Arrhythmias following Cardiac Valve Replacement

By Roger Smith, M.D., William Grossman, M.D., Lewis Johnson, M.D., Herman Segal, M.D., John Collins, M.D., and James Dalen, M.D.

SUMMARY
A prospective study of 50 consecutive patients undergoing cardiac valve replacement was designed to determine the incidence, types, and predisposing factors to postoperative arrhythmias. Patients were monitored continuously for the first 7 days following surgery.

Thirty-seven patients (74%) experienced a total of 66 episodes of arrhythmia. Supraventricular arrhythmias were the most common (43 of 66; 65%). The most frequent specific arrhythmia was atrial fibrillation (21 of 66; 32%). Arrhythmias occurred 77% of the time within the first 48 hours of surgery.

Of 25 factors evaluated preoperatively in each patient, only two were found to predispose to postoperative arrhythmias. These were: (1) previous cardiac surgery; and (2) elevated blood urea nitrogen.

There were four hospital deaths, representing a hospital mortality of 8%. No deaths were due to a primary arrhythmia.

It is concluded that whereas arrhythmias are a very common complication of cardiac valve replacement, early detection and treatment has lessened their significance as a cause of postoperative mortality and morbidity.

Additional Indexing Words:
Aortic valve replacement Mitral valve replacement Postoperative arrhythmias Tricuspid valve replacement

During the past decade, cardiac valve replacement has become a standard surgical procedure for the treatment of certain patients with valvular heart disease. The medical complications following valve replacement have been assessed by numerous investigators.1–12 In these studies arrhythmias have been found to be one of the most common complications and their incidence has varied from 8 to 30%.

In most of these reports the incidence of arrhythmias has been determined by retrospective review of cases, and the clinical significance of the arrhythmias has not been clearly delineated. Furthermore, few investigators have analyzed the types of postoperative arrhythmias with respect to predisposing factors.

In order to define more precisely the incidence, types, predisposing factors, and clinical significance of arrhythmias occurring after valve replacement, a prospective study was undertaken in 50 consecutive patients.

Methods
For the first 7 days following cardiac valve replacement, 50 patients (16 men and 34 women) were monitored continuously by a bedside electrocardiographic monitor. The patients ranged in age from 30 to 74 years (median 54); 19 patients were under 50 years of age; 17

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Arrhythmias were recorded daily as they occurred and were classified into three major groups: supraventricular, ventricular, and conduction abnormalities. The specific arrhythmias comprising each group are detailed in table 1. Occasional ectopic atrial or ventricular beats were not considered significant arrhythmias unless their frequency required therapy or they were found to herald a major arrhythmia.

Nearly all patients (48 of 50) had received digitalis preparations prior to admission for surgery. Of these, 10 patients were suspected of having digitalis toxicity and, therefore, their digitalis preparations were stopped at varying intervals before operation. In the absence of digitalis toxicity, digoxin was given up to 24-48 hours prior to surgery. Maintenance digoxin was resumed 48 hours after surgery if no contraindications were present, unless clinical indications prompted its use earlier.

Twenty-five preoperative factors were evaluated for each patient in order to determine if any specific factor predisposes to the development of postoperative arrhythmias (table 2).

Serum potassium levels were monitored frequently during the intra- and postoperative periods. The serum potassium level was very labile in many patients. Throughout the postoperative period, supplemental potassium was administered as necessary to maintain the serum level at 4.2-5.0 mEq/liter. Potassium was given by bolus or constant infusion in the early postoperative period or by the oral route when feasible.

Results

Of the 50 patients, 37 (74%) experienced one or more episodes of arrhythmia in the first

### Table 1

**Arrhythmias Occurring within One Week of Valve Replacement in 37 Patients**

<table>
<thead>
<tr>
<th>Arrhythmia</th>
<th>No. of episodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supraventricular:</td>
<td></td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>21</td>
</tr>
<tr>
<td>Atrial flutter</td>
<td>7</td>
</tr>
<tr>
<td>Nodal (junctional) rhythm</td>
<td>12</td>
</tr>
<tr>
<td>Paroxysmal atrial tachycardia</td>
<td>2</td>
</tr>
<tr>
<td>Supraventricular, unspecified</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>43 (65%)</td>
</tr>
<tr>
<td>Ventricular:</td>
<td></td>
</tr>
<tr>
<td>Bigeminy</td>
<td>2</td>
</tr>
<tr>
<td>Ventricular tachycardia</td>
<td>3</td>
</tr>
<tr>
<td>Ventricular fibrillation</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>6 (9%)</td>
</tr>
<tr>
<td>Conduction abnormalities:</td>
<td></td>
</tr>
<tr>
<td>1st heart block</td>
<td>3</td>
</tr>
<tr>
<td>2nd heart block</td>
<td>1</td>
</tr>
<tr>
<td>3rd heart block</td>
<td>6</td>
</tr>
<tr>
<td>Right bundle-branch block</td>
<td>2</td>
</tr>
<tr>
<td>Left bundle-branch block</td>
<td>2</td>
</tr>
<tr>
<td>A-V dissociation</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>17 (26%)</td>
</tr>
<tr>
<td>Total episodes</td>
<td>66</td>
</tr>
</tbody>
</table>

Symptoms:
- Angina
- Syncope
- Congestive heart failure

Electrocardiographic data:
- Rhythm on admission
- Bundle-branch block
- Extrasystoles
- History of arrhythmias
- Evidence of digitalis toxicity

Radiographic:
- Calcification of mitral valve
- Calcification of aortic valve
- Heart size

Hemodynamic data:
- Cardiac index
- Left ventricular diastolic pressure
- Type of valvular lesion

Medications on admission:
- Digitalis preparation and dosage
- Diuretics
- Antiarrhythmics

Laboratory data:
- Serum potassium
- Blood urea nitrogen
- Arterial pO₂
- Arterial pCO₂

Other:
- Age
- Sex
- Previous cardiac surgery

were between 50 and 59; and 14 were over 60 years.

Surgical procedures included aortic valve replacement in 16 patients, mitral valve replacement in 22 patients, and mitral valve plus either aortic or tricuspid valve replacement in 12 patients.

### Table 2

**Postoperative Factors**
week following cardiac valve replacement. These 37 patients had a total of 66 episodes of arrhythmia (table 1).

Supraventricular arrhythmias were the most frequent type, accounting for 43 of 66 episodes of arrhythmia (65%). The most frequent supraventricular arrhythmia was atrial fibrillation (21 episodes).

The second most frequent supraventricular arrhythmia was nodal (junctional) rhythm (12 episodes). Of these 12 episodes, six occurred in patients who had been in sinus rhythm, five in atrial fibrillation, and one in a patient who had been in third-degree heart block before surgery.

Of the 66 episodes of arrhythmia, 17 (26%) were conduction abnormalities with third-degree heart block occurring in six patients.

Ventricular arrhythmias were least common with only six episodes. These included three episodes of ventricular tachycardia, two of persistent bigeminy requiring therapy, and one episode of ventricular fibrillation.

Arrhythmias occurred within the first 48 hours of surgery in 77% of cases. In patients undergoing mitral valve replacement alone, 90% of the arrhythmias occurred within the first 48 hours.

There was no significant difference in the total incidence of arrhythmias following aortic as compared to mitral valve replacement (table 3). However, the distribution of arrhythmias was significantly different (P < 0.05) in these two groups. Following aortic valve replacement, only six of the 14 episodes of arrhythmia were supraventricular (43%). Five were conduction abnormalities (36%), and three were ventricular arrhythmias (21%). In contrast, following mitral valve replacement, 19 of the 26 arrhythmias were supraventricular (73%), five were conduction abnormalities (19%), and only two were ventricular arrhythmias (8%).

Of the 25 preoperative factors that were evaluated (table 2), only two were found to be related to the occurrence of postoperative arrhythmias. These were: (1) previous cardiac surgery; and (2) elevated blood urea nitrogen (BUN) (> 30 mg%). Conduction abnormalities occurred in 10 of 16 patients with previous cardiac surgery (63%) but in only six of 34 patients (18%) without previous cardiac surgery (P < 0.01). Similarly, conduction abnormalities occurred in all five patients who had a preoperative BUN greater than 30, but in only 12 of 45 patients (27%) with normal BUN levels (P < 0.05).

The influence of the preoperative rhythm was assessed and is summarized in table 4. Of the 50 patients, 29 were in normal sinus rhythm preoperatively, but 21 (73%) of these patients experienced postoperative arrhythmias. This was essentially the same incidence as for the 18 patients who were in atrial fibrillation preoperatively, 12 of whom experienced postoperative arrhythmias (66%). In patients who were in atrial fibrillation before surgery, atrial fibrillation was classified as a postoperative arrhythmia if the ventricular response exceeded 130 beats/min and if supplemental digoxin was required in the early postoperative period. Supraventricular arrhythmias were the most common postoperative arrhythmia in both groups.

Table 3

<table>
<thead>
<tr>
<th>Procedure (no. patients)</th>
<th>Supraventricular</th>
<th>Ventricular</th>
<th>Conduction abnormality</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVR (16)</td>
<td>6</td>
<td>3</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>MVR (22)</td>
<td>19</td>
<td>2</td>
<td>5</td>
<td>26</td>
</tr>
<tr>
<td>*Multiple (12)</td>
<td>18</td>
<td>1</td>
<td>7</td>
<td>26</td>
</tr>
<tr>
<td>Total</td>
<td>43</td>
<td>6</td>
<td>17</td>
<td>66</td>
</tr>
</tbody>
</table>

*Nine patients had aortic and three patients had tricuspid valve replacement in addition to mitral valve replacement.

Abbreviations: AVR = aortic valve replacement; MVR = mitral valve replacement.
POSTOPERATIVE ARRHYTHMIAS

Table 4

Influence of Preoperative Rhythm on Postoperative Arrhythmias

<table>
<thead>
<tr>
<th>Postoperative arrhythmia</th>
<th>Preoperative rhythm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal sinus (n = 29)</td>
</tr>
<tr>
<td>Supraventricular:</td>
<td></td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>12</td>
</tr>
<tr>
<td>Atrial flutter</td>
<td>5</td>
</tr>
<tr>
<td>Nodal rhythm</td>
<td>6</td>
</tr>
<tr>
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<td>Conduction abnormalities:</td>
<td></td>
</tr>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; heart block</td>
<td></td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt; heart block</td>
<td>1</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt; heart block</td>
<td>1</td>
</tr>
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<td>2</td>
</tr>
<tr>
<td>Left bundle-branch block</td>
<td></td>
</tr>
<tr>
<td>A-V dissociation</td>
<td></td>
</tr>
<tr>
<td>Total patients with arrhythmia</td>
<td>21 (73%)</td>
</tr>
<tr>
<td>Total episodes of arrhythmia</td>
<td>37</td>
</tr>
</tbody>
</table>

Treatment of the arrhythmias encountered during the course of this study was entirely dependent upon the patient's overall clinical status. Whenever an arrhythmia was detected, the presence of extracardiac causes (hypovolemia, hyperkalemia, ventilatory problems, malpositioned monitoring lines) were evaluated, and in many cases correction of these factors obviated the need for specific antiarrhythmic therapy.

The most common arrhythmias (atrial fibrillation and atrial flutter) were treated with supplemental digoxin, using the ventricular rate as a guide. Whenever nodal rhythm occurred, digoxin was withheld, and the need for supplemental potassium was assessed. No other treatment was required for this arrhythmia in this series of patients.

Of the conduction abnormalities, first-degree heart block and right or left bundle-branch block required no therapy. Third-degree heart block was treated with ventricular pacing via epicardial pacing electrodes that had been placed at the time of surgery. One patient required a permanent pacemaker due to the persistence of third-degree block.

Four patients died during hospitalization, resulting in a hospital mortality of 8%. None of the four deaths was secondary to an arrhythmia. Two patients died of persistent hemorrhage, one of a myocardial infarction and low cardiac output syndrome, and one of uremia and hepatic failure.

Discussion

The most striking finding of this study was the very high incidence of arrhythmias (74%) developing within the first week following valve replacement. In sharp contrast to this high incidence of arrhythmias was the fact that no patient died of a primary arrhythmia. This seemingly paradoxical observation is reminiscent of the experience reported by Lown with respect to the incidence and significance of arrhythmias occurring in a coronary care unit. Lown reported that careful monitoring of patients during the acute phase of myocardial infarction revealed a previously unsuspected high incidence of arrhythmias. Despite this, the incidence of death due to an arrhythmia was reduced by early recognition and prompt treatment. We believe that a
similar explanation may be applicable to the findings of the present study.

This study demonstrated that the most common arrhythmias following valve replacement are supraventricular and that 77% occurred within the first 48 hours postoperatively. This finding is similar to that of Williams who reported that eight of 11 episodes of atrial fibrillation occurred within the first 3 postoperative days.

Atrial fibrillation, the most common specific arrhythmia to occur, did not present a major problem, since ventricular rates were relatively slow (<140 beats/min) requiring only supplementary digoxin. This, no doubt, is the result of the fact that 48 of the 50 patients received digitalis preparations preoperatively.

Complete heart block also occurred early; all six episodes occurred within 48 hours of surgery. In one patient, the block remained, requiring a permanent pacemaker; in four, temporary pacing was required; and, in one, digitalis toxicity was suspected and following discontinuance of digitalis the block subsided. Only two of the episodes of heart block occurred after aortic valve replacement, three after mitral valve replacement, and one after mitral and tricuspid valve replacement. In contrast to earlier reports in the mid-1960’s by Gannon and Ross, the incidence of permanent heart block following aortic valve replacement is decreasing, reflecting improved surgical technique. The use of temporary epicardial leads implanted at the time of surgery has greatly facilitated the management of this arrhythmia.

The fact that the vast majority of these patients had been digitalized prior to admission obviated a comparison between digitalized and undigitalized patients. Therefore, the results of this study do not permit us to draw any conclusions as to the advantages or disadvantages of prophylactic digitalization prior to cardiac surgery. However, the fact that there were no deaths due to an arrhythmia, and that there was a low incidence of arrhythmias that might be related to digitalis, lends some support to the thesis that digitalization prior to cardiac surgery is appropriate.

Careful evaluation of 25 preoperative factors revealed only two (previous cardiac surgery and elevated BUN) which were related to the occurrence of postoperative arrhythmias. This study, therefore, failed to define clearly a profile of factors which predispose to postoperative arrhythmias.

We conclude that, although the frequency of cardiac arrhythmias is very high after valve replacement, their significance can be minimized by early recognition and prompt, appropriate therapy.

References


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