Repeat sternotomy for surgical aortic valve replacement in octogenarian patients with aortic valve stenosis and previous coronary artery bypass graft operation: What is the operative risk?

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Objectives: There are limited data defining the risk of repeat sternotomy for surgical aortic valve replacement in octogenarian patients with aortic valve stenosis and previous coronary artery bypass graft operation. Our study assesses the risk of operation.

Methods: We conducted a retrospective review of 629 octogenarian patients with aortic stenosis who received isolated surgical aortic valve replacement between January 1993 and December 2011. Patient characteristics included age 83.7 ± 3.2 years, male sex in 322 patients (51.2%), and Society of Thoracic Surgeons predicted risk of mortality of $6.2\% \pm 4.4\%$. Operations included a primary sternotomy in 518 patients (82.4%) and a repeat sternotomy in 111 patients (17.6%) who had previous coronary artery bypass graft operation. Patients with other cardiac operations were excluded from the study.

Results: Cardiopulmonary bypass time was longer with repeat sternotomy (88.0 ± 45.7 minutes) in comparison to primary sternotomy (66.5 ± 25.1 ; $P < .001$); but there was no difference in the aortic crossclamp time (51.1 ± 19.7 minutes vs 49.2 ± 17.7 minutes; $P = .282$). Stroke occurred in 3 patients (2.7%) following repeat sternotomy and in 10 (1.9%) after primary sternotomy ($P = .710$). Rates of myocardial infarction, renal failure, and reoperation for bleeding were similar between the 2 groups. Operative mortality occurred in 7 patients (6.4%) after repeat sternotomy and in 19 patients (3.7%) following primary sternotomy ($P = .196$). Repeat sternotomy was not predictive of operative mortality.

Conclusions: Repeat sternotomy and surgical aortic valve replacement can be done with low risk in octogenarian patients with previous coronary artery bypass graft operation. (J Thorac Cardiovasc Surg 2014;148:1899-902)

Surgical aortic valve replacement improves symptoms and prolongs survival with low operative morbidity and mortality rates in most series of patients.^{1,2} In general, repeat sternotomy does not increase the risk of operation.³ There are limited data on repeat sternotomy for surgical aortic valve replacement in octogenarian patients, with some series reporting an operative mortality of around 20%.^{4,5} But no study has looked specifically at the outcome in octogenarian patients with previous coronary artery bypass graft operation. Unfortunately, such patients may be denied operation, or offered alternative therapy (ie, transcatheter aortic valve replacement), based on a perception of prohibitive risk of operative morbidity and/or mortality associated with surgical replacement.

The objective of our study was to define the risk of repeat sternotomy for surgical aortic valve replacement in octogenarian patients with previous coronary artery bypass graft operation.

METHODS

This study was approved by the Mayo Clinic Institutional Review Board. We reviewed the records of 1745 octogenarian patients who received aortic valve replacement for aortic valve stenosis between January 1993 and December 2011. We excluded from study patients with a history of previous noncoronary artery bypass graft cardiac operation (eg, valve replacement or pericardiectomy) or infective endocarditis. In addition, we excluded patients who received planned concomitant coronary artery bypass graft operation, transcatheter aortic valve replacement, or other nonaortic valve-related operation (eg, mitral or tricuspid valve operation or pericardiectomy). We included in the study patients who received an aortic root patch or enlargement procedure.

We identified an intent-to-treat cohort of 637 octogenarian patients who met our inclusion and exclusion criteria. Of this group, 8 patients refused research authorization; they were subsequently excluded from further study. That left 629 octogenarian patients for study. We formed 2 study groups that included 518 patients (82.4%) who received primary sternotomy (primary sternotomy group) and 111 patients (17.6%) who received repeat sternotomy (repeat sternotomy group). All patients in the repeat sternotomy group had undergone previous coronary artery bypass graft operation. All operations were performed at Mayo Clinic, Rochester, Minn.

The Division of Cardiovascular Surgery database and individual patient medical records were reviewed for data on patient characteristics and

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Abbreviation and Acronym

STS = Society for Thoracic Surgeons

operative intervention, morbidity, and mortality. Data on these variables were collected in keeping with the standard definitions set forth by the Society of Thoracic Surgeons (STS) as part of the National Adult Cardiac Surgery Database. Operative mortality was defined as death occurring within 30 days of operation or at any time during the index hospitalization.

Descriptive statistics for categorical variables are reported as frequency (percentage) whereas continuous variables are reported as mean $\pm$ standard deviation or median (range) as appropriate. Categorical variables were compared using χ^2 or Fisher exact test and continuous variables using 2-sample *t* test or Wilcoxon rank-sum test where appropriate. Logistic regression models were used to find the univariate and multivariate predictors of operative mortality. The multivariable model considered univariate significant variables ($P < .05$) with model selection using the stepwise method. All statistical tests were 2 sided.

RESULTS

Patient characteristics included a mean age of 83.7 ± 3.2 years, male sex in 322 patients (51.2%), and an STS predicted risk of mortality of $6.2\% \pm 4.4\%$. Operation occurred during the second half of the study period in 86 patients (78.2%) in the repeat sternotomy group and in 357 patients (67.6%) in the primary sternotomy group ($P = .065$). Patient characteristics of the 2 study groups are detailed in Table 1.

All patients received surgical aortic valve replacement. Operations included an aortic root enlargement in 5 patients (4.6%) in the repeat sternotomy group and in 36 patients (6.8%) in the primary sternotomy group ($P = .126$). Cardiopulmonary bypass time was longer in the repeat sternotomy group (88.0 ± 45.7 minutes) in comparison to the primary sternotomy group (66.5 ± 25.1 minutes; $P < .001$). But there was no difference in the aortic crossclamp time in the repeat sternotomy group (51.1 ± 19.7 minutes) in comparison to the primary sternotomy group (49.2 ± 17.7 minutes; $P = .282$). Intra-aortic balloon pump therapy was used in 15 patients (13.5%) in the repeat sternotomy group and in 10 patients (1.9%) in the primary sternotomy group ($P < .001$).

We report operative morbidity and mortality data in Table 2. Stroke occurred in 3 patients (2.7%) following repeat sternotomy and in 10 patients (1.9%) after primary sternotomy ($P = .710$). Rates of myocardial infarction, renal failure, and reoperation for bleeding were similar between the 2 groups. Operative mortality occurred in 7 patients (6.3%) in the repeat sternotomy group and in 19 patients (3.7%) in the primary sternotomy group ($P = .196$). The cause of death was cardiac-related in 16 patients (64.0%). In the repeat sternotomy group, 1 death was related to a sternal reentry injury of the right ventricle and left internal mammary artery bypass graft. There were

no operative deaths in the 7 patients who received either a third ($n = 6$) or fourth ($n = 1$) sternotomy.

We report the results of univariate logistic regression of variables predicting operative mortality in Table 3. The only preoperative patient characteristics predictive of death were ejection fraction (odds ratio [OR], 0.97; 95% confidence interval [CI], 0.95-1.0; $P = .032$) and previous myocardial infarction (OR, 6.99; 95% CI, 1.47-49.45; $P = .014$). Repeat sternotomy was not predictive of operative mortality in the univariate analysis (OR, 1.77; 95% CI, 0.68-4.14; $P = .387$). Multivariate analysis identified only previous myocardial infarction as being predictive of operative mortality (OR, 5.63; 95% CI, 0.96-43.87; $P = .042$).

DISCUSSION

The main finding in our study is that repeat sternotomy is not a predictor of operative mortality for isolated surgical aortic valve replacement. We evaluated 629 octogenarian patients with aortic valve stenosis who underwent operation for isolated surgical aortic valve replacement. Of those patients, 111 (17.6%) required repeat sternotomy because of a previous coronary artery bypass graft operation. Patients who underwent a repeat sternotomy had greater prevalence of preoperative comorbidity and higher STS predicted risk of mortality scores. Despite the greater operative risk, the repeat sternotomy group experienced similar operative mortality in comparison to patients who received primary sternotomy (6.4% vs 3.7%; $P = .196$).

The outcome of medical management in elderly patients with symptomatic severe aortic is disappointing. Leon and colleagues² demonstrated a 1-year mortality rate of 49.7% with aggressive medical therapy in patients (mean age, 83.2 years) with symptomatic severe aortic valve stenosis. However, there is general agreement in the literature that such patients benefit from surgical aortic valve replacement.⁶ For instance, Varadarajan and colleagues⁷ reported 5-year survival of 68% in elderly patients (mean age, 85.3 years) treated with surgical aortic valve replacement in comparison to 22% in patients (mean age, 83 years) managed without operation ($P < .001$). And importantly, Saxena and colleagues⁸ reported the 5-year survival of male elderly patients (mean age, 83.4 years) undergoing surgical aortic valve replacement at 65%, which is comparable to the expected survival of age-matched Australian men (mean age, 83 years) at 64.3%.

As a general finding, repeat sternotomy does not increase the risk of operative mortality. LaPar and colleagues⁹ reported the outcome of 99 patients who underwent operation from 2004 through 2007 with repeat sternotomy for surgical aortic valve replacement. The group had equivalent mortality to patients who underwent operation for primary sternotomy (3.5% vs 2.0%; $P = .65$). Importantly, in this series, patients undergoing repeat

TABLE 1. Society of Thoracic Surgeons (STS) defined patient characteristics

Characteristic	Repeat sternotomy (n = 111)	Primary sternotomy (n = 518)	P value
Continuous variables			
	Mean ± standard deviation		
Age, y	83.2 ± 2.5	83.9 ± 3.3	.214
Creatinine, mg/dL	1.4 ± 0.8	1.2 ± 0.5	.077
Ejection fraction, %	54.5 ± 15.7	59.2 ± 13.0	.003
STS predicted risk of mortality, %	8.6 ± 5.6	5.6 ± 3.9	<.001
Categorical variables			
	n (%)		
Male sex	89/111 (80.2)	233/518 (45.0)	<.001
Diabetes	29/111 (26.1)	91/518 (17.6)	.045
Chronic lung disease	99/111 (89.2)	414/518 (79.9)	.022
Peripheral vascular disease	29/111 (26.1)	631/518 (12.2)	<.001
Cerebrovascular disease	29/111 (26.1)	98/518 (18.9)	.091
Previous myocardial infarction	34/64 (53.1)	45/224 (20.1)	<.001
Previous percutaneous coronary intervention	32/85 (37.7)	42/322 (13.0)	<.001
Previous coronary artery disease	111 (100)	71/518 (13.7)	<.001
New York Heart Association functional class III-IV	87/111 (78.4)	342/518 (66.0)	.013
Operative status urgent	6/111 (5.4)	46/518 (8.9)	.260

sternotomy had more preoperative comorbidity and operative risk; however, the mean age of the patients was only 66.5 years. Similar results were also reported in a study of 427 patients by Sundt and colleagues.³ They noted no difference in 30-day mortality following repeat sternotomy in comparison to primary sternotomy for surgical aortic valve replacement (7.7% vs 6.3%; $P = .763$); but, mean age was 73.1 years.

There are limited data on the effect that repeat sternotomy has on the outcome of surgical aortic valve replacement in octogenarian patients. Melby, Langanay, and colleagues^{4,5} reported operative mortality rates of 20% and 23.5%, respectively; but the number of patients in each study was 25 or fewer. Vasquez and colleagues⁶ published a meta-analysis of 9 studies with data on 1981 octogenarian patients who received surgical aortic valve replacement, among which there were patients with a history of prior cardiac surgery. The pooled proportion operative mortality was 6.6% (95% CI, 5.0-8.3). However, none of the 9 studies looked specifically at the risk of repeat sternotomy for surgical aortic valve

replacement in patients with a history of coronary artery bypass graft operation.

Surgical valve replacement appears to be equally safe as transcatheter replacement. In the Placement of Aortic Transcatheter Valve Trial, Smith and colleagues¹⁰ demonstrated no difference in 30-day operative mortality rates in patients who received transcatheter replacement versus surgical replacement (3.4% vs 6.5%; $P = .07$). In that study, 299 patients (42.8%) had a history of previous coronary artery bypass graft operation and the mean age of members of each of the 2 groups was greater than 80 years. An important point to note is that the risk of death from any cause at 1 year was higher in patients in the transcatheter replacement group (risk ratio, 1.35; 95% CI, 0.88-2.08; $P = .02$). Kodali and colleagues¹¹ reported a similar finding at 2 years of follow-up.

We noted no difference in the outcomes of stroke, reoperation for bleeding, and renal failure with repeat

TABLE 2. Operative morbidity and mortality, by operation

Variable	Repeat sternotomy, n (%) (n = 111)	Primary sternotomy, n (%) (n = 518)	P value
Mortality	7 (6.3)	19 (3.7)	.196
Any complication	26 (23.4)	63 (12.2)	.004
Intra-aortic balloon pump therapy	15 (13.5)	10 (1.93)	<.001
Myocardial infarction	1 (1.0)	1 (0.2)	.333
New pacemaker	2 (1.8)	15 (2.9)	.750
Renal failure	7 (6.3)	20 (3.9)	.298
Reoperation for bleeding	9 (8.1)	24 (4.6)	.157
Stroke	3 (2.7)	10 (1.9)	.710

TABLE 3. Univariate logistic regression of preoperative variables predicting operative mortality

Variable	Odds ratio (95% confidence interval)	P value
Previous myocardial infarction	6.99 (1.47-49.54)	.014
Left ventricle ejection fraction	0.97 (0.95-1.00)	.032
Repeat sternotomy	1.77 (0.68-4.14)	.230
Cerebral vascular disease	0.50 (0.12-1.58)	.232
Age	1.07 (0.95-1.19)	.279
Peripheral vascular disease	1.41 (0.46-3.57)	.513
Operative status urgent	1.47 (0.34-4.43)	.556
New York Heart Association functional class III-IV	1.28 (0.55-3.32)	.580
Diabetes	1.29 (0.50-3.28)	.610
Creatinine	0.80 (0.20-1.76)	.660
Gender, female	1.05 (0.48-2.33)	.901

sternotomy in comparison to primary sternotomy. However, patients who received repeat sternotomy experienced a higher prevalence of intra-aortic balloon pump therapy than those who received primary sternotomy (13.5% vs 1.9%; $P < .001$). It is controversial to compare the 2 groups because the repeat sternotomy group had greater prevalence of comorbidity (ie, coronary artery disease) and more than 1.5 times the STS predicted risk of operative mortality. There are no studies in the literature with which to make a direct comparison, and unfortunately, many studies do not even report the data on intra-aortic balloon pump therapy.

We found 2 studies that provide some insight on intra-aortic balloon pump therapy after repeat sternotomy and surgical aortic valve replacement, but not necessarily in octogenarian patients. Vohra and colleagues¹² reported on 104 patients (median age, 75 years; range, 37-90 years). In that study, 8 patients (7.7%) required intra-aortic balloon pump therapy. And Khaladj and colleagues¹³ reported on 34 patients (median age, 75 years; range, 60-84 years) of whom 2 patients (5%) received intra-aortic balloon pump therapy. The results from these 2 studies are comparable to what we report (ad hoc Fisher exact test comparison to our data: Vohra study,¹² $P = .123$; and Khaladj study,¹³ $P = .185$).

Our report has the inherent limitations of a retrospective study that includes an 18-year study period and probable significant selection bias. Fortunately, the majority of patients in both study groups received operation during the second half of the study period. Theoretically, patients would have been exposed to the same time-related biases with equal effect. The patients in our report were operated on at a high-volume tertiary referral center and were selected for operation by a group of surgeons well versed in complex reoperative cardiac surgical procedures. Importantly, the reported outcomes may not be reproducible at centers without similar reoperative cardiac experience. It is impossible to fully assess the selection bias, and referral to a center with such experience is an option to be considered in these patients.

CONCLUSIONS

Surgical aortic valve replacement can be done safely in octogenarian patients with a previous coronary artery

bypass graft operation. Our experience is that the prevalence of operative morbidity and mortality is the same as for primary sternotomy and surgical aortic valve replacement. Based on the available evidence, there is no compelling argument to abandon the technique in favor of transcatheter replacement. Repeat sternotomy for surgical aortic valve replacement is a safe option.

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