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Pseudoaneurysm of the Pulmonary Artery After the Banding Procedure: Two-Dimensional Echocardiographic Description

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This report describes an infant with double-outlet right ventricle who underwent pulmonary artery banding as palliation for excessive left to right shunting through a ventricular septal defect. Three weeks after this procedure, there was abrupt clinical deterioration, and two-dimensional echocardiography clearly defined a large pseudoaneurysm arising from a breach in the posterior pulmonary artery wall, just proximal to the band. The diagnosis was confirmed at surgery, during which total correction was performed with successful outcome. The two-dimensional echocardiographic features of a pseudoaneurysm of the pulmonary artery are shown and the role of this noninvasive technique in the evaluation of pulmonary artery bands is discussed.

Pulmonary artery banding is well established as a palliative procedure for limiting pulmonary blood flow in patients with excessive left to right shunting through a ventricular septal defect or other more complex congenital malformations (1–5). Of the reported complications of this procedure, rupture of the pulmonary artery wall in the region of the band is potentially the most devastating. We report an instance of pseudoaneurysm formation at the site of rupture of the pulmonary artery after banding, in which the definitive diagnosis was made by two-dimensional echocardiography. The use of this method in the assessment of this and other complications of the pulmonary artery banding procedure is discussed.

Case Report

A full-term 4 kg female infant was admitted to the special care nursery with cyanosis and acidosis. Two-dimensional echocardiography and subsequent cardiac catheterization defined the cardiac abnormality to be that of D-loop transposition of the great vessels with double-outlet right ventricle and a subpulmonary ventricular septal defect of the Taussig-Bing type. In addition, there was a severe coarctation of the aorta and a large patent ductus arteriosus. A Rashkind balloon septostomy was performed and surgical repair of the coarctation and ligation of the ductus were undertaken to relieve symptoms of congestive heart failure. However, persistence of congestive failure due to high pulmonary blood flow then necessitated the palliative placement of a pulmonary artery band.

Marked clinical improvement followed this procedure. However, 3 weeks after pulmonary artery banding, the infant developed a left pleural effusion and recurrent hemorrhagic pericardial effusions. Increasing respiratory distress and radiographic evidence of left upper pulmonary lobe collapse led to a request for echocardiographic examination to determine the status of the pulmonary artery band.

Two-dimensional echocardiography demonstrated the echo-dense pulmonary band in the appropriate position around the main pulmonary artery. However, from the subcostal four chamber view, an echo-free space, not present on prior examinations, was seen compressing the lateral wall of the left atrium. Following a peripheral venous injection of saline solution, this space opacified soon after the right atrium. From the parasternal view, the space was observed to be located behind the main pulmonary artery and to compress the superior wall of the left atrium. On scanning superiorly, the space was seen to lie behind the main pulmonary trunk and to extend superiorly, displacing the pulmonary artery bifurcation (Fig. 1). From both the parasternal long- and short-axis views, there was a clearly observed breach in the posterior wall of the proximal pulmonary artery adjacent to

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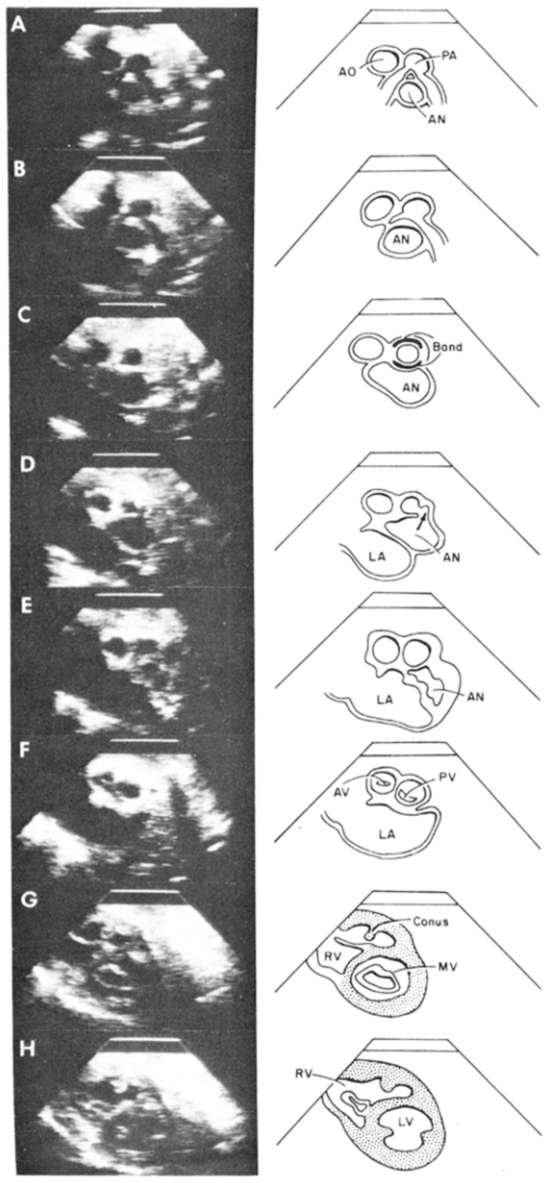
the band (Fig. 2). This allowed communication between the main pulmonary artery and the echo-free space interpreted as a pseudoaneurysm, which was verified by saline contrast echocardiography. Cardiac catheterization confirmed the echocardiographic findings (Fig. 3).

The infant underwent surgical reexploration and the diagnosis of pulmonary artery rupture with pseudoaneurysm formation was confirmed. The proximal pulmonary artery and pseudoaneurysm were resected. Total intracardiac repair was then undertaken by patch closure of the ventricular septal defect connecting the left ventricle with the aorta and placement of a valved conduit from the right ventricle to the pulmonary artery bifurcation. After the procedure, the infant had a remarkably good clinical recovery and was discharged with normal systemic saturations.

Figure 1. Parasternal short-axis planes obtained by sweeping the transducer from base to apex to visualize: **A,** The pulmonary artery (PA) bifurcation (note transposed aorta [AO] to the right); **B,** Sweeping inferiorly; **C,** At the level of the pulmonary artery band; **D,** Just proximal to the band to visualize the posterior and slightly lateral tear (**arrow**) in the pulmonary artery; **E,** At the superior border of the left atrium (LA); **F,** At the level of the two semilunar valves; **G,** At the mitral valve (MV) level with the double-outlet anatomy from the anterior right ventricle (RV) clearly defined; **H,** At the left ventricular (LV) papillary muscle level. The pseudoaneurysm (AN) of the pulmonary artery extends from: **A,** where it displaces the pulmonary artery bifurcation, to **C,** where it is located behind the area of the pulmonary artery band, to **E,** where it displaces the superior left atrial wall.



Discussion

Complications of pulmonary artery banding. Despite an increasing tendency toward primary repair of many congenital cardiac malformations in the first year of life, pulmonary artery banding remains useful as a palliative procedure in infants with complex cardiac lesions. Although a relatively simple procedure to perform, such banding is not without its complications. These may include minor structural alterations in the pulmonary artery and valve, fibrosis and scarring of the artery wall, slippage of the band distally along the pulmonary trunk, or rarely pulmonary artery necrosis and rupture (5–11). This case illustrates the two-dimensional echocardiographic features of the latter most ominous complication: pulmonary artery rupture with pseudoaneurysm formation.

Role of two-dimensional echocardiography in evaluating pulmonary artery banding. This is the sixth reported case (5,9,12–15) that we have encountered of pseudoaneurysm formation in the early period after the banding procedure, and the first in which two-dimensional echocardiography established the diagnosis. The location of the tear in the pulmonary artery wall adjacent to the band and the posterior relation of the pseudoaneurysmal cavity to the main pulmonary artery in our patient is similar to the descriptions in the previous reports. In our case, echocardiography also established the position of the pulmonary artery band with respect to the pulmonary valve and confirmed that migration had not occurred, a phenomenon previously described by Orsmond et al. (16).

Another potential application of two-dimensional echocardiography in the assessment of patients with a pulmonary artery band is the determination of the adequacy of the band in reducing distal pulmonary artery pressures. Previous M-mode studies (17) have suggested that a ratio between the internal diameter of the band and that of the proximal main pulmonary artery of 0.35 and 0.60 is consistent with a satisfactory reduction in pulmonary flow. Although this method has not been reported utilizing the two-dimensional echocardiographic technique, the improved ability to visualize the pulmonary artery and band by two-dimensional

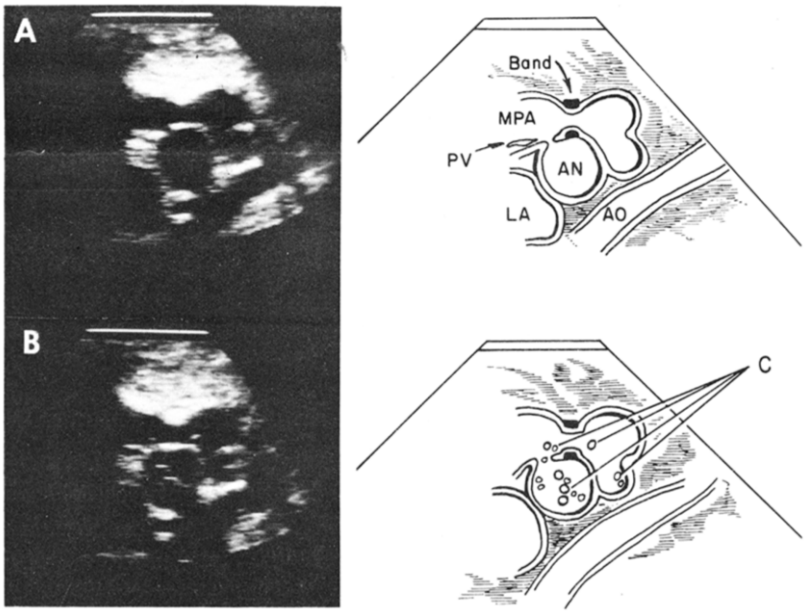
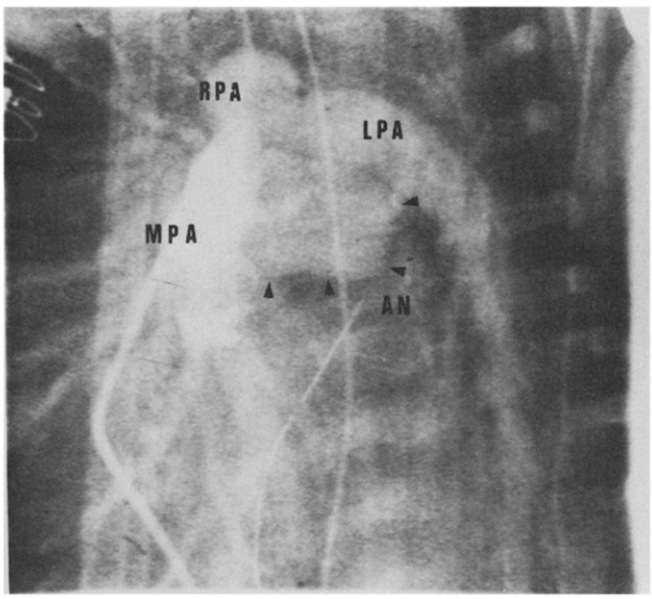


Figure 2. A, Parasternal long-axis view oriented along the long-axis of the main pulmonary artery (MPA). Note the echo-free aneurysmal (AN) cavity lying behind the pulmonary artery and the defect in the posterior artery wall. **B,** Similar long-axis view with the appearance of contrast echoes in the pseudoaneurysm that stream across the tear in the posterior pulmonary artery wall proximal to the band. C = contrast echoes; PV = pulmonary valve; RPA = right pulmonary artery; other abbreviations as in Figure 1.

study should allow more accurate determination of these dimensions. In our patient, the internal luminal dimension at the band was 4 mm with a proximal pulmonary artery dimension of 11 mm, giving a ratio of 0.36, indicating an adequate restriction to pulmonary blood flow. This was confirmed by a catheterization gradient of 50 mm Hg across the band and a distal pulmonary artery systolic pressure of 38 mm Hg.

Figure 3. Left anterior oblique projection of the angiogram demonstrating contrast medium within the main pulmonary artery (MPA) and right (RPA) and left (LPA) branches. Extrusion of contrast medium behind the main pulmonary artery delineating the pseudoaneurysm (AN) is denoted by **arrowheads**. Abbreviations as in Figure 2.



Implications. Our experience suggests that in using two-dimensional echocardiography to evaluate patients whose condition deteriorates after the banding procedure, particular attention should be directed to the pulmonary artery wall just proximal to the band, and the region behind the main pulmonary artery where the potential pseudoaneurysmal cavity might extend. Furthermore, if suspected, peripheral venous injection of contrast medium should be used to confirm the connection between the pulmonary artery and the aneurysmal cavity. Although angiography has been the method of choice for determining the anatomy of the pulmonary trunk, this procedure is not without risk in patients who may have partial necrosis of the pulmonary artery in the region of the band. Two-dimensional echocardiography with peripheral venous contrast injection provides a safe alternative to angiography in the diagnosis of this potentially life-threatening complication.

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