SECTION ON CARDIOVASCULAR DISEASES

The Value of Left Heart Catheterization in Patients with Rheumatic Mitral Valve Disease

JOSEPH F. URICCHIO, M.D., F.C.C.P.,* LAMBERTO BENTIVOGLIO, M.D.,** JANET DICKENS, M.D.† and HARRY GOLDBERG, M.D., F.C.C.P.‡
Philadelphia, Pennsylvania

Diagnostic and therapeutic problems commonly arise in patients with rheumatic heart disease despite the use of all available clinical data, including electrocardiographic and roentgenographic studies. The deficiencies of the conventional aids have become more apparent with attempts to define the physiological significance of mitral valve lesions.

Since its introduction by Courand and associate¹ in 1941, right heart catheterization has been employed with singular success. Its primary contribution has been in the patient with congenital heart disease, although it has served to clarify much of the altered physiology in patients with rheumatic mitral and tricuspid stenosis. In aortic stenosis and mitral and tricuspid insufficiency, the procedure has been of little value.

In contrast, left heart catheterization enables pressure measurements to be recorded across the aortic valve during systolic ejection and across the mitral valve during ventricular filling.² ³

The present report illustrates the importance of left heart catheterization in the study of patients with rheumatic mitral valve disease. The material is presented in the form of the five most common problems encountered. In each instance, the diagnostic and therapeutic enigma was resolved by left heart catheterization.

All patients were studied by the Fisher⁴ modification of the Björk³ technique.

Problem 1. Objective evidence of mitral stenosis combined with equivocal symptoms and a normal roentgenogram and electrocardiogram.

All of the catheterization and other physiological data were supplied by the Brith Sholom Cardiopulmonary Laboratory, Hahmemann Medical College. This work was supported by the Mary Bailey Foundation for Heart and Great Vessel Research.

*Assistant Professor of Medicine, Hahmemann Medical College and Hospital, and Cardiologist, Bailey Clinic, Philadelphia, Pa.
**Research Associate, Brith Sholom Cardiopulmonary Laboratory, Hahmemann Medical College and Hospital, Philadelphia, Pa.
†Assistant Director, Brith Sholom Cardiopulmonary Laboratory Hahmemann Medical College and Hospital, Philadelphia, Pa.
‡Assistant Professor of Medicine, Hahmemann Medical College and Hospital; Director, Brith Sholom Cardiopulmonary Laboratory, Hahmemann Medical College and Hospital; and Cardiologist, Bailey Clinic, Philadelphia, Pa.
Case 1: M. K., a 36 year old white woman, presented a history of lifelong fatigue. Chronic cough was attributed to smoking. Shortness of breath was noted intermittently, but was often sighing in character. Palpitation and precordial aching were mentioned. Cardiac examination revealed a normal sinus rhythm, a grade 2 apical middiastolic rumble with presystolic accentuation, an opening snap and a sharp mitral first sound. The pulmonic second sound was accentuated. Blood pressure was 122/80. The electrocardiogram showed only atrial dysfunction. The cardiac roentgenograms showed a silhouette that was borderline in size with no clear-cut enlargement of the left atrium (Figure 1).

Figure 1: P-A, left lateral and right anterior oblique chest roentgenograms of patient M. K. The heart was borderline in size.

Figure 2: Continuous pressure tracing in patient M. K. as catheter is withdrawn from left ventricle to left atrium. Note ventricular filling gradient. Upper: EKG. Middle tracing is brachial artery pressure curve.
Physiological data are listed in Table I. The mean ventricular filling pressure gradient across the mitral valve was 15 mm. Hg. (Figure 2).

A mitral commissurotomy was performed on July 27, 1955. The mitral valve was finger tip in size and an adequate opening to 1-1/4 fingers was obtained. The tricuspid valve was normal. A follow-up examination several months later revealed that the patient was doing satisfactorily.

Comment: Left heart catheterization demonstrated a dynamically significant mitral stenosis when the clinical findings suggested an insignificant narrowing of that valve orifice. Surgery confirmed the presence of a severe mitral stenosis.

Case 2: R. G., a 37 year old white woman, presented the chief complaint of fatigue of several years' duration. A slight cough had been present for years. She described four attacks in which she was awakened from sleep by a bad dream with a feeling that she could not catch her breath.

Cardiac examination revealed the presence of a normal sinus rhythm with a characteristic apical midlate diastolic rumble and sharp mitral first sound. The second pulmonic sound was accentuated. The blood pressure was 142/84.

---

**Figure 3:** P-A, left lateral, and right anterior oblique chest roentgenogram in patient R. G. Minimal enlargement of the right ventricle, but not the left atrium, was demonstrated.

**Figure 4:** Continuous pressure tracing as catheter is withdrawn from the left ventricle into the left atrium in patient R. G. Note lack of ventricular filling gradient. The unusual contour of the first portion of the atrial curve is related to the position of the catheter directly at the mitral orifice.
The electrocardiogram showed only atrial dysfunction.

The cardiac roentgenograms revealed questionable enlargement of the left atrium only (Figure 3).

The physiological data are listed in Table I. There was no measurable pressure gradient across the mitral valve during ventricular filling even after exercise (Figure 4).

She was advised that she did not need cardiac surgery at the present time.

**Comment:** In contrast to Case 1, this patient, with similar clinical findings, did not have a physiologic obstruction at the mitral valve on left heart catheterization. Hence, conservative management was advocated and it was concluded that this patient’s complaints were unrelated to her cardiac lesion. A recommendation was made that the study be repeated in one year to determine the rate of progression, if any, of the rheumatic disease process during this interval.

**Problem 2.** The absence of auscultatory evidence to confirm mitral stenosis when the symptoms, roentgenogram, and electrocardiogram are suggestive of mitral valve obstruction:

**Case 1:** I. K., a 53 year old white woman, had suffered from exertional dyspnea and fatigue for over eight years. There was one bout of pulmonary edema. Intermittent ankle edema was common. A strict cardiac regimen had to be employed.

Cardiac examination revealed a normal sinus rhythm and a grade 3 blowing apical systolic murmur. The mitral first sound was not sharp. The second pulmonic sound was accentuated. There was evidence, on admission, of congestive failure. The neck veins were distended; the liver felt four fingers below the costal margin and 1 plus ankle edema was present. The blood pressure was 125/75.

The electrocardiogram revealed right axis deviation and atrial dysfunction.

The cardiac roentgenograms revealed 3 plus enlargement of the right ventricle and 2 plus enlargement of the left atrium (Figure 5).

The physiological data are presented in Table I. The mean pressure gradient across the mitral valve during ventricular filling was 21 mm. Hg. (Figure 6).

Mitral commissurotomy was performed on November 1, 1956. The mitral valve was heavily calcified with small projections of calcium extending into the valve orifice.

![Figure 5A](image1.png) ![Figure 5B](image2.png)

**Figure 5:** P-A and right anterior oblique chest roentgenogram in patient I. K. There was 3 plus enlargement of the right ventricle and 2 plus enlargement of the left atrium.

Downloaded From: http://journal.publications.chestnet.org/pdfaccess.ashx?url=/data/journals/chest/21317/ on 04/04/2017
LEFT HEART CATHETERIZATION

The opening prior to commissural separation was less than a finger tip and no regurgitation was present. Following surgery, an adequate opening to more than 1 nger was obtained. The tricuspid valve was normal.

**Comment:** The presence of a dynamic obstruction at the mitral valve in patients who lack the typical rough murmur of mitral stenosis has been recorded in our experience in only five cases with normal sinus rhythm. In each, the clinical impression was mitral regurgitation. Only by means of left heart catheterization was the correct diagnosis established and the proper treatment instituted.

**Problem 3.** Clinical manifestations suggestive of co-existing mitral stenosis and insufficiency. The requirement exists to determine which is the major lesion.

**Case 1:** A. Z., a 38 year o.d white man, presented a clear-cut history of progressive increase in shortness of breath on exertion, fatigue, cough and nocturnal dyspnea. He had been hospitalized three times for acute pulmonary edema. A strict cardiac regimen was employed.

Cardiac examination revealed the presence of atrial fibrillation. A grade 3 blowing systolic murmur combined with a midlate diastolic rumble accompanied by a thrill was present. The pulmonary second sound was markedy accentuated. The blood pressure was 148/88.

The electrocardiogram revealed atrial fibrillation and ST-T changes characteristic of digitalis therapy.

The cardiac roentgenogram demonstrated 3 plus enlargement with involvement of both ventricle and the left atrium (2 plus) (Figure 7). Physiological data are listed in Table I. Left heart catheterization revealed no pressure gradient across the mitral valve during ventricular filling. A prominent C-V wave was present in the left atrial pressure tracing suggestive of mitral regurgitation (Figure 8). The latter was confirmed at surgery performed for the correction of mitral valve leak.

**Comment:** The patient presented clinical findings consistent with both mitral stenosis and regurgitation. An air of uncertainty was created because of the inability to critically define the relative significance of the

![FIGURE 6: Continuous pressure tracing as the catheter is withdrawn from the left ventricle to the left atrium in patient I. K. A marked ventricular filling gradient is demonstrated.](Image)
regurgitation and the stenosis. With the left heart catheterization data at hand, the decision to perform surgery for mitral regurgitation was predicated upon the availability of an acceptable procedure for treatment of that lesion and the absence of a gradient across the mitral valve during ventricular filling. The presence of a marked C-V wave in the left atrial curve, though of occasional help in the differential diagnosis of mitral valve lesions, may be seen in patients without dynamic mitral regurgitation, especially in the presence of atrial fibrillation.

![Figure 7: P-A view of chest in patient in A. Z. Note prominence of hilar vascular and greater density of the enlarged left atrium.](image)

![Figure 8: Patient A. Z. had mitral regurgitation at surgery. Note lack of ventricular filling gradient and prominence of C-V wave in left atrial curve.](image)
Case 2: M. W., a 45 year old white man, presented a history of progressive exertional dyspnea, fatigue, and cough of five years' duration. There had been one severe bout of hemoptysis. More recently, ankle edema had appeared. He was unable to work and required a strict cardiac regimen.

Cardiac examination revealed atrial fibrillation and a grade 3 apical systolic murmur. The mitral first sound was considered sharp. A grade 1 midlate diastolic rumble was heard by some observers. The second pulmonic sound was accentuated. No opening snap was heard. The blood pressure was 130/78.

The electrocardiogram revealed right axis deviation and atrial fibrillation.

The cardiac roentgenograms revealed 3 plus enlargement of the heart with involvement chiefly of the right ventricle and the pulmonary artery segment. There was questionable enlargement of the left atrium (Figure 9).

Physiological data are listed in Table I. Left heart catheterization revealed a ventricular filling pressure gradient across the mitral valve of 25 mm. Hg. (Figure 10).

Mitral commissurotomy was performed on July 20, 1956, and the mitral valve was found to be a tight finger in size. A heavy ridge of calcium was noted at the an-

**FIGURE 9A**

**FIGURE 9B**

*Figure 9:* Patient M. W. There is marked prominence of the pulmonary artery segment, right ventricle and hilar vasculature. The left atrium is borderline in size.

**FIGURE 10:** Left heart catheterization reveals a marked ventricular filling gradient in patient M. W. Note ventricular extrasystoles. EKG above.
terior commissure. No regurgitation was noted at the mitral valve, and the tricuspid valve was normal. By manual and instrumental techniques, an opening of 2 fingers was obtained.

Comment: The intensity of the apical systolic murmur pointed strongly to the diagnosis of major mitral regurgitation. The electrocardiogram and x-ray film did not eliminate this consideration. Left heart catheterization revealed a major stenosis, paving the way to the performance of a successful commissurotomy.

Case 3: M. M., a 26 year old white woman, had experienced dyspnea on exertion for two years. Orthopnea was marked and was associated recently with ankle edema and palpitation. A strict cardiac regimen was employed.

Cardiac examination revealed a normal sinus rhythm. The mitral first sound was loud and the second pulmonic sound was accentuated. A faint apical presystolic murmur and a grade 3 blowing systolic murmur, audible over the lower sternum with transmission laterally, were present. The blood pressure was 118/74.

Electrocardiogram indicated right ventricular hypertrophy and strain.

Roentgenogram revealed 3 plus enlargement of the heart with involvement chiefly of the right ventricle. A lesser degree of left atrial and right atrial enlargement was thought to be present.

Left heart catheterization revealed a pressure gradient of 26 mm. Hg. across the mitral valve. The physiological data are listed in Table I.

Surgery was recommended. A tight mitral stenosis with no regurgitation was encountered and an adequate opening was obtained. The tricuspid valve was explored and revealed 3 plus regurgitation.

Comment: Clinically, there was wide disagreement regarding the major valve lesion in this case. Some observers argued for mitral stenosis combined with tricuspid regurgitation while others felt that mitral stenosis was present in association with a significant degree of mitral regurgitation. The problem was resolved by left heart catheterization which indicated a tight mitral valve obstruction. A successful commissurotomy was performed and the patient's clinical progress has been excellent.

Problem 4. The clinical manifestations unequivocally are those of mitral stenosis. Marked cardiac enlargement initiates the issue as to whether

FIGURE 11A  FIGURE 11B

Figure 11: Patient A. F. There is marked cardiac enlargement secondary to isolated mitral stenosis.
myocardial degeneration contributes more to the clinical problem than valve obstruction.

**Case 1:** A. F., a 42 year old white man, suffered a cerebral embolism when he was 31 years old. Dyspnea on exertion, chest discomfort, ankle edema, and epigastric discomfort had been present for two years. A second embolic issue occurred in 1956. He was on a strict cardiac program. Cardiac examination revealed the presence of a normal sinus rhythm with a sharp mitral first sound and a grade 3 midlate diastolic rumble. The pulmonic second sound was considerably accentuated. The blood pressure was 130/80.

Electrocardiogram revealed a normal sinus rhythm with atrial dysfunction.

Roentgenograms revealed a 4 plus enlargement of the cardiac silhouette with in-

<table>
<thead>
<tr>
<th>TABLE I</th>
<th>LEFT HEART CATHETERIZATION DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pressures</td>
</tr>
<tr>
<td></td>
<td>Initial</td>
</tr>
<tr>
<td>MK</td>
<td>MS of questionable dynamic significance</td>
</tr>
<tr>
<td>RG</td>
<td>MS of questionable dynamic significance</td>
</tr>
<tr>
<td>IK</td>
<td>Dynamic MI</td>
</tr>
<tr>
<td>AZ</td>
<td>Dynamic MS and MI</td>
</tr>
<tr>
<td>MW</td>
<td>Dynamic MS and MI</td>
</tr>
<tr>
<td>MM</td>
<td>Dynamic MS and MI</td>
</tr>
<tr>
<td>AF</td>
<td>Dynamic MS</td>
</tr>
<tr>
<td>LP</td>
<td>Recurrent</td>
</tr>
</tbody>
</table>

All pressures and gradients are expressed in mm. Hg. Figures in parentheses refer to mean pressures. The denominator of the fraction under “Left Ventricle” refers to end-diastolic pressure. Mitral valve area is expressed in cm².
volvement chiefly of the right ventricle. The left atrium was enlarged 2 plus (Figure 11).
Physiological data are listed in Table I. A gradient across the mitral valve of 8 mm. Hg. was found.
Cardiac surgery was performed on March 4, 1956. The mitral valve was a finger tip in size with some subvalvular fusion and valvular calcification. An adequate opening was obtained. The tricuspid valve was normal.

Comment: Clinically, everything pointed to the presence of pure mitral stenosis. Yet, a gradient of only 8 mm. Hg. was detected across the mitral valve. This was attributed to a poor cardiac output resulting from associated myocardial disease. The anticipated result from mitral commissurotomy in such cases may be less than ideal.

Problem 5. The diagnosis of restenosis of the mitral valve.

Case 1: L. P., a 39 year old woman had a mitral commissurotomy performed in May of 1955 because of dyspnea, fatigue, edema, hemoptysis and recurrent attacks of pulmonary edema. The preoperative diagnosis of mitral stenosis was confirmed at operation and an adequate opening was obtained to one and three-fourths fingers without the production of mitral regurgitation.
She remained in asymptomatic state until a short while before her readmission to Hahnemann Hospital on March 26, 1956. Her symptomatic pattern was exactly similar to that described prior to her original operation one year previously.
Cardiac examination revealed atrial fibrillation, a sharp mitral first sound, an opening snap, and an accentuated pulmonic second sound. A presystolic accentuation of a loud midlate apical diastolic rumble, and a grade 2 apical systolic blow were noted.

The electrocardiogram showed atrial fibrillation and right ventricular hypertrophy.
The roentgenograms revealed 2 plus enlargement of the right ventricle and left atrium. There was no alteration in size and configuration since the date of original mitral valve surgery.
The physiological data are listed in Table I. Left heart catheterization, performed on March 28, 1956, revealed a ventricular filling gradient across the mitral valve of 9 mm. Hg.
She was re-operated and a tight mitral stenosis again was encountered. A successful commissurotomy was performed for the second time.

Comment: The recurrence of cardiac symptoms in a patient who has been operated previously for mitral stenosis poses many problems. One must evaluate the adequacy of the medical regimen and the contribution to the clinical picture of other valve lesions, not correctible at the time of the original mitral commissurotomy. The myocardial factor must be appraised. None of these appeared to play a significant role in the above case. Rather, left heart catheterization confirmed the presence of a significant gradient across the mitral valve. Surgery was decided upon and a tight mitral stenosis without regurgitation was actually encountered and relieved.

Discussion
With the introduction of left heart catheterization, a method has been provided which clarifies the dynamics at the mitral valve itself. Usually, there is no measurable difference in pressure between the left atrium and the left ventricle during ventricular diastole. The constant physiological abnormality in mitral stenosis is the presence of a pressure gradient during ventricular filling. When this information is combined with an estimation of the cardiac output, the degree of mitral stenosis can be precisely determined and the valve orifice area calculated. This is best accomplished by combined heart catheterization. The complications and hazards of this procedure are generally minimal.
It is natural to accept left heart catheterization for the study of those cases in whom the clinical aids have failed to accurately assay the physiological significance of rheumatic mitral stenosis. The measurements obtained at left heart catheterization also have been of value when marked discrepancies exist between the symptomatic picture and the classical signs of the disease. The objectivity provided by the determination of pressure gradients also permits the application of more exact criteria in the selection of cases for cardiac surgery. This information helps to eliminate the confusion that constantly arises in the borderline case concerning the type of future management.

Finally, left heart catheterization offers an acceptable method for evaluating the results of surgery.7

The indications for left heart catheterization in rheumatic heart disease will probably increase. Its use is envisioned in the routine study of the inexorable progression of the rheumatic process at the mitral and aortic commissures.

SUMMARY AND CONCLUSIONS

1. The value of left heart catheterization in patients with rheumatic mitral valve disease is documented.

2. Case histories are presented in which therapeutic and diagnostic problems were resolved by the attainment of the ventricular filling gradient across the mitral valve.

3. Left heart catheterization is chiefly of value in patients with rheumatic heart disease in whom marked discrepancies exist between the objective and subjective clinical picture.

4. Left heart catheterization also is helpful in evaluating the results of cardiac surgery and analyzing the progression of the rheumatic process following mitral commissurotomy.

RESUMEN Y CONCLUSIONES

1. El valor de la cateterización cardiaca izquierda en enfermos con enfermedad valvular reumática de la mitral, se justifica.

2. Se presentan dos historias en los que los planes de diagnóstico y de tratamiento se resolvieron alcanzando el gradiente de llenado ventricular a través de la mitral.

3. La cateterización cardiaca izquierda es principalmente de valor en los enfermos con enfermedad cardiaca reumática en los que existen discrepancias marcadas entre los cuadros clínicos subjetivo y objetivo.

4. La cateterización cardiaca izquierda también es útil para valuar los resultados de la cirugía cardiaca y para analizar la evolución del proceso reumático después de la comisurotomía mitral.

RESUME

1. Les auteurs apportent des documents militant en faveur du cathétérisme du coeur gauche chez les malades atteints de maladie mitrale.

2. Les auteurs présentent des observations où la thérapeutique et le
diagnostic sont liés au remplissage progressif du ventricule à travers la valvule mitrale.

3. Le cathétérisme du cœur gauche est de grande valeur chez les malades atteints de rhumatisme articulaire aigu, chez lesquels existent des divergences marquées entre les signes cliniques objectifs et subjectifs.

4. Le cathétérisme du cœur gauche est également utile pour évaluer les résultats de la chirurgie cardiaque et analyser l'évolution du processus rhumatismal à la suite de la commissurotomie mitrale.

ZUSAMMENFASSUNG UND SCHLUSSFOLGERUNGEN


2. Es werden Krankengeschichten gebracht, deren therapeutische und diagnostische Programme zur Lösung kamen durch die Kenntnis des ventrikulären Füllungs-Druckgefalles durch die Mitralklappen hindurch.


4. Die Katheterisierung des linken Herzens ist außerdem eine Hilfe bei der Auswertung der Ergebnisse der Herzchirurgie und Analyse des Fortschreitens des rheumatischen Prozesses im Anschluss an eine Mitral-Commissurotomie.

REFERENCES


