Banding of the main pulmonary artery is a palliative surgical procedure which may be applied in certain cases of congenital heart disease with excessive pulmonary blood flow. The principle of the operation was elaborated by Muller and Dammann in 1951, before intracardiac surgery was available. Despite the tremendous advances in open heart surgery since that time, there is still a place for this palliative procedure in some infants with ventricular septal defect and occasionally in other congenital lesions characterized by a patent ventricular septum and a great increase in pulmonary blood flow. Since this latter group is a heterogeneous one, we will confine most of the discussion which follows to infants with ventricular septal defect. The major purpose of this communication is to suggest in which infants this procedure is indicated.

The Principle of the Operation

Most infants born with ventricular septal defects pass through infancy without difficulty. In about 5 per cent, however, signs and symptoms of heart failure will develop in the first six months of life. It is important to realize that these features may disappear during the second six months as the child grows. Those infants who develop failure characteristically appear dyspneic and tachypneic with signs of right heart failure such as hepatomegaly and pleural effusion; nonetheless the major signs and symptoms are usually pulmonic. Moist rales, indrawing of the costal margin and superimposed pulmonary infections are the common findings. Clinically the heart appears enlarged and hyperdynamic, a harsh pansystolic murmur is evident along the left sternal border and a prominent diastolic flow murmur is heard at the apex. Radiologic investigation reveals an enlarged heart with a prominent left ventricle and pulmonary artery, and the pulmonary vessels appear strikingly flooded; areas of pneumonic infiltration may be present.

Left axis deviation and left ventricular strain may appear on the electrocardiogram.

The imposition of resistance to flow through the pulmonary artery may dramatically change the entire clinical picture. The constriction of the main pulmonary artery with a band of fabric, when properly applied, decreases the pulmonary flow and nearly abolishes the left-to-right shunt. Left ventricular work is reduced and the tachycardia decreased; heart size may be reduced to normal and the child returned to good health. The effect of such a band is shown schematically in Figure 1.

Pulmonary artery bands are generally applied through a left anterior thoracotomy. The intrapericardial portion of the pulmonary artery is exposed and dissected from the ascending aorta. A band of cotton or Dacron tape is passed about the main pulmonary artery and tightened using recordings of aortic, right ventricular and distal pulmonary artery pressures as a guide. At the onset right ventricular and pulmonary artery pressures are at

![Figure 1](http://journal.publications.chestnet.org/pdfaccess.ashx?url=/data/journals/chest/21467/ on 04/16/2017)
the defect in infancy. The decision whether or not to carry out an intracardiac procedure will be based on the experience of the surgical unit involved. Some surgeons feel that cardiopulmonary bypass carries a great risk in infancy. It is our belief that infants can undergo cardiopulmonary bypass with about the same risk as older children. The problem is that the infant must be in critical condition for operation to be considered and so the mortality rate is likely to be higher. In the past few years, we have closed the defects of ten infants with ventricular septal defect and nine of these have survived. These infants were more robust and larger than the infants selected for pulmonary artery banding and, in addition, their pulmonary infections were better controlled. There were no hemodynamic differences between the two groups and the decision of which operation to carry out was made by the surgeon at the patient's bedside. The sicker infants were treated by pulmonary artery banding.

Report of Cases

Two cases illustrating the use of banding of the main pulmonary artery are included. The first case illustrates the conventional use of the technique in the management of congestive heart failure in an infant with a ventricular septal defect. The second case illustrates the use of the hemodynamic principles of banding in the management of an infant suffering from a more complex congenital cardiac anomaly. The application of this procedure to such bizarre anomalies requires strict individualization of the cases and a careful hemodynamic analysis of the anomaly.

Case 1:

This baby was admitted to The Montreal Children's Hospital, May 20, 1960, at age five months, with evidence of a respiratory tract infection, fever and congestive heart failure. Radiologic investigations revealed increased lung vascularity and cardiomegaly with areas of bronchopneumonia. The child was managed initially with penicillin therapy and diuretics. The patient's response was poor, diuretics produced little improvement and he was subsequently digitalized.

Heart catheterization was performed June 20, 1960, and a ventricular septal defect with a left-to-right shunt calculated to be 4.9/1 was demonstrated. Right ventricular and pulmonary artery pressures were in the systemic range.

Because of the inadequate response to medical management, the child underwent a banding of the main pulmonary artery on July 5, 1960; the final main pulmonary artery systolic pressure was 25 mm Hg. The child had some postoperative pneumonia which cleared over the ensuing week and he was discharged taking digitalis July 20, 1960.

Over the ensuing year, the patient's condition improved satisfactorily and digitalis was discontinued. He was re-
catheterized on two subsequent occasions. On July 23, 1962, he was shown to have a left-to-right shunt of 1.3/1 with pressures in the right ventricle of 85 mm Hg and the main pulmonary artery of 21/5 mm Hg. On November 8, 1965, the shunt was left-to-right at a ratio of 1.25/1 with pressures in the right ventricle of 115/0 mm Hg and pulmonary artery 11/2 mm Hg. Over this period, his growth record was satisfactory and his activity limited only by some dyspnea on exertion. A harsh ejection systolic murmur remained at the left sternal border throughout this period.

The patient underwent reoperation on November 23, 1965, using cardiopulmonary bypass. The pulmonary artery band was removed, increasing the pulmonary artery diameter from 8 mm to 16 mm and the ventricular septal defect was closed with a Teflon felt patch. The postoperative course was uneventful and he was discharged December 7, 1965.

A keloid formed on the sternotomy incision and the child was readmitted to the hospital on May 22, 1968, for its removal. At that time, he was completely without cardiovascular symptoms and engaged actively and successfully in athletics.

X-ray films illustrating the patient's course are shown in Figure 2 and his weight-growth record shown in Figure 3. The time of the banding and of the definitive repair are shown and each is seen to be followed by an improvement in his growth.

CASE 2:

This eight-month-old baby girl was admitted August 21, 1960 to The Montreal Children's Hospital with evidence of right heart failure and history of cyanosis with exertion. Her weight was 6.0 kg, which was well below the third percentile for weight. Tachypnea and tachycardia were apparent.

Investigations performed in the Departments of Cardiology and Radiology suggested that the child had both transposition of the great vessels and atresia of the tricuspid valve. Because of the progressive deterioration of the patient's clinical condition despite intensive medical management, the decision was undertaken to operate upon the child with the intention of banding the large pulmonary artery and performing a superior cavo-pulmonary shunt.

The child was operated upon on October 5, 1960, through a transverse sternotomy at the fourth interspace. Diagnosis of transposition of the great vessels and tricuspid atresia were confirmed. The pressures within the aorta and pulmonary artery were both 50 mm Hg before the application of the band, with post-banding pressures of 30 mm Hg in the pulmonary artery and 80 mm Hg in the aorta being achieved. Pressures within the superior vena cava were 4 mm Hg and with occlusion rose to 50 mm Hg. An end-to-side superior caval right pulmonary artery anastomosis was performed with ligation of the right pulmonary artery proximal to the anastomosis. Pressure within the superior vena cava on completion of this anastomosis was 20 mm Hg and the left pulmonary artery pressure had risen to 50 mm Hg.

FIGURE 2. Anteroposterior chest roentgenograms of patient (case 1) at times: (a—upper) before banding of the pulmonary artery; (b—center) prior to removal of the band and correction of the ventricular septal defect, and (c—lower) one and one-half years following the debanding procedure.
BANDING OF PULMONARY ARTERY

FIGURE 3. The weight-percentile growth record of case 1 through the course of the surgical management of his ventricular septal defect. The weight-percentile values are from the anthropometric chart produced by the Children's Medical Center, Boston, Massachusetts.

The patient's postoperative course was one of slow and progressive recovery, medications were successfully discontinued and the patient was discharged on October 23, 1960. Clinical follow-up over the ensuing five and one-half years reveals that the child is well, requires no medications, is acyanotic and is attending school in Europe.

This is a most gratifying result in an infant with an extremely complicated cardiac anomaly. Pulmonary artery banding was required to reduce the pulmonary flow. The cavo-pulmonary shunt was added to allow the superior caval blood to bypass the deformed right side of the heart and perfuse directly through the right lung. Thus, rather than a large volume of mixed arterial and venous blood being ejected into the lungs under systemic pressure, the right lung is perfused under venous pressure with pure venous blood and the left lung flow has been reduced by the band.

The results of such procedures in complicated cases are not entirely predictable and patients must be strictly individualized.

CONCLUSION

Pulmonary artery banding has a place in the treatment of infants dying of heart failure from a ventricular septal defect. Banding may be considered in the treatment of certain more complicated forms of congenital heart disease.

REFERENCES


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