Aortic Valve Surgery as an Emergency Procedure

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SUMMARY
Twenty-three patients critically ill from aortic valvular disease underwent emergency aortic valve replacement as a life-saving measure. Sixteen patients (70%) survived hospitalization and 14 (61%) are presently living. Of eighteen patients who underwent solitary aortic valve replacement, there were four hospital deaths and two late deaths. Five patients required double valve surgery, with three hospital deaths and no late deaths. The survivors often had dramatic improvement and have done well during an average follow-up period of 9 months. The major factor contributing to mortality after surgery was irreversible myocardial damage particularly evident in patients with longstanding severe valvular disease. Valve replacement can be successfully accomplished in patients critically ill with aortic valve disease, especially if it occurs as an isolated lesion.

Additional Indexing Words:
Aortic valve surgery  Myocardial damage  Veno-arterial bypass

The replacement of severely diseased heart valves with prosthetic valves has represented one of the great surgical advances of the past decade. Generally, valve replacement is undertaken as an elective procedure. However, on occasion patients are encountered who are so near the end stage of their disease or who have undergone such sudden hemodynamic deterioration that valve replacement must be performed as an urgent, life-saving measure.

Presented here is our experience at the Massachusetts General Hospital with emergency aortic valve replacement in a group of 23 patients who were in such critical condition that emergency valve replacement was thought to provide the only hope for survival.

Description of Patients and Indications for Surgery
Twenty-three patients underwent emergency aortic valve replacement between March 1966 and May 1969, of whom 19 were operated upon after January 1968. The pertinent features of these patients are presented in Table 1. The group included 15 men and eight women ranging in age from 31 to 84 years with an average age of 58.7 years. Four patients were over the age of 70.

The predominant aortic valve lesion was stenosis in 11 patients and regurgitation in 12. Of the latter 12 patients the cause of aortic regurgitation was acute or subacute bacterial endocarditis in seven. Four patients had associated significant mitral valve dysfunction and a fifth had disease of both the mitral and tricuspid valves.

The major indication for surgery was a critical state of refractory low cardiac output with hypotension in five patients, intractable congestive heart failure with pulmonary edema in five, and a combination of low output state and severe
### Table 1

**Pertinent Features of 23 Patients with Emergency Aortic Valve Surgery**

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age/sex</th>
<th>Major valvular lesions</th>
<th>Etiology</th>
<th>Duration of symptoms</th>
<th>Indications for surgery</th>
<th>Other valve surgery</th>
<th>Results</th>
<th>Duration of follow-up (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80F</td>
<td>AS ++</td>
<td>? Senile</td>
<td>1 Y</td>
<td>+ + +</td>
<td>CHF</td>
<td>+</td>
<td>3+</td>
</tr>
<tr>
<td>2</td>
<td>67M</td>
<td>AR +</td>
<td>Bicuspid</td>
<td>4 Y</td>
<td>+ + +</td>
<td></td>
<td>+</td>
<td>7+</td>
</tr>
<tr>
<td>3</td>
<td>69M</td>
<td>MS +</td>
<td>? Senile</td>
<td>3 Y</td>
<td>+ + +</td>
<td></td>
<td>+</td>
<td>3+</td>
</tr>
<tr>
<td>4</td>
<td>84F</td>
<td>MR +</td>
<td>? Senile</td>
<td>2 Y</td>
<td>+ + +</td>
<td></td>
<td>+</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>55M</td>
<td>TR +</td>
<td>Bicuspid</td>
<td>2 Y</td>
<td>+ + +</td>
<td></td>
<td>+</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>74M</td>
<td></td>
<td>? Senile</td>
<td>?</td>
<td>+ + +</td>
<td></td>
<td>+</td>
<td>1/3</td>
</tr>
<tr>
<td>7</td>
<td>51F</td>
<td>+</td>
<td>Senile</td>
<td>3 M</td>
<td>+ + +</td>
<td></td>
<td>+</td>
<td>1+</td>
</tr>
<tr>
<td>8</td>
<td>62M</td>
<td>+</td>
<td>Senile</td>
<td>7 M</td>
<td>+ + +</td>
<td></td>
<td>+</td>
<td>10+</td>
</tr>
<tr>
<td>9</td>
<td>44M</td>
<td>+</td>
<td>Rheumatic</td>
<td>4 Y</td>
<td>+ + +</td>
<td></td>
<td>+</td>
<td>6</td>
</tr>
<tr>
<td>10</td>
<td>53M</td>
<td>+</td>
<td>Rheumatic</td>
<td>8 Y</td>
<td>- + +</td>
<td></td>
<td>+</td>
<td>10+</td>
</tr>
<tr>
<td>11</td>
<td>68M</td>
<td>+</td>
<td>Aortitis</td>
<td>1 Y</td>
<td>+ + +</td>
<td></td>
<td>+</td>
<td>10+</td>
</tr>
<tr>
<td>12</td>
<td>56M</td>
<td>+</td>
<td>BE</td>
<td>2 W</td>
<td>- + +</td>
<td></td>
<td>+</td>
<td>7+</td>
</tr>
<tr>
<td>13</td>
<td>53M</td>
<td>+</td>
<td>BE</td>
<td>2 W</td>
<td>+ + +</td>
<td></td>
<td>+</td>
<td>9</td>
</tr>
<tr>
<td>14</td>
<td>54M</td>
<td>+</td>
<td>BE</td>
<td>3 M</td>
<td>+ + +</td>
<td></td>
<td>+</td>
<td>1+</td>
</tr>
<tr>
<td>15</td>
<td>31F</td>
<td>+</td>
<td>BE</td>
<td>4 W</td>
<td>- + +</td>
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<td>10+</td>
</tr>
<tr>
<td>16</td>
<td>53M</td>
<td>+</td>
<td>BE</td>
<td>2 W</td>
<td>+ + +</td>
<td></td>
<td>+</td>
<td>38+</td>
</tr>
<tr>
<td>17</td>
<td>51M</td>
<td>+</td>
<td>BE</td>
<td>4 W</td>
<td>- + +</td>
<td></td>
<td>+</td>
<td>22+</td>
</tr>
<tr>
<td>18</td>
<td>78M</td>
<td>+</td>
<td>BE</td>
<td>?</td>
<td>+ + +</td>
<td></td>
<td>+</td>
<td>12+</td>
</tr>
<tr>
<td>19</td>
<td>63F</td>
<td>+</td>
<td>Rheumatic</td>
<td>10 Y</td>
<td>+ + +</td>
<td>MV</td>
<td>+</td>
<td>8+</td>
</tr>
<tr>
<td>20</td>
<td>60F</td>
<td>+</td>
<td>Rheumatic</td>
<td>7 Y</td>
<td>+ + +</td>
<td>MVR</td>
<td>+</td>
<td>6+</td>
</tr>
<tr>
<td>21</td>
<td>34F</td>
<td>+</td>
<td>Rheumatic</td>
<td>2 Y</td>
<td>+ + +</td>
<td>TVR</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>57M</td>
<td>+</td>
<td>Rheumatic</td>
<td>6 Y</td>
<td>+ + +</td>
<td>MVR</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>52F</td>
<td>+</td>
<td>Rheumatic</td>
<td>9 M</td>
<td>+ + +</td>
<td>MVR</td>
<td>+</td>
<td></td>
</tr>
</tbody>
</table>

**Abbreviations:**
- AS = aortic stenosis
- AR = aortic regurgitation
- MS = mitral stenosis
- MR = mitral regurgitation
- TR = tricuspid regurgitation
- BE = bacterial endocarditis
- Y = years
- M = months
- W = weeks
- CHF = congestive heart failure
- OR = operating room
- MV = mitral valve replacement
- MVR = mitral valve replacement
congestive heart failure in the remaining 13. Twelve patients required vasopressors or beta-adrenergic agents or both to maintain blood pressure during the 24 hours prior to surgery, and two patients (one with aortic stenosis and another with aortic regurgitation) suffered cardiac arrests with successful resuscitation during this period. Preoperative blood urea nitrogen levels were greater than 20 mg% in all but three patients and were over 50 mg% in seven, reflecting prerenal azotemia. Cardiac catheterization was performed preoperatively in seven patients. In the others the cardiac diagnosis and decision for surgery were made on the basis of the clinical examination.

In all 23 cases it was judged unlikely by the attending cardiologist and cardiac surgeons that the patient would survive without emergency surgery. Seventeen patients underwent surgery within 24 hours of admission to the hospital or within 24 hours of sudden hemodynamic deterioration in the hospital. The other six patients went to surgery after 2 to 4 days of progressive cardiac deterioration on a maximal medical program.

**Operative Technic**

Because of the critical condition of these patients the common femoral vessels were often cannulated in the operating room under local anesthesia to allow circulatory assistance by way of partial cardiopulmonary bypass until full bypass could be achieved.

General anesthesia was then induced usually with large doses of intravenous morphine (2 mg/kg) used in conjunction with muscle relaxants. Following median sternotomy patients were placed on full cardiopulmonary bypass using a disposable bubble oxygenator with hemodilution and blood flows of approximately 55 cc/kg/min at 28 C. The left and occasionally both coronary arteries were routinely perfused. The Starr-Edwards caged ball prostheses were used for aortic valve replacement and, in three patients, for mitral valve replacement as well. Mitral valvulotomy using a Tubbs dilator was performed in a fourth patient and tricuspid valve replacement with a Kay-Shiley prosthesis in a fifth. Atrial and ventricular pacing electrodes were usually applied to the epicardium at surgery.

**Postoperative Course**

The details of intensive care in the postoperative cardiac surgical patient have been discussed elsewhere. Ventilatory support via an endotracheal tube was given all patients until their ventilatory mechanics and arterial blood gases were satisfactory and stable. Such support was required for an average of 39 hours (range 13 to 66 hours) after surgery. Inotropic agents consisting of epinephrine, isoproterenol, calcium chlo-

ride, or glucagon were required by 10 patients for an average of 3 days (range 2 hours to 7 days) postoperatively.

Arrhythmias were common in the postoperative period. Atrial fibrillation and nodal tachycardia were each present in seven patients. Frequent ventricular premature beats were present in three patients and sinus bradycardia, transient complete heart block, and ventricular fibrillation were encountered in single instances. Thirteen patients were paced for a variety of reasons. Atrial and ventricular pacing were commonly used for suppression of ectopic nodal or ventricular activity by rate overdrive and for augmentation of cardiac output in patients with slow heart rates. Sequential atrioventricular pacing was sometimes used to enhance cardiac output by establishing a more favorable relationship between atrial and ventricular contraction.

Transient alterations in central nervous system function were seen in 10 patients after surgery. In six, brief periods of confusion or paranoia or both occurred, usually on the second or third postoperative day. Two patients awoke slowly following surgery and required 4 days for full recovery of mental alertness. One of these patients also had left-sided hemiparesis. The remaining two patients had brief periods of emotional depression postoperatively.

Transient jaundice with elevations of both direct and indirect bilirubin was seen in nine patients. Two patients developed the postperfusion syndrome and one had mild acute renal tubular necrosis with full recovery. Pneumonitis was encountered in only one patient who died after 11 days of persistent low cardiac output and obtundation.

The nine surviving patients without bacterial endocarditis left the hospital an average of 19 days after surgery. The seven patients with bacterial endocarditis stayed in the hospital an average of 44 days postoperatively, usually to complete antibiotic therapy.

**Results**

Sixteen of the 23 patients (70%) survived hospitalization and 14 (61%) are living at the time of this writing. The relationship between the predominant valvular lesions, duration of symptoms, and survival is shown in table 2. Of the nine deaths, three occurred in the operating room (patients 21 to 23). All three patients had end-stage biventricular disease requiring double valve replacement. These patients were unable to sustain an effective cardiac output when coming off cardiopulmonary bypass despite vigorous cardiotonic
support. A fourth patient (case 11) was terminally ill from aortic regurgitation and went to surgery in severe pulmonary edema with hypotension, cyanosis, and acidosis (pH 6.9). Postoperatively he had a markedly poor cardiac output, repeated ventricular fibrillation, and irreversible metabolic acidosis, which led to his death 12 hours later. Another patient (case 6) with aortic stenosis who was in shock at the time of surgery died 11 days later from a continued profound low output state associated with congestive heart failure and ventricular irritability. The sixth hospital death occurred in an 84-year-old woman (patient 4) with florid congestive heart failure and low cardiac output due to aortic stenosis. She had sustained a cardiac arrest with successful resuscitation 1 hour before surgery. Although considerable improvement in cardiac function was seen after aortic valve replacement, her postoperative course was marked by arrhythmias and mild mental confusion. On the 26th postoperative day she fell and sustained a subdural hematoma which eventually proved fatal. The seventh patient (case 5) died suddenly 12 weeks after surgery after repeated episodes of ventricular tachyarrhythmias.

Two late deaths have occurred, both in patients with aortic regurgitation. One patient (case 9) had such severe myocardial disease that despite correction of his aortic regurgitation he remained in chronic congestive heart failure and eventually died 6 months later. The other patient (case 13) expired 9 months postoperatively after a fall in which he sustained head trauma.

The 14 surviving patients have been followed for 2 to 38 months at the time of this writing (average 9 months) and have done remarkably well.

**Discussion**

The 23 patients reported here underwent emergency aortic valve replacement because of profound and intractable congestive heart failure, low cardiac output, or both. Although survival is notoriously difficult to judge in any given case, the clinical status of these 23 patients was so critical that both the attending cardiologists and cardiac surgeons considered it unlikely that any would survive without emergency valve replacement. This was indeed the primary criterion for inclusion in this series. Two recent reports describe gratifying results with acceptable operative risks after emergency open heart surgery for a variety of lesions.8,9 Our experience with emergency aortic valve replacement has likewise been encouraging. The overall hospital mortality of 30% in the present series is far higher than that of elective aortic valve replacement.10 On the other hand, this mortality seems quite acceptable for such a critically sick population.

Analysis of the mortality figures indicates at least two factors which bear heavily on survival. First, those patients with associated significant disease of other valves did poorly. Three of the five patients with double valve

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**Table 2**

<table>
<thead>
<tr>
<th>Major valve lesions</th>
<th>Average duration of symptoms prior to surgery</th>
<th>Total number of patients</th>
<th>Mortality Hospital</th>
<th>Mortality Late</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aortic stenosis alone</td>
<td>22 months</td>
<td>8</td>
<td>3 (37%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Aortic regurgitation alone</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-endocarditis</td>
<td>52 months</td>
<td>3</td>
<td>1 (33%)</td>
<td>1 (33%)</td>
</tr>
<tr>
<td>Endocarditis</td>
<td>4 weeks</td>
<td>7</td>
<td>0 (0%)</td>
<td>1 (14%)</td>
</tr>
<tr>
<td>Double valve disease*</td>
<td>82 months</td>
<td>5</td>
<td>3 (60%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>23</td>
<td>7 (30%)</td>
<td>2 (9%)</td>
</tr>
</tbody>
</table>

*All patients with major double valve disease required double valve surgery.*
surgery died in the hospital in contrast to the four hospital deaths among 18 patients with isolated aortic valve replacement. Second, both early and late survivals are greatly dependent upon the reversibility of the myocardial damage caused by the severely diseased valves and probably acutely aggravated by the prolonged periods of low cardiac output and consequent low coronary perfusion which immediately preceded surgery. This “pump failure” after heart surgery was responsible for death in five of the seven patients who died in the hospital and in one of the two patients who succumbed later. In addition, another hospital death was caused by recurrent ventricular tachyarrhythmias, also likely due to severe myocardial disease.

One factor probably influencing the reversibility of myocardial changes is the duration of time that the heart has been subjected to the severe hemodynamic burden imposed by the diseased valve. Thus, the absence of hospital mortality among the seven patients with bacterial endocarditis may be related to the relatively brief duration (days to weeks) of insult to the left ventricle which did not cause irreversible myocardial damage. On the other hand, the four hospital deaths among the 11 patients with longstanding aortic valve disease may be related to the irreversibility of myocardial changes that might be expected to result from months to years of insult prior to the final decompensation that led to surgery.

The critical status of these patients presents special problems in anesthesia, surgery, and postoperative management. Of particular aid has been the use of veno-arterial bypass instituted by cannulation of the femoral vessels under local anesthesia prior to induction of general anesthesia and the routine implantation of atrial and ventricular pacing wires allowing postoperative pacing for a variety of problems.

Many of the patients in this series illustrate that surgery is often too long postponed in patients with severe valvular disease. Other patients present initially to the physician with end-stage disease or with rapid deterioration from a previously stable state, particularly when the heart valves are destroyed by endocarditis. In such cases, emergency valve replacement, though associated with a high operative risk, may offer the only chance of survival and should be undertaken.

References
Aortic Valve Surgery as an Emergency Procedure
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Circulation. 1970;41:623-627
doi: 10.1161/01.CIR.41.4.623

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