Aortic Valve Replacement With and Without Coronary Artery Bypass Surgery

By Theodore B. Berndt, M.D., E. W. Hancock, M.D., Norman E. Shumway, M.D., and Donald C. Harrison, M.D.

SUMMARY

Twenty-eight patients who underwent aortic valve replacement and coronary artery bypass grafts (group A) were compared, with respect to clinical presentation, operative mortality and morbidity and follow-up clinical status, with 40 patients who had normal coronary arteriograms and underwent aortic valve replacement only (group B). Groups A and B had a similar incidence of angina pectoris, cardiomegaly, and radiographic evidence of congestive heart failure prior to operation. Group A had a higher incidence of positive history of congestive heart failure, electrocardiographic changes indicative of an old myocardial infarction, and pure aortic regurgitation or mixed aortic stenosis-aortic regurgitation. In patients with pure aortic stenosis, the aortic valve area was greater and the aortic valve gradient was lower when there was associated coronary artery disease. The operative mortality was 14.3% in group A; 0% in group B. Postoperative morbidity was similar, except for a higher incidence of perioperative myocardial infarction in group A (10.7% vs 0%). There have been no late deaths in group A; four in group B. In the survivors, 23 of 24 group A and 36 of 36 group B patients are in NYHA class I or II, with good relief of symptoms. We conclude that the diagnosis of coronary artery disease in aortic valve disease is difficult to make without coronary arteriography. Combined aortic valve replacement and coronary artery bypass graft surgery carries a higher operative mortality than aortic valve replacement or coronary artery bypass graft surgery alone, but the clinical results at 1-3 year follow-up are equally satisfactory.

Additional Indexing Words:
Aortic stenosis
Operative mortality

AORTIC VALVE REPLACEMENT has become an established form of therapy for patients with symptomatic aortic valve disease, and evidence for clinical improvement and prolongation of life is available. However, aortic valve replacement continues to be associated with a significant operative mortality which has been reported to range from 6 to 16%, early and late myocardial infarction as high as 10%, occasional poor relief of symptoms postoperatively, and other long-term morbidity.

In one study it was also established that as many as 48% of patients having aortic valve replacement had significant coronary artery disease. The associated coronary artery disease has been proposed as one of the explanations for the morbidity and mortality associated with aortic valve replacement. Several authors have therefore suggested that coronary artery bypass graft surgery should be performed in patients who are subjected to aortic valve replacement, when significant coronary artery disease, usually with angina pectoris, is also present. How the addition of this procedure to routine aortic valve replacement affects the operative and later results has not been precisely defined. Accordingly, this report of our results with aortic valve replacement, with and without coronary artery bypass graft surgery, is an attempt to answer this question.

Methods

A review was made of all patients who underwent aortic valve replacement at Stanford Medical Center from January 1, 1970 to November 1, 1972. All those patients who had presurgical coronary arteriography in addition to routine cardiac catheterization were selected for this study and were then further subdivided into two groups: group A — twenty-eight patients who underwent aortic valve replacement and coronary artery bypass graft surgery; group B — forty patients who did not have any significant coronary artery disease on preoperative selective coronary arteriography and underwent aortic valve replacement only.

These 68 patients represent only 23% of the 296 who came to aortic valve replacement during this time. All 68 had undergone coronary arteriography because of a history suggestive of coronary artery disease, since our policy dur-
ing this period was to perform coronary arteriography only when associated coronary disease was suspected. With the exception of one patient in group A and seven patients in group B, all had a history of angina pectoris or previous myocardial infarction, or both, or showed preoperative electrocardiographic changes of an old myocardial infarction.

Patients were considered to have pure aortic regurgitation if they had 3 to 4+ aortic regurgitation on a scale of 1-4 on 9 preoperative aortograms, with no significant systolic gradient across the aortic valve; mixed aortic stenosis and aortic regurgitation if they had 2+ aortic regurgitation or greater on a preoperative aortogram and a mean aortic valve gradient greater than 20 mm Hg; and predominant aortic stenosis if there was an aortic valve gradient greater than 20 mm Hg and insignificant aortic regurgitation noted clinically on 9 preoperative aortograms (< 1 +), or at surgery. Cardiomegaly was defined as a cardiac thoracic ratio greater than 50% on chest film.

The surgical technique employed has been previously described. Aortic valve replacement was performed first, followed by coronary artery bypass grafting. Thirteen patients had coronary artery bypass grafting to the right coronary artery, 21 to the left anterior descending coronary artery, and two to the left circumflex coronary artery. The average number of grafts per patient was 1.3. The Starr-Edwards aortic valve prosthesis was used in 66 patients. One patient in group A received an aortic porcine heterograft, and one patient in group B received an aortic homograft. In addition, resection of an aneurysm of the ascending aorta was performed in two group A patients, and repair of an aneurysm of the sinus of Valsalva in one group B patient.

Follow-Up

Follow-up information was obtained in 100% of patients, either by clinic visits, questionnaire, or correspondence with the patient’s private physician. Follow-up extended over periods of more than 36 months in three patients, more than 24 months in 21 patients, and more than 12 months in all of the survivors.

Table 1

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group B</th>
<th>Statistical significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>28</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Ages (years)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>41-73</td>
<td>35-78</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>58.6</td>
<td>58.2</td>
<td>NS</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Males</td>
<td>96</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>% Females</td>
<td>4</td>
<td>15</td>
<td>P &lt; .01</td>
</tr>
<tr>
<td>History</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angina pectoris</td>
<td>23 (82%)</td>
<td>31 (77.5%)</td>
<td>NS</td>
</tr>
<tr>
<td>Syncope</td>
<td>5 (18%)</td>
<td>13 (32.5%)</td>
<td>NS</td>
</tr>
<tr>
<td>CHF</td>
<td>14 (50%)</td>
<td>10 (25%)</td>
<td>P &lt; .01</td>
</tr>
<tr>
<td>Previous MI</td>
<td>9 (32%)</td>
<td>0</td>
<td>P &lt; .01</td>
</tr>
<tr>
<td>NYHA classification</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>21 (75%)</td>
<td>33 (82.5%)</td>
<td>NS</td>
</tr>
<tr>
<td>IV</td>
<td>7 (25%)</td>
<td>7 (17.5%)</td>
<td>NS</td>
</tr>
</tbody>
</table>

Abbreviations: MI = myocardial infarction; NS = not significant; CHF = congestive heart failure.

Table 2

Preoperative Electrocardiograms

<table>
<thead>
<tr>
<th>Number of patients</th>
<th>Group A (total 28)</th>
<th>Group B (total 40)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>LVH</td>
<td>19</td>
<td>27</td>
</tr>
<tr>
<td>CLBBB</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CRBBB</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Complete heart block</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Old MI</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Inferior</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Antero-septal</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Inferior and antero-septal</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Notspecific ST-T wave changes</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: LVH = left ventricular hypertrophy; CLBBB = complete left bundle branch block; CRBBB = complete right bundle branch block; MI = myocardial infarction.

Results

Groups A and B were comparable with respect to age, history of angina pectoris, syncope, and NYHA classification (table 1). Group A had a prevalence of males and a higher incidence of congestive heart failure and previous myocardial infarction. Preoperative chest films showed cardiomegaly in 54% of group A and 45% of group B patients, and were consistent with findings of congestive heart failure in 11% of group A and 5% of group B patients. Neither of these changes was statistically significant. Preoperative electrocardiograms were comparable in both groups, with the exception of a higher incidence of diagnostic criteria for old myocardial infarction in group A and complete heart block in group B (table 2). In three group B patients, the electrocardiographic pattern which was called infarction was QS waves in precordial leads V1 and V2, which may well represent left ventricular hypertrophy rather than anteroseptal infarction. In group A, 43% had predominant aortic stenosis, 32% had predominant aortic regurgitation, and 25% had mixed aortic stenosis-aortic regurgitation; in group B, 70% had predominant aortic stenosis, 17.5% had predominant aortic regurgitation, and 12.5% had mixed aortic stenosis-aortic regurgitation.

In patients with predominant aortic stenosis or mixed aortic stenosis-aortic regurgitation, group A patients (those with associated coronary artery disease) generally had a lower aortic valve gradient and greater calculated valve area than those with pure aortic valve disease (group B) (table 3). In table 4 is shown the distribution of the significant coronary artery disease lesions in group A. This distribution does not differ significantly from patients studied at Stanford.
AV REPLACEMENT WITH/WITHOUT BYPASS

Table 3
Cardiac Catheterization Data

<table>
<thead>
<tr>
<th>Predominant AS</th>
<th>Group A</th>
<th>Group B</th>
<th>Statistical significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number (information available)</td>
<td>12 (12)</td>
<td>28 (27)</td>
<td></td>
</tr>
<tr>
<td>AV gradient (mm Hg)</td>
<td>22–78</td>
<td>39–135</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>48</td>
<td>79</td>
<td>$P &lt; .001$</td>
</tr>
<tr>
<td>AVA (cm$^2$)</td>
<td>0.4–1.6</td>
<td>0.3–0.9</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>0.83</td>
<td>0.38</td>
<td>$P &lt; .025$</td>
</tr>
<tr>
<td>Mixed AS-AR</td>
<td>5</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>AV gradient (mm Hg)</td>
<td>18–55</td>
<td>18–74</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>33</td>
<td>45</td>
<td>NS</td>
</tr>
</tbody>
</table>

Abbreviations: AS = aortic stenosis; AV = aortic valve; AVA = aortic valve area; AS-AR = aortic stenosis-aortic regurgitation.

Medical Center for coronary artery disease without aortic valve disease.

In group A, there were four early deaths (< 30 days) for an operative mortality of 14.3%. Of these four patients who died at operation, all had a history of congestive heart failure and showed cardiomegaly on preoperative chest film; three were in NYHA classification IV, and preoperatively had radiographic findings of congestive heart failure; two had a history of a previous myocardial infarction, three had triple-vessel and one had double-vessel coronary artery disease. The valvular lesion was predominant aortic stenosis in three. The cause of death was inability to come off bypass in two patients, a low cardiac output state in one patient, and progressive congestive heart failure with renal failure leading to death 26 days after operation in the fourth patient. There were no operative deaths in group B. Table 5 lists the nonfatal surgical complications in groups A and B. There were two myocardial infarctions in group A, one cerebrovascular accident in group B, and a comparable incidence of arrhythmias and bleeding in groups A and B. As seen in table 6, the total bypass time in group A was longer, while the aortic cross-clamp time was similar in groups A and B.

In Table 7 is shown postoperative follow-up data for groups A and B. There were no deaths in group A and four in group B. One patient died suddenly of massive intracerebral bleeding three months after surgery. The postmortem examination showed a ruptured lentilostriate artery. The second patient was noted in the immediate postoperative period to have a perivalvular leak and died four months after surgery from progressive congestive heart failure. The third patient had the sudden onset of aortic regurgitation three months after surgery and died several hours later of severe congestive heart failure. The fourth patient died suddenly of a pulmonary embolism 46 months after surgery. All but one of the surviving patients are in NYHA class I and II, being partially or completely relieved of their angina pectoris, with comparable results in groups A and B. Six patients in group B have persisting but less severe angina pectoris. On again reviewing their preoperative coronary arteriograms, it was found that one of these six patients had a significant (75%) obstruction of the left anterior descending coronary artery which was not detected initially and consequently not bypassed. The incidence of thromboembolic phenomena is higher in group B.

Discussion

In spite of earlier suggestions that aortic stenosis protects the coronary arteries from significant arterial disease, subsequent reports have shown a high incidence of coronary artery disease in patients with aortic valve disease, especially aortic stenosis. It would also appear likely that the presence of coronary artery disease in patients with aortic valve disease would

Table 4
Anatomy of CAD in Group A (> 60% Obstruction)

<table>
<thead>
<tr>
<th>Number</th>
<th>%</th>
<th>Number of</th>
</tr>
</thead>
<tbody>
<tr>
<td>LMCA</td>
<td>1</td>
<td>3.6</td>
</tr>
<tr>
<td>LADCA</td>
<td>20</td>
<td>71.4</td>
</tr>
<tr>
<td>CCA</td>
<td>14</td>
<td>50</td>
</tr>
<tr>
<td>RCA</td>
<td>20</td>
<td>71.4</td>
</tr>
</tbody>
</table>

Patient = 2.0

Abbreviations: CAD = coronary artery disease; LMCA = left main coronary artery; LADCA = left anterior descending coronary artery; CCA = circumflex coronary artery; RCA = right coronary artery.

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*Plus 1 patient who died.

Abbreviations: CVA = cerebro-vascular accident.
affect the clinical presentation. Bonchek\textsuperscript{12} thought
that in patients with valvular heart disease and coro-
nary artery disease, the increased external work im-
posed by the valvular heart disease increased myocar-
dial oxygen demands and therefore was likely to
 precipitate symptoms of coronary artery disease
earlier. In his experience, patients with combined
valvular and coronary artery disease always had
angina pectoris. Basta\textsuperscript{13} confirmed these findings. Our
results are similar. In our study, 23 of 28 group A
patients had a history of angina pectoris. Of the
remaining five patients, four had a history of, or
showed electrocardiographic changes of a previous
myocardial infarction, or both. Coronary arteriograms
were not performed in enough patients without
angina pectoris to determine the incidence of
associated coronary artery disease in this popula-
tion of patients. Our results confirm the well known fact that
the presence of angina pectoris is of little help in
deciding whether a patient with aortic stenosis does or
does not have associated coronary artery disease, since
82\% of group A and 77.5\% of group B patients had
angina pectoris.

It is noteworthy that in patients with significant aor-
tic stenosis the mean aortic valve area was greater and
the gradient lower in group A as compared to group B,
in spite of a higher incidence of previous congestive
heart failure in group A. Either the aortic valve dis-
ease was an incidental finding or symptoms were
precipitated earlier in group A because of the
presence of coronary artery disease, as suggested by
Bonchek.\textsuperscript{12}

The incidence of perioperative myocardial
infarction in group A patients is comparable to that in
patients undergoing coronary artery bypass graft sur-
gery alone, without aortic valve disease, in patients at
Stanford Medical Center.\textsuperscript{14} The reported incidence of
perioperative myocardial infarction in all patients un-
dergoing aortic valve replacement without any
knowledge of their coronary artery status is 3 to 5\%.\textsuperscript{2, 4}

The reported operative mortality of combined valve
replacement and coronary artery bypass graft surgery
ranges from 4 to 14\%.\textsuperscript{5, 8, 9} Our operative mortality of
14.3\% in this group of patients falls in this range.

Group A had a definitely higher operative mortality
than group B. Many reasons for this can be cited. The
difference in aortic valve disease in groups A and B
should not be a factor.\textsuperscript{16} Very likely the most im-
portant factor was the greater incidence of congestive
heart failure and previous myocardial infarction in
group A. The associated coronary artery disease in this
group may well have been one of the causes for this
greater incidence of congestive heart failure. Left ven-
tricular cineangiograms may well have shown very
poorly contracting ventricles and low ejection frac-
tions, so that surgery might not have been recom-
manded in these patients. These studies, which were
not routinely performed during that period of time in
all patients with aortic valve disease, are now per-
formed in all of these patients.

The one to three year results were favorable and en-
tirely comparable in groups A and B. Of particular
note is the fact that, in spite of a history of congestive
heart failure in 50\% of group A patients, 23 of 24 sur-
viving patients were in NYHA classification I or II
postoperatively. Thus, the policy of performing pre-

\begin{table}[h]
\centering
\caption{Bypass Time}
\begin{tabular}{|c|c|c|}
\hline
 & Group A & Group B & Statistical significance \\
\hline
\textit{Total bypass time in minutes} & & & \\
(Number of patients' information available) & & & \\
Range & 75–265 (25) & 52–106 (40) & \\
Mean & 128.8 (25) & 77.6 (40) & \textit{P < .001} \\
\hline
\textit{Aortic cross-clamp time} & & & \\
Range & 39–99 (25) & 37–80 (40) & \\
Mean & 61.6 (25) & 54.7 (40) & \textit{NS} \\
\hline
\end{tabular}
\end{table}

\begin{table}[h]
\centering
\caption{Postoperative Follow-Up}
\begin{tabular}{|c|c|c|}
\hline
 & Group A & Group B \\
\hline
Range (months) & 12–33 & 12–46 \\
Mean (months) & 18.3 & 23.8 \\
Deaths & 0 & 4 \\
Status of survivors (total) & (24) & (36) \\
Class I & 11 & 10 \\
Class II & 12 & 26 \\
Class IV & 1 & \\
Angina pectoris & & \\
Completely relieved & 15/20 (75\%) & 25/31 (80\%) \\
Partially relieved & 4/20 (20\%) & 6/31 (20\%) \\
No change & 1/20 (5\%) & 0 \\
Emboli & & \\
CVA & 2 & 6 \\
MI & 0 & 2 \\
\hline
\end{tabular}
\end{table}
operative coronary arteriography in patients with aortic valve disease and symptoms of coronary artery disease, and of performing coronary artery bypass grafting on the lesions demonstrated appears to be sound and justified.

Whether the addition of coronary artery bypass graft surgery in patients with significant coronary artery disease who undergo aortic valve replacement decreases the operative mortality or improves the long-term results remains an unanswered question. To answer this more fully, it would be helpful to observe an additional group of patients with significant coronary artery disease who undergo aortic valve replacement only, and compare their results with those of groups A and B. Such a large contemporary group no longer exists at Stanford. The benefit of coronary artery bypass graft surgery to these patients must be weighed against the mortality of coronary arteriography, increasing the length of the operative procedure (table 6), and changes in the native coronary circulation with coronary artery bypass graft surgery, especially should graft occlusion occur.

The question of whether all patients coming to aortic valve replacement should have preoperative coronary arteriography, regardless of their symptoms, or whether significant coronary artery obstructions should be bypassed with graft surgery at the time of aortic valve replacement in the absence of angina pectoris or previous myocardial infarction, cannot be answered definitely at this time. It is hoped that controlled studies involving larger groups of patients will provide some meaningful guidelines.

References

Aortic Valve Replacement With and Without Coronary Artery Bypass Surgery
THEODORE B. BERNDT, E. W. HANCOCK, NORMAN E. SHUMWAY and DONALD C. HARRISON

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