represents a study by nature that is not randomized. In our group reduction aortoplasty with additional reinforcement results in a safe and effective technique with low mortality, low morbidity, and only a few late complications for selected chronic aneurysms in the absence of...
structural disease. Seeing the long-term survival rates and the efficacy of the method, and the uneventful immediate perioperative course, it represents nowadays a standard concept for surgical treatment of such kind of disease.

In conclusion, reduction aortoplasty is not a replacement for time-proven modern aortic operation such as Bentall's or David's procedure. It is rather an additional option in a limited group of patients suffering from concomitant aortic valve disease. It is rather an additional option in a limited group of patients suffering from concomitant aortic valve disease. It is rather an additional option in a limited group of patients suffering from concomitant aortic valve disease. It is rather an additional option in a limited group of patients suffering from concomitant aortic valve disease.

Appendix A. Conference discussion

Dr D.C. Miller (Stanford, California, USA): So it works in Dusseldorf too, as we read it works in Berlin with Roland Hetzer's group. On the other hand, I don't know many who still believe in this aortoplasty operation with or without external wrapping. How many of the aortic valves were bicuspid valves?

Dr Feindt: No one.

Dr Miller: No bicuspid aortic valve disease?

Dr Feindt: No.

Dr Miller: They were all trileaflet aortic valves?

Dr Feindt: Yes.

Dr Miller: Interesting.

Dr H. Sons (Kassel, Germany): Did you make a decision only on the macroscopic view intraoperatively, or did you use some histological examinations during surgery or later on? Exactly, do you prove it by histology intraoperatively or only by your view?

Dr Feindt: We have histological examination from all these 50 patients, but after. And we have in no case a collagen disease or something else.

Dr Sons: No cases with disturbance?

Dr Feindt: No.

Dr Sons: I think you made the point and that's why it works.

Dr B. Zipfel (Berlin, Germany): What are you going to do with these patients who have aortic valve disease and an ascending diameter between 50 mm and 65 mm? I think it's a quite high threshold to indicate surgical correction above 65 mm. What are you going to do with these patients in between?

Dr Feindt: The patients in between, we look at the history and all the other things for our indications. And if a patient has a diameter of the aorta between 50 and 60, and the root is okay, the arch is okay, and we see intraoperatively that the wall of the aorta is not too thin, it's normal, but with, for example, a poststenotic dilatation, we also use this procedure.

Dr T. Savunen (Turku, Finland): Your personal opinion, do you really think that there could be a dilation of ascending aorta without any connective tissue disease in the wall of the aorta, except for poststenotic dilatation? Do you really think so?

Dr Feindt: I don’t know.

References