Improved Visualization of Aortopulmonary Collateral Arteries by Abdominal Aortic Compression During Angiography

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SUMMARY Increased filling of aortopulmonary collateral arteries occurs when the descending aorta is obstructed distal to their origin. We used this fact to develop a simple, safe technique for improving angiographic visualization of these arteries. The abdominal aorta is manually compressed against the spine during injection of contrast medium. A slight reflex bradycardia resulted, which probably also enhanced filling of the collateral arteries. In eight infants and children with either pulmonary atresia and a ventricular septal defect or truncus arteriosus communis, excellent visualization was consistently achieved without complication.

SURGICAL TECHNIQUES for correction of congenital heart malformations with a single arterial outlet from the heart (pulmonary atresia with ventricular septal defect or truncus arteriosus communis) have been significantly improved. It is important, therefore, to accurately identify all collateral pulmonary arteries as they arise from the aorta and carefully define their course, size and distribution, and the presence and site of stenotic areas. Previously, this has been possible only by selective catheterization using special techniques or by selective angiography. We devised a simple, safe technique that improves visualization of aortopulmonary collateral arteries at any level of the thoracic aorta. Clear anatomic definition of the arteries and their origins from the aorta is possible.

Methods

We studied eight patients with a single arterial outlet overriding a ventricular septal defect and with absent direct connection between the right ventricle and pulmonary trunk. Six were less than 6 months old and two were 1-2 years old. All underwent routine diagnostic cardiac catheterization under light halothane anesthesia.

The procedure consisted of manual compression of the abdominal aorta against the spine. Aortic pulsation was palpated through the abdominal wall and we then observed the amount of compression necessary to raise the proximal aortic systolic pressure by 50-100% (fig. 1). A similar amount of compression was then used during cineangiography. Compression was started immediately before injection of the contrast medium and was released as soon as possible. The duration of compression did not exceed 8 seconds in any patient. Adequate compression was more difficult in the older children. Formerly, we used 1.5 ml/kg of contrast material; with this technique, visualization is excellent with 0.75-1.0 ml/kg.

Results

Aortic compression was most useful during aortic root and particularly aortic arch injections, but visualization of aortic collaterals was also enhanced with ventricular injections. In many instances, an initial ventricular injection was performed with the patient in the anteroposterior position to define the origin and course of the major collateral arteries (fig. 2A). For subsequent angiograms performed by injecting contrast medium into the aorta (fig. 2B), the patients were repositioned.

In all patients, anatomic detail was clearly obtained. The origin and course of arteries, even those arising from disparate regions of the aorta (fig. 3), were easily defined by a single injection of contrast medium. Areas of diffuse or localized narrowing were identified clearly (figs. 2B and 3), whether at the origin of the arteries from the aorta or peripherally, perhaps at the level of junction with the true pulmonary arteries. The origin of the pulmonary arteries in truncus arteriosus communis could be observed clearly and narrowing at their origin could be seen (fig. 4).

Despite injection of contrast medium into the aortic arch, the ascending aorta was well filled to the level of the aortic or truncal valve in each case, and valvar regurgitation, if present, could be assessed.

Discussion

In patients with a single arterial outlet (pulmonary atresia or truncus arteriosus communis), reliable demonstration of true pulmonary arteries or of major collateral arteries arising from the aorta is desirable because the surgical approach depends on the anatomy. Delineation of the origin, size and course of the major aortopulmonary collateral arteries is also a prerequisite to recommending specific corrective surgery. To this end, various specific techniques have been applied during cardiac catheterization. Each artery can be catheterized by selective angiography, but this is not always possible and, when successful, is difficult and time-consuming.

Recently, balloon-tipped angiographic catheters

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FIGURE 1. Ascending aortic blood pressure (mm Hg) recorded during a control period and then during and after release of abdominal compression. Start and release of compression is indicated by arrows.

manipulated from the ventricle into the aorta have been used to enhance visualization of the collateral arteries.\(^4\) Inflation of the balloon reduces flow into the descending aorta, which allows better filling of arteries proximal to the balloon. To avoid air embolism, carbon dioxide must be used for balloon inflation; this technique cannot be used for retrograde catheterization of the aorta. In addition, the balloon must be positioned at or just below the diaphragm or several injections performed to assure filling of all branches.

The abdominal compression technique we devised to enhance filling and thereby angiographic visualization of collateral arteries is simple to perform, reproducible, and without complication. Although performed under light general anesthesia in this group of patients, when performed in awake children the degree of compression used has caused no apparent distress. The slight reflex bradycardia seen in all instances was transient and caused no obvious ill effect. In fact, the bradycardia probably contributed to better filling of the arteries.

This technique has several major advantages. Unless specifically needed for pressure measurements, selective arterial catheterization is unnecessary; fluoroscopy and catheterization time can therefore be shortened, often to a great degree. A ventricular injection alone may be sufficient to identify all branches and may obviate the necessity to perform a retrograde arterial catheterization when the aorta cannot be entered directly. The number of contrast injections and the volume of contrast medium for each injection can be reduced without sacrificing angiographic detail. This is particularly important in small infants.

One need not use expensive balloon catheters, which are not always available, and the potential risk of balloon rupture is removed. Our technique can be performed during retrograde arterial catheterization or ventriculography; this cannot be done with a balloon catheter in these circumstances.

Although we have described this technique for pedi-
atrial patients only, other applications are possible. Better anatomic visualization is probable in the presence of a patent ductus arteriosus or surgically created aortopulmonary shunts. Better visualization of the coronary arteries and aortic valve also is possible.

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FIGURE 3. Aortogram in an infant with pulmonary atresia. (A) During early phase showing filling of collateral artery arising from aortic arch. (B) During later phase showing collateral artery arising from the lower portion of the descending thoracic aorta. Thin arrows indicate areas of stenosis. Thick arrow indicates true pulmonary artery.

FIGURE 4. Aortogram during abdominal aortic compression in an infant with truncus arteriosus communis type II.
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