Bronchoscopic Method for Measuring Left Atrial Pressure
An Aid to Diagnosis in Mitral Disease

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The possibility is examined that measurements from the records of left atrial pressure obtained by direct puncture of the left atrium through the bronchoscope might help in the diagnosis of mitral disease. The left atrial pressure records of 156 patients have been analyzed and the results are presented.

It was suggested that the record of left atrial pressure, obtained through the bronchoscope, might help to differentiate between mitral stenosis and mitral regurgitation and also to distinguish those patients in whom the mitral lesion is not the major cause of the symptoms.1

The validity of these suggestions has been tested in a series of 156 patients.

Method
The apparatus used was the same as that previously described by Allison and Linden.1,2 The manometer system was damped only by the puncturing needle and the degree of damping was 60 to 70 per cent of the critical value. It must be emphasized that in a system of this type no other damping is required. If, to eliminate artifacts, further damping is applied by electric or mechanical means, the amplitude of the recorded pressure pulse will be reduced, and inaccuracies of an unknown degree will occur.

The Patient. At rapid heart rates the records of the left atrial pressure contours are less accurate: (1) because the ratio of the frequency of the impressed force to the natural frequency of the manometer system is large and this causes distortion; and (2) because, in some patients with mitral disease and atrial fibrillation, regurgitation may occur when the heart rate is slow and may not be present when the rate is faster.1

In an investigation by this method the fact that the patient does not have a general anesthetic and is aware of the surroundings tends to increase the heart rate. To avoid tachycardia, therefore, it is advisable to give a vagal-stimulating drug such as morphia and withhold any vagal-paralyzing drug such as atropine. If the patient is apprehensive, additional sedation with a barbiturate may be necessary. The most important factors are adequate explanation and reassurance of the patient.3

Records. Pressure records were obtained with the center of the manometer membrane level with the upper edge of the manubrium sterni, and this point was taken as the zero reference point in all figures. In all tracings an electrocardiogram and a phonocardiogram were recorded to facilitate the recognition of the individual waves of the pressure pulse contours. The method of measuring the records has been described previously, but is briefly reviewed. The cardiac cycles to be examined were chosen from those that occurred during the expiratory phase. Pressures were then measured at 2 points in the atrial cycle: at the "Z" point, which is a point on the atrial pressure curve just before the beginning of the "v" wave, and at the top of the "v" wave. These 2 points of the atrial pressure curve correspond to the beginning and end of ventricular systole. A calculation was then made of the "mitral value" as described and discussed previously: the difference between the pressures at the "V" and the "Z" points (Pr-Pz) is expressed as a percentage of the pressure at the top of the "v" wave (Pr). It is important to select the correct points on the curve at which to measure the pressures; these are illustrated in figure 1, which shows records from patients with sinus rhythm and with atrial fibrillation.

Selection of Material. The records of patients accepted for this study were taken in order according to the numbers in the departmental files; but this is not truly an unselected series, as mere attendance at a thoracic surgical clinic infers some degree of selection.

The cases were divided into groups, first according to the clinical diagnosis and, second, according to the findings at operation. The diagnoses of mitral stenosis, mitral regurgitation, and combined lesions were made from the now well-described symptomatology, physical signs, and radiology of these variations of rheumatic heart disease.2,4 The size of the mitral orifice was determined by the surgeon's finger; a method has been described by Goodwin et al., who expressed the size of the orifice in terms of the distance between the commissures. They arranged their cases in

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FIG. 1. Diagram to show the position of the 'Z' and 'V' points. Single cardiac cycles from the records of each of 4 patients: a, sinus rhythm and mitral stenosis; b, sinus rhythm and mitral regurgitation; c, atrial fibrillation and mitral stenosis; d, atrial fibrillation and mitral regurgitation. Upper curve in each record, left atrial pressure pulse; lower curve electrocardiogram. In each cycle the 'a,' 'c,' 'v' waves of the venous pulse are indicated; the position of intersection of each vertical line with the atrial curve indicates the point at which the pressure was measured.

The records of 156 patients were grouped according to their clinical and operative diagnoses. Briefly, 26 patients had no operation; 7 patients were not operated upon because their left atrial pressures were low, 2 because they were unfit as a result of other illness, 4 because of severe associated lesions of the heart, and 18 because of severe mitral incompetence. It is impossible to say how much the decision not to operate in this last group was influenced by the pressure record from the left atrium, but most certainly it was. These 26 cases were excluded from further consideration in this discussion.

In a further 5 patients a definite diagnosis could not be made at operation and these cases were also excluded from the following discussion.

The remaining 125 patients were divided into 2 groups, those with sinus rhythm and those with atrial fibrillation. In each of these 2 large groups the mitral lesion was assessed

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clinically and at operation according to the described criteria.

The results of comparing the operative findings with the forecast obtained by calculating the "mitral value" from the pressure record are shown in diagrammatic form in figures 2 and 3. In figure 2 the difference between the pressure at the 'V' point and at the 'Z' point (Pv-Pz); abscissa, the pressure at the 'V' point (Pv). A line is drawn to indicate a 'mitral value' of 30. The open circles represent values from patients who had proved mitral stenosis at operation. No patient with sinus rhythm had severe regurgitation at operation.

In figure 3 the patients had atrial fibrillation and the line is drawn to indicate a 'mitral value' of 50. The open circles represent values from patients who had proved mitral stenosis at operation and the closed circles those who had severe regurgitation.

these 6 patients the diagnosis, based upon this value alone, was not made with confidence. In addition, 2 patients, observed to have mitral stenosis at operation each had a "mitral value" of 58 (shown as 2 open circles above the line in figure 3); one had a calcified valve and a palpable regurgitant stream at operation but the lesion was mainly stenotic. No adequate explanation exists from the results in these 2 patients. Nevertheless the prediction of the diagnosis on a basis of the mitral value alone was wrong in only 2 patients.

The value of the method may be assessed in another way; in the following 13 patients the clinical diagnosis did not agree with the diagnosis made at operation, whereas in every case a prediction was made by means of the "mitral value." In figure 3 there are 9 points represented by closed circles above the line; at operation all these were proved to have a severe degree of regurgitation. All had "mitral values" of over 50 and because the hearts of these patients were fibrillating, these "mitral values" correctly predicted the diagnosis. But as a result of clinical and radiologic examinations 8 of these patients were said to have either a severe degree of pure mitral stenosis (3 cases) or a combined mitral lesion with predominant stenosis (5 cases). In addition in 3 patients, although the clinical and radiologic diagnosis of pure stenosis was severe enough for operative treatment, the left atrial pressure was within
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the accepted range of normal (maximum pressure less than 20 cm. of water) and at operation there was minimal or mild stenosis. Lastly 2 patients were considered clinically to have combined stenosis and incompetence with the regurgitation predominant; both had pressure pulse contours that suggested mitral stenosis; and severe mitral stenosis was found at operation. One of these, a nursing sister, is a classical case in the department and has been quoted by Allison;3 if it had not been for her own insistence on surgery, she would not have been operated upon. Her "mitral value" was 31 which, because of atrial fibrillation, clearly indicated stenosis, and at operation an uncomplicated tight stenosis was found and relieved.

Discussion and Conclusions

As long as there is no adequate operative procedure with which to alleviate the effects of mitral regurgitation, it is essential to distinguish preoperatively, as accurately as possible, between patients with stenosis and those with regurgitation. To this end any technic that increases the accuracy of diagnosis and limits the mistakes made, must be welcomed.

It is suggested that such a technic is that of recording the left atrial pressure through the bronchoscope; the attempt to predict the diagnosis solely from an examination of the pressure record was wrong in 2 patients, whereas a similar attempt by clinical and radiologic means was wrong in 18 patients out of a total of 125 patients. Also as a result of the interpretation of the left atrial pressure records, at least 11 patients out of 156 would rightly not have been operated upon if, with the experience possessed now, more attention had been paid to the pressure record and less to the clinical and radiologic diagnosis. Also examination of the left atrial pressure record suggested that no operation was necessary in 7 patients and helped to an unknown degree in weighing against operation in 13 patients who were considered to have severe mitral regurgitation. This empirical method is not infallible, and this is illustrated by the 2 patients whose left atrial pressure pulses predicted a major degree of regurgitation but who, at operation, had an operable degree of stenosis.

Since the first report of this empirical assessment1 Morrow8 has reported that this method of calculation from left atrial pressure records correctly predicted the diagnosis of mitral stenosis and regurgitation in patients with atrial fibrillation but the method was not so reliable when the heart was in sinus rhythm. However, by his modification of the technic of atrial puncture the zero was recorded at the level of the needle in the atrium, some 5 to 10 cm. below the manubrium sterni; all pressures measured on such a record would be 5 to 10 cm. of water greater than if they had been measured on a record obtained when the zero was level with the manubrium sterni. Thus "mitral values" calculated with the zero level 5 to 10 cm. below the manubrium sterni would give lower values and should not be compared with those presented in this report. The manubrium sterni zero level was deliberately chosen so that the "border line" between the values indicating stenosis and those indicating regurgitation could be set at 30 for patients in sinus rhythm and 50 for patients with atrial fibrillation.1 Should it be desired to use a different zero level then it would be necessary to take a new "border line" obtained by assessing a large group of patients, or calculate it from the figures presented in this series.

Hutchison, Lawrie, and Thomson9 have also had little success with this method. Detailed evidence on which this conclusion is based is not given. However their figure 5 (h) shows a record which, on their interpretation, suggested that gross mitral incompetence was present, but at operation the patient was found to have a tight mitral stenosis. In our opinion their interpretation of this record was wrong and the prediction from the record should have agreed entirely with their operative findings.

It is concluded that the examination of the left atrial pressure record is useful in patients with mitral disease, first to diagnose the lesion in those patients with mild or minimal stenosis (and this includes the patients followed post-
operatively because a maintained low left atrial pressure would indicate that there was no recurrence of severe stenosis) and second to distinguish between those patients with mitral stenosis and those with mitral regurgitation.

It must be emphasized that this method will only be of value if the limitations enumerated above are remembered and if in the original recording of the pressure contours attention is paid to the correct degree of needle damping, the absence of air bubbles in the system, the leveling of the manometer zero to, and only to, the manubrium sterni, and the correct measurement and interpretation of the records.

**Summary**

Some of the necessary conditions for the accurate recording of left atrial pressure by the bronchoscopic method are emphasized.

The records of 156 patients were examined and the patients placed in groups according to the clinical and radiologic diagnosis, the diagnosis at operation, and the diagnosis based only on an examination of the pressure record.

The attempt to predict the diagnosis solely from an examination of the pressure record was wrong in 2 patients only, whereas a similar attempt by clinical and radiologic means was wrong in 13 patients; out of a total of 125 cases.

It is concluded that in mitral disease this technic, used correctly, is useful to differentiate between stenosis and regurgitation and to distinguish those patients in whom the diseased mitral valve is not the main cause of the symptoms.

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**Summario in Interlingua**

Es signalate certe del conditiones necessari pro le accurate registration de pression sinistro-atrial per le metodo bronchoscopic.

Le dossiers de 156 patientes esseva examinates, e le patientes esseva organisate in gruppos secundo le diagnose clinic e radiologic, secundo le diagnose al operation, e secundo un diagnose basate exclusivemente super le examine del registration de pression.

Le essayo de predicer le diagnose exclusive mente super le base del examine del registration de pression succedeva mal in solmente 2 patientes. Un simile essayo super le base de solmente le datos clinic e radiologic succedeva mal in 13 patientes. Le total del casos in iste phase del studio esseva 125.

Es presentate le conclusion que in morbo mitral le technica bronchoscopic, si usate correctemente, representa un medio efficace pro differentiar inter stenosis e regurgitation e pro identificar le patientes in qui le morbide valvula mitral non es le causa principal del symptomas.

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