Age Does Not Limit Quality of Life Improvement in Cardiac Valve Surgery

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OBJECTIVES We sought to determine the association of age with the change in quality of life (QOL) after valve surgery.

BACKGROUND Improvement in QOL is one of the principal goals of valve surgery. These procedures are being done with increasing frequency for older patients.

METHODS We prospectively studied 148 patients with aortic valve procedures and 72 patients with mitral valve procedures. Patients’ QOL was measured at baseline and at 18 months using the Medical Outcomes Trust Short Form 36-Item (SF-36) Health Survey (response rate 90%).

RESULTS Overall improvement in most domains of the SF-36, including the MCS and the PCS scores, was substantial. Improvement in the MCS score was not influenced by age in either aortic (0.09 score point improvement per 10-year age increments; p = 0.9) or mitral (0.90 score point improvement per 10-year age increments; p = 0.3) patients. Similarly, improvement in the PCS score did not vary by age in aortic patients (−1.00 score points per 10-year age increments; p = 0.2) and only slightly varied by age in mitral patients (−1.90 score points per 10-year age increments, p = 0.02). In the latter, despite statistical significance, the association was not substantial or clinically important.

CONCLUSIONS Among patients referred for cardiac valve surgery, age does not appear to limit the QOL benefits of surgery. (J Am Coll Cardiol 2003;42:1208–14) © 2003 by the American College of Cardiology Foundation

More than 79,000 cardiac valve replacement procedures are performed annually in the U.S. (1,2), with more than 16% performed for patients who are older than 75 years of age (3,4). Given the rapidly growing older population (5) and the increasing prevalence of symptomatic valve disease with advancing age (6,7), the number of elderly patients referred for cardiac valve surgery is likely to grow.

Several recent studies have reported “acceptable” operative risk (in-hospital mortality 11% to 14%) and late survival (five-year survival >70%) for elderly patients undergoing cardiac surgery (8–10). However, because the long-term consequences of cardiac valve surgery extend beyond mere survival and morbidity, physicians are often hesitant to recommend surgery based on mortality data alone (11). In addition, cardiac valve surgery in elderly patients is still associated with higher resource utilization and morbidity than in younger patients (9,10,12).

There is a growing interest in the use of health status to evaluate clinical strategies. Improvement in quality of life (QOL) is considered to be one of the principal goals of valve surgery (13). Patients deciding among treatment options may value information about the change in QOL that they can expect after valve surgery. It is particularly important to evaluate QOL in elderly patients, who have a higher prevalence of comorbidity, stress of surgery, and rate of complications—all factors that may hinder improvement in QOL. Moreover, whether age modifies the expected QOL benefit is not known. Previous studies addressing QOL in patients undergoing cardiac valve surgery and the importance of age as a predictor of QOL were limited by the absence of younger controls, cross-sectional design, small sample size, retrospective design, and use of substandard QOL instruments (11,14–16).

The relative lack of information on change in QOL after major valve surgery impedes informed decision-making by physicians and patients. Accordingly, we sought to investigate whether older patients derived less health status and QOL benefit after valve surgery than did younger patients.

To achieve this objective, we prospectively studied whether age is associated with change in QOL at 18 months after aortic or mitral valve surgery.

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Abbreviations and Acronyms

- CABG = coronary artery bypass graft surgery
- MCS = Mental Component Summary
- NYHA = New York Heart Association
- PCS = Physical Component Summary
- PVD = peripheral vascular disease
- QOL = quality of life
- SD = standard deviation
- SF-36 = Medical Outcomes Trust Short Form 36-Item Health Survey

Methods

Study sample. We performed a longitudinal prospective cohort study of consecutive patients undergoing isolated valve or simultaneous valve-coronary artery bypass graft (CABG) procedures at Yale-New Haven Hospital from March 31, 1998, to March 30, 1999. Detailed clinical and non-clinical information was abstracted from medical records. During the first week after surgery, patients completed baseline questionnaires focusing on their functioning in the month before surgery. Patients were contacted at 18 months after surgery for outcome status assessment. There was a six-week time window allowed for follow-up questionnaire completion.

Measurement of QOL. Quality of life was measured at baseline and at follow-up using the Medical Outcomes Trust Short Form 36-Item Health Survey (SF-36), a survey with demonstrated high reliability and validity (17–20). The SF-36 consists of 36 questions, grouped into the following eight multi-item domains, which measure functioning in different aspects of daily life:

1) Physical functioning: limitations in lifting, climbing, bending, kneeling, walking, or running;
2) Role physical: degree of physical health to perform activities typical for the specific age and social responsibility, such as a job, community activities, and volunteer work;
3) Bodily pain: intensity and duration of bodily pain and limitations in activities due to pain;
4) General health: beliefs and evaluations of overall health;
5) Vitality: feelings of energy, pep, fatigue, and tiredness;
6) Social functioning: ability to develop, maintain, and nurture mature social relationships (including family, friends, and spouse);
7) Role emotional: personal feelings about job performance, work, or other activities;
8) Mental health: emotional, cognitive, and intellectual status.

The Mental Component Summary (MCS) and the Physical Component Summary (PCS) are two meta-scores of the SF-36. They combine eight multi-item domains and represent overall physical functioning and mental functioning (17). These summary scales are used in this study as the primary health-related QOL outcome variables for the multivariable analyses. Validated U.S. population norms for different age groups were used to gauge the significance of the improvement in QOL after surgery (21).

Study variables. Society of Thoracic Surgery forms and definitions were used for clinical data collection (22). Socio-demographic variables included age, gender, and body mass index (cut-offs: <22, 22 to 30, >30 kg/m²). Comorbidities included renal disease, peripheral vascular disease (PVD), chronic obstructive pulmonary disease, diabetes, and hypertension. Heart disease–related variables were history of heart failure, New York Heart Association (NYHA) functional class, ejection fraction (mainly abstracted from ventriculography reports), cardiomegaly, chronic atrial fibrillation, previous myocardial infarction, aortic stenosis, mitral stenosis, angina type (stable or unstable), previous CABG, and previous valve procedure. Procedure-related variables were implant type (tissue, mechanical, or repair), simultaneous coronary bypass, and urgency of operation.

Statistical analysis. First, we calculated descriptive statistics for the study variables. Next, after stratification of age into three groups (≤64, 65 to 74, ≥75 years), we determined the improvement in QOL after valve surgery by comparing QOL at baseline and at 18 months after surgery and comparing these values with U.S. population norms. Mean values and 95% confidence intervals were used to demonstrate the difference. Patient scores were considered similar to the U.S. norms if the scores were within one-fourth of one standard deviation (SD) of the mean. This was a conservative standard, as published guidelines to interpret these scores suggest that even differences of one-half of one SD are small (23). In addition, one-fourth of one SD (i.e., 5 to 10 points) represents the difference that is considered clinically relevant for SF-36 domains (24). For MCS and PCS meta-scores, a clinically relevant difference is likely to be 4 to 7 points (one-half of one SD) (25), which is, again, larger than our conservative estimate of one-fourth of one SD. Given our set effect size, we had over 80% power to determine statistical significance of the change in QOL with 95% confidence (alpha level of 0.05). Finally, we measured the impact of age (continuous variable) on change in QOL by multiple regression analysis of the change in two meta-scores of the SF-36: the MCS and the PCS. We constructed four multiple regression models (2 for aortic and 2 for mitral subgroups). Aortic and mitral patients were analyzed separately to determine if the association of age with change in QOL is different after aortic or mitral surgery. Baseline score (MCS or PCS, depending on whether change in MCS or PCS was predicted) was the most significant predictor of change in score from the baseline and was included in all models. Because the variance inflation factor did not exceed 2.5 and the tolerance was >0.4, there was little or no evidence of colinearity among predictors in determining the change in QOL. We also adjusted for disease severity characteristics (cardiomegaly, NYHA class), procedure type (isolated valve vs. valve...
plus CAGB), and valve implant type (tissue vs. mechanical). In addition, we adjusted for gender and comorbid conditions (hypertension, body mass index, PVD) that may influence the change in QOL.

The generalized estimating equations method was used to determine age-related differences in QOL changes by testing the interaction between age and time and adjusting for measurement correlation. The latter was confirmatory to multiple regression, and only results of the multiple regression are reported here. We used the Statistical Analysis System (SAS Institute, release 8.02, Cary, North Carolina) for data management and analysis.

RESULTS

Cohort characteristics. Of the 285 consecutive patients who underwent cardiac valve procedures, 220 (77.2%) participated in the study. Reasons for non-participation included death (n = 13), neurological problems (n = 10), data entry problems (n = 10), inability to administer the QOL questionnaire before discharge (n = 10), refusal (n = 9), language barriers (n = 4), and other reasons (n = 9). There was no difference between the baseline participants and non-participants with regard to age and gender. For other characteristics, cerebrovascular accidents, PVD, and urgent surgeries were more frequent in non-participants (Table 1).

Of 220 baseline participants, 14 patients (6.4%) died within 18 months, leaving 206 patients available for follow-up. All but one of the deceased patients were >65 years of age, and half were >75 years of age. There were seven patients (3%) who did not reply within the six-week response period, four (2%) who refused to complete the questionnaire, and nine (4%) who were lost to follow-up. Thus, of the baseline participants, follow-up QOL measurements at 18 months were obtained in 186 (90%) cases.

At baseline, there were 148 (67%) patients who had aortic valve surgery and 72 (33%) patients who had mitral valve surgery. Simultaneous valve and CAGB procedures were performed in 38% of patients, and the proportion of patients >75 years of age was 34%. Elderly patients (age ≥75 years) were more likely than younger patients (age groups <65 and 65 to 75 years) to have hypertension and higher NYHA class, and they more often had valve-CAGB procedures (data not presented). They were similar to younger patients in terms of mean ejection fraction, diabetes, and chronic obstructive pulmonary disease.

Improvement of QOL after surgery and comparison with normative values. There were 126 aortic and 60 mitral patients who reported both their baseline and follow-up QOL. Improvement in QOL after surgery was similar in both aortic and mitral patients after stratification into three age groups (scores were within one-fourth of one SD compared with normative values). Thus, after age stratification into three categories and comparisons with population norms, the groups were combined.

All age groups showed improvement in most QOL domains at 18 months. In the younger age group (≤64 years), there were statistically significant improvements in all domains except those of general health and role emotional (Fig. 1, Table 2). In the latter scales, pre-operative norms were comparable with population norms, thus limiting the possibility of recording higher absolute improvements.

Among older patients (age groups 65 to 74 and ≥75 years), overall absolute improvements in QOL were noted in the domains of physical functioning, role physical, vitality, and mental health, as well as in the MCS and the PCS meta-scores (Figs. 2 and 3, Table 2). As found in younger patients, there was little or no absolute improvement reported on the general health, role emotional, bodily pain, and social functioning scales, where pre-operative scores were comparable with population norms. In all age groups, mean values for the QOL domains at 18 months after surgery were comparable and sometimes higher than population norms.

Effect of age on the improvement in QOL in regression analysis. The multivariable models had good predictive power in both aortic (R-square: 0.34 for change in MCS and 0.48 for change in PCS) and mitral (R-square: 0.48 for change in MCS and 0.61 for change in PCS) samples. In the multiple regression analysis of overall mental functioning as measured by MCS, age was not a significant predictor of change in score (Table 3). Similarly, after controlling for clinically relevant factors, the association of age with the change in overall physical functioning as measured by PCS was small and not statistically significant in the aortic sample (see statistical analysis) (Table 3). In contrast, age had a statistically significant association with PCS for patients undergoing mitral valve surgery. However, it was modest in magnitude, with a 10-year increment in age resulting in a score reduction of 1.90 (less than one-fourth of one SD).

### Table 1. Comparison of Responders With Non-Responders*

<table>
<thead>
<tr>
<th>Variables</th>
<th>Participants (n = 220)</th>
<th>Non-Participants (n = 65)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD)</td>
<td>66.5 ± 14.4</td>
<td>65.1 ± 15.1</td>
<td>0.52</td>
</tr>
<tr>
<td>LVEF, mean (SD)</td>
<td>50.8 ± 13.2</td>
<td>50.0 ± 15.8</td>
<td>0.74</td>
</tr>
<tr>
<td>Male gender (%)</td>
<td>54.5</td>
<td>64.6</td>
<td>0.15</td>
</tr>
<tr>
<td>NYHA (III–IV) class (%)</td>
<td>56.4</td>
<td>63.1</td>
<td>0.53</td>
</tr>
<tr>
<td>History of MI (%)</td>
<td>23.6</td>
<td>28.1</td>
<td>0.46</td>
</tr>
<tr>
<td>Urgent surgery (%)</td>
<td>33.0</td>
<td>50.0</td>
<td>0.013</td>
</tr>
<tr>
<td>PVD (%)</td>
<td>13.6</td>
<td>26.1</td>
<td>0.017</td>
</tr>
<tr>
<td>CVA (%)</td>
<td>5.0</td>
<td>16.9</td>
<td>0.002</td>
</tr>
<tr>
<td>Diabetes (%)</td>
<td>15.9</td>
<td>23.1</td>
<td>0.18</td>
</tr>
<tr>
<td>Hypertension (%)</td>
<td>58.9</td>
<td>55.4</td>
<td>0.61</td>
</tr>
<tr>
<td>Cardiomegaly (%)</td>
<td>41.8</td>
<td>44.6</td>
<td>0.68</td>
</tr>
<tr>
<td>COPD (%)</td>
<td>20.2</td>
<td>29.1</td>
<td>0.15</td>
</tr>
<tr>
<td>Angina (%)</td>
<td>41.7</td>
<td>33.8</td>
<td>0.26</td>
</tr>
<tr>
<td>Aortic stenosis (%)</td>
<td>54.1</td>
<td>43.1</td>
<td>0.12</td>
</tr>
</tbody>
</table>

*Groups were also not different with regard to arrhythmia, mitral stenosis cases, pulmonary artery pressure, family history of coronary disease, body mass index, and reoperation. NYHA class I–II was the reference category.

Variables included in the analysis: COPD = chronic obstructive pulmonary disease; CVA = cerebrovascular accident; LVEF = left ventricular ejection fraction; MI = myocardial infarction; NYHA = New York Heart Association; PVD = peripheral vascular disease; SD = standard deviation.
DISCUSSION

We found that patients reported improvement in their QOL after valve surgery in all age groups and across almost all QOL domains. The improvements from the baseline after 18 months were larger than one-half of one SD in most scales of the SF-36, as well as for overall mental functioning and physical functioning (MCS and PCS meta-scores), supporting the clinical importance of the changes. In addition, we found that 18 months after surgery, QOL mean scores were comparable to U.S. population normative scores in all age groups of patients undergoing either aortic or mitral surgery. This is notable, given that the national norms used for comparison with our study population were derived from a general population of “healthy” people not reporting any symptomatic illness (21,26).

After adjusting for clinically relevant variables, we found that age alone was not strongly predictive of QOL improvement after surgery. We did not find an association between age and change in global mental health functioning (MCS meta-score) for aortic or mitral patients (Table 3). The magnitude of improvement in mental health was similar in elderly and younger patients. Similar conclusions can be drawn with regard to physical functioning (PCS meta-}

![Figure 1. Quality of life (QOL) values with 95% confidence intervals in the ≥64-year age group (combined mitral and aortic patients). Open boxes = pre-operative QOL scores; open circles = 18-month follow-up QOL scores; closed triangles = U.S. population QOL norms for the ≥64-year age group. BP = bodily pain; GH = general health; MCS = mental component summary; MH = mental health; PCS = physical component summary; PF = physical functioning; RE = role emotional; RP = role physical; SF = social functioning; VT = vitality.](image-url)

Table 2. Preoperative, Postoperative, and Normative Mean QOL Values* in Different Age Groups

<table>
<thead>
<tr>
<th>QOL Scales</th>
<th>Preoperative</th>
<th>Postoperative</th>
<th>Norms</th>
<th>Preoperative</th>
<th>Postoperative</th>
<th>Norms</th>
<th>Preoperative</th>
<th>Postoperative</th>
<th>Norms</th>
</tr>
</thead>
<tbody>
<tr>
<td>PF</td>
<td>61 ± 31</td>
<td>81 ± 20</td>
<td>76</td>
<td>49 ± 30</td>
<td>72 ± 28</td>
<td>69</td>
<td>40 ± 25</td>
<td>58 ± 26</td>
<td>53</td>
</tr>
<tr>
<td>RP</td>
<td>43 ± 44</td>
<td>80 ± 30</td>
<td>74</td>
<td>33 ± 41</td>
<td>63 ± 41</td>
<td>65</td>
<td>17 ± 29</td>
<td>42 ± 42</td>
<td>45</td>
</tr>
<tr>
<td>BP</td>
<td>66 ± 32</td>
<td>84 ± 21</td>
<td>68</td>
<td>71 ± 28</td>
<td>80 ± 24</td>
<td>68</td>
<td>64 ± 32</td>
<td>75 ± 27</td>
<td>61</td>
</tr>
<tr>
<td>GH</td>
<td>59 ± 11</td>
<td>59 ± 9</td>
<td>65</td>
<td>57 ± 14</td>
<td>59 ± 8</td>
<td>63</td>
<td>55 ± 12</td>
<td>58 ± 8</td>
<td>57</td>
</tr>
<tr>
<td>VT</td>
<td>44 ± 25</td>
<td>63 ± 23</td>
<td>60</td>
<td>42 ± 19</td>
<td>61 ± 22</td>
<td>60</td>
<td>38 ± 22</td>
<td>50 ± 21</td>
<td>50</td>
</tr>
<tr>
<td>SF</td>
<td>71 ± 29</td>
<td>84 ± 22</td>
<td>81</td>
<td>74 ± 25</td>
<td>83 ± 23</td>
<td>81</td>
<td>71 ± 25</td>
<td>75 ± 26</td>
<td>74</td>
</tr>
<tr>
<td>RE</td>
<td>64 ± 45</td>
<td>79 ± 36</td>
<td>80</td>
<td>62 ± 44</td>
<td>74 ± 41</td>
<td>81</td>
<td>59 ± 46</td>
<td>56 ± 43</td>
<td>63</td>
</tr>
<tr>
<td>MH</td>
<td>59 ± 11</td>
<td>75 ± 19</td>
<td>75</td>
<td>59 ± 13</td>
<td>78 ± 18</td>
<td>81</td>
<td>58 ± 11</td>
<td>76 ± 16</td>
<td>74</td>
</tr>
<tr>
<td>MCS</td>
<td>45 ± 9</td>
<td>50 ± 10</td>
<td>51</td>
<td>46 ± 9</td>
<td>51 ± 11</td>
<td>53</td>
<td>46 ± 9</td>
<td>49 ± 11</td>
<td>50</td>
</tr>
<tr>
<td>PCS</td>
<td>41 ± 10</td>
<td>49 ± 6</td>
<td>46</td>
<td>39 ± 10</td>
<td>45 ± 10</td>
<td>43</td>
<td>34 ± 8</td>
<td>41 ± 9</td>
<td>38</td>
</tr>
</tbody>
</table>

*QOL values presented as means ± SD.

BP = bodily pain; GH = general health; MCS = mental component summary; MH = mental health; PCS = physical component summary; PF = physical functioning; QOL = quality of life; RE = role emotional; RP = role physical; SF = social functioning; VT = vitality.
score). In the aortic sample, the parameter estimate for age was small (−1.00; less than one-fourth of one SD for a 10-year increment) and not statistically significant (p = 0.22) in predicting the improvement in overall physical functioning (Table 3). In the mitral sample, the parameter estimate for age was slightly larger (−0.19) and statistically significant (p = 0.02). However, interpretation of this estimate suggests that two otherwise identical patients whose ages differ by 10 years can expect a PCS differential of 1.9 points (less than one-fourth of one SD). This is clearly a small difference, as the SD for the PCS score is 10 and differences up to one-half of one SD are considered small in health-related QOL evaluations (23). Furthermore, the overall results of our study suggest that older age does not limit the QOL benefits of cardiac valve surgery.

Although other studies have compared QOL before and after valve surgery to population norms, they were limited by samples that excluded older or younger patients, as well as by other aspects of study design. A study of 100 participants by Phillips et al. (26) considered only younger patients and obtained 67% follow-up. Later prospective studies (14,27) that evaluated QOL after valve surgery had only six months of follow-up, and one of these studies, based on only 32 patients, had no younger controls (14). Another cross-sectional study included 147 elderly patients; however, pre-operative QOL data were not available, and the study was limited to aortic valve procedures (11). Additional studies did not separate valve patients from isolated coronary bypass patients (16,27). All previous studies reported considerable improvement in QOL among elderly patients, and the consistency of the results in a variety of study designs supports the validity of the findings in the current study.

The advantages of our study are its prospective design, relatively large sample size, accurate control over possible confounding, and use of a validated and widely accepted instrument for QOL assessment. In addition, this study is the first to evaluate long-term outcomes (18 months), as well as the first to evaluate the impact of age on improvement in QOL in aortic and mitral patients using a regression approach. Comparison of QOL scores before and after surgery with population norms provided another estimate of the effect of cardiac surgery on QOL improvement in elderly and younger patients.

**Study limitations.** First, this study was conducted at a single center, perhaps limiting its generalizability. However, we compared our sample with the Society of Thoracic Surgeons summary data from 1991 to 1995 (28) and found the patients to be similar. Second, because we were unable to interview patients before surgery, baseline QOL data were obtained during the first week after surgery. However, patients were asked to report their QOL in the month before surgery. Third, we attempted to enroll every patient but were not able to do so. In addition, we compared participants with non-participants and found that the two groups were not different with regard to major risk factors. Fourth, we did not test for cognitive decline that can potentially be associated with QOL. Finally, our findings

Figure 2. Quality of life (QOL) values with 95% confidence intervals in the 65- to 74-year age group (combined mitral and aortic patients). Open boxes = pre-operative QOL scores; open circles = 18-month follow-up QOL scores; closed triangles = U.S. population norms for the 65- to 74-year age group. BP = bodily pain; GH = general health; MCS = mental component summary; MH = mental health; PCS = physical component summary; PF = physical functioning; RE = role emotional; RP = role physical; SF = social functioning; VT = vitality.
are relevant to patients being referred for valve surgery, and their relevance to patients with mitral or aortic disease who did not undergo surgery is unknown. It is possible that concerns about recovery lead some physicians not to recommend surgery to some older patients who might have a different recovery experience. Nevertheless, we believe that these limitations had a minor impact on our finding that age does not limit QOL benefits that can be attained after surgery.

Conclusions. Patients reported improved QOL at 18 months after aortic and mitral surgery that was comparable to population norms for their age. Among patients currently referred for cardiac valve surgery, age does not appear to independently influence or limit the improvement in QOL. Elderly patients should be educated about the expected health status benefits associated with valve surgery. Furthermore, these findings should help surgeons and elderly patients to make informed decisions regarding the suitability of the valve surgery.

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