Quality of life after aortic valve surgery: Replacement versus reconstruction

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Objective: Quality of life has been shown to be influenced by aortic valve replacement, particularly in younger patients. Aortic valve repair is a recent alternative to replacement. We investigated quality of life and anxiety and depression after aortic valve repair and compared with 2 established replacement alternatives, mechanical valve and pulmonary autograft.

Methods: In a cross-sectional study, 166 patients (age, 18–45 years) were studied after isolated elective aortic valve surgery. They had undergone aortic valve repair (group I, n = 86), replacement with mechanical prosthesis (group II, n = 41), or pulmonary autograft (group III, n = 39). Assessment was performed by Short Form Health Survey, Hospital Anxiety and Depression Scale, Cardiac Anxiety Questionnaire, and valve-specific questions.

Results: In Short Form Health Survey, groups I and III revealed similar or identical scores better than group II in physical functioning ($P = .02$), general health ($P = .03$), and mental health ($P = .05$). No differences were found in Hospital Anxiety and Depression Scale score. In cardiac anxiety, there was less heart-focused attention in groups I and III than in group II ($P = .043$, $P = .053$). In response to valve-specific questions, there were no differences between groups I and III. Interestingly, fear of reoperation was identical in all 3 groups.

Conclusions: In young patients after aortic valve surgery quality of life is influenced by type of operation. Although differences are limited, aortic valve reconstruction and pulmonary autograft replacement lead to less long-term alteration from normal values. (J Thorac Cardiovasc Surg 2011;142:e19-24)

Aortic valve replacement has become the standard of care for hemodynamically severe regurgitation or stenosis of the aortic valve.¹ Mechanical and biologic substitutes result in good hemodynamic relief but expose the patient to valve-related complications at a clinically relevant incidence.^{2,3} The pulmonary autograft is a possible alternative, particularly for young patients or those who wish to avoid long-term anticoagulation.⁴ Recent data suggest that the autograft is associated with a low incidence of valve-related complications.⁵ In the past decade, reconstructive surgery has become a new alternative in surgical treatment of aortic valve regurgitation, both for dilated and for normal roots.⁶⁻¹⁰

Currently, recommendations for a specific aortic valve procedure or substitute are based primarily on postoperative survival data.¹ This assumes that the primary consideration of the patient is survival and not the incidence of valve-related complications. The relative incidence of complications and a more individualized estimate of life expectancy

have only recently been studied and recommended as guide for therapeutic decisions.¹¹

In our experience, numerous discussions with patients before and after aortic valve operations have shown a general trend toward strongly considering the incidence of valve-related complications and also quality of life (QoL) when choosing the procedure for their aortic valves.

The effect of different aortic valve operations on postoperative QoL has been studied only more recently. It has been demonstrated that aortic valve replacement markedly improves QoL relative to the preoperative status.^{12,13} In several studies, no differences were found between biologic and mechanical prostheses.^{12,13} A comparison between QoL after implantation of a pulmonary autograft and after mechanical aortic valve replacement revealed significantly higher scores in physical QoL after autograft replacement.¹⁴

As yet there are no published data comparing QoL after aortic valve repair with that after more established alternatives. It may be assumed that patients would intuitively prefer preservation of their own valve over replacement with material from a foreign body; however, any informed consent must include the fact that the current replacement options allow a 20-year prognosis, whereas the scarcity of long-term data on aortic valve repair allow at best a 10-year prognosis. In addition, the durability of repair has not always been ideal,^{15,16} and this knowledge may have a negative effect on QoL. On the other hand, aortic valve reconstruction has been shown to be associated with a low

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Abbreviations and Acronyms

NYHA = New York Heart Association
 QoL = quality of life
 SF-36 = German version of the Short Form Health Survey

incidence of valve-related complications,^{17,18} which may contribute to a positive attitude toward this procedure.

We therefore investigated the QoL and the impact of heart-related and general anxiety and depression after aortic valve repair and compared them with those of 2 established alternatives for the young patient, replacement with a mechanical valve and replacement with a pulmonary autograft. Our hypothesis was that the absence of anticoagulation and the low incidence of valve-related complications after repair should result in a QoL comparable to that after pulmonary autograft.

MATERIALS AND METHODS**Patients**

In a clinical cross-sectional, study patients were studied who had undergone aortic valve surgery during a 10-year interval (1997–2007) and were alive at the time of the investigation. To minimize the effect of patient age on QoL, only patients who were older than 18 and younger than 45 years were included. Patients were excluded if more than the aortic valve required surgical treatment (eg, ascending aorta, mitral valve) or if they required treatment for active endocarditis. To minimize potential effects of communication problems, only patients who spoke and understood German fluently were included.

Secondary exclusion criteria for matching were left ventricular ejection fraction less than 50%, more than minimal residual aortic regurgitation, postoperative New York Heart Association (NYHA) class greater than I, the presence of a psychiatric disorder, and dialysis-dependent renal failure. These criteria led to exclusion of 4 patients who were in NYHA class II in conjunction with depressed left ventricular function; these patients also had grade II aortic regurgitation. In addition, patients with other cardiac comorbidity (eg, mitral regurgitation requiring surgery) and active endocarditis as indication for surgery were excluded ($n = 13$) to avoid interference between type of operation and other physical limitations, such as previous stroke. None of the patients underwent reoperation after the index procedure for which they were studied. A total of 6 patients were included for whom the index operation was a reoperation. Three patients underwent biologic aortic valve replacement during the study period; these patients were not included.

Only patients who gave their consent to the study and the publication of the results in anonymized fashion were included, and the institutional review board gave its approval for this investigation. Twenty-five of 191 patients refused to participate, and the remaining 166 (positive response rate 87%) are considered in this study. Of these, 86 had undergone aortic valve repair (group I), 41 had undergone valve replacement with a mechanical prosthesis (group II), and 39 had undergone replacement with a pulmonary autograft (group III). Patients in group II were treated with warfarin sodium–based anticoagulation; patient in groups I and III received aspirin (100 mg/d) for 6 weeks and no anticoagulation thereafter.

Instruments and Assessment

All patients were contacted directly regarding participation in the study during an outpatient visit or by telephone. They were given the questionnaires and asked to return them by mail.

Assessment of health-related QoL was performed with the German version of the Short Form Health Survey (SF-36).¹⁹ The 36 items were analyzed in 8 subscales (physical functioning, physical role, bodily pain, general health, vitality, social functioning, emotional role, and mental health).

Anxiety and depression were analyzed with the German version of the Hospital Anxiety and Depression Scale.²⁰ The 14 items were those included in the 2 dimensions of anxiety and depression.

The patients were also assessed with the German version of the Cardiac Anxiety Questionnaire,²¹ consisting of 17 questions in 3 scales: fear (regarding the heart), avoidance (cardioprotective behavior, avoidance of physical exertion), and attention (awareness of heart functioning and heart-beat). Finally, valve-specific questions were asked, as published by Perchinsky and colleagues.¹³

In addition, preoperative hemodynamic data (type and severity of aortic valve lesion, left ventricular ejection fraction, NYHA class, left ventricular dimensions, transvalvular pressure gradients, comorbidity) were collected and analyzed. Postoperative cardiac data including NYHA class, transvalvular gradients, degree of aortic regurgitation, and left ventricular function and dimensions were collected and analyzed. Personal data included age, sex, and schooling.

Statistical Analysis

Categoric variables were described as absolute and relative frequencies and continuous variables as mean $\pm$ SD. The comparisons between groups were performed by Kruskal–Wallis test for categoric variables and by 2-sided analysis of variance for continuous variables. The SPSS software package version 16.0 (SPSS Inc, an IBM Company, Chicago, Ill) was used.

RESULTS**Clinical Data**

There were no significant differences between the groups with regard to sex distribution (Table 1), preoperative NYHA class, or parameters of left ventricular function. There was a significantly higher proportion of patients with preoperative aortic regurgitation in group I (86.2% vs 65% in group II and 62.1% in group III, $P = .001$). Similarly, there was no difference between the groups with regard to postoperative clinical or cardiac parameters. There was a higher proportion of individuals with college education in group I (40.2% vs 20.5% in group II and 17.9% in group III, $P = .023$).

In group I, the interval between operation and survey date was 2.46 ± 2.16 years. In groups II and III, this interval was significantly longer, at 6.48 ± 2.38 years and 6.07 ± 2.59 years, respectively.

Patients in group I were significantly younger at the time of the investigation, resulting from both slightly younger age at surgery ($P = .114$) and shorter follow-up ($P = .08$). To correct for the nonsignificant difference in follow-up, all analyses were repeated for a subgroup of patients with a follow-up of 3 to 7 years. This cohort included 71 patients (group I, $n = 27$; group II, $n = 22$; group III, $n = 22$).

Health-Related QoL (SF-36)

In physical functioning, group I had significantly higher scores than group II (88.39 vs 80.37, $P = .022$), whereas the difference between groups I and III (82.56) was not

TABLE 1. Patient characteristics

	No.	Sex (male/female)	Age at operation (y, mean $\pm$ SD)	Age at survey (y, mean $\pm$ SD)
Group I	87	63:24	38 $\pm$ 6	40 $\pm$ 6
Group II	40	35:5	40 $\pm$ 7	46 $\pm$ 7
Group III	39	27:12	40 $\pm$ 7	46 $\pm$ 7

Group I, Patients with valve repair; Group II, patients after mechanical aortic valve replacement; Group III, patients after Ross procedure.

significant ($P = .099$; Table 2). Some of the analyzed parameters were not constant but varied in relation to time elapsed since the operation. This effect was particularly apparent for the physical sum scale (Figure 1). We therefore performed an additional analysis in which only a subgroup of patients for whom the follow-up ranged from 3 to 7 years was studied. In this subgroup with more defined follow-up duration, physical functioning after repair (group I, 92.50) was significantly higher than that after mechanical replacement (group II, 80.9; $P = .01$) and was comparable to that in group III (85.0, $P = .089$).

There were no difference among the 3 groups in physical role. In bodily pain, there were identical scores in groups I and III, with a trend toward higher scores than in group II, although the differences were not significant (Table 2). Only in the subgroup of patients with a follow-up of 3 to 7 years did patients who had undergone repair reveal significantly less pain than those who had undergone mechanical replacement (86.8 vs 72.54, $P = .037$). With regard to general health, there was a significantly higher score in group I (66.21) than in group II (57.67, $P = .029$), whereas the difference between groups II and III (64.86) was not significant.

In social functioning, comparable data were obtained in all 3 groups, although there was a trend toward superiority of group III relative to group II. Identical scores were seen regarding emotional role (Table 2). In mental health, group I scored better than group II ($P = .054$), and the difference between groups III and II was also significant (63.4 vs 73.23, respectively, $P = .016$). Similar findings were made after correction for follow-up, although only the inferiority of mechanical replacement relative to the autograft remained significant ($P = .018$).

Anxiety and Depression (Hospital Anxiety and Depression Scale, Cardiac Anxiety Questionnaire)

No differences were found between the groups with regard to anxiety and depression in the Hospital Anxiety and Depression Scale score (Table 3), either in the whole cohort or in the subgroup of 3 to 7 years of follow-up. Relative to age-corrected published data for healthy subjects (23), anxiety scores were higher than normal in groups I ($P = .04$) and II ($P = .025$), whereas the group III score was not significantly different from normal ($P = .134$). With regard to depression, group I scored lower than age-matched healthy subjects (23, $P = .038$), whereas the differences between groups II and III and healthy control subjects were not significant or only borderline significant ($P = .193$ and $P = .055$, respectively).

In the Cardiac Anxiety Questionnaire, group II expressed significantly more fear than group III, whereas group I showed intermediate scores (Table 3). With respect to heart-focused attention, groups I and III exhibited statistically identical scores that were better than the group II score ($P = .043$ and $P = .053$, respectively; Table 3). There were no significant differences in avoidance (Table 3). The differences were not significant after correction for follow-up.

Our patients were different from published healthy control subjects in exhibiting higher fear (group II, 1.67; $P = .008$), lower avoidance (1.21, $P = .005$), and higher attention (1.52, $P = .034$). With regard to Cardiac Anxiety Questionnaire scores, they were similar to other patients who had undergone valve replacement or coronary bypass surgery, with more anxiety but less avoidance.²²

With regard to the valve-specific questionnaire, there were no differences between the groups on question 1 (positive view of the decision to have undergone surgery, $P = .821$; Table 4). As expected, patients in group II were more frequently disturbed by valve sounds. Interestingly, 8.4% in group I and 7.7% in group III noted subjective disturbance by valve sounds ($P = .000$). Patients in group II more frequently felt disturbed by follow up visits and blood tests than did those in groups I and III ($P = .011$). There were no differences among the 3 groups in concern regarding possible complications related to the valve operation

TABLE 2. Valve-specific questions as proposed by Perchinsky and colleagues¹³ handed out as questionnaire

SF-36 subscales	Group I	P value I vs II	Group II	P value II vs III	Group III	P value I vs III
Physical functioning	88.39 $\pm$ 16.21	.022	80.37 $\pm$ 19.59	.594	82.56 $\pm$ 20.77	.099
Role physical	75.28 $\pm$ 34.2	.960	75.6 $\pm$ 36.02	.684	78.84 $\pm$ 36.06	.599
Bodily pain	81.04 $\pm$ 23.28	.057	72.4 $\pm$ 26.58	.180	79.82 $\pm$ 24.84	.739
General health	66.21 $\pm$ 20.19	.029	57.67 $\pm$ 21.74	.118	64.86 $\pm$ 18.34	.733
Vitality	58.82 $\pm$ 19.58	.057	51.53 $\pm$ 20.55	.049	60.38 $\pm$ 18.93	.682
Social functioning	83.67 $\pm$ 18.5	.184	79.43 $\pm$ 22.46	.093	86.21 $\pm$ 22.35	.522
Role emotional	80.84 $\pm$ 32.0	.392	75.0 $\pm$ 39.04	.979	75.21 $\pm$ 39.52	.413
Mental health	70.07 $\pm$ 17.75	.054	63.4 $\pm$ 18.26	.016	73.23 $\pm$ 17.79	.362

SF-36, German version of the Short Form Health Survey; Group I, patients with valve repair; Group II, patients after mechanical aortic valve replacement; Group III, patients after Ross procedure.

FIGURE 1. Mean physical sum scores at follow-up in patients with valve repair (*group I*), patients after mechanical aortic valve replacement (*group II*), and patients after the Ross procedure (*group III*).

($P = .309$). The possibility of bleeding related to anticoagulation was rarely a concern in groups I and III, whereas it was frequent in group II ($P = .000$; Table 4). There was a significant difference in the fear of valve failure, with patients in group II more frequently afraid than those in groups I and III ($P = .036$). With regard to the fear of requiring a repeat operation, the groups were comparable ($P = .382$).

DISCUSSION

QoL achieved by therapeutic procedures has been receiving more attention in the last 10 years. Several studies have compared aortic valve replacement with mechanical versus biologic prostheses.^{12,13} The conclusion of these studies was that there was no significant difference between the 2 different types of valves, despite the need for anticoagulation after mechanical replacement. Those results stand in contrast to the findings of Nötzold and coworkers,¹⁴ who compared QoL after pulmonary autograft implantation with that after mechanical valve replacement. Nötzold and coworkers¹⁴ found significantly higher scores in physical and mental items of the SF-36, which they

attributed in part to the absence of anticoagulation after pulmonary autograft implantation. The evidence, however, is less clear at a second look. The same authors published another investigation,²² in which the QoL score parameters were similar between pulmonary autograft implantation and mechanical aortic valve replacement with self-controlled anticoagulation.

We found similar scores in SF-36 parameters for all 3 investigated therapeutic options. QoL after all 3 was generally comparable to that published for healthy control subjects¹⁹ and to data published for recovery after valve replacement and coronary bypass surgery.²³ Interestingly, our patients scored lower in symptoms of general depression than did age-matched healthy control subjects.²⁴ This difference was significant for the patients who had undergone aortic valve reconstruction. We have also observed this phenomenon after other cardiovascular operations. It is probably related to positive readjustment of the patient after having successfully coped with a major life event, such as a cardiac operation. As expected, both general and cardiac-related levels of anxiety were increased relative to published norms. This can easily be explained by the fact that all our patients by definition had undergone the realization of vulnerability, the fact of having a life-threatening cardiac disease. It may be seen as a positive coping strategy for facing life after a valve operation, in which attention and awareness will lead to better compliance with follow up and medical recommendations. Nevertheless, QoL and heart-related anxiety as measured in this study were not as much influenced by the type of operation as we had expected.

We did, however, find some differences, mainly between mechanical valve replacement versus repair or autograft. In general, patients with mechanical valve substitutes scored lower than did those after repair or pulmonary autograft implantation. These differences were not always significant, but the trend was consistent. We can confirm the findings of Nötzold and coworkers¹⁴ and can extend them to repair. Thus our working hypothesis—that patients intuitively appreciate the absence of anticoagulation and avoidance of a foreign body, resulting in higher QoL—appears to be confirmed.

On the other hand, there were some differences between a previous investigation¹⁴ and our own. As a trend, our

TABLE 3. Means and SDs of German version of the Short Form Health Survey subscales

SF-36 subscales	Group I	P value I vs II	Group II	P value II vs III	Group III	P value I vs III
Hospital Anxiety and Depression Scale subscales						
Anxiety	5.69 ± 4.01	.841	6.75 ± 5.07	.258	4.90 ± 3.82	.324
Depression	3.69 ± 3.25	.814	3.70 ± 3.51	.265	2.76 ± 2.98	.161
Cardiac Anxiety Questionnaire subscales						
Fear	1.32 ± 0.88	.153	1.68 ± 0.91	.059	1.14 ± 0.73	.571
Avoidance	0.80 ± 0.86	.264	1.16 ± 0.79	.542	0.88 ± 1.11	.627
Attention	1.03 ± 0.65	.081	1.38 ± 0.89	.303	1.19 ± 0.79	.500

P values are results of analysis of variance. *Group I*, Patients with valve repair; *Group II*, patients after mechanical aortic valve replacement; *Group III*, patients after Ross procedure.

TABLE 4. Means and standard deviations of Hospital Anxiety and Depression Scale subscales and items

Valve-specific questions	Group I	Group II	Group III	P value
1. If I had to do it over again, would I make the same decision to have surgery?				
Yes	94.0%	89.7%	100.0%	.821
I don't know	3.6%	7.7%	0.0%	
No	2.4%	2.6%	0.0%	
2. Is there a valve sound that bothers me?				
Never/rarely	91.5%	41.0%	92.4%	<.001
Occasionally	6.1%	33.3%	5.1%	
Frequently/always	2.4%	25.7%	2.5%	
3. Following my valve surgery, the frequency of doctor visits and blood tests bothers me.				
Never/rarely	75.9%	61.6%	84.2%	.011
Occasionally	20.5%	17.9%	13.2%	
Frequently/always	3.6%	20.5%	2.6%	
4. The possibility of complications due to my implanted valve concerns me.				
Never/rarely	48.2%	48.7%	61.5%	.309
Occasionally	43.4%	30.8%	33.3%	
Frequently/always	8.4%	20.5%	5.2%	
5. I am concerned about possible bleeding caused by my anticoagulant medication.				
Never/rarely	80.5%	43.6%	79.5%	<.001
Occasionally	12.2%	15.4%	7.7%	
Frequently/always	7.3%	41.0%	12.8%	
6. I am afraid that my valve may fail.				
Never/rarely	53.7%	51.3%	76.9%	.036
Occasionally	34.1%	28.2%	17.9%	
Frequently/always	12.2%	20.5%	5.2%	
7. I am afraid that I may need another valve operation.				
Never/rarely	38.0%	48.7%	53.8%	.382
Occasionally	45.0%	25.6%	25.6%	
Frequently/always	17.0%	25.7%	20.6%	

P values are results of analysis of variance. Group I, Patients with valve repair; Group II, patients after mechanical aortic valve replacement; Group III, patients after Ross procedure.

patients after mechanical valve replacement showed higher scores than in the previous study, whereas our patients after pulmonary autograft implantation scored lower. The reasons for these differences are not clear. One reason may be a difference in patient age; our patients were by selection younger than those studied previously.¹⁴ There is also a methodologic difference between our study and those of Nötzold and coworkers.¹⁴ They had assessed QoL through an interview according to SF-36, whereas we handed out the questionnaires to be returned later. A personal interview may be able to “sharpen” the questionnaire by modifying wordings to meet the needs of the interviewee. On the other hand, the same process may also lead to bias and skewed results. In view of the fact that the validating studies of the SF-36 form included filling out a questionnaire by the patient without interference from an interviewer, we decided to follow the validated procedure. We cannot, how-

ever, rule out that misinterpretation of questions may have influenced the results.

The results of the valve-specific questionnaire were as expected and can possibly explain the differences in QoL as assessed by the SF-36. As expected, patients after mechanical aortic valve replacement more frequently reported being bothered by valve sounds, follow-up visits, fear of valve-related complications, and fear of anticoagulation-related bleeding.

We did observe some unexpected findings from the valve-specific questions. Completely unexpected was the result that approximately 8% each in the repair and autograft groups reported that they were bothered by valve sounds. The reason can only be speculative, but possibly these patients exhibited a high degree of attention to their heart function postoperatively. Another surprising finding was that 20% of the well-informed patients were afraid of possible failure of their mechanical valve, whereas this fear was found in only 12% of patients in the repair group and 5% of those in the autograft group. This is in strong contrast to the information given preoperatively at the time of informed consent, when the mechanical valve was described as having an excellent 40-year durability. Also surprising was the fear of a second operation, which was similar among the 3 groups, even though all were informed preoperatively that mechanical replacement was the option with the least long-term likelihood of repeat surgery. A possible explanation may be that the coping process after having undergone aortic valve surgery involves not only rational but also emotional components. In patients without a mechanical valve, anxiety may be projected into sensations involving the heart, which are misinterpreted as disturbing valve sounds. Patients with a mechanical valve could project their anxiety into fear of failure, despite rationally knowing otherwise. It remains to be clarified whether patients with these unexpected reactions exhibit more pronounced psychopathology, such as anxiety.

The results of any investigation dealing with QoL and distress after an acute event may also be influenced by duration of follow-up as an indicator of time since the operation. We found that in the first 6 to 18 months, there was a trend for patients to express higher levels of anxiety and concerns. This leveled off at 1.5 to 2 years. For this reason, we repeated the calculations for a cohort of patients with a more defined postoperative interval. A more exact determination of time-related changes would require a longitudinal comparison of the different treatment methods.

Finally, the diagnostic limitations of questionnaires also must be considered. The questions are not always understood by all individuals in identical fashion, and a questionnaire is not able to assess the effects of personality and individual expectations of the individual. To detect subtle effects, such as those induced by expectation or by the informed consent, qualitative interviews would be necessary.

There are several limitations to our current investigation. This was not a randomized study, but rather a retrospective cross-sectional study. The preoperative condition varied among the groups, with a higher proportion of advanced academic education also seen in the repair group. This may have led to a selection bias in that patients undergoing repair had different psychologic profiles and a higher level of preoperative information. A bias through the way the informed consent was obtained cannot be ruled out, although we tried to present the same information to every patient. The patient cohorts were relatively small in relation to the expected variability in psychologic profiles. Finally, we are studying the attitude of patients toward anticoagulation in general in an ongoing research project, and there seem to be marked differences despite the same information level. This was not assessed at the time of this study. Future studies should take these aspects into consideration.

In conclusion, all 3 investigated surgical methods led to excellent QoL and limited changes in anxiety and depression relative to published data on healthy control subjects. Interestingly, the level of depression was lower than age-matched published norms for all groups. Both aortic valve reconstruction and replacement with a pulmonary autograft resulted in a lesser degree of postoperative subjective disturbance. Further research will be needed to clarify possible reasons for the observed differences.

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