Effect of Mitral Valvulotomy on Tricuspid Insufficiency Associated with Mitral Stenosis

By Pier Federico Angelino, M.D., Beniamino Lo Bue, M.D., and Valeria Levi, M.D.

Twenty patients, affected by mitral disease associated with tricuspid insufficiency and selected for mitral commissurotomy on the basis of clinical evidence of advanced heart disease, have been studied before and after surgery. The further course of the disease could be related to various clinical and pathophysiologic conditions, the importance of which in the selection of patients is stressed.

TRICUSPID lesions are less common as isolated valvular diseases than in association with a more severe involvement of other valves.

The incidence of tricuspid involvement in rheumatic mitral disease has been reported to be frequent, but statistics are extremely variable on this point, due to the difficulty in having a diagnosis unequivocally confirmed,1-11 at least as far as tricuspid lesions of lesser degree are concerned.

The possibility of surgical correction of the mitral valve increases the importance of recognizing the nature and type of combined valvular lesions. While no doubts exist as to some contraindications to mitral valvulotomy (severe mitral and aortic insufficiency, persistence of rheumatic activity, etc.), there are some other associated conditions the importance of which in the selection of patients is not well established. Among these are tricuspid lesions coexisting with pure mitral stenosis or with combined mitral stenosis and insufficiency. Pure tricuspid stenosis may be corrected surgically.5,9-11 As to tricuspid insufficiency, there are as yet no surgical techniques for its direct treatment, and in many instances medical care is ineffective. Since tricuspid insufficiency can be reduced by hemodynamic improvement in pulmonary circulation, mitral valvulotomy should be considered as an indirect treatment.

This report concerns the outcome after mitral commissurotomy in patients with associated tricuspid insufficiency. Particular attention is given to those hemodynamic factors that seem to have greater importance in the further course of the operated patients.

MATERIALS AND METHODS

During the 6-year period from 1951 to 1956, at the Heart Surgery Center in Turin, more than 2,000 patients affected by valvular disease, mostly mitral stenosis with or without insufficiency, were operated upon. This survey is restricted to the 20 patients who had tricuspid insufficiency in addition to mitral disease. The tricuspid damage was always severe, and quite often it was responsible for the majority of the symptoms. Eleven of the patients were females and 9 were males, and their ages varied between 21 and 45 years. All had advanced heart disease: 14 were in class IV, and 6 in class III, according to the criteria of the New York Heart Association. The subjects were divided in 2 groups: In group I were 13 patients with pure mitral stenosis (table 1); in group II were 7 with associated variable degrees of mitral insufficiency (table 2).

As to the tricuspid involvement, insufficiency was confirmed during operation in 18 patients, a systolic regurgitation being clearly perceived by the surgeon’s finger inserted into the right atrium. In 2 additional cases tricuspid insufficiency was associated with tricuspid stenosis; the latter was corrected by tricuspid valvulotomy.

All patients exhibited symptoms of tricuspid insufficiency. The liver was enlarged in all instances, with definite systolic pulsations in 13 cases; cervical veins were engorged in all subjects, a systolic pulsation being visible in 13; ascites had been previously noted in 5 cases and in 2 it was present during hospitalization.

Auscultatory findings were those of mitral disease; moreover, tricuspid involvement produced
MITRAL VALVULOTOMY AND TRICUSPID INSUFFICIENCY

TABLE 1.—Clinical Findings in Thirteen Patients with Pure Mitral Stenosis and Tricuspid Insufficiency, Group I

<table>
<thead>
<tr>
<th>Age</th>
<th>Sex</th>
<th>Rheumatic fever</th>
<th>Dyspnea</th>
<th>Pulmonary edema</th>
<th>Hemoptysis</th>
<th>Ascites</th>
<th>Heart failure</th>
<th>Liver enlargement</th>
<th>Peripheral edema</th>
</tr>
</thead>
<tbody>
<tr>
<td>31</td>
<td>M</td>
<td>yes</td>
<td>++++</td>
<td>+</td>
<td>+++</td>
<td>—</td>
<td>++</td>
<td>+++</td>
<td>+</td>
</tr>
<tr>
<td>28</td>
<td>F</td>
<td>yes</td>
<td>++</td>
<td>—</td>
<td>+</td>
<td>—</td>
<td>+</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>28</td>
<td>M</td>
<td>no</td>
<td>+++</td>
<td>—</td>
<td>++</td>
<td>—</td>
<td>++</td>
<td>+++</td>
<td>+</td>
</tr>
<tr>
<td>24</td>
<td>F</td>
<td>yes</td>
<td>+++</td>
<td>+</td>
<td>—</td>
<td>—</td>
<td>+++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>21</td>
<td>F</td>
<td>yes</td>
<td>+</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>+</td>
<td>—</td>
</tr>
<tr>
<td>45</td>
<td>M</td>
<td>yes</td>
<td>++++</td>
<td>—</td>
<td>+</td>
<td>—</td>
<td>+++</td>
<td>+++</td>
<td>++</td>
</tr>
<tr>
<td>45</td>
<td>F</td>
<td>yes</td>
<td>++++</td>
<td>—</td>
<td>+</td>
<td>—</td>
<td>+++</td>
<td>+++</td>
<td>++</td>
</tr>
<tr>
<td>29</td>
<td>F</td>
<td>yes</td>
<td>++</td>
<td>—</td>
<td>+</td>
<td>—</td>
<td>+++</td>
<td>+++</td>
<td>+</td>
</tr>
<tr>
<td>36</td>
<td>M</td>
<td>yes</td>
<td>++</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>+</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>37</td>
<td>M</td>
<td>yes</td>
<td>+++</td>
<td>++</td>
<td>++</td>
<td>—</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>40</td>
<td>F</td>
<td>yes</td>
<td>++++</td>
<td>+</td>
<td>+</td>
<td>—</td>
<td>+++</td>
<td>+++</td>
<td>++</td>
</tr>
<tr>
<td>42</td>
<td>M</td>
<td>yes</td>
<td>+++</td>
<td>+</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>+++</td>
<td>+</td>
</tr>
<tr>
<td>43</td>
<td>M</td>
<td>yes</td>
<td>+++</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>+++</td>
<td>+++</td>
<td>++</td>
</tr>
</tbody>
</table>

Table 2.—Clinical Findings in Seven Patients with Mitral Regurgitation and Tricuspid Insufficiency, Group II

<table>
<thead>
<tr>
<th>Age</th>
<th>Sex</th>
<th>Rheumatic fever</th>
<th>Dyspnea</th>
<th>Pulmonary edema</th>
<th>Hemoptysis</th>
<th>Ascites</th>
<th>Heart failure</th>
<th>Liver enlargement</th>
<th>Peripheral edema</th>
</tr>
</thead>
<tbody>
<tr>
<td>31</td>
<td>M</td>
<td>yes</td>
<td>++++</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>++</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>28</td>
<td>F</td>
<td>yes</td>
<td>++</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>+++</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td>40</td>
<td>F</td>
<td>yes</td>
<td>++</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>+</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>37</td>
<td>M</td>
<td>yes</td>
<td>+++</td>
<td>—</td>
<td>+</td>
<td>—</td>
<td>+</td>
<td>++</td>
<td>—</td>
</tr>
<tr>
<td>21</td>
<td>F</td>
<td>yes</td>
<td>++</td>
<td>++</td>
<td>—</td>
<td>—</td>
<td>+</td>
<td>+++</td>
<td>++</td>
</tr>
<tr>
<td>36</td>
<td>F</td>
<td>yes</td>
<td>++</td>
<td>++</td>
<td>—</td>
<td>—</td>
<td>+</td>
<td>+++</td>
<td>+</td>
</tr>
<tr>
<td>38</td>
<td>F</td>
<td>yes</td>
<td>++</td>
<td>+</td>
<td>—</td>
<td>—</td>
<td>+++</td>
<td>+++</td>
<td>++</td>
</tr>
</tbody>
</table>

A systolic murmur over the lower end of the sternum : its increase in intensity after a deep inspiration could not be observed in all patients.12 Roentgen examination and angiocardiograms13 revealed enlargement of right atrium and ventricle in both groups (fig. 1); moreover, additional enlargement of left cavities was revealed in group II. Sixteen patients had atrial fibrillation. Electrocardiographic evidence of combined ventricular hypertrophy was present in 6 patients of group II, while all other patients showed only right ventricular hypertrophy.

At operation in all subjects of group I, a severe degree of mitral stenosis was found (0.4-0.8 cm.2); the area of the valve orifice after commissurotomy was about 3 to 3.5 cm.2

Patients of group II, in whom a preoperative diagnosis of associated mitral insufficiency was made, were operated upon: in 2 of them a plastic repair of the mitral insufficiency was also attempted.

Clinical, radiologic, and electrocardiographic examinations were systematically made within 6 months and up to 2 years after operation, in order to evaluate further modifications of cardiocirculatory function.

RESULTS

Postoperative Course

In the first postoperative week, clinical conditions did not differ significantly in the 2 groups. Fifteen patients had a certain improvement of dyspnea, but hepatic enlargement and jugular venous engorgement were practically unchanged, except in 3, who...
showed only for a few days a less engorged liver. Five patients, including 1 with mitral insufficiency, had a normal postoperative course, as is usually observed in patients with pure mitral stenosis.

Late Results

The late results have been quite different in the 2 groups (table 3).

Group I. Also among the patients of this group, the results have been quite variable. Three of them had considerable benefit, showing 2 or 3 weeks after the operation a definite improvement in cardiocirculatory function: liver enlargement and jugular venous engorgement were reduced and the size of the right heart and pulmonary artery significantly decreased (fig. 2). At the same time, the loud first sound and systolic murmur that were present before operation at the lower left sternal border or adjacent to it disappeared, and the findings became more clearly those of mitral stenosis, due to elimination of tricuspid insufficiency and increase in cardiac output. Electrocardiographic changes characterized by the disappearance of right ventricular hypertrophy, were noted only after 6 months or a year. Further observation demonstrated that the good results remained unchanged after 2 years.

In 3 others benefit was only partial, the evidence of tricuspid insufficiency being essentially unchanged, while the dyspnea and the other findings of mitral stenosis were reduced. In 2 of them an associated degree of tricuspid stenosis was detected by the surgeon and corrected by tricuspid valvulotomy, while in the third calcific fibrosis of the mitral cusps was found.

Seven other patients failed to demonstrate any improvement postoperatively, though severe mitral stenosis had been removed. In these subjects the most important finding at the operation was the rigidity and hardness of lungs, which hardly could be collapsed. In some of them, biopsy showed microscopic changes in the small pulmonary vessels, mainly in the arterioles, consisting in subintimal thickening with narrowing or obliteration of the lumen. Four of them developed congestive heart failure after the early postoperative course, with alternating periods

Fig. 1 Left. Dextrocardiogram made at 5 seconds in a patient with mitral stenosis and severe tricuspid insufficiency, showing marked enlargement of the right atrium and moderate opacification of the right ventricle. Compare this picture with the dextrocardiogram of a patient with pure mitral stenosis (Right), revealing a smaller right atrium and a uniform opacification of right atrium and ventricle.
of slight improvement, and demonstrated some months later a more severe failure as compared with the preoperative observations. Finally, the remaining 3 died within 4 months after operation.

**Group II.** The 7 patients in whom a diagnosis of mitral regurgitation was made (of moderate degree in 5 and of a major degree in 2), showed no improvement. A few weeks after operation, the most striking clinical features were (1) a considerable increase in the apical systolic murmur, due to the mitral insufficiency, also in the 5 cases with a lesser degree of regurgitation; (2) left ventricular enlargement, present in all cases at the roentgen examination. The enlarged and dilated left ventricle was unable to carry on the increased work load determined by the change in hemodynamics. Thus, dyspnea and cardiac asthma were added to the preexistent tricuspid symptomatology. The electrocardiogram showed evidence of left ventricular strain in addition to the right or combined ventricular hypertrophy. One of these patients died of congestive heart failure 2 months after operation.

**Discussion**

Tricuspid insufficiency associated with mitral disease, particularly mitral stenosis, raises a difficult problem as to the surgical correction of the latter.

This problem has been examined in 20 patients with advanced mitral disease, belonging to functional classes III and IV, in whom tricuspid insufficiency did not represent a transient episode of congestive heart failure, but was established for many years and did not respond to medical treatment. In 2 patients tricuspid insufficiency was associated with tricuspid stenosis. All patients were considered candidates for mitral commissurotomy on the basis of clinical findings of pure or predominant mitral stenosis.

Following operation, the course of the disease may be related to various clinical and pathophysiologic data, mainly: (1) type of mitral stenosis (pure or with insufficiency); (2) anatomic and functional conditions of pulmonary circulation; (3) type of tricuspid lesion (organic or functional); (4) myocardial function.

It is obvious that in the selection of patients for mitral commissurotomy, all these factors must be considered and possibly evaluated preoperatively. Some of them are difficult to assess on the basis of the preoperative findings; nevertheless, all are of paramount importance for the subsequent course of the disease.

**Type of Mitral Stenosis.** In all patients with mitral stenosis and insufficiency (group II), though the latter was moderate except in 2, the clinical improvement was slight or absent. All exhibited left ventricular failure, while the tricuspid insufficiency was unchanged.

Usually, moderate regurgitation associated with severe mitral stenosis was not reduced by operation and rather increased in many instances; however, moderate benefit was derived in most cases. When, on the contrary the same condition occurred with complicating tricuspid insufficiency, little or no clinical improvement was observed. In fact, the persisting mitral regurgitation allowed only partial decrease in pulmonary hypertension, which was responsible for the right ventricular dilatation, and, in turn, for the subsequent enlargement of the tricuspid ring.

### Table 3.—Late Results after Commissurotomy in Patients with Mitral Disease Associated with Tricuspid Insufficiency

<table>
<thead>
<tr>
<th></th>
<th>Group I</th>
<th></th>
<th>Group II</th>
<th>Total patients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>With pulmonary arteriopathy</td>
<td>Without pulmonary arteriopathy</td>
<td>Group II</td>
<td>Total</td>
</tr>
<tr>
<td>Improved</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>markedly</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Unchanged</td>
<td>4</td>
<td>0</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Deaths</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>5</td>
<td>7</td>
<td>20</td>
</tr>
</tbody>
</table>
and incompetence of the valve leaflets. Thus, mitral regurgitation, even of a lesser degree, seems to contraindicate the operation when tricuspid insufficiency is also present. Accordingly, the discovery of mitral insufficiency must be the subject of careful preoperative evaluation.

Better results were obtained in the group of patients (group I) with pure mitral stenosis. However, conditions mentioned below could interfere significantly in the postoperative course.

Anatomic and Functional Changes in Pulmonary Circulation. The 7 patients with pure mitral stenosis who had no improvement (3 of them died within 4 months after operation) demonstrated severe pulmonary arteriopathy.

Following the relief of valvular obstruction, the pulmonary resistances may fall only if functional in nature or if the anatomic vascular lesions are limited to muscular hypertrophy. Therefore, an attempt to evaluate the anatomic condition of the pulmonary bed, should be made preoperatively. In our experience, the changes in pulmonary resistances after injection of reserpine during heart catheterization can be of great help if the pulmonary hypertension is mainly functional, injection of 2 mg. of this drug induces after 1 or 2 hours, a definite fall of pulmonary systolic pressure (10 to 70 mm Hg), while systemic pressure remains unchanged (fig. 3). In 3 patients of this group, reserpine was injected during catheterization: 2 of them, who had a considerable fall in systolic pulmonary pressures, exhibited a good improvement after commissurotomy; on the contrary, the third who did not respond to the reserpine test, because of the presence of a pulmonary organic arteriopathy, showed poor postoperative results.

Type of Tricuspid Lesion. Of the 5 patients without pulmonary arteriopathy, 3 had partial, temporary relief from operation, but the symptoms due to tricuspid insufficiency relapsed as soon as they resumed their physical activity.

The lack of improvement in 2 cases was due to the existence of an organic lesion of the tricuspid valve: in fact a coexisting tricuspid stenosis was surgically corrected, probably resulting in a more severe insufficiency, as often occurs after operation of mitral stenosis associated with insufficiency. The other case concerned a man with calcific fibrosis of the mitral leaflets, which could not be satisfactorily fractured.
The problem of differentiating organic from functional tricuspid insufficiency, is far from being solved. In the rare cases in which associated tricuspid stenosis is established by cardiac catheterization, the diagnosis of an organic lesion is certain. On the other hand, in the presence of pure insufficiency the functional lesion is always doubtful and only presumptive on the basis of a severe mitral obstruction leading to pulmonary arterial and right ventricular hypertension and eventually to right ventricular failure.

Myocardial Function. The myocardial response to the mechanical improvement brought about by mitral commissurotomy is an important determining factor in the subsequent course of the disease. It cannot completely be foreseen before operation, nevertheless it must be considered, not only in the presence of mitral regurgitation, but also when pure mitral stenosis is accompanied by roentgenologic evidence of enlargement of the left ventricle. The latter may have been damaged by a previous myocarditis.

Summary and Conclusions

Twenty patients, affected by mitral disease with tricuspid insufficiency and selected for mitral commissurotomy on the basis of clinical evidence of advanced heart disease, have been studied before and after surgery, in order to evaluate further modifications in cardiocirculatory function.

According to the type of mitral disease, 2 groups of patients have been distinguished: in 13, pure mitral stenosis was demonstrated, while in 7 mitral stenosis was associated with mitral insufficiency. An additional subdivision was made between subjects with moderate pulmonary hypertension and those with pulmonary arteriopathy among patients with pure mitral stenosis.

Good results were obtained in a few patients with severe pure mitral stenosis, moderate pulmonary hypertension, and functional tricuspid insufficiency.

Very poor improvement was observed in patients with mitral regurgitation, pulmonary arteriopathy, or organic tricuspid insufficiency. Two patients in this group died.

Fig. 3. Pressure tracings obtained from pulmonary artery, right ventricle, and brachial artery before and after injection of 2 mg. of reserpine through the catheter in a patient with pure mitral stenosis. Note the definite fall in systolic pulmonary and right ventricular pressure 60 minutes after injection (from 100 to 50 mm. Hg). Systemic pressure was unchanged. No significant modification was observed in the cardiac output and the heart rate.
The myocardial response to the mechanical improvement brought about by mitral commissurotomy is an important factor in the subsequent course of the disease.

**SUMMARIO IN INTERLINGUA**

Vinti patientes, afficite de morbo mitral con insufficientia tricuspidal e seligite pro commissurotomia mitral super le base de provas de morbo cardiæ de forma avançate, esseva studiate ante e post le intervention chirurgie con le objectivo de evaluar modificacions additional in le functiones cardiocirculatori.

Secundo le typo de morbo mitral presente, 2 gruppoues de patientes esseva distingute: In 13, pur stenosis mitral esseva demonstrate, durante que le 7 aleres habeva stenosis mitral in association con insufficientia mitral. Le gruppoue de patientes con pur stenosis mitral esseva subdividite additionalmente in subjectos con moderate grados de hypertension pulmonar e subjectos con arteriopathia pulmonar.

Bon resultatos esseva effectuate in plure patientes con grados sever de pur stenosis mitral con grados moderate de hypertension pulmonar, e con functional insufficientia tricuspid.

Pauchissimo satisfacente esseva le melioration observate in patientes con regurgitation mitral, arteriopathia pulmonar, o organic insufficientia tricuspidal. Duo mortes occurreva in iste gruppou.

Le responsa myocardial al melioration mechanic que esseva effectuate per le commissurotomia mitral es un factor importante in le curso subsecvente del morbo.

**REFERENCES**


Effect of Mitral Valvulotomy on Tricuspid Insufficiency Associated with Mitral Stenosis

PIER FEDERICO ANGELINO, BENIAMINO LO BUE and VALERIA LEVI

_Circulation._ 1959;20:360-366

doi: 10.1161/01.CIR.20.3.360

_Circulation_ is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231

Copyright © 1959 American Heart Association, Inc. All rights reserved.

Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the World Wide Web at:

http://circ.ahajournals.org/content/20/3/360

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in _Circulation_ can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:

http://www.lww.com/reprints

Subscriptions: Information about subscribing to _Circulation_ is online at:

http://circ.ahajournals.org/subscriptions/