Mural Thrombosis and Arterial Embolism in Mitral Stenosis
A Clinicopathologic Study of Fifty-one Cases

By ROBERT A. JORDAN, M.D., CHARLES H. SCHEIFLEY, M.D., and JESSE E. EDWARDS, M.D.

A clinicopathologic study of 51 cases of mitral stenosis with intracardiac mural thrombi is presented with particular reference to the locations of these thrombi and their relationship to the associated thromboembolic phenomena. In 27 cases the thrombi were present only in the left side of the heart, in 15 cases they were in both sides of the heart, and in 9 cases they were present only in the right atrium. Of 42 cases in which thrombi were located in the left side of the heart, in 20 the thrombi were limited to the left auricular appendage. In the remaining 22 cases in this group the thrombi in the left side of the heart were situated on the main atrial wall, in the auricular appendage and on the main atrial wall together, or in the left ventricle. Systemic arterial emboli occurred frequently regardless of the particular site in the left side of the heart at which the thrombus formed. Of 24 cases in which thrombi were situated in the right side of the heart, in 20 the thrombi were restricted to the right auricular appendage.

ARTERIAL embolism is a frequent and sometimes fatal complication of mitral stenosis. Willius stated that emboli are present in 30 per cent of all cases of mitral stenosis in which death is due to myocardial failure. Weiss and Davis found pulmonary or visceral infarcts at necropsy in 45 per cent of 164 patients who died from rheumatic heart disease. In addition these authors studied 48 consecutive patients who had cerebral emboli and found rheumatic heart disease in 23 instances. Bull in a necropsy study found severe mitral stenosis in 5 of 15 cases in which arterial embolism of the extremities occurred.

Most of the arterial emboli occurring in patients with mitral stenosis arise from mural thrombi in the left atrium. Intracardiac mural thrombi were present in nearly a third of 116 cases of severe rheumatic heart disease studied at necropsy by Garvin. Several workers have demonstrated that the intracardiac mural thrombi in mitral stenosis are situated predominantly in the atria, particularly in the left atrium. Rarely do mural thrombi occur in the ventricles in mitral stenosis.

The impression is gained from the writings of Welch, Bull and others that it is rare for atrial mural thrombi to be found anywhere except in the auricular appendages. A review of the literature disclosed three studies on the mural thrombi in mitral stenosis wherein the exact locations of these thrombi were designated. In the study by Graef and associates there were 19 cases of mitral stenosis in which left atrial mural thrombi occurred. In only 9 of these 19 cases were the thrombi limited to the left auricular appendage. In the same study there were 10 cases in which there were right atrial thrombi, all of which were found in the auricular appendage. Of the 5 cases of mitral stenosis in which there were left atrial thrombi, reported by Bull, in 3 cases the thrombi were limited to the auricular appendage. There were left atrial mural thrombi in 50 cases of rheumatic heart disease in the study reported by Söderström. Mural thrombi were found in the left auricular appendage in 29 instances, and on the main left atrial wall in 25 instances. No statement was made as to the number of cases in which thrombi in the left auricular appendage and on the main left atrial wall coexisted.

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The exact location of the intracardiac mural thrombi occurring in mitral stenosis is a consideration of current interest. Surgical removal of the left auricular appendage has been suggested as a possible means of reducing the hazard of recurring arterial emboli in patients with mitral stenosis. Madden has reported on 2 patients with mitral stenosis and recurring arterial emboli in whom he resected the left auricular appendage. In 3 patients with similar conditions Baronofoisky ligated the left auricular appendage. Resection of one or both auricular appendages has been performed successfully in dogs.

The present study was stimulated by the desire to determine if there is a sound pathologic basis for the proposal that the left auricular appendage be ligated or resected to prevent the recurrence of arterial emboli in patients with mitral stenosis. It is a clinical and pathologic analysis of 51 cases of mitral stenosis in which intracardiac mural thrombi were found at necropsy.

**MATERIAL**

The 51 cases used for this study included all cases of mitral stenosis with intracardiac mural thrombi found in a series of 11,536 necropsies performed at the Mayo Clinic during the 20 year period ending Dec. 31, 1948. All cases of bacterial endocarditis and all cases in which there was gross evidence of ventricular myocardial infarction were excluded from the study. Mitral stenosis of a moderate to severe degree was present in all cases. In several instances there were associated rheumatic lesions of the aortic or the tricuspid valve, or of both.

The average age of the 51 patients at the time of death was 45 years. The ages ranged from 17 years to 83 years. The majority of the patients died during the fourth, fifth and sixth decades of life. There were only 9 patients who were 60 years of age or older at the time of death.

**DISTRIBUTION OF MURAL THROMBI**

The distribution of mural thrombi according to the side of the heart in which they were found is given in table 1.

In certain cases the left atrial mural thrombi were limited to the left auricular appendage; in other cases they were present only on the main left atrial wall; and finally in some cases they were in both locations.

Of the 27 cases in which mural thrombi were present only in the left side of the heart, in 10 the thrombi were restricted to the left auricular appendage. Of the remaining 17 cases, in 10 the thrombi were found both in the auricular appendage and on the left atrial wall, in 4 they were found only on the main left atrial wall, in 2 they were found only in the left ventricle, and in 1 case they were found in the auricular appendage, on the left atrial wall and in the left ventricle. In the 15 cases in which the thrombi were present in both sides of the heart, there were 10 instances in which the thrombi in the left side were restricted to the left auricular appendage. There were thrombi on the left atrial wall alone in 2 of the 15 cases, and in the auricular appendage and on the main left atrial wall in 3 cases. Thus in 42 cases mural thrombi were present in the left side of the heart, but in only 20 of the 42 cases were they restricted to the left auricular appendage.

A somewhat different distribution was found for the mural thrombi occurring in the right atrium. In 15 cases mural thrombi in the right atrium were associated with thrombi in the left side of the heart. In 11 of these 15 cases the right atrial thrombi were restricted to the auricular appendage. In 9 additional cases in which mural thrombi were present only in the right atrium, the thrombi were limited to the auricular appendage. Thus in a total of 24 cases in which right atrial mural thrombi were present, there were 20 cases in which the auricular appendage was the only site of mural thrombosis in the right side of the heart.

**THROMBOEMBOLIC PHENOMENA**

Pathologic evidence of systemic arterial embolization was present in 32 of the 51 cases studied. In 21 of these cases there were arterial...
emboli to two or more organs, and in 17 of the 32 cases there were pulmonary infarcts or emboli in addition to the systemic arterial emboli. The incidence and distribution of emboli to various organs are shown in figure 1. The mural thrombi in the left side of the heart were restricted to the left auricular appendage in only 13 of the 32 cases in which there were systemic arterial emboli (table 2). In 4 of the 32 cases there were no mural thrombi in the left side of the heart.

Fig. 1. Distribution and incidence of emboli in 51 cases of mitral stenosis with intracardiac mural thrombi.

There were 15 patients in this study who had clinically recognized systemic arterial embolic episodes. In 5 of these patients the emboli had been the major or a contributory cause of death. There were emboli to more than one organ in 14 of the 15 cases. Peripheral arterial emboli were present in 11 cases, cerebral emboli in 9 cases, and mesenteric arterial emboli in 3 cases. The mural thrombi in the left side of the heart were limited to the left auricular appendage in 8 of the 15 cases (table 3).

Pulmonary emboli or infarcts were present at necropsy in 27 cases, in 16 of which mural thrombi were found in the right atrium. Peripheral venous thrombi were found in 8 cases, in 5 of which they were associated with right atrial mural thrombi. In 8 cases no source of pulmonary embolism was found at necropsy.

There were 5 cases of fatal pulmonary embolism. In all 5 cases there were mural thrombi in the right atrium, in 3 of which thrombi were demonstrated in the peripheral veins as well.

Table 2.—Distribution of the Mural Thrombi in the Left Side of the Heart in 32 Cases of Mitral Stenosis with Systemic Arterial Emboli

<table>
<thead>
<tr>
<th>Location of thrombi</th>
<th>Cases</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left auricular appendage only</td>
<td>13</td>
<td>40.6</td>
</tr>
<tr>
<td>Left auricular appendage and main left atrium</td>
<td>8</td>
<td>25.0</td>
</tr>
<tr>
<td>Main left atrium only</td>
<td>5</td>
<td>15.6</td>
</tr>
<tr>
<td>Left ventricle only</td>
<td>2</td>
<td>6.3</td>
</tr>
<tr>
<td>No thrombi present in left side of heart</td>
<td>4</td>
<td>12.5</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td></td>
</tr>
</tbody>
</table>

Table 3.—Distribution of the Mural Thrombi in the Left Side of the Heart in 15 Cases of Mitral Stenosis with Clinically Recognized Systemic Arterial Emboli

<table>
<thead>
<tr>
<th>Location of thrombi</th>
<th>Cases</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left auricular appendage only</td>
<td>8</td>
<td>53.3</td>
</tr>
<tr>
<td>Left auricular appendage and main left atrium</td>
<td>4</td>
<td>26.7</td>
</tr>
<tr>
<td>Main left atrium only</td>
<td>2</td>
<td>13.3</td>
</tr>
<tr>
<td>No thrombi present in left side of heart</td>
<td>1</td>
<td>6.7</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.—Incidence of Thrombi Limited to the Left Auricular Appendage in Mitral Stenosis with Mural Thrombi in the Left Side of the Heart

<table>
<thead>
<tr>
<th>Author</th>
<th>Total cases</th>
<th>Thrombi limited to left auricular appendage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Cases</td>
</tr>
<tr>
<td>Bull</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Graef and associates</td>
<td>19</td>
<td>9</td>
</tr>
<tr>
<td>Present study</td>
<td>42</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>66</td>
<td>32</td>
</tr>
</tbody>
</table>
CARDIAC RHYTHM

Several authors have pointed out that intracardiac mural thrombi occurring in mitral stenosis are usually associated with auricular fibrillation. In this study the cardiac rhythm was known in 50 of the 51 cases studied. In 42 of these 50 cases there were physical signs of auricular fibrillation. The diagnosis was confirmed by electrocardiographic studies in 38 of the 42 cases; no electrocardiograms had been taken in the remaining 4 cases.

CONGESTIVE CARDIAC FAILURE

It has been stated by several authorities that the incidence of mural thrombosis in all types of cardiac disease including mitral stenosis is higher in those patients who have had congestive cardiac failure than in those who have not had cardiac failure. Forty-seven patients in this study either had congestive cardiac failure at the time of the final hospital admission or had had a history of previous episodes of congestive failure; 4 patients gave no history of such failure. Of these 4 patients, the left atrial mural thrombi were restricted to the left auricular appendage in 3, to the main left atrial wall in 1.

COMMENT

From the data presented in this study and from the studies of Bull, of Graef and associates, and of Söderström, it seems reasonable to conclude that mural thrombi occurring in the left side of the heart in mitral stenosis are restricted to the left auricular appendage in approximately half of the cases (table 4). It would thus appear that resection or ligation of the left auricular appendage of patients with mitral stenosis and recurring arterial emboli would probably offer no more than a 50 per cent chance of eliminating the source for systemic arterial emboli.

A somewhat different situation exists with regard to the predominant locations of the right atrial thrombi in mitral stenosis. In our study as well as that of Graef and associates the right atrial thrombi were in most instances restricted to the right auricular appendage. It should be remembered, however, that in our study, while 16 of the 27 patients with pulmonary emboli had mural thrombi in the right atrium, 8 of these 27 patients had thrombi also in the peripheral veins.

The reason for the frequent occurrence of mural thrombi on the main wall of the left atrium in mitral stenosis is not definitely known. It seems probable that the MacCallum patches or endocardial pockets, so often found in the left atrial wall in mitral stenosis, may be the site of origin of mural thrombi.

SUMMARY AND CONCLUSIONS

1. A clinicopathologic study of 51 cases of mitral stenosis with intracardiac mural thrombi is presented, with particular reference to the incidence and location of the mural thrombi and the associated thromboembolic phenomena.

2. In mitral stenosis mural thrombi are found most frequently in the atria, and approximately twice as often in the left as in the right atrium.

3. Only about half of the mural thrombi in the left side of the heart are restricted to the left auricular appendage.

4. The majority of the right atrial thrombi in mitral stenosis are restricted to the right auricular appendage.

5. Systemic arterial emboli were found with approximately the same frequency whether the mural thrombi were restricted to the left auricular appendage or were located elsewhere in the left side of the heart.

6. In patients with mitral stenosis and mural thrombosis there is a high incidence of auricular fibrillation.

7. The majority of patients with mitral stenosis who are found to have intracardiac mural thrombi at necropsy have had congestive cardiac failure at some time during life.

REFERENCES


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