SURGICAL CLOSURE OF AURICULAR SEPTAL DEFECT

IVAN BARNAT, F.R.C.S.

Durban

The decade since the war has witnessed startling developments in surgery of the heart. Extracardiac operations for the treatment of patent ductus arteriosus and coarctation of the aorta are now accepted and everyday procedures. The construction of a systemo-pulmonary anastomosis of the Blalock or Potts type in the treatment of the tetralogy of Fallot is performed in many units in preference to the direct procedures developed by Brock. Pericardectomy for the relief of constrictive pericarditis is well established. Operative procedures upon the heart itself embrace the relief of stenosis of all the valves; mitral valvotomy is one of the major triumphs of surgery; pulmonary and tricuspid valvotomy pose no real problems for the surgeon; and even aortic valvotomy, although a much more hazardous procedure, is being effectively tackled. But the problems presented by the surgical treatment of valvular incompetence and coronary insufficiency are far from being solved.

The problem of closing abnormal communications between the two sides of the heart has appeared very formidable. It had seemed that open cardiotomy with the aid either of an artificial circulation or of hypothermia would be required. These techniques have in fact been employed in the treatment of these conditions, but they are still fraught with grave risks. Safe repair of defects between the two ventricles is still a vision for the future, but the repair of defects between the two auricles is much more hopeful and many relatively safe procedures have now been devised without recourse

to the risks of open cardiotomy. Much ingenuity has been displayed by the various workers in this field. A remarkably simple technique has been described by Senning[1] and Parantela,[2, 3] which indicates that what has been a major problem may turn out to be capable of a fairly straightforward solution. In this article I describe a case successfully treated by their technique.

EMBRYOLOGY AND MORPHOLOGY

A short review of the embryological development of the atrial septum is necessary for the understanding of the morphology of the various septal defects encountered. Briefly, the single primitive atrium is first divided by the septum primum, which grows down and forward towards the developing ventricular septum. However,

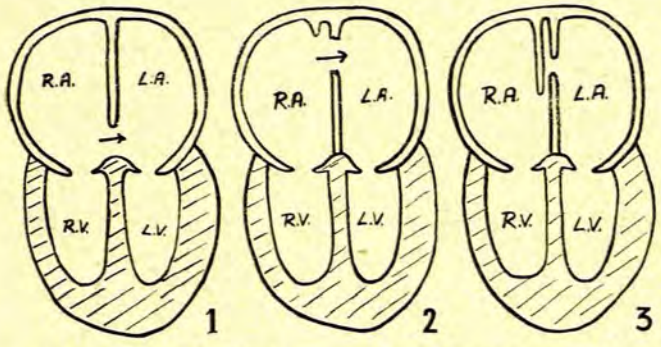


Fig. 1. Down-growth of septum primum dividing primitive auricle. Arrow indicates ostium primum.
Fig. 2. Upper portion of septum primum has broken down to form ostium secundum (arrow) appearing to right of septum primum.
Fig. 3. Ostium secundum now closed by downgrowth of septum secundum.

a communication—the ostium primum—remains for a time just above the ventricular septum but eventually closes (Fig. 1). The upper part of the septum primum gradually breaks down (Fig. 2), but this opening—the ostium secundum—is closed by the development of the septum secundum, which grows downward to the right of the original septum, the free edge eventually forming the annulus ovalis of the foramen ovale (Fig. 3). The overlapping septa explain the valvular action of a persistent foramen ovale, which is physiologically closed by the greater pressure in the left auricle.

One can readily appreciate how imperfect development may result in a persistent ostium primum, or persistent ostium secundum, or various combinations of the two. These defects may be relatively small or may amount to a virtual absence of the septum. In practice it is found that most defects are situated postero-superiorly and are, in fact, persistent ostia secunda. A persistent ostium primum is frequently combined with congenital defects of the mitral and tricuspid valves, and the fact that the bundle of His is very close to the inferior margin renders effective and complete surgical repair rather hazardous. Fortunately this does not apply to the repair of the commoner type (approximately 90%) which is situated well away from the bundle of His.

PATHOLOGICAL EFFECTS

The pathological effects of an auricular septal defect can readily be appreciated. One must exclude cases complicated by tricuspid or pulmonary stenosis or atresia, in which the defect is life-saving and allows a right-to-left shunt to persist. In uncomplicated cases a left-to-right shunt occurs because of the higher pressure in the left auricle. This results in an increased circulation through the lungs and the pulmonary flow may be several times greater than the systemic flow and secondary pulmonary hypertension and pulmonary artery atheroma may ensue. The right auricle and the right ventricle enlarge, the pulmonary artery becomes prominent and the lungs become plethoric. As the shunt is from left to right cyanosis is absent. The right side of the heart becomes subject to considerable strain. Effort dyspnoea and orthopnoea is usually present and eventually congestive failure may supervene. Sub-acute bacterial endocarditis as a complication is fortunately almost unknown. The degree of disability varies very considerably but in most cases is quite marked and the eventual prognosis is poor. Some cases survive to middle age. Frequently difficulty only commences in the 4th decade.

DIAGNOSIS

A typical case will manifest a systolic murmur over the base of the heart. This is thought to be due to the increased flow in the pulmonary artery and not to the flow through the shunt. The second pulmonary sound is usually widely split and frequently accentuated. Evidence of right ventricular hypertrophy can usually be obtained by palpation. The radiological appearances are fairly characteristic and usually indicate enlargement of the right auricle and ventricle and characteristic prominence of the pulmonary artery, which usually displays marked pulsation or 'hilar dance'. Pulmonary plethora is usually present. These changes may be slight or very gross. The electrocardiogram usually displays evidence of right heart strain and very frequently evidence of an incomplete right bundle-branch block (95%).[4] This is thought to be due to the relative hypertrophy or dilatation of the right ventricle muscle, causing more widespread conduction of the electrical impulse. Cardiac catheterization should confirm the diagnosis by demonstrating an increase in oxygen saturation of blood in the right ventricle as compared with caval blood. However, one must beware of being misled, for aberrant entry of a pulmonary vein into the right auricle will give a similar finding. The catheter may pass from the right auricle into the left auricle but this is not confirmatory of an atrial septal defect, for the catheter may pass through a persistent foramen ovale with a valvular action which is yet able to prevent a shunt in the reverse direction. The role of angiocardiography in the diagnosis of atrial septal defect is limited, but it may be indicated and may prove helpful if the diagnosis is in doubt.[5] In most cases careful assessment of the various physical signs and investigations will enable the diagnosis to be confidently made. The persistent ostium-primum type of defect should

be suspected if there is evidence of mitral or tricuspid incompetence.

SURGICAL CLOSURE

Numerous techniques for surgical closure have been devised. If open cardiotomy, under hypothermia or with the aid of an artificial circulation, were a safe procedure, direct suture of the defect under vision would be the recommended procedure. However, this is not yet attainable, although several series of operations on these lines have been reported.[6] I do not propose to discuss all the closed techniques which have been suggested. They are legion. Amongst the methods that have been attempted are sutures passing from front to back, through the auricles in the line of the atrial septum,[7] and the indentation and suture of the redundant lateral wall of the right auricle to the margin of the defect,[8] thus producing a doughnut-shaped auricle (Figs. 4 and 5). These methods cause considerable

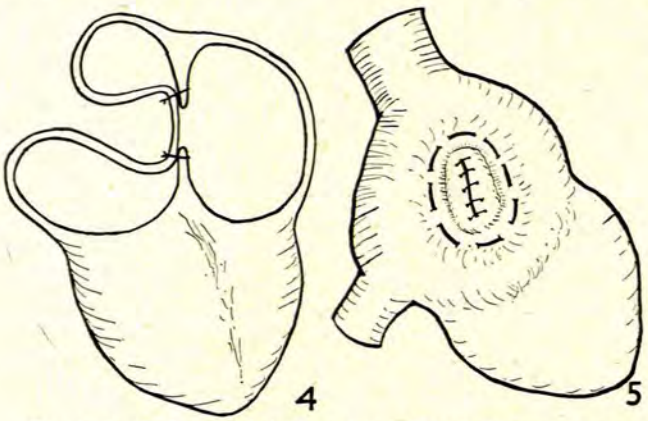


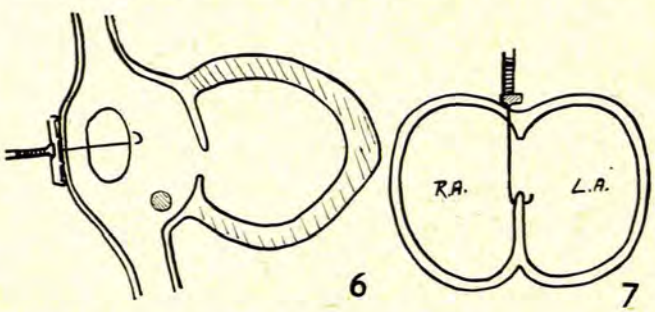
Fig. 4. Lateral wall of right auricle indented and sutured to margins of atrial septal defect.
Fig. 5. Doughnut-shaped auricle produced by atrioseptopexy.

deformity of the right auricle although good results are claimed by the latter method,[8] and it is stated that an adequate lumen exists in front of and behind the sutured portion. Gross has developed an ingenious method of operating through a rubber well-sutured to an incision in the wall of the right auricle and which when filled with blood offers an entry to the interior of the heart without affecting the circulation.[9] An objection to this technique, which also applies to closure by open cardiotomy, is the danger of the stitches tearing out of the edges of the defect because relaxation and lack of tension have not been obtained.[10]

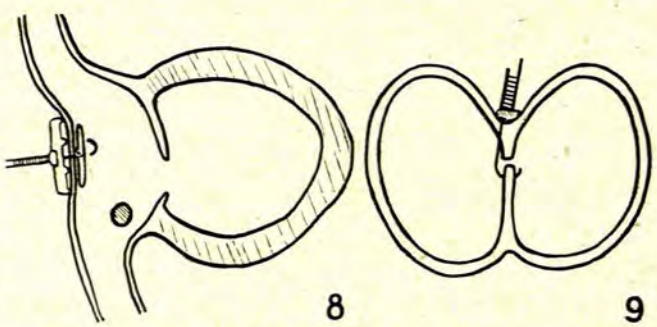
Numerous other methods have also been devised and some have been applied clinically,[11, 12] but the most fruitful line of approach appears to be one where the junction between the auricles posteriorly is mobilized and this posterior wall or raphe is displaced forward and sutured to the anterior margin of the defect. This causes the minimal amount of distortion of the auricles and avoids undue tension upon the sutures. This especially applies since most of the defects are situated in the posterior portion of the septum. Several applications of this principle have been described,[13] but the simplest and most effective has been evolved by Senning[1] and Parantela.[2, 3]

SENNING AND PARANTELA'S OPERATION

Parantela has devised a rather ingenious instrument which facilitates this technique.* A right thoracotomy is performed, the pericardium is widely opened anterior to the phrenic nerve, and the right auricle and the superior and inferior venae cavae are displayed. The left forefinger is introduced through an incision in the appendix of the right auricle and the defect in the auricular septum is palpated. The superior and inferior vena-caval openings and the coronary sinus opening are located and the tricuspid valve is palpated. A finger can be passed through the defect into the left auricle and the pulmonary vein openings should be palpated to ensure that they enter normally into the left auricle. This is important, since aberrant entry into the right auricle can be corrected. The mitral valve is then palpated to ensure that mitral stenosis is not present (Lutembacher's syndrome). The finger is then withdrawn and an appendicular clamp applied to the appendix, and the following dissection then performed (Blalock-Sondergaard). The right pulmonary veins are closely adherent to the back of the right auricle, where they come in contact in process of passing to the back of the left auricle. By dissection the plane between these veins and the back of the right auricle is entered and, by continuing the dissection to the left, one can display the site of junction of the two auricles posteriorly. The superior and inferior venae cavae are adequately mobilized. The left forefinger is again introduced through the appendix of the right auricle and it will be found that the posterior wall at the raphe can be displaced forward to the anterior rim of the defect if adequate mobilization has been obtained. The special hook of the instrument is then introduced through the posterior raphe and hooked into the anterior margin of the defect, being guided by the finger inside the heart (Figs. 6 and 7). The cross-bar of the instrument



Figs. 6 and 7. Demonstrating atrial septal defect and insertion of fine hook of Parantela instrument through posterior raphe and engaging in anterior rim of defect.



Figs. 8 and 9. Posterior wall displaced forward to anterior rim of septal defect and position maintained by Parantela instrument.

* Heljestrand-Parantela instrument, manufactured by Heljestrand, Eskilstuna, Sweden.

is then slowly moved forward until the posterior raphe comes in contact with the anterior margin (Figs. 8 and 9). If the defect is large, one or both of the additional hooks, which can be incorporated in the instrument, will need to be similarly inserted. The final position is maintained by a ratchet. It will now be found that the defect has been temporarily closed with minimal distortion of the auricles. External sutures can now be simply inserted from the back of the heart around the cross-bar of the instrument, as the anterior lip of the defect has in fact been brought in direct contact with the posterior raphe. The finger in the heart assists in the placement of these sutures, which are tied by the assistant, and the instrument and the finger are then withdrawn.

This technique was adopted in the case here reported and proved to be very straightforward and satisfying. There was almost no loss of blood and the heart appeared relatively unaffected by the manipulations, apart from an occasional extra-systole. This method is applicable to most atrial septal defects but in the ostium-primum type it may be wisest not to place any sutures in the lower end for fear of damaging the bundle of His. If aberrant insertion of a pulmonary vein into the right auricle is present, then one can displace the right auricular wall to the right of the aberrant vein forward to the anterior rim of the defect, and the aberrant vein will now enter to the left of the reconstructed septum and thus into the left auricle. If the aberrant vein enters the superior vena cava the same principle is adopted.

CASE RECORD

Mrs. K.A., aged 32 years, referred by Dr. H. Schaffer and Dr. J. Rossiter with the diagnosis of auricular septal defect.

Patient was quite well until 6 years ago. Since then there had been progressive dyspnoea. For the past year she became dyspnoeic after very moderate exertion. She was unable to climb stairs. She preferred sleeping with several pillows. She was originally told that she had mitral stenosis.

On examination (27 September 1955). The patient was somewhat obese, with a very limited exercise tolerance. There was no evidence of congestive cardiac failure. A marked right ventricular heave could be palpated. There was a blowing systolic murmur over the pulmonary area and a widely split and accentuated second pulmonary sound.

On screening there was seen to be moderate cardiac enlargement, which appeared to be confined to the right auricle and the right ventricle. The left auricle revealed no signs of enlargement. The pulmonary-artery segment was markedly prominent and convex, and displayed vigorous pulsation or 'hilar dance'. The vascular shadows in both lungs were very prominent.

The electrocardiogram showed evidence of right heart strain and broadened QRS complexes (0·12 seconds) which were considered to indicate partial right bundle-branch block (Fig. 10).

Cardiac catheterization was performed on 14 October 1955 (Dr. T. G. Armstrong). The findings were as follows: Pressure in right auricle 6/0 mm. Hg, in right ventricle 30/0 mm. Hg, in pulmonary artery 30/10 mm. Hg.

The following oxygen saturation figures were obtained: Peripheral arterial 92·5%, superior vena cava 67%, right auricle 78%, right ventricle 80%, pulmonary artery 80%.

The diagnosis of atrial septal defect appeared very definite. However, we were not convinced that the severity of the patient's symptoms justified operative intervention and she was observed for several months. Her dyspnoea became progressively worse and it was eventually decided to repair the defect surgically.

The operation was performed on 29 February 1956 under general anaesthesia, administered by Dr. H. Grant Whyte and with ECG monitoring (Dr. D. Pittaway). The defect in the auricular septum was situated postero-superiorly and was considered to be a persistent ostium secundum. It was roughly circular in shape and was estimated to measure 3×3 cm. The mitral and tricuspid valves were normal and there was no evidence of aberrant insertion of the pulmonary veins into the right auricle. The method of closure employed was that which has been described above, and was performed quite uneventfully. Three sutures were required. There was no loss of blood and the heart tolerated the manipulations very well, apart from an occasional extra-systole. Post-operative convalescence was uneventful and patient was discharged home on 14 March 1956.

She has revealed marked clinical improvement and is no longer dyspnoeic on exertion. She has no orthopnoea. X-ray screening does not reveal any change in the contour of the heart. The pulmonary-artery segment is still prominent and convex but the 'hilar dance' has ceased. Pulmonary plethora is no longer present. The second pulmonary sound is still split but does not appear to be as accentuated as it was previously.

Electrocardiogram (1 May 1956) reveals a definite change in the length of the QRS complexes, which now measure 0/08 sec. (Fig. 10). The full significance of these changes is uncertain they appear sufficiently definite to suggest that there is now less strain on the right side of the heart.

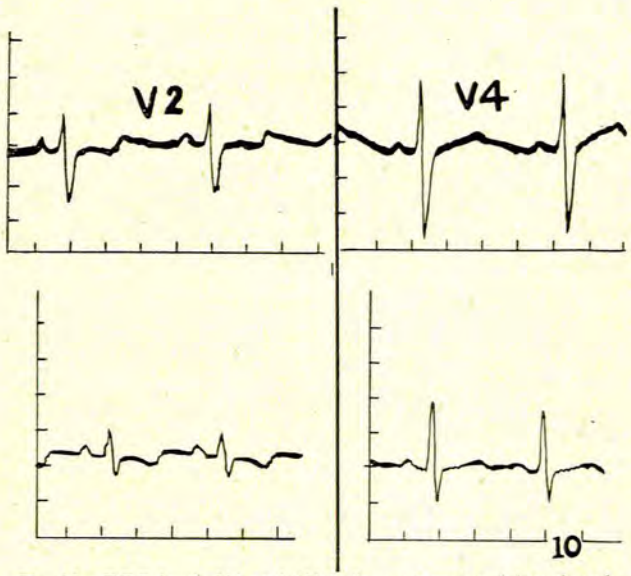


Fig. 10. ECG leads V2 and V4 before operation (above) and 2 months after closure of atrial septal defect (below).

SUMMARY

A case of successful closure of an auricular septal defect is presented. A relatively simple and effective technique is suggested and the main principles described.

REFERENCES

1. Senning, A. (1955): Acta chir. scand., 109, 229.
2. Parantela, A. (1955): Atti Soc. Romana Chir., **12.**
3. *Idem* (1955): Gazz. int. Med. Chir., **60,** 438.
4. Wood, P. (1952): *Diseases of the Heart and Circulation*, p. 218. London: Eyre and Spottiswood.
5. Kjellberg, S. R. *et al.*, (1955): *Diagnosis of Congenital Heart Disease*, pp. 346-357. Chicago: Year Book Publishers Inc.
6. Lewis, F. J. *et al.* (1955): Ann. Surg., **142,** 401.
7. Murray, G. (1948): *Ibid.*, 128, 843.
8. Bailey, C.P. *et al.* (1954): *Ibid.*, **140,** 805.
9. Gross, R. E. (1953): J. Amer. Med. Assoc., **151,** 795.
10. Bailey, C. P. (1955): *Surgery of the Heart*, p. 332. Philadelphia: Lea and Febiger.
11. Bjork, V. O. and Crafoord, C. (1953): J. Thorac. Surg., **26,** 300.
12. Sondergaard, T. *et al.* (1955): Acta chir. scand., **109,** 188.
13. Edwards, F. R. *et al.* (1955): Brit. Med. J., **2,** 1463.