SOME OBSERVATIONS ON MITRAL STENOSIS

A survey of 100 cases surviving mitral valvotomy

by

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Thesis submitted for the Degree of M.D.

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This thesis is dedicated

to those patients who suffered under my hand.

"It is of use, from time to time, to take stock, so to speak, of our knowledge of a particular disease, to say exactly where we stand in regard to it, to enquire to what conclusion the accumulated facts seem to point and to ascertain in what direction we may look for fruitful information in the future". Osler.

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INTRODUCTION.

I am attempting a review of cases of mitral stenosis that have already been submitted to surgery. The first, and possibly the most important, factor that presents itself is the decision for surgery. The condition of mitral stenosis is fairly common, and numbers of these patients are offered for surgical treatment. The decision then that has to be made is exceedingly difficult on ethical as well as clinical grounds.

The operation of mitral valvotomy is a comparatively new one and the surgeon has to build up his own clinical experience. There is little information from past experience to guide him in assessing the cases, and there is little help to be found in making the decision over borderline cases. The surgeon would not wish to feel he had denied the patient a chance of improvement, for fear of raising the operative mortality or bringing the operation into disrepute. On the other hand, he has been unable to assess the ultimate result on similar cases that have already received surgery. I hope that an analysis of the results of the first 100 patients surviving operation will shed some light on the type of case most suitable for surgery and prove a guide to the decisions over borderline cases.

There has obviously been much to be learnt from experience about the surgical technique of the operation itself, the technique varying in different circumstances with each different case. For this reason I must devote some discussion to surgical technique, with the obvious understanding that the result must vary according to the technical skill of the operator, once the decision for operation has been taken. Also, naturally, when difficulties are encountered during the operation, the mortality can be reduced by experience and attention to detail. Thus, I have given a full account of these difficulties and the measures used to combat them, in the hope that they will be more easily recognised and overcome in future.

The post-operative care of patients undergoing mitral valvotomy has proved almost as important as the operation itself. For this reason I have sifted and recorded methods that have been found successful in post-operative care, as inadequate attention to detail can vitiate the results of an otherwise satisfactory operation.

In common with other surgeons, I find that the variability of results at a later date causes much concern. This series has been investigated with particular reference to the ultimate result, compared with the success achieved at the operation. A further cause for concern is the failure of some patients to maintain their initial improvement. I hope that the analysis of these cases may reveal some common factor responsible for deterioration. As some authors have stated categorically that positive auricular biopsies showed no relationship to later deterioration, it seemed justifiable to carry out an investigation in this series to see if, in fact, the results in these cases conformed to their findings.

The doubts raised by some authors regarding the advisability of carrying out lingular biopsies in view of possible dangers that may arise during convalescence, justified a review of the findings and a comparison of these dangers with the clinical results.

I performed the operation of mitral valvotomy on the 100 patients concerned in this review. In order to have the 100 surviving cases, 110 were operated on. The majority were operated on at the Western Infirmary, Glasgow and at Hairmyres Hospital, East Kilbride, and a few at the Infectious Diseases Hospital, Paisley.

HISTORICAL.

The history of the surgery of mitral stenosis is well known. Suffice it to state here that Souttar reported the first successful valvotomy in this country in 1925.

Cutler & Beck (1929) reported a case surviving for 4 years but six other cases died shortly after the operation.

In the United States first Harkin (1948) and then Bailey (1949) reported ever increasing numbers of operative survivals.

In this country the pioneer work was carried out at Guy's Hospital (Baker, Brock & Campbell, 1950), and since 1950 many other surgical centres throughout the country have undertaken the surgical treatment of mitral stenosis.

The first case in this series was operated on in November, 1951.

CLINICAL FEATURES.

AGE. The average age of patients submitted to operation was 34.4 years. The youngest was a girl of 15 and the oldest a woman of 56. The number of cases in each five year group is shown in Table No.1.

TABLE NO. I.

Age	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60
Number of Cases	1	2	11	15	25	26	15	4	0	1

It will be noted that only 3 cases were operated on under the age of 20, one at 15, another at 16 and a third at 19. It has generally been accepted that patients should be over 20 years old before being operated upon for mitral stenosis; indeed the more conservative type of cardiologist has been known to advocate delay until the patient is over 30. The reason for this delay lies on the one hand in the fear of further attacks of rheumatism, and on the other in the possibility that the heart may still show active rheumatic carditis in those not yet 30 years of age. Whether this cautious approach is justified in our present knowledge is a matter of considerable doubt.

The youngest patient was a girl of 15 years 3 months who was admitted to hospital in congestive cardiac failure. She had had rheumatic fever at the age of 9 and St. Vitus Dance 2 years later. On admission to hospital she was complaining of severe breathlessness and pain in the right hypochondrium, the latter being the result of enlargement of the liver to three fingersbreadth below the costal margin. The liver was tender to palpation. She was orthopnoeic and showed cyanosis of the lips and finger nails. There was distension of the neck veins. The cardiologist, having controlled the congestive cardiac failure, offered her for surgery and expressed the opinion that if operation was denied her she would not live to the age of 20. One had no alternative but to perform mitral valvotomy in the face of this opinion. At operation a tight valve was found, the opening being reduced to 1 cm. The fused anterior commissure split readily, but the posterior commissure was hard and thick even at this early age. It was deemed unwise to attempt to split this commissure, as it was feared division of such a thick fusion might well give rise to incompetence. A good opening had been obtained by splitting the anterior commissure, and the orifice was about 3 cm. in length at the conclusion of the operation. The endocardium contained Aschoff bodies, but the myocardium was not involved. The specimen taken from the lung showed marked vessel thickening only in the vessels close to the pleura; there were many iron-filled macrophages. The expected result in this case was classed as "adequate relief". From a pre-operative grading of Group III she was transformed to a "very good" result. She returned to school and later worked for over a year as a clerkess. She increased in physical stature and was able to climb to the third floor in a tenement. She could also spend a whole evening dancing. She remained well for two and a half years and then quite suddenly her symptoms returned. She is now, three and a half months later, considered to have developed mitral stenosis again and is awaiting a second operation. At no time has there been evidence of re-activation of rheumatic carditis, although the present practice of giving oral penicillin for three months after operation had not been started at this time. It is quite likely that re-fusion would not have occurred had the posterior commissure also been split.

An office boy, age 16, although Graded II, was also considered to require immediate operation. In this case there was tight stenosis, the orifice being under 1 cm. in length. The valve was not funnel shaped, and the commissures were perfectly smooth and apparently free from active disease. The anterior commissure split out to the A-V ring with the greatest of ease; only a little splitting of the posterior commissure was possible and the narrow neck of the appendage precluded the use of a knife. At the conclusion of the operation the valve was 2.75 cm. in length. The histological picture of the endocardium in this case showed only a few Aschoff bodies, some of which were fibrosing, but others appeared to be of more recent origin. There was no great thickening of the blood vessels, but very many of the alveoli were filled with macrophages. This boy returned to work three months after his operation, and he has now worked as a costing clerk for three years. From a somewhat stunted pale youth he has developed into a well-developed man. His grade is excellent.

The third case under 20 years of age was a factory worker of 19, who required to give up work six months before her operation on account of increasing dyspnoea, haemoptysis and retrosternal pain brought on by exertion. She had had three attacks of pulmonary oedema and was classed as Grade III. The mitral valve orifice was extremely small, being .5 cm. in size. In spite of her youth, the commissures were greatly thickened, fibrous and hard; indeed splitting was achieved with difficulty and the finger required to be supplemented with the Brock knife. The valvotomy was not as good as one hoped for; the valve orifice would only admit the finger and no more, being about 2 cm. in length. Once again subendocardial Aschoff bodies were present, and the lungs showed moderate invasion of alveoli by iron-filled macrophages. She returned to factory work nine months after her operation, and she has now been working for just short of three years. The result is classed as excellent.

It would seem that, on the results achieved in these three cases (even although the youngest has relapsed), operation must be carried out irrespective of the patients being under 20 years of age if the symptoms are sufficiently commanding, if there is a fear that survival to over 20 may not be achieved, and provided there is no evidence of continuing rheumatic activity.

HISTORY of RHEUMATIC FEVER, CHOREA or GROWING PAINS.

A previous history of the active rheumatic state was obtained in 63% of the series; a single attack occurred in 44% while there were recurrent attacks in 19%. One patient claimed to have had an attack annually for 14 years. Chorea occurred alone in 9%, both chorea and rheumatism in 8%, and only subacute rheumatism or growing pains in 7%. A history of rheumatism was obtained in 73% of those cases in which more than one valve was affected, and when there was mitral incompetence as well as stenosis the incidence of rheumatism rose to 80%. These figures, which show an increased incidence of rheumatic infection in cases in which some element of mitral incompetence was found or in which other valves were affected, tend to confirm the view expressed by Wood (1954) that pure mitral stenosis would seem to be the least florid form of rheumatic heart disease.

Of those patients from whom no history of rheumatic infection was obtained 6 gave a history of acute tonsillitis or quinsy, 3 of diphtheria, or diphtheria and scarlet fever, 2 had an acute febrile illness such as influenza and 1 could only give a previous history of measles. Eight patients without previous rheumatism dated their symptoms to a pregnancy; no doubt the heart lesion was present prior to the increased effort required of the circulation during pregnancy, although the relative frequency of this sequence of events raises the question of post hoc or propter hoc.

In 22% of the cases symptoms due to the mitral stenosis became apparent for the first time during pregnancy. If the male patients are excluded, one finds that in one quarter of the female patients (25.6%) pregnancy was the deciding factor in bringing on symptoms.

Dyspnoea and the Method of Grading.

The method of grading of the cases in regard to effort intolerance, commonly due to dyspnoea, was carried out in the manner suggested by Wood (1954).

Logan & Turner (1953) rightly stress the difficulty in ascertaining just how breathless a patient is; dyspnoea on exertion may be purely subjective, and patients vary widely in their appreciation of its severity. On the one hand some minimise what to the observer is clearly marked disability, and on the other some make much of what appears to be slight limitation of physical effort. Logan & Turner (1953) warn against the danger of underestimating a complaint of dyspnoea in young people, since tight mitral stenosis and pulmonary hypertension may be present at the time of examination although the heart is of normal size and the lungs are clear.

This difficulty of assessment became apparent early in this series of cases. The distance of a mile for one patient was equivalent to three or four hundred yards for another. The valuable information obtained from the degree of dyspnoea occurring while climbing stairs presented further variations in their estimate. A flight of stairs to one patient represented a tenement house one stair up; to another it was a half landing on the way up to the first house, and to a third patient it represented a matter of only a few steps. In an endeavour to standardise distance and stairs, an attempt was made to try to base each patient's symptoms against a more certain distance and a more definite series of steps. The vast majority of the cases came from areas in which tenement houses were a feature; thus each case was asked how many tenement blocks they could walk at normal pace; in respect of stairs, they were asked to state how many tenement houses they could climb up to at normal pace, and how many stops, if any, they required to make because of breathlessness. This method of interrogation seemed to provide a ready means of assessment particularly in regard to stairs, for the patient with mild symptoms would quickly state that she could reach the second house, but would require to stop; the moderately disabled case might claim that she could reach the second house with one or two stops, and perhaps more slowly. The moderately severely disabled would require to rest at the half-landing on the way to the first house, while the severely disabled, if able to climb stairs at all, would require to stop before starting on the stairs, and would reach the first house with difficulty and with frequent stops.

A useful additional gauge of disability was the hospital drive in those hospitals like Hairmyres and the Infectious Diseases Hospital, Paisley, where the approach to the hospital is on an uphill gradient. The patients and the observer both knew the degree of incline and the distance involved, thus the number of stops required and the pace it was taken at provided helpful data in assessment; this information could be further amplified by the effect of a windy day on the patient's progress and the capacity or otherwise for conversation on the way.

Other everyday activities where housewives were concerned provided excellent measures for assessment, and these appeared to provide quite a reasonable common standard. For example the patient with little disability could not only do her own shopping, but could carry it all or most of it home, while the patient with moderate disability could still do her own shopping but could only carry the lighter articles, and the patient with severe disability required to give up shopping altogether. These same patients, the housewives, had two activities connected with their housework which provided a very accurate measurement of their disability, namely the scrubbing and polishing of floors. The stooping and muscular exertion required for both of these household chores provided a practically unfailing grading of their discomfort. The housewife with little disability could fulfil both of these duties without much difficulty; where moderate disability was suspected both scrubbing and polishing were done slowly and with difficulty; while in those with severe disability both had required to be abandoned, as indeed had most of the rest of the housework. The accuracy of the observations relevant to the triad of shopping, scrubbing and polishing made the grouping of the housewives comparatively simple and, one believes, reasonably accurate.

The female patients who had been working, or were still working, and the male patients were found rather more difficult to assess and group. For assessment in these cases one was dependent on the patient's ability to climb up to tenement houses and to pass a series of tenement buildings while walking on the level.

According to Wood's method of classification Grade I were able to lead normal lives, but could not keep up with their fellows. No patients in Grade I were operated upon. Patients in Grade II were unable to run or hurry; they found hills difficult, but could walk indefinitely on level ground. This group were further subdivided into (a) and (b) as suggested by Wood (1954). Grade II(a) contained only two patients while Grade II(b) had sixteen.

In Grade III patients could only walk a few hundred yards on the level or the equivalent of three or four tenement blocks. Shopping and housework were carried out with difficulty, that is to say, in this series of cases they could shop but could not carry their shopping; also they could dust in the home but they would only do a little scrubbing and polishing. There were 71 cases in Grade III.

In Grade IV were classed the patients who were more or less totally incapacitated; to manage 100 yards on the level was their limit, and shopping and housework had been abandoned; several were confined to bed. There were 11 patients in Grade IV.

TABLE NO. II.

Grade of Disability.

Grade	No. of Patients
I	0
II(a)	2
II(b)	16
III	71
IV	11
Total	100

TABLE NO. III.

Grade of Disability Compared with Valve Size Found at Operation.

Valve Orifice Size	Grade of Dyspnoea I	II	III	IV	Total
> 2 cm.	0	3	5	0	8
1.5-2 cm.	0	3	9	3	15
1-1.5 cm.	0	9	51	4	64
< 1 cm.	0	3	6	4	13
Total	0	18	71	11	100

It can be extremely difficult to measure accurately with the finger the mitral valve orifice and this may account for the discrepancy between the figures in Table No.III and those reported by Goodwin et al (1955). In a series of 75 patients they found 42 to have a mitral orifice less than 1 cm. in size as against 13 in this series, while 28 had a mitral orifice of 1-1.5 cm. instead of 64. Four per cent of their cases were in Grade IV in place of 11% in this series, 53% were in Grade III in place of 71%; 39% in Grade II against 18% and 4% were in Grade I as against none.

TABLE NO. IV.

Grade & Age Group.

Group	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	Total
II(a)		1	1								2
II(b)		1	4	2	3	4	1	1			16
III	1		6	13	19	16	12	4		1	72
IV					3	6	1				10
Total	1	2	11	15	25	26	14	5		1	100

Age, Sex and Cardiac Rhythm.

There were 86 female and 14 male patients. The age, sex and cardiac rhythm relationships are shown in Table No. V.

TABLE NO. V.

Age (years)	Total No. of patients	Male	Female	Auricular Fibrillation
11-15	1	0	1	0
16-20	2	1	1	0
21-25	11	3	8	1
26-30	15	2	13	1
31-35	25	2	23	6
36-40	26	3	23	5
41-45	14	2	12	6
46-50	5	1	4	2
51-55	0	0	0	0
56-60	1	0	1	1
Total	100	14	86	22

Just over half the patients (51%) were in the group 31-40 years of age.

Twenty-two patients had auricular fibrillation at the time of operation.

Haemoptysis and Embolism.

Haemoptysis occurred in 50% of the cases, and varied in quantity from simple streaking to frank bleeding amounting to several ounces. Sixty-two per cent had a cough, and 41% gave a history and had physical signs of bronchitis. Paroxysmal dyspnoea occurred in 42%; while 31% had had one or more attacks of congestive cardiac failure.

Seven patients had had cerebral emboli before operation; all made a rapid and complete recovery. One patient had a peripheral embolism in one leg, but the collateral circulation was sufficiently good to prevent any permanent damage occurring. Another patient, the victim of a peripheral embolus, had the misfortune to occlude his right femoral artery at the common site - the origin of the profunda branch. Surgical aid was not sought early enough, and the leg had to be amputated. Fourteen days later a second embolus was released and became impacted in the left femoral at the same level. Fortunately this second episode was appreciated for the disaster it was, surgical help was called and the embolus was removed by the author six hours after its occurrence. The leg was saved, although a little circulatory insufficiency of the foot and toes remains. This patient returned to work and remained well for 7 years, apart from occasional blood streaking of his sputum and some limitation of walking on the level, the result of impairment of his circulation. He then began to have increasing dyspnoea which overshadowed the disability from his leg. The difficulties and dangers of the operation from the presence of clot were explained to him, but he decided he was becoming increasingly disabled and elected to undertake the risks involved. The auricular appendage was large and bulging with clot and thrombus. Clot was so abundant at first that it appeared doubtful if entry via the appendage would be possible. The atrium was lined with clot, making entry through the atrial wall extremely undesirable. Fortunately a track, sufficiently wide to admit the finger, was found through the adherent thrombus in the appendage. The valve was tightly stenosed, being 1 cm. in size; the anterior commissure split easily out to a contracted atrio-ventricular ring to give an opening of 2.5 cm. A posterior commissure shelf would not split with the finger, and the risk of using a knife was deemed to be too great; indeed, when some blood was allowed to escape on withdrawing the finger, a ball thrombus 2 cm. in diameter was flushed out of the appendage. This patient has maintained a very good result for over a year since his operation (Case No.94).

PREGNANCY.

Seven of the patients were pregnant at the time of operation. In one case the pregnancy was only two and a half months old, and was not suspected; in four the pregnancy was between the third and fourth month, while in the remaining two cases the pregnancy was in the fifth month. In three it was the first pregnancy, and one had had a miscarriage in the eighth week. In two the breakdown occurred in their second pregnancy, and in one during the third.

All seven patients survived mitral valvotomy and all went to term. Only one required to be sectioned and sterilised, and this occurred fairly early in the series. In view of the success of the mitral valvotomy one believes that perhaps the obstetrician had been rather too radical in her treatment at the time of delivery by performing a section operation and sterilisation.

A characteristic feature of these cases operated on during pregnancy was the rapid deterioration which occurred from the third month of pregnancy onwards. Two patients developed pulmonary oedema, and one developed a transient hemiplegia during the third month.

The attitude adopted in regard to valvotomy during pregnancy depended on the amount of deterioration occurring during the early weeks. Naturally one was asked to see only those cases which were deteriorating; thus, in consequence, all the cases seen during early pregnancy were in difficulties and were operated upon. Several patients were seen during the seventh month, but none were operated on. The explanation for this was twofold. It was felt that towards the end of the seventh month a stabilisation of the circulatory load on the mother could be expected and it was hoped that improvement, or at least no further increase in her symptoms would occur till term was reached. According to information available, no case suffered as a result of this conservative approach, and several of these cases were subsequently submitted to valvotomy some months after delivery. The other, and perhaps less sound, reason for this refusal to operate on these patients was the feeling that one was endangering what amounted to two lives instead of one.

PHYSICAL EXAMINATION.

My approach to physical examination in the earlier cases was of necessity somewhat sketchy, untutored and largely dependent on the skill and knowledge of the cardiologist, for now I was looking for signs occurring in a system about which I had forgotten much, a system which for long I had taken more or less for granted. In consequence, the recorded detail and the accuracy of physical examination in the earlier cases has left much to be desired. As in all things in medicine and surgery, experience became more mature as the series of cases grew in number. The surgeon experienced in valvotomy by correlating the operative findings with the physical signs in previous cases will be able to judge even better than the cardiologist what his index finger will find at operation in future cases.

As in other new operative ventures of this kind, surgeons are unanimous in their wish that they could do the first 50 cases over again, believing that now they would obtain a much better valvotomy. So it is in giving an account of the physical findings in the earlier cases.

Peripheral Cyanosis and Peripheral Pulse.

Peripheral cyanosis in the face and hands was fairly common, and was most frequent in Grade IV cases. In common with Goodwin et al (1955), the peripheral pulse was not found to be of much value in assessing the size of the mitral orifice and, in fact, with increase in experience of these cases, the tendency was rather to ignore the pulse volume as a sign of any real value. Twenty-two patients had established auricular fibrillation.

Auricular Fibrillation.

This series of cases demonstrates that auricular fibrillation increases with age. Fourteen of the patients with fibrillation were over 35; 9 out of 20 cases over 40 were fibrillating. Auricular fibrillation also tended to occur in those patients with large hearts. I am of the opinion that the possibility of the onset of this complication, with the ever present risk of embolism and the likelihood of a more difficult and hazardous operation, should be regarded as one very important factor in deciding between early operation or a wait and see policy. Fourteen of the 22 cases with auricular fibrillation had naked eye evidence of thrombus; three of these patients had ball thrombi and a fourth had much free clot within the atrium. Twenty-four patients with normal rhythm also had organised thrombus, but only one had a ball thrombus. The importance of the complication of auricular fibrillation is best summed up in the words of Baker et al (1950) "the presence of fibrillation is not so much a contra-indication to operation as an indication that the optimum time has passed".

Inspection and Palpation.

Much has been written on the value of inspection and palpation in this condition. It is therefore sufficient to stress the confirmation in diagnosis of finding a visible right ventricle thrust in the third and fourth left interspaces and frequently also in the epigastrium. These findings, confirmed by palpation, indicate right ventricular hypertrophy. When the right ventricle enlarges it does so by pushing the apex to the left, i.e. the right ventricular hypertrophy overlies and overcomes, as far as palpation is concerned, the left ventricular impulse. In consequence, the palpating hand feels the diffuse impulse of the right ventricle medial to the apex beat, and on occasions this impulse is more prominent than the apex beat itself. There is no longer felt the closed fist impulse of a normal left ventricle; instead the palpating hand feels the more diffuse slapping hand effect of the right ventricle. Further the right ventricular hypertrophy has the effect of converting the apex beat from the normal blow from a closed fist into a tap. These findings originally stressed by Sellors et al (1953) have been found of considerable value. Palpation over the pulmonic area is also of importance, for when the second pulmonic sound is accentuated, the result of pulmonary hypertension, a diastolic shock will be felt over this area. Palpation is of additional value in detecting the presence or absence of thrills, but the tendency has been to depend more on the auscultation of murmurs rather than on palpation for thrills.

Auscultation.

The difficulties associated with the interpretation of auscultatory findings.

It was in the sphere of auscultatory findings that the greatest difficulty arose in the assessment of the earlier cases in this series. One had forgotten, or had never heard of some of the important signs in the diagnosis of mitral stenosis; while the cardiologists themselves were discovering new signs, such as the "closing" and "opening snaps", they were also having some of their time-honoured conceptions corrected by the surgeon's exploring finger.

This, then, was perhaps a good time at which to relearn the mysteries of heart sounds and associated murmurs. A good time because one was learning the correct interpretation of these findings, and also because one had the opportunity later to confirm many of them at operation. Even more important, it gave one a sympathetic understanding of the student's difficulties in similar circumstances, the difficulty of timing the first heart sound in a rapid heart action as in a rapid fibrillation, and in consequence the resultant difficulty in placing the murmurs correctly.

Summary of Physical Findings in Tight Mitral Stenosis.

Many papers have been written giving an account of the findings to be expected in a case with tight mitral stenosis and it is unnecessary to quote these papers, as the facts are now well known. Cases of mitral stenosis will show enlargement of the right ventricle as evidenced by a cardiac thrust felt in the third and fourth left interspaces, just to the left of the sternum and sometimes in the left epigastrium. The anterior overriding, as it were, of the right ventricle over the left tends to push the apex to the left and to cause the apical impulse to become tapping in character. Palpation may also reveal the presence of a presystolic and/or a diastolic thrill at the apex, with a diastolic shock at the base due to the pulmonic valve closing against considerably increased pressure.

Undoubtedly the most important and the most helpful findings to the practical clinician are those obtained on auscultation. A short, sharp, slapping first sound, which is best heard with the patient lying on his left side, is perhaps the most important sign of all and so long as the first sound has this character serious mitral incompetence and a hopelessly rigid valve are unlikely to be found. Indeed Sellors et al (1953) go so far as to say that in the presence of such a first sound a systolic murmur may be ignored; a statement which I have found to be correct. Further, I believe that experience can teach me to assess with a fair degree of accuracy from the character of the first sound just how tightly stenosed the valve will be. The presence of an opening snap, best heard just internal to or above the apex beat, is further evidence of a valve favourable for operation in that the opening snap indicates a diaphragmatic valve which is still usually thin enough to split with the finger alone. It is also of negative value in that its presence precludes the finding of predominant mitral regurgitation and it is unlikely to be heard when there is a heavily calcified valve (Mounsey 1953; Wynn 1953). The fact that there is a presystolic and a loud rumbling diastolic murmur constitutes reliable evidence of considerable mitral stenosis, particularly when accompanied by a loud sharp first sound and associated with an opening snap. Where these murmurs are present, but the first sound is less abrupt and softer than usual, and in the absence of an opening snap, a fair degree of stenosis may be found but the valve need not necessarily be operable; in fact, it is quite likely to be rigid, even calcified, and it may well be funnel shaped. Conversely the absence of an impressive diastolic murmur does not exclude severe stenosis; indeed Levine & Love (1952) have drawn attention to the occasional absence of all diastolic murmurs for, if there is active pulmonary vasoconstriction, the rate of blood flow through the valve may be held back to such an extent as to prevent the occurrence of an audible diastolic murmur. No such case was operated on in this series.

As already indicated a systolic murmur can usually be ignored in the presence of a slapping short first sound which is followed by a second sound and an opening snap, provided there is no enlargement of the left ventricle (assessment of which must be made against the presence of aortic incompetence). Where, however, the first sound is less accentuated than is usually the case in stenosis, or where the first sound is replaced in part at least by the systolic murmur (especially if the murmur is harsh in character) one should suspect a considerable degree of incompetence, particularly if the left ventricle shows hypertrophy and aortic incompetence is not a feature. Wood (1954) stresses the important distinguishing finding of left instead of right ventricular thrust in these cases.

I have not found the presence or absence of a presystolic murmur of importance. A presystolic murmur was recorded in 72% of cases, while 38% had an opening snap. This latter figure is probably low for in 1951 when this series began the importance of an opening snap was not fully appreciated.

Other Valve Involvement.

Involvement of another valve in addition to the mitral valve was suspected in 26% of cases operated on. As one would expect, in the vast majority the valve involved was the aortic valve, but in 4 cases the tricuspid was under suspicion.

Ancillary Methods of Investigation.

Of the ancillary methods of investigation perhaps the most important is X-ray screening. In the right oblique view the barium swallow reveals the backward bulge of the enlarged left atrium, while in the postero-anterior view the enlarged left atrium is frequently seen as a dense rounded shadow superimposed on the shadow of the right ventricle. If the rheumatic infection has occurred in childhood, the aortic arch will be hypoplastic and lying well below the clavicle. The characteristic appearances of pulmonary arterial enlargement and pulmonary congestion are also a feature.

Electrocardiographic findings of value were a widened P wave of normal or slightly increased voltage. It was usually notched, bifid or flat topped. Right ventricular preponderance was found to be an additional feature in favour of valvotomy.

Cardiac catheterisation was not carried out as a routine and was, in fact, rarely used and then only in cases of doubtful assessment.

PRE-OPERATIVE PREPARATION.

The assessment for suitability for operation in the earlier cases of the series largely resulted from the opinion of the cardiologist in charge of the case. It could not have been otherwise! As experience was gained with each patient operated on, surgical confidence was advanced to the stage when an equal responsibility was reached between the cardiologist and the surgeon in the decision whether to operate or not. With still further experience it would be correct to say that the surgeon is now better able to make the decision in the borderline cases. Were this not so, it would suggest that the surgeon had so far only acted as a carpenter rather than as an index finger with a brain behind it! Once the decision had been reached that a case was suitable for surgery, a routine procedure was set in motion. The possibility of continuing rheumatic activity by carrying out the erythrocyte sedimentation rate and three blood cultures had already been ruled out by the physician.

As this series of cases was operated on by a surgeon trained in thoracic surgery, it is understandable that all patients were given at least one week of intensive physiotherapy before operation. The object of this preliminary physiotherapy was varied. I firmly believe that it is to the patient's great advantage to have the individual attention of a good physiotherapist, someone whom they come to know and in whom they can confide their problems and their fears. I would go so far as to say that a competent and understanding physiotherapist can boost the patient's recovery by 25%. The tasks of the physiotherapist are to regain full lung expansion and all that this entails, and to prevent deformity developing as the result of failure on the patient's part to undertake movement in spite of pain in the early post-operative days. The former is achieved first by teaching the patient to breathe correctly using the diaphragm. It is surprising to find so many people often of excellent physique who do not know how to breathe properly. Once the correct art of breathing has been mastered, the patient is then taught to breathe with particular attention to the use of the left lung, and especially the left lower lobe, by concentrating on pushing away the physiotherapist's hand placed over the left side of the chest. An understanding of respiratory physiology will, however, make one appreciate that these expansion exercises are insufficient, for sputum will have accumulated with the temporary collapse of the left lung inherent in the performance of the operation. If this sputum is not expectorated, it will tend to accumulate in the bronchi. The bronchus will become blocked and this in turn will lead to absorption of air in the alveoli distal to the blockage and thus further inhibit re-expansion. Therefore it is vital that the correct method of expectoration should already be known to, and practised by the patient. In consequence, he is taught how to "chase" the sputum by several half-strength coughing efforts. These efforts loosen the sputum, and are climaxed by a full-strength coughing effort, the wound being supported by the physiotherapist's hands. These efforts are supplemented by some general exercises designed to mobilise the patient in bed quite soon after his operation. The patient, when fully conscious and usually about four hours post-operatively, is sat up in bed and carries out these "chasing" and coughing exercises with which he is now well familiar.

It is as well to accustom the patient before operation to the method of oxygen therapy to be used in the first post-operative hours. In this series of cases a B.L.B. oxygen mask or a nasal catheter were the routine methods of oxygen administration. If it is intended to place the patient in an oxygen tent immediately on return from the theatre, it is a wise precaution to put him into a tent beforehand to familiarise him with the surroundings he will find himself in on awakening from the anaesthetic. If this precaution is omitted, he may well panic on regaining consciousness when he finds himself shut in.

With very few exceptions the patients in this series were not placed in an oxygen tent; when it was employed it tended to indicate that the operation had gone badly and that the patient was in poor condition.

I believe that an oxygen tent is unnecessary; therefore I think the use of an oxygen tent is undesirable. It is undesirable in principle, for any superfluous measures in surgery generally carry an additional risk, and so it is in the use of an oxygen tent, the risk that the oxygen supply may fail and the failure remain unrecognised; further there is no provision in an oxygen tent for CO_2 absorption.

All cases were given a pre-operative test dose of quinidine and mersalyl or neptal. Because of the frequent occurrence of auricular fibrillation in the post-operative phase, it is well to know before operation that the patient is not sensitive to quinidine. A test dose of mersalyl or neptal was given as in the later cases of this series it was realised that a diuretic, given twice a week in the post-operative phase, considerably reduced the amount of sputum that the patient required to expectorate.

BLOOD REPLACEMENT.

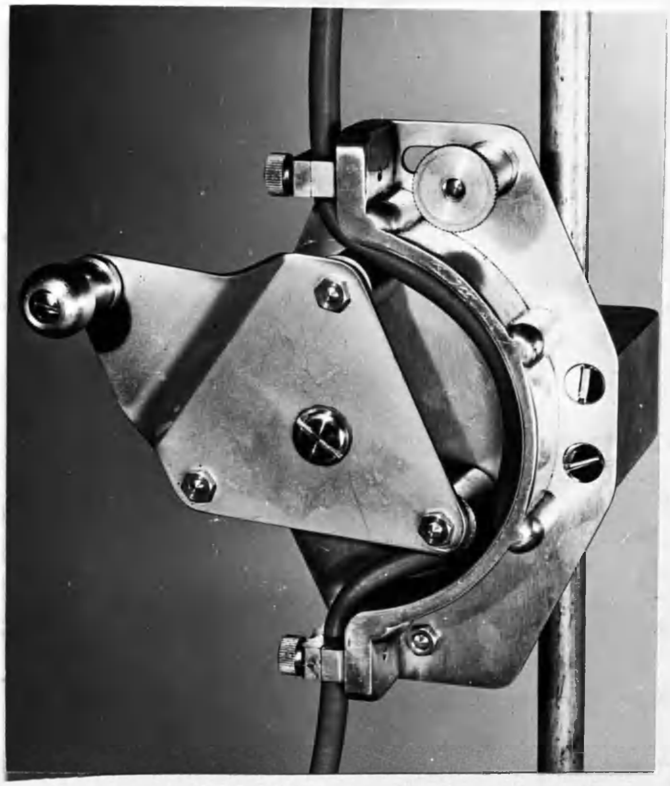
To attempt an operation on the heart of the magnitude of mitral valvotomy without having a minimum of four pints of appropriately grouped and matched blood in the theatre precincts is to court disaster. However skilled the operator and however fortunate he has been in previous cases, a day will come when he will want blood, will want it badly and in a hurry. Warning of the possibility of blood loss can frequently be foreseen before intracardiac manipulations have been started from the finding of technical difficulties, such as an unsuitable appendage. Appropriate measures can and should be taken to meet this danger. But dangerous, even disastrous haemorrhage may occur in the course of trying to split a particularly resistant posterior commissure if the operator's finger "buckles up" and a tear of the atrial wall results (Case No.20), or a Brock's knife may slip and cause a cut to occur in the heart wall, or too energetic use of the knife blade on the anterior commissure may push the knife through the ventricle wall at the A-V ring. It is too late when this happens to send for blood from a blood bank several storeys away or many streets distant.

The technique adopted in the cases in this series varied from hospital to hospital in which the cases were operated on, and it depended to some extent on the experience and skill of the available assistance. The most suitable arrangement, when circumstances permitted, was to have a cannula inserted into the right saphenous vein just above the ankle, immediately prior to the patient going to the operating theatre. When the patient was placed in the right lateral position on the operating table care was taken to see that the left leg was not pressing on the right. A solution of glucose saline was run in slowly until the operation started, when the glucose saline was replaced by blood. By delaying the commencement of intravenous fluids to immediately before the start of the operation, one avoided any likelihood of overloading the heart and lungs.

If, on opening the pericardium, a small or unsuitable appendage was found, a second intravenous set was used to deliver blood into a vein on the back of the left forearm. This site was very convenient, for with the patient in the right lateral position the left arm and forearm lie naturally flexed across the front of the upper chest and a few inches in front of his face, suitably placed for the anaesthetist whose duty it became to set up this second "drip".

A further wise precaution is to have a third delivery set and a bottle of blood immediately available, to be handed to the surgeon for delivery of blood into the left ventricle or into the aorta proximal to an occlusion clamp. This would only be required where massive haemorrhage had occurred, and the heart was more or less flaccid and empty of blood. It is, however, a safety measure which could mean the difference between life and death; providing, as it does, a means of maintaining the coronary artery and cerebral blood flow immediately the haemorrhage has been controlled.

I always insist that a Martin's accelerator pump is not only available in the theatre, but is attached to the delivery set ready for immediate use. The pump is a very valuable adjunct to have available in operations in which sudden loss of large amounts of blood may occur with alarming rapidity. It has a simple mechanism. The instrument is clamped on to the delivery stand and the rubber tubing of the delivery set below the drip chamber is threaded through the pump. The pump has a rotating device of three rollers which revolve on turning the handle, and which rotate in such a manner as to compress the rubber tubing and thus milk the contained blood towards the patient (Fig. Nos. I & II). A pint of blood can be pumped into the patient in 2-3 minutes. It is the author's impression that the existence of the Martin's pump is not sufficiently well known. It would be invaluable in circumstances in which sudden loss of blood is likely to occur, conditions such as pre- and post-partum haemorrhage. I have demonstrated its value in the resuscitation of a patient admitted with severe blood loss. The usual attempts at intravenous blood replacement were proving futile on account of the collapsed condition of his veins. The patient, from being unconscious, sat up and asked what had



I.

II.

Fig No.I: Martin's accelerator blood transfusion pump. Two of the three "rollers" can be seen.

Fig No.II: Rotation of the pump handle causes the "rollers" to compress the rubber tubing and thus drives the blood towards the patient.
The pump is capable of delivering one pint of blood in 2-3 minutes.

happened to him following the infusion of 500 c.c. of blood given rapidly with the aid of the Martin's pump.

If blood loss round the finger during valvotomy has been rather more than usual, it has become customary to apply a few turns to the pump handle and replace the blood loss. Further, if the heart has flagged and is a little flaccid after the intracardiac manipulations, one can immediately regain lost ground by the rapid delivery of the amount of blood lost during the manipulations. It is then possible to release the clamp on the appendage and allow blood to escape, and thus flush out any clot that has formed during the operation or any fragments of thrombus or calcium that have been released. Without this preliminary boost of blood it would be dangerous in some cases to empty the heart further in this way. The blood lost in flushing out the atrium can be replaced by further pumping.

The Importance of Blood Replacement in time and measure with Blood Loss.

During this series of cases some experimental work was carried out in conjunction with R. Murdoch. At that time he was studying the changes in blood sugar levels in haemorrhagic shock of pregnancy and associated conditions. Murdoch (1953 & 1954) had already shown in his own researches that the type of anaesthesia used in these operations, namely Pentothal, Gas Oxygen, Curare and Pethidine, had no adverse effect on the blood sugar level, whereas ether anaesthesia or intentionally induced phases of hypoxia under gas and oxygen anaesthesia produced a marked rise in blood sugar; further he showed that this rise occurred much more quickly than it does in shock from haemorrhage (30 minutes). In ether anaesthesia it occurred in 15 minutes, and in hypoxia under gas and oxygen anaesthesia only 5 minutes was required before changes occurred.

Five cases in this series were studied in respect of the change in blood sugar levels in a peripheral vein at different stages in the operation with the object of comparing these levels with those obtained in cases in which blood was not replaced as loss occurred (Table No.VI).

TABLE NO. VI.

Blood Sugar Levels during Valvotomy with Continuous Blood Replacement.

Case	1st Blood Sample Pre-anaesthetic			2nd Blood Sample On Opening the Heart				3rd Blood Sample Post-Anaesthetic		
	B.P.	Pulse	Venous Blood Sugar	B.P.	Pulse	Venous Blood	Heart Blood	B.P.	Pulse	Venous Blood
A	120/60	84	86	110/60	88	78	89	110/60	92	107
B	120/80	96	105	120/80	92	111	119	115/70	98	165[A]
C	120/70	74	78	120/70	90	87	94	120/70	88	109
D	100/60	140	200[B]	90/50	120	158	162	85/50	108	113
E	135/80	84	91	115/65	100	90	94	120/70	88	110

A Rapid blood loss

B Difficulty in setting up intravenous drip.

From Table No. VI it will be seen that there was little change between the Values of samples 1 and 2 in spite of anaesthesia lasting an average of 40 minutes plus the effect of a thoracotomy. It will be noted, however, that Case D started with a pulse rate of 140 and a blood sugar of 200. The reason for these abnormal figures was the result of persistent, but well meant, attempts by an unfortunate house surgeon to set up an intravenous transfusion during the course of one hour. When the patient reached the operating theatre, she was in a state of shock and the operation was very nearly cancelled. As can be seen her condition steadily improved throughout the induction of the anaesthetic and the course of the operation, and on return to the ward her condition was much improved. If Case D is excluded, it will be seen that only Case B shows any appreciable rise at the end of the operation of 60 mg., and this was accounted for by profuse momentary haemorrhage when brief loss of control of the atrial appendage occurred.

If these cases are compared with the series of Wertheim's operation by Murdoch (1954) Table No.VII, it will be seen that the glucose level in Murdoch's cases is greatly in excess of that in the valvotomy cases. The explanation would appear to lie in the fact that blood loss in the valvotomy series was made good from the start of the operation whereas in most of the Wertheim cases blood loss was only replaced once it had occurred.

TABLE NO. VII.

Wertheim Operations in which Blood was Replaced after Loss Occurred (Murdoch).

Case	Operation Time	Venous Blood Samples Throughout Operation					Highest % Rise	Transfusion started
1	$2\frac{1}{2}$ hrs.	157	204	224	288	314	100	at 224 when bleeding most severely.
2	$1\frac{1}{2}$ "	110		131		217	98	110 after operation started.
3	$2\frac{1}{3}$ "	98	114	135		170	73	at 135.
4	$1\frac{3}{4}$ "	139	139	179	183	176	31	not required.

From these findings of greatly elevated blood sugar recordings following blood loss which is not immediately replaced, it would seem obvious, if shock is to be minimised or prevented, that blood replacement should be instituted as blood is lost and should not be delayed until the patient becomes shocked. This statement is axiomatic to any cardiac surgeon, for not only must preparations be in hand for shock developing during the operation, but these preparations must already be in action to counteract any unexpected severe and uncontrollable haemorrhage.

In the course of these investigations an interesting observation was made which we have not found previously published, namely that 7% to 10% of glucose in the blood is utilised in the lungs (See Table No.VIII).

TABLE NO. VIII.

Blood Sugar Levels in Mitral Valvotomy Operations.

Case	Pulmonary Artery	Aorta	Peripheral Vein.
F	144	129	131
G	162	141	122
H	149	140	135
I	192	183	179

A further investigation along similar lines has been carried out subsequent to this series of cases. The above findings have been confirmed, the investigation has been amplified and the results will be published shortly by R. Murdoch, A.D.T. Govan and the Author.

ANAESTHESIA for the OPERATION of MITRAL VALVOTOMY.

This aspect was left entirely in the hands of the anaesthetist. It is right and proper that the author should pay tribute to the anaesthetists at this stage. He has indeed been most fortunate in the people who took charge of the anaesthetics, and he can truthfully say that only in Case No.10 did he have even the least anxiety due to the anaesthetic. The premedication was usually Omnopon gr.$\frac{1}{3}$ and Atropine gr.1/100. Some of the more recent cases have had in addition 25 mg. of largactil, both to alleviate the patient's anxiety and to prolong the action of the premedication. Anaesthesia has generally been induced by intravenous pentothal and curare and when the trachea is intubated the anaesthetic then continues with gas and oxygen, supplemented by curare and pethidine as required. Once the chest was opened and the heart had been exposed, I tested the irritability of the heart by putting a finger on its surface. If several extrasystoles occurred, the anaesthetist was informed and 100 mg. of procaine amide was given provided the heart rate was not below 70. This dose of procaine amide was generally sufficient, but on occasions a second dose was required. If the heart flagged or the blood pressure fell below 75 mm.Hg. during the intracardiac manipulations 3-4 mg. intravenous methedrine was given. Towards the conclusion of the operation and when the chest was being closed, 2.5 mg. prostigmin, preceded by atropine gr.1/100 to prevent the side effects of prostigmin, was given to counteract the curare action.

DIATHERMY.

It is my opinion that the use of diathermy in all chest operations is invaluable; particularly is this so if there is only one assistant - many of these operations were carried out with this minimum of available assistance. Once the subcutaneous tissues were reached, diathermy was used and the knife was discarded. The muscles were divided by diathermy and bleeding points were picked up by dissecting forceps and touched with diathermy. In this way the bleeding points were much more rapidly controlled than by individual ligation, and the chest was opened in 10-15 minutes. One has seen a dexterous surgeon such as Logan in Edinburgh enter the chest equally rapidly ligating the bleeding points with linen thread, but having the help of two assistants and two theatre sisters, all working as a well-trained team. Diathermy has the advantage of giving control of bleeding from inaccessible situations, such as bleeding points deep to cut rib ends or oozing from flat surfaces. It is very useful to control the "weeping" that occurs from the chest wall when the lung has been extensively adherent to it. I have employed diathermy in chest operations for over twelve years, in performing many hundred lung resections and in over one thousand thoracoplasties, and I have never had occasion to regret its use; indeed, I have been frequently thankful for it to control widespread oozing unsuitable for control by forceps and ligation.

One cannot devote too much care to the application of the diathermy earth electrode, for electrical appliances in operating theatres are notoriously fickle and the earthing mechanism of many operating theatres is suspect. A little carelessness may result in the diathermy "failing" in the middle of the operation and, worse still, may result in the patient being burned. In later convalescence the patients are apt to wonder why, when they have had an operation on their heart, stitches are being removed from their buttock!

A thick gauze bag of sufficient size to cover completely the diathermy earth plate and attached terminal was wrung out of saline solution and fitted over the pad. The pad was then placed either between the sacrum and "chest rest", used as a sacral support, or on the medial aspect of the right thigh; in either position the plate lies snugly and is completely out of harm's way.

The Position on the Operating Table.

The earlier cases in the series were operated on through a left antero-lateral incision, and to do so the patient was placed in the right semi-lateral position supported by a "chest" rest placed against the sacrum and a sand bag behind the upper chest. This position was retained by fixing the patient to the operating table by a lightly placed strip of 2" adhesive strapping across the left hip region, adequately protected by clothing, and fixed beneath the operating table at each end. A second band of strapping was quite loosely applied over the calves in order to obviate any danger of calf vein compression. The table was then jack-knifed by 40° to an angle of 140° and in those operating theatres with a thoracic surgery operating table, an additional lowering of the head end was added. Both of these manoeuvres are routine in operations of lung surgery, and the aim is to allow any secretion released on handling the lung to gravitate into the stem bronchus and up the trachea, rather than across the carina and down the right side where it will be less accessible to suction. In this position the chest was opened in these earlier cases by resecting the 5th rib from the posterior axillary line to the costal cartilages.

Experience soon proved, however, that this method of approach was not ideal. The relatively short incision obtained by it allowed only limited retraction of the ribs and, in consequence, the closed fist position of the surgeon's hand while carrying out the intracardiac part of the operation was sometimes impeded and hindered in its movements. Further, in those cases in which the auricular appendage was found to be unsuitable on account of size or thrombosis, the use of the Rumel's cardiac snare was made more difficult, for in this position very little of the left atrium is revealed and what there is tends to be partly obscured by the circular branch of the coronary artery, as it runs between the left atrium and left ventricle.

One final reason for dissatisfaction with this approach arises when the disaster of haemorrhage overtakes the surgeon. His efforts to find the tear in the atrial wall are greatly hampered by lack of room in which to work and by the greater depth in the wound of the left atrium.

The later cases, including the majority in this series, have been operated on with the patient in the true right lateral position, that is with the left side of the chest completely exposed. This position is maintained by placing the "chest rest", which is fixed by an adjustable bracket to the side of the operating table, at the back of the sacrum. The 2" band of adhesive strapping is fixed to the under-surface of the table at the front of the patient, and is brought up and over the patient and "chest rest" and passed underneath the table surface at the patient's back, where it is fixed to the table. It will be impossible for the patient's position to alter, if this method of fixation is properly carried out, and the irritation caused by the patient rolling on to his front or back will be avoided. Once the patient's legs are strapped to the table the jack-knife position with a slightly head-down angulation can be completed without fear of the patient slipping off the table.

THE OPERATION.

With the patient placed in the right lateral position the skin incision is started just lateral to the left sternal border, at the level of the fifth costal cartilage, passing just under the breast and running across the lateral aspect of the chest a good three inches below the angle of the scapula; on reaching the lateral border of the erector spinae, it curves proximally for about four inches ending about one inch from the spinous processes. When the skin had been incised with the knife, diathermy was used for all further cutting. The fibres of pectoralis major arising from the fifth rib were divided, and care was taken to cut lattissimus dorsi as low as possible and fully three inches below the angle of the scapula. Low division of latissimus dorsi prevents the possibility of weakness of the shoulder movements at a later date. The lower fibres of trapezius were divided in the length of the wound. This enabled the operator's left hand to be passed up under the scapula, and, by lifting anteriorly with this hand, the fibres of pectoralis major and minor passing to the fourth rib were held on the stretch and divided close to the lower border of the fourth rib. The fourth rib is easily identified, for when the fingers of the left hand pass up beneath the scapula their further upward progress is prevented by the first digitation of serratus anterior, as it takes origin from the second rib. This method of identifying the fourth rib is more certain, and in stout patients is considerably easier than trying to count the ribs from below the manubrium sterni which in a patient draped for operation can be a quite uncertain procedure. The reason for incising along the lower border of the fourth rib, instead of clearing the entire outer aspect of the rib, is to simplify the closure of the chest at the conclusion of the operation; any remnants of the pectoralis muscles attached to the rib give additional material to hold the stitches. It can be quite difficult, and sometimes impossible, to get air-tight closure of the chest in the operation of mitral valvotomy, particularly at the anterior end of the wound, where the immobility of the costal cartilages prevents approximation of the tissues.

The incision along the lower edge of the fourth rib enables the periosteum to be stripped off the under aspect of the rib starting anteriorly, and in this way the periosteal elevator runs easily into the acute angle of the fourth intercostal muscle as it runs upwards and laterally from the upper aspect of the fifth rib to the under aspect of the fourth. A flat periosteum elevator is then passed deep to the inner aspect of the fourth costal cartilage about one inch from the costo-chondral junction, and the cartilage is cut with a scalpel against this guard. The access is greatly increased if the posterior end of the fourth rib is disarticulated from the tip of the vertebral transverse process by means of a rib disarticulator. Not only is the access greatly increased by disarticulating the rib in this way, but the danger of rib fracture occurring with too enthusiastic retraction is avoided. The pleura is incised along the bed of the fourth rib. (Some surgeons enter the chest through the bed of the fifth rib or the fifth intercostal space. This lower approach will be necessary if a transventricular attack is to be made on the mitral valve. Logan 1957). Whether bleeding occurs from the intercostal vessels or not, the third and fourth intercostal vessels are picked up anteriorly and the fourth posteriorly and coagulated with diathermy. If the lung was adherent to the anterior or lateral chest wall or the pericardium, it was gently freed over as wide an area as necessary to expose the entire pericardium in front of the lung hilum and to allow of widespread deflation of the lung. The Ronald Edwards modification of the Finochietti rib spreader was now inserted and opened up. Before proceeding further all frankly bleeding points and all oozing areas were either picked up and coagulated, or the nose of a long curved pressure forceps was laid against those areas which had insufficient tissue available to allow of their being picked up; the diathermy electrode was then applied to the forceps, which was moved slowly backwards and forwards over the oozing area until satisfactory coagulation had occurred and the bleeding had ceased. Naturally no such direct pressure coagulation was applied to the pericardium, as cardiac irregularity immediately occurs. There are always several bleeding points on the cut edge of the pericardium and these require to be clamped with forceps. While the forceps is held away from the heart diathermy can be safely used.

The lung was deflated and held displaced in the paravertebral gutter by a moist saline pack. When an antero-lateral incision was used in the earlier cases of the series, the pericardium was generally most conveniently opened in front of the phrenic nerve. On occasions this comparatively anterior opening of the pericardium did give a rather restricted view of the auricular appendage. The true lateral approach allowed the pericardium to be opened routinely posterior to the phrenic nerve with a consequently greatly improved view of the left atrium and the appendage. The incision in the pericardium extended from the level of the middle of the pulmonary artery above, vertically downwards, and curving well posteriorly behind the heart in the last one and a half inches. The posterior curve of the incision at its lower end was left partly open after the operation and was ideally placed to give dependent drainage; further, the apex of the heart cannot herniate through this wound, as it can if the opening is continued vertically downwards to the diaphragm. Such herniation during the operation causes cardiac irregularity, usually extrasystoles. If herniation occurs in the post-operative phase, the apex may become strangled and asystole quickly occurs, as has been reported following radical pneumonectomy operations for cancer in which a small window of pericardium has been removed to allow of intra-pericardial ligation of the vessels.

Better exposure of the heart can be achieved if the right edge of the pericardial opening is stitched to the inner aspect of the chest wall just lateral to the sternum. This stitch must not be drawn so tight as to cause constriction of the heart by the pericardial edge as it runs obliquely across the anterior surface of the heart. This method gives a considerably better view of the heart than does the series of stitches along the pericardial edge, each stitch being held in forceps and slung over the side of the wound. If the posterior edge of the opening in the pericardium is just in front of the entry of the pulmonary veins into the left atrium, this edge will lie snugly out of the way and will not require stitches to hold it back.

Once the pericardium is opened and held back the heart is inspected. The size of the atrial appendage, the atrium, the ventricles and pulmonary artery are all noted. Generally speaking, mitral stenosis of moderate to severe degree has a moderately enlarged left atrium; on the other hand, the pulmonary artery, while it may be as much as 6 cm. in diameter, quite frequently is not enlarged. Instead it may show a well marked yellow appearance due to arteriosclerosis. The heart is now lightly palpated to test for cardiac irritability; if several extrasystoles occur the anaesthetist is advised that the heart is tending to be irritable, and 50 to 100 mg. of procaine amide are given with the twofold object of acting as a test dose in case more is required, and to control the irritability. In the vast majority of cases one dose of procaine amide is adequate; the immediate response of extrasystoles to finger touch disappears.

The heart is now palpated for thrills, and the appendage is felt to ascertain whether or not there is thrombus in its lumen. In the earlier cases of this series a routine procedure was to use a silk thread purse string suture at the base of the appendage. The reason for this step was the fear that uncontrollable bleeding might occur. With increase of experience it soon became apparent that this step was unnecessary and, in fact, that it might dislodge lightly adherent thrombus from the appendage wall. The procedure now adopted is to choose the appendage clamp with the curve most suitable for the size and shape of the appendage. If the appendage is long with a comparatively narrow neck the most curved clamp is used, whereas a shorter appendage with a broader base generally requires the clamp with less curvature and longer blades.

This clamp is laid ready to the operator's right hand. The appendage is picked up and a small cut is made into it at a point which is deemed to give most suitable access to the finger. This preliminary opening is made of sufficient size that a jet, rather than a trickle, of blood may escape. The opening in the appendage can be controlled to a large extent by the dissecting forceps which are holding up the appendage close to the opening. The scissors, with which the cut has been made, are exchanged for the previously chosen appendage clamp. Now the control of the opening is released, the gush of blood is allowed to escape and the appendage clamp is then applied proximal to the opening in the appendage wall. When free clot is present in the appendage, the gush of blood will be temporarily or completely arrested depending on the size of the clot. If clot is found, the clamp is not applied until all the clot has been washed out. This point will be dealt with in a later section. The escaping blood is sucked out by the assistant using a large bore suction tube with a wide nozzle.

The opening in the appendage is now enlarged until it is considered to be of sufficient size to allow the index finger to enter the appendage without restriction. It is very important that the opening should be just right, neither too big nor too small. The size of the opening necessary to achieve this is quickly appreciated after a few cases have been operated on. If too large a hole is made, quite profuse bleeding may occur around the finger, and as much as a pint or more of blood may be lost in the time necessary for the finger to remain in the appendage to complete the valvotomy. If the opening is too large, it is better to withdraw the finger, re-apply the clamp and insert a purse string suture around the base of the appendage and start again. If too small an opening is made, there is grave danger that in forceful attempts to split the commissures, particularly the anterior commissure, that the opening will increase in size in the line of pressure and this tear may well extend on to the atrial wall, producing what may prove to be disastrous haemorrhage. It is far better to make a planned opening than to allow this to happen (see Case No.39).

The index finger is lubricated with liquid paraffin and an assurance from the anaesthetist having been given that the patient's condition is satisfactory, the clamp is slowly released with the left hand and the finger is entered through the opening into the appendage. The gradual release of the clamp allows the appendage slowly to fill with blood; this balloons the appendage outwards and facilitates the entry of the finger. Should the finger find the opening in the appendage too tight or too wide, the clamp should be re-applied, the finger withdrawn, a re-assessment of the situation made and appropriate measures taken.

Once the finger has securely entered the appendage the clamp is removed, but left conveniently to hand in case it is required in a hurry. If the appendage contains thrombus, or if a ball thrombus is felt floating within the atrium, measures to deal with these complications will require to be taken. These measures will be dealt with in a later section.

The initial observation noted is the behaviour of the heart in response to the insult of a finger within its lumen. In the vast majority of cases the finger is well tolerated and little, if any, upset of the rhythm or of the character of the heart's action occurs. Should the heart prove unduly restive, further procaine amide is given; generally, such irritability only occurs when the finger enters the mitral valve and even then surprisingly infrequently. Next, note is taken of the width of the

A-V ring. Since this observation has been made as a routine, it is surprising to find the A-V ring considerably reduced in size in so many patients with mitral stenosis; indeed, in some, usually those with funnel-shaped valves, it may be no more than 2.5 cm. in diameter. It is just possible that this narrowing of the A-V ring may be responsible for the fallacious clinical findings encountered in some cases. This seems particularly likely to occur in a funnel-shaped valve which is not tightly stenosed, and yet in which all the findings suggested a tight valvular stenosis which one expected would have a good commissure fusion and which would split readily.

The finger is now advanced into the atrium and the mitral valve is felt. A regurgitant jet of blood will be felt if there is incompetence of any degree, before the valve orifice is reached. In the great majority of cases the regurgitation emanates from the region of the posterior commissure or from just anterior to this point. The site of the regurgitation posteriorly accounts for its presence being noted, as the finger approaches the valve, for as the finger does so, it traverses the track that such a posteriorly placed reflux of blood must take.

If the exact size of the valve orifice is to be measured accurately, the approach to the valve proper must be gradual and very gentle. On several occasions, and particularly in earlier cases when one was unaware of the necessity of the "quiet" approach, a partial split of the valve occurred before the size of the orifice of the valve could be ascertained. The size of the valve orifice is noted, the mobility of the cusps is assessed, and the thickness of the commissures and the presence or absence of calcification is recorded. Funnel deformity of the valve becomes immediately apparent, as the finger requires to be inserted further to reach the valve.

Once the various assessments have been established, the forefinger is pushed into the valve lumen to test the possibilities of splitting. Generally speaking the consistency of the valve fusion gives a reliable impression of whether or not splitting will readily occur. This is not always so, however, as on occasions a densely fibrous commissure fusion may suddenly give way against a greater or lesser degree of finger pressure. The explanation for this happening must be in the type of fibrous tissue bridging the commissure, allied to the shape of the valve being such that pressure can be made against good resistance. This factor of good resistance is all important in commissurotomy. In general successful splitting of the valve is achieved when one commissure is more fused than the other (as a rule the anterior commissure is more fused) thus presenting a shelf of resistance to the operator's forefinger. When the posterior commissure is the more fused commissure, success in separating it with the finger is less certain, for it is much more difficult to exert pressure with any force on this commissure. While the anterior commissure can be attacked from its inferior aspect by passing the finger tip through the valve, the usual manner in which the split is completed out to the A-V ring at the anterior end, because of the position of the posterior commissure, this is quite impossible to achieve. Indeed if it were possible to attack the posterior commissure from below, it could not be carried out, as the surgeon's finger cannot be flexed against this commissure, and the split must be achieved by pressing downwards on the fused area, with the finger extended or hyperextended. This aspect of the operation will be discussed later under the heading of unsatisfactory factors in the operation (page 93).

Pressure against the commissures and occlusion of the entire valve lumen by the exploring finger must not be maintained for more than two to three beats at a time. If this advice is not followed, and occlusion of the blood flow is increased to several seconds by over enthusiastic manipulations, the dangers of cardiac anoxia will become very real and the attendant risk of coronary artery insufficiency with extrasystoles, cardiac arrest or ventricular fibrillation will most certainly be courted, and warning of these complications, if further warning be required, will be visible in the flagging cyanosed heart. Scrupulous attention to the need for brief attacks on the mitral valve with frequent rest periods probably accounts for the fact that asystole or ventricular fibrillation do not appear as complications in this series of cases (about the only complication that is not recorded!). After each attempt to split the commissures the finger is withdrawn into the atrium and lies against the posterior atrial wall, while blood flow through the valve is re-established and the heart action regains most of its original vigour and rhythm.

Every endeavour is made to split both anterior and posterior commissures out to the A-V ring. Frequently only partial success is achieved, for once one commissure is split in the nature of things resistance to pressure of the finger is lost, and the other commissure resists all attempts at more than partial splitting; somehow the valve becomes more mobile and further splitting more difficult.

If the heart action remains good and the appendage is satisfactory (not narrow necked), the operator may decide to withdraw his finger and after arming the finger with a Brock's posterior valvulotomy knife re-enter the left atrium.

After using Brock's anterior knife on a few occasions its use has been abandoned; probably the fault lies in my lack of skill, as I could never be quite certain where the knife part of the blade was and where the guarded part. With the posterior commissurotomy unguarded knife blade an attack may be made on any remaining posterior shelf. The difficulty in dividing the posterior commissure, particularly in the funnel-shaped valve, will be discussed later.

When the most complete split of anterior and posterior commissures possible has been achieved, the valve orifice is measured and its size is judged in relation to the index finger. In my cases if the forefinger could be passed into the valve orifice, but the finger was tightly gripped by the valve cusps, then the opening was adjudged to be just over 2 cm. If the finger lay freely in the valve opening it was assessed as being 2.5 cm.; free mobility of the finger backwards and forwards within the valve was considered to have provided an opening fully 3 cm. in length, and depending on the freedom of finger movement within the opening 3.5 cm. or rarely 4 cm.

In common with other surgeons accustomed to operating on stenosed mitral valves, I was more often disappointed than satisfied with the valve split I achieved. Further, again in common with other surgeons, I would like to have the opportunity of re-operating on the first 50 cases or more, in the belief that with experience and more determination these cases could, with few exceptions, have been given a better "split".

Finally, and before the finger is withdrawn from the left atrium, the development of incompetence the result of operative interference is felt for, or, if incompetence was previously present, whether it was now increased or decreased, due allowance being made for a poorer heart action and therefore presumably a reduction in volume of any regurgitant jet already present.

Before the finger is withdrawn from the appendage a wise precaution is to "suck" out any blood lying around the appendage, in order to obtain an unimpeded view of the base of the appendage, and thus become aware of any tear that has extended from the "planned" appendage incision down on to the atrial wall. In the nature of things such a tear will be much better controlled by flexing the terminal phalanx against it, while it is stitched with the operator's left hand or alternatively by the assistant. One cannot hope for or expect such a tear to be occluded by the appendage clamp unless the tear is very short; when it is very short it may be possible to pull on the appendage and draw this part of the atrial wall upwards to such an extent that it becomes feasible to occlude the tear with the clamp.

A wise precaution against the danger of embolism is to release the clamp and allow a gush of blood to escape before proceeding to stitch the appendage; in this way one hopes to wash out any fragments of clot or thrombus which may be circulating in the left atrium. Before releasing the clamp the operator knows from his continuous observations during the intracardiac manipulations the state of the heart; if it has flagged naturally it will be allowed to regain more vigorous contractions before this further insult is added. Further, if a moderate amount of blood has been lost during the intracardiac manipulations, the operator may wait for a few minutes until he thinks that the Martin's pump has forced a quantity of blood into the circulation sufficient to replace the loss. To the experienced surgeon the approximate amount of blood loss can be quickly assessed by observing the number of swabs on the swab rack and noting the amount of blood in the suction bottle, due allowance being made for the previously reckoned amount of saline used to wash out the appendage. It is desirable to wash out the appendage while the clamp is in place and before each insertion of the operator's finger into the appendage, if more than one expedition is made; the necessity for this step is apparent at every mitral valvotomy operation. Clot formation will be seen to occur in the appendage distal to the clamp during the brief time of a minute or two necessary to enlarge the opening to admit the finger. It will be recalled that the appendage has a small opening made in it to allow blood to escape before it is clamped at all, and it is following this clamping that the clotting occurs in the blood trapped in the appendage distal to the clamp. Any particle of this clot carried into the atrium by the finger and thence swept on through the mitral valve would be quite sufficient to cause a cerebral embolism sufficiently large to result in a hemiplegia.

Closure of the Appendage.

The appendage is closed by interrupted No.00 atraumatic silk thread stitches, each stitch overlapping its predecessor. It is desirable to place these stitches at the base of the appendage in order to avoid leaving any dead space within the appendage in which blood may stagnate and clot, thus becoming a potential site of post-operative embolism.

The ease with which the appendage bleeding is stopped by using this method of closure is a continuing source of surprise and relief. It is my custom once the appendage clamp has been released, to add a continuous mattress suture distal to this first layer of stitches. This suture line is used as an extra precaution against haemorrhage.

Unlike the practice of some other surgeons (Sellors 1956) the tip of the appendage is not excised until valvotomy has been completed, and haemostasis of the appendage wound is assured. The reason for leaving the appendage intact is based on the knowledge that it is still available if required as a homograft to cover over any tear in the atrial wall (Bailey 1951).

A final inspection of the appendage and its suture line is made to be quite certain that bleeding is completely arrested; if there is still a little leakage further mattress stitches are inserted, although haemostasis has usually been satisfactory and complete before insertion of the continuous suture. Any blood clot lying within the pericardial sac is sucked out, the most likely site for clot being in the transverse sinus.

Closure of the Pericardium.

The pericardium is closed only loosely. In the earlier cases it had been customary to close the pericardium securely with many stitches, but this tight closure has been blamed for some of the cases of auricular fibrillation and for the post-commissurotomy syndrome. Now the pericardium is only closed with a few stitches in order to allow any fluid accumulating to escape into the pleural cavity. It will be recalled that a further measure to this end was to make the incision in the pericardium deviate posteriorly at its lower end, this area being left open for about 1" to allow drainage to occur.

Any bleeding points in the cut edges of the pericardium not already controlled are coagulated with a brief touch of diathermy. While this is being done care is taken to hold the area away from the heart to prevent cardiac irregularity. Damage to the phrenic nerve should also be avoided.

Closure of the Thorax.

The anaesthetist is now asked to inflate the lungs by positive pressure on the anaesthetic bag. A suitable rest period between each inflation allows the heart to refill with blood.

The re-expansion of the left lung is observed closely, and areas of atelectasis are massaged and observed until re-expansion is definitely assured and complete.

At this point a portion of the lingula is excised for later histological examination. The biopsy tissue is taken to provide a means of assessing the state of the pulmonary vascular elements and to observe the presence or otherwise of pulmonary hypertension. While it has been appreciated for some years that a lingular biopsy is not a true representation of lung histology (Enticknap et al, 1954), it is nevertheless the most readily available portion of lung, and removal of a portion of lingula is less likely to cause difficulty with lung re-expansion later. The carrying out of any procedure disadvantageous to the well-being of the patient has always been regarded by me as being quite unjustified, and it is for this reason that lingular biopsy has been persisted with in preference to removing lung tissue from other areas.

To carry out the biopsy the tip of the lingula is held in a Duval lung forceps, and at an appropriate proximal level a running silk thread stitch is inserted. The portion of lung distal to the stitch is excised, and any obvious bleeding points are coagulated with diathermy before the running stitch is completed by retracing the original suture line to the initial point of suture commencement.

Once the biopsy of lung has been taken a further observation of the completeness of lung re-expansion is made, and if this is satisfactory the chest is cleared of blood and closed.

Satisfactory drainage of the chest is as vital in this operation as it is in any case of lung resection. In the earlier cases of this series a short drainage tube was inserted in the scapular line low down in the chest. Subsequent experience has shown that a drainage tube so placed is painful and tends to be leaned against, even if the tube is led away between two columns of supporting pillows. The consequent discomfort and pain experienced by the patient reduces by a very considerable margin his willingness to cough and his readiness to take full advantage of his breathing exercises. As a result this positioning of the drainage tube was found to be unsound.

In theory one would expect a drainage tube at the most dependent area of the chest to be most suitably placed to drain off all the accumulated fluid;

in practice, experience with segmental resections and lobectomies has shown that as the lung re-expands the lower chest is the first to be filled. As lung expansion increases the periphery of the lung rises up ~~to~~ the chest wall, and the level of any air and fluid present rises with it. In consequence, the apex of the pleural cavity is the last stronghold of fluid and air.

From experience it has been found that a polythene drainage tube long enough to reach the first interspace should be used. Three lateral openings of at least one and a half inches in length are made at different levels and on different aspects of the tube. The tube is inserted obliquely upwards through the lowest convenient interspace above the diaphragm and in the axillary line; it is directed upwards and posteriorly so that the top of the tube is near the necks of the second and third ribs but well clear of the subclavian vessels. This position is maintained by a catgut stitch which encircles the tube and holds it against the chest wall. By this means all levels of the chest are drained; further, when the tube is being removed it can be withdrawn slowly for several inches. In this way it is usual to obtain several more ounces of fluid. This may obviate the necessity for aspiration of the chest. Using this type of drainage tube has eliminated any difficulty in obtaining 100 per cent lung re-expansion.

in all cases. It should be mentioned, however, that in about 50 per cent of cases a trace of fluid may still remain within the chest, and one aspiration carried out at the time of tube withdrawal will make quite certain that the chest is dry and, in consequence, that pleural thickening with resultant diminution in lung function will not occur.

Closure of the chest wall is generally complete and air tight now that entry into the chest is made by mobilisation of the fourth rib, with division of the 4th costal cartilage and incision of the fourth rib bed. The divided ends of the costal cartilage are held together by a strong silk thread stitch inserted with a heavy cutting needle. The ribs are approximated using a running No.1 catgut stitch which picks up, on the one side, the fourth intercostal bundle and, on the other, the periosteum on the anterior aspect of the fourth rib. If the periosteum is very thin and does not hold the stitch, the third intercostal bundle may be used in place of the periosteum. Very little difficulty is encountered in obtaining complete closure of the chest wall if a Holmes Sellors rib approximator is used during the closure. An occasional supplementary stitch may be required.

The use of wire to approximate the costal cartilage is unnecessary and in my opinion unjustified. The pain and discomfort due to the wire in later months and years experienced by some of these patients makes the use of wire undesirable.

Once a few retaining muscle stitches of No.1 silk thread have been placed to strengthen the closure, the muscle layers are stitched with interrupted No.00 silk thread. Two layers of stitches are used, and as far as possible only the aponeurotic edges are sutured. From experience gleaned from re-opening thoracoplasty wounds a much neater result is obtained if the muscle fibres are not included. At the anterior end of the wound there may be insufficient aponeurotic layer and whole muscle stitches may be required. The skin is closed with interrupted mattress stitches.

The drainage tube is held in place by the ends of a mattress stitch used to close the stab wound around the tube; one end of the stitch is passed through the tube care being taken to use a round and not a cutting needle, for the latter is liable to leave a hole wider than the stitch diameter, and become a potential source of air leakage. In chest operations it has been apparent that transfixion of the tube by a stitch is necessary in order to avoid the periodic and annoying occurrence of the patient or his attendants pulling out the tube. For this to occur, as happened in a case of lobectomy, and not to be noticed at the time may have disastrous consequences. A second mattress stitch is inserted but left untied in readiness for tying when the tube is removed.

Twenty c.c. of fluid containing one million units of penicillin and 1 g. of streptomycin are injected into the tube close to its point of entry into the chest. The hole made by the needle will not leak air, if the needle is of fine bore and inserted obliquely through the tubing.

As small a dressing as possible is used, as in all chest operations, in order to avoid giving the patient the impression that he has been cut in half and must restrict his movement in bed. The patient is transferred from the operating table direct to his bed, and great care is taken to avoid jolting him in the process. Oxygen is given by a B.L.B. mask or by a nasal catheter. An oxygen tent is only used when the patient is in poor condition.

The wounds of mitral valvotomy operations, lying as they do along the line of the nerves, heal neatly. If one wishes to obtain the neatest skin wound possible, the skin stitches should be removed on the fourth day and H-shaped adhesive dressings, as supplied by Johnson & Johnson, should be used.

The drainage tube is removed rather according to convenience than according to a set timetable. The convenience depending on the presence of a reasonably senior member of the staff or the surgeon himself being available to remove the tube; in general the tube is removed in 48 to 72 hours. The cases operated on at Hairmyres Hospital always have an aspiration at the time of tube removal, and as the cases are operated on on a Friday afternoon the theatre is not routinely available until the Monday morning. It is my impression that lung re-expansion is better in these cases than in those in other hospitals, when no aspiration is done.

IMMEDIATE POST-OPERATIVE CARE.

The post-operative care in the first twelve hours is of vital importance. Following a successful, and at the same time, a not too difficult operation, the patient will generally be fit to be sat up after about four hours, the sitting up process being carried out in easy stages of one or two pillows at a time. A watchful eye is kept on the blood pressure which should rise to 110 mm. or 120 mm. systolic in one or two hours after the operation; thereafter the pressure frequently falls to 100 mm. or even 95 mm. systolic, at which point it may remain for a few hours before gradually climbing back to a more normal level for that patient. It is at this stage that many of these patients show evidence of what appears to be a vasomotor upset consisting of a low blood pressure, thin pulse and fairly profuse sweating. It is at this time that the careful surgeon knows confidently that haemostasis of the heart, the pericardium and the chest wall is complete, and therefore that this reaction need not cause undue anxiety, being only a phase in the post-operative convalescence.

The Care of the Drainage Tube.

To a nursing staff well drilled in the post-operative treatment of chest patients it becomes a sine qua non that the glass tube in the drainage bottle must show a fluctuation of several inches with each respiration. If this fluctuation is not present, the reason for its absence must be ascertained and must be corrected; in general, the explanation is easily found and is usually due either to the tube lying kinked in the bed, the patient sitting or lying on it or, and a common fault, the tube being too long and hanging down to the floor before turning back up to the top of the drainage bottle; when the tube is too long and hangs down below the bottle neck, fluid will accumulate in this loop of tubing and will very likely have insufficient pressure behind it to force it up the ascending limb of the loop to the top of the bottle. The fluid, which is mainly blood, will clot and all drainage will cease; in consequence, fluid will collect within the chest, preventing full lung re-expansion, sputum will be retained and atelectasis will inevitably follow.

The house surgeon responsible should be immediately called if the nursing staff are unable to find the cause of the absence of fluctuation of the fluid level in the drainage tube. If it is found that everything appears to be in order and milking of the tube has no effect, it is a useful measure to connect a Higginson's syringe to the airway tube of the drainage bottle, and by a few pumping movements extract air from the bottle; this negative pressure will be sufficient to re-establish drainage provided this step is not delayed for some hours.

The surgeon should visit the patient three of four hours after the operation, by which time the patient should be fully conscious and co-operative. He should confirm that sufficient blood has been given, usually two pints, and that drainage is taking place and is not excessive; it should be remembered that drainage will usually not commence until the patient is propped up. The amount of blood drained from the chest in the first twelve hours will depend, of course, on adequate care being spent on haemostasis during the operation, and on whether the lung has been adherent and has required to be stripped off the chest wall and pericardium. Depending on the operative conditions 8 to 25 ounces of drainage should not cause comment, but drainage much in excess of 25 ounces should be viewed with concern and steps should be taken to replace this loss by further transfusion of blood. If the operation has been performed with due care, such a step should rarely be needed and in this series has only been necessary in three cases; in no instance was re-operation for control of haemorrhage required. At this first post-operative visit the surgeon with assistance should gently sit the patient upright, and insist that he "chases" and coughs up any secretions lying free in his lung; the left chest and particularly the wound area should be supported during this procedure. Much post-operative trouble in the succeeding days will be avoided if the surgeon personally supervises this measure; success on this occasion will convince the patient that it is possible to expectorate his secretions, and that to do so is not as painful as he had feared. If the surgeon stands over the patient and helps him over this initial phase, the subsequent task of the physiotherapist and nurses will be much less arduous and more successful.

Sedation.

Initial sedation will depend on the drugs and the quantity used during the anaesthetic. Sedation may not be required for some hours if pethidine and largactil have taken a prominent place in the anaesthetic. A very convenient method of sedation is to make up $\frac{1}{4}$ gr. of morphia in a sterile solution of 10 c.c. and, when the patient starts to become restless, 2 c.c. of this solution may be given into the blood drip; after a few minutes, if restlessness continues, further c.c. are given at intervals until the patient settles. Thereafter, adequate sedation will be obtained with $\frac{1}{3}$ gr. of omnopon six hourly for the first twenty four hours; for the subsequent 48 hours 100 mg. injections of pethidine can be given when required.

Oxygen Therapy.

The vast majority of the cases in this series were given oxygen by a B.L.B. mask until fully conscious; thereafter the therapy was continued using a nasal catheter. After twelve hours the oxygen is given intermittently, and by twenty four hours it should not be required.

In my view an oxygen tent is no more necessary in mitral valvotomy than it is in the general run of lung resections.

Physiotherapy.

It has already been stressed in a previous section that efficent physiotherapy given by an understanding, sympathetic but determined physiotherapist is of great value. Most of the cases were operated on in the afternoon, and physiotherapeutic measures learnt before operation are recommenced on the morning of the first post-operative day. Much post-operative trouble, including sputum retention and atelectasis, has been avoided, thanks to an excellent physiotherapy service.

Sputum.

In the earlier cases considerable concern resulted from the wetness of the lungs on the second and third post-operative days; however efficiently the secretions were cleared by the physiotherapist they rapidly re-accumulated. It became apparent that it was the rule rather than the exception for this "wetness" to occur, and the explanation appeared to lie in the occurrence of some element of left heart failure. On reflection, it is not really surprising that left heart failure should occur following the insult that the left side of the heart had undergone. Various measures were discussed with the anaesthetists led by Dr. Pinkerton, and it was decided to give one patient 1/100 gr. injections of atropine sulphate (Case No.11). These injections had the most dramatic and unexpected result. The patient had even more difficulty than usual in getting rid of her sputum, atelectasis of most of the left lung occurred and she was literally snatched from death's door by urgent bronchoscopy. It seemed that the atropine sulphate had increased the tenacity of the sputum and made expectoration even more difficult, instead of reducing it as had been hoped for. Needless to say this experiment was not repeated.

The idea was then hit upon that if one could reduce the body fluids by general therapeutic measures, the sputum would also be reduced and, in fact, this has proved to be the answer. In the last fifty cases of the series, and in subsequent cases, it has become routine to give 2 c.c. of mersalyl or neptal on the second post-operative day, and thereafter every alternate day as required. The diuretic is accompanied by 7½ gr. ammonium chloride thrice daily. Three doses are generally all that are required. Some patients show an increase in urinary output, but the majority seem to respond to the injections by maintaining or perhaps slightly increasing their output which would otherwise have fallen considerably below normal levels. Since this routine has been adopted sputum is much less, and is easily controlled by physiotherapeutic measures. An indication of the value of this procedure, on the one hand, is the surgeon's impression that it is a considerable help and, on the other, the physiotherapist's opinion that it is a "God send".

Ambulation.

The encouragement of the patient in early mobility is important. It makes him realise that he is expected to move about the bed from the start of his convalescence, and this has the beneficial effect of encouraging early lung re-expansion. He is encouraged to swing his legs over the side of the bed on the fourth post-operative day, provided the temperature is not above 100°F. and auricular fibrillation has not occurred. He is allowed to sit in a chair on the fifth day, and thereafter to progress to full ambulation. While this regime is not as active as that adopted by Bailey in Philadelphia, it seems to work satisfactorily in this country where hospital beds don't cost the patient five pounds per day! Following an uninterrupted convalescence the patient with good home circumstances is discharged about the fourteenth or sixteenth day.

When home circumstances are less suitable, or where a young family is likely to demand much attention from a patient mother, convalescence is arranged at a convalescent home for two to four weeks. In order to combat the possibility of a flare-up of the rheumatic process consequent on the upset caused by the operation, it has been the practice to tell the patient, and to ask the general practitioner, to continue penicillin therapy by mouth for the first three months, with the additional request to the doctor that, should a chest cold develop during this period, the dosage of the penicillin be increased. The last 45 cases of the series were treated on this regime, and it has been continued in subsequent cases. This treatment was suggested by Dr. Alexander of the Chemotherapy Department of the Western Infirmary, who argued that if one could keep the streptococcus in check for three months the likelihood of rheumatic reactivation occurring was small. His counter-argument to the possibility of a resistant strain of streptococci being produced was the very sound one, namely that it was vitally important to prevent a further attack of rheumatism, and in any case other drugs were available if resistant strains developed. According to the research work carried out in the Chemotherapy Department, far more patients have latent nasopharyngeal streptococci than is generally appreciated. Certainly this treatment has caused no harm; it is not possible to say if it has done any good other than that no patient has developed rheumatism, and my general impression is that heavy chest colds, the bugbear of mitral stenosis cases, have been much less frequent.

The patients report back at one month after the operation and, if they continue to be well, at three months. The male and the unmarried female patients are encouraged to start light work about four months after operation; the housewife is expected to undertake moderate household duties at this stage. By six months full work and household duties should be undertaken. Naturally the patients with a less satisfactory operative result should be seen more frequently, and will require to progress more slowly.

THE OPERATIVE DIFFICULTIES ASSOCIATED with the TYPE of VALVE FOUND.

The operation of mitral valvotomy would be one of the easiest operations to perform if all mitral valve cusps affected by stenosis were fused together by a thin fibrinous sheet. Now that the first run of cases is over, it is my impression that in the majority of cases at present submitted to operation the valve will be found to have cusps fused by, at the very least, a moderate amount of fibrous tissue, and in a considerable number the valve will be densely fibrotic if not, in fact, partly or wholly calcified. Furthermore, over one third of the cases show some element of funnel deformity, that is, the valve is not fused as a thin slightly concave diaphragmatic sheet, but exhibits some depression in a distal direction towards the ventricle at the site of the valve opening. Funnel deformity is due to contraction of the more dense depositions of fibrous tissue, and in its gross form the chordae tendineae and papillary muscles being involved in this process, become shortened and pull the valve cusps down into the ventricle; in consequence, the finger entering the valve passes into a gradually narrowing cone, the opening of the valve being at the extremity of the cone. A fully developed funnel valve may be completely impossible to split with the finger.

In 70 cases details of the density and shape of the valve are available from the operation notes; in some of the earlier cases these details were not obtained (Table No.IX).

TABLE NO. IX.

Degree of Fibrosis of the Commissures.

Degree of Fibrosis	No. of Cases
Diaphragmatic	5
Slight	12
Moderate	29
Gross and/or grossly calcified	24
Total	70

Thirty-six valves were funnel-shaped in some degree. As one would expect, the more severe grades of the deformity were found in the moderate and densely fibrous valves, only four valves with funnel deformity being classed as slightly fibrous (Table No.X).

TABLE NO. X.

Gradation of Funnel Deformity.

Degree of Funnel Deformity	No. of Cases.
Slight	11
Moderate	5
Marked	19
Gross	1
Total	36

While a thickly fibrous valve is likely to show funnel deformity, in some the deformity may not be marked; instead one commissure, generally the posterior, may be greatly thickened, rolled over and even beaded. On occasions the commissure may be as much as 1 cm. in thickness (Case No.36). It is very unlikely that such a thickened commissure will split with a finger or even divide with a knife; the only hope of success lies in the opposite commissure being thinner and splitting more easily or, by approaching the valve through the left ventricle. A Brock's knife was used in 31 cases, and in at least 5 others it would have been used, had the neck of the appendage been less narrow and allowed room for the knife to be entered into the atrium.

Thus the presence of a thick fusion of the commissures or a funnel deformity increases the operation difficulties and tends to lower the efficiency of the result obtained. The operation problems are increased as it is necessary to use force to break the commissure and this may lead to atrial tears or incompetence, or the use of a knife may be essential, and thus increase the operative risks of haemorrhage and cerebral embolism. Several attempts to cut with the knife may release a small fragment of the tissue cut. The result is impaired when there is a thick fusion, because one has not re-established the free action of the valve cusps as well as one would have liked.

Furthermore, it is much more difficult to split a funnel-shaped valve than a diaphragmatic one. In the former the fused cusps are lying with a downward inclination into the ventricle and pressure against such angulation of the commissure is much less efficient and effective than in the diaphragmatic valve, when the commissure is more horizontal and therefore at right angles to the axis of finger pressure.

The commissures of a diaphragmatic stenosed valve can be easily cut with a Brock's knife, if finger pressure is insufficient to achieve maximum separation of the valve leaflets. The commissures of a funnel-shaped valve are much more difficult to cut because of their downward inclination away from the finger and the knife; this is particularly true of the posterior commissure. When a marked degree of funnel deformity is present it may be exceedingly difficult even to make contact with the knife on the commissure, far less to cut the commissure. At one moment the knife is placed against the A-V ring ready to move forward on to the commissure to cut it, the next moment the knife and finger instead of pressing against the commissure are lying free in the centre of the valve orifice, the heart as it were having moved away from the knife (Fig.III).

Undoubtedly the solution of this problem of downward inclination of the commissures is to approach the valve via the ventricle. This was not done in this series, as the necessary instrument has only recently been devised by Tubbs and was not available when these cases were treated. Tubbs devised a valve dilator which is

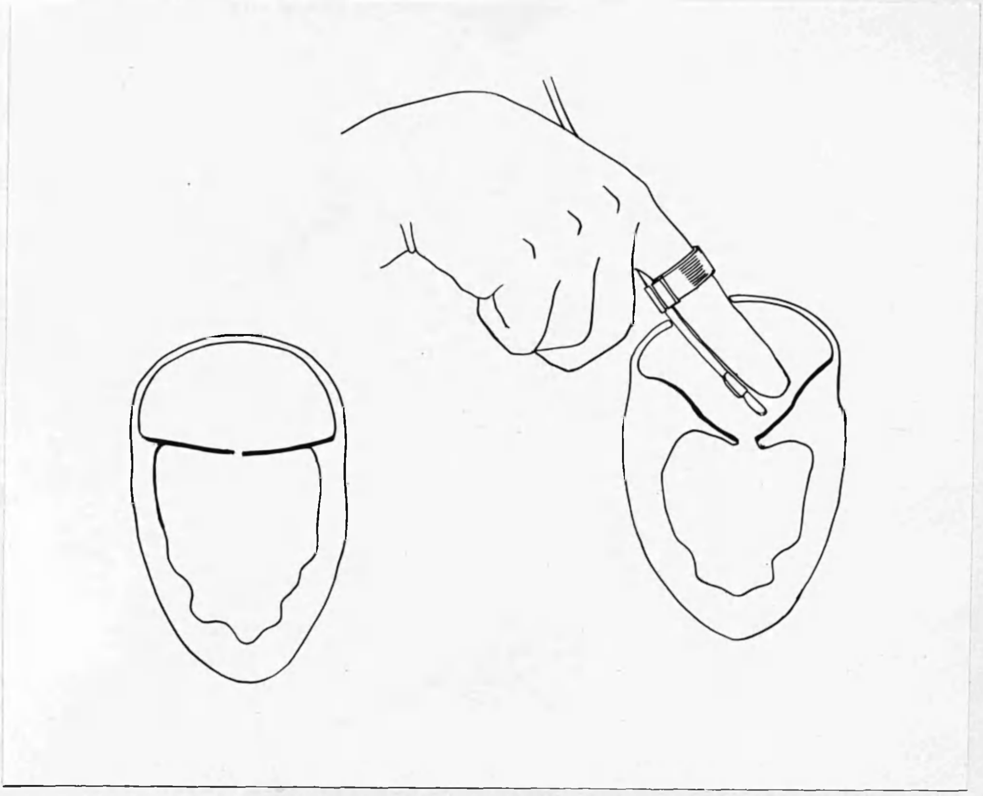


Fig. No. III: The diagram on the left shows a diaphragmatic mitral stenosis. The one on the right depicts a funnel shaped stenosis and it illustrates the difficulty, and on occasions the impossibility, of cutting the posterior commissure on account of its thickness and downward inclination away from the knife allied to its continuous movement with each cardiac contraction.

passed through a small hole near the apex of the left ventricle, and is directed upwards to the valve orifice where it is guided into position with the right index finger passed in the normal way through the left auricular appendage. The dilator is forced open, and as a rule a considerably more effective split is achieved than is obtained by other means; indeed, Logan (1957) uses the dilator in 9 out of 10 cases.

I have been so impressed, or perhaps it is more correct to say depressed, by the incomplete results obtained with the finger or the finger and knife methods, that I have asked Messrs. Thackray's to make a special pair of curved scissors which will pass into the heart through the ventricle, and which are curved in such a way that one blade of the scissors will pass behind the posterior commissure and the other in front. By this means it is hoped to cut the posterior commissure out to near the A-V ring.

Addendum.

Since the completion of this thesis the Tubb's mitral valve dilator has become available. It has been used in several cases and I am able to confirm the views of those surgeons already experienced in its use. Undoubtedly a great advance has been made in the operation of mitral valvotomy with the invention of this instrument.
The chest is opened through the bed of the fifth rib

instead of the fourth and the costal cartilage~~s~~ of th ~~the fifth and~~ sixth rib~~s~~ is ~~are~~ divided. A small incision, controlled by a purse string stitch threaded through the cardiac snare, is made near the apex of the left ventricle. The right index finger is passed into the appendage in the usual way and guides the tip of the dilator, which has been inserted through the opening in the ventricle, up through the mitral valve. Once the dilator is in position its blades are opened and the commissures are torn apart.

The extent of the commissurotomy using the dilator is quite beyond one's expectations, and in funnel-shaped valves a far larger "split" is obtained than one imagined possible, presumably because the dilator brings pressure against the fused commissures in their axis of least resistance.

Of a truth a new standard of technical success has resulted from the use of the dilator and considerably improved long term results can be anticipated.

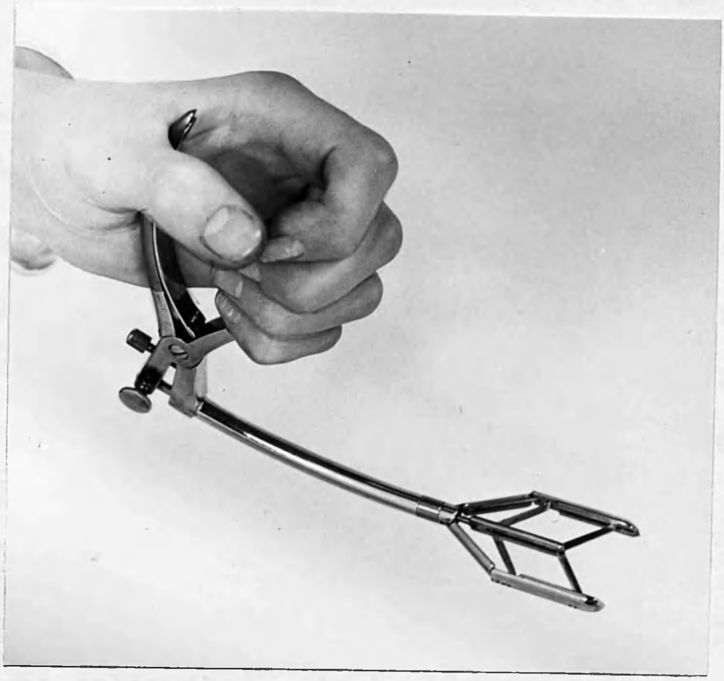


Fig. No. IV: The Tubb's mitral valve dilator. The instrument is passed through a hole near the apex of the left ventricle and is guided into the valve orifice by the index finger of the right hand entered through the atrial appendage. The blades of the dilator are seen partly open.

EMBOLISM.

The occurrence of embolism, particularly cerebral embolism, is one of the great problems of the operation. It seems at times that there is no explanation for the occurrence of cerebral emboli. Admittedly cases with calcification and free clot are much more likely to develop emboli, but sooner or later cases are encountered in which cerebral embolism occurs during or within a few hours of the operation for which there is no accounting. Case No.146, operated on subsequent to this series, is a case in point; there was a good auricular appendage devoid alike of thrombus and clot, the valve split anteriorly, but a knife was required to split the posterior commissure and a good commissurotomy was obtained. No clot escaped when the finger was withdrawn, and yet the delay in recovery from the operation and the all too obvious left hemiplegia present on regaining consciousness made it quite apparent that a cerebral embolism had occurred.

It is quite possible that when a knife is used, two of the several cuts generally required for success may separate a portion of the commissure which acts as an embolus. It may be that blood may clot on the operator's finger in spite of using liquid paraffin, and a portion of this clot may be swept away into the circulation. Certainly the blood of some patients seems to clot on the finger and within the appendage much more quickly than it does in others.

There were 7 instances of embolic phenomena in this series. Three of these patients developed cerebral emboli. Case No.57 died in 9 hours without recovering consciousness; Case No.102 developed telescopic vision and mental changes, and although she was ambulant for some weeks, she gradually deteriorated and died two months later. Case No.78 was very nearly conscious at the end of the operation, but one hour later she was much more deeply unconscious. Several hours later she regained consciousness, but she had paralysis of the left arm and leg. After twelve hours the paralysis had worn off and she was left with a paresis. Fortunately the embolus must have been small, as recovery was complete by the third day. Case No.69 was found to have an embolus which at the end of the operation appeared to be affecting only the right leg, but by the next day it was obvious that there was a saddle embolus astride the aortic bifurcation. An embolectomy was carried out within six hours of the complete obstruction, but unfortunately, while under heparin therapy, she died from a generalised oozing of blood into the peritoneal cavity. Case Nos. 12 and 92 developed emboli in the right brachial artery; in both cases the radial pulse returned spontaneously in three days. Case No.6 developed a small embolus on the 12th day which caused pain and paraesthesia in the right lower leg and foot. The effects of the embolus had cleared up in 12 hours. Unlike the other six cases she had no clot or thrombus at the operation; paradoxically she was the only patient of 7 to have a pre-operative embolus. Three of the others had free clot circulating in the atrium (Case Nos. 12, 92 and 102) and the remaining three had organised thrombus (Case Nos. 57, 69 and 78). The three cases developing emboli, in which only organised thrombus was seen at the operation, probably had fresh clot on the inner aspect of the organised thrombus which was not seen at the time (Turner & Fraser, 1956).

The 7% of post-operative emboli is closely similar to the figure of 6% given by Sellors et al (1953), although their series had a greater number of cerebral than peripheral emboli.

Five of the cases were fibrillating at the time of operation and two were in sinus rhythm (Case Nos. 6 and 78).

Measures to Prevent Embolism.

In order to minimise the danger of embolism occurring, blood should be allowed to escape freely from the auricular appendage before any clamp is applied. By doing this free clot will either be washed out or will obstruct the opening in the appendage, when it will require to be removed either by enlarging the opening in the appendage or by picking the clot out in pieces (for example Case Nos.92 and 102). If a ball thrombus is discovered, it must be removed (see page 110). When thrombus, clot or calcification were present it has been the policy in this series to ask the anaesthetist to occlude the carotid vessels as each attack on the commissure is announced. This method may be effective if the patient is not heavily built, but it is not foolproof (no method is foolproof). Experience in cases subsequent to this series suggests that this measure is inadequate, and it is now a routine to dissect out and snare the left carotid and the right innominate arteries. Logan (1957) suggests that this should be done in all cases of fibrillation and in the presence of clot and calcification; this seems a very sound rule. The "snares" are pulled taut by the assistant when the surgeon announces that he is about to attack the commissures, and after each attack six or seven beats of the heart are allowed to occur before the snares are released. The basic idea being the successful redirection of the clot to a less vulnerable area. Unfortunately, the occlusion cannot be maintained for more than a minute at a time, with several minutes of free circulation in the interval between each phase of occlusion, for in the type of case envisaged valvotomy with rest periods may take 5 - 10 minutes to complete, so that one is left rather wondering what is the most appropriate time to have effective occlusion. In cases in which the valve is known to be calcified, it may be justifiable to cool the patient to allow longer periods of cerebral arterial occlusion.

For preference the patient should be nearly conscious before leaving the operating table, in order that the mobility of the limbs may be confirmed along with the presence of peripheral pulsation. The peripheral pulsation and the colour of the limbs should be checked before the patient leaves the theatre, although in all probability saddle embolus of the aorta is the only embolus in which surgical interference is indicated, and should be carried out there and then.

THE OPERATIVE and POST-OPERATIVE COMPLICATIONS.

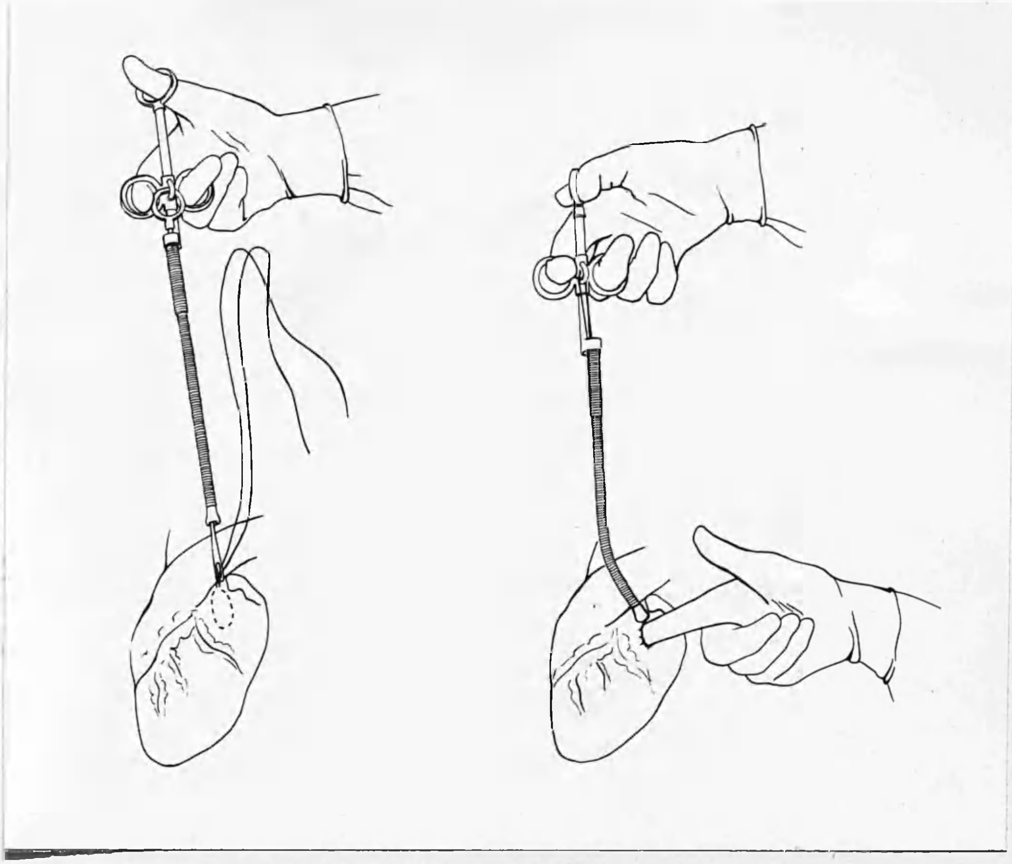
Difficulties Arising from the Appendage.

Inadequate auricular appendage: A small proportion of the cases had an auricular appendage which was inadequate. The most common cause was the smallness of the appendage, associated with a narrow neck which was inadequate to accept the index finger. On occasions the appendage neck may be wide enough grudgingly to admit the finger, and once the finger has entered the neck it may be possible slowly to dilate the opening with the finger to allow the mitral valve to be reached. This dilatation is fraught with grave danger, and may well cause the appendage neck to give way and a tear in the atrial wall to result; furthermore, it is one thing to be able to dilate the neck sufficiently to allow the mitral valve to be reached, but it is quite another matter thereafter to split a tough mitral valve; the extra force required may be more than the neck of the appendage can stand and the atrial wall may tear.

Thrombosed appendage: The appendage lumen may be completely blocked by thrombus, making finger entry impossible. If the thrombus is of recent origin, it may be possible to lift some of it out and a passageway for the finger may then be found; once some thrombus is removed a gush of blood will occur and further thrombus and clot will be expelled. When the thrombus is old, it will be densely adherent to the appendage wall and removal is likely to be impossible. Commonly one finds that the appendage is small and contracted when the thrombus is of long-standing. One should not overlook the possibility of the atrium being lined by thrombus. In cases with an appendage filled with thrombus, this lining may be more than 1 cm. in thickness. In these circumstances one has the double problem of difficult finger entry and the danger of dislodging a portion of the thrombus lining. In Case No.21 the operation required to be abandoned, as no means of entry could be found, thrombus filling the left pulmonary veins as well as lining the left atrium. She died four hours after operation from acute pulmonary oedema. In this series of cases the problem of large amounts of thrombus appeared to occur only in patients in Grade IV who had been suffering from auricular fibrillation and who were looked on as poor operative risks.

The approach to the mitral valve, in which the appendage is too small or in which the lumen is occluded by thrombus, should be through the atrial wall. It will be recalled that the later cases here have been operated on in the full lateral position, that is, with the left side of the chest uppermost. The former half lateral position gave access to the antero-lateral aspect of the chest, but in this position only the appendage is seen and practically nothing of the left atrium, for the circumflex coronary artery runs round the anterior aspect of the base of the appendage and only 1 cm. to 2 cm. in front of it; in the antero-lateral position the left atrium lies posteriorly behind the superior surface of the heart. Obviously then, if an approach through the atrial wall is likely to be necessary, much more of the atrium must be seen; with the patient in the full lateral position a good view of the atrium and the left atrial horn is obtained.

In the earlier cases an approach through the atrial wall was not possible, but a great advance was made when the Rumel's cardiac snare became available (Fig. No. V and VI). This is an instrument with a hollow flexible metal end 6" long, through which ligature ends can be threaded and tied to a hook which slides up and down the instrument handle; as the hook is pulled upwards and away from the heart the untied ligature is drawn tight against the flexible end of the instrument. A purse string suture of strong silk thread (No.1 or 2) is stitched in a circle or, if insufficient room is available, as an oval in the atrial wall just in front of the appendage base, or just below and in front of it. The stitch is so placed as to



V. VI.

Fig. No.V: A purse string stitch has been inserted in the left atrium and the long stitch ends have been threaded through the eye of the "seeker" on the Rumel's cardiac snare.

Fig. No.VI: The ligature has been tied over the hook at the "finger hold" of the snare and is ready to be tightened thus holding the purse string tight around the finger within the atrium.

provide a wide enough area within its circle to admit the forefinger and still leave an edge of atrial wall between the stitch and the finger. When the stitch has been inserted, the ends are threaded through the cardiac snare and tied over the hook sufficiently tightly to maintain the flexible metal end snugly against the atrial wall, but without tension. The cardiac snare is given into the care of the assistant with instructions that he is not to pull it tight until told to do so, and then only sufficiently tight to control the bleeding (Fig. No.VI). An incision is made in the centre of the area formed by the stitch through myocardium but stopping short of the endocardium. The forefinger is then pressed against the endocardium which gives way easily and permits entry into the atrium. Thereafter, the valvotomy is performed in the usual manner. Before withdrawing the finger all blood round about it is aspirated to be quite certain that the hole in the atrial wall is still confined within the ligature, and has not extended beyond the ligature's bounds. If the hole has enlarged beyond the confines of the ligature, bleeding from it will be very obvious and the site of the tear will be readily apparent. This is a vitally important matter, for the flood of blood once released by withdrawing the finger makes the finding of the hole most difficult. Once the finger has been removed, the snare is gently drawn tight and the bleeding is generally found to be completely controlled. Any leakage is checked by the assistant's forefinger placed over the leaking area. The purse string stitch is now undersewn by overlapping mattress silk stitches, and finally the purse string stitch itself is tied. I have always made it a rule never to use a Brock's valvotomy knife when a cardiac snare is in use. The entry and exit of a finger armed with the knife places the ligature in grave danger of being cut.

A disaster in a case subsequent to this series provides an important lesson. Case No.121 was found at operation to have a contracted appendage which was just too small to admit the finger. In order to guard against the possibility of a tear extending from the appendage on to the atrial wall in such a situation, one may decide to use the appendage guarded by a purse string suture placed at one half inch distance around the base of the appendage and threaded into the Rumel's cardiac snare. This was done in Case No.121, but unfortunately, instead of using a No.2 silk thread, a suture of equal thickness of mersiline was used. When the finger had just entered the opening into the atrium, the mersiline suture slipped and gave way in spite of a surgical knot being used. Once bleeding had been controlled and the situation had to some extent been retrieved, it seemed that the cause of the haemorrhage was the suture material being cut against a rough surface on the cardiac snare. In consequence this approach was abandoned and it was decided instead to use the superior pulmonary vein. As so often happens in this type of operation, once complete control has been lost, the situation goes from bad to worse. So it was here. One of the Pott's clamps applied to the pulmonary vein made a small hole in the posterior aspect of the pulmonary artery, naturally enough the subsequent bleeding was believed to be from the pulmonary vein, and equally naturally all attempts to control the vein failed to stop the bleeding. It was only at post mortem that the true site of bleeding was discovered. The lesson to be learnt from this case is never to use mersiline as the purse string material for a Rumel's cardiac snare.

Ball Thrombus.

This is an appropriate point to consider the complication of floating ball thrombus. Thirty-six cases showed thrombus either within the lumen of the appendage or within its wall; in the vast majority the thrombus was adherent, but ball thrombus occurred in five cases, four of which were fibrillators. The ball thrombus may be too large to enter the appendage. When the appendage clamp is released for flooding purposes the ball thrombus neither escapes in the flood of blood from the appendage, nor does it give warning of its presence by blocking the opening in the appendage.

Thus despite allowing 2 - 3 ounces of blood to escape from the appendage, one should realise that a ball thrombus and even free clot may still be present. Case No.94 illustrates this point. This is the male patient previously mentioned, who had a valvotomy seven and three quarter years after having double femoral emboli, requiring amputation of one leg and embolectomy in the other. At mitral valvotomy the appendage was bulging with clot and thrombus. At first it was thought unlikely that entry through the appendage would be possible; however, on picking out some thrombus sufficient space was obtained to admit the finger. During the intracardiac manipulations there was no indication that free thrombus was present in the atrium despite the atrial wall being completely lined by thrombus 1 cm. thick. When blood was allowed to escape on withdrawing the finger a ball thrombus 1.75 cm. in diameter was extruded along with several other portions of clot. Case Nos. 74 and 92 both expelled clot at the preliminary flushing phase, and in addition the former produced a ball thrombus 2 cm. in diameter. In Case No.12 the clot was felt floating over the valve orifice just as the finger approached the valve for the first time, the presence of the finger must have propelled the clot towards the valve, for immediately it began to disappear through the opening; its progress was held up momentarily at the edge of the valve by the finger trapping it against the atrial wall. But it was already caught in the stream of blood passing through the valve, and the author was left in the hopeless position that one experiences when trying to arrest the last fragment of a cloth as it disappears down a drain. The clot disappeared through the valve; by great good fortune it passed into the right subclavian and became impacted in the brachial artery. For forty-eight hours she complained of tingling in, and some weakness of, the right hand but by the third day the radial pulse had returned, and shortly thereafter the hand returned to normal.

Case No.101 illustrates the finding of a ball thrombus while the finger is within the left atrium. During the preliminary explorations to find out the valve size etc., something was felt lightly touching the finger from time to time. This sensation was not unlike the feeling one experiences when a finger is held in a bowl of gold fish, and one of the fish noses up against the finger. This similarity of sensation is reported, for the significance of such a happening might well be missed by the surgeon, were he unaware that a ball thrombus acts in this way; indeed, for a moment or two some doubt was raised in the author's mind of the explanation of this occurrence. Furthermore, the ball thrombus having touched the finger may float away from it and not be felt again. When such a ball thrombus has been felt, the forefinger should immediately seek it out, and with the carotid arteries controlled by snaring or digital pressure, the thrombus should be lightly caught between the flexed forefinger and the postero-lateral atrial wall. In Case No.101 a certain amount of "fishing" with the finger was necessary before the clot was "caught". The finger then slowly and quietly slides up the atrial wall to the base of the appendage bringing the thrombus with it. Fortunately the neck of the appendage was sufficiently wide to allow the finger and thrombus to emerge as one. Then followed what at first appeared to be a disastrous occurrence, control of the appendage was lost for several brief moments and a considerable amount of blood was lost. Once control was re-established by gripping the appendage between the forefinger and thumb, a clamp was applied. The operation field was tidied up and a pint or so of blood was cleared away. It was then found that the disaster had in fact been a blessing in disguise. For when the tide of blood had receded down the suction apparatus, two further fragments of the thrombus were found lying free in the chest. Subsequently one read that Bailey (1955) does this precise step as a planned procedure. When dealing with ball thrombi he allows free haemorrhage to occur, as the finger holding the thrombus emerges from the appendage. The thrombus produced from the heart in Case No.101 measured 3.5 cm. in diameter; on histological examination it was found to be covered by endothelium and was deemed to have been present for some time.

Calcification.

It should be stated that, in the earlier cases of this series, recognition of such matters as calcification would be less accurate than in the later cases. At this time the intracardiac manipulations were carried out as quickly as possible, and frequently time was not taken to carry out a careful search for other than features which were quickly and easily recognised. Nevertheless calcification in some form or other was felt in 54% of cases. Turner & Fraser (1956) reported calcification in only 27% of patients in their series of 250 surgical cases, but they state that the real incidence must be greater than this figure suggests. Calcification in my series was considered to be present if smooth pin head hard nodules were felt, these being classified as instances of subendocardial calcification; the great majority were felt on the atrio-ventricular ring. There were 27 instances of this occurrence. If these examples are excluded the incidence of calcification corresponds to the 27% of Turner & Fraser (1956). The more gross calcific lesions occurred with the following frequency: 16 had calcification at the posterior commissure usually in the shape of a horse-shoe of calcification, the limbs on the horse-shoe extending on to the posterior aspects of the two cusps; four had calcification of the anterior cusps; three had total calcification; the aortic cusp had one example of plaques, one of spicules and one of erosion with calcification; the remaining case had plaques of calcium just proximal to the edges of the valve curtains (Table No.XI).

TABLE NO. XI.

Sites of Calcification.

Site	No. of Cases
Subendocardial, usually on the A-V ring	27
Posterior Commissure	16
Anterior Commissure	4
Total valve calcification	3
Aortic cusp with plaques	1
" " " spicules	1
" " " calcification and erosion	1
Proximal edge of valve curtains	1
Total	54

The degree of calcification ranged from the milder grade of subendocardial nodules and calcific plaques of pumice stone hardness (Case Nos.9 and 65), through elevated plaques, resembling fish scales (Case Nos. 5 & 35), right up to frank spicules which were present in five cases (Case Nos. 37, 63, 76, 90 and 96). In Case No.96 the spicules were judged to be $1\frac{1}{4}$ cm. in height. In Case Nos.5 and 65 spicules were so sharp that the glove was torn.

Although the incidence of incompetence in the entire series will be discussed later, it is of interest at this stage to consider the relationship of calcification to the occurrence of mitral incompetence, and to mention the effect of valvotomy on the incompetence. Fifteen cases with calcification showed some degree of incompetence and of these 8 had calcific nodules and 7 had gross calcification. Following operation the incompetence appeared to have increased in 3, diminished in 3 and disappeared in 2. A further 8 cases showing calcification without incompetence developed a faint regurgitation after commissurotomy.

At the time of final assessment of the series the results obtained in the 54 cases showing calcification are shown in Table No. XII.

TABLE NO. XII.

Final Assessment Result where Calcification was present at Operation.

Grade		No. of Cases
Excellent		10
Very Good		21
Good		15
Slight improvement		2
No improvemnt		3
Died		3
	Total	54

It will be obvious that the presence of calcification does not of necessity nullify the value of the operation. But the presence of calcification has disadvantages. Effective splitting of the commissures may be impossible if gross calcification is present, and strenuous attempts to achieve splitting increase the operative risk (Case Nos.20 & 39). Even if heavily calcified commissures are divided, good function of the valve may not be restored. Furthermore, there is a greatly increased risk of cerebral embolism and this may prove fatal (Case No.57). The problem of shutting off the carotids during the intracardiac manipulations arises here, but will be considered later under cerebral embolism (Boulton et al 1952).

Before leaving the subject of calcification of the mitral valve, it should be recalled that to obtain 100 survivors for this series 110 patients were operated on. Of the 10 operative deaths 5 had gross calcification of the valve, and in three of these the calcification could be blamed directly or indirectly for the patient's death. Two died as a result of haemorrhage through tears of the atrium caused by forceful attempts to split the valve, and one died from a cerebral embolism.

Mitral Incompetence.

In 21 patients some degree of mitral incompetence was felt at operation. It was slight in 14, moderate in 6 and marked in 1. It occurred at the posterior commissure in 8, in 4 of these the incompetence being moderate or marked, in the centre in 4, combined anterior and posterior in 1, and in the remaining 8 the site was either not definitely ascertained or not recorded. The fact that 8 of the cases had incompetence at the posterior commissure suggests that this is by far the commonest site for incompetence to occur, and it is certainly the site most frequently encountered by the operator's finger. The explanation for incompetence to occur at this area of the valve appears to depend on several factors. It is a common site for calcification. The posterior commissure is commonly thicker and tougher than the anterior, and therefore is liable to be more rigid; it follows that any defect in the valve cusps just anterior to the fused commissure will be exaggerated. Because of the rigidity there will be less opportunity for compensatory overlap of the cusp edges, and in any event there is less valvular tissue posteriorly to spare (Chiechi et al 1956). The axis of the valve in relation to the left ventricle may also play a part.

There is the tendency to think that the mitral valve lies at right angles to the ventricle; after feeling a large number of mitral valves functioning at operation this impression is not confirmed. Indeed it seems that the valve lies obliquely, and while it is difficult to be certain with the patient lying on his side, it is my impression that the posterior commissure is probably placed slightly above the anterior; further the left ventricle appears to lie with the apex rather more anteriorly; in other words the left ventricular compartment is slightly curved posteriorly. If both of these impressions are accurate, it would follow that back pressure occurring with ventricular contraction would exert greater force towards the posterior end of the valvular closure, namely at the posterior commissure.

Twelve of the patients with incompetence had had symptoms for 4 years or more, 8 of them admitted to symptoms for more than 5 years, and one for more than 10. Seven, or 33%, gave a history of more than one attack of acute rheumatism or chorea as compared with 19% in the entire series. While these figures are too small to be significant, they do point to recurrent bouts of rheumatism as being more likely to cause incompetence. The degree of incompetence in relation to the size of the valve opening is shown in Table No. XIII.

TABLE NO. XIII.

The Degree of Incompetence in Relation to Mitral Valve Orifice.

Grade of Incompetence	Less than 1.5 cm.	2 cm.	3 cm.	Over 3 cm.
Faint	10	-	4	-
Moderate	-	4	1	1
Marked	-	-	-	1
Total	10	4	5	2

All of these cases showed some fusion of the mitral commissures, but in the 2 cases with an orifice over 3 cm. with moderate or marked incompetence, the fusion was minimal and the splitting achieved was small in extent.

If it were possible, in the light of greater knowledge today, to examine many of the earlier cases in the series, more accurate findings would be available than have been recorded. Of the details available it is perhaps worthy of mention that 14 of the 21 cases had an accentuated first mitral sound, 9 were thought to have an opening snap, 16 to have a presystolic murmur and only 12 are recorded as having a systolic murmur but one of the latter was not confirmed on the phonocardiograph, although the physicians suspected some incompetence. Of much more significance are the reports of the findings on x-ray screening which was usually performed by a panel of clinical and radiological experts. In only 2 of the 21 cases showing grades from slight to marked incompetence was any evidence recorded of left ventricular enlargement; one of these had faint incompetence (Case No.28) and one had moderate (Case No.30).

From experience of the cases presented here, and from more experienced judgment in those operated on subsequent to the series, I believe that the important findings suggesting incompetence are tiredness more than breathlessness, a first sound which is not as sharp nor as accentuated as I have come to expect in tight valves and a systolic murmur. I believe that a systolic murmur ought to be heard in all cases of incompetence of moderate or greater degree, and I now have the impression that it will be heard, if not at the first, at some subsequent examination. I agree with Sellors et al (1953) that if the systolic murmur encroaches on the first sound then a definite grade of incompetence will be found. On the other hand, the finding of an opening snap in 9 cases does not conform to their view that no opening snap should be heard, although in making this statement they are referring to serious incompetence. When only 2 out of the 21 cases showed radiological evidence of incompetence, it is perhaps natural that one should now be rather sceptical of the value of x-ray screening. It seems evident that left ventricular enlargement only occurs in gross mitral incompetence, and it is only in such cases that radiology is helpful.

I agree wholeheartedly with Turner & Fraser (1956) that clinical examination is still the best and most reliable method with which to assess this complication. No case showing good evidence of tight mitral stenosis should be refused operation because there is thought to be associated incompetence, provided the incompetence is apparently of less significance. The onus of this argument lies elsewhere, namely in the failure to diagnose lesser degrees of incompetence, and it is towards this end that clinicians, physicians and surgeons alike, must strive to improve their clinical knowledge.

The final assessment of the 21 cases found to have incompetence is shown in Table No. XIV.

TABLE NO. XIV.

Assessment of the Result in 21 cases having Associated Mitral Incompetence.

Grade		No. of Patients
Excellent		2
Very Good		10
Good		2
Slight improvement		1
No improvement		3
Since died		3
	Total	21

One death occurred 4 months, one 7 months, and one 10 months following the operation, and they accounted for three of the five deaths in addition to deaths included under operative mortality.

One final word relative alike to cases found to be more incompetent than stenosed, and to cases found to have little stenosis whether incompetent or not. Under no circumstances should the patient be told the operative findings or be given even an inkling of the surgeon's disappointment at the result of the operation. Whether one cares to admit the fact or not, there is a psychological overlay in nearly all these cases undergoing heart operations. A considerable number of these patients will feel better at least for some months, merely because the operation has been performed even if nothing beneficial has been achieved (Case No.66).

In my opinion it is not part of the surgeon's duty to damn the patient by telling her the facts, and it is certainly not dishonest if the relatives are told the truth. Curiously enough, it is exceptional for these patients to enquire if the operation has been successful or not, and they appear to assume that having had the operation they are now certain to get well. In my opinion it is no part of the surgeon's duty to shatter the patient's hopes by telling her the truth. If thought appropriate, the relatives may be told and by appropriate one refers to the relatives, i.e. if they are intelligent, sensible people and can be trusted not to divulge the information to the patient.

THE CAUSES of HAEMORRHAGE.

There are very few operations in which haemorrhage can be as profuse, unexpected and uncontrollable as in mitral valvotomy, possibly only those associated with the aorta and pulmonary artery. The amount and speed with which blood can be lost from a 1 cm. tear in the atrial wall is quite unbelievable. Immediately the tear occurs there is a swishing sound reminiscent of the noise made by a torn pulmonary artery or aorta. At once the chest begins to fill with blood; indeed so great is the rush of blood that in the space of seconds not only the tear but the entire heart is out of sight. The standard large size suction drainage tube of ½" in diameter is quite incapable of keeping pace with the blood loss; furthermore the four pint suction bottle fills in a matter of seconds with resultant temporary loss of suction until the bottle has been emptied and the vacuum re-established. It is therefore vitally important that a definite plan of action should be thought out beforehand and be known to all the members of the team; only in this way will the case be saved in the few seconds available between life and death.

The causes of haemorrhage are:-

1. The appendage opening for the finger enlarging on to the atrial wall.
2. Loss of control of the appendage at the moment of withdrawing the finger.
3. Careless use of an operating knife.

1. Tear of the atrial wall: A tear of the atrial wall is most likely to occur when the auricular appendage is small and admits the finger grudgingly, or when the valve is densely fibrous and thickened, resisting forceful attempts at splitting with the finger, particularly if the appendage is small (Case Nos. 20 & 39). In Case No.20 the neck of the appendage was narrow admitting the finger unwillingly, the valve being calcified on all aspects; the anterior commissure split in part, but the posterior commissure resisted more and more forceful pressure of the finger. While attempting the last effort to split this commissure, the fully extended finger buckled into hyperextension, and a tear in an anterior direction occurred, extending from the appendage on to the atrial wall. Profuse haemorrhage resulted and was not controlled until the heart was nearly empty and had ceased to beat. All attempts failed to restart the heart. This disaster happened in early 1953, and naturally provoked much thought and heart searching. A plan of campaign was evolved should such an occurrence happen again, but as circumstances ultimately proved this plan was not foolproof, for in December of the same year Case No.39 died of haemorrhage due to an atrial tear. Again the appendage was inadequate; it was narrow necked, and in addition to turning posteriorly its dimensions were somewhat vitiated by the fact that it

sprouted into two rabbit's ears instead of one. Only a small atrial tear occurred, and by means of pulling on the appendage it was possible to pull on the atrial wall and bring the tear into the appendage clamp. The opening in the appendage was closed in the usual way by means of overlapping mattress stitches of silk thread placed distal to the appendage clamp. When the clamp was released profuse bleeding occurred from the area of the tear which had been occluded between the clamp blades. In the anxious seconds which followed, attempts were made to control the tear with stitches, but all that was achieved was to increase the size of the hole. Unbelievable as this may be to the reader, this is in fact what happened. It is a further illustration of the danger of an atrial tear and the profuse nature of the haemorrhage which follows. Obviously this patient should not have died from haemorrhage on the operating table. Even greater heartburning and recrimination was felt following this death. It had been thought that haemorrhage from an atrial tear was controllable and that this disaster should not have occurred. As indeed it should not. It is then of paramount importance that measures to prevent bleeding, or to control it immediately it starts, should be well thought out. One makes bold to state "that no matter how experienced the surgeon may be, sooner or later he will find himself faced with haemorrhage from an atrial "tear". I should add that both these fatalities occurred before the Rumel's cardiac snare was available.

First and foremost the surgeon should take steps to prevent haemorrhage occurring. When the atrial appendage is small, narrowed or otherwise, and likely to cause difficulty, the surgeon is well advised to take precautionary measures before attempting to attack the mitral orifice. It is quite true that in many instances successful entry of the operator's finger will be achieved, but in my opinion it is even more certain that sooner or later a disaster will occur, the neck of the appendage will give way and an atrial tear will follow. It is far better to expect and prepare for such a happening than to await its occurrence. A purse string stitch of No.1 or 2 silk thread should be placed around the appendage base, and encircling at sufficient distance from the base to allow of a tear occurring, and still lie within the control of the purse string stitch. The ends of the purse string are threaded through the Rumel's cardiac snare which may then be left lying in the operation field ready for immediate use if a tear occurs (Fig. No.VI).
Considerable bleeding will occur from each of the stitch holes, but the surgeon experienced in the use of the snare

knows that this bleeding will be completely controlled with the usual mattress stitches after the valvotomy is performed. It is as well, however, to warn the surgeon inexperienced in its use that bleeding from the stitch holes is to be expected; indeed, the atrial wall is so thin that it would be surprising if bleeding did not occur.

If the appendage is completely occluded with thrombus and old clot one must use the cardiac snare and enter the atrium through a purse string stitch placed in the atrial wall clear of the appendage. Sometimes there is room for this stitch just anterior to the appendage base and between it and the circumflex branch of the coronary artery, but it may be necessary on account of the proximity of the appendage to this artery to use the atrial wall below the appendage base and more posteriorly. This region cannot be safely reached using the antero-lateral approach, and it is for this reason that I always use the complete lateral position with in addition a very slight anterior tilt. With the patient in the lateral position and very slightly tilted forward, no change of the patient's position is necessary if a posterior atrial wall approach is required; in consequence the surgeon is not tempted to "take a chance" and use an area that may be inadequate for proper control.

Haemorrhage during mitral valvotomy has made such an impression on me, that the finding of an appendage which presents difficulties because it is on the small side or doubtfully adequate, is sufficient in itself to request a second blood transfusion drip to be set up in the arm, a cut down transfusion at the ankle being standard practice. The left arm is very conveniently placed to the anaesthetist in this lateral position, and the installation of a second drip takes only a matter of moments. It is a further rule that a Martin's blood transfusion propelling pump must be attached to the blood transfusion in all cases. If real trouble is anticipated, it is wise to have a third drip set mounted and ready with a bottle of blood. This third "drip" is in charge of the theatre sister, and is immediately available to hand to the surgeon should haemorrhage be so profuse that the heart is emptied and flaccid before the haemorrhage has been controlled. In the event of this unhappy occurrence the blood can be run into the aorta proximal to a clamp placed across the aorta at any convenient level distal to the left subclavian artery. By this means the coronary arteries are perfused and the carotid arteries are supplied. It follows from these observations that a minimum of four pints of appropriately matched blood must be available for all cases of mitral valvotomy, not only available but in the theatre precincts. If it is thought that the operation may be difficult it is advisable to have six pints of blood prepared for use. It is quite useless to have blood available but stored in the hospital blood bank, if the latter is several hundred yards away. Immediately surgical difficulties are envisaged, and before any irrevocable surgical steps are taken, the blood must be brought to the operating theatre and be ready for immediate administration. Under these conditions to leave blood in a blood bank even at the expense of wasting it is tantamount to courting disaster and is crass stupidity; if an atrial tear occurs the patient may be dead before the blood arrives.

An atrial tear may occur in spite of all reasonable precautions being taken; for example, an adequate appendage of wide base may be found and yet forceful pressure to split a densely fibrous commissure may cause the finger to "buckle up", the resultant sudden extra pressure on the neck of the appendage may produce an atrial tear. A tear of any size will be immediately obvious from the blood pouring out of the atrium at the base of the appendage. A small tear may not be immediately apparent, and only when the finger has been withdrawn and the clamp has been re-applied is it discovered that the clamp has not achieved complete control. Considerable bleeding is found to be coming from the tear in the flat wall of the atrium proximal to and beyond the reach of the clamp. The wary surgeon is familiar with the likelihood of this occurrence, and before withdrawing his finger from the appendage he gives the assistant instructions to aspirate the blood around the appendage; then and only when he has seen that there is no tear of the atrium does he withdraw his finger and apply the clamp.

One result of the attention given to this problem of atrial tears was to devise an instrument which could control the smaller tears. A Duval lung forceps was modified so that the two blades were curved outwards while still retaining the usual grip at the blade edges. If a small tear extends beyond the grasp of the appendage clamp, gentle traction on the clamp will draw up sufficient of the atrial wall behind the neck of the appendage to allow this modified Duval clamp to be applied proximal to the clamp and the tear (see Fig. No.VII). The fluted blades of the modified Duval forceps permit closure of the atrial wall and the appendage base by leaving room for the stitches to be placed between the two clamps. Had this instrument been thought of and available at the

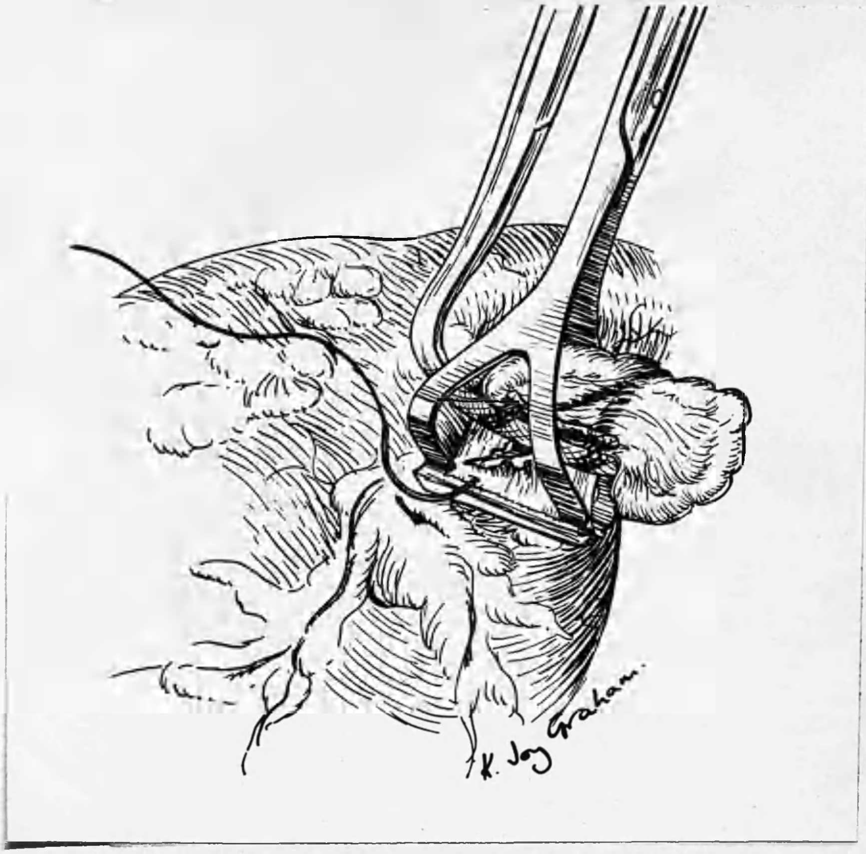


Fig No. VII: This illustrates the modification of the Duval lung forceps designed to control the smaller atrial tears. Gentle traction on the appendage clamp "pulls up" the portion of the atrial wall which is torn and allows the Duval forceps to be applied proximal to the tear. Stitches can be inserted distal to the blades of the forceps.

Nöte the proximity of the circular coronary artery.

time of the operation on Case No.20, the atrial tear would have been easily controlled. Case No.39 was the case in which a small tear occurred but was just controlled by the appendage clamp blades; in the usual manner stitches were inserted, but on removing the clamp it was found that incomplete control had been obtained and haemorrhage resulted. To the reader unfamiliar with cardiac surgery the fact that such profuse bleeding could occur from so small an opening, capable of control by the edges of the appendage clamp, will serve to underline the disasters with which the cardiac surgeon may be faced. The surgical reader will appreciate that this case would have been saved by placing the stitches proximal to the clamp through the atrial wall before the clamp was removed, but this accident occurred early in the series and I was afraid that the bleeding from the stitch holes would in turn be uncontrollable. Alas for the patient, one learns from experience!

When a cardiac snare is not in use, the occurrence of a larger atrial tear is more likely to be successfully treated if the surgeon keeps his head and keeps his finger in the atrium; if necessary, and the tear is large enough, two fingers. Bleeding through the tear should be to a large extent controllable if the finger is flexed at the distal interphalangeal joint, so that the palmar aspect of the distal phalanx lies against the atrial wall at the site of the tear (Fig. No.VIII). By this means the bleeding will be controlled sufficiently to allow the assistant to insert mattress stitches deep to the tear. Only when the tear is sutured should the finger be withdrawn from the atrium and the clamp applied to the appendage. When haemorrhage from an atrial tear occurs it is very tempting to withdraw the finger and apply the clamp, in the hope that the clamp will control the bleeding; indeed, such a temptation is very natural in haemorrhage at any site and here the tendency is equally reflex. I am certain it is quite wrong to give in to this temptation, as the clamp will not control the bleeding in a tear of half a centimetre or more. By applying the clamp one has lost instead of gained ground; bleeding continues unabated from the tear, control by direct finger pressure, always inefficient in this situation, is made more difficult with the clamp in place, and the operation field is lost sight of in a welter of blood. So far, since 1953 I have not been faced with this situation, but I am quite certain the only hope of successful control

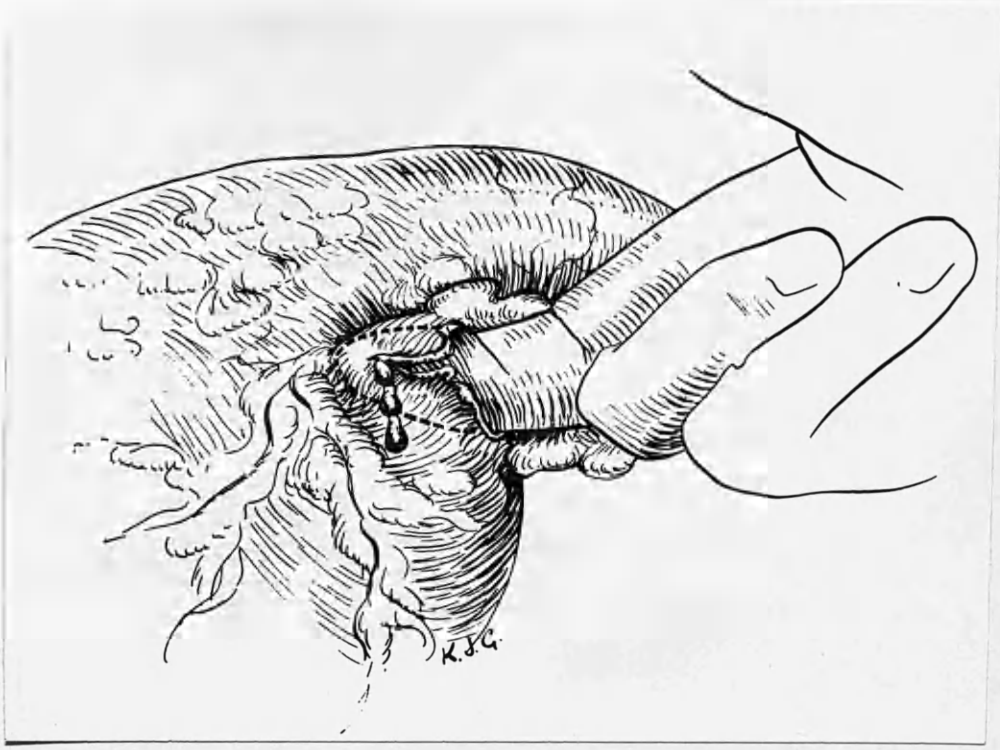


Fig. No. VIII: The opening in the atrial appendage has extended as a tear on to the atrial wall. The flexed terminal phalanx is controlling bleeding from the tear preparatory to stitches being inserted. The circular branch of the left coronary artery curves just in front of the base of the appendage and the tear. The pulmonary artery is seen behind the fingers.

is to resist the quite natural inclination to remove the finger, instead of using the finger from within the atrium as a shutter against the tear. It may be necessary to supplement any repair of the atrium by stitching the appendage over the suture line.

2. <u>Loss of control of the appendage when the finger is withdrawn</u>: Loss of control of the appendage may happen at the moment of finger withdrawal. As a rule, this should only happen when the appendage is short and very little room is available between the base of the appendage and the opening made in it for the operator's finger. Normally as the finger is withdrawn the appendage is allowed to fill out with blood, the clamp being applied just before the finger leaves the appendage; when the appendage is short the two circumstances may coincide, the finger leaving the appendage opening just as it fills with blood, and the appendage drops as it were off the finger before the clamp is applied.

On occasions loss of control may occur as a result of over enthusiastic use of the "sucker" by the assistant, when the operator may find himself with the appendage clamp closed around the "sucker" while the appendage slips free from between the blades of the clamp.

If loss of control of the appendage does occur, panic need not follow, all that is required is to grasp the appendage between the fingers and thumb and the bleeding will stop. Aspiration of the blood from the chest then provides a clear field for the application of the clamp to the appendage base, clear alike of the circular coronary artery and proximal to the opening in the appendage. I have found the modified Duval clamp very useful to grip and occlude the appendage, should re-application of the clamp be necessary. Re-application of the clamp may be necessary if the appendage opening is inadequately controlled, or if there is insufficient room between the appendage opening and the clamp to allow of sutures being placed. A more proximal "bite" can be taken while bleeding is controlled by grasping the appendage opening in the blades of the modified Duval clamp.

3. <u>Haemorrhage resulting from damage accidentally caused when using a knife</u>: No instance of this complication occurred in this series. The most likely time for this to happen will be when the finger, armed with a Brock's knife, enters or leaves the appendage. Provided the appendage neck is not narrow, and care is taken to see that the knife has adequate clearance by forcing the dorsum of the finger hard against the opposite end of

the opening, an inadvertent cut should not occur. It is sometimes possible to ease the knife entry further by grasping the anterior end of the appendage with the modified Duval forceps and pulling the appendage toward the operator, at the same time as the finger presses away from the operator. Some surgeons have had the unhappy experience, while cutting the anterior commissure, of seeing the knife cut through the heart wall at the A-V junction. The only remedy when this happens would appear to be to remove the knife and try to control the haemorrhage by flexing the finger within the heart against the tear, while the assistant controls the tear with mattress stitches so placed as to avoid the circular coronary artery.

CARDIAC ARREST.

Cardiac arrest and ventricular fibrillation did not occur during the operation on the 100 cases here recorded. It will be seen, however, under operative deaths that one case died of cardiac arrest. Case No.10 caused some concern during anaesthetic induction, virtually the only case to do so, with some fall in blood pressure and difficulty in obtaining his pulse. During this period of anaesthetic difficulty I stood back and waited for the sanction of the anaesthetist to start the operation. After 10 to 15 minutes of positive pressure anaesthesia, and when the patient's colour appeared to have improved, the operation was started and the chest was quickly opened. Immediately the heart was seen it was obviously in asystole. The pericardium was quickly opened, and massage was at once commenced, but no return of contraction of the heart occurred. At post mortem the heart was found to be large and the mitral valve was calcified and narrowed.

There is a very salutory lesson to be learnt from this case. If there is a fall in blood pressure to doubtfully recordable levels, and if the pulse is not definitely palpable, it must be assumed, until proved otherwise, that the heart has stopped. Immediate thoracotomy with cardiac massage is imperative if the patient's life is to be saved. Two grave errors of judgment are liable to occur from time to time and at infrequent intervals, if the surgeon fails to bear in mind that under modern anaesthesia a dead patient may still be pink in colour, and may still show responses on the electrocardiographic tracing. Case No.10 illustrates the first of these errors. The occurrence of cardiac arrest during anaesthetic induction in mitral valvotomy must be quite infrequent, but it does occur and must be thought of if difficulties during induction are encountered; if the cardiac arrest is not remembered and immediate thoractotomy performed followed by cardiac massage a life may be lost. One is very liable to stand back during such anaesthetic difficulties and imagine that the good colour of the patient indicates that matters are not too bad, when in fact the good colour is the result of oxygenation from positive pressure anaesthesia, and is not indicative of normal cardiac contractions.

The second error of judgment can result from too assiduous observation of the electrocardiographic tracing. The surgeon should be prepared to accept mechanical aids such as electrocardiographic patterns during operation, but, as in many other spheres of surgery, a time and stage is reached when the surgeon's clinical acumen and knowledge should tell him that his mechanical aids have become worthless and are recording false information. In effect, a darkly cyanosed patient whose electrocardiograph still records apparent intermittent cardiac contractions should be regarded as in cardiac asystole. I have seen Holmes Sellors and his assistant Belcher (1956) delay performing thoracotomy in a difficult heart case for pulmonary stenosis, because the electrocardiograph still showed periodic cardiac contractions, and they delayed the start of the operation in the hope that the child's condition would improve. Clinical observation indicated that the child's heart had stopped some minutes previously, but they were reluctant to open the chest because the electrocardiograph showed apparent continuing cardiac contractions. Seemingly this was the third occasion on which by relying on the electrocardiograph they had been misled, and delayed resuscitative measures too long. The tendency to stand back and wait for better conditions under the mistaken impression that the surgeon must not rush the anaesthetist in his efforts is highly commendable, but this attitude must not be allowed to outrun the surgeon's clinical judgment, nor can the surgeon afford to allow mechanical devices to overstep their truthfulness.

It is my belief that no instance of cardiac arrest or ventricular fibrillation occurred in this series of cases due to the fact that the colour and the action of the heart were observed closely and continuously throughout the intracardiac manipulations. The most important single factor appears to be the maintenance throughout of a pink myocardium. If any cyanosis of the myocardium develops, all manipulations should be avoided and the anaesthetist should be asked to inflate the lungs until the heart regains a good colour. Furthermore, if too enthusiastic attempts to carry out the valvotomy are persisted in without adequate rest periods, the valve orifice will be occluded for sufficient length of time to impair the coronary circulation and cyanosis will result; therefore, attempts to split the commissures must not last for more than three or four beats at the most at one time. Between each attack on the commissures the finger should be withdrawn into the atrium and lie against the postero-lateral atrial wall thus allowing a free passage of blood through the valve. In addition, attempts to split the valve should not be repeated until such time as the heart action has regained its former rhythm and strength of contraction.

<u>If cardiac arrest occurs</u> the finger must be withdrawn from the atrium as soon as possible, although preferably after the valve has been split. It is a sine qua non of all heart valve operations that the best chance of saving the patient is to complete the valvotomy, if this is quickly possible, before starting resuscitative measures. This is particularly important in aortic stenosis in order that a sufficient valve orifice will be obtained to gain the maximum advantage to the coronary circulation by the subsequent cardiac massage. Cardiac massage should be immediately started, and if the heart is small this will be carried out most advantageously by grasping the heart between the two hands and compressing the heart between them; obviously a large adult heart will be unsuitable for this method of massage and one will require to be satisfied with grasping as much of the two ventricles as possible between the hands and compressing them towards the outflow tracts. From personal experience this latter method is much more traumatising to the myocardium than direct pressure by compressing the heart between the two hands. After a few minutes of massage the outer surface of the heart begins to show numerous petechial

haemorrhages, which become more obvious and more numerous the longer the massage continues. Efficient cardiac massage along with continuing oxygen ventilation will quickly restore the colour of the myocardium and this, in turn, will usually restore the cardiac contractions. If cardiac action does not immediately return the massage must be continued by relays of people for at least one hour. After several minutes, if cardiac massage has failed to restore contractions, resort should be made to injections into the aorta proximal to a clamp applied distal to the subclavian artery (Ehrenhaft et al 1951; Sealy et al 1954).

From experience of cardiac arrest occurring during other operations, the injection of 2 c.c. of 10% calcium chloride seems to be the most effective, but if this fails after several further minutes of massage, 20 ug/ml. of noradrenaline or 0.1 - 0.2 c.c. of 1/1000 adrenaline chloride should be tried.

<u>If ventricular fibrillation occurs</u> or develops after cardiac arrest the heart should be massaged until it is pink, when electrical defibrillation should be carried out by giving one shock of 130 volts (50 cyc/sec); the heart should stop fibrillating and restart in normal rhythm either on its own or after further massage.

If the fibrillation continues the heart should be massaged for 1 - 2 minutes, and this procedure then repeated. If the fibrillation is intractible serial defibrillation should be tried giving 5 - 7 shocks of 0.5-1 second. It may be necessary to increase the voltage up to 220-250. Defibrillation may stop if 5 c.c. of 4% potassium chloride are injected into the aorta proximal to the clamp, but first the other methods should be tried as restarting the heart may be difficult after injection of potassium chloride.

POST-OPERATIVE COMPLICATIONS.

Haemorrhage.

Post-operative haemorrhage should not occur if the operation is carried out with due attention to haemostasis. The standard method of overlapping horizontally placed mattress stitches of silk thread at the base of the appendage and just proximal to the line of incision will give complete haemostasis. If this stitch is supplemented by a continuous overlapping mattress stitch, there need be no fear of bleeding from the heart. Knowing that the appendage is properly sutured is a great source of encouragement and is very helpful in deciding on the necessary treatment if in the post-operative phase the patient develops signs of a mild to moderate degree of collapse. Unless some disaster has occurred during the operation the surgeon should, and must, be quite confident that haemorrhage from the heart has not occurred; indeed one would go so far as to state that the last place to expect haemorrhage from was the heart itself. The most likely sites of bleeding in order of importance are the intercostal vessels, which can bleed profusely, pleural adhesions and pericardial vessels. Particular care should be taken to pick up the intercostal vessels at the anterior and posterior ends of the wound. They should be coagulated with diathermy or tied off routinely, whether they are bleeding or not. Pleural adhesions should only be divided sufficiently to permit of access to the left side of the heart; the adhesion stump should be controlled, and it is here that diathermy is so valuable. Frequently the adhesion has been a synthesis of parietal and visceral pleura which, when separated, leaves little or no stump; the raw area can be easily controlled by diathermy when picking up with forceps and ligation would be impossible.

Pericardial vessels are capable of considerable oozing, and one should therefore be satisfied that bleeding from them is controlled before the chest is closed. Finally, when the wound is being closed the divided muscle edges should be inspected again in order to deal with any bleeding points missed during entry into the chest.

In no case in this series, nor in subsequent cases, has it been necessary to reopen the chest to control bleeding or, for that matter, for any other reason.
The average loss of blood during the operation is adequately replaced by a two pint transfusion.
If loss of blood has been greater than usual three,

and rarely four, pints may be necessary.

One expects 8 - 15 ounces of drainage in the first 12 hours. It should be remembered that a large proportion of the cases will have a fall in blood pressure to 95 mm. or 90 mm. systolic during this initial period without haemorrhage being present. If more than 20 ounces are drained in the first 12 hours, and if the blood pressure falls below 95 mm., one should give at least one more pint of blood (Case Nos. 65 & 83).

Auricular Fibrillation.

Twenty-two patients were fibrillating before operation, and none of these cases returned to sinus rhythm after valvotomy. Of the remaining 78 cases in sinus rhythm 37 developed auricular fibrillation during the post-operative phase, i.e. 47% of those cases in normal rhythm. This figure of 47% is very nearly double the figure quoted by Turner & Fraser (1956) in their series, but, on the other hand, the incidence of pre-operative fibrillation quoted by them was 43% which is very nearly double the number in this series. Eight of the 37 cases failed to regain normal rhythm and persisted in auricular fibrillation. One additional case relapsed into auricular fibrillation at three months (Case No.63); this is in sharp contrast to the 2 out of 34 cases quoted by Turner & Fraser (1956) as failing to return to normal rhythm, but conforms to the figure of 9 cases persisting in fibrillation quoted by Glover et al (1955).

It has not been possible to demonstrate that digitalis or quinidine given before operation had any effect in diminishing the occurrence of post-operative auricular fibrillation. Case Nos.100, 51 & 15 were on pre-operative digitalis, but fibrillated on the 3rd, 7th and 18th days respectively; similarly, Case Nos.23 & 76 were given quinidine pre-operatively, but fibrillated on the 2nd and 3rd days respectively. Furthermore, Case Nos. 1 & 6 having both digitalis and quinidine fibrillated on the 5th and 10th days.

This failure of these drugs to have any deterrent effect on the occurrence of post-operative fibrillation became so apparent in the earlier cases of the series, that their use was eventually abandoned in later cases. Similar findings were reported by Turner & Fraser (1956).

The post-operative day on which fibrillation occurred varied widely. Case No.63 fibrillated during the operation, Case Nos.19 & 82 on the evening of the operation day and Case No.15 on the 18th day.

The greater number of cases (8) developed fibrillation on the second day. The full details are shown in Table No.XV.

TABLE NO. XV.

The Post-Operative Day on which Auricular Fibrillation Developed.

	Operation	Day 1	2	3	4	5	6	7	8	9	10	13	14	18
No. of Cases	3	3	8	3	4	5	1	1	2	-	1	1	4	1

Total = 37.

Nine cases had more than one episode of auricular fibrillation. Case No.63 fibrillated during the operation. In spite of digoxin and quinidine therapy restoring sinus rhythm, the auricular fibrillation recurred on five occasions, the last attack occurring three months post-operatively before the final restoration of normal rhythm. It will be observed that fibrillation develops in most instances in the first few days; when the onset is delayed for a week or two its development is possibly related to the increasing physical activity. Presumably the fibrillation is related to traumatic pericarditis and epicarditis following operation in a heart the seat of old rheumatic heart disease.

It seems apparent that the earlier in convalescence the onset of fibrillation occurs, the more rapid will the heart rate be, although Case No.56 exemplifies fibrillation developing for the first time on the fourteenth post-operative day with a heart rate of 160.

The Treatment of Auricular Fibrillation: The author is convinced from experience of these and more recent cases undergoing mitral valvotomy, that by far the most important observation is the early diagnosis of auricular fibrillation which is only next in importance to the recognition of post-operative haemorrhage. If fibrillation develops, particularly in the early post-operative phase, the heart rate will be in the region of 160 to 180 beats per minute. If the onset of fibrillation is not appreciated, and this heart rate is allowed to continue for a matter of four to eight hours, cardiac failure will develop and the patient will quickly become gravely ill, with vomiting due to gastric congestion, upper abdominal pain from liver congestion and breathlessness and cough from pulmonary oedema (Case No.141). Any or all of these symptoms may be the first indication to the inexperienced that all is not well, and attempts to treat the patient symptomatically will, of course, be unhelpful.

Each member of the medical, nursing and physiotherapy staff having contact with these patients must be familiar with the possibility of fibrillation developing, and be taught to take the patient's pulse at regular intervals and to report immediately any irregularity noted. The physiotherapy staff are included here, because they can be most helpful in observing such details and, furthermore, fibrillation can start after such procedures as the daily routine of physiotherapy activity, chest aspirations or bronchoscopy. The development of extrasystoles is commonly a herald of impending fibrillation; similarly a rising pulse rate and, to the intelligent observer, the fact that the patient is not just as well as she had been a few hours previously. To members of staff trained and schooled in these observations the development of fibrillation will neither be a matter for surprise nor will its onset be overlooked.

To miss the development of fibrillation may be disastrous for the patient. At the very least, a patient making a good convalescence will in a few hours deteriorate into such poor condition that all one's resources including intravenous digoxin, aminophylline and bronchoscopy may be required to save her life.

Case No.141 illustrates just such a course of events. On the evening of the first post-operative day it was noticed that he was not as well as he had been earlier in the day, that the pulse rate was climbing steadily and that occasional extrasystoles were occurring. Before going off duty the sister of the Ward told the oncoming night staff nurse these details and strongly impressed on her their importance and likely significance as forewarnings of fibrillation. She further instructed the staff nurse to keep a close watch on the patient's progress and to report immediately to the house surgeon any heart-pulse deficit. Coming on duty the following morning the first thing the sister did was to look at the night report of this patient; to her horror she read that the pulse rate was 140 and the apex rate was 120! (A prerequisite of the treatment of such surgical cases is a staff with at least a modicum of intelligence and knowledge). One look at the patient was enough. He was completely collapsed, extremely breathless and cyanosed and was fibrillating with a heart rate of 170. Certainly this patient's life was saved only by the dawn, and with it the arrival of the day staff.

There is then an element of prophylaxis in the treatment of fibrillation, namely the awareness of the possibility of its development with immediate diagnosis and treatment.

From experience of the treatment of fibrillation, and it obviously has been an extensive experience, one has no doubt at all that the first essential is to slow the heart rate. The fibrillation of itself, and for the moment, is of no consequence. If the heart rate is 150 or more it has become routine practice to give intravenous digoxin. As a rule 0.5 mg. is given slowly intravenously while observing the pulse rate. After four hours, and depending on the heart rate, further intravenous digoxin is given. If the rate is still 120, or over, a further intravenous injection of 0.25 mg. or 0.5 mg. is injected depending on the heart rate and the response as the second injection is given; thereafter, 0.25 mg. of digoxin is given orally four hourly until such time as the apex rate drops to the region of 80 to 90, when the number of doses given is generally reduced to thrice daily, but so regulated as to maintain a heart rate of between 70 and 80. Naturally, the dangerous practice of giving intravenous digoxin to a patient already on digitalis therapy is avoided; in any case, the heart rate will be lower and all that will be required is to increase the oral dosage.

It was not until 1954 when visiting Holmes Sellors (1954: personal communication) that one fully appreciated that other surgeons were experiencing the same failure of quinidine to restore normal rhythm when given in the early post-operative days. The uselessness of using the drug so soon after the operation is becoming increasingly appreciated (Turner & Fraser 1956). Quinidine is not used now until at least the fourteenth post-operative day. This delay has a threefold advantage; it ensures that the drug is not given while the patient is still in heart failure, it allows the digoxin to return the heart to sinus rhythm and it avoids the occurrence of possible quinidine poisoning. While reversal on digoxin alone occurred in only two cases in this group (Case Nos.82 & 103) it must be recalled that probably less than half the fibrillating cases were treated in this way, and it should be recorded that several further cases outwith the series have reverted on digoxin alone.

Treatment with quinidine should be started if the heart is still fibrillating after fourteen days of digoxin therapy. As a test dose of 3 gr. of the drug has always been given before the operation, the routine of 6 grs. four times a day is started. Case Nos. 42 & 99 are typical examples of the success of this method of treatment. Case No.42 fibrillated on the 3rd day and was given digoxin from the 3rd to the 24th day when quinidine therapy was added and produced sinus rhythm the next day.

It is important to maintain the full dosage of quinidine for about three days after normal rhythm has been restored, and then gradually to reduce the dose to 3 grs. for the last seven days of treatment. Failure to continue the treatment with quinidine, either by withdrawing the drug entirely or by reducing the dose too quickly, invites a recurrence of the fibrillation. Case No.108 fibrillated on the second day and was started on digoxin treatment; on the twenty-second day quinidine was started and after 24 grs. she returned to normal rhythm. The dose of quinidine was immediately reduced and fibrillation recurred on the twenty-fifth day; with a return to 24 grs. per day the heart reverted to normal rhythm in a further five days. Case No.63 similarly reverted to fibrillation with too early reduction of the dose of quinidine, and did so on six occasions.

It will be recalled that 8 out of 37 cases developing fibrillation failed to regain normal rhythm. On looking into the reports of these 8 cases, one cannot help wondering if at least two of them might not have regained sinus rhythm had they been given digoxin first and for 14 days before quinidine was used. Case No.29 is an example. He was given quinidine pre-operatively and yet developed fibrillation on the second day, and while his heart returned to normal on the tenth day, fibrillation recurred and persisted from the fifteenth day.

Before leaving the subject of quinidine therapy, the possibility of quinidine poisoning must not be overlooked, and this in itself is a further argument in favour of delaying the use of quinidine until other methods have failed, e.g. nature and digoxin. Case No.17 fibrillated on the 4th day and was started on full doses of quinidine on the seventh day. She reverted to normal rhythm by the 8th day, but on the eleventh post-operative day, and while being maintained on full doses of quinidine, she developed a sore throat, swelling and tenderness of her hands, elbows and shoulders. It was thought that these manifestations, rather than being rheumatic in origin, were the result of quinidine sensitivity. Case No.22 definitely developed quinidine poisoning. She had fibrillated on the fifth day and was treated with 24 grs. of quinidine daily; on the twelfth day she collapsed suddenly with cessation of respiration, cold clammy skin and thin thready pulse. She was treated with 10 c.c. intravenous aminophylline and 2 c.c. intramuscular nikethamide. She gradually regained consciousness, and her pulse improved and was found to be regular.

Congestive Cardiac Failure.

As the occurrence of such things as a small sacral pad of oedema or moderate ankle swelling have obviously not been recorded in the case reports as often as they have developed, no definite figures can be given for the incidence of congestive cardiac failure. It is my impression, however, that rather more than half the patients show some evidence of early congestive failure, be it a small pad of sacral oedema, mild ankle swelling or bilateral pulmonary congestion of mild degree. If trouble is taken to look for pulmonary congestion, it will be found in some degree in over 70% of the cases.

The mild degrees of congestive cardiac failure are adequately controlled by the routine now adopted in all cases of giving 2 c.c. of neptal intramuscularly twice a week along with ammonium chloride grs. 7½ thrice daily. Restriction of fluids and exclusion of salt from the diet, should the oedema prove intractable to this routine, may be necessary.

Thus mild congestive cardiac failure is to be expected in the majority of cases and, will respond to nature and/or simple measures. Severe grades of congestive cardiac failure are quite a different matter, and should give cause for considerable alarm and prompt treatment. Auricular fibrillation is the commonest cause and, as already indicated, should be treated with vigour and at once. When the onset of fibrillation has been overlooked for some hours, or where congestive cardiac failure has progressed to the extent that the patient is breathless with obvious pulmonary oedema which is causing much sputum and cyanosis, when vomiting has started and when upper abdominal pain and tenderness are a feature, then heroic measures are called for if the patient is to be saved.

First and foremost, steps must be taken to control the heart rate if fibrillation is present (see page 153). Secondly, and at the risk of shocking some medical authorities, 0.25 g. in 10 c.c. of intravenous aminophylline must be given, but, of course, given carefully and very slowly over a period of 15 minutes. To the mere surgeon faced with this complication in the middle of the night, and when the physician is long since abed, there is no more wonderful drug than aminophylline. I am fully aware that to some cardiologists the drug aminophylline spells danger with a capital D. I learnt of this only quite recently, and I am convinced that I lost a case subsequent to this series through being swayed and instructed by a medical colleague on the dangers of sudden death from convulsions following its use. My patient died three days later in extreme cardiac failure from gross pulmonary oedema, in spite of three bronchoscopies and the delayed use of aminophylline (Case No.145). Of a truth it is dangerous to know too much! To anyone questioning the wisdom of the use of aminophylline I would say this - considerable congestive cardiac failure following valvotomy is a desperate disease and desperate diseases require desperate measures. An intramuscular injection of neptal is given, and finally a 1/6 or 1/4 gr. of morphine, the dose depending on the size of the patient, is administered intravenously. Within a few hours of such treatment the patient should be so vastly improved as to be almost unrecognisable. A programme of digoxin and neptal therapy is continued.

Pleural Effusion.

Inevitably some pleural fluid will develop following thoracotomy. The quantity of fluid will depend on two main factors; the care with which bleeding is controlled during the operation and the completeness of early lung re-expansion. Both of these subjects have already been dealt with in extenso (pages 56 & 85). Suffice it to say here that blood allowed to accumulate within the chest, the result of inadequate drainage, will cause not only atelectasis of the adjacent lung tissue, but of its own presence stimulate the production of further fluid from the pleural surfaces with further atelectasis as the amount of fluid increases. On the other hand, sputum retention gives rise to atelectasis, atelectasis leaves a pneumothorax, nature abhors a vacuum and thus pleural fluid develops and continues the vicious circle. The amount of pleural fluid developing is minimised by good haemostasis, by a wide bored well placed drainage tube which drains right to the top of the pleural cavity and by early expectoration of sputum combined with early breathing exercises. When a drainage tube with three lateral openings has been used, if it is withdrawn inch by inch, as much as 15 - 20 ounces of additional drainage may be obtained. Naturally when the first opening in the tube appears and air commences to be sucked into the chest the rest of the tube is quickly withdrawn. The chest should be aspirated if the post-operative x-ray shows the presence of fluid, evidenced by opacity or ground-glass appearance at the left base and the withdrawal of the tube producing very little fluid. A satisfactory tap will generally be obtained through the fourth or fifth interspace in the axillary line; if at first only air is obtained, the air should be withdrawn when the fluid will be found to rise with lung re-expansion, the result of air withdrawal, to the needle level. Fluid within the chest, left to re-absorb, invariably causes some degree of pleural thickening, visceral and parietal. It is only within the last two or three years that the importance of preventing pleural thickening has been fully understood, and the loss of lung function resulting from such thickening fully appreciated (Reid 1957).

In this series of cases 9% required additional aspiration on one or more occasions; all of these cases were drained with short drainage tubes, as they occurred early in the series before the era of the multi-holed tube which drains the entire length of the pleural cavity.

Atelectasis.

There will be some atelectasis of the left lower lobe if intra-pleural fluid is present. It follows that the first x-ray film taken on the first post-operative day will almost without exception show some degree of collapse, however slight this may be. The recording of atelectasis as a complication naturally does not take account of this occurrence, it only refers to those cases in which atelectasis persisted. The most severe instances developed in patients who were either unable to cough or were afraid to do so during the first two days. Case No.11 was the only exception; she was given atropine empirically in an attempt to reduce the amount of sputum. It will be recalled that the atropine made the sputum so tenacious that total left lung collapse resulted and her life was saved by bronchoscopic suction on the third day (page 86).

Sixteen patients (16%) were recorded as having persisting atelectasis. All except two involved the left lung. Four had more or less total atelectasis of the lung and required bronchoscopic suction (Case Nos. 1, 11, 62 and 91). Case No.31 developed collapse of the right upper lobe, and Case No.83 collapse of the right lower lobe. The atelectasis cleared in all these cases with appropriate measures.

<u>The treatment of atelectasis</u>: Once again this is a complication which is usually preventible. Adequate pre-operative training in the correct method of breathing and coughing by using the diaphragm, will do much to eliminate atelectasis, provided such measures are put into operation on the first day and pursued with sufficient vigour. The author is very much in favour of a sympathetic attitude to the patient, but such sympathy must not, on any account, be allowed to overrule the necessity of causing the patient pain and discomfort in expectorating the sputum. Kind, but firm, insistence towards this end must prevail. It is so easy to think that the patient is not sufficiently well to sit up and cough, and that more harm than good will come of such efforts. Such an attitude is wrong and courts later trouble, viz. atelectasis.

From time to time a patient is operated on who finds it quite impossible to "bring up" the sputum. Success may be achieved by giving omnopon gr. 1/3 half an hour before the return visit of the physiotherapist. If this measure fails, the expert physiotherapist will succeed in getting rid of the sputum by "tipping the patient".

The patient is laid flat down and lies on her right side with a pillow under her right chest, the foot of the bed is lifted on to blocks eight to twelve inches high. After several minutes active attempts to "chase" and then cough out the sputum are started; due regard to the law of gravity is generally rewarded with the "raising" of the sputum. An alternative method of treatment in the anxious nervous patient is to give 10 oz. of 1% solution of procaine hydrochloride intravenously; this has the effect of allaying the patient's fears, reduces the amount of sedation required and should enable the patient to cough.

One must bronchoscope the patient and aspirate the sputum if these measures fail to dislodge the plugs of sputum responsible for the atelectasis. Similarly bronchoscopic suction may become imperative in congestive heart failure, when so much sputum has accumulated that the already exhausted patient is now unable to cope with the situation unaided. A possible pitfall here awaits the inexperiencedsurgeon, when he is called to see the patient who may well be completely collapsed, extremely breathless and endeavouring to cough up the flood of fluid which can be heard from the foot of the bed. These features combined with a thin thready pulse complete the gloomy picture of a patient at death's door. In his inexperience he may be afraid to take the major decision to bronchoscope the patient for fear he kills her. Yet, in such circumstances this is the one life saving procedure left to him, the one procedure which will keep the patient alive long enough for intensive medical measures to take effect. The thoracic surgeon, accustomed to such crises occurring in cases of partial or total lung resection, knows that he must take the risk of killing the patient; he is also aware that it is a procedure which he can carry out quickly and very easily; the more ill the patient the easier the bronchoscopy becomes. That a patient with pulmonary oedema or atelectasis is never too ill to bronchoscope is axiomatic to the thoracic surgeon. Time and again one has seen thoracic surgery patients literally snatched from the jaws of death by bronchoscopic suction (Case No. 11).

If the patient is conscious and the situation is not yet desperate she is given two decicain lozenges to suck. Fifteen minutes later the throat is painted with 1% amethocaine, with 1/1000 adrenaline added, or 4% xylocaine; after several applications at intervals of a few minutes the aryepiglottic folds are painted with the local anaesthetic; after a further few minutes the cords are viewed and, as the patient is instructed to breath in, two successive applications each of 1 c.c. of amethocaine are squirted at them. The patient will be ready to be bronchoscoped after a few minutes which are utilised to make a final check of lighting equipment and the suction and oxygen availability. As she is already sitting well propped up with 8 - 10 pillows at the top of the bed, all that is required is to adjust the pillows so that the head can be hyperextended. The eyes are covered, the tongue is held well out and the bronchoscope is passed with the greatest of ease. Oxygen is piped into the side passage of the instrument immediately the cords have been negotiated. Intermittent aspirations of sputum of a few seconds only each time, are carried out. The aspiration must be intermittent to avoid aspirating all the oxygen from the patient. The bronchoscope should be passed into the left stem bronchus, and all lobar orifices should be sucked out until dry and clearly seen. The best method of suction is to use the standard rubber tipped metal rod bronchoscopic sucker; it is possible quickly to direct this instrument to any desired point, unlike more flexible apparatus such as catheters. The opportunity should be taken to "dry out" the right lung as well. Information as to the character and rate of the patient's pulse must be called out from time to time throughout the bronchoscopy. One further point, the suction tube must be flushed with water between each aspiration, otherwise it is liable to block with tenacious sputum, and there is no time to allow this to happen or for the "sucker" to be replaced. Throughout the procedure restorative drugs such as coramine should be held ready for immediate injection. The desperately ill patient will require little if any anaesthetic preparation.

Successful bronchoscopic suction immediately restores the patient's colour, for the removal of the sputum now enables the alveoli to utilise the oxygen which formerly had been unable to reach them. The quality of the pulse quickly improves with the now adequate oxygenation. When the bronchoscopic suction has been required because of congestive cardiac failure, measures to treat the latter must be immediately started if they are not already under way (page 161).

Pulmonary Infarction.

The development of pulmonary infarction is announced by a sudden sharp and sometimes quite severe pain in the affected area of the chest. Confirmation of the diagnosis usually follows a few hours later with the expectoration of blood-stained sputum. A portable x-ray film of the chest will show an area of consolidation varying in extent with the size of the infarction. A return to morphine sedation may be required, as a temporary expedient, to tide the patient over the initial severe pain. Some relief may also be obtained with local applications to the affected area of the chest, e.g. a kaolin poultice.

Eleven patients had pulmonary infarctions. Five of these occurred from the tenth to the twenty-third day.

There seems to be a distinct preference for the right side of the chest, as 8 infarctions were in the right lung and only two in the left; one case had the misfortune to have bilateral infarctions (Case No.65).

As none of these cases had obvious superficial phlebitis, one may presume that the infarctions resulted from atheromatous plaques dislodged from the hypertensive pulmonary artery (Turner & Fraser 1956). The selection of the right lung, rather than the left, may be explained by the right pulmonary artery being in a slightly more direct axis to the pulmonary conus than the left.

Embolism.

Three cases appear to have had embolic phenomena in the post-operative period; a fourth case (Case No. 78) is not included, because the embolism appeared to occur one hour after the operation, and thus this case was considered in the group of operative emboli (page 99). One of the three cases (Case No.102) was also discussed in the operative emboli series, but is included here as she may have developed a further embolus on the 21st day when she complained of difficulty with vision. She was found to have telescopic vision; she developed mental deterioration and died two months later. Case No.6 developed an embolus on the twelfth day in the right femoral artery which caused weakness and paraesthesia in the lower leg and foot. The leg and foot returned to normal in twelve hours. Case No.93 died very suddenly, while on holiday, five months after the operation; while she may have died from coronary thrombosis, it is more probable that cerebral embolism was the explanation of her instantaneous death.

Superficial Phlebitis.

Six patients suffered from this complication; three in the left leg, two in the right and one in which the side is not recorded. These cases were given anticoagulant therapy, starting with heparin and later dindevan, the treatment being continued for the first few days of ambulation. Local treatment consisted of kaolin poultices.

Wound Infection.

Three cases had definite wound infection. Part of the wound sloughed in Case No.80 and required to be resutured. A course of Terramycin cleared up the infection in Case No.34. A course of Terramycin was also given to Case No.48 and the "mild" wound infection appeared to be controlled. Unfortunately, she developed a "bad chest", but was not sent back to hospital for review and eventually she died at home seven months after the operation. A post-mortem examination revealed the cause of death to be a staphylococcal empyema. She had reported back at four months when she was found to be well. If this patient had been returned to hospital when she developed the final illness (she was regarded by her practitioner simply as an operation failure), the empyema would have been recognised on x-ray examination, if it had not already been diagnosed on clinical grounds, and it is conceivable that appropriate treatment might have saved her life. This case raises an important point in the subsequent treatment of patients undergoing such operations as mitral valvotomy, pneumonectomy and lobectomy, namely, that it is quite unreasonable to expect a general practitioner to know the reason for a post-operative illness. Thus, when the case is discharged from hospital, the letter to the practitioner should, while outlining the reporting-back arrangements, point out very clearly that the surgeon will be very glad to see the patient at any time, should the practitioner have any cause for concern about her condition. The statement is couched in such terms that the practitioner realises that the surgeon knows the convalescence may be difficult, and that he does not expect the practitioner to be able to deal with all the upsets in this type of case. Following pneumonectomy for cancer of the lung, particularly the right lung, this information to the practitioner is of vital importance; for the news some months after pneumonectomy that such a case has developed pyrexia with cough and spit does not signify pneumonia of the remaining lung, but is diagnostic of a delayed empyema with bronchial fistula, urgently requiring tube drainage, to prevent the patient drowning in pus. If the practitioner hesitates for several days to inform the surgeon that the patient is ill, the delay may cost the patient's life. So it is in mitral stenosis; a friendly co-operation between surgeon and practitioner is essential if tragedies are to be avoided. A complication developing may require all the ancillary investigations such as electrocardiography, radiology and bacteriology, which can be most conveniently and expeditiously obtained as a hospital inpatient.

OPERATIVE MORTALITY.

Ten patients out of 110 cases died directly, or indirectly, as the result of the operation; that is, they died within one month of the operation. The causes of death are shown in Table No. XVI.

TABLE NO. XVI.

Operative Deaths.

Cause	No. of Patients
Haemorrhage	2
Inadequate Commissurotomy	2
Cardiac arrest during anaesthetic induction	1
Cerebral embolism	1
Aortic embolism	1
Pulmonary embolism	1
Acute Pulmonary Oedema	1
Auricular flutter	1
Total	10

The two deaths from haemorrhage resulted from tears of the atrial wall, and have already been fully discussed (page No. 127). One case occurred in March 1953 (Case No.20) and one in December of the same year (Case No.39); both were early in the series, and one would hope that experience gained since, plus the advent of the Rumel's cardiac snare, would avoid any recurrence of such disasters.

Similarly the two deaths from inadequate commissurotomy took place early on in the series; Case No.2 died on the 10th post-operative day in January, 1952 and Case No.13 died on the first post-operative day in January, 1953. In Case No.2 the valve orifice was less than 1 cm. and did not split kindly. A Brock's knife was used and the precautionary purse string stitch was severed by the knife blade, the chest filling with blood. Control was re-established, but the heart was stopped for twelve seconds; it restarted following an injection of procaine hydrochloride. At this time of inexperience, it was not sufficiently appreciated that once the operation was undertaken an adequate split of the valve was essential to survival, and so no further attempts were made to improve the valvotomy. With the experience now gained and with the advent of the Rumel's cardiac snare plus the Martin's blood transfusion pump, the course of events would be quite different. On the finding of a small auricular appendage the cardiac snare would be used on a purse string stitch, well clear of the appendage base; if haemorrhage had occurred the blood loss would have been rapidly replaced using the Martin's pump, and further attempts at valvotomy would have been carried out until successful.

Case No.13 was a further example of inexperience. Her heart was unusually irritable. Too large a hole was made in the appendage and about three quarters of a pint of blood escaped around the finger. The finger was withdrawn and re-entry was made with a supporting purse string stitch. Some splitting of the valve, already 2.5 cm. in width, was achieved but further splitting was thought to require a knife. As the pulse was no longer obtainable, and as frequent ventricular extrasystoles were occurring, it was decided to abandon further attempts at valvotomy. Today, an opening too large for the finger is a mistake less likely to be made; if it were made it would be immediately recognised, and the finger would be withdrawn before much blood was lost and a new start made using a cardiac snare. The cardiac irritability would now be controlled with procaine amide before any intracardiac manipulations were attempted. These measures plus the restoration of any blood lost using the Martin's pump would have permitted re-entry of the heart with a Brock's knife and adequate relief of stenosis would have followed.

These two cases emphasise what is now well known and appreciated, namely, that once an operation for valvular stenosis is started the valvotomy must be performed if the patient is to survive, whatever complication or misfortune may occur in the process of the operation. During the induction of the anaesthetic Case No.10 caused difficulty in maintaining his colour, and at one stage his pulse became imperceptible. This case of cardiac arrest has already been discussed on page 141, and the necessity of realising that the heart may have stopped in spite of the patient's good colour, due to good oxygenation by the anaesthetist, has been stressed.

Case No.57 never recovered consciousness following the operation and died 9 hours later. This patient was fibrillating and her valve was grossly calcified. The glove was torn in two places by the calcification. It was assumed that she died from a cerebral embolism, although no actual embolism was found at post mortem.

Case No.69 died following operation for an aortic bifurcation embolus on the first day following valvotomy. She was fibrillating at operation (page 99).

Case No.105 developed a superficial phlebitis at the site of transfusion in the right saphenous vein. It was suspected that he had a deep venous thrombosis as well. Anticoagulant treatment was delayed until the fourth day for fear of causing wound bleeding. On the fifth day he became hysterical, and died quite suddenly from what was presumed to be a massive pulmonary embolism.

Case No.21 died of acute pulmonary oedema. At operation a short, small appendage was found, quite inadequate to admit the finger. The left atrium was obviously lined with a thick rind of thrombus and clot, and the superior pulmonary vein was practically solid. The inferior pulmonary vein was patent, but it was thought to be unsuitable and the chest was closed without valvotomy being attempted. Unfortunately, she was left lying flat in bed and developed pulmonary oedema from which she died in five hours in spite of intravenous aminophylline, etc. This was only the eighteenth case in the series. At the present time, and in the full knowledge of the necessity of performing a valvotomy once the operation has started, a more determined effort might have been made to achieve this. Today if these difficulties were met with at operation, one would snare the carotid arteries and then try to gain entry through one of the pulmonary veins or through the thrombus in the atrial wall. One realises now that a case of this kind should be returned to bed with the top of the bed elevated to try and prevent the onset of pulmonary oedema.

Case No.45 was aged 45 and fibrillating. Entry into the heart was made using the cardiac snare through the left atrium which was lined with clot. She developed auricular flutter on the seventh day and died.

This operative mortality of 10% is a quite considerable figure. Logan in his first 100 cases had an operative mortality of 7% (Logan & Turner 1953), while Sellors in 150 cases had a mortality of 2.7% (Sellors et al, 1953). Only one death attributable to the operation occurred in the last 40 cases operated on by the author.

Undoubtedly, experience in the operation technique and in the post-operative care is very important. As the operator's experience increases the mortality rate should fall. If one studies the causes of death, it will be seen that the two deaths resulting from atrial tears should probably not occur today with greater operative experience, and the availability of the Rumel's cardiac snare. Again, the two deaths from inadequate commissurotomy should not occur; with the present day facilities a "split" of the valve, sufficient at least to keep the patient alive through the post-operative phase ought to be obtained. The development of cerebral embolism during the operation in Case No.57 might now be prevented with the present day practice of snaring the carotid arteries in cases of fibrillation. Two of the deaths might well have been omitted from the operative mortality figures, as neither case had valvotomy performed (Case Nos.10 & 21), but they have been included in order that a true picture of the hazards of the operation should be given.

It is generally recognised that on the average the operative mortality in mitral valvotomy lies between 5% and 10%, the figure being governed by the type of case the surgeon is willing to accept for operation (Lancet, 1953, 2, 711). Glover et al (1953) rightly point out that no one awaits the complications and end results of mechanical deformities such as patent ductus arteriosus or coarctation of the aorta before proceeding to their surgical correction. If this attitude were adopted in mitral stenosis, the operative mortality would be still lower.

A careful choice of cases, which excluded the moderate and poor risks, would very likely give a mortality rate below 5%. On the other hand, a conscientious surgeon may consider that to operate in a certain group of cases is to offer that group their only chance of survival; to accept these patients for operation will undoubtedly raise the mortality rate of the whole series.

A further factor was experienced in the earlier cases, namely, the inexperience of the surgeon who had no previous standard with which to judge the clinical condition of a patient against a previous personal experience of operative results to be expected. Thus, the surgeon was left in the position on the one hand of wishing to have as low an operative mortality as possible, and on the other was faced with the ethical problem of whether it was justifiable to refuse to operate on a case which might be difficult, in rather poor condition, or in which the diagnosis of pure stenosis was in some doubt. I found this decision on occasions most difficult. With experience gained from operating on 148 cases, I now have a much better knowledge of what will be found at operation when certain clinical findings are present. This experience points to the belief that on average, when I doubt the wisdom of operating on a particular case, I should not now agree to operation for my experience has been that, either the patient will die, or some factor such as mild stenosis will be found and the patient will not benefit from the operation.

Perhaps one concluding statement should be made before leaving the subject of operative mortality, and that is this, no matter how skilful the surgeon becomes in the execution of the operation, there will always be a few cases snatched from his grasp for no very obvious clinical or pathological reason, i.e. at post mortem.

ALTERATIONS in the CLINICAL FINDINGS FOLLOWING VALVOTOMY.

Apart from the patient's subjective improvement and obvious well-being, the following features resulting from a successful valvotomy are worthy of mention.

Change in Weight.

While four patients thought they had lost weight, five considered their weight had been steady. Twenty patients put on up to half a stone in weight; nineteen from half to one stone, eight from one to one and a half stones, nine to two stones, one three stones and the record was held by one patient gaining three and a half stone. The available weight changes are shown in Table No.XXI.

TABLE NO. XXI.

Weight Changes following Valvotomy.

	Loss in Weight	No Change	Increase in weight up to				
			½ stone	½-1 stone	1-1½ stone	2 stone	3 st. or over
No. of Cases	4	5	20	19	8	9	2

One of the important factors in the follow-up of the cases is to control by dietary measures excessive weight increase.

Changes in Clinical Examination.

Right ventricle thrust: One hopes to find less prominence, or absence, of the right ventricular thrust following successful valvotomy; this in turn should lead to a less tapping and more marked apical impulse.

The first mitral heart sound: Following operation one expects the first mitral heart sound to be longer, less abrupt and less accentuated, but to be still abnormally short and accentuated.

The opening snap: While assessing the alteration in the opening snap following valvotomy, it must be recalled that there was considerable clinical inexperience in the earlier cases of the series. Thirty-eight patients were considered to have an "opening snap" before operation. After operation twenty of these patients appeared to lose the "opening snap", that is 53% compared with 32% quoted by Wood (1954).

The second pulmonic heart sound: Following operation one hopes for, and expects, a rather less abrupt second pulmonic heart sound. Further evidence of reduction of the pulmonary hypertension is found in the absence of rhonchi and rales in the lung fields.

The presystolic murmur: While it is well known that the first heart sound at the mitral area may be less abrupt and less loud following successful valvotomy, it is equally well known that the heart murmurs at the mitral area may show little alteration and are still consistent with mitral stenosis. Seventy-two cases had a presystolic murmur at the mitral area before operation; in twenty the presystolic murmur persisted after the operation, a persistence rate of 28%. Clinical inexperience may account for the difference in this series from the figure of 42% quoted by Wood (1954). In view of these post-operative findings, it is reassuring to read the statement that a presystolic murmur may occur with only a trivial degree of mitral stenosis (Wood 1954). The advent of the transventricular approach using the Tubb's mitral valve dilator, which gives a greater increase in the valve orifice, may well alter these clinical findings.

The diastolic murmur: The diastolic murmur may be shorter and less loud following valvotomy, but in many instances no appreciable change in the quality or length of the murmur is noted.

Pregnancy.

Seven patients were pregnant at the time of operation and each survived surgery and was delivered in due course. In common with other surgeons dealing with mitral stenosis, the occurrence of pregnancy following operation was a feature in patients apparently formerly unable to become pregnant. Seven patients became pregnant, and one of these had three pregnancies subsequent to surgery. Despite successful surgical treatment for the mitral stenosis, pregnancy still seems to have a bad effect on these patients. Case Nos.58, 59 and 78 have retained their grade of improvement, but Case No.8 has slipped from "very good" to "good" following her pregnancy, and Case No.15 has deteriorated from "very good" to "worse".

It would seem that if patients seek advice in regard to pregnancy following valvotomy, it should be given cautiously and with due regard to any family already present. The findings in this series would suggest that post-valvotomy pregnancy is a definite hazard, and if an adequate family already exists, it might be wise to advise against further pregnancy. If there is no family, one pregnancy might be suggested but certainly not more than two.

THE RESULT PREDICTED at the TIME of OPERATION.

When writing the operation notes of a case it is now routine to include a statement predicting the result expected. This was not done in the earlier cases, but is available in 32 later ones. In only 3 cases was the estimated result above the result obtained. Case No.32 was expected to have only a moderate result as the valve was already 3.75 cm. when felt at operation and the valve only split by 0.5 cm. He died after ten months. It was predicted that Case No.100 would obtain a very good result as the mitral valve was 1.25 cm. and split to 3 cm. However, she developed congestive heart failure and died in four months. Case No.85, aged 56, proved temperamentally to be quite unsuitable for operation; it was believed that a "good" result would be obtained from the operation, but she would never admit to having obtained any benefit. The full details are shown in Table No.XVII.

TABLE NO. XVII.

Result Predicted at the Time of Operation
Compared with the Result Obtained.

Predicted result in 32 cases.

Result Obtained	Fair	Moderate	Good	Very Good or Excellent
Poor		1 died	2 (1death)	
Good	1	6		
Very Good or Excellent	1	6	9	6
Total	2	13	11	6

It will be seen from Table No. XVII that the estimated result was quite frequently too conservative and that a better result than expected was obtained.

RESULT ASSESSED AT SIX MONTHS IN RELATION TO THE SIZE OF VALVE "SPLIT" AT OPERATION.

An analysis of the result at six months after operation compared with the increase in size of valve orifice obtained at operation shows less uniformity than one might expect; for example, a valve split of more than 2 cm. would be expected to give an almost uniformly excellent result. In fact, this was not the case. 13 operations gave an increase in the valve orifice over 2 cm. but only 6 results were classed as "excellent", 4 as "very good" and 3 as "good". On the other hand, an increase in valve orifice of from 1 cm. to 1.5 cm. was obtained in 58 operations : 12 were classed as "excellent", 28 as "very good", 12 as "good" and 6 as slight or no improvement (3 of the latter died).

At the other end of the scale those cases in which the valve was split by less than 1 cm. were 8 in number. Admittedly two had no improvement and died in 10 months and 2 years 4 months respectively; one had slight improvement, still maintained at 1 year 8 months. Of the remainder one had a "good" result still maintained one year later, three had very good results continuing after 2 years 2 months, 2 years 8 months and 3 years 3 months; one result was "excellent" and was still maintained at the time of assessment 2 years later.

These rather variable results underline the fact that improvement is not based solely on the increase in the size of the valve obtained at operation, but is also dependent on other factors including valve texture and the state of the myocardium.

The full details are shown in Table No. XVIII.

TABLE NO. XVIII.

Result Assessed at Six Months Compared with the Size of Valve Split at Operation.

Size of "Split"	No Improvement	Slight Improvement	Good	Very Good	Excellent	Total
> 2 cm.	-	-	3	4	6	13
1.5-2 cm.	2	-	2	11	6	21
1-1.5 cm.	5	1	12	28	12	58
< 1 cm.	2	1	1	3	1	8
Total	9	2	18	46	25	100

A COMPARISON OF RESULTS AT SIX MONTHS AND AT FINAL ASSESSMENT.

I assessed the patients personally in January, 1957. The time elapsing since the operation ranged from a minimum of six months to a maximum of five years and two months. Naturally, I would have preferred to assess all the cases after five years and longer, but one cannot wait for this length of time in order to discover whether the operation is justifiable or not. I had to make this interim assessment.

Some difficulty was experienced in tracing a few of the cases, but eventually only two were not traced, and for the purpose of assessment two cases operated on in another hospital about the same time have been substituted. Three cases have emigrated, one to British Columbia, one to Australia and one to Rhodesia, and contact has been maintained with the first two. The third has been presumed to have a good result, or her emigration would not have been possible. One patient is now living in London and I am grateful to the doctors at Mile End Hospital for a report of her present condition.

The assessment is based on six categories, being a summation of the findings recorded on the assessment sheet which the author compiled and a copy of which is appended. In the interest of simplicity, and as only 4 patients are involved, "No improvement" and "Worse" are included together under "No Improvement". The other categories are "Slight Improvement", "Good", "Very Good", "Excellent" and "Dead". An excellent result was only recorded if the patient was able to do everything, was aware of no disability and was not fibrillating. The results of the assessment are given in Table No. XIX.

TABLE NO. XIX.

The Results of Mitral Valvotomy in 100 Patients after Six Months and at Final Assessment.

	No Improvement	Slight Improvement	Good	Very Good	Excellent	Dead
At six months	4	3	18	47	24	4
At Final Assessment	6	6	18	41	22	7

There is a distinct move towards a less well category from the assessment at six months to the final assessment. At six months 89% are in the groups "good", "very good" or "excellent". The final figure has been reduced to 81%. It must be remembered that this shift to lesser grades will continue each year.

If one groups the "good", "very good" and "excellent" results together, as seems to be the common practice (Sellors et al: 1953; Turner & Fraser: 1956), one finds that 81% at final assessment had a worthwhile result. Sellors et al

(1953) found that 74% of their patients had a good result, while Fraser & Turner (1956) reported 80% as obtaining a satisfactory result. A personal communication from Sellors (1956) indicates that his good results are now about 85%. The author believes that throughout the country good stable results are being obtained in between 75% to 85% of cases.

Wood (1954) found that 5% of cases had re-stenosed after three years; yet Glover et al (1955) in their review of 50 cases operated on for five years or more, found no evidence of re-stenosis in 41 living patients nor in the valves of those who died in the post-operative period.

So far, re-stenosis would appear to have occurred in two cases of this series. The question whether the re-stenosis results from an inadequate commissurotomy or from re-activation of the rheumatic process must remain for the present unanswered. Case No.6, which has since been re-operated on and Case No.49 who awaits re-operation, both had a valve split of at least 2 cm. and both had a positive auricular biopsy.

<u>Addendum</u>. In August, 1957 news from Australia indicated that Case No.3 appeared to have re-stenosed and would require re-operation. The auricular biopsy in Case No.3 was positive.

RESULTS AFTER THREE OR MORE YEARS.

The shift to the left has been assessed for those patients operated on for three or more years and is shown in Table No. XX.

TABLE NO. XX.

Assessment of the Result Obtained in 37 Cases Operated on Three or More Years Previously, Compared with the Result at 6 Months.

	No Improvement or Worse	Slight Improvement	Good	Very Good	Excellent	Dead	Total
At 6 months	-	1	6	19	11	-	37
After 3 yrs. or more	3	3	7	14	9	1	37

"Excellent" Cases deteriorating after 3 years:

Two cases regarded as "excellent" results deteriorated at $3\frac{1}{2}$ and $4\frac{1}{2}$ years respectively to "no improvement" and "slight improvement". The former had the operation re-done $4\frac{1}{2}$ years later in British Columbia (Case No.6) and the latter had two miscarriages and commenced fibrillating but improved after hospital treatment (Case No.4). She has been regarded as "slight improvement". Both were fairly easy operations and both split from rather less than 1 cm. to 3 cm., the former starting from Grade IV, the latter from Grade III.

"Very Good" cases deteriorating after 3 years:

Case No.5 was "very good" for two years, when he deteriorated and died at 4 years 5 months. He was Grade III. At operation his valve was funnel-shaped and had calcareous scales on the cusps; the valve split from 1 cm. to 2.5 cm. Case Nos. 8 & 26 shifted from "very good" to "good". Case No.26 started from Grade IV. The valve split from 0.5 cm. to 2.5 cm.; she was "very good" for 2 years 9 months, when she developed "flutter" and after treatment for this was regraded as "good". Case No.8 started as Grade III and her valve split from rather less than 1 cm. to 2.5 cm. Subsequantly she had a baby and reverted to "good". Case No.15 was Grade III and the only fibrillating case deteriorating in this group; her valve was not tightly stenosed, being 1.75 cm. splitting to 2.75 cm. She was "very good" for 3 years, when she had a baby and reverted to "worse". The fifth case defaulting from the grade of "very good" is Case No.7. This is the patient who went to stay in London. She has proved to be a most difficult patient, refusing to stay in hospital for treatment of recurring congestive cardiac failure for more than short periods at a time. She has been pregnant on three occasions. She has been re-classified as "slight improvement".

<u>"Good" case deteriorating at 3 years</u>: Case No.19 started from Grade III. The valve was calcified, but split from 1 cm. to 3.5 cm. It is surprising to find that she could only be classified as having a "good" result in view of the good "split" that was obtained at operation. She has now deteriorated to "slight improvement".

<u>"Slight Improvement" deteriorating to "Worse"</u>: Case No.35, a Grade IV case, was found at operation to have fish scale calcification of the valve; nevertheless, the valve split from 1.75 cm. to 3.25 cm. In spite of this good operation result she was only "slightly improved" and latterly she appeared to be "worse".

ANALYSIS of 9 CASES DETERIORATING after 3 YEARS.

Thirty-seven patients had been operated on from 3 to 5 years previously. Eight of these patients deteriorated from their original grade of assessment at six months and one other case died after 4 years 5 months. An analysis of these patients was carried out to see if one or more factors was common to all, which might account for the failure to maintain the original improvement. In respect of age, five of the cases were over 30 and the average for the series was 34. Six of the cases had had symptoms for 4 years or more. Three were classed as Grade IV and six were grade III and only one was fibrillating. Six of the cases had a mitral orifice of 1 cm. or less (in 4 the mitral orifice was judged to be under 1 cm.); of the remainder one was 1.25 cm. and two were 1.75 cm. In four cases a valve split of 2 cm. or more was obtained, three had a split of between 1.5 cm. and 2 cm., and in only two cases was the split less than 1.5 cm. (Case No.15 - 1 cm., Case No.7 - 1.25 cm.). Three valves were calcified, two having fish scale calcification, four were fibrous and two were thin and diaphragmatic (Case Nos. 4 & 6). Six cases retained their grade of improvement for three years or longer, Case No.4 maintaining her improvement for 4 years and Case No.6 for 4½ years.

Four of these patients had one or more pregnancies following the operation and deterioration in each case was dated from the pregnancy.

One other noticeable feature was that five cases were done early in the series, being recorded as operations 4, 5, 6, 7 and 8, but on the other hand, two of these 5 cases had very good operation results with an increase of 2 cm. or more in valve size (Case Nos.4 & 6),. while in 7 out of 9 patients who deteriorated the split was 1.5 cm. or more. Although a valve split of 1.5 cm. might not be looked on as satisfactory, at the present stage of operative experience it is a split of reasonable dimensions, particularly when achieved in a valve found at operation to be less than 1 cm. in size.

The analysis of these cases, to find a common factor responsible for deterioration, had so far been unhelpful. The cases were not older than the average, as one might have expected. In fact, the average age was 2 years less than the average for the 100 cases. The physical disability appears to have been only slightly greater than for the entire series, whereas one would scarcely have been surprised to find that all the cases were in Grade IV. The figures were 3 in Grade IV and 6 in Grade III; in the whole series 10% were in Grade IV and 72% in Grade III. Six of the cases had really tight mitral valve orifices, although two of these were calcified, and all six had a satisfactory "split" and in 4 the split was 2 cm. or more. It seems then that neither the absence of really tight stenosis, nor the failure to achieve a satisfactory "split" at operation can be the reason for the deterioration. It seemed possible that these recurrences in spite of all these patients having low erythrocyte sedimentation rates, one had an E.S.R. of 1, three of 3, one of 4 and four of 5 and a negative blood culture before operation, were due to continuing rheumatic activity. It is, of course, generally accepted that a low erythrocyte sedimentation rate and a negative blood culture are not reliable evidence of the absence of continuing mild rheumatic infection. An analysis of the histological reports obtained from the auricular appendage biopsy of these cases was quite revealing and in sharp contrast to the findings of Goodwin et al (1955). Six, one other has what were regarded as effete Aschoff bodies, of the 9 biopsies revealed well formed Aschoff bodies and the overall histological picture was accepted by the pathologist as showing evidence of continuing rheumatic activity. Curiously enough three of the cases had calcified valves which might be looked on as evidence of burnt out infection. It might be argued that six of the 9 cases retained their grade of improvement for 3 years or longer before relapsing and that, therefore, it is unlikely that continuing rheumatic activity at the time of the operation could have been responsible for relapses after 3 or more years. Counter-argument to this statement might underline the clinical and pathological ignorance that still exists on the pathological course that rheumatic infection takes and when, if ever, rheumatic infection, particularly of the heart, is completely burnt out. No one is aware of any clinical or biological test that will definitely confirm that rheumatic infection has been completely overcome.

In view of the pathological findings of continuing rheumatic activity in six, or possibly seven, out of 9 cases relapsing, the suggestion recently put forward to me by Dr. Alexander of the Chemotherapy Department at the Western Infirmary is all the more interesting. His suggestion is that a series of cases to be submitted to mitral valvotomy should have a full pre-operative course of salicylates for approximately one month before operation. The treatment to be given in hospital and under full biochemical control. The primary purpose of his suggestion was the comparison of the histological picture seen from sections of the appendage taken in comparable series of cases, the one series previously treated with salicylates, the other without salicylates.

In the presence of this evidence of continuing rheumatic activity in six, possibly seven, out of 9 cases deteriorating after initial post-operative improvement, this experiment might well produce interesting long term results as well.

Addendum. Case No.3, reported from Australia in August, 1957, has apparently re-stenosed. At the time of the operation five and a half years ago she was Grade IV. Her valve split from 1 cm. to 3 cm. and she was believed to have had an excellent result. She had worked as a head waitress for six days a week for three years. The auricular biopsy was positive.

If this case is included it will be seen that 10 cases have deteriorated after three or more years. Of these seven, possibly eight, out of the ten had auricular biopsies showing continuing rheumatic activity.

THE INCIDENCE OF POSITIVE AURICULAR BIOPSIES.

Evidence of active carditis as seen in the presence of well formed Aschoff's nodes in the auricular biopsy material is found in 30 - 50% of cases (Lancet: 1953; B.M.J. 1952). These findings do not necessarily preclude an excellent result.

Some authors, notably Goodwin et al (1955), Baker et al (1955), Papp & Zion (1956), Turner & Fraser (1956) and Mounsey (1957), have only been able to show poor correlation between the finding of positive auricular biopsies and the ultimate clinical result.

In this series there appears to be a quite definite tendency for some cases with a positive biopsy to obtain either a less satisfactory operative result or to show deterioration at a later date. The inability of some writers to find positive correlation between the positive biopsies and the poorer results may be because insufficient time has elapsed for the deterioration to occur. According to Wood (1954) mitral stenosis takes from three to fifteen years to develop after active rheumatic valvulitis and he believes that a similar time interval must elapse before the true incidence of re-stenosis is known. If this is true, patients having active carditis at operation may not re-stenose for some years; further, less good results may be obtained because subsequent to the operation a mild, but active, myocarditis smouldering over a period of months or years impairs the action of the myocardium. Glover et al (1955) found repeated episodes of rheumatic activity occurring in 19.5% of patients surviving for five years after operation and in only one third of these cases was the auricular biopsy positive for rheumatic activity.

Ninety-nine auricular biopsies were available in this series; 41 were considered to be positive and 58 were negative. It seemed justifiable to study the progress of these two groups of patients. The result of this study is interesting and seems to be definitely significant. The patients showing a poor operative result or deteriorating from six months to four and a half years after operation were investigated in relation to a positive or negative biopsy. It was found that of 16 cases who had deteriorated, 12 had positive biopsies. Of these patients one has been re-operated on (Case No.6), and one is awaiting re-operation (Case No.48), and five have died (Case Nos.31, 45, 92, 99 and 101). It was possible that no real significance could be attached to this deterioration in these cases and the association of a positive biopsy was fortuitous; perhaps the cases had had a poor valve "split". In fact, only three patients had a "split" of 1 cm. or less; in 9 patients the "split" was 1.5 cm. or more, being over 2 cm. in five instances (Case Nos.4, 6, 19, 26 & 49). It would seem reasonable, therefore, to assume that 9 cases had quite a good operation and that in five the operation had been very successful; therefore it does seem very likely that the factor responsible for the deterioration was active carditis as evidenced by the positive biopsies.

The operation in two of the five positive biopsy cases which died was not very successful, but in the other three cases a valve split of 1.5 cm. or more was obtained. Case No.102 died after 2 months, Case No.100 after 4 months, Case No.93 after 5 months, Case No.32 in 13 months and Case No.46 in 2 years 3 months.

Four patients having negative biopsies deteriorated. One was in Grade II, two were in Grade III and one was in Grade IV (Case Nos. 7, 8, 35 and 62). In Case No.8 the valve opening was enlarged by only 1.25 cm. She was very well for 2 years, but she was a difficult patient to keep under observation and a succession of three pregnancies caused considerable deterioration accompanied by bouts of congestive cardiac failure. Now after 4½ years she is classed as only "slight improvement". The other three cases had valve enlargement of 1.5 cm. at operation; one subsequently had a baby and regressed from "very good" to "good" after 4½ years; one had a good result but reverted to "no improvement" after 2 years; and one was only "slightly improved", deteriorating to worse after 3 years.

It could be argued that these four patients have deteriorated for no very obvious reason. Could it be that the 12 positive biopsy patients showing deterioration had done so through a similar unknown cause? Against this argument it should be pointed out that only 4 patients out of 58 having a negative biopsy have deteriorated, whereas no less than 12+ patients from a considerably smaller number, namely 41 patients with positive biopsies, have deteriorated, surely making this disproportion highly significant. These figures are in sharp contrast to those reported by Mounsey (1957).

In view of these findings the suggestion made by Dr. Alexander of the Chemotherapy Department, Western Infirmary of giving cases of mitral stenosis a course of salicylates before operation would seem more than justified.

+now 13.

THE VALUE of LINGULAR BIOPSY SPECIMENS.

In view of the doubts cast by Enticknap et al (1954) on the value of lingular biopsy, and the possible post-operative complications arising as a result of removing a portion of lingula for this purpose, it seemed desirable to analyse the histological results in 99 biopsies taken in this series.

Enticknap et al (1954) proved that haemosiderosis could be diagnosed and graded in severity very nearly as accurately by expert radiological examination. They also showed that the lingula and right middle lobe have a greater amount of arteriolar disease than the other lung lobes and that patients undergoing lingular biopsy have a higher and more prolonged fever than patients having no such biopsy. They further found pleural effusion more frequently and of greater quantity necessitating additional aspirations. Occasionally local lung abscess or necrosis develop at the site of the biopsy, the procedure being therefore not without risk.

No attempt has been made here to confirm or disprove their findings; indeed, much of their work is self evident and one agrees with them that lingular biopsy provides no information that cannot be roughly estimated on clinical grounds.

The investigation carried out on lingular biopsy in this series of cases has been confined to the association, if any, that pulmonary arteriolar hypertrophy might have on the results of the operation, and any relationship that there might be between pulmonary arteriolar hypertrophy and subsequent deterioration of the cases involved.

Thirty-two lingular biopsies out of a total of 99 revealed evidence of pulmonary vascular hypertrophy. Of these patients seven maintained an "excellent" result, sixteen a "very good" result and two a "good" result. Three patients died. One "excellent" result required re-operation at 4½ years, one "very good" result awaits re-operation at 3 years, one "very good" result is now classed as "worse" and one had "no improvement". That is to say that seven out of thirty-two patients showing pulmonary vascular hypertrophy deteriorated, but at least two of these did so for quite a different reason, namely re-stenosis; the three deaths were thought to have resulted from a combination of badly deformed valves and rheumatic carditis. The case showing no improvement was Case No.85, who had a successful operation, but proved ultimately to be temperamentally unsuited for surgery. This leaves Case No. 15 who was "very good" for 3 years, when she had a baby and became worse.

Taken all in all pulmonary vascular hypertrophy, as found at lingular biopsy, seems to bear no relationship to the clinical result ultimately obtained; these findings conform to the clinical impression reported by Mounsey (1957).

In view of this evidence it would now seem that lingular biopsies are no longer justified.

As a point of additional, but passing interest, 68 out of the 99 specimens showed iron-filled macrophages.

CONCLUSIONS.

The analysis of this series of 100 cases surviving valvotomy proves conclusively that the operation is well worthwhile. The patients surviving operation will show nearly 90% "good" to "excellent" results at six months. This figure will be reduced to approximately 80% to 85% after three years; thereafter some further reduction may be expected, but it should be small in amount.

The Type of Case suitable for operation: Now that the pioneer work of Brock and others has been completed, it is quite evident that poor risk cases should not be submitted to operation. Even in my much more limited experience, sufficient cases have been operated on and results assessed to give a very definite impression that not only should the poor risk cases be refused operation, but also the type of case in which for one reason or another I have doubts as to the wisdom of performing valvotomy. The latter type of patient is generally middle-aged, and fibrillating, presenting clinical signs which raise considerable doubt as tb the tightness of the stenosis and uncertainty in the patient's ability to withstand a major surgical procedure. It has been my unhappy experience that to operate on such cases is to prove either that the uncertainty of the diagnosis was more than justified, or that the doubt of the patient's ability to withstand surgery was proved by the fatal outcome of the operation.

I believe that the emphasis should be at the other end of the scale, that operation should be carried out as soon as symptoms develop; only in this way will a lower operative mortality be obtained and a better post-operative result be achieved.

In young people there is a danger of attaching too little importance to a complaint of breathlessness, since tight mitral stenosis and pulmonary hypertension may be present, although the heart is of normal size and there is no obvious congestion of the lungs at the time of the examination. An attack of pulmonary oedema should be regarded as a danger signal, and operation should no longer be delayed. Turner & Fraser (1956) state that at one time, when there were many cases awaiting operation, the mortality was greater among those on the waiting list than in those undergoing operation. Three years ago I saw a male patient of 25 with classical signs of mitral stenosis, and as the patient had only mild symptoms, it was agreed that he should be kept under observation and that operation should be delayed. Some months later the patient died suddenly during a first attack of pulmonary oedema.

It should be recognised that a policy of delay is dangerous in patients having symptoms. No one can tell when sudden deterioration may occur or when auricular fibrillation may develop, and greatly increase the hazards of the operation. Auricular fibrillation raises the likelihood of intracardiac thrombus and clot, with their attendant problems at operation, the difficulty of gaining entry into the heart and the danger of cerebral embolism. It is also reasonable to assume that the myocardium of patients having symptoms will withstand the strain of mitral stenosis only so long before failure begins and the heart starts to enlarge. No one can tell when this will happen.

<u>Blood replacement at operation</u>: It is essential that at least four pints of blood, already matched, be available in the theatre precincts. It has been shown that replacement of blood, as it is lost in the course of the operation, is much to be preferred to replacement later.

For this purpose a Martin's blood transfusion accelerator pump is invaluable, not only to replace large quantities of blood suddenly lost, but also quickly to replace smaller quantities in order to restore the heart action to normal. It is used to "boost" the blood pressure, before allowing further escape of blood to wash out any intracardiac clot at the end of the valvotomy. Blood sugar levels taken in five patients undergoing valvotomy, clearly demonstrate the value of blood replacement in preventing shock, when compared with blood sugar levels in a series of patients undergoing Wertheim's operation without continuous blood replacement.

The Operation: I have found that the right lateral is the best position and I prefer a complete thoracotomy through the bed of the mobilised fourth rib. I also believe that this wider exposure is safer and gives more room in which to work.

If a shrivelled, or otherwise inadequate, auricular appendage is found, the atrial wall is immediately available should it be found necessary to alter the approach and use the atrium. Experience with the antero-lateral approach gave a feeling of insecurity, in that the atrial wall was not really visible nor was it readily available. Further, if an atrial tear occurred, the full lateral position provided much more room in which to work.

In the earliest cases the pericardium was opened in front of the phrenic nerve; experience has shown that it is better to open the pericardium behind the nerve and to curve the incision posteriorly at its lower end. Instead, as formerly, of closing the pericardium completely, it is thought to be wiser to leave an opening of one inch at the lower end, to allow drainage from the pericardium into the pleural cavity. Free drainage from the pericardium may reduce the incidence of auricular fibrillation and the post-commissurotomy syndrome.

The appendage should be opened before any stitches or clamps are applied, thus reducing the danger of clot dislodgement. If the neck of the appendage is narrow and admits the finger grudgingly, it is much wiser to use the Rumel's cardiac snare on the atrium around the base of the appendage, rather than to take any chances by proceeding without this additional precaution. If the appendage is unsuitable, then entry through the atrial wall using the Rumel's cardiac snare provides good and safe access. Nevertheless, in either of the latter circumstances it is a wise precaution to fit up a second blood transfusion before entering the heart. The use of mersilene as the suture material for the cardiac snare is dangerous, and resulted in the knot slipping in one case.

The difficulties associated with leathery, calcified and funnel valves are discussed. It is clear that the best method of dealing with this type of valve is through the ventricle, using a Tubbs mitral valve dilator or special scissors, either instrument being guided into position by a finger inserted through the appendage in the usual way. The impossibility of dividing the posterior commissure in a funnel valve, using a knife entered through the atrial appendage, is illustrated.

The possibility of a "ball" thrombus circulating within the atrium, and particularly one too large to reach the appendage opening, is mentioned. It may be felt gently nudging against the finger during the intra-atrial manipulations. Such a thrombus must be "fished out" by the flexed finger through the appendage opening, and an extensive escape of blood be permitted to flush out any broken off fragments still floating in the atrium.

Valve calcification: The complication of valve calcification was found in 54% of valves, if one includes subendocardial pin-head nodules. These nodules were usually on the A-V ring and did not interfere with the valvotomy. In 27% the calcification was on the valve cusps and in 3% the valve was completely calcified. Calcification appeared to have a predilection for the posterior commissure; it was localised to this site in 59% of valves showing cusp calcification, and it commonly occurred as a horse-shoe encircling the posterior aspect of the valve orifice. The calcification may be in the form of spicules which may tear the surgeon's glove. Fifteen cases with calcified valves had some degree of incompetence.

While calcification by itself does not necessarily nullify the operative result, its presence makes the operation more difficult and dangerous because of the possibility of cerebral embolism and of atrial tears, the result of forceful attempts to split the valve.

Closure of the appendage should be complete and certain. It is readily achieved using interrupted overlapping mattress stitches. It is pointed out that any doubt in regard to adequate control of the appendage opening is inexcusible.

The value of diathermy over ligation in controlling bleeding from flat surfaces is stressed and the advantages of a wide-bore polythene drainage tube with three lateral openings, passed up to the level of the first rib, is underlined. Gradual removal of the tube generally allows an additional 5-10 ounces of fluid to escape.

Physiotherapy: Efficient and early physiotherapy is important. The desirability of at least one week of preliminary pre-operative education is stressed, and the necessity for early post-operative expectoration, even in the presence of wound discomfort, is urged. Good physiotherapy is shown to obviate much post-operative trouble.

Operative complications: These are discussed in detail, and the various methods found most appropriate to deal with each is mentioned. The control of atrial tears is best dealt with by avoiding them or by using the Rumel's cardiac snare when there is any likelihood of a tear occurring. An instrument has been devised to control the smaller tears, which allows sutures to be inserted while the tear is controlled. Larger tears would seem to be best controlled by retaining the finger within the atrium and using the flexed finger to dam-up the hole while it is being sutured.

The prevention of cerebral embolism is likely to be most efficiently achieved by snaring the carotid and innominate arteries, but even this method is not foolproof.

Post-operative complications: Apart from haemorrhage, the most important post-operative complication is auricular fibrillation. The urgent necessity of the early recognition and treatment of auricular fibrillation is discussed. It is believed that the auricular fibrillation per se is of little importance, but that slowing of the heart rate by intravenous digoxin, before congestive cardiac failure can develop, is of paramount importance. The danger of failing to recognise that auricular fibrillation is present is pointed out, and the disastrous consequences that may follow are mentioned.

Return to sinus rhythm may occur on digoxin therapy alone. If not, it is advised that the use of quinidine should be delayed for at least 14 days after the onset of fibrillation, when it is more likely to produce normal rhythm, than if employed at an earlier date. Once sinus rhythm has been regained, quinidine therapy should be continued for several days, when the dose can be gradually reduced.

To stop quinidine too rapidly invites the recurrence of the fibrillation.

The pre-operative use of digoxin and quinidine, singly or together, appears to have no effect in the prevention of fibrillation. The use of these drugs before operation has now been abandoned.

Congestive heart failure: The urgency of the treatment of congestive heart failure is stressed, and should consist of digoxin, if fibrillation has occurred, accompanied by diuretics such as mersalyl or neptal. If pulmonary oedema is present, and the patient has difficulty in "raising" the sputum, bronchoscopic aspiration should be undertaken.

The "preparation" for bronchoscopy is outlined, and the ease with which the bronchoscopy can be carried out with the patient in bed is emphasised. It is pointed out that a patient with pulmonary oedema is never too ill to be bronchoscoped.

Sputum retention: The avoidance of sputum retention by efficient physiotherapeutic measures is discussed in detail. Reduction in the amount of sputum produced after the operation has been achieved by giving 2 c.c. of neptal or mersalyl, as a routine, every second day from the second post-operative day. Two or three doses are usually sufficient. The diuretic is given along with ammonium chloride, gr. $7\frac{1}{2}$ thrice daily. It has been found that diuresis following these measures is not excessive, that urinary output tends to approach more nearly to normal amounts, instead of being reduced following the operation, and that the amount of sputum collecting is much decreased.

Post-commissurotomy syndrome: While some patients have continued to be in a mild pyrexial state for several days longer than others, the post-commissurotomy syndrome does not appear to have been a very clear cut post-operative occurrence.

Convalescence: The value of close co-operation between the general practitioner and the surgeon during the months following the operation is indicated. The general practitioner cannot be expected to diagnose and treat all the complications that may arise. Further, there is the danger that the practitioner may accept a patient's deterioration as an operative failure when, in fact, some other condition such as a delayed empyema may be the cause.

Operative mortality: There were 10 deaths directly or indirectly associated with the operation. Two deaths resulted from haemorrhage and two occurred early in the series from inadequate valvotomy. It is thought that with increased operative experience, deaths due to these causes should not now occur.

The possibility of cardiac arrest, occurring during induction of anaesthesia, should always be kept in mind, so that immediate resuscitative measures including cardiac massage can be instituted.

The operative mortality will be between 3 and 10%, depending on the type of case being accepted for surgery.

Clinical findings following valvotomy: The majority of patients put on weight following a successful valvotomy, in some quite alarming amounts requiring strict dietary control.

Auscultatory findings frequently show little alteration. Shortening and accentuation of the mitral first sound are usually less obvious; while the slapping character of the second pulmonic heart sound is reduced. In 47% of patients with a pre-operative opening snap, the snap was still present. In 28% of the patients with a pre-operative presystolic murmur, the murmur could still be heard, The diastolic murmur usually remained little, if at all, altered.

Pregnancy. Successful valvotomy enables the patient, previously suffering considerable disability, to have sexual intercourse; as a result, pregnancy following valvotomy is quite a frequent occurrence. Seven cases in this series became pregnant, one of these on three occasions. Pregnancy definitely throws a strain on these patients and may lead to subsequent relapse. It seems desirable, therefore, that following valvotomy, pregnancy should be avoided for at least one year, and that the number of pregnancies should be strictly limited and should depend on the patient's response to the first pregnancy which should be very carefully supervised.

Comparison of predicted result with actual result. It was found that the result predicted at the time of the operation erred quite considerably on the conservative side. Generally, a valve split of small extent was expected to give only a moderate result, but this was by no means always the case, as several patients had good or excellent results. This would suggest that the grade of improvement need not necessarily depend solely on the size of the valve split achieved; other factors, such as unsuspected smouldering rheumatic carditis or impaired myocardial muscle, must play a part. The reverse is equally true, as a commissurotomy of poor extent, in an otherwise healthy heart, may give a beneficial result far beyond one's expectations. Sixty nine per cent of the patients in whom a comparatively small commissurotomy was obtained, i.e. 1-1.5 cm., when assessed at six months, were found to have a "very good" to "excellent" result.

Comparison of assessment at six months with final assessment.

Ideally, and in order to obtain an accurate picture of the progress of patients undergoing mitral valvotomy, one would wish to compare the assessment of each case at six months and at five years or longer. Naturally, this would entail undue delay, and some feature of importance might be missed in the treatment of those cases awaiting surgery. Thus, in each case the assessment at six months had to be compared with the "final" assessment made in January, 1957. Consequently, some cases were being compared at five years while in others the comparison was a little more than six months. Unsatisfactory as this method is, it does provide some useful information.

As expected, there is a distinct "shift" to a less satisfactory category. At six months 89% were assessed as "good", "very good" or "excellent", but at the "final" assessment this figure had been reduced to 81%. It is anticipated that a further, though smaller, shift will occur when all the cases have completed the five years period of observation. It would appear, from various papers published and personal communications with other thoracic surgeons, that 75% to 85% of patients should derive a good result from the operation (Brit.Med.J. 1955).

Analysis of 37 cases operated on three or more years previously.

Thirty-seven cases had been operated on three or more years previously. This group was analysed more completely, and it was found that 8 patients had deteriorated and one had died. Seven of the patients had a valve "split" of 1.5 cm. or more (in 4 the split was over 2 cm.), and thus these cases had a good and effective operation. The average age was below the average for the series; admittedly, the valve was calcified in three instances, but only one case was fibrillating. Six maintained their initial improvement for 3 years or longer (one for 4 years and one for 4½ years). Four of the eight female patients fell pregnant, and each dated the deterioration from the pregnancy. Until the auricular biopsy reports of these cases were studied, it seemed that there was no factor common or peculiar to them, other perhaps than pregnancy occurring in four.

Six of the 9 biopsies showed well-formed Aschoff bodies, and the overall picture was accepted by the pathologist as showing evidence of continuing rheumatic activity. It is suggested that this finding is the reason for the deterioration in the majority, if not all, of these cases, and that the explanation for the maintenance in improvement for 3 or more years is probably due to the mild nature of the rheumatic process. Since the completion of this investigation, the suggestion was made by Dr. Alexander of the Chemotherapy Department, Western Infirmary, Glasgow, that a series of cases of mitral stenosis should be given a full course of salicylates before valvotomy and that comparison should be made of the histological results of auricular biopsies from these patients with the biopsies from patients without such pre-operative medication. Primarily, his idea was to see what effect, if any, a course of salicylates would have on the histological picture of mitral valvotomy cases, this being the only method whereby histological tissue could be obtained from the heart in cases under salicylate therapy. In view of the above findings of positive auricular biopsies in a large proportion of patients deteriorating after valvotomy, Dr. Alexander's suggestion of giving a course of salicylates before operation is well worthy of trial, and might well prove to have far-reaching effects in obtaining better long term results.

Following the discovery and recognition of this association between deterioration of cases and positive auricular biopsies, it became obvious that the entire 100 cases should be analysed for the relationship between post-operative results or subsequent deterioration and the presence of positive auricular biopsies.

In spite of the fact that the authors of several authoritative papers failed to find any relationship between the operative results and positive biopsies, there appears to be a quite definite association in this series of patients. Of ninety-nine auricular biopsies available for study, 41 were considered to be positive and 58 negative. Sixteen patients (including 5 deaths), showed a poor operative result or deteriorated from six months to four and a half years after the operation, and of these, 12 had positive auricular biopsies. It was considered possible that the operations might not have been satisfactory but, in fact, investigation showed that in 9 instances the "split" was 1.5 cm. or more, being over 2 cm. in five cases, and therefore the operation had been successful in these cases. That is to say, 12 out of a total of 41 cases with positive auricular biopsies had either a poor operative result or deteriorated later; whereas only 4 out of 58 patients with negative biopsies showed similar deterioration, and two of the four patients fell pregnant, one three times, before this occurred.

Lingular biopsies. In view of the doubts cast by Enticknap et al (1954) on the value and advisability of performing lingular biopsies, an investigation was made into the lingular biopsy results in this series. It was found that out of a total of 99, thirty-two showed evidence of pulmonary vascular hypertension and on investigation it was decided that this finding bore no relationship to the ultimate clinical result obtained. In view of the potential dangers associated with lingular biopsies, it was considered that they were no longer justified.

To sum up, undoubtedly the operation of mitral valvotomy is a great advance in surgery, bringing as it does considerable improvement to the majority of patients operated on, an improvement which, in most instances, is maintained. It would be foolish and quite unjustified, however, to imagine that the battle against mitral stenosis has been won. Clearly there are several problems still to be solved with ample scope for further research into their solution. Perhaps the most important problem is the cause of the deterioration that occurs in a proportion of cases after several years. The cause of this deterioration must be sought for and, if possible, eradicated. Of almost equal importance is the uncertainty, even amongst skilled pathologists, of what represents on histological grounds the presence of continuing rheumatic carditis. Until some solution of this aspect of the problem is found, the diversity of views at present expressed regarding the relationship of positive biopsy findings to later deterioration will continue. Some clarification might result from a study of the auricular biopsies taken from comparable series of cases, the one series treated with salicylates for fully one month before operation, the other without such treatment. By adopting this investigation it is just possible that the group treated with salicylates might show no, or obviously effete Aschoff bodies, while the untreated group would continue as in this series to produce a number of positive biopsies. It does seem to me that, only by a positive method of attacking the problem such as here envisaged, will a solution, or at least a partial clarification, of this problem be achieved. It is difficult to see the solution of this problem being reached without some positive attempt such as is suggested here.

It may ultimately be proved that prolonged penicillin treatment subsequent to the operation greatly reduces the incidence of deterioration. In this present series the first patients given prolonged post-operative penicillin are only now reaching three years after operation and further time must elapse before any conclusions can be made.

It is essential to plan now for those cases yet to be operated on if progress is to be made and new knowledge is to be gained. It would seem desirable to divide the new cases into groups. With the advent of a much better valvotomy using the mitral valve dilator, it is essential to re-assess the effect of a good technical operation. Therefore, one group of cases will require to have the operation without supplementary therapeutic measures. A second group of cases should have a preliminary course of salicylates before the operation, with a continuation of salicylate treatment after operation, possibly combined with penicillin for several months. A third group of cases should continue on prolonged oral penicillin therapy after valvotomy and this treatment might be extended from the present three months to several years. Prolonged courses of oral penicillin have been used so extensively in other conditions without dangerous side effects, that a similar long term course in these cases would seem justified.

It seems to me that only by some positive approach such as grouping of cases along the lines suggested, will further progress in the treatment of mitral stenosis be made, better long term results be obtained, and some answers to our present problems be forthcoming.

SUMMARY.

The clinical features of mitral stenosis are discussed with particular reference to age, the incidence of rheumatic fever and the method of grading in 100 cases surviving valvotomy. The cardinal features of the examination of these cases are discussed. The pre-operative preparation is mentioned and the various important aspects of anaesthesia, blood transfusion and the technique of the operation are explained. Some of the operative difficulties are underlined, and suggestions are made in preventing or dealing with them. The recognition and the treatment of the various post-operative complications is important. The operative mortality figures are given, and the causes of death are discussed. The alterations in the clinical examination following the operation are detailed. The results predicted at the time of operation are compared with the results obtained. The result at six months is assessed in relation to the valve split. The assessment at six months is compared with the "final" assessment. A special analysis is made of the cases operated on for three or more years, with particular reference to those cases showing deterioration. Positive auricular biopsies are

correlated with the results and the value of lingular biopsies discussed. Various conclusions are drawn from these different aspects of mitral stenosis and its treatment.

Acknowledgements.

It is a real source of pleasure to me to express my sincere thanks to Mr. George Dalziel and Mr. Bruce M. Dick for their kindness in granting me facilities to start the operative treatment of these patients in their wards. Truly, without their kindly encouragement and co-operation, this work would not have been possible. I also wish to thank Mr. A.B. Kerr for so happily continuing the facilities granted by Mr. Dalziel, Professor Illingworth for providing me with some of the operating theatre facilities and the Anaesthetic staff of the Western Infirmary Hospital Group, in particular Dr. Pinkerton, ably supported by Dr. H.Y. Wishart, Dr. A.G. Millar and many others.

It would be ungracious of me to forget to thank the physicians for their co-operation in sending the patients to me, in spite of the many trials and tribulations I caused them and their patients.
I am most grateful to the late Dr. Snodgrass, Sir John W. McNee, Professor Wayne, Dr. MacCluskie, Dr. T.N. Fraser, Dr. J.D. Olav Kerr, Dr. J.G. Graham, Dr. Semple, Dr. Morris and many more.

I wish to thank Professor D.F. Cappell and his staff for the pathological reports; the Registrars, House

Officers, Sisters and the Nursing and Physiotherapy staffs of the Western Infirmary, Glasgow; Hairmyres Hospital, East Kilbride and the Infectious Diseases Hospital, Paisley.

I am indebted to Miss Graham for the drawings and Mr. Robert McLean for the photographs, prepared for me in the Medical Illustration Department, Western Infirmary, Glasgow.

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MITRAL VALVOTOMY FOLLOW-UP

Full Name..

Address..

Date of reporting....................
Date of operation....................
How long since operation.....................

Assessment of exercise tolerance.

A. Breathlessness.	On level ground No. of tenement blocks.	cf. before op.
	Hospital drive	" " "
	Stairs, how many tenement houses	" " "
B. Housework.	A little	cf. before op.
	All	" " "
	Scrubbing	" " "
	Polishing	" " "
	Vacuum	" " "
C. Shopping.	Carry all shopping	cf. before op.

Pillows at night

Nocturnal dyspnoea.

Cough. Spit. Haemoptysis. Tiredness. Chest Pain.

D. Working. cf. before op.

Occupation cf. before op.

Increase in weight. Digitalis.

Pregnancies since operation

Hospital re-admissions & diagnosis.

Still improving. Deteriorating since

Patient's assessment of operative result -
Worse. No improvement. Slight improvement. Good. V.Good. Excellent.

Other observation X-ray.

Examination.
Appearance - Well. Unwell. Breathless. Cyanosis. Neck veins. Oedema.

Pulse Regular / Irregular Pulsation / Thrills. Rt. ventricle thrust. Character of Apex.

M.1. Normal. Slight accentuation. Marked accentuation. Short. Sharp. Slapping.

M.2. Normal. Reduplicated. Definite opening snap.

Mitral Murmurs. Presystolic. Diastolic. Early. Mid. Late. Soft. Rough.
Systolic. Early. Mid. Late. Harsh. Replacing M.1.

Aortic Murmurs. Systolic. Short. Long.
Diastolic. Short. Long.

Pulmonic Murmurs. Tricuspid.

Examiner's assessment of result.

Worse.
No improvement.
Slight improvement.
Good.
Very good.
Excellent.

Remarks.

APPENDIX.

Brief Case Summaries.

Case No. 1.	M.B.
Sex:	F.
Age:	30.
History:	Breathless for 5 years since confinement. Haemoptysis. Regular. Presystolic.
Grade:	III.
Operation:	26.11.51. Valve - 1 cm. to 3 cm.
Complications:	Fibrillation 6th day in spite of pre-operative quinidine and digitalis; became regular. Right pulmonary infarction.
Auricular Biopsy:	Negative.
How long since Operation?	5 years 2 months.
Assessment:	Very good.

Case No. 2.	J.B.
Sex:	Male.
Age:	37.
History:	Attack of acute pulmonary oedema while driving his car 3 weeks ago. Breathless for 3 years. Haemoptysis.
	Regular. Presystolic.
Grade:	III.
Operation:	14.1.52.
	Valve - 1 cm. to 1.5 cm. Knife cut purse string stitch. Haemorrhage. Asystole for 12 seconds. Further split abandoned.
Complications:	Fibrillation 2nd day; regular 6th day. 10th day drowsy; pins and needles in left arm. Collapsed suddenly and died.
Auricular Biopsy:	Positive.
Assessment:	Died 10th day. Operative death.

Case No. 3.	E.H.
Sex:	Female.
Age:	36.
History:	Breathless 2½ years when pregnant - terminated. In bed for long periods. Massive haemoptysis. Regular. Presystolic.
Grade:	IV.
Operation:	23.1.52. Valve - 1 cm. to 3 cm. Brock's knife.
Complications:	Effusion.
Auricular Biopsy:	Positive.
How long since Operation:	5 years.
Assessment:	Excellent. Emigrated to Australia. Head waitress working six days a week

Addendum: A letter from Australia received on 25.8.57 stating that the valve appears to have re-stenosed and that further valvotomy will be required.

Case No. 4. E.P.

Sex: Female.

Age: 28.

History: Increasing breathlessness for several years. Cerebral embolism 6/52 ago - cleared completely. Three months pregnant.
Chorea three times.
Regular. Presystolic.

Grade: III.

Operation: 28.1.52.

Valve - 1cm. to 3cm. Pinheads of calcification.
Slight regurgitation after valvotomy.

Expected result: Very good.

Auricular Biopsy: Positive.

Weight increase: 3 lbs.

How long since Operation: 5 years.

Assessment: Excellent for 4½ years; following two miscarriages - fibrillation - slight improvement.

Case No. 5. C.P.

Sex: Male.

Age: 37.

History: 4 years breathless following pneumonia. Incapacitated 18 months.

Regular.

Grade: III.

Operation: 30.4.52.

Valve - 1cm. to 2.5cm. Funnel. Fish scale calcification; glove torn.

Auricular Biopsy: Negative.

How long since Operation: 4 years 5 months.

Assessment: Very good for 2 years.

Deteriorated and died 4.5/12 years.

Case No. 6. M.R.

Sex: Female.

Age: 37.

History: Breathlessness 3 years. Bouts of congestive failure.
Rheumatism at 18.
Regular.

Grade: IV.

Operation: 18.6.52.

Valve - 1cm. to 3 cm. Diaphragmatic.

Expected result: Very good.

Complications: Fibrillation 10th day in spite of pre-operative digitalis and quinidine.

Embolus right lower leg 12th day (popliteal).

Auricular Biopsy: Positive.

Weight increase: 11 lbs.

How long since Operation: 4 years 7 months.

Assessment: Excellent for $3\frac{1}{2}$ years. Deteriorated and re-done at 4 years.

Case No. 7.	M.V.
Sex:	Female.
Age:	25.
History:	Breathless since pregnancy 4 years ago. Early congestive failure one year ago. Difficulty with even simple household duties. Haemoptysis.
	Regular. Presystolic.
Grade:	III.
Operation:	1.7.52.
	Valve - 1.25 cm. to 2.5 cm. some calcification.
Complications:	Thrombophlebitis left leg on 7th day.
Auricular Biopsy:	Negative.
How long since Operation:	4½ years.
Assessment:	Very good but has had three babies and deteriorated to slight improvement. Unco-operative.

Case No. 8. M.H.

Sex: Female.

Age: 32.

History: Pregnancy $1\frac{1}{2}$ years ago, breathless since. Unable to carry child.
Haemoptysis. St. Vitus Dance. Angina.

Regular. Presystolic.

Grade: III.

Operation: 8.7.52.

Valve - 1cm. to 2.5cm.

Complications: Pleural effusion.

Auricular Biopsy: Negative.

How long since Operation: $4\frac{1}{2}$ years.

Assessment: Very good; then pregnancy to good.

Case No. 9. W. O'N.

Sex: Male.

Age: 26.

History: Breathless 18 months; in hospital several times with haemoptysis.
Rheumatic fever.
Regular. Presystolic.

Grade: III.

Operation: 5.9.52.

Valve - 1cm. to 2.5cm.; gritty calcification.

Auricular Biopsy: Positive.

Weight increase: 9 lbs.

How long since Operation: 4 years 4 months.

Assessment: Excellent.

Case No. 10. J.F.

Sex: Male.

Age: 32.

History: 3 years breathlessness on exertion with angina. Palpitation, haemoptysis. Occasional "rheumatics".
Presystolic.

Grade: II(b).

Operation: 26.9.52.

Complications: Cardiac asystole during anaesthetic induction. Not appreciated at first on account of good colour. Rapid thoracotomy; heart stopped; heart would not re-start.

Assessment: Operative death.

Case No. 11.	M.G.
Sex:	Female.
Age:	26.
History:	Breathlessness following pregnancy 5 years ago. Chorea and muscular rheumatism. Regular. Presystolic. Opening snap.
Grade:	II(b).
Operation:	8.10.52. Valve -.1cm. to 2.5+. Very slight regurgitation after.
Complications:	Fibrillated. Atelectasis - total left lung. Bronchoscopy.
Auricular Biopsy:	Negative.
Weight increase:	2 stone.
How long since Operation:	4 years 3 months.
Assessment:	Excellent.

Case No. 12. I.W.

Sex: Female.

Age: 43.

History: Breathless and chest pain 13 years. Cardiac failure four times. Bedridden. Haemoptysis. No rheumatism. Fibrillating.

Grade: IV.

Operation: 3.11.52.

Valve - 5 cm. to 2.5 cm. Funnel, very fibrous. Ball thrombus.

Complications: Embolus in right brachial artery.

Auricular Biopsy: Negative.

Weight increase: 2 stone.

How long since Operation: 4 years 2 months.

Assessment: Very good.

Case No. 13. M.J.

Sex: Female.

Age: 40.

History: Four years breathlessness. Haemoptysis. Muscular rheumatism.

Fibrillating. Aortic.

Grade: III.

Operation: 14.1.53.

Valve - 2.5cm. to 3.5cm. Heart unusually irritable. Profuse bleeding around finger; some splitting but required a knife and pulse now unrecordable - knife not used.

Auricular Biopsy: Positive.

Complications: 24 oz. drainage.

Result: Died 1st post-operative day.

Remarks: Now with Martin's pump should have forced blood in and once recovered used Brock's knife.

Assessment: Operative death.

Case No. 14.	J.M.
Sex:	Male.
Age:	38.
History:	3 years breathlessness. Off work six weeks. Regular. Presystolic.
Grade:	III.
Operation:	1.12.52. Valve - 1 cm. to 2.5 cm. Heavy leaves of calcification. Faint regurgitation.
Complications:	Superficial phlebitis 17th day.
Auricular Biopsy:	Positive.
Weight increase:	1 stone.
How long since Operation:	4 years 1 month.
Assessment:	Originally excellent now very good.

Case No. 15. H.W.

Sex: Female.

Age: 29.

History: Breathlessness during first pregnancy seven years ago, worse during second pregnancy. Walk on level slowly; few steps only. Haemoptysis. Paroxysmal dyspnoea. Rheumatic fever.

Fibrillating.

Grade: III.

Operation: 23.1.53.

Valve - 1.75 cm. to 2.75 cm. Knife.

Complications: Fibrillation on 18th day, in spite of pre-operative digitalis.
Atelectasis and sputum retention.
Pleural thickening.

Auricular Biopsy: Positive.

Weight increase: 3 lbs.

How long since Operation: 4 years.

Assessment: Very good till pregnancy at 3 years to worse.

Case No. 16. N.P.

Sex: Female.

Age: 49.

History: Breathless. Little housework.
Irregular. Presystolic.

Grade: III.

Operation: 11.2.53.
Valve - 1cm. to 3.75cm. Moderately thick. Some calcification.

Auricular Biopsy: Negative.

How long since Operation: 3 years 11 months.

Assessment: Good.

Case No. 17.	D.B.
Sex:	Female.
Age:	32.
History:	Two years breathlessness on exertion. three months tired. Housework slowly. Haemoptysis. Rheumatic fever twice. Regular. Presystolic.
Grade:	III.
Operation:	13.2.53. Valve - 1 cm. to 3 cm. slight funnel. Moderately thick.
Complications:	Fibrillation. Developed sore throat. swelling and tiredness of her hands, elbows and shoulders. ?quinidine poisoning. Sputum retention. Atelectasis.
Auricular Biopsy:	Negative.
Weight increase:	2 stone.
How long since Operation:	3 years 11 months.
Assessment:	Very good +.

Case No. 18. M.B.

Sex: Female.

Age: 40.

History: 9 years increasing breathlessness. Haemoptysis. Measles only.

Regular. Presystolic.

Grade: III.

Operation: 17.2.53.

Valve - 1 cm. to 4 cm. Slight calcification.

Complications: Fibrillation in spite of pre-operative quinidine.

Auricular Biopsy: Positive.

Weight increase: $1\frac{1}{4}$ stone.

How long since Operation: 3 years 11 months.

Assessment: Very good.

Case No. 19. J.T.

Sex: Female.

Age: 24.

History: Five years breathless on exertion; found work increasingly difficult. No real housework for 2 years. Haemoptysis. Chorea.

Regular. Presystolic.

Grade: III.

Operation: 20.2.53.

Valve - 1 cm. to 3.5 cm. Some calcification. Slight regurgitation.after.

Complications: Fibrillation evening of operation - persisting.

Auricular Biopsy: Positive.

How long since Operation: 4 years.

Assessment: Good till 3½ years. "Bronchitis" to slight improvement.

Case No. 20. B. McK.

Sex: Female.

Age: 28.

History: 9 years breathlessness since rheumatic fever. Haemoptysis. Stopped work 1 year.

Presystolic. Diastolic.

Grade: III.

Operation: 3.3.53.

Valve tightly stenosed, uniformly calcified. Appendage small. Difficulty in splitting thick posterior commissure. Atrial tear occurred. Not controlled till heart stopped. Heart would not restart.

Assessment: Operative death.

Case No. 21. B.B.

Sex: Female.

Age: 42.

History: Breathlessness and ankle swelling 5 - 6 years. Breathless during pregnancies. Congestive failure. Cyanosis.

Fibrillating. Aortic.

Grade: IV.

Operation: 23.3.53.

Valve not attempted.

Complications: Appendage short and small would not admit finger. Atrium thick shell of organised thrombus, superior vein thrombosed, inferior vein not very suitable.

Operation abandoned.

Developed acute pulmonary oedema and died five hours after the operation.

Assessment: Operative death.

Case No. 22. R.C.

Sex: Female.

Age: 31.

History: Pneumonia 9 years ago, breathless since. No shopping; lightest housework. In bed each winter. Chorea.

Extrasystoles. Opening Snap. Presystolic.

Grade: III.

Operation: 1.5.53.

Valve - .75 cm. to 2.5 cm.
Some calcification posteriorly.

Complications: Fibrillated 5th day. 12th day sudden collapse with cessation of respiration, loss of pulse, cold and clammy. Responded to coramine etc.

Auricular Biopsy: Positive.

Weight Increase: 2 stone.

How long since Operation: 3 years 9 months.

Assessment: Excellent. Quinidine poisoning.

Case No. 22.	R.C.
Sex:	Female.
Age:	31.
History:	Pneumonia 9 years ago, breathless since. No shopping; lightest housework. In bed each winter. Chorea. Extrasystoles. Opening Snap. Presystolic.
Grade:	III.
Operation:	1.5.53. Valve - .75 cm. to 2.5 cm. Some calcification posteriorly.
Complications:	Fibrillated 5th day. 12th day sudden collapse with cessation of respiration, loss of pulse, cold and clammy. Responded to coramine etc.
Auricular Biopsy:	Positive.
Weight Increase:	2 stone.
How long since Operation:	3 years 9 months.
Assessment:	Excellent. Quinidine poisoning.

Case No. 23. E.S.

Sex: Female.

Age: 40.

History: Breathless for 11 years. No housework 6-7 years. Increased by pregnancy. Haemoptysis. Rheumatic fever.

Regular. Presystolic.

Grade: IV.

Operation: 9.6.53.

Valve - + 1 cm. to 2.25 cm.
Densely fibrous.

Complications: Fibrillation 2nd day despite quinidine : persisting.

Auricular Biopsy: Negative.

How long since Operation: 3 years 7 months.

Assessment: Good.

Case No. 24.	I.McM.
Sex:	Female.
Age:	30.
History:	Breathlessness during pregnancy 6 years ago. Recurrence of breathlessness three months ago when became pregnant. Haemoptysis. Rheumatic fever.
	Regular. Opening snap. Presystolic.
Grade:	III.
Operation:	15.6.53.
	Valve - 1.25 cm. to 2.5 cm. Faint regurgitation.
Auricular Biopsy:	Negative.
Weight increase:	2 stone.
How long since Operation:	3 years 7 months.
Assessment:	Very good.

Case No. 25. R.McC.

Sex: Female.

Age: 19.

History: Increasing breathlessness for 2 years on moderate exertion. Gave up work five months. Pulmonary oedema. Haemoptysis. Tightness on exertion. Growing pains.

Regular. Presystolic.

Grade: III.

Operation: 19.6.53.

Valve - 0.5 cm. to 2.5 cm.
Very densely fibrous and calcified; knife.

Auricular Biopsy: Positive.

Weight increase: 7lbs.

How long since Operation: 3 years 7 months.

Assessment: Excellent.

Case No. 26.	A.McD.
Sex:	Female.
Age:	39.
History:	7 years breathlessness. Breathless walking on the level. Nocturnal dyspnoea. Haemoptysis. No rheumatism.
	Regular. Opening snap. Presystolic. Aortic.
Grade:	IV.
Operation:	1.7.53.
	Valve - .5 cm. to 2.5 cm. Fibrous and anterior calcification; faint regurgitation.
Complications:	Fibrillation in spite of quinidine.
Auricular Biopsy:	Positive.
How long since Operation:	$3\frac{1}{2}$ years.
Assessment:	Very good but a bout of "flutter" at 2 years 9 months - re-assessed as good.

Case No. 27. M.G.

Sex: Female.

Age: 41.

History: Following influenza 25 years ago - breathless. Worse for 6 years. Nocturnal dyspnoea. No washing, polishing or bending. Haemoptysis. Rheumatic fever twice.

Fibrillating.

Grade: III.

Operation: 21.8.53.

Valve - 1 cm. to 2.5 cm. Slight regurgitation after. Appendage too tight for knife.

Auricular Biopsy: Negative.

How long since Operation: 3 years 5 months.

Assessment: Very good.

Case No. 28. J.H.

Sex: Male.

Age: 35.

History: Breathless $1\frac{1}{2}$ years; in hospital twice with pulmonary oedema. Haemoptysis. Rheumatic fever.

Fibrillating. Opening snap.

Grade: II(b).

Operation: 28.8.53.

Valve - 2.5 cm. to 4 cm. Slight posterior regurgitation. A-V ring 5 cm.

Expected result: Fair.

Auricular Biopsy: Negative.

How long since Operation: 3 years 5 months.

Assessment: Very good.

Case No. 29. W.W.

Sex: Male.

Age: 43.

History: Progressive dyspnoea 15 years, stopped work 6 years. Some angina. Nocturnal dyspnoea. Measles only.

Regular - occasional extrasystoles. Presystolic.

Grade: III.

Operation: 15.9.53.

Valve - 2 cm. to 3 cm. Funnel-shape. Very fibrous and commencing calcification. Knife.

Expected result: Some improvement.

Complication: Fibrillation persisting in spite of pre-operative quinidine.

Auricular biopsy: Negative.

How long since Operation: 3 years 4 months.

Assessment: Good.

Case No. 30.	H.R.
Sex:	Male.
Age:	27.
History:	Breathless eighteen months. In bed one year, lighter work. Rheumatism twice. Regular. Presystolic. Aortic.
Grade:	II(b).
Operation:	13.10.53. Valve - 2 cm. to 3.5 cm. Very fibrous; jet of regurgitation posteriorly.
Complication:	Pleural effusion.
Auricular Biopsy:	Positive.
How long since Operation:	3 years 3 months.
Assessment:	Very good.

Case No. 31. C.W.

Sex: Female.

Age: 25.

History: Pregnancy 6 years ago - breathless and tired since; increasing dyspnoea 3 years. Haemoptysis. No housework. Rheumatic fever twice.

Regular. Presystolic. Opening snap. Inconstant systolic.

Grade: III.

Operation: 23.10.53.

Valve - 1.5 cm. to 3 cm. Very densely fibrous and calcified. Knife.

Complication: Atelectasis of segment right upper lobe.

Auricular Biopsy: Negative.

How long since Operation: 3 years 3 months.

Assessment: Very good. Emigrated to Rhodesia.

Case No. 32. E.D.

Sex: Male.

Age: 44.

History: Btreathlessness and increasing difficulty with his labouring job. Rheumatic fever.

Fibrillating.

Grade: III.

Operation: 27.10.53.

Valve - 3.75 cm. to 4.25 cm.
Marked incompetence posterior commissure - possibly less after "split".

Expected Result: Moderate.

Auricular Biopsy: Positive.

How long since Operation: 10 months. Died.

Assessment: No improvement and died after 10 months.

Case No. 33. E.H.

Sex: Female.

Age: 34.

History: Eight years breathless and palpitation. No polishing or cleaning. Can't carry shopping. Haemoptysis. Rheumatic fever.

Regular. Presystolic. Opening snap. Aortic.

Grade: III.

Operation: 30.10.53.

Valve - 2 cm. to 3.25 cm. Densely fibrous, fairly marked calcification, knife. Slight regurgitation after.

Expected Result: Considerable improvement.

Auricular Biopsy: Negative.

Weight increase: 9lbs.

How long since Operation: 3 years 3 months.

Assessment: Very good.

Case No. 34. J.S.

Sex: Female.

Age: 33.

History: Onset of bfeathlessness with first pregnancy 15 years ago, increasing with each pregnancy. Some shopping, dish washing and dusting. Two attacks nocturnal dyspnoea. Rheumatic fever. Haemoptysis.

Regular. Opening snap. Systolic. Aortic.

Grade: II(b)

Operation: 6.11.53.

Valve - 1.25 cm. to 3 cm.

Expected result: Excellent.

Complication: Fibrillation; persisting. Wound infection treated with Terramycin.

Auricular Biopsy: Negative.

How long since Operation: 3 years 3 months.

Assessment: Very good.

Case No. 35.	M.McK.
Sex:	Female.
Age:	34.
History:	Eight yaars increasing breathlessness. Stopped work 5 months. Rheumatism 3 times. Regular. Presystolic. Opening snap.
Grade:	IV.
Operation:	10.11.53. Valve - 1.75 cm. to 3.25 cm. Moderately thick. Fish scale calcification; slight to moderate regurgitation at posterior end.
Complication:	Fibrillation 5th day; persisting. Atelectasis. Effusion.
Auricular Biopsy:	Positive.
How long since Operation:	3 years 2 months.
Assessment:	Slight improvement deteriorating to worse.

Case No. 36.	M.W.
Sex:	Female.
Age:	26.
History:	Growing pains. Breathless 1 year. Regular. Presystolic. Aortic lesion.
Grade:	III.
Operation:	24.11.53. Valve - 1 cm. to 2.5 cm. Posterior commissure 1 cm. thick. Calcific nodules. Brock's knife.
Complications:	Superficial thrombosis.
Auricular Biopsy:	Positive.
Weight increase:	12lbs.
How long since Operation:	3 years 2 months.
Assessment:	Excellent.

Case No. 37. M.W.

Sex: Female.

Age: 37.

History: Many years easily tired and breathless; ankle swelling; symptoms worse 2 years ago; light housework. Yearly attacks of chorea from 7-14 years of age.

Fibrillating. Systolic.

Grade: III.

Operation: 4.12.53.

Valve - 1.75 cm. to 2.75 cm. moderately thick, severe calcification consisting of a plaque ½" long and ⅓" high at posterior end of aortic cusp. Moderate regurgitation posteriorly after.

Complications: Infarction left base.

Auricular Biopsy: Negative.

How long since Operation: 3 years 1 month.

Assessment: Very good.

Case No. 38.	C.C.
Sex:	Male.
Age:	16.
History:	Increasing breathlessness 3 years.
Grade:	II.
Operation:	8.12.53. Valve - 1 cm. to 2.75 cm.
Auricular Biopsy:	?Active.
How long since Operation:	3 years 1 month.
Assessment:	Excellent.

Case No. 39. M.W.

Sex: Female.

Age: 31.

History: Breathless 2 years. 14 steps only. Most household duties but no scrubbing. Growing pains twice. Haemoptysis.

Presystolic.

Grade: III.

Operation: 18.12.53.

Valve - 1.5 cm. Calcification marked posteriorly and on cusps. Narrow necked appendage. Atrial tear occurred. Controlled by appendage clamp but on releasing clamp tear uncontrolled. Tear increased with attempts at suturing.

Died from haemorrhage.

Assessment: Operative death.

Case No. 40. G.T.

Sex: Male.

Age: 24.

History: 3½ years giddy attacks and breathless. Angina. "Black-outs". Frequent sore throats.

Fibrillating.

Grade: II(a).

Operation: 22.12.53.

Valve - 1.25 cm. to 3.25 cm.

Funnel-shaped. Knife.

Auricular Biopsy: Negative.

Weight increase: 1½ stone.

How long since Operation: 3 years 1 month.

Assessment: Very good. But has had several black-outs - thought to be epileptiform after medical investigation.

Case No. 41. E.H.

Sex: Female.

Age: 38.

History: Acutely ill 10 years ago from dyspnoea following birth; breathless since. Worse past year. Light shopping, wash dishes, dusting.

Cerebral embolus 8 years ago - recovery.

Fibrillating. Opening snap. Aortic.

Grade: III.

Operation: 25.1.54.

Valve - 1.25 cm. to 3 cm. Funnel valve. Moderate calcification; very densely fibrous.

Auricular Biopsy: Negative.

Weight increase: 2 stones.

How long since Operation: 3 years.

Assessment: Very good +.

Case No. 42. G.M.

Sex: Female.

Age: 29.

History: Six years ago gave up badminton and netball because of breathlessness. No scrubbing; light housework. Tonsilitis only.

Regular. Presystolic and Systolic. Aortic.

Grade: III.

Operation: 29.1.54.

Valve - 1.75 cm. to 3.75 cm. very densely fibrous, some calcification; knife.

Auricular Biopsy: Negative.

Complications: Fibrillated 3rd day. Reverted on quinidine.

Weight increase: 1 stone.

How long since Operation: 3 years.

Assessment: Excellent.

Case No. 43.	D.G.
Sex:	Male.
Age:	50.
History:	10 years increasing breathlessness. Cerebral embolism 5 years ago - complete recovery. Rheumatic fever twice.
Grade:	III.
Operation:	2.2.54. Valve - 1 cm. to 2.25 cm. Considerable posterior calcification. Narrow appendage neck.
Auricular Biopsy:	Negative.
How long since Operation:	3 years.
Assessment:	Good.

Case No. 44. L.G.

Sex: Female.

Age: 30.

History: Breathless on exertion for 17 years, increasing for 6 years; frequently in hospital; dish washing, light dusting. Scarlet fever.

Regular. Opening snap.

Grade: IV.

Operation:- 5.2.54.

Valve - 1 cm. to 2 cm. Funnel; very densely fibrous.

Auricular Biopsy: Negative.

Weight increase: 1 stone.

How long since Operation: 3 years.

Assessment: Very good.

Case No. 45. W.S.

Sex: Male.

Age: 45.

History: Breathless 19 years, worse 3 years. Increasing for three months. Haemoptysis.

Fibrillating. Opening snap.

Grade: III.

Operation: 12.2.54.

Valve - 1 cm. to 3 cm. No appendage. Clot around atrial wall. Rumel's cardiac snare.

Died 7th day - auricular flutter and ? pulmonary embolus.

Assessment: Operative death.

Case No. 46. E.M.

Sex: Female.

Age: 24.

History: Breathless since pregnancy five months ago. Difficulty with housework. Paroxysmal dyspnoea. Haemoptysis. Rheumatic fever.

Regular. Presystolic. Opening snap.

Grade: III.

Operation: 16.2.54.

Valve - 3.75 cm. to 4 cm.

Considerable regurgitation - valve defect.

Auricular Biopsy: Positive.

Assessment: No improvement.

Died after 2 years 4 months.

Case No. 47. G.McK.

Sex: Male.

Age: 35.

History: Rheumatic fever twice. Gradually increasing breathlessness for 19 years. Progressively lighter work.

Fibrillating. Opening snap.

Grade: III.

Operatiom: 16.3.54.

Valve - 2 cm. to 3 cm.
Posterior commissure densely fibrous.

Complications: Fibrillated 1st day despite quinidine; persisting.

Auricular Biopsy: Negative.

How long since Operation: 2 years 10 months.

Assessment: Slight improvement.

Case No. 48. J.T.

Sex: Female.

Age: 38.

History: Breathless 4 years. No housework two months. Failure.

Regular. Presystolic.

Grade: IV.

Operation: 13.4.54.

Valve - 2 cm. to 3.25 cm.
Calcific nodules. Slight increase of regurgitation. Erosion aortic cusp.

Complications: Fibrillation 4th day. Persisted.
Wound infection - mild.Terramycin.

Auricular Biopsy: Negative.

Assessment: Died from staphylococcal empyema at 7 months.

Case No. 49. E.R.

Sex: Female.

Age: 16.

History: Breathlessness and chest pain 10 days. Sometimes unable to climb stairs; more at home than at school. Haemoptysis, Rheumatic Fever and St. Vitus Dance.

Regular. Opening snap.

Grade: III.

Operation: 23.4.54.

Valve - 1 cm. to 3 cm. moderate fibrosis.

Expected result: Adequate.

Auricular Biopsy: Positive.

How long since Operation: 2 years 9 months.

Assessment: Very good but deteriorated.

Now awaits re-operation.

Case No. 50. A.N.

Sex: Female.

Age: 34.

History: Increasing breathlessness for 12 years following pregnancy. No housework for 2 years; bedridden four months. Rheumatism also "myocarditis".

Regular. Presystolic. Opening snap.

Grade: IV.

Operation: 30.4.54.

Valve - 1 cm. to 2.5 cm.+.
Funnel valve; moderate fibrosis; subendocardial calcification. Slight regurgitation after valvotomy.

Expected result: Excellent.

Auricular Biopsy: Positive.

Weight increase: 1 stone.

How long since Operation: 2 years 9 months.

Assessment: Very good.

Case No. 51. S.L.

Sex: Female.

Age: 42.

History: Chest colds and breathless 10 years, worse 4 years. No housework. Haemoptysis. Rheumatic fever.

Regular. Presystolic. Opening snap.

Grade: III.

Operation: 7.5.54.

Valve - 1 cm.to 2.25 cm.
Funnel and densely fibrous; too tight to knife.

Expected result: Moderate.

Complications: Fibrillation 7th day in spite of pre-operative digitalis.

Auricular Biopsy: Positive.

Weight increase: 3½ stone.

Assessment: Very good.

Case No. 52.	C.B.
Sex:	Female.
Age:	38.
History:	Breathlessness for 7 years. much worse after pregnancy 1 year ago.
	Regular. Presystolic. Opening snap.
Grade:	IV.
Operation:	11.5.54.
	Valve - 1.75 cm. to 3.25 cm. Densely fibrous.
Complications:	Left lower lobe collapse.
Auricular Biopsy:	Negative.
Weight increase:	1¼ stone.
How long since Operation:	2 years 9 months.
Assessment:	Excellent.

Case No. 53. A.F.

Sex: Male.

Age: 22.

History: 4 years ago discharged from R.A.F. because of bfeathlessness; palpitation; haemoptysis. Rheumatism twice.

Regular. Presystolic. Opening snap.

Grade: II(b).

Operation: 14.5.54.

Valve - 2.5 cm. to 3.75 cm.
Very fibrous, some calcification.
Slight regurgitation at mid-point; knife.

Complications: Fibrillation 16th day.

Auricular Biopsy: Positive.

Weight: Lost a little weight.

How long since Operation: 2 years 8 months.

Assessment: No improvemant.

Case No. 54. J.Y.

Sex: Female.

Age: 39.

History: Glandular fever 1 year ago - increasing breathlessness since; ordinary housework but washing too much. Arthritis.

Regular. Presystolic. Opening snap. Aortic.

Grade: II(b).

Operation: 28.5.54.

Valve - 2.25 cm. to 3 cm. moderate calcification, faint regurgitation.

Expected result: Considerable improvement.

Auricular Biopsy: Positive.

How long since Operation: 2 years 8 months.

Assessment: Very good.

Case No. 55. A.B.

Sex: Female.

Age: 38.

History: Breathless for 5 years and required to stop work. Light housework. Neuritis.

Regular. Opening snap.

Grade: III.

Operation: 8.6.54.

Valve - 1 cm. to 2.5 cm. Subendocardial calcification.

Auricular Biopsy: Negative.

Weight increase: 5lb.

How long since Operation: 2 years 7 months.

Assessment: Very good.

Case No. 56. E.P.

Sex: Female.

Age: 23.

History: Breathless since pregnancy 2 years ago; now 5 months pregnant and confined to bed. Growing pains and chorea.

Regular. Opening snap. ?Aortic.

Grade: III.

Operation: 11.6.54.

Valve - 1.5 cm. to 3 cm.+.
densely fibrous, some calcification.
Knife. Faint regurgitation after.

Complications: Fibrillation on 14th day.

Auricular Biopsy: Positive.

Weight increase: 2 stone.

How long since Operation: 2 years 7 months.

Assessment: Excellent.

Case No. 57. M.McK.

Sex: Female.

Age: 31.

History: 10 years breathlessness; 2 years palpitation. In bed four months. Acute anginal attacks in bed. Haemoptysis. Rheumatic fever three times.

Fibrillating. Systolic.

Grade: IV.

Operation: 27.8.54.

Valve - 1.25 cm. to 3 cm.
Gross calcification posterior half.
Glove torn.

Died 9 hours later - presumably cerebral embolism. Not found at post mortem.

Assessment: Operative death.

Case No. 58. C.M.

Sex: Female.

Age: 34.

History: Increasing breathlessness 7 years; ankle swelling for 5 years.
Two attacks congestive failure, haemoptysis.

Regular. Presystolic. Opening snap.

Grade: III.

Operation: 24.9.54.

Valve - 0.5 cm. to 2 cm.
Funnel and some calcification.
A-V ring 2.5 cm.

Auricular Biopsy: Negative.

How long since Operation: 2 years 4 months.

Assessment: Good. Baby since and again pregnant.

Case No. 59. E.W.

Sex:	Female.
Age:	30.
History:	19 years increasing dyspnoea. Breathlessness increased with two pregnancies. Bout of cardiac failure. Rheumatic fever.
	Regular. Opening snap. Presystolic.
Grade:	III.
Operation:	28.9.54.
	Valve - 1.25 cm. to 3 cm. Funnel; densely fibrous and calcified. Knife.
Complications:	Fibrillation. Atelectasis left lower lobe.
Auricular Biopsy:	Negative.
Weight increase:	$1\frac{1}{2}$ stone.
Assessment:	Excellent. One baby since operation.

Case No. 60.	I. O'L.
Sex:	Female.
Age:	22.
History:	Breathlessness since rheumatic fever 6 years ago; gave up work 2 years ago. Rheumatic fever.
	Regular. Presystolic. Opening snap. Occasional systolic.
Grade:	II(b).
Operation:	1.10.54.
	Valve - 1.25 cm. to 3.5 cm.
Expected result:	Excellent.
Complications:	Pleural effusion.
Auricular Biopsy:	Positive.
Weight increase:	4lbs.
How long since Operation:	2 years 3 months.
Assessment:	Very good.

Case No. 61. E.T.

Sex: Female.

Age: 40.

History: Breathlessness 8 years. Unable to climb hill up to house. Housework with rests. Rheumatic fever.

Regular. Opening snap. Presystolic. Aortic.

Grade: III.

Operation: 11.10.54.

Valve - 1.25 cm. to 2.75 cm.
A-V ring 5 cm.

Complications: Pleural fluid.

Auricular Biopsy: Positive.

Weight increase: 1 stone.

How long since Operation: 2¾ years.

Assessment: Excellent.

Case No. 62.	J.D.
Sex:	Female.
Age:	36.
History:	Increasing breathlessness 9 years; worse for 2 years; several fainting turns. Rheumatism.
	Regular. Opening snap.
Grade:	II(b).
Operation:	12.10.54.
	Valve - 2 cm. to 3.5 cm. Moderately fibrous.; some calcification. Knife.
Expected result:	Reasonably good.
Complications:	Atelectasis left lung. Bronchoscopy.
Auricular Biopsy:	Negative.
Weight:	Slight weight loss.
How long since Operation:	2 years 3 months.
Assessment:	Good for 10 months then deterioration to "no improvement".

Case No. 63. M.G.

Sex: Female.

Age: 26.

History: Breathlessness 9 years and gave up work. One year ago "heart attack" following pregnancy. Ankle swelling. Breathless on hills. Rheumatic fever.

Regular. Presystolic & Systolic. Aortic.

Grade: III.

Operation: 15.10.54.

Valve - 1.25 cm. to 2.5 cm.; densely fibrous and calcified; spikes at posterior commissure. Knife.

Slight regurgitation posterior and middle ?less after valvotomy.

Complications: Fibrillated six times due to too early reduction of quinidine. Superficial phlebitis, right leg.

Auricular Biopsy: Negative.

How long since Operation: 2 years 3 months.

Assessment: Very good. Relapsed into fibrillation at six months.

Case No. 64.	B.McD.
Sex:	Female.
Age:	38.
History:	Breathless for 17 years; onset in first pregnancy; worse in second and third pregnancy. No shopping; very little housework. Rheumatic fever. Fibrillating. Probably opening snap.
Grade:	IV.
Operation:	26.10.54. Valve - 1 cm. to 2.5 cm.; moderately fibrous; subendocardial calcification. A-V ring 4.5 cm.
Expected result:	Good.
Complications:	Some atelectasis.
Auricular Biopsy:	Negative.
Weight increase:	1 stone.
How long since Operation:	2 years 3 months.
Assessment:	Good.

Case No. 65. M.McF.

Sex: Female.

Age: 36.

History: Breathlessness 9 years duration commenced during pregnancy; worse after further pregnancy. Shopping slowly and assistance with housework. Haemoptysis.

Regular. Aortic.

Grade: III.

Operation: 22.11.54.

Valve - 1.5 cm. to 3 cm.
A-V ring 3.75 cm.; funnel; marked gritty calcification - glove torn.

Expected result: Good.

Complications: Required extra blood transfusion.
Left lower lobe atelectasis.
Left and Right pulmonary infarcts.

Auricular Biopsy: Negative.

Weight increase: 1 stone.

How long since Operation: 2 years 3 months.

Assessment: Good.

Case No. 66. | J.McH.

Case No. 66.	J.McH.
Sex:	Female.
Age:	33.
History:	Breathless 3 years. Muscular rheumatism. Fibrillating. Diastolic. Opening snap. Aortic.
Grade:	III.
Operation:	23.11.54. Valve - 3 cm. to 3.75 cm.
Weight increase:	1 stone.
Auricular Biopsy:	Negative.
How long since Operation;	2 years 2 months.
Assessment:	Very good.

Case No. 67. A.M.

Sex: Female.

Age: 24.

History: 4 years breathless on moderate exertion, six months acute dyspnoea - breathless on slight exertion. Haemoptysis. Diphtheria.

Regular. Presystolic. Opening snap.

Grade: III.

Operation: 26.11.54.

Valve - 1 cm. to 2.5 cm.; moderately fibrous.

Expected result: Good.

Complication: Pleural effusion.

Auricular Biopsy: Negative.

Weight increase: 1 stone.

How long since Operation: 2 years 2 months.

Assessment: Excellent.

Case No. 68.	L.K.
Sex:	Female.
Age:	31.
History:	Breathlessness, palpitation and oedema of ankles for 1 year; 12 steps. Rheumatic fever. Continuous extrasystoles. Presystolic. Aortic.
Grade:	III.
Operation:	10.12.54. Valve - 2.5 cm. to 3.75 cm. Some calcification; faint regurgitation. Knife.
Complications:	Fluid both bases. Right pulmonary infarction.
Auricular Biopsy:	Negative.
Weight increase:	4lbs.
How long since Operation:	2 years 1 month.
Assessment:	Very good +.

Case No. 69. E.D.

Sex: Female.

Age: 43.

History: Breathless since pregnancy 7 years ago; increasing; chest pain. Unable to shop. Haemoptysis.

Fibrillation. Opening Snap. Systolic.

Grade: IV.

Operation: 17.12.54.

Valve - 1 cm. to 3 cm. Faint regurgitation after. Marked thrombus and difficult entry.

Complications: Aortic saddle embolus removed 1st day. Died from intra-peritoneal oozing.

Assessment: Operative death.

Case No. 70.	J.H.
Sex:	Female.
Age:	45.
History:	Increasing breathlessness 13 years. "Growing" pains. Fibrillating.
Grade:	II(b).
Operation:	21.12.54. Valve - 1 cm. to 2.5 cm. Funnel-shaped.
Auricular Biopsy:	Negative.
Weight increase:	$1\frac{1}{2}$ stone.
How long since Operation:	2 years.
Assessment:	Very good.

Case No. 71.	M.S.
Sex:	Female.
Age:	41.
History:	7 years ago in hospital severe illness, breathless since; several times in hospital; light housework. Rheumatic fever.
	Regular. Aortic.
Grade:	III.
Operation:	7.1.55.
	Valve - 1 cm. to 2.5 cm. Funnel; grossly fibrous and moerate calcification; faint regurgitation.
Complications:	Fibrillation 6th day in spite of pre-operative digoxin.
Auricular Biopsy:	Positive.
Weight:	Lost 3 stone.
How long since Operation:	2 years.
Assessment:	Good.

Case No. 72. T.J.

Sex: Female.

Age: 35.

History: Breathlessness 3 years; unable to do much; haemoptysis; growing pains.

Regular. Presystolic. Opening snap.

Grade: III.

Operation: 28.1.55.

Valve - 1 cm. to 2.5 cm.; moderate calcification.

Complications: Fibrillated 4th day.

Auricular Biopsy: Positive.

Weight increase: 1½ stone.

How long since Operation: 2 years.

Assessment: Good.

Case No. 73.	M.W.
Sex:	Female.
Age:	43.
History:	14 years of increasing breathlessness. Until 13 years ago keen dancer and 4 handicap golfer; thereafter very little exercise; attacks acute pulmonary oedema for 6 years. Past 5 years increasingly disabled. Chorea at 12.
	Regular. Presystolic. Opening snap. Aortic.
Grade:	III.
Operation:	6.2.55.
	Valve - 1.25 cm. to 2.25 cm. Knife. Faint regurgitation from mid-point.
Expected result:	Very good.
Complications:	Fibrillation 4th day.
Auricular Biopsy:	Negative.
How long since Operation:	2 years.
Assessment:	Excellent "New person".

Case No. 74. H.M.

Sex: Female.

Age: 38.

History: Gradually increasing breathlessness for years. Sleeps propped up. Does housework. Eight pregnancies. In hospital with fibrillation and congestive failure. Embolism in right leg, one month ago.

Regular. Presystolic. Opening snap.

Grade: III.

Operation: 7.2.55.

Valve - 1 cm. to 3 cm. Moderately fibrous; some calcification. A-V ring 4 cm. Ball thrombus.

Complications: Fibrillation; persisting.

Auricular Biopsy: Negative.

How long since Operation: 1 year 11 months.

Assessment: Good.

Case No. 75. M.I.

Sex: Female.

Age: 35.

History: Slight breathlessness 20 years; worse 4 years ago during first pregnancy. "Section". Angina. No rheumatism.

Regular. Presystolic. Opening snap.

Grade: III.

Operation: 21.2.55.

Valve - 1 cm. to 3 cm.
Very fibrous and calcified.

Auricular Biopsy: Negative.

Weight increase: 3 stone.

How long since Operation: 1 year 11 months.

Assessment: Excellent.

Case No. 76. G.F.

Sex: Male.

Age: 22.

History: Admitted to hospital 2 years ago with haemoptysis and breathlessness. Breathlessness increased; re-admitted with haemoptysis.
Rheumatic fever twice.

Regular. Opening snap. Presystolic.

Grade: II(b).

Operation: 9.3.55.

Valve - 1 cm. to 3.5 cm.; moderate funnel; grossly fibrous and some spicules of calcification at posterior commissure. Knife.
Slight posterior regurgitation; not felt after.

Complications: Fibrillated 3rd day in spite of pre-operative quinidine.

Auricular Biopsy: Positive.

Weight increase: 2 stone.

How long since Operation: 1 year 10 months.

Assessment: Excellent (Plays football).

Case No. 77. M.H.

Sex: Female.

Age: 30.

History: Following 'flu 2 years ago breathless since. 3½ months pregnant admitted in pulmonary oedema. Haemoptysis.

Regular. Presystolic.

Grade: III.

Operation: 11.3.55.

Valve - 1 cm. to 3 cm. diaphragmatic; knife.

Auricular Biopsy: Negative.

Weight increase: 3lbs.

How long since Operation: 1 year 10 months.

Assessment: Very good +.

Case No. 78. B.McM.

Sex: Female.

Age: 26.

History: Breathless 7 years, worse during pregnancy 5 years ago and again 2 years ago.

Regular. Presystolic.

Grade: III.

Operation: 28.3.55.

Valve - +1 cm. to 3 cm.; commencing funnel, densely fibrous; knife.

Expected result: Very good.

Complications: Cerebral embolism after leaving theatre. Left hemiparesis - cleared up.

Auricular Biopsy: Negative.

Weight increase: 1 stone.

How long since Operation: 1 year 10 months.

Assessment: Excellent. Pregnant within two months.

Case No. 79. E.W.

Sex: Female.

Age: 22.

History: Stopped work 3 years ago for breathlessness and palpitation. No scrubbing or polishing. Cerebral embolus 3 years ago - recovery. Growing pains.

Regular. Presystolic. Opening snap.

Grade: III.

Operation: 1.4.55.

Valve - 1 cm. to 3 cm.+; diaphragmatic.

Expected result: Excellent.

Weight increase: 1 stone.

How long since Operation: 1 year 9 months.

Assessment: Excellent.

Case No. 80. C.D.

Sex: Female.

Age: 31.

History: First pregnancy 5 years ago, breathlessness since and increased with each of two later pregnancies. Only light housework. Rheumatic fever.

Regular. ? Tricuspid.

Grade: III.

Operation: 11.5.55.

Valve - 2.5 cm. to 3 cm.; some calcification. Tiny regurgitation anterior and posterior.

Complications: Some sloughing of wound. Re-suture of wound.

Auricular Biopsy: Negative.

Weight increase: 31bs.

How long since Operation: 1 year 8 months.

Assessment: Slight improvement.

Case No. 81.	M.S.
Sex:	Female.
Age:	25.
History:	Breathlessness 14 months, worse in past 2 months. Few steps to breathlessness. Unable to play games. Tonsilitis.
	Regular. Presystolic. Opening snap.
Grade:	II(b).
Operation:	25.5.55.
	Valve - 1.75 cm. to 3.5 cm. moderate funnel. Moderately fibrous and some calcification. A-V ring 4.5 cm.
Auricular Biopsy:	Negative.
How long since Operation:	1 year 9 months.
Assessment:	Very good till a cold at 9 months to good.

Case No. 82. M.J.

Sex: Female.

Age: 36.

History: 6 years breathless on exertion; worse 2 years. Light housework. No shopping 2 years.

Regular. Presystolic.

Grade: III.

Operation: 27.5.55.

Valve - 1 cm. to 2.75 cm.

Funnel; very fibrous; mostly dilatation. A-V ring 4 cm.

Expected result: Considerable.

Complications: Fibrillation at 3 hours. Returned to normal rhythm on digoxin. Infarction.

Auricular Biopsy: Negative.

Weight increase: 10lbs.

How long since Operation: 1 year 8 months.

Assessment: Good but deteriorating.

Case No. 83. R.G.

Sex: Female.

Age: 44.

History: 6 years ago breathless; haemoptysis.

Presystolic. Opening snap.

Grade: III.

Operation: 3.6.55.

Valve - 1 cm. to 2.5 cm.; commencing funnel, moderately fibrous and calcified; slight regurgitation after. A-V ring 5 cm.

Complications: Atelectasis right lower lobe. Superficial thrombophlebitis.

Auricular Biopsy: Not available.

Weight: Slight loss.

How long since Operation: 1 year 7 months.

Assessment: Good, probably deteriorating.

Case No. 84.	I.C.
Sex:	Female.
Age:	36.
History:	6 years ago breathless following pregnancy; increasing; cardiac failure. No housework for 6 years. Measles.
	Regular. Opening snap.
Grade:	III.
Operation:	17.6.55.
	Valve - 1 cm. to 2.5 cm.; funnel and moderately fibrous. A-V ring 3 cm.
Expected result:	Good to very good.
Complications:	Required blood post-operatively. Fibrillation 36 hours and again 11th day.
Auricular Biopsy:	Negative.
How long since Operation:	1 year 7 months.
Assessment:	Very good.

Case No. 85. J.H.

Sex: Female.

Age: 56.

History: Following acute febrile illness 4 years ago - breathless, increasing. No housework. One flight slowly.

Fibrillating. Opening snap.

Grade: III.

Operation: 20.6.55.

Valve - 1 cm.+ to 3 cm. Slight funnel; some calcification; slight regurgitation.

Expected result: Quite good.

Complications: Fibrillation.
Atelectasis left lower lobe.

Auricular Biopsy: Negative.

Weight increase: ½ stone.

Assessment: No improvement. This patient was felt to be temperamentally unsuitable for surgery.

Case No. 86.	S.C.
Sex:	Female.
Age:	46.
History:	2 years breathlessness. Angina. Regular. Presystolic.
Grade:	II(b).
Operation:	21.6.55. Valve - 1 cm. to 3 cm. Slight funnel. A-V ring 4.5 cm.
Expected result:	Good.
Complications:	Fibrillation. Pleural fluid - two aspirations. Right upper lobe infarction.
Auricular Biopsy:	Negative.
Weight increase:	2 stone.
How long since Operation:	1 year 7 months.
Assessment:	Very good +.

Case No. 87.	A.W.
Sex:	Female.
Age:	35.
History:	Breathless since pregnancy 7 years. Some housework. No polishing. Pneumonia only. Fibrillating. Opening snap.
Grade:	III.
Operation:	4.7.55. Valve - 1.c cm. to 2.5 cm.
Complications:	Fibrillation 1st day, and again 12th day.
Auricular Biopsy:	Negative.
Weight increase:	2lbs.
How long since Operation:	1 year 6 months.
Assessment:	Excellent.

Case No. 88. M.B.

Sex: Female.

Age: 32.

History: 8 years listless, breathless; now breathless at all times on slight exertion; unable for ordinary housework. Haemoptysis.

Extrasystoles, Presystolic. Opening snap.

Grade: IV.

Operation: 12.7.55.

Valve - 1 cm. to 3 cm. Slight funnel, densely funnel-shaped. Some dilatation; knife anteriorly ? faint regurgitation.

Complications: Fibrillation 2nd day persisting.

Auricular Biopsy: Negative.

Weight increase: 1½ stone.

Assessment: Excellent.

Case No. 89.	J.S.
Sex:	Female.
Age:	30.
History:	Breathless 8 years, worse since pregnancy 3 years ago. Angina. Occasional haemoptysis. Chorea twice.
	Regular. Presystolic, rough systolic. Aortic.
Grade:	III.
Operation:	5.9.55.
	Valve - 1 cm. to 4 cm. Slight funnel. A-V ring 4 cm.
Auricular Biopsy:	Negative.
Weight increase:	1½ stone.
How long since Operation:	1 year 4 months.
Assessment:	Excellent.

Case No. 90. A.D.

Sex: Female.

Age: 39.

History: Bfeathlessness 10 years - increasing. Changed to ground floor 2 years ago. Light housework. Rheumatism, twice.

Regular. Presystolic. Opening snap

Grade: III.

Operation: 30.9.55.

Valve - 2 cm. to 3 cm. Densely fibrous, some spicules of calcification at posterior commissure. Posterior regurgitant jet, ?less after valvotomy. A-V ring 5 cm.

Complications: Right basal infarction.

Auricular Biopsy: Positive.

How long since Operation: 1 year 4 months.

Assessment: Very good.

Case No. 91.	A.B.
Sex:	Female.
Age:	42.
History:	Many years increasing breathlessness. Housework difficult: tired.
	Regular. Opening snap. Presystolic.
Grade:	III.
Operation:	17.10.55.
	Valve - 1.5 cm. to 3 cm. Funnel-shape; some calcification. Surprised in view of typical clinical findings.
Complications:	Left lung atelectasis. Bronchoscopy.
Auricular Biopsy:	Positive.
Weight increase:	2lbs.
How long since Operation:	1 year 3 months.
Assessment:	Good.

Case No. 92. A.R.

Sex: Female.

Age: 36.

History: Breathless moderate exertion 5 years. Angina. Rheumatic fever three times.

Fibrillating. Opening snap. Soft systolic. Aortic.

Grade: III.

Operation: 25.10.55.

Valve - 1.5 cm. to 2.5 cm. Clot present and expelled. Densely fibrous. Some calcification. Knife.

Complications: Fibrillation 1st day. Embolus right brachial.

Auricular Biopsy: Negative.

Weight increase: $\frac{3}{4}$ stone.

Assessment: Very good.

Case No. 93. J.D.

Sex: Female.

Age: 49.

History: 5 years increasing breathlessness; no stairs; bronchitis. Rheumatism.

Regular. Presystolic.

Grade: III.

Operation: 2.12.55.

Valve - 1.5 cm. to 3 cm.; moderate funnel and thickness.
A-V ring 3.5 cm.

Complications: Infarction right lower lobe.

Auricular Biopsy: Probably positive.

Assessment: Died suddenly on holiday at 5 months; probably cerebral embolus.

Case No. 94.	J.B.
Sex:	Male.
Age:	40.
History:	Embolus right femoral 29.1.48 - amputation left leg. Embolus left femoral 12.2.48 - embolectomy. Grade I Scots Guards 1942 - intensive training lead to breathlessness. Breathlessness worse 7 years ago - much worse 1 year. Haemoptysis for years. Quinsy only. Fibrillating. Opening snap.
Grade:	II(b).
Operation:	5.12.55. Valve - 1 cm. to 2.5 cm. Calcified. A-V ring 3.5 cm. Ball thrombus.
Complications:	Right pulmonary infarction.
Auricular Biopsy:	Negative.
Weight increase:	3lbs.
How long since Operation:	1 year 1 month.
Assessment:	Very good.

Case No. 95. C.W.

Sex: Female.

Age: 41.

History: Breathlessness 4 years worse after flu 2 years. Tiredness. Much worse six weeks. Can do a little scrubbing. Rheumatism and chorea five times.

Regular. Presystolic.

Grade: III.

Operation: 6.12.55.

Valve - 1 cm.+ to 2.5 cm. Slight funnel. Fairly fibrous. Knife.

Complications: Paroxysmal tachycardia.

Auricular Biopsy: Negative.

Weight increase: 2 stone.

How long since Operation: 1 year 1 month.

Assessment: Excellent.

Case No. 96. V.B.

Sex: Female.

Age: 31.

History: 2 years increasing breathlessness and haemoptysis; 1 year on slight exertion. Several attacks pulmonary oedema, one of failure.
Rheumatism twice.
Regular. Presystolic. Opening snap.

Grade: III.

Operation: 20.1.56.

Valve - 1.75 cm. to 2.5 cm.; spicules $1\frac{1}{4}$ cm. high; moderate funnel and fibrous; gross calcific, partly split, partly dilated; some central regurgitation - no worse. A-V ring 3 cm

Complications: Tympanitis.

Auricular Biopsy: Positive.

How long since Operation: 1 year.

Assessment: Good.

Case No. 97. A.G.

Sex: Female.

Age: 29.

History: Increasing breathlessness for 5 months. St. Vitus Dance and rheumatism.

Regular. Presystolic. Opening snap.

Grade: III.

Operation: 28.2.56.

Valve - 1 cm.+ to 3 cm.
Moderately fibrous; knife.
A-V ring 4.25 cm.

Complications: Atelectasis left lower lobe.

Auricular Biopsy: Positive.

Weight increase: 1 stone.

How long since Operation: 11 months.

Assessment: Very good +.

Case No. 98.	S.C.
Sex:	Female.
Age:	40.
History:	Breathlessness from pregnancy 6 years ago, worse in last year. Some houswwork. Nocturnal dyspnoea. No rheumatic fever. Regular. Presystolic.
Grade:	III.
Operation:	3.3.56. Valve - 1.25 cm. to 3.5 cm. Funnel valve. Very fibrous. At first dilatation only later split.
Complications:	Left pulmonary infarction.
Auricular Biopsy:	Negative.
Weight increase:	$1\frac{1}{2}$ stone.
How long since Operation:	10 months.
Assessment:	Very good +.

Case No. 99. R.B.

Sex: Female.

Age: 31.

History: Breathless on moderate exertion 8 years, worse during pregnancy 5 years ago. For six months much worse; angina. haemoptysis. Rheumatism annually for 14 years.

Regular. Presystolic. Opening snap.

Grade: III.

Operation: 9.3.56.

Valve - 1.25 cm. to 2.5 cm.; some calcification. Knife.
A-V ring 4 cm.

Complications: Fibrillation 14th day. Reverted on quinidine.
Fluid right base.

Auricular Biopsy: Negative.

Weight increase: 3lbs.

How long since Operation: 10 months.

Assessment: Very good.

Case No. 100.	J.McN.
Sex:	Female.
Age:	41.
History:	Breathless for 10 years, worse for 3 months - tired; haemoptysis, two attacks cardiac asthma. Rheumatic fever twice.
	Regular. Presystolic. Variable systolic.
Grade:	III.
Operation:	23.3.56.
	Valve - 1.25 cm. to 3 cm.; slight funnel, very fibrous and considerably calcified. Knife. A-V ring 5 cm.
Expected result:	Very good.
Complications:	Fibrillation 3rd day in spite of pre-operative digitalis. Superficial thrombophlebitis.
Auricular Biopsy:	Positive.
Assessment:	Died at four months, having developed a pronounced aortic diastolic and cardiac failure.

Case No. 101	B.K.
Sex:	Female.
Age:	44.
History:	Breathless 9 years, worse 7 years; rested one year; three years very breathless; previous cerebral embolus. Rheumatic fever 3 times. Fibrillation. Aortic.
Grade:	III.
Operation:	15.4.56. Valve - 1 cm. to 2.5 cm. Commencing funnel; A.V ring 5 cm. Ball thrombus caught with finger in atrium and scooped out; control lost momentarily.
Complications:	Fibrillation.
Auricular Biopsy:	Negative.
Weight increase:	3lbs.
How long since Operation:	9 months.
Assessment:	Very good.

Case No. 102.	M.H.
Sex:	Female.
Age:	41.
History:	Breathless 8 years, worse for six months. One attack cardiac failure. Digitalis for five months. Fibrillation. Presystolic. Opening snap.
Grade:	III.
Operation:	27.4.56. Valve - 1.5 cm. to 3 cm. Slight funnel, very fibrous; knife; considerable clot evacuated.
Complications:	Probably cerebral embolus - delayed anaesthetic recovery - later telescopic vision and mental changes.
Assessment:	Died at two months.

Case No. 103. M.McC.

Sex: Female.

Age: 34.

History: One year breathlessness. Sit down at housework; shop slowly. Angina. Tired for six months; growing pains.

Regular. Presystolic. Opening snap. ? Aortic.

Grade: III.

Operation: 30.4.56.

Valve - 1.25 cm. to 2.5 cm. Funnel; fibrous and calcified; Knife.

Expected result: Quite good.

Complications: Fibrillation. Returned to sinus rhythm on digoxin.

Auricular Biopsy: Positive.

How long since Operation: 9 months.

Assessment: Good.

Case No. 104. J.F.

Sex: Female.

Age: 34.

History: 16 years breathlessness; worse 2 years. $2\frac{1}{2}$ years off work. Angina. Carry a little shopping.

Regular. Presystolic. Opening snap.

Grade: III.

Operation: 8.5.56.

Valve - 1.5 cm. to 2.5 cm.; slight funnel; moderately fibrous. Appendage neck too narrow for knife.

Expected result: Considerable improvement.

Complications: Fibrillation.

Auricular Biopsy: Negative.

Weight increase: 1 stone.

How long since Operation: 8 months.

Assessment: Very good.

Case No. 105. W.L.

Sex: Male.

Age: 30.

History: Since third attack rheumatic fever two years ago - breathless on hills and severe exertion; haemoptysis.

Regular. Presystolic. Blowing systolic.

Grade:

Operation: 1.6.56.

Valve - 1.5 cm. to 3 cm. Gross horse-shoe posterior calcification. Some spicules 1 cm. high.

Complications: Developed superficial and deep phlebitis 1st day. Anticoagulants 4th day. Became hysterical and collapsed.

Died 5th day - presumed pulmonary embolus.

Assessment: Operative death.

Case No. 106.	M.W.
Sex:	Female.
Age:	29.
History:	Breathlessness for 18 years; in bed for past 18 weeks. R.brachial embolus one year ago. Only Scarlet fever. Fibrillating. Opening snap.
Grade:	III.
Operation:	5.6.56. Valve - 1.5 cm. to 2.5 cm. Rumel cardiac snare. Some calcification. Mainly dilatation. Knife thought to be dangerous.
Auricular Biopsy:	Negative.
Complications:	While washing on morning of going home fell back unconscious and died 20th day. Presumably cerebral embolus.
Assessment:	Operative death.

Case No. 107.	M.McC.
Sex:	Female.
Age:	34.
History:	4 years increasing breathlessness; worse when polishing. Does shopping. Haemoptysis. Regular. Presystolic. Opening snap. Systolic.
Grade:	II(b)
Operation:	8.6.56. Valve - 1 cm. to 2.5 cm.; commencing funnel; grossly fibrous and some calcification; faint regurgitation; knife. A-V ring 4 cm.
Expected result:	Moderate to good.
Complications:	Effusion. Breast haematoma.
Auricular Biopsy:	Negative.
Weight increase:	6lbs.
How long since Opeeation:	7 months.
Assessment:	Very good.

Case No. 108. M.H.

Sex: Female.

Age: 47.

History: 10 years breathlessness; progressive and worse on stairs; washing and polishing. Light housework. Rheumatic fever.

Extrasystoles. Presystolic. Opening snap.

Grade: III.

Operation: 22.6.56.

Valve - 1 cm. to 2.25 cm.; gross funnel deformity; moderatedly thickened and some calcification. A-V ring 3.5 cm.

Complications: Fibrillation 2nd day in spite of pre-operative digitalis.
Too early reduction of dose of quinidine caused recurrence of fibrillation.
Superficial phlebitis 14th day.

Auricular Biopsy: Postive.

Weight increase: 1 stone.

How long since Operation: 7 months.

Assessment: Very good.

Case No. 109. M.D.

Sex: Female.

Age: 31.

History: Rheumatic fever 10 years ago - breathless since. Pregnancy two years ago - more breathless. Only light housework. Chorea and Rheumatic fever.

Regular. Opening snap. Presystolic. Aortic.

Grade: III.

Operation: 25.6.56.

Valve - 1.5 cm. to 2.5 cm. Moderate funnel; densely fibrous. A-V ring 3.5 cm.

Auricular Biopsy: Positive.

How long since Operation: 7 months.

Assessment: Very good.

Case No. 110. R.McC.

Sex: Female.

Age: 36.

History: For 10 years increasing breathlessness on exertion. No polishing or scrubbing. Nocturnal dyspnoea, haemoptysis. Six years ago pregnancy terminated because of haemoptysis. Only sore throat at 18.

Regular. Presystolic. Aortic.

Grade: III.

Operation: 3.7.56.

Valve - 1.5 cm. to 3 cm.
A-V ring 5 cm. Probably clot.

Expected result: Excellent.

Auricular Biopsy: Positive.

Weight increase: 1 stone.

How long since Operation: 6 months.

Assessment: Very good.

Case No. 111. M.T.

Sex: Female.

Age: 32.

History: Thirteen years breathless on exertion; washing and polishing. Six months ago bronchitis with pulmonary oedema. Breathless carrying shopping. Rheumatic fever.

Regular. Presystolic. Opening snap. Marked systolic.

Grade: III.

Operation: 6.7.56.

Valve - 1 cm. to 2 cm.; commencing funnel. Moderately thickened and some calcification, mainly dilatation. A-V ring 3.5 cm.

Expected result: Moderate to good.

Auricular Biopsy: Positive.

Weight increase: 10lbs.

How long since Operation: 10 months.

Assessment: Excellent.

Case No. 112. M.K.

Sex: Female.

Age: 40.

History: 4 years breathlessness and tightness; no polishing; occasional haemoptysis and nocturnal dyspnoea. No rheumatic fever but a feverish illness 18 years ago ?typhoid or scarlet with joint pains.

Regular. Presystolic. Blowing systolic.

Grade: II(b).

Operation: 13.7.56.

Valve - 1 cm. to 3 cm. Slight funnel; diaphragmatic, trace regurgitation. A-V ring 4.5 cm.

Expetted result: Excellent.

Complications: Fibrillation 2nd day in spite of digitalis beforehand.
Right pulmonary infarction 17th day.

Auricular Biopsy: Negative.

Weight increase: 1½ stone.

How long since Operation: Six months.

Assessment: Very good.

Case No. 121.	M.M.
Sex:	Female.
Age:	35.
History:	Increasing breathlessness for 5 years; only do shopping slowly; no scrubbing or polishing. Regular. Presystolic.
Grade:	III.
Operation:	22.8.56. Small contracted appendage quite unsuitable for entry. Rumel's cardiac snare inserted around appendage base and incision made; as the finger was being entered and the snare tightened, the mersilene suture gave way - the knot slipped. It was believed that the "snare" had cut the stitch and was not realised till later that the knot had slipped. The "snare" was abandoned and entry through inferior pulmonary vein attempted. Death from haemorrhage.

Case No. 141. J.B.

Sex: Male.

Age: 35.

History: Increasing breathlessness for 5 years and difficulty in carrying on his work. Haemoptysis.

Regular. Presystolic.

Grade:

Operation: 28.3.57.

Valve - 1.25 cm. to 3 cm.

Complications: On the evening of the first post-operative day was seen to be not so well. Numerous extrasystoles.
Night staff nurse warned to watch his pulse for development of fibrillation.
Fibrillation occurred but was not noticed nor reported; by early morning he was in extreme collapse due to cardiac failure.
Responded to intravenous digoxin etc.

Case No. 145. J.A.

Sex: Female.

Age: 40.

History: Increasing dyspnoea for 4 years and much worse since pregnancy developed four months. Nocturnal dyspnoea and haemoptysis.

Grade: III.

Operation: 23.5.57.

Valve - 1.25 cm. to 3 cm.
Fairly fibrous.

Complications: Fibrillation on 5th day.

I wished to give aminophylline intravenously but was swayed from doing so by a medical colleague in fear of death from convulsions.

By 8th day she was in extreme cardiac failure with gross pulmonary oedema.

Given intravenous aminophylline and digoxin, bronchoscoped three times, but of no avail. Died.

Case No. 146. E.S.

Sex: Female.

Age: 45.

History: Breathless on exertion for 6 years; increasing; difficulty with housework.

Regular. Presystolic. Opening snap.

Grade:

Operation: 10.6.57.

Valve - 1.25 cm. to 3 cm.
Moderately fibrous. Knife.

Complications: Cerebral embolus.

Recovery from the anaesthetic was delayed and she was found to have a left hemiplegia. The first post-operative day showed slight returning sensation in the right leg. She developed fibrillation that night; Did not respond to intravenous digoxin and died that night.