

Congenital Surgery

Transventricular Repair of Tetralogy of Fallot

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Although in the widest definition, tetralogy of Fallot includes pulmonary atresia and ventricular septal defect (VSD), only the 'simple' form [i.e., right ventricular outflow tract obstruction (RVOTO) and VSD] will be considered. Historically, the results of repair in infancy were poor and surgeons tended to palliate infants requiring surgery and undertake correction later (e.g., at about 4 years of age). In the early 1970s, following the lead of Barratt-Boyes,¹ other surgeons started to repair those babies presenting with severe cyanosis or spells who would otherwise have been palliated.^{2,3} The reason these babies became cyanotic early was because they had narrower outflow tracts and therefore were more likely to need a transannular outflow patch. Because results have been good, many surgeons are now repairing all their patients in infancy with excellent outcomes.

Traditionally, if an outflow patch was not thought to be necessary, a transverse right ventriculotomy was made with resection of infundibular muscle and a good view was obtained of the VSD,⁴ which was closed with a patch and the ventriculotomy sewn up with a simple continuous suture. However, it can be difficult to decide when a transannular patch is necessary. The approach of Pacifico⁵ is sensible, and after making a vertical right ventriculotomy, the incision is stopped short of the pulmonary valve, muscle excised, a pulmonary valvotomy performed if necessary, and then the annulus measured with a Hegar dilator. The measurement is compared with a table adjusted for the size of the patient and a decision made as to whether a transannular patch is necessary. If no transannular patch is thought to be needed, the VSD is closed through the ventriculotomy, and closure of the ventriculotomy is performed with a patch to prevent narrowing of the infundibulum. The ratio of the right ventricular to left ventricular pressure (pRV/LV) can then be measured after coming off bypass, and if less than 0.8, probably indicates adequate relief of the outflow tract obstruction. In the early 1970s, surgeons changed from using a right ventriculotomy to a transatrial approach for closing isolated VSDs. In

the 1980s,^{6,7} some surgeons changed to closing the VSD and resecting the obstructing outflow tract muscle through the right atrium and tricuspid valve in patients with tetralogy of Fallot.

When the preoperative assessment done by echocardiography, and often angiography demonstrates an annulus that is too small to allow an adequate cardiac output, then the patient will need a transannular patch. In this case, there seems to be merit in making a longitudinal incision in the pulmonary artery down to the valve and inspecting the valve and annulus. A valvotomy can be performed and the annulus measured and compared with Pacifico's tables. If no patch is needed, it would seem sensible to close the VSD through the right atrium, as avoidance of the ventriculotomy is probably in the best long-term interests of the patients. However, if a transannular patch is needed (and this is even more likely if the valve is bicuspid), the incision must be taken down through the ring into the right ventricle. With an incision of perhaps 1.5 to 2 cm in the right ventricle, a good view of the VSD can be achieved and the VSD patched satisfactorily. Some surgeons elect to insert a small transannular patch and close the VSD through the right atrium. It is also possible to use both approaches, using the atrial approach to suture the lower part of the VSD and the ventricular approach for suturing the upper part. In either case, it is important to avoid damage to the bundle of His, tricuspid valve, and aortic valve cusps.

Although there has been concern that a ventriculotomy will cause late arrhythmias, there is very little evidence of this. Reports of late arrhythmias in patients who had undergone repair of tetralogy of Fallot were mainly in those having surgery at an older age.⁸ Patients having repair with a transventricular approach in infancy have short qrs intervals and infrequent arrhythmias.³

A transannular patch inevitably causes pulmonary regurgitation. If the patch is small this will be less, but as the patient grows, it is bound to get worse. If a large patch is used, early regurgitation can be lessened by use of a monocusp, which can be either homograft, Goretex, or autologous pericardium. Although reducing pulmonary regurgitation improves the post operative cardiac output and helps to provide an easy postoperative course, all these valves will leak in due course, and many patients will need pulmonary valves inserted. This may not be for more than 20 years,³ and the use of percutaneous methods of pulmo-

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nary valve replacement⁹ may reduce the need for reoperation. However, it is important not to leave it too late when irreversible right ventricular dilation with associated arrhythmias may occur.

Different materials have been used for the VSD patch. Traditionally, Dacron was used, but this can occasionally cause hemolysis and Goretex is probably more satisfactory. In infants where Goretex may be less easy to handle, calf pericardium is

very satisfactory. If autologous pericardium is used, it should be soaked in glutaraldehyde for 10 minutes to toughen it and prevent dilation. Pericardium used for transannular patches should also be treated in glutaraldehyde to prevent distension and late aneurysm formation. This is more likely if there is residual distal obstruction. It is important to relieve distal obstruction in the pulmonary arteries, and it may be necessary to extend the patch into a pulmonary artery.

Surgical Technique

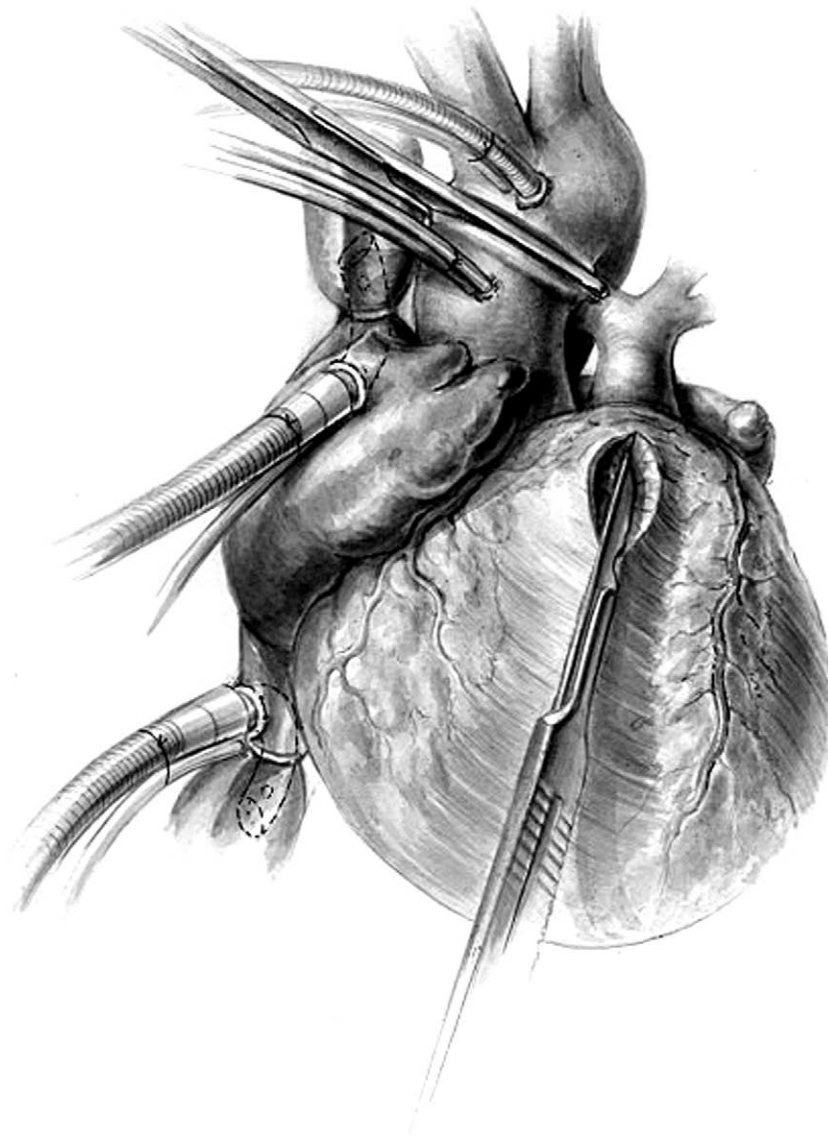


Figure 1 Cardiopulmonary bypass is instituted with an aortic and two venous cannulae. After clamping the aorta, blood cardioplegic fluid is infused into the proximal aorta and the caeve snugged. A longitudinal incision is made in the right ventricle stopping a few millimeters short of the pulmonary valve.

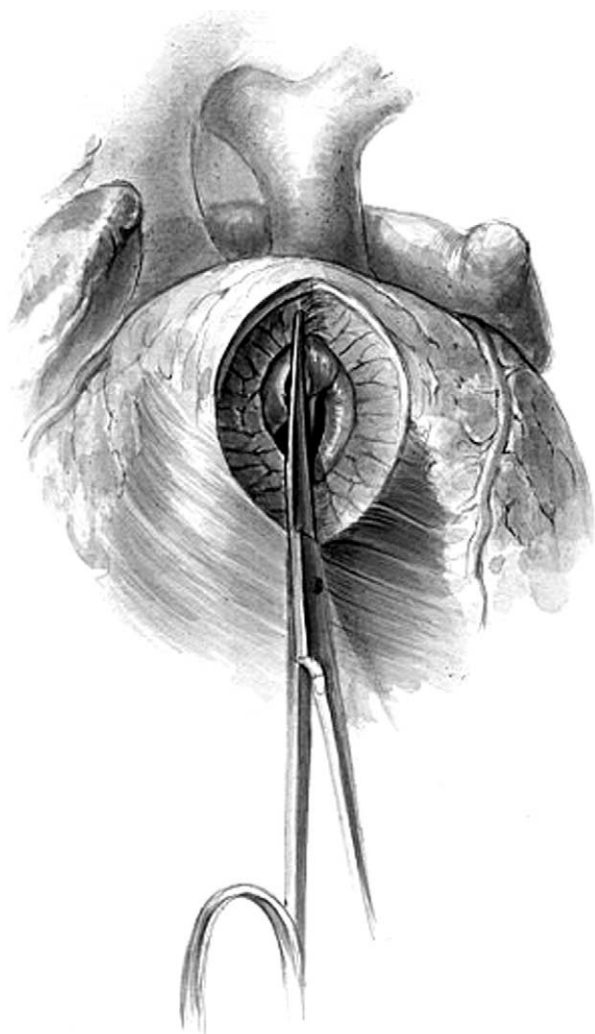


Figure 2 The obstructing muscle in the right ventricular outflow tract is excised and the VSD can be inspected.

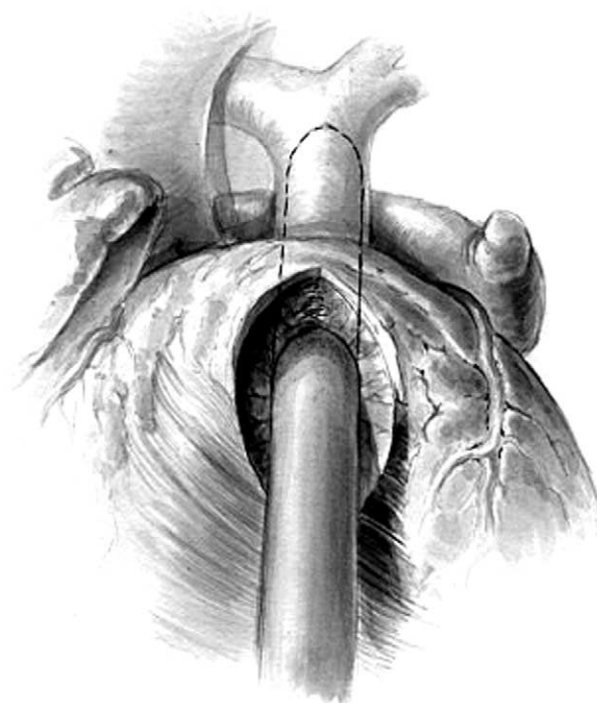


Figure 3 The pulmonary valve is inspected from below and any cuspal fusion incised. The annulus size is then measured with Hegar dilators, and the maximum diameter that will comfortably accept a Hegar dilator is compared with the acceptable diameter for that size of patient as noted in Pacifico's tables.³ The VSD is closed with a patch, as shown in Figs. 7 to 8.

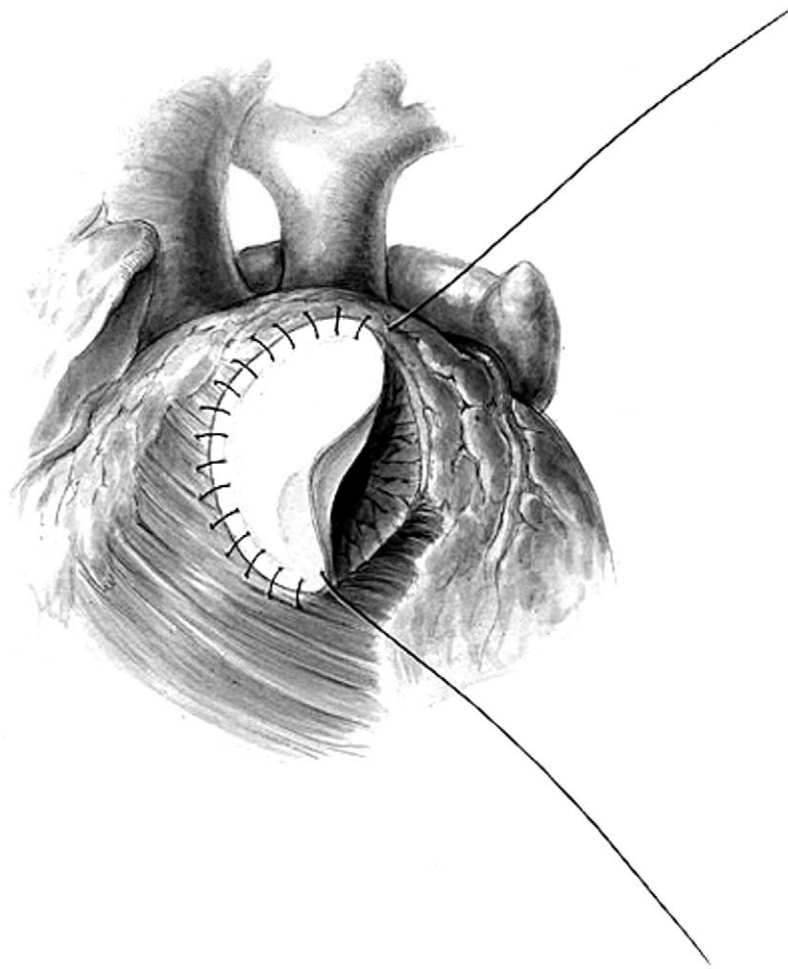


Figure 4 If the annulus diameter is acceptable, the longitudinal right ventriculotomy is closed with an elliptical-shaped patch. Autologous pericardium, which has been soaked in glutaraldehyde for 10 minutes is very satisfactory, but Dacron or Goretex can be used, though the latter two may bleed more.

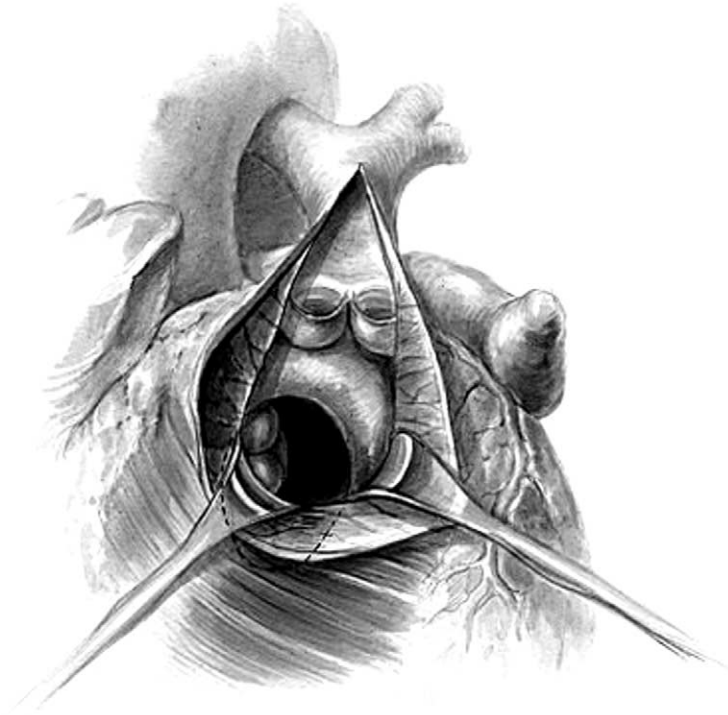


Figure 5 If the annulus diameter is inadequate, the incision is carried upwards through the pulmonary valve to the bifurcation of the main pulmonary artery. If there is a proximal narrowing in one of the individual pulmonary arteries, the incision should be continued across this. When making the incision through the pulmonary valve ring, it is best to try to take the incision between cusps so as to preserve the cusps if possible. If a unicuspid transannular patch is used, the remaining cusps will help to reduce regurgitation. With retractors at the lower end of the ventriculotomy, a good view is obtained of the VSD, but it is unnecessary to extend the incision downwards, and usually the ventriculotomy in an infant need not be more than 1.5 to 2 cm.



Figure 6 A retractor is placed in the upper margin of the VSD and, with upward retraction, a better view of the lower margin of the VSD is achieved. The tricuspid valve abuts the lower edge of the defect and the bundle of His is indicated in the diagram. Care must be taken to avoid this when suturing. The aortic cusps can be seen through the upper right margin of the VSD and great care must be taken to avoid damaging them with sutures.

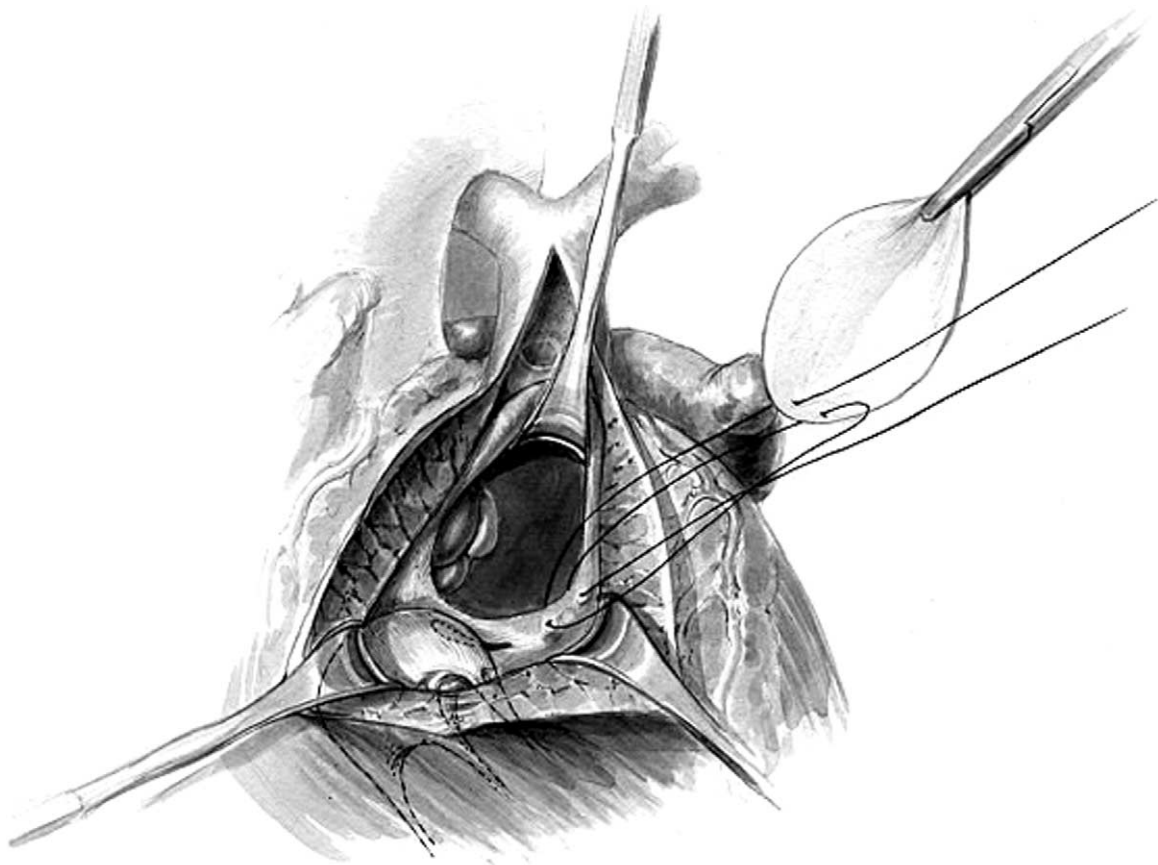


Figure 7 The VSD is closed with a patch of Dacron, Goretex, or calf pericardium. A running stitch is very satisfactory and several sutures can be placed before pulling the patch down into position.

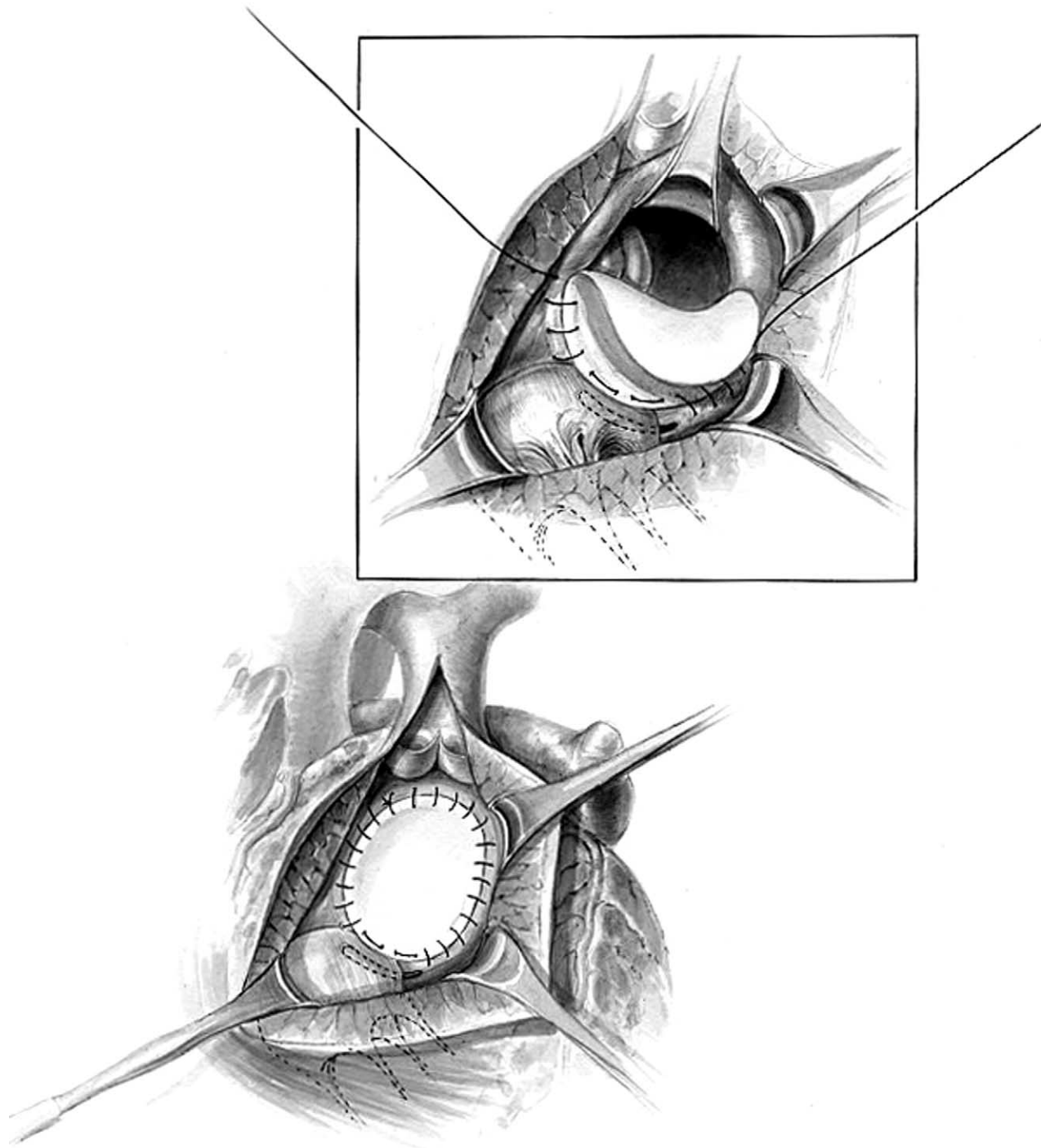


Figure 8 After pulling the patch down, the sutures are continued in a clockwise direction, taking care to keep on the right side of the septum. In the region of the bundle of His, it is safer to place the sutures in the base of the tricuspid valve leaflet. Particularly if the tissue here is rather thin, extra pledgeted sutures can be used. The other end of the continuous suture is used to run round in an anticlockwise direction and the knot tied at the top. The use of sutures of 5/0 prolene is very satisfactory for infants and of 4/0 for older children.

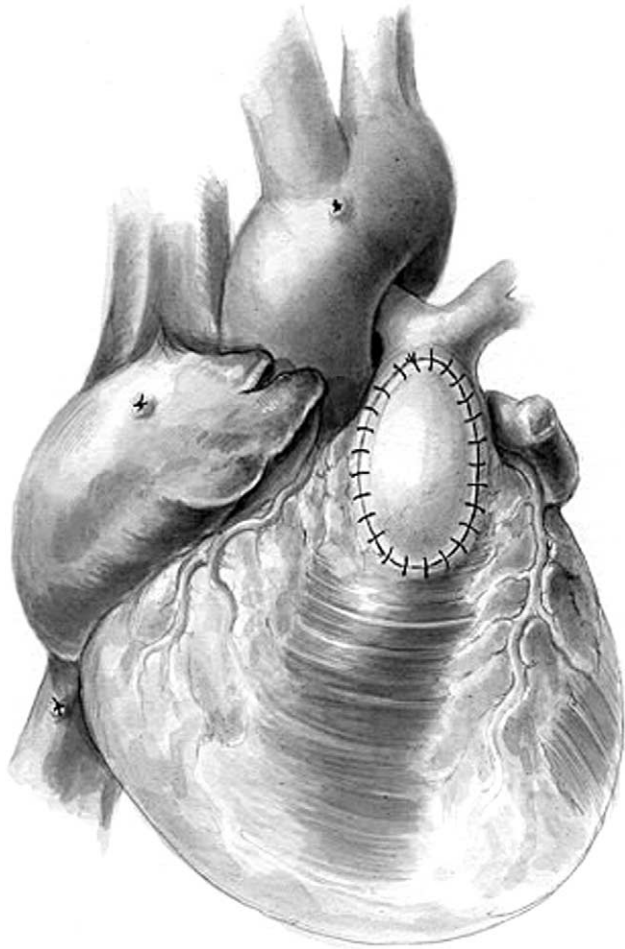


Figure 9 The transannular patch is then inserted with a continuous suture. Care must be taken not to pull the sutures too tight as this can have a “pursestring” effect, causing a distal stenosis. The patch should not be too wide, or excessive regurgitation will occur. If a unicus patch is used, it is important to get the anterior cusp at the same level as the residual pulmonary cusps. This will minimize initial regurgitation, but as the patient grows, pulmonary regurgitation will inevitably occur. It is possible to insert a transannular patch with the heart beating, having released the aortic clamp. In either case, it is important to remove all air from the left side of the heart. Once the heart is beating well, bypass can be discontinued. A pressure needle should be inserted through the right ventricle into the left ventricle. This is then pulled back into the right ventricle and virtually simultaneous LV and RV pressures are measured. The post operative pRV/LV should be less than 0.8 if adequate relief of RVOTO has been achieved. When a transannular patch has been inserted, it is usually much less.

Summary

When the preoperative assessment suggests that the pulmonary valve annulus is of adequate size, repair through the right atrium seems the best option. However, when the annulus is obviously small and a transannular patch will be needed, a ventriculotomy will be needed, and a small extension allows an adequate view of the VSD. This is a very satisfactory approach, and particularly when the repair is performed in infancy (which seems to be the current trend), late arrhythmias are very infrequent. When the annulus size is equivocal, either approach can be used and even a combination of ventricular and transatrial methods used to close the VSD.

The results with both approaches are now very good, but an increased recurrence of RVOTO has been reported with the transatrial approach, presumably because of inadequate resection of obstructing muscle in the RVOT.¹⁰ Because transannular patches cause pulmonary regurgitation, many patients will come to late pulmonary valve replacement. However, even when the pulmonary valve is preserved, late regurgitation may occur and all these patients need careful follow-up.

References

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