

Conservative treatment of the aortic root in acute type a dissection¹

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Abstract

Objective: In acute type A dissection long-term results of conservative aortic root surgery were compared with the outcome of primary valve and/or root replacement. **Methods:** Between 1985 and 1995, 199 patients (mean age 59 years, 154 men) were operated on. The aortic root was involved in the dissection process and valve incompetence of varying degree was present without exception. Replacement of a proximal aortic segment was standard procedure in all patients. The aortic valve was preserved in 126 patients: commissural suture resuspension (12 patients), root reconstruction with GRF-glue (gelatine-resorcin-formaldehyde/glutaraldehyde-glue) (114 patients). Valve replacement was performed in 73 patients (50 composite grafts, 23 valve prostheses with separate supracoronary grafts). Preoperative risk factors (valve replacement vs. preservation): coronary artery disease (11 vs. 8%, NS), tamponade (18 vs. 17%, NS), unstable hemodynamics (22 vs. 15%, NS), renal failure (4 vs. 6%, NS), neurologic disorder (19 vs. 32%, NS). **Results:** The overall early mortality was 23.6% (47/199 patients) and increased after commissural suture resuspension compared with GRF-glue reconstruction ($P = NS$). Parameters of the early postoperative period did not differ between conservative treatment and root/valve replacement: low cardiac output, 34 versus 38% ($P = NS$); myocardial infarction, 10 versus 11% ($P = NS$); hemorrhage, 25 versus 23% ($P = NS$); duration of intensive care ($P = NS$). Survival was 61% after 8 years without difference between the two principal treatment groups ($P = NS$) and between the two conservative subgroups ($P = NS$). At 2 years, GRF-glue reconstruction had an increased freedom from reoperation on the aortic root (92 vs. 70%, $P = 0.0253$) and event free survival (77 vs. 41%, $P = 0.0224$) compared with suture resuspension. Commissural suture resuspension was an independent, significant predictor for reoperation ($P = 0.0221$, relative risk = 4.7130). **Conclusion:** Surgery for acute type A dissection still carries a considerable early risk. Preservation of the aortic root is safe in the absence of Marfan or annuloaortic ectasia, but a certain incidence of reoperations on the aortic valve and the aortic root has to be accepted. Root reconstruction using GRF-glue is the method of choice and is superior to suture resuspension, with a significantly better reoperation-free and event-free survival. © 1999 Elsevier Science B.V. All rights reserved.

Keywords: Aortic dissection; Ascending aorta; Aortic root; Aortic valve; Valve reconstruction; Composite graft

1. Introduction

In acute dissection of the ascending aorta undelayed surgery is the therapy of choice with superior results compared with conservative treatment [1–3]. During the emergency operation important decisions have to be taken by the surgeon concerning the extent of aortic replacement and the

application of appropriate surgical techniques. One of the key questions is whether the aortic root and/or aortic valve can be safely preserved. Handling of the dissected aorta is most demanding and technically difficult. Therefore, a more conservative approach preserving pertinent structures and avoiding extensive suturing and anastomoses seems reasonable, especially in view of bleeding complications. Avoiding the implantation of foreign material could additionally reduce the risk of endocarditis and thromboembolism. The dissection process and the related pathology of the aortic wall are mostly diffuse and widespread. This aspect would favor a more complete replacement procedure in order to

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prevent recurrent dissection and future aneurysmatic or degenerative changes of the aortic root indicating reinterventions. In view of these controversies we have evaluated our early and late surgical results of type A dissection. Conservative and valve preserving techniques were compared with primary valve and/or root replacement.

2. Materials and methods

Between 1985 and 1995, 199 patients (mean age 59 years, 154 men) had emergency surgery for acute type A aortic dissection (Stanford-classification [4]) at the University Hospital of Zurich, Switzerland. The mean interval between onset of symptoms and operation was 13.2 h (minimum 5 h, maximum 24 h, SD \pm 6.6 h). Clinical data were obtained by a retrospective review of hospital records. Postoperative follow-up data contain periodical follow-up reports of cardiologists and written and/or telephone communication with the patients or their physicians. A follow-up of more than 1 month was known in 143/152 early survivors (94%) with a mean duration of 37.4 months (maximum 133 months) totaling 617 patient-years. Demographic and preoperative clinical data are listed in Table 1.

In 90% of patients the diagnosis of acute dissection was based on echocardiography in conjunction with the recent medical history. In the whole study population, the aortic

root was involved in the dissection process and aortic valve incompetence of varying degrees was diagnosed without exception.

Replacement of an aortic segment including the ascending aorta was standard procedure and performed in all 199 patients. In 126/199 patients (63%) the aortic root including the valve could be preserved. In 114/126 patients (91%) of this conservative group root- and valve reconstruction was performed using GRF-glue (gelatine-resorcin-formaldehyde/glutaraldehyde glue (Trigon GMBH, Mönchengladbach, Germany). In the remaining 12/126 patients (9%) valve and/or root reconstruction was performed using commissural suture resuspension.

In 73/199 patients (37%) the aortic valve or the complete aortic root were replaced. Root replacement by composite graft insertion was performed in 50/73 patients (69%). Marfan's disease or clear annuloaortic ectasia indicated complete root replacement with a composite graft. In 23/73 (31%) patients prosthetic aortic valve insertion was performed together with supracoronary graft replacement of the ascending aorta. The implanted aortic valve prosthesis was mechanical in 64 patients and biological in nine patients.

A total of 18 patients had a known history of coronary artery disease. In the preoperative evaluation a relevant coronary artery disease was found in 15 patients of the replacement group (21%) and in 17 patients of the conservatively treated group (14%) all of whom had simultaneous coronary artery bypass grafting (CABG).

Table 1

Demographic and preoperative clinical data. Unstable hemodynamics are defined as systolic arterial blood pressure below 90 mmHg

Parameters	Valve/root preservation (n = 126)	Valve/root replacement (n = 73)	P
<i>Gender</i>			
Male	94 (75%)	60 (82%)	0.2175
Female	32 (25%)	13 (18%)	
Mean age (years)	60.3 \pm 12.2	56.7 \pm 14.7	0.07185
Mean OP-delay	7.6 \pm 5.8 h	9.4 \pm 3.0 h	0.17268
CAD	10 (8%)	8 (11%)	0.4738
Pericardial tamponade	22 (18%)	13 (18%)	0.9505
Unstable hemodynamics	20 (16%)	16 (22%)	0.2857
Neurologic disorder	40 (32%)	14 (19%)	0.0547
Renal failure	7 (6%)	3 (4%)	0.6527
LVEF <45%	10 (9%)	10 (14%)	0.1926
Aortic sinus (mean \emptyset)	39.7 \pm 7.8 mm	52.0 \pm 10.0 mm	0.0088
Aortic annulus (mean \emptyset)	26.7 \pm 3.4 mm	28.9 \pm 8.1 mm	0.9431
Ascending aorta (mean \emptyset)	57.8 \pm 15.1 mm	61.7 \pm 13.0 mm	0.1275
AI severe	20 (16%)	40 (55%)	<0.0001
AV pathology severe	1 (0.8%)	19 (26%)	<0.0001
Coronary ostial dissection	15 (21%)	10 (8%)	0.0097

OP-delay, interval between onset of symptoms and emergency operation. Abbreviations: CAD, coronary artery disease (in medical history); LVEF, left ventricular ejection fraction; AI, aortic insufficiency; AV, aortic valve.

2.1. Surgical technique

A standard median sternotomy was performed and total cardiopulmonary bypass was instituted by cannulation of the femoral artery and the right atrium. Hypothermic circulatory arrest was applied in a total of 108 patients (54%) for the performance of an open distal anastomosis and for arch replacement. In all 199 patients retrograde cold blood cardioplegia with high potassium content was applied for cardioplegia using a transatrial cannulation of the sinus venosus. The left heart was vented through a transmitral catheter.

In the root/valve replacement group mean aortic cross-clamp time was 90 \pm 31 min, circulatory arrest time was 16.9 \pm 9.7 min and extracorporeal circulation time was 155 \pm 79 min. In the root/valve preservation group the corresponding figures were 60 \pm 22 min (P < 0.0001), 18.3 \pm 8.9 min (P = 0.389342) and 122 \pm 63 min (P = 0.000038).

2.2. Graft replacement

In all 199 patients a variable segment of the proximal aorta was replaced by a Dacron polyester tube graft. The extent of aortic replacement was principally determined by the localization of the entry tear. Arch replacement was performed in case of aneurysmal dilatation, impending rup-

ture or if this aortic segment contained an intimal rupture. In the preservative group arch replacement was performed in 41/126 (33%) patients (total arch, three patients; hemiarch, 38 patients). In the replacement group 21 (29%) patients ($P = 0.5797$) had arch replacement (total arch, three patients; hemiarch, 18 patients).

For composite graft implantation the open technique with resection of the diseased aortic segment and reimplantation of the coronary ostia with an aortic button [5] was applied in 16/50 patients (32%). The inclusion technique (wrapping of the graft with remnant aortic wall) was used in 34/50 patients (68%). In 15 patients with graft inclusion (44%) the perigraft space was decompressed with a shunt to the right atrium [6]. In 153 patients (supracoronary graft, 114; composite graft, 16; AV replacement + supracoronary graft, 23) the dissected aortic wall at the level of the distal graft to aorta anastomosis was readapted with GRF-glue in order to reinforce the aortic wall tissue and to get a more secure and reliable anastomotic suture. The adhesive was warmed to 45°C and applied in two components on a dry and bloodless field. With special clamps corresponding wall segments were held in anatomic position. With an intraluminal Fogarty balloon they were kept under pressure for 3 min until glue polymerization. With a second balloon, placed several cm distal into the aortic arch or into the proximal descending aorta, a disappearance of glue into an extended distal dissection was avoided.

2.3. Conservative treatment of the aortic root

A similar gluing technique was used for the reconstruction of the aortic root and the proximal aorta to graft anastomosis in 114 patients. Dissected valve commissures were anatomically repositioned and fixed with the tissue adhesive. Care was taken not to contaminate the aortic valve or the coronary ostia.

In 12 patients root reconstruction was performed using transmural and pledgetted resuspension sutures of the valve commissures. All graft to aorta anastomoses were secured with an external Teflon felt strip. If the dissection extended into the aortic arch and/or the descending aorta reperfusion was performed in an antegrade fashion by cannulation of the graft in order to avoid retrograde redissection.

2.4. Statistical analyses

The Statistica software package (Stat Soft, 1993) and SPSS (SPSS, Chicago, IL) were used for statistical analysis. Continuous variables were summarized as the mean \pm SD. Survival and event-free probabilities \pm SE were calculated by actuarial analyses [7]. Differences between survival curves were estimated using the log-rank test. Predictors for mortality and reoperation were determined by univariate and multivariate analysis. In univariate analysis discrete variables were analyzed by the Chi² or Fisher's exact test. Continuous variables were analyzed by the Mann–Whitney

test. Statistical significance was associated with a P -value of less than 0.05. Selected variables were entered into multivariate analysis by a stepwise logistic regression or by Cox proportional hazard regression to determine independent predictors. The following variables were tested: age, gender, Marfan disease, operation-period, diameter of aortic annulus and of ascending aorta, unstable preoperative hemodynamics, pericardial tamponade, preoperative renal failure, preoperative neurologic disorder, severe aortic regurgitation, severe degeneration of aortic valve, reduced LVEF, inclusion technique, aortic root replacement, valve replacement, mechanical or biological valve prosthesis, suture resuspension of aortic valve, replacement of aortic valve and of supracoronary aorta, root reconstruction with GRF-glue, aortic arch replacement, CABG, aortic cross-clamp time, ECC duration, duration of circulatory arrest, perioperative myocardial infarction, low cardiac output, rethoracotomy.

3. Results

Early mortality in all 199 patients was 23.6% (47/199 patients). In the valve/root-replacement group early mortality was 20.6% (15/73 patients) compared with 25.4% (32/126 patients) in the valve/root-reconstruction group ($P = 0.43767$). In the subgroup with root reconstruction the resuspension technique had an early mortality of 8.3% (1/12 patients; 95% confidence limits: 0–26%) compared with 27% (31/114 patients; 95% confidence limits 19–36%) in the GRF group ($P = 0.2931$).

Univariate significant predictors for early mortality were: age ($P = 0.0017$), preoperative unstable hemodynamic situation ($P = 0.0512$), pericardial tamponade ($P < 0.0001$), aortic valve morphology ($P = 0.0281$), inclusion technique ($P = 0.0198$), simultaneous coronary artery bypass grafting ($P = 0.0034$), duration of extracorporeal circulation ($P < 0.0001$), perioperative infarction ($P = 0.0034$), postoperative low cardiac output ($P < 0.0001$). Independent significant risk factors for early mortality were: gender ($P = 0.0250$, relative risk 2.7341), pericardial tamponade ($P = 0.0001$, relative risk 7.2506), severe valve degeneration ($P = 0.0057$, relative risk 4.2070), duration of extracorporeal circulation ($P = 0.0069$, relative risk 1.0085/min), perioperative infarction ($P = 0.0056$, relative risk 4.9381), postoperative low cardiac output ($P = 0.0386$, relative risk 2.4534).

Overall survival was 76.4 \pm 3.0% after 30 days, 71.4 \pm 3.3% after one year and 61.3 \pm 4.4% after 8 years. Survival was not significantly different ($P = 0.13746$) between the two principal treatment groups (valve/root preservation vs. valve/root replacements, Fig. 1) and between the two subgroups of root reconstruction (suture resuspension vs. GRF-glue reconstruction, $P = 0.47930$; Fig. 2). Survival was not significantly different ($P = 0.48712$) when three treatment groups were compared: (I) conservative root surgery (aortic

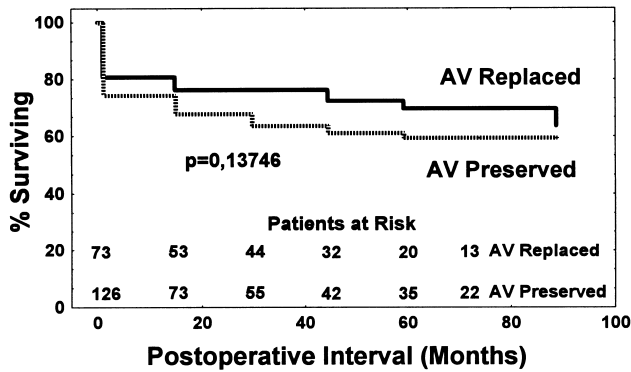


Fig. 1. Actuarial survival comparing valve/root replacement with preservation in acute dissection. AV = aortic valve.

root and valve preservation, $n = 126$) (II) composite graft replacement of the aortic root ($n = 50$) (III) isolated aortic valve replacement with supracoronary graft replacement of the aorta ($n = 23$) [12]. Univariate significant predictors for late mortality were: age ($P = 0.0580$), suture resuspension of the aortic valve ($P = 0.0366$) and use of IABP postoperatively ($P = 0.0007$). Independent significant predictors of late mortality were: duration of hypothermic circulatory arrest ($P = 0.0341$, relative risk 1.0307/min), perioperative infarction ($P = 0.0321$, relative risk 3.9884), postoperative IABP ($P = 0.0032$, relative risk 24.1103).

Cause of death (root/valve replacement group vs. root/valve reconstruction group) was: low cardiac output, 7 versus 14 ($P = 1.0$); myocardial infarction, 0 versus 1 ($P = 1.0$); hemorrhage, 5 versus 10 ($P = 0.9998$); sepsis, 1 versus 5 ($P = 0.6566$); neurologic disorder, 4 versus 12 ($P = 0.7584$); sudden death, 1 versus 1 ($P = 0.5319$); malignant tumor, 1 versus 0 ($P = 0.3134$); other causes, 2 versus 4 ($P = 0.9901$).

Frequency rates and actuarial results of follow-up variables (overall reoperation rate, rate of AV reoperation, survival, freedom from all reoperations, freedom from aortic valve reoperations, freedom from late events) comparing four treatment groups (valve/root replacement vs. valve/root preservation; suture reconstruction of aortic root versus GRF-glue reconstruction) are indicated in Fig. 3 and Table

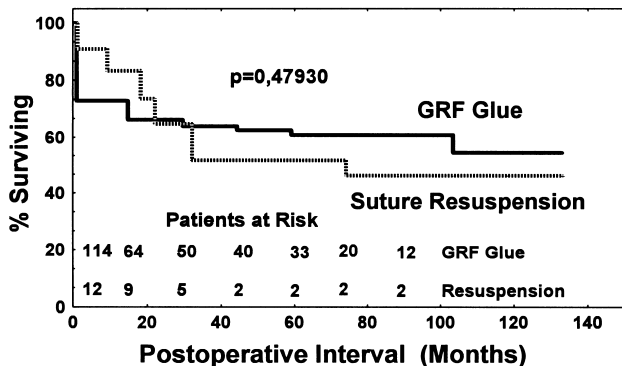


Fig. 2. Actuarial survival comparing GRF-glue reconstruction of the aortic root with commissural suture resuspension. GRF = gelatine-resorcin-formaldehyde/glutaraldehyde glue.

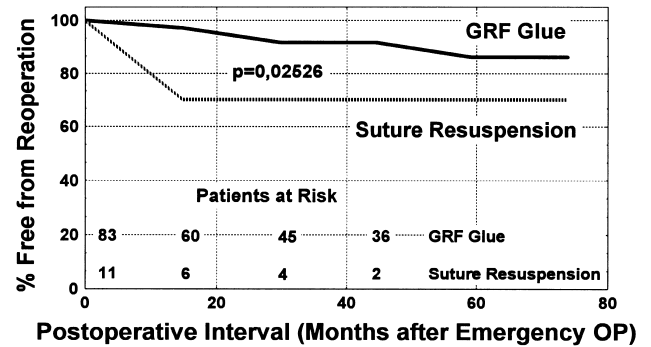


Fig. 3. Actuarial freedom from aortic valve reoperation comparing GRF-glue reconstruction of the aortic root with commissural suture resuspension. GRF = gelatine-resorcin-formaldehyde/glutaraldehyde glue.

2. Parameters of the early postoperative period and the late follow-up are listed in Table 3.

3.1. Reoperation

After a mean postoperative interval of 34.6 ± 35.2 months a total of 22 reoperations had to be performed on the aortic root and the aorta including their side branches (Table 2). After suture resuspension of the aortic valve late composite graft replacement of the aortic root had to be performed in three patients (25%). Following glue reconstruction of the aortic root 11 patients (9.7%) were reoperated at the level of the proximal aorta. Composite graft replacement of the aortic root was performed in four patients, and mechanical valve replacement in seven patients including a separate replacement of the ascending aorta in three of them.

Resuspension of the aortic valve was a significant predictor for reinterventions on the valve in univariate ($P = 0.0119$) and multivariate analysis ($P = 0.0221$, relative risk 4.7130).

4. Discussion

In acute ascending aortic dissection surgical mortality and morbidity [8,9] remained considerable despite numerous diagnostic and therapeutic improvements over the last decades. In the present series, early mortality was 23.6% paralleling many reports in the literature [8–11]. This unchanged fatality may reflect an increasing number of high risk patients referred for an emergency operation which presents an unchanged challenge to the surgeon.

The proximal aorta is the primary target of the emergency intervention in order to prevent death from complete rupture of the dissected aorta and from heart failure due to acute and massive valve regurgitation.

4.1. Aortic root replacement

In this case, 15% of the patients presented with an acute

Table 2

Late results. Differences between survival- and event free probabilities were calculated by the log rank test. For event free survival analyses early mortality was excluded

	Valve/root replacement (<i>n</i> = 73)	Valve/root reconstruction (<i>n</i> = 126)	<i>P</i>	Valve/root reconstruction (<i>n</i> = 126)		
				Suture (<i>n</i> = 12)	GRF (<i>n</i> = 114)	<i>P</i>
Survival at 2 years	76.4 ± 5.0%	66.3 ± 4.4%	0.1374	64.8 ± 14.3%	66.7 ± 4.6%	0.4793
Reoperation rate (all reop.)	7 pat. (9.6%)	15 patients (11.9%)	0.6156	4 patients (33.3%)	11 patients (9.7%)	0.0160
Reoperation free at 2 years (all reop.)	96.3 ± 2.6%	84.5 ± 4.1%	0.1584	61.4 ± 15.3%	89.4 ± 3.8%	0.0169
Reoperation rate (reop. aortic root)	4 patients (5.5%)	14 patients (11.1%)	0.1819	3 patients (25%)	11 patients (9.7%)	0.1075
Reoperation free at 2 years (Reop. aortic root)	100%	89.3 ± 3.6%	0.0724	70.0 ± 13.4%	92.0 ± 3.4%	0.0253
Free of late events at 2 years	85.9 ± 4.6%	74.8 ± 4.7%	0.1965	40.9 ± 15.6%	76.7 ± 5.0%	0.0224
Late NYHA class	1.75 ± 0.8	1.92 ± 0.7	0.1503	2.5 ± 0.8	1.8 ± 0.8	0.0574

GRF, gelatine-resorcin-formaldehyde/glutaraldehyde glue; NYHA, New York Heart Association.

ascending aortic dissection, therefore, root replacement was mandatory due to clear annuloaortic ectasia or Marfan disease [12–15]. Whether root replacement with preservation of a morphologically normal valve can be recommended under these conditions remains to be answered [16,17]. In recent reports [12,14,18], good early and late results following composite graft replacement of the aortic root in acute dissection were presented. A low risk of late reinterventions on the proximal aorta could especially be emphasized. In contrast Lytle et al. [19] documented significantly inferior late survival following composite graft insertion compared with the replacement of the ascending aorta alone or in combination with separate aortic valve replacement. Except for Marfan or annuloaortic ectasia he recommends avoidance of composite graft implantation in acute dissection. In his series 43% of late deaths were sudden or due to aneurysm rupture which is possibly related to sequelae of anticoagulation.

4.2. Preservation of aortic valve and/or root

Preexisting and relevant morphologic changes of the valve cusps and the annulus or a bicuspid calcified valve indicate replacement. Successful repair techniques for

otherwise normal bicuspid valves and in absence of acute dissection have been described [20]. In the majority of patients valve morphology and root dimensions are in the range of normal (Table 1). In these situations valve insufficiency is only related to commissural detachment by the dissection process. A certain increase in external diameter of the ascending aorta is also caused by dissection. The false lumen is distended by perfusion pressure creating an acute aortic ectasia with a mean external diameter of 59.8 mm in the present series (Table 1). Aortic dimensions can be expected to return to normal values after corrective surgical treatment. In marginal findings of aortic dimensions and/or valve function a rapid decision has to be made concerning aortic root treatment. Technical difficulties of a more aggressive replacement procedure have to be weighed against potential failures of conservative techniques. One of the key questions in this study was whether preservative surgical techniques for the aortic valve/root are practicable and reliable and whether it is safe to leave a patient with a repaired but dissected aortic root.

4.3. Differences between groups

In the present series (*n* = 199) 126 patients (63%) had reconstructive root surgery including 114 GRF-glue reconstructions and 12 suture reconstructions with commissural resuspension of the valve. The remaining 73 patients (37%) served as a comparison group including 23 patients with replacement of the aortic valve and the supracoronary aorta, and 50 patients with composite graft replacement of the aortic root.

The retrospective analysis of our data may be responsible for certain limitations and the statistical and predictive power are restricted by the non-randomized study design. In indefinable situations the choice of the operation technique was at surgeon's discretion.

There was no survival difference between the reconstruction- and replacement group. A similar finding was made by

Table 3

Parameters of the early postoperative period and the late follow-up

Parameters	Valve/root preservation (<i>n</i> = 126)	Valve/root replacement (<i>n</i> = 73)	<i>P</i>
Low cardiac output	43 (34.1%)	28 (38.4%)	0.5274
Periop. myocardial infarction	12 (9.5%)	8 (11.0%)	0.7456
Reexploration for hemorrhage	31 (24.6%)	17 (23.3%)	0.8107
Duration of intensive care	8.6 ± 8.7 days	7.2 ± 11.9 days	0.07417
Late NYHA class	1.92 ± 0.7	1.75 ± 0.8	0.15025
Late angina pectoris	8 (6.4%)	2 (2.7%)	0.2613
Thromboembolism	3 (0.2%)	1 (1.4%)	0.6243

Fann and Jex [11,15] reporting no significant differences in survival according to the management of the aortic valve. Considering different reconstruction techniques, in our series suture resuspension and the gluing procedure, had an almost identical survival at 2 years of 65 and 67%, respectively. Good early and late results of local GRF-glue application at the anastomotic site of dissected aortic wall could be demonstrated by Guilmet [21], Fabiani [22], Bachet [23] and Niederhäuser (publication accepted for *Ann Thorac Surg*). The tissue adhesive allowed firm readaptation of dissected aorta. Anastomotic suturing was easier and allowed to abandon the inclusion technique, a significant predictor for early mortality in our patients. In the present study we could also demonstrate the safety and reliability of GRF-glue for aortic root reconstruction in acute dissection. The gluing technique allowed anatomical repositioning of dissected valve commissures without the need of sutures and avoiding potential flow disturbance by intraluminal foreign material. The glue-reconstruction was additionally secured by the circumferential graft suture line at the level of the sinotubular junction and finally by the intraluminal pressure of an antegrade, axial blood flow. During the follow-up of our patients reoperation-free and event-free survival did not differ significantly between valve/root replacement and preservation. Following conservative valve surgery the reoperation rate on the aortic valve was only insignificantly increased. Similar results advocating valve preservation were reported by other authors [11,15,24,25]. In the present study different reconstruction techniques were additionally evaluated. GRF reconstruction showed significantly better results compared with suture resuspension which was the only independent predictor for aortic valve reoperation. Following the gluing-technique the rate of all reinterventions (reoperation on aortic valve, aortic root, ascending and distal aorta) was significantly smaller (10 vs. 33%) and reoperation free survival (89 vs. 61% at 2 years) was increased. The same was true for event free survival (77 vs. 41% at 2 years) and for reoperations concerning only the proximal aorta including the aortic root (92 vs. 70% at 2 years).

4.4. Conclusions

We conclude that surgery for peracute type A dissection still carries a considerable early risk. Preservation of the aortic root is safe in absence of Marfan or annuloaortic ectasia, but a certain incidence of reoperations on the aortic valve and the aortic root has to be accepted. Root reconstruction using GRF-glue is the method of choice and is superior to suture resuspension, with a significantly better reoperation-free and event-free survival.

References

- [1] Pressler V, McNamara JJ. Thoracic aortic aneurysm: natural history and treatment. *J Thorac Cardiovasc Surg* 1980;79:489–498.
- [2] Masuda Y, Yamada Z, Morooka N. et al. Prognosis of patients with medically treated aortic dissections. *Circulation* 1991;84:III7–III13.
- [3] Appelbaum A, Karp RB, Kirklin JW. Ascending versus descending aortic dissections. *Ann Surg* 1976;183:296–300.
- [4] Daily PO, Trueblood HW, Stinson EB. Management of acute aortic dissections. *Ann Thorac Surg* 1970;10:237–247.
- [5] Kouchoukos NT, Wareing TH, Murphy SF, Perrillo JB. Sixteen-year experience with aortic root replacement. Results of 172 operations. *Ann Surg* 1991;214:308–320.
- [6] Cabrol C, Pavie A, Gandjbakhch I, Villemont JP, Guiraudon G, Laughlin L. et al. Complete replacement of the ascending aorta with reimplantation of the coronary arteries. New surgical approach. *J Thorac Cardiovasc Surg* 1981;81:309–315.
- [7] Kaplan EL, Meier P. Nonparametric estimation from incomplete observations. *J Am Stat Assoc* 1958;53:457–481.
- [8] Crawford ES, Svensson LG, Coselli JS, Safi HJ, Hess KR. Aortic dissection and dissecting aortic aneurysms. *Ann Surg* 1988;208:254–273.
- [9] Fann JI, Smith JA, Miller DC, Mitchell RS, Moore KA, Grunkemeier G. et al. Surgical management of aortic dissection during a 30-year period. *Circulation* 1995;92 (suppl II):III13–III21.
- [10] DeBakey ME, McCollum CH, Crawford ES, Morris GC, Howell J, Noon GP. et al. Dissection and dissecting aneurysms of the aorta: twenty-year follow-up of five hundred twenty-seven patients treated surgically. *Surgery* 1982;92:1118–1134.
- [11] Fann JI, Glower DD, Miller DC, Yun KL, Rankin JS, White WD. et al. Preservation of aortic valve in type A aortic dissection complicated by aortic regurgitation. *J Thorac Cardiovasc Surg* 1991;102:62–75.
- [12] Niederhäuser U, Rüdiger H, Vogt P, Künzli A, Zünd G, Turina M. Composite graft replacement of the aortic root in acute dissection. *Eur J Cardio-thorac Surg* 1998;13:144–150.
- [13] Haverich, A., Miller, D.C., Scott, W.C., Mitchell, R.S., Oyer, P.E., Stinson, E.B. et al., Acute and chronic aortic dissections-determinants of long-term outcome for operative survivors. *Circulation* 1985;Suppl II:II22–II34.
- [14] Ergin MA, McCullough J, Galla JD, Lansman SL, Griep RB. Radical replacement of the aortic root in acute type A dissection: indications and outcome. *Eur J Cardio-thorac Surg* 1996;10:840–845.
- [15] Jex RK, Schaff HV, Piehler JM, Orszulak TA, Puga FJ, King RM. et al. Repair of ascending aortic dissection. Influence of associated aortic valve insufficiency on early and late results. *J Thorac Cardiovasc Surg* 1987;93:375–384.
- [16] David TE, Feindel CM, Bos J. Repair of the aortic valve in patients with aortic insufficiency and aortic root aneurysm. *J Thorac Cardiovasc Surg* 1995;109:345–352.
- [17] David TE, Feindel CM. An aortic valve-sparing operation for patients with aortic incompetence and aneurysm of the ascending aorta. *J Thorac Cardiovasc Surg* 1992;103:617–622.
- [18] Hilgenberg AD, Akins CW, Logan DL, Vlahakes GJ, Buckley MJ, Madsen JC. Composite aortic root replacement with direct coronary artery implantation. *Ann Thorac Surg* 1996;62:1090–1095.
- [19] Lytle BW, Mahfood SS, Cosgrove DM, Loop FD. Replacement of the ascending aorta. Early and late results. *J Thorac Cardiovasc Surg* 1990;99:651–658.
- [20] Fraser CD, Wang N, Mee RBB, Lytle BW, McCarthy PM, Sapp SK, Rosenkranz ER, Cosgrove DM. Repair of insufficient bicuspid aortic valves. *Ann Thorac Surg* 1994;58:386–390.
- [21] Guilmet D, Bachet J, Goudot B, Laurian C, Gigou F, Bical O. et al. Use of biological glue in acute aortic dissection. A new surgical technique. Preliminary clinical results with a new surgical technique. *J Thorac Cardiovasc Surg* 1979;77:516–521.
- [22] Fabiani JN, Jebara VA, Deloche A, Carpentier A. Use of glue without graft replacement for type A dissections: a new surgical technique. *Ann Thorac Surg* 1990;50:143–145.
- [23] Bachet J, Goudot B, Teodori G, Brodaty D, Dubois C, De Lentdecker P. et al. Surgery of type A acute aortic dissection with gelatine-

resorcine-formol biological glue: a twelve-year experience. *J Cardiovasc Surg* 1990;31:263–273.

- [24] Glower DD, Speier RH, White WD, Smith LR, Rankin JS, Wolfe WG. Management and long-term outcome of aortic dissection. *Ann Surg* 1991;214:31–41.
- [25] Von Segesser LK, Lorenzetti E, Lachat M, Niederhäuser U, Schönbeck M, Vogt PR. et al. Aortic valve preservation in acute type A dissection: is it sound? *J Thorac Cardiovasc Surg* 1996; 111:381–391.

Appendix A. Conference discussion

Mr S. Westaby (*Oxford, UK*): What features of the aortic root and aortic valve make you determine whether to repair or replace the valve?

Dr Niederhäuser: Valve replacement or reconstruction is primarily dependent from the morphology. If there are considerable morphological changes, mostly of degenerative or rheumatic etiology, or if the valve is bicuspid, we favor valve replacement. Aortic root and valve replacement with a composite graft is indicated in annuloaortic ectasia and Marfan disease.

Mr Westaby: You replace rather a lot of valves. I go along with the basic understanding that if the valve was normal before the dissection, you can make it normal by resuspension with glue, and I agree with you that glue is really terrific for this if you use it properly. So perhaps surgical choice came into the decision whether to replace or repair the valve, as well as morphology, in this particular series that goes back 10 years.

Dr Niederhäuser: In acute dissection, surgical glue reconstruction of the aortic root and the aortic valve indeed has proven to be a simple and reliable method. Over the last decade we have seen a growing number of older patients with an increasing number of risk factors. Due to improved preoperative medical treatment, prompt diagnosis and undelayed referral they come to emergency surgery. In these older patients we see an increasing number of severely altered and degenerated valves indicating replacement.

Dr R. Dion (*Brussels, Belgium*): We have the same attitude, to try to preserve the valve whenever possible. We have used the gluing of the aortic root in about 20 patients, with a perfect immediate result, but four patients came back after a postoperative interval of between 6 months and 2 years with a redissection of the aortic root.

Therefore we have modified our technique: first we are still gluing the root, but then we resect the previously dissected Valsalva sinuses, and perform a Magdi Yacoub or a Tirone David procedure. By doing so, we feel that we have eliminated all the dissected tissue. The rationale for gluing before resecting is to reinforce the area adjacent to the commissures.

Would you consider adopting this approach?

Dr Niederhäuser: In the surgical treatment of acute dissection early mortality is still a major drawback due to neurological deficits, organ malperfusion and bleeding complications. In addition a growing number of older high risk patients is operated. In this situation extensive and technically demanding surgery should be avoided in favor of a simple and reliable surgical technique. Therefore, we think that the David- or

Yacoub-procedure has a restricted indication and should be reserved for a very selected group of young patients. We have not performed it in acute aortic dissection until now.

I agree with Dr. Dion that the application of the GRF-glue to dissected aorta reinforces the friable tissue. In a number of patients we have performed a local glue repair without graft replacement. We had the same experience, like Dr. Dion, with one third of these patients coming back for reoperation due to recurrent dissection.

Dr L. von Segesser (*Lausanne, Switzerland*): There has been some concern about the availability of GRF glue due to EU regulations. What will you use if there is no GRF glue available anymore?

Dr Niederhäuser: We are also concerned about future availability of GRF glue. Until now we have no substitute. At the present meeting there were, however, some presentations about a new tissue glue, which seems to be more biocompatible.

Dr N. Stolf (*Sao Paulo, Brazil*): We share the same ideas as you have. Recently we reviewed 130 consecutive patients with acute type A dissection followed from 5 to 12 years, and valve replacement or aortic root replacement was done only in Marfan's or primary valve disease. In the rest of the patients, we used a conservative procedure, with Teflon felt suspension of the valve and GRF glue, and no patient was reoperated on for aortic insufficiency in the conservative group. So we think that we don't need an aggressive approach to Type A dissection unless you have primary valve or Marfan's annuloaortic ectasia.

Dr M. Torka (*Weimar, Germany*): Do you wrap a Teflon strip around the glued aortic root?

Dr Niederhäuser: We use a small Teflon felt strip. It is wrapped around the aorta which is, in most patients, near the sinotubular junction.

Dr Torka: Maybe that's the reason for the good results. I think the GRF glue alone doesn't stabilize the wall enough.

Mr Westaby: I go along with the presenters. I think the glue is excellent. I don't use Teflon on the root, just glue, and we get very good results, I promise.

Dr K. Frimpong-Boateng (*Accra, Ghana*): If I remember rightly, you had 189 cases. Was there a case where the right coronary artery was sheared off as a complication of the root dissection?

Dr Niederhäuser: Sixteen percent of patients had coronary artery dissection.

Dr Frimpong-Boateng: And what was your reaction?

Dr Niederhäuser: All patients had dissection of the aortic root without exception. In most patients the dissection process involved the coronary ostium. GRF-glue reconstruction of the aortic wall at this level was possible and proved to be a safe and reliable method.

Dr Frimpong-Boateng: What I am saying is I have had cases where the right coronary artery was sheared off completely. In such cases what will you do?

Dr Niederhäuser: In case of displacement of both coronary ostia due to of annuloaortic ectasia, composite graft replacement of the aortic root is performed. If the right coronary artery is sheared off completely due to the dissection process, graft interposition or aortocoronary bypass grafting is performed.