Closed mitral valvotomy: early results and long-term follow-up of 3724 consecutive patients


ABSTRACT Between 1956 and 1980 closed mitral valvotomies were performed in 3724 consecutive patients (male:female ratio 1.1:1) with mitral stenoses. Their ages ranged from 6 to 69 years, with a mean (SD) of 27.3 (9.3). Mitral stenosis in the younger age group is a unique condition and a great majority of these patients rapidly develop significant pulmonary hypertension and congestive cardiac failure. In this study a large number of subjects belonged to functional class IV (41.5%). Hospital mortality was 1.5% over the last 5 years. After valvotomy, 11 patients (0.3%) developed severe mitral regurgitation that made valve replacement necessary in the immediate postoperative period. Early postoperative embolism occurred in 0.4% of those who were in atrial fibrillation and had preoperative anticoagulation whereas it occurred in 0.95% of those in sinus rhythm who had no anticoagulation. Late postoperative embolism occurred at a rate of 0.3 to 1.6 per 1000 patients per year over a 20 year period. Rheumatic reactivity occurred at a rate of 1.3 to 2.2 per 1000 patients per year during the same period. Rate of occurrence of restenosis varied from 4.2 to 11.4 per 1000 patients per year between the fifth and fifteenth year of follow-up. Closed transventricular revalvotomy for restenosis was accomplished in 130 subjects with a 6.7% mortality. Excellent symptomatic improvement was evident in 86% of long-term survivors at the end of 15 years. Actuarial survival was 95%, 93.1%, 89.5%, and 84.2% at 6, 12, 18, and 24 years, respectively, after closed mitral valvotomy. Late deaths occurred in 4.3%. This study serves to highlight the excellent palliative effect of closed valvotomy for mitral stenosis without significant valvular calcification, substantial regurgitation, or significant associated valvular lesion.

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THE FIRST SUCCESSFUL closed mitral commissurotomy was reported as early as 1923 by Cutler and Levine1 and this was followed by a report by Souttar2 in 1925. Three decades later this procedure was resurrected by Harken et al.,3 Bailey,4 and Baker et al.5 At the Department of Cardiothoracic Surgery of the Christian Medical College Hospital, Vellore, India, we have been carrying out closed mitral valvotomies since 1956. This is a referral center and patients who underwent closed mitral valvotomies over a 25 year period serve as the basis for this report.

Material and methods

Between 1956 and 1980 3724 subjects with mitral stenosis underwent closed valvotomy. Their ages ranged from 6 to 69 years, with a mean (SD) of 27.3 (9.3) years; 25% were less than 20 years old and 40% were in their third decade. Male patients constituted 53.5% of the patient population.

Presenting symptoms and signs. Sixty-five percent of patients had symptoms for less than 3 years and only 4% had complaints beyond 10 years. A history of rheumatic fever was obtained in 47.2% of patients, 14.1% of whom had more than two episodes. Major preoperative clinical features are listed in table 1; 41.5% belonged to functional class IV, 57.5% to class III, and the remaining 1% to class II. Four hundred sixty-nine (12.5%) were in atrial fibrillation and the remainder were in sinus rhythm. The preoperative embolic episodes in those with sinus rhythm was 3.1% and it was 11.3% in subjects with atrial fibrillation. A poor nutritional status was a striking feature in many. Over 40% of our patients under 20 years old were in the second- or third-degree stage of malnutrition (less than 70% based on weight for age by American standards). Auscultatory
TABLE 1
Major preoperative clinical features

<table>
<thead>
<tr>
<th>Clinical features</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effort dyspnea</td>
<td>99.0</td>
</tr>
<tr>
<td>Palpitation</td>
<td>80.0</td>
</tr>
<tr>
<td>Right heart failure</td>
<td>72.0</td>
</tr>
<tr>
<td>Paroxysmal nocturnal dyspnea</td>
<td>40.0</td>
</tr>
<tr>
<td>Haemoptysis</td>
<td>30.0</td>
</tr>
<tr>
<td>Preoperative embolic episode</td>
<td>4.2</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>12.5</td>
</tr>
<tr>
<td>Opening snap</td>
<td>98.2</td>
</tr>
</tbody>
</table>

Findings of a sharp opening snap was evident in 93.5% and a loud first heart sound in 96.5%. Fluoroscopic examination revealed mild-to-moderate calcification in 15.3%. The other associated valvular lesions encountered were mild mitral regurgitation in 12.8%, mild aortic regurgitation in 15.5%, and tricuspid regurgitation (which was functional in almost every instance) in 40.5%. Functional tricuspid regurgitation was considered to be present when the typical clinical features of tricuspid valve incompetence were present along with right ventricular failure and pulmonary arterial hypertension and when these signs became less marked, with total disappearance of some, after mitral valvotomy. Patients were not considered for mitral valvotomy if significant mitral regurgitation and heavy calcification were observed before surgery.

Electrocardiographic evidence of left ventricular hypertrophy in mitral stenosis was seen in 8.5% of patients, presumably the result of associated aortic valve disease or thin chest walls, which were common. The criteria for left ventricular hypertrophy was an R wave in V1 or V6, and an S wave in V1 more than 35 mm in height (for adults) or over 45 mm in height (for children).

Cardiothoracic ratio ranged from 50% to 80%, with a mean (SD) of 56.2 (5.6). Pulmonary venous hypertension as defined by Braunwald was evident in 75% of patients. Although cardiac catheterization and angiocardiographic examination on a routine basis is not feasible, these procedures were performed in 214 subjects (including many young subjects) to quantitate the degree of pulmonary hypertension and in other patients they were used to document the degree of associated valvular lesion when it was deemed mandatory because of tight mitral stenosis.

Surgical considerations. A left anterolateral thoracotomy through the fifth intercostal space has been the method of choice for all those in sinus rhythm. A posterolateral incision was routinely used in all subjects with atrial fibrillation; this allowed access through the body of the atrium when the appendage was shriveled and fibrosed. This approach was always used in patients with restenosis of the mitral valve when a closed valvotomy was carried out.

Instrumental dilatation of the mitral valve was achieved in almost all instances with the Tubbs transventricular dilator. Early in our experience, finger fracture of the mitral valve was done in 219 subjects. Postoperative ventilatory assistance was carried out for at least 24 hr in those who belonged to class IV and had complicating pulmonary hypertension. It was extraordinary that 83.7% of subjects had a valve orifice of 0.5 cm or less, the measurement being judged by digital assessment.

Follow-up. All patients at the time of discharge were prescribed long-term chemoprophylaxis and were advised to report at the end of 1 year to the outpatient department. Once every 3 weeks chemoprophylaxis was achieved by the use of intramuscular injections of 1.2 million U benzathine benzylpenicillin in those weighing more than 27 kg and of 600,000 U in those weighing less than 27 kg. In less than 2% of the patients daily sulfadiazine was used for chemoprophylaxis since penicillin could not be given due to problems of sensitization. Over 90% of the patients adhered to this regimen. Routine check-up included physical, x-ray, electrocardiographic, and echocardiographic examinations in the recent past. Following this, patients were asked to come for periodic review at the end of 2 years and subsequently at 5 year intervals. However, if symptoms recurred, they were asked to report to us immediately. The assistance of referral physicians was also sought in getting the required data. Those patients who failed to come in were sent a printed questionnaire to be filled out and returned. Vigorous attempts were also made to locate the nonresponders with the help of a social worker who made personal visits. The follow-up period ranged from 1 to 24 years and the success of follow-up at various time intervals is depicted in table 2. In view of the fact that the patients treated hailed from remote corners of the country and even from abroad, it was not possible to have a 100% response. However, it is remarkable that, as shown in this table, we were able to achieve over 70% follow-up at the end of 15 years. A comparison between nonresponders at each follow-up period with those who responded revealed that the various clinical and other features were not significantly different.

Means, SDs, proportions, and their SEs were computed when necessary. The incidence of various events and mortality were expressed per 1000 patients per year. Actuarial survival rates were computed by the method of Cutler and Ederer.

Results

The hospital mortality (defined as death occurring within 30 days after surgery) was 4.2% in class IV and 3.6% in class III subjects, averaging 3.8% for the group as a whole. The list of causes of death given in table 3 indicates that the most common of these were refractory cardiac failure and tachyarrhythmias or bradyarrhythmias.

A satisfactory surgical result was achieved in 98% of patients. This was considered adequate or nearly normal in our experience when the orifice admitted 1½ to 2 fingers or more. In 74 patients (2%) it was presumed that the valvotomy was incomplete. The common adverse features sometimes responsible for an inadequate valvotomy were tough fibrotic valves, extensive subvalvar fusion, and dense calcification inadvertently encountered at surgery. The outcome of valvotomy in each group, i.e., those with and without sharp opening snaps, loud first heart sounds, and calcification, is given in table 4. Nevertheless, the presence

TABLE 2
Number and percent of patients available for follow-up at various time intervals

<table>
<thead>
<tr>
<th>Years of follow-up</th>
<th>Patients at risk</th>
<th>No. followed up</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3580</td>
<td>3561</td>
<td>99.5</td>
</tr>
<tr>
<td>5</td>
<td>2751</td>
<td>2587</td>
<td>94.0</td>
</tr>
<tr>
<td>10</td>
<td>1736</td>
<td>1422</td>
<td>81.9</td>
</tr>
<tr>
<td>15</td>
<td>892</td>
<td>639</td>
<td>72.0</td>
</tr>
<tr>
<td>20 or more</td>
<td>252</td>
<td>175</td>
<td>69.4</td>
</tr>
</tbody>
</table>

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of certain adverse features need not negate a successful valvotomy.

A mild degree of postoperative mitral regurgitation resulted in 18%, which we believed was not hemodynamically significant. Eleven subjects (incidence of 0.3%) developed severe mitral regurgitation. Of these, seven underwent emergency valve replacement in the early postoperative period and this resulted in one death. Four died without surgery. In the 12.8% of patients in whom a mild degree of regurgitation was noted before surgery, a successful valvotomy resulted in its disappearance in 47%. In only 8% did it increase to regurgitation of a moderate degree.

Over the past decade, patients with mitral stenosis and complicating atrial fibrillation underwent a 3 week anticoagulant regimen before surgery. In this group of 265 patients the incidence of postoperative embolism was 0.4%. Early in this series, in 204 subjects with atrial fibrillation who did not undergo the anticoagulant regimen, the occurrence of postoperative embolism was 6.2%. In patients who were in sinus rhythm the overall incidence of postoperative embolism was only 0.95%.

Eighty patients had concomitant closed transventricular mitral and aortic valvotomies while four had triple valvotomies (tricuspid valve included). In the presence of associated tricuspid stenosis, closed combined mitral and tricuspid valvotomies were accomplished in three patients. This will be the subject of a later report.

The functional status of patients at each stage of follow-up is illustrated in figure 1. In the 639 subjects who were followed up for 15 years, clinical status data revealed that 86% maintained an excellent or good condition. It is noteworthy that of 119 subjects who were seen beyond 20 years, 27 were in functional class I and 53 in functional class II. Actuarial analysis by the method of Cutler and Ederer indicates a good long-term survival, with 94.0%, 89.4%, 85.0%, and 78.3% alive at 6, 12, 18, and 24 years, respectively, without having to undergo a second procedure (figure 2).

The incidence of various events at different stages of follow-up is given in table 5. The occurrence of restenosis varied from 4.2 to 11.4 per 1000 patients per year between the fifth and fifteenth year of follow-up. The incidence of rheumatic reactivity was low and its occurrence showed a progressive decline after the tenth year. It is apparent from this study that besides the incidence of restenosis, incidence of other important events, such as rheumatic reactivity, embolic phenomena, and mitral regurgitation, did not show a positive correlation with time.

One hundred and seventy-two patients underwent a second operation on the mitral valve. Sixty-eight subjects who did not heed the advice to undergo another operation died without having had it. It is relevant to mention that in 130 of these (ranging in age 13 to 59 years; mean ± SD, 31.9 ± 8.8) closed transventricular valvotomies were carried out with an operative mortality of 6.7%. In 26 patients, mitral valve replacement was accomplished. The remainder are awaiting surgery (table 6). Late deaths occurred in 4.3%, the most common cause being progressive cardiac failure.

### Discussion

There is a growing body of surgeons who support open commissurotomy as the preferred surgical approach for mitral stenosis. The operative mortality for this procedure ranges from 1.5% to 10%. At this center, open valvotomy is the method of choice in those with Lutembacher’s syndrome, massive left atrial thrombus, and restenosis with atrial fibrillation. Houseman et al. mentioned 16% occurrence of restenosis after an open procedure. Brewer stated that an “open” operation frequently did not give a better result than a “closed” procedure. The one deterrent to open valvotomy that stands out is the fact that the number of valves that tend to be replaced varies from a figure as high as 44% to 28%. The tactile impression in assessing function of the valve after closed

### Table 3

<table>
<thead>
<tr>
<th>Causes of hospital deaths</th>
<th>No.</th>
</tr>
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<tbody>
<tr>
<td>Refractory cardiac failure</td>
<td>66</td>
</tr>
<tr>
<td>Arrhythmias</td>
<td>42</td>
</tr>
<tr>
<td>Embolism</td>
<td>15</td>
</tr>
<tr>
<td>Septicemia</td>
<td>7</td>
</tr>
<tr>
<td>Renal failure</td>
<td>6</td>
</tr>
<tr>
<td>Respiratory infection</td>
<td>3</td>
</tr>
<tr>
<td>Gastrointestinal bleeding</td>
<td>1</td>
</tr>
<tr>
<td>Penicillin anaphylaxis</td>
<td>1</td>
</tr>
</tbody>
</table>

### Table 4

<table>
<thead>
<tr>
<th>Preoperative findings</th>
<th>No. of cases</th>
<th>Adequate valvotomy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium +</td>
<td>574</td>
<td>94.0</td>
</tr>
<tr>
<td>No calcium</td>
<td>3150</td>
<td>97.8</td>
</tr>
<tr>
<td>Loud first heart sound</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>3585</td>
<td>98.1</td>
</tr>
<tr>
<td>No</td>
<td>139</td>
<td>97.9</td>
</tr>
<tr>
<td>Sharp opening snap</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>3471</td>
<td>98.2</td>
</tr>
<tr>
<td>No</td>
<td>242</td>
<td>95.7</td>
</tr>
</tbody>
</table>

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mitral valvotomy is superior to that obtained during the open procedure.

The present study shows that in terms of safety, efficacy, excellent long-term results, and low-cost effectiveness, closed valvotomy remains the treatment of choice as a palliative operation for mitral stenosis. A large number of subjects in the Vellore study were in their third decade while other authors\textsuperscript{19} have reported that a significant proportion of their subjects were in the fifth decade of life. Furthermore, there is a preponderance of men in our study as compared with other large series.\textsuperscript{10, 19-24} Profound disability and chronic congestive failure were observed in many patients and several were moribund at the time of surgery. A higher incidence of atrial fibrillation (63%), together with a greater occurrence of postoperative embolism, have been recorded by other authors\textsuperscript{20, 25-28} as compared with the 12.5% incidence of atrial fibrillation and low incidence of postoperative embolism we observed. Various authors\textsuperscript{10, 19, 25, 29, 30} have quoted mortality figures ranging from 1% to 8.7%. Ellis et al.,\textsuperscript{31} in their review of 1000 patients, noted a mortality of 19% in class IV patients. In this study the hospital mortality among 1545 class IV patients was only 4.2%. The low incidence of severe postoperative mitral regurgitation (0.3%) is at variance with reports of others.\textsuperscript{32}

Even in those subjects with mild-to-moderate calcification a favorable result was achieved in 94%. Olinger et al.\textsuperscript{30} carried out closed valvotomies in 23 patients with calcific mitral stenosis. It is pertinent that the use of a transventricular dilator in this procedure is imperative and these authors believe that the occur-

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure1}
\caption{Functional status of patients at different stages of follow-up.}
\end{figure}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure2}
\caption{Actuarial survival curve after closed mitral valvotomy.}
\end{figure}
rence of significant regurgitation when this dilator is in use is a dangerous hazard. In a finger fracture valvotomy the force to open the valve is unidirectional and this maneuver could result in the dislodgement of calcific emboli.

During the last decade the routine use of anticoagulants in subjects with mitral stenosis and atrial fibrillation has resulted in a postoperative thromboembolic occurrence rate of 0.4%, as contrasted with a figure of 10% to 22% significant emboli observed by other authors. 11, 33-36

The incidence of restenosis herein was low compared with figures varying from 50% to 10%. 37, 38 Restenosis is not the result of an inadequate valvotomy, but of the inexorable progress of the fibrotic process; our results with this entity have been reported earlier. 39-41 It should be noted that a great majority of patients in our series were in a younger age group as compared with subjects in other studies and they therefore had more pliable valves and were, in our opinion, excellent subjects for closed mitral valvotomy. The follow-up data in our study indicates that the peak time for incidence of restenosis is about year 12, with a gradual decline in its incidence thereafter. Schoevar-dts et al. 42 stated that the tenth postoperative year is the critical period when the need for reoperation is the greatest, irrespective of whether the procedure was open or closed. Salerno et al. 43 reported a 9.5% operative mortality in those having a second closed valvotomy, whereas it was 6.7% in our study.

Symptomatic improvement was sustained and actuarial analysis revealed that 78.3% of patients were alive at the end of 24 years. In light of the excellent symptomatic benefit — both early and long-term — obtainable with the transventricular dilator techniques, it seems logical to continue the use of mitral valvotomy in most cases of isolated mitral stenosis.

Our appreciation in a large measure goes to Mr. V. Nagarajan for secretarial help. We also express our grateful thanks to the staff of Medical Records Department and Biostatistics Department for their help and cooperation. Many others have given much of their time and effort in compiling the data.

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TABLE 5
Incidence of various events (per 1000 patients/year) at different periods of follow-up

<table>
<thead>
<tr>
<th>Years of follow-up</th>
<th>No. of cases followed</th>
<th>Mitral stenosis</th>
<th>Rheumatic reactivity</th>
<th>Mitral regurgitation</th>
<th>Systemic embolism</th>
<th>Late deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3,564</td>
<td>0.0</td>
<td>1.6</td>
<td>4.2</td>
<td>0.3</td>
<td>1.7</td>
</tr>
<tr>
<td>5</td>
<td>2,643</td>
<td>4.2</td>
<td>2.2</td>
<td>5.5</td>
<td>0.2</td>
<td>0.7</td>
</tr>
<tr>
<td>10</td>
<td>1,473</td>
<td>8.1</td>
<td>1.7</td>
<td>3.5</td>
<td>0.3</td>
<td>0.7</td>
</tr>
<tr>
<td>15</td>
<td>670</td>
<td>11.4</td>
<td>1.8</td>
<td>4.7</td>
<td>0.6</td>
<td>0.7</td>
</tr>
<tr>
<td>20 or more</td>
<td>186</td>
<td>5.6</td>
<td>1.3</td>
<td>1.9</td>
<td>1.6</td>
<td>3.8</td>
</tr>
</tbody>
</table>

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