BRIEF COMMUNICATION

Cardiac Surgery in Neonates and Infants

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No pediatric cardiologist would deny either the need for, or the advantages of, safe one-stage intracardiac repair of the numerous correctable forms of congenital heart disease which present with severe symptoms in infancy. Not only would this result in increased survival but also it would avoid the need for palliation and subsequent frequent review before the corrective repair.

Unfortunately, until recently, the cardiac surgeon has been unable to provide safe corrective surgery in the first year of life. It is for this reason that various palliative procedures have come to be accepted as the treatment of choice despite the fact that they carry an appreciable mortality and provide imperfect relief of symptoms.

This situation has been altered radically with the demonstration that intracardiac correction can be performed safely in neonates and infants using a technique which employs surface-induced deep hypothermia followed by circulatory arrest and rapid core rewarming with extracorporeal circulation. This method was introduced some years ago in Japan,1,2 and results from Kyoto using this technique3 reveal only six deaths in 78 infants weighing between 4 and 10 kg. Sixty-two of these infants had repair of a ventricular septal defect with five deaths; nine had correction of tetralogy of Fallot with one death; five had atrial septal defect repair; and two had valvotomy for pulmonary stenosis.

These are impressive results. The reluctance of other surgeons to adopt the method possibly stems from the fact that the lesions operated upon were amenable to reasonable palliative procedures, or even to conservative management, and, at least in the case of ventricular septal defect, to safe closure using conventional cardiopulmonary bypass.4 Also, earlier Japanese publications1 suggested that both preliminary administration of fatty acids and ether anesthesia were essential to this technique. In fact, more recent Japanese work and our own experimental and clinical results5 indicate that neither of these is necessary.

It is not difficult to define the optimal conditions for safe and accurate repair of complex defects within these tiny hearts. First, caval cannulation should not be required for it is technically difficult and also interferes with atrial exposure. Second, the heart should be totally free of blood and completely still and atonic. Finally, the technique must not result in myocardial or pulmonary damage.

All these criteria are met by the method described. Indeed it seems devoid of any important drawbacks or complications, probably because the duration of extracorporeal circulation is strictly limited and because core rewarming rapidly reverses the metabolic acidosis produced by cooling and circulatory arrest.6 This is in contrast to methods using surface cooling and surface rewarming,7 where the results have been disappointing,8 and to those requiring prolonged extracorporeal circulation, which is poorly tolerated in infants, does not provide a dry, still, relaxed heart, and results in frequent and often fatal pulmonary complications postoperatively.9,10,11

Since adopting this technique at Green Lane Hospital, results comparable to those from Kyoto have been obtained in many varieties of congenital heart disease in infancy5,12
regardless of age or weight. As a result, our concepts of surgical management in most, if not all, potentially totally correctable intracardiac defects in the neonate and infant have undergone a radical change. Thus, pulmonary artery banding is no longer performed in high-flow ventricular septal defect, and shunt procedures are no longer performed in tetralogy of Fallot, for one-stage repair appears to give superior results in these infants. The same appears to be true in more complex situations such as double-outlet right ventricle with or without pulmonary stenosis, pulmonary atresia with large ventricular septal defect, and truncus arteriosus for we have successfully repaired each of these conditions very early in life. The increased patient salvage in transposition of the great vessels has been one of the most striking gains. We now carry out atrial baffle repair electively within the first year of life and, when symptoms demand it (including those with large ventricular septal defect), in the neonatal period.

There remains a further group of infants where palliation is either impossible or unsatisfactory but where salvage is possible by total correction. In this category our results have been good in total anomalous pulmonary venous connection, in partial atrioventricular canal with mitral incompetence, and in interrupted aortic arch, although to date they have been unsatisfactory in total atrioventricular canal.

In conclusion, it would appear that intracardiac repair can be highly satisfactory in infancy, regardless of age or weight or severity of symptoms, and that our concepts of management should be reoriented accordingly. A word of caution is, however, appropriate. Good results in infant cardiac surgery are dependent, as in other age groups, primarily on events in the operating room, but also on accurate and complete preoperative assessment and painstaking postoperative management. In each of these categories, particularly the first, there is no room at all for error. Surgery of this sort must therefore be learned first in older children as the results in infants are bound to be disappointing in inexperienced hands.

References

5. **Barratt-Boyes BG, Simpson MM, Neutze JM:** Intracardiac surgery in neonates and infants using deep hypothermia with surface cooling and limited cardiopulmonary bypass. Circulation 43 (suppl I): I-25, 1971
12. **Barratt-Boyes BG, Nicholls TT, Brandt PWT, Neutze JM:** Aortic arch interruption associated with patent ductus arteriosus, ventricular septal defect and total anomalous pulmonary venous connection: Total correction in an eight-day-old infant using profound hypothermia and limited cardio-pulmonary bypass. Submitted for publication