The Selection and Medical Management of Patients with Mitral Stenosis Treated by Mitral Commissurotomy

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The selection of patients for mitral commissurotomy must be made after considering all manifestations of the rheumatic state. A conservative approach is urged and no patients should be operated upon without evidence of increasing pulmonary hypertension and right heart strain. The preparation of the patient, the management of the arrhythmias during surgery and the postoperative care are the full responsibilities of the physician. A team composed of physiologists, cardiologists and surgeons must work together.

A NEW generation of dynamic surgeons and physiologists armed with experimental data gained through cardiac catheterization techniques has approached the baffling hemodynamic problems of which mitral stenosis is an outstanding example. The clinical course of mitral stenosis in a fairly large group of individuals represents a slowly progressive sequence of events often leading to permanent cardiac disability. The development of auricular fibrillation and thromboembolism increase the likelihood of invalidism and result in an average life span of only 46 years, according to Levine. This clinical pattern is physiologically defined in terms of elevated left atrial pressure behind the blocking action of the stenosed mitral valve. In order to establish a satisfactory pulmonary arterial gradient, elevation of pulmonary artery pressure must take place, with the vicious cycle ending in hypertrophy, dilatation and failure of the right ventricle. Therefore, the internist and cardiologist are compelled to evaluate the patients with mitral stenosis in order to submit to surgery that group of patients which can be helped most, to prevent needless surgery in that larger group which can be treated medically, and lastly, to find those patients in which surgery may be harmful. To do this successfully, the selection of cases depends upon many manifestations other than the narrowed mitral orifice. Table 1 serves a useful purpose in the evaluation of each prospective candidate for mitral commissurotomy. The historical background and review of the progress in this field are stated in recent excellent articles (Andrus and Bland) and will not be repeated here.

Selection of Patients for Mitral Commissurotomy

1. The Natural History of the Disease. In acute rheumatic fever, active rheumatic carditis is present in 100 per cent of the cases, but it is not demonstrable in more than 50 to 60 per cent of the patients in the primary attack. It is very difficult to state when the rheumatic activity has subsided and become completely quiescent. There are many patients who never show evidence of demonstrable rheumatic activity, but who develop valvular disease later in life. Hall demonstrated that 97 per cent of the patients with aortic valvular stenosis have evidence of active rheumatic carditis even though they have not had any evidence of active rheumatic fever during life. The absence of arthritis, chorea, fever, tachycardia, and even the absence of an increased sedimentation rate do not fully rule out a smoldering rheumatic state. As rheumatic fever is more com-
mon in the first three decades of life and tends
to become quiescent in the third decade, there
is much less danger of lighting up rheumatic
activity in, or after, the third decade. For this
reason patients over 25 years of age are more

likely to be suitable for operative intervention
than those under 20, as far as rheumatic activity
is concerned. In our operated cases Aschoff
nodules were found in 25 per cent of the ampu-
tated auricular appendages.

2. *Multiple Valve Involvement.* Aortic insuffi-
ciency is at present regarded as a contraindia-
tion, but many patients with mitral stenosis
have a minimal early diastolic murmur audible
along the left border of the sternum. This may
be due to pulmonary incompetency, the so-
called Graham-Steele murmur, resulting from

<table>
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<td><strong>Favorable</strong></td>
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<tr>
<td>1. Age of patient</td>
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<td>2. Length of time of rheumatic fever</td>
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suortomy. Organic tricuspid insufficiency leads to permanent liver damage and adds greatly to the risk.

3. Mitral Valve Insufficiency. This is without a doubt a most important factor since a high degree of mitral regurgitation is a grave threat to operative success and, at this time, is believed to be a definite contraindication to mitral commissurotomy. A loud, blowing systolic murmur in the mitral area associated with a large left ventricle and an increased atrial pulsation, as seen in the right oblique position, are important signs of mitral insufficiency. Free mitral regurgitation associated with some degree of mitral stenosis results in extreme enlargement of the left atrium. In relatively pure mitral stenosis with minimal regurgitation, slight to moderate enlargement of the left atrium with hypertrophy of the muscle of the atrium is the rule. The massive left atrium usually indicates long continued rheumatic involvement of the muscle, a large degree of mitral insufficiency and associated auricular fibrillation. We accept the widely held view that evidence of mitral regurgitation of more than a minimal degree is a contraindication to mitral commissurotomy.

4. Calcification of the Mitral Valve. The mitral valve of many older patients shows some evidence of calcification which interferes with valvular function and makes surgery more difficult, especially in relation to the risk of thrombosis and embolization. Calcification of the mitral valve, if very marked, is a moderate contraindication but not an absolute contraindication at the present time, as the mitral commissures may be separated without much difficulty even though the anterior and posterior leaflets may be calcified. The danger is embolism from a calcific plaque.

5. Pulmonary Hypertension. The first effect of mitral stenosis is a rise of pressure in the left atrium and in the pulmonary vascular bed. Pulmonary artery pressure may rise to a high degree, even approaching the systemic arterial pressure. The degree of pulmonary hypertension is most difficult to evaluate clinically. It is best determined by cardiac catheterization. Mitral stenosis of severe degree occasionally has been found to be accompanied by a normal pulmonary artery pressure and in each case we learned later there was an active rheumatic carditis. Our best results have been obtained in those patients in whom operation has produced the most marked drop in the pulmonary artery pressure, as will be shown later. Therefore, it is important to know the pulmonary artery pressure, and if cardiac catheterization cannot be performed, then the following criteria are helpful.

(a) The mean pulmonary artery pressure has been compared with readily available clinical data (fig. 1). Using a mean pressure of 40 mm. Hg as the dividing line between high and moderately elevated pulmonary artery pressures, it is noted that normal sinus rhythm occurs equally in the groups with high and moderately high pressure. Auricular fibrillation occurs with greater frequency in those whose pressure is above 40 mm. Hg.

(b) Patients with a history of occasional failure are found to occur frequently in the group with moderately elevated pressure while patients with a history of chronic failure are found to belong almost wholly in the group with high pressure.

(c) A normal sized heart is found frequently in the group with moderately elevated pressure. Patients with enlarged hearts fall entirely in the group with high pressures.

(d) The same thing applies to patients who have normal electrocardiograms; that is, normal electrocardiograms are found much more frequently in those with a moderately elevated pressure.
pressure while electrocardiograms exhibiting evidence of right ventricular hypertrophy occur almost entirely in the group with high pressure.

If the clinician will use the readily available clinical data he may be able to avoid the necessity of cardiac catheterization as far as the selection of the patient for mitral commissurotomy is concerned. However, the benefits to be derived from mitral commissurotomy are determined best through the physiologic measurement of cardiac output and pulmonary artery pressures pre- and postoperatively (table 2).

6. Atrial Fibrillation. The presence of atrial fibrillation is not so much a contraindication to mitral commissurotomy as an indication that the optimum time for surgery may have passed. If atrial fibrillation has been present over a long period of time, it points to a proportionately greater dilatation than hypertrophy of the atrial muscle. However, if there is no congestive failure and the myocardium is relatively sound, controlled atrial fibrillation should not be a contraindication to mitral commissurotomy.

7. Right-sided Heart Failure. In patients with mitral stenosis, hemoptysis and pulmonary edema, evidence of right ventricular hypertrophy and intermittent right ventricular failure occurs. This is not a contraindication if the failure is controlled. It is good evidence of a severe degree of pulmonary hypertension. In this state mitral commissurotomy may give striking relief. In the late stages, however, where there is chronic, uncontrollable right ventricular failure with tricuspid insufficiency, increased venous pressure, engorgement of the liver, ascites and edema, mitral commissurotomy is definitely contraindicated. With respect to the myocardium in mitral stenosis, not all of the symptomatology is due to the mechanical effect of the obstruction, but some is due to the damaged heart muscle. Evidence of marked muscle damage is a contraindication to mitral commissurotomy. A damaged left ventricle may be unable to carry the increased load following the relief of the obstruction. It is important, therefore, to judge the optimum time when a mitral obstruction should be relieved, preferably before irreversible changes have occurred in the pulmonary vessels, in the right heart, and finally, in the myocardium.

8. Increasing Incapacity. The American Heart Association Classification of the functional capacity of the heart to perform work is most useful in the selection of patients as eligible candidates for mitral commissurotomy. Since classes I and II represent organic disease with only slight limitation in work performance, these classes are ineligible. Class III represents a group of patients whose capacity to perform work is limited to the necessary movements of life. Therefore, it is most important to know if there has been a gradual reduction in the capacity to do work, that is, from class II to class III. On the other hand, many patients have gone beyond class III into class IV and are totally incapacitated, requiring bed rest and the entire medical armamentarium to maintain life. If patients in class IV can be fully compensated and for a short time returned to class III, surgery may be performed. The most important criterion is the estimation of the degree of incapacity in each patient.

9. Thromboembolism. Thromboembolism is a strong indication to perform mitral commissurotomy. If there is a recent history of major or minor arterial or venous embolism and the patient has recovered, there is good reason to lessen the stasis in the left atrium. The improvement in cardiac output likewise lessens the danger of venous thromboembolism. The amputation of the left auricular appendage plus the decrease in pooling in the left atrium is one of the great advantages resulting from mitral commissurotomy.
MANAGEMENT OF PATIENTS SELECTED FOR MITRAL COMMISSUROTOMY

This is the task of the internist and cardiologist. The nutrition and state of well-being of each candidate should reach its maximum level. Patients with incapacity to perform normal functions, willingly accept the possible advantages of surgery. The cardiologist, therefore, must plan a program so that auricular fibrillation and congestive failure are controlled. This requires digitalization to keep the ventricular rate between 70 and 80 and a diet to eliminate an excess of salt and water, with a high protein intake to improve the liver function. This objective can be attained by a diet composed of protein, 1.5 Gm., carbohydrate, 2 Gm. and fat, 1 Gm. per kilogram of body weight with not more than 2 Gm. of sodium chloride per day. Distilled water, ad libitum, is used. Mercureial diuretics are used with care to promote diuresis, but never dehydration, because of the increased danger of thrombosis during the dehydrated state. If congestive failure cannot be controlled on this regimen, then a liquid diet made up from Lonalac, 250 Gm., Protenum, 100 Gm., cane sugar, 125 Gm., in 2000 cc. of distilled water plus 500 cc. of pure orange juice is given throughout the 24 hours. This formula has been found adequate to improve the liver function while compensation is being restored.

The patient should not be submitted to surgery if there is evidence of congestive failure, liver engorgement or myocardial irritability other than the auricular fibrillation. Preoperative medication other than that used to control the heart rate and the congestive failure should be minimal. We have found that 50 to 75 mg. of Demerol is sufficient.

The cardiologist must observe the patient during anesthesia and through surgery; direct-writer electrocardiographic recording and blood pressure determination are requisite. The team composed of the anesthetist, surgeon and cardiologist must work closely together. It is in this manner that any alteration of the hemodynamics of the surgical patient is quickly detected and the cause determined. If the heart rate slows dangerously, atropine or isopropyl norepinephrine, given intravenously, is indicated. When the blood pressure drops and there is electrocardiographic evidence of coronary insufficiency, a vasopressor drug such as meth-oxamine in a 5 mg. intravenous dose is indicated. If rapid auricular fibrillation occurs, ouabain is given slowly intravenously while the surgeon waits until control is gained. When ventricular irritability develops the surgeon waits, and if the irritability does not subside promptly, then intravenous procaine amide in a dosage of 500 to 1000 mg. is given. In other words, the surgeon is free to concentrate on his work while the anesthetist maintains the lightest possible anesthesia with full oxygenation, and the cardiologist is responsible for the function of the heart at all times. Blood or plasma are infused as needed to prevent shock.

Postoperatively the cardiologist continues full responsibility for the physiologic state of the heart. Hydration must be maintained to prevent fever, tachycardia and thromboembolism. The preoperative diet and digitalis are reinstated within 12 to 24 hours. The head of the bed is elevated moderately as soon as full consciousness is restored. Deep breathing and arm and leg movements are insisted upon at an early time and the patient is gotten out of bed on the commode within four to six days. An x-ray film of the chest and an electrocardiogram are made prior to discharge from the hospital. The average hospital stay is five days preoperatively and 10 days postoperatively. At home, if there has been no sign of failure, the patient rests in bed with bathroom and dining-room privileges for 10 days and then gradually increases physical activity.

Postoperative Depo-Heparin, 200 mg. plain, intramuscularly, every 18 hours, is started within six hours and continued for three to four days if thrombi have been found in the atrium. Attempts to convert auricular fibrillation to sinus rhythm are not made until one or two months have passed.

RESULTS

Of the first 35 patients on whom mitral commissurotomies were attempted, eight were lost. None has been lost in the last 39 operations. It is believed that a lowered mortality rate can be obtained by careful selection, pre-
operative preparation, team work among the cardiologist, anesthetist and surgeon during surgery, and wisely directed postoperative care.

Mitral commissurotomy was performed in 74 patients prior to May 15, 1952. Of this number, preoperative cardiac catheterizations have been done in 31 and postoperative catheterizations have been done in eight. A short term clinical evaluation of 2 to 24 months has been made. The evaluation is not the opinion of one man, but of the team composed of the

| Cardiac Arrest | 2 |
| 1 During Anesthesia | |
| 1 During Surgery | |
| Ventricular Fibrillation | 1 |
| Embolic Phenomena During Surgery | 2 |
| Calcified Plaque | 1 |
| Ruptured Valve with Acute Congestive Failure | 1 |
| Ruptured Left Atrium | 1 |
| Cerebral Thrombosis (Late) | 1 |

Table 3.—Causes of Eight Deaths in 74 Patients on Whom Mitral Commissurotomy Was Performed

1. Cardiac Standstill
2. Cardiac Arrhythmias
   a. Atrial Premature Beats
   b. Supraventricular Tachycardia
   c. Nodal Rhythm
   d. Ventricular Premature Beats
   e. Bigeminal Rhythm
   f. Ventricular Tachycardia
   g. Ventricular Fibrillation
3. Hypotension
4. Hemorrhage
5. Thromboembolic Phenomena
6. Rupture of Left Atricle

Table 4.—Complications During Surgery

Cardiologist, physiologist and surgeon, who meet once each week. On the basis of the combined opinion, the following estimation has been made. About one-third of the 74 patients has been greatly improved. The patients feel so much better that they tend to disregard the physician’s instructions and advice. About one-third is markedly improved, the team believes, and the patients again feel greatly improved. The remaining one-third shows little or no evidence of change in the murmurs or in the physiologic function of the heart, and has been long in recovering from the surgery. None has been made worse except that mild reactivation of rheumatic fever has occurred in two cases. Eight deaths have occurred.

Cardiac arrest during surgery is a real problem which must be dealt with promptly by both pharmacologic and surgical means (table 3). Many patients develop arrhythmias, but it has been learned that if the finger is removed from the valve area and held in the lumen of the atrium, the arrhythmias tend to disappear promptly (table 4). Embolic phenomena represent a real threat to the success of the operation. At least one-half of our patients have had thrombi in the left atrium. Thrombi which become detached are permitted to flow out through the opened auricular appendage. Occasionally a small embolus passes through the mitral valve. A calcified plaque on one occa-

Table 5.—Postoperative Complications in 74 Patients on Whom Mitral Commissurotomy was Performed

| 1. Reactivation of Rheumatic Fever | 2 |
| 2. Hemiplegia, Transient | 1 |
| 3. Chest Pain (Parietal) | 1 |
| 4. A.V. Nodal Rhythm (New) | 1 |
| 5. Auricular Fibrillation (New) | 1 |
| 6. Congestive Failure (Recovered) | 1 |
| 7. Cardiac Enlargement (Temporary) | 1 |
| 8. Mitral Insufficiency (Excessive) | 3 |

sion became dislodged from the mitral valve and passed to the middle cerebral artery, causing paralysis and death promptly. One case of acute congestive heart failure occurred because the valve leaflet was ruptured, resulting in atrial mitral insufficiency. Another patient died from a rupture of the left atrium. This was not the fault of the surgeon, but of the cardiologist who sent this patient with a giant left atrium to the surgeon. When dehydration occurs postoperatively, especially in those patients with hypotension, cerebral thrombosis is a real danger. One such case has been lost.

The complications which the cardiologist must face during surgery are related above. Under the heading “Management” we have mentioned the use of atropine and isopropyl norepinephrine for the treatment of bradycardia and cardiac standstill. The atrial arrhythmias are best treated with a quick-acting digitalis or digitalis-like preparation such as
ouabain (table 4). The ventricular arrhythmias are best controlled with procaine amide, 500 to 1000 mg. intravenously. Hypotension is treated by the use of methoxamine compounds such as Vasoxyl or Wyamine. Hemorrhage is treated by replacement therapy. Thromboembolic phenomena are treated best by using the anticoagulants prior to surgery in those patients who have had recent emboli. The anticoagulant is stopped preoperatively for 24 to 36 hours and reinstituted, using Depo-Heparin, six hours after surgery. The complications following surgery are enumerated (table 5). These are treated by the clinician in the accepted manner, that is, by bed rest, digitalization, dietary management and mercurial diuretics.

 SUMMARY

To evaluate a patient with mitral stenosis all the manifestations of the rheumatic state must be considered. Only those patients with a narrowed mitral orifice whose capacity to perform work has been diminished are considered eligible for surgery. The criteria whereby selection is made are enumerated. The management of the patient before, during and after surgery is a team job, with the internist or cardiologist carrying the main responsibility.

 ADDENDUM

Since this study was reported, 52 additional patients have been operated upon, one patient being lost through uncontrolled ventricular tachycardia. This result has been accomplished by strict adherence to the criteria for the selection of and management of patients for mitral commissurotomy which have been outlined in this paper.

 ACKNOWLEDGMENTS

We wish to acknowledge our indebtedness to Miss Mary Mayo and Dr. Andrew Farr for valuable technical assistance.

 SUMARIO ESPAÑOL

La selección de pacientes para comisurotomía mitral se debe hacer considerando todas las manifestaciones del estado reumático. Un acercamiento conservativo se urge y ningún paciente se debe operar a menos que no haya evidencia de aumento en hipertensión pulmonar y esfuerzo del corazón derecho. La preparación del paciente, el tratamiento de las arritmias durante la operación y el cuidado postoperatorio son responsabilidades del médico internista. Una cooperativa de fisiólogo, cardiólogo y cirujano deben funcionar juntos.

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