Cardiac Surgery for Acquired Valvular Disease:
Modifications Experienced with 2,000 Cases

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Introduction

The surgical treatment of acquired valvular abnormalities resulting from acquired heart disease is of recent origin. The purpose of this paper is to report modifications in cardiovascular techniques made to improve our clinical results. Efforts were first directed toward the correction of the obstructive type of mitral valvular pathology. Eight years have now passed since the performance of the first successful operation for mitral stenosis.1 The development of such an efficient surgical procedure has, like most other significant advances, been preceded by a long period of investigation, formulation and clarification of concepts. The first good description of the pathological entity which we know as mitral stenosis was given by de Vissusens2 in 1705. In 1819, Laennec3 correlated the clinical features of the disease with the observed pathological changes, and described the findings which make an accurate diagnosis possible during life.

Direct surgical attack upon the stenotic valve was suggested by Samways4 in 1898, and by Brunton5 in 1902. No further progress was made until Cutler's6 method of transventricular section of the stenotic mitral valve opening was published in 1924. The amount of regurgitation produced, however, militated against its acceptance as a satisfactory technique. The following year, Souttar7 successfully “dilated” a stenosed mitral valve, inserting the index finger through the left auricular appendage. Further clinical attempts to open a stenosed valve were unreported until Bailey presented his concept of separation of the fused valve leaflets along the lines of the obliterated commissures in 1948. This allowed surgical correction of the obstruction without the necessity of producing regurgitation. The first successful mitral commissurotomy was accomplished on June 10, 1948.1 Independently of the American accomplish-

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ments. Brock, in September, 1948, successfully carried out a commissural separation by digital pressure only.

**MITRAL VALVULAR DISEASE**

*Mitral Stenosis*

All the corrective procedures for mitral stenosis were originally carried out through a left posterolateral thoracotomy. This approach afforded an easy means of digital exploration of the left cardiac chambers through the auricular appendage. Digital splitting of the anterior commissure was facilitated by counterpressure over the ventricular wall. Auricular appendectomy was accomplished routinely, hoping to prevent further hazard from emboli. The concept of temporary occlusion of the carotid flow during interatrial manipulations was proposed by Bailey et al. to prevent cerebral embolization. This was done by passing umbilical tapes around the innominate and the left common carotid arteries at their origin from the aortic arch.

Although the operation of mitral commissurotomy as performed from

**FIGURE 1A**  
**FIGURE 1B**  
**FIGURE 1C**

**Figure 1:** Technique for the right-sided approach for mitral commissurotomy.—**Figure 1A:** The relationship of the right pulmonary veins to the vena cavae is demonstrated, viewing the heart from the right side.—**Figure 1B:** The interatrial groove, anterior to the pulmonary veins, and posterior to the right atrium is dissected. The purse string suture is shown.—**Figure 1C:** The interatrial groove is deepened by blunt finger dissection.—**Figure 1D and E:** Entry into the left atrium through the reflection of the septum.—**Figure 1F:** Commisurotomy is accomplished by digital or instrumental technique.
the left side was becoming more widely accepted, its shortcomings were also recognized. Adequate digital and instrumental opening of the posteromedial commissure was seldom obtained. Since mobilization of the valve leaflets was only partially accomplished, it is quite probable that this group of patients eventually will show a higher incidence of recurrent valvular obstruction or re-stenosis.

A right-sided approach to the mitral valve was first presented by Neptune and Bailey, in 1954. The ease with which posteromedial commissurotomy could be carried out by this approach stimulated its clinical use. Improvements in technique have led to its adoption for routine commissurotomy. This approach has now been used in more than 200 cases of mitral stenosis (Figure 1).

There are many advantages to the right-sided approach compared with the left-sided approach. More adequate mobilization of the anterior and posterior commissures is attained by this method (Tables I and II).

Coexisting tricuspid and aortic valvular pathology may be treated during the same operative procedure. During anesthesia, the supine position is tolerated more readily than the left lateral position. The incidence of hypotension and diminished cardiac output has been greatly averted with the supine position. The presence of an unrecognized coexisting interatrial septal defect may be diagnosed and treated by atrio-septo-pexy. The submammary incision used in this approach produces less pain and shoulder dysfunction and is shorter and cosmetically more acceptable. Interatrial thrombi, when encountered, are carefully avoided. When atrial thrombi are encountered during surgery, postoperative anti-coagulants are utilized until such a period has elapsed that organization and fixation of the thrombus seems certain and further propagation is obviated. Although protection of the cerebral vessels is not carried out, the incidence of operative embolization remains low (Table III). In comparing the two approaches, the over-all operative mortality presents no difference of statistical significance (Table IV).

There are some problems encountered in the right-sided approach. Change in position of the patient produces a different anatomical commissural approach. This must be carefully noted before attempts at commissurotomy are carried out. Closure of the left atrium is slightly more difficult.
cult because of the absence of an appendage. With further experience, this has not posed a serious handicap.

**Mitral Insufficiency**

Our initial attempts at correction of mitral insufficiency or regurgitation were universally unacceptable because of a prohibitive mortality rate, varying between 20 and 40 per cent. Subvalvular slings in the form of pericardial tubes and vein grafts were used as the first procedure. Direct valvular suture was attempted, but these invariably pulled through due to the constant motion of the valve leaflets. Baffle plates of living tissue and plastics also failed. All methods of repair ultimately proved unsatisfactory. The concept of annular constriction was introduced by Davila et al. Although the authors admit that the procedure is technically difficult, early results suggest diminution in the leak. The operative procedure of polar cross plication of the mitral annulus, as reported by Henry T. Nichols, one of the surgeons at our Clinic, is at present giving the best results in repair of mitral insufficiency. The success of this operation is

![Figure 2: Left atrial pressure tracing in mitral insufficiency. The mean left atrial pressure is elevated. A large C-V wave is demonstrated. Its absence is noted in the post-operative pressure tracing.](http://journal.publications.chestnet.org/pdfaccess.ashx?url=/data/journals/chest/21297/)
dependent upon several basic principles. The annulus of the valve is the only structure which is strong enough to hold sutures under great tension. Experimental studies on dogs indicate that actual fibrous fusion occurs where the plication has brought the two points of the annulus into apposition. The evaluation of these patients has included pre and postoperative left heart catheterization and cardiac ventriculography. The preoperative left atrial tracings showed a ventricularization pattern, with absence of this finding in the postoperative study. Seventy per cent diodrast injection into the left ventricle in the presence of mitral regurgitation resulted in opacification of the left atrial chamber (Figure 3). This type of radiographic study has been carried out in 82 patients without mortality. Postoperative studies from 10 days to three months later show little evidence of insufficiency when the surgeon considered the plication adequate.

When mitral stenosis and major insufficiency coexist, the stenosis is corrected first, utilizing the left-sided approach. Mitral annulus plication is then carried out simultaneously, when indicated.

**AORTIC VALVULAR DISEASE**

**Aortic Stenosis**

The first surgical attempt at the correction of aortic stenosis was that of Tuffier in 1913. He invaginated the anterior wall of the aorta and dilated the valve digitally without entering the lumen of the vessel. The first successful aortic commissurotomy was done on June 22, 1950 by Bailey, passing a now obsolete dilator through the valve from the ventricular approach. Only a limited dilatation was accomplished. An improved Donaldson tri-radiate dilator was developed and first used in 1952. Transventricular aortic commissurotomy is essentially a blind procedure. With this technique, it is suspected that an accurate commissural separation was not always obtained. The myocardial insult from the incision frequently resulted in serious cardiac arrhythmias.

In order to circumvent these problems, transaortic commissurotomy was developed. This procedure allows digital palpation of the valve through
an artificially created pouch attached to the ascending aorta just above the valve. Commissurotomy may then be carried out under digital guidance. The commissures may then be separated by digital pressure, incision, dilatation, or by a combination of these modalities. Although this method represented a distinct advance, it did not always permit the surgeon to correct the stenosis when severe structural abnormalities of the valve are found. Extreme calcification and rigidity of the leaflets may preclude adequate mobilization of the obstructed valve in some cases. Accordingly, with recent development of practical equipment for heart-lung bypass, extracorporeal oxygenation of the blood, and the perfection of methods for the performance of surgery within the heart under direct vision, it was logical to apply such techniques to the correction of aortic stenosis.

From April 1952 to February 1956 the Bailey Thoracic Clinic treated 287 patients with aortic stenosis by closed heart techniques. One hundred and nine of them had associated mitral stenosis (Table IV). Ventricular fibrillation was the main cause of death in patients operated for pure aortic stenosis. When the results of transventricular and transaortic routes are compared (Table IV), our experience seems to indicate that the combination of mitral with aortic stenosis results in a better prognosis than when the patient has surgical correction of isolated aortic stenosis. The stenosed mitral valve apparently protects the left ventricle against the severe myocardial injury which is so characteristic of isolated aortic valvular disease. Fatal arrhythmias have not occurred in this combined group. At the present time, the transventricular approach is preferred for the surgical correction of this combination. More definitive surgical correction may have to be instituted at a later date. If physiological

FIGURE 3: Preoperative and postoperative left ventriculography. The left x-ray shows massive regurgitation from the left ventricle into the left atrium. The x-ray on the right shows minimal mitral valve leak following a Nichols operation for the four plus insufficiency which was present.
studies indicate residual stenosis, this can be treated by open techniques. Aortic stenosis is seldom of congenital origin. In some cases, the valve may be bicuspid or occasionally multicuspid. Dilatation of the funnel or megaphone type of aortic stenosis frequently produces some degree of aortic insufficiency. To avoid this end result, open heart surgery must be considered in all of the congenital cases. One often encounters a child with aortic stenosis of such severity that progressive myocardial degeneration is imminent. Under such circumstances, a transventricular approach may be the appropriate technique recommended as a temporizing procedure.

Our experience with open heart surgery includes 11 patients with aortic stenosis. The extracorporeal circulation was maintained by the Friedland-Gemeinhardt oxygenator for periods ranging from seven to 30 minutes. All except one survived. This death was due to ventricular fibrillation, not responding to defibrillatory measures. Retrograde perfusion of the coronary sinus was carried out as described by Blanco, Adam, and Fernandez who observed that coronary circulation could be sustained, when the aorta was opened, by retrograde perfusion of the myocardial capillary bed by way of the coronary sinus.

### TABLE III

**OPERATIVE EMBOLIZATION INCIDENTAL TO MITRAL COMMISSUROTOMY FROM THE RIGHT—210 CASES**

<table>
<thead>
<tr>
<th>Patient Procedure</th>
<th>Clot In Atrium</th>
<th>Calcification In Leaflets</th>
<th>To</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>P. R. Mitral comm., aortic explored</td>
<td>Large, soft granular</td>
<td>Posterior commisure and septal leaflet</td>
<td>Brain</td>
<td>Survived with alexia and agraphia only</td>
</tr>
<tr>
<td>L. G. Mitral comm., tricuspid comm.</td>
<td>3 cm. in diameter above ant. comm.</td>
<td>Moderate</td>
<td>Aortic bifurcation</td>
<td>Survived. Removed at same operation, no complications</td>
</tr>
<tr>
<td>M. L. Mitral (re-operation), tricuspid explored</td>
<td>Large, soft</td>
<td>Slight</td>
<td>Mid-brain</td>
<td>Survived. Complete relief with con. caudal block only—3 days</td>
</tr>
<tr>
<td>W. B. Mitral comm., tricuspid explored</td>
<td>Numerous small vegetation-like clots</td>
<td>Moderate</td>
<td>Right femoral artery</td>
<td>Died 24 hrs. Spastic bplegia. No recovery</td>
</tr>
<tr>
<td>M. M. Mitral comm.</td>
<td>None</td>
<td>Embolus believed of calcific origin, Periorificial nodular calcification located diffusely around all edges of both leaflets and commissures. Felt to be loose during surgery</td>
<td>Brain</td>
<td>Hemiplegia</td>
</tr>
</tbody>
</table>
Aortic Insufficiency

The clinical and objective evidences of disability are almost directly proportional to the diastolic regurgitant flow, regardless of the etiology. Luetic aortitis is associated with a generalized dilatation of the aortic annulus fibrosus, due to necrosis and weakening of the ring. This type of valvular pathology has been treated clinically by a surgical procedure designed to constrict the annulus below the coronary ostia. Clinically, this has been discarded because of an operative mortality of 30 per cent. In addition, the annulus wrap was observed to migrate toward the apex of the heart, slipping off the annulus and failing to help the insufficiency.

More recently, external plication of the base of the aorta and the annulus fibrosus was carried out, placing this plication in the area of the non-coronary-bearing aortic cusp. Suture of the aorta and annulus is facili-

<table>
<thead>
<tr>
<th>Group</th>
<th>Valvular Pathology</th>
<th>Approach</th>
<th>Number of Cases</th>
<th>Number of Operative Deaths</th>
<th>Operative Mortality Rate Per Cent</th>
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</thead>
<tbody>
<tr>
<td>I</td>
<td>Mitral stenosis, pure, or with insignificant insufficiency</td>
<td>L 1051</td>
<td>79</td>
<td>7.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>R 210</td>
<td>14</td>
<td>6.7</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>Aortic stenosis, pure, or with insignificant insufficiency</td>
<td>L 93</td>
<td>25</td>
<td>26.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>R 88</td>
<td>14</td>
<td>15.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Open heart technique—Open bilateral</td>
<td>11</td>
<td>1</td>
<td>9.1</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>Aortic stenosis, and mitral stenosis, pure</td>
<td>L 21</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>R 4</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>Aortic stenosis, and mitral stenosis with minor insufficiency associated</td>
<td>L 64</td>
<td>15</td>
<td>23.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>R 20</td>
<td>2</td>
<td>10.0</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>Major aortic stenosis and insufficiency. (Treated by aortic commissurotomy only)</td>
<td>L 7</td>
<td>4</td>
<td>57.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>R 9</td>
<td>1</td>
<td>11.1</td>
<td></td>
</tr>
<tr>
<td>VI</td>
<td>Mitral insufficiency Nichols operation</td>
<td>L 48</td>
<td>7</td>
<td>14.6</td>
<td></td>
</tr>
<tr>
<td>VII</td>
<td>Mitral insufficiency—operations other than Nichols</td>
<td>L 170</td>
<td>67</td>
<td>25.4</td>
<td></td>
</tr>
<tr>
<td>VIII</td>
<td>Major mitral stenosis and insufficiency. (Treated by mitral commissurotomy only)</td>
<td>L 115</td>
<td>21</td>
<td>18.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>R 32</td>
<td>5</td>
<td>15.6</td>
<td></td>
</tr>
<tr>
<td>IX</td>
<td>Mitral stenosis plus multi-valvular lesions</td>
<td>R 58</td>
<td>17</td>
<td>29.3</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>Lutembacher's syndrome</td>
<td>R 8</td>
<td>1</td>
<td>12.5</td>
<td></td>
</tr>
<tr>
<td>XI</td>
<td>Mitral stenosis, interatrial septal defect and anomalous pulmonary venous drainage of right lung</td>
<td>R 1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
tated by use of a fenestrated aortic insufficiency clamp. Complete correction by this closed technique has not yet been accomplished. While there are shortcomings in this technique, the current experimental work would indicate that these shortcomings could be obviated.

Aortic insufficiency of rheumatic origin has been considered to exist only in association with some degree of aortic stenosis. Most cases have heavy valvular calcification to compound the problem. Aortic prosthetic valves of many types have been tried; results to date are unsatisfactory. Our experiences with the prosthetic ball valve in the descending aorta have been equally as discouraging as those of Hufnagel. His initial operative mortality of 40 per cent has now been reduced to 26 per cent.

With open heart surgery, it is anticipated that some of these problems can be handled more easily. Certainly, visual division of the commissure should prevent the creation of additional leak due to misplaced or too vigorous commissurotomy.

**Tricuspid Valvular Disease**

*Tricuspid Stenosis*

Tricuspid stenosis of rheumatic origin occurs only in the presence of mitral valvular disease. Although Reale et al. have described well the physiological findings which are characteristic of its presence, in practice significant tricuspid disease can be recognized with certainty only by digital exploration at the time of surgery. Some degree of tricuspid stenosis was present in 22 per cent of those patients explored for mitral stenosis as the primary lesion. These patients were treated by mitral and tricuspid commissurotomy.

*Tricuspid Insufficiency*

This defect was found in 34 patients of the group of 175 rightsided mitral commissurotomies done for known mitral stenosis. Tricuspid annular plication was done in 2 patients with severe insufficiency. In several suspected cases of tricuspid incompetence, right cardiac ventriculography was carried out. Massive regurgitation of diodrast into the right atrium was demonstrated in these cases.

**Discussion**

Our earlier experiences with patients submitted to surgery for diseased valves of rheumatic origin were usually those patients with single valvular lesions. Gradually, the patients referred to us became more complicated and it was necessary to devise methods or techniques applicable to a case needing two and oftentimes three valves operated upon.

By virtue of this need, we have devised a right thoracotomy approach through the third or fourth intercostal space with the patient in the supine position. This incision allows easy access to the mitral, aortic, and tricuspid valves for the relief of stenosis (Figure 1).

One thousand and fifty-one patients were operated upon from the left side for mitral stenosis. This group had either a “pure” mitral stenosis or stenosis with an associated mitral insufficiency of insignificant degree. The resulting operative mortality rate was 7.5 per cent (79 deaths in
1,051 patients operated upon). By utilizing the right-sided approach to the mitral valve via the interatrial groove, the operative risk was reduced to 6.7 per cent (14 deaths in 210 patients operated using this technique) (Table V). These two groups were unselected and represented 1,261 consecutive patients and included all functional classifications (Table VI). There were other groups of patients who had mitral commissurotomy performed but had other associated lesions (Table IV). The operative risk in these latter categories is much greater.

The present technique of operating upon the stenotic mitral valve from the right side has resulted in a greater technical efficiency as reflected by the fact that both commissures were opened in 97.3 per cent of the cases (Table I). Such was the case in only 33.1 per cent of the patients operated from the left side. The opening or valvular orifice size obtained when the patient is operated from the right side has been significantly larger than in those operated from the left. Sixty-six and one half (66.6) per cent operated from the right obtained a two finger or larger opening, while only 45 per cent operated from the left side obtained a two finger (4 sq. cm.) or larger valve opening by commissurotomy (Table II).

These statistics show that the merits of the surgical correction of mitral stenosis are far superior from the right side as compared with the approach from the left.

The early operative procedures for mitral regurgitation include a variety of methods for the surgical correction of the insufficiency. The resulting operative risk of 25.4 per cent was prohibitive and such surgery was abandoned until the Nichols' operation was devised. Although the total number treated by the later technique has been small, the results at this early stage have been most encouraging. Seven operative deaths occurred in the first 48 patients treated by this technique, presenting a mortality rate of 14.6 per cent. This reduction in the operative risk, coupled with the marked decrease and in some cases obliteration of regurgitation, presents an entirely new perspective of a previously most discouraging valvular defect. The Nichols' procedure for mitral insufficiency has resulted in a reduction in the operative mortality of more than 50 per cent. The reduction or obliteration of the regurgitation through the mitral valve is determined by the palpating finger within the left atrium during surgery, and is substantiated by a reduction in heart size after surgery and further confirmed by cardiac catheterization and ventriculography (Figure 3).

The presence of an interatrial septal defect does not significantly alter the correction of a coexisting mitral stenosis (Lutembacher's syndrome). We have operated on eight such cases with only one death (Table IV). Another was found to have an interatrial septal defect, right anomalous pulmonary venous drainage, and mitral stenosis. Simultaneous correction of all the defects was possible with an uneventful recovery.

There have been 192 patients operated upon for aortic stenosis with or without an associated aortic insufficiency of physiologic insignificance (Table IV). These relatively pure stenotic lesions operated upon from the
Figure 5: Technique of aortic commissurotomy from the left-sided approach (transventricular). Figure 5a: Aortic dilator in position. Figure 5b: Aortic dilator expanded to separate the commissures of the stenotic aortic valve. A pericardial pouch is sutured to the aorta, the index finger is inserted into the aorta for exploration and commissurotomy.
left by the transventricular route resulted in the alarmingly high operative mortality rate of 26.9 per cent (25 deaths in 93 cases). By utilizing the right-sided transaortic approach to the valve, the risk was reduced to 18.9 per cent. Until such a time when we are able to institute prophylactic measures to obviate the occurrence of ventricular fibrillation during the transventricular approach, it would seem that the transaortic commissurotomy from the right side is the technique of choice between these two methods. Recently the risk appears to have been reduced further (one death in 11 patients, 9.1 per cent) by utilizing the "open" technique, performing commissurotomy under direct vision.

Late follow-up results of this series of patients who had aortic commissurotomy (28) revealed that 70 per cent were symptomatically improved. While the right-sided transaortic approach does reduce the operative risk, their postoperative improvement almost parallels those cases having had transventricular aortic commissurotomy. Over a four year period, there has been a late death incidence of 19.7 per cent. This high rate may be related to the fact that a high percentage of these patients were over 50 years of age at the time of surgery.

The best postoperative results were obtained in the combined aortic and mitral stenosis group. Twenty-five were included in this category. All but four of these operative procedures were done from the left approach. There was no operative mortality in either group. Only two late deaths occurred in these cases. These results indicate that the left approach is equally as safe as the right one when both valves are stenotic. In view of this experience, we are now utilizing the left-sided approach in the treatment of combined aortic and mitral stenosis.

The remaining patients in Table IV are those with dynamically significant insufficiency in either the mitral or aortic valve in combination with other valvular lesions. The immediate operative mortality is high. However, the late results appear promising when the valvular competence can be restored.

Restenosis of a mitral valve following commissurotomy has occurred in 17 patients previously operated by one of the three surgeons in our group. Eleven of them were reoperated upon and in each case the original surgeon was in attendance at the subsequent operation. This procedure was followed in order to be certain that the original postoperative state of the valve could be compared accurately with its present restenotic condition. There was no operative death in this group, and adequate opening was obtained by the second operation. Two of these patients were reoperated a third time, one by the senior author and one by another surgeon of our group. Six with known restenosis were confirmed at autopsy.

A number of other patients who had initial valvular surgery elsewhere have been reoperated for "recurrent stenosis" by our group. It has not been possible to evaluate these patients without precise knowledge of the condition of the valve after the initial operation. It is anticipated that an increased incidence of restenosis will occur when only one commissure was opened, or when less than adequate mobilization of the valve leaflets...
was obtained. In caring for a patient having had a mitral commissurotomy, one must always be alert, for, if restenosis occurs, secondary surgery must be considered, even though its occurrence is extremely rare.

**Long Term Follow-up — Mitral Commissurotomy Symptomatic Changes**

A follow-up study of 200 patients who had mitral commissurotomy was done. The postoperative period of observation ranged between 5½ and 8 years. Dyspnea occurred in 190 patients preoperatively. Postoperatively, it was absent in 57, unchanged in 21, better in 41, much better in 66, and worse in 5 patients. The presence of or history of edema was noted in 119 patients prior to surgery. Postoperatively, this symptom was observed in 25 patients. Hemoptysis was recorded in 93 patients before surgery, and in only three patients after surgery. Fatigue was present in 178 patients in the group; its presence postoperatively was recorded in 37 patients.

Twenty-two patients now complain of symptoms which were not present preoperatively. These include 2 cases with edema and 1 patient with fatigue. Two patients developed epilepsy. The remainder complained of nervousness, insomnia, and palpitations. In the majority of this latter group, it was suspected that a psychosomatic factor was prominent.

Postoperative febrile episodes occurred in 26 patients; in 6 of these, the episode was recurrent. Ten of these patients were suspected of having rheumatic fever, the diagnosis being proven in 2 cases. Ten additional patients were considered as cases of "post-commissurotomy syndrome." Four cases had fever with no known or suspected cause. Subacute bacterial endocarditis was confirmed in 1 patient and suspected in another.

A history of preoperative embolization was obtained in 33 patients. Only 2 of these have had embolic episodes since commissurotomy. One patient with no preoperative embolic episode has had an incident subsequent to surgery.

### TABLE V

**FUNCTIONAL CLASSIFICATION OF PATIENTS, OPERATED FOR MITRAL STENOSIS, ACCORDING TO THE AMERICAN HEART ASSOCIATION; COMPARING THE RIGHT AND LEFT THORACOTOMY APPROACH TO THE MITRAL VALVE**

<table>
<thead>
<tr>
<th>AHA Class</th>
<th>Left Side</th>
<th>Operative Deaths</th>
<th>Late Deaths</th>
<th>Right Side</th>
<th>Operative Deaths</th>
<th>Late Deaths</th>
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<tbody>
<tr>
<td>1.</td>
<td>17</td>
<td>1</td>
<td>0</td>
<td>3</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>5.9</td>
<td>0</td>
<td>0</td>
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<tr>
<td>2.</td>
<td>355</td>
<td>9</td>
<td>27</td>
<td>83</td>
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</tr>
<tr>
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<td>7.6</td>
<td>3.6</td>
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<tr>
<td>3.</td>
<td>612</td>
<td>59</td>
<td>36</td>
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<td>9.6</td>
<td>5.9</td>
<td>6.8</td>
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<tr>
<td>4.</td>
<td>67</td>
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<td>13</td>
<td>6</td>
<td>3</td>
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<tr>
<td></td>
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<td>14.9</td>
<td>19.4</td>
<td>50</td>
<td>33.3</td>
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<tr>
<td>TOTAL</td>
<td>1051</td>
<td>79</td>
<td>76</td>
<td>210</td>
<td>14</td>
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<td>7.5</td>
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</tbody>
</table>
Seventeen patients have had pregnancies during the follow-up period. Two of these were primiparas and delivered full term babies with no difficulty. Fifteen of the patients had pregnancies preoperatively as well. Twelve of these delivered full term infants; 1 has borne 2 children since commissurotomy. One patient had an abortion at three months, but had no cardiac symptoms. One patient had a tubal pregnancy, requiring laparotomy. One patient in the group had the pregnancy terminated at four months of gestation for medical cardiac reasons.

**Objective Findings**

The systemic blood pressure showed no change postoperatively in 186 patients. Fourteen now have some degree of hypertension. The cardiac rhythm showed no change in 180 patients. Nine cases with normal sinus rhythm have now converted to atrial fibrillation. Ten cases have now converted to paroxysmal atrial fibrillation. One patient having atrial fibrillation preoperatively has now been converted to normal sinus rhythm.

The heart sounds remained unchanged in 141 patients. The first mitral sound was normal or not as sharp in 54 patients. It was diminished because of mitral insufficiency in 5 patients. Mitral systolic murmurs remained unchanged in 119 patients. Seventy patients without systolic murmur developed a murmur after commissurotomy. Five patients with preoperative murmur had a louder murmur postoperatively. Six patients with a preoperative murmur now have no evidence of residual systolic murmur. Mitral diastolic murmurs remained unchanged in 150 patients. The murmur was absent in 21, decreased in 28, and louder in 1 patient. Twenty-six patients developed basal murmurs suggestive of aortic valvular disease.

Heart size remained unaltered in 142 patients. The heart size was

| TABLE VI |
| OPERATIVE RISK SHOWING COMPARISON OF RIGHT AND LEFT THORACOTOMY APPROACH TO THE MITRAL VALVE FOR CORRECTION OF MITRAL STENOSIS |

<table>
<thead>
<tr>
<th></th>
<th>Approach to Mitral Valve</th>
<th>Number of Cases</th>
<th>Operative Mortality Rate</th>
<th>Late Deaths</th>
<th>Late Deaths Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure MS or associated</td>
<td>Left thoracotomy approach</td>
<td>1061</td>
<td>79</td>
<td>7.5</td>
<td>76</td>
</tr>
<tr>
<td>insignificant valve lesions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Right thoracotomy approach</td>
<td>210</td>
<td>14</td>
<td>6.7</td>
<td>4</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>1261</td>
<td>93</td>
<td>7.4</td>
<td>80</td>
</tr>
</tbody>
</table>
smaller in 29 patients, 24 of these showing significant decrease. The heart size was larger in 29 patients, 18 of these demonstrating significant increase. The American Heart Classification remains unchanged in 79 patients. One hundred and thirteen patients were moved into a better functional class by commissurotomy. Eight unimproved patients showed more limitation in their activities.

In the patients' self-evaluation, 48 consider themselves cured; 110 classify themselves as improved, 63 of these markedly improved; 4 are questionably better; and 9 patients are worse.

SUMMARY

Our experiences in the operative treatment of more than 2,000 patients with acquired valvular disease are presented. Recent modifications in surgical technique are described and their advantages outlined.

1. More adequate mobilization of the mitral valve leaflets has been attained when commissurotomy is done from the right thoracic approach. A bicommissural opening was attained in 97 per cent of those patients operated by the right sided approach, and only in 33 per cent of those explored through the left side.

2. Cross-polar plication of the valve annulus, as proposed by Nichols, provides effective relief of mitral regurgitation with a reduction in the mortality rate to 14 per cent.

3. A five and one-half to eight year follow-up was obtained in 200 mitral commissurotomies, and their present status reported.

4. The indications and the techniques for aortic commissurotomy are presented with a discussion of our results by the open technique.

RESUMEN

Se presenta nuestra experiencia del tratamiento operatorio en más de 2,000 enfermos con enfermedad valvular adquirida. Se describen las recientes modificaciones de la técnica quirúrgica y se señalan sus ventajas.

1. Se ha obtenido una movilización de las hojillas de la válvula mitral cuando la comisurotomía se ha hecho por la vía torácica derecha.

Se obtuvo una abertura bi-comisural en 97 por ciento de los enfermos operados por el lado derecho y sólo 33 por ciento en aquellos operados por el lado izquierdo.

2. La plegadura crucial-polar del anillo valvular, como se propuso por Nichols, da alivio efectivo de la regurgitación mitral con una reducción de la mortalidad a 14 por ciento.

3. Se logró un seguimiento de los enfermos de cinco y medio a ocho años en 200 enfermos y se refiere su condición actual.

4. Las indicaciones y las técnicas para la comisurotomía aórtica se presentan con una discusión de nuestros resultados por la técnica abierta.

RESUME

Les auteurs présentent leur expérience du traitement chirurgical de plus de 2,000 malades, atteints d'affection valvulaire acquise. Ils décrivent de
ZUSAMMENFASSUNG


1. Es wurde eine adequate Mobilisation der Mitralklappensegel erzielt, wenn die Commissurotomie von der rechten Thoraxseite aus vorgenommen wurde. Eine Eröffnung beider Commiurren wurde bei 97% solcher Patienten erzielt, die von einem rechtseitigen Zugang aus operiert wurden gegenüber nur 33% bei denjenigen, die von der linken Thoraxseite aus angegangen wurden.

2. Eine Faltung des Klappringes mit gekreuften Polen nach dem Vorschlag von Nichols gewährte effektive Beseitigung des mitralen Rückstromes mit einer Herabsetzung der Sterblichkeitsziffer auf 14%.

3. Eine sich über 5½ bis 8 Jahre erstreckende Nachkontrolle wurde bei 200 Fällen von mitralen Commissurotomien erreicht, und über ihren gegenwärtigen Befund wird berichtet.


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