

Demonstration of pulmonary arteries by contrast injection into pulmonary vein

S. P. SINGH, M. L. RIGBY, AND R. ASTLEY

From the Departments of Cardiology and Radiology, Birmingham Children's Hospital, Dudley Road Hospital, and University of Birmingham

Pulmonary venous injection of contrast medium in the near-wedge position produced a flow into the pulmonary arterial tree in 15 out of 21 children with cyanotic congenital heart disease. In 5 there was good opacification of both sides from a single injection. The technique provides an additional method of demonstrating the anatomy of the pulmonary arteries where surgical treatment is contemplated.

In children with cyanotic congenital heart disease, an essential part of assessment for possible surgical treatment includes the demonstration by angiography of the precise anatomy of the major pulmonary arteries. While this is often possible by the standard methods of selective contrast injection (Jefferson *et al.*, 1972; Macartney *et al.*, 1972), any safe way of obtaining additional information about of the size and position of the pulmonary arteries will be helpful in making what is often a difficult decision about operability.

Therefore, in children where there was reason to expect relatively undeveloped pulmonary arteries, we have attempted to demonstrate their anatomy by contrast injection into a pulmonary vein. The ages of the 21 patients ranged from 1 day to 18 years, and are shown with the diagnoses in the Table. All the patients were cyanosed, with serious anaemia. The diagnosis was established by right heart catheterisation and right and/or left ventriculography and aortography when possible and necessary. Small infants were examined under sedation and older infants and children under general anaesthesia. In each child contrast injections were made into one or more pulmonary veins, entered by way of the foramen ovale (or atrial septal defect) and left atrium. Pressure injection of contrast was made with the catheter tip in a position just short of the wedge situation. After initial experience, the dose of Conray 420 employed was usually 1.0 ml/kg body weight. The catheters varied in type; some had both end and side holes, others had only side holes. Biplane cineradiography was employed, using a steep left anterior oblique projection and anteroposterior or slightly right

oblique projection. There were follow-up clinical examinations at 24 hours, 48 hours, and 4 weeks after the procedure, with chest radiographs and electrocardiographic examination.

Results and comments

Opacification of a pulmonary artery was achieved in 15 of the 21 subjects. In 7 the opacification was confined to the pulmonary arterial tree of the side injected (but in one of these both sides were demonstrated by making an injection on each side in turn). In another 3 children, as well as obtaining good opacification on the injected side, a certain amount of radio-opaque medium passed to the opposite side, and in 5 children there was good opacification of both sides from a single injection; in 2 of these contrast passed back to the site of an atretic pulmonary valve. In 3 children even a small hand injection to check the catheter position produced some arterial opacification but the larger

Table *Diagnoses and ages*

	Ages	
	PA filling	No filling
Pulmonary atresia with intact ventricular septum	1d, 2d, 5m*	1d
with ventricular septal defect	4y	7m, 10m
with transposed aorta		3y
with single ventricle	12m	4d
with tricuspid atresia	8y, 18y	
Tricuspid atresia	4m, 14m, 18m,	
	4y, 9y, 13y	
Fallot's tetralogy	4m, 8y	
Truncus arteriosus		4d

*Extreme valvar stenosis.

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dose appeared much more satisfactory and more likely to demonstrate both sides. Opacification was dense and early; it did not appear to matter into which pulmonary vein the injection was made, but when the injection was at too proximal a site, much of the contrast leaked back to the left atrium. It was more difficult to find a satisfactory injection site in very small babies.

Comparison with the findings obtained by contrast injection at other sites showed that pulmonary arterial opacification produced by pulmonary venous injection was usually as good or better. Certainly, in 2 children, pulmonary venous injection changed a situation in which there was uncertain identification of the pulmonary arteries to one where there was very clear demonstration of their very small size. In another child the denser opacification obtained by a pulmonary venous injection showed the arteries to be in fact larger than they had appeared when less well opacified from other injection sites.

The rapidity and density of pulmonary vein opacification was too great for the communication to have occurred through the capillaries; in a number of children there was some extravasation of contrast medium (Fig. 1) but the shunt from pulmonary veins to arteries was seen to take place before this happened (Fig. 2). In most children the site of communication could be identified as lying beyond the hilum of the lung but proximal to the capillaries, about half-way across the width of the chest (Fig. 3). This level of shunt might well correspond with the communications shown experi-

mentally by Tobin and Zariquiey (1950) to lie at the apices of the lobular subdivisions of the bronchopulmonary segments.

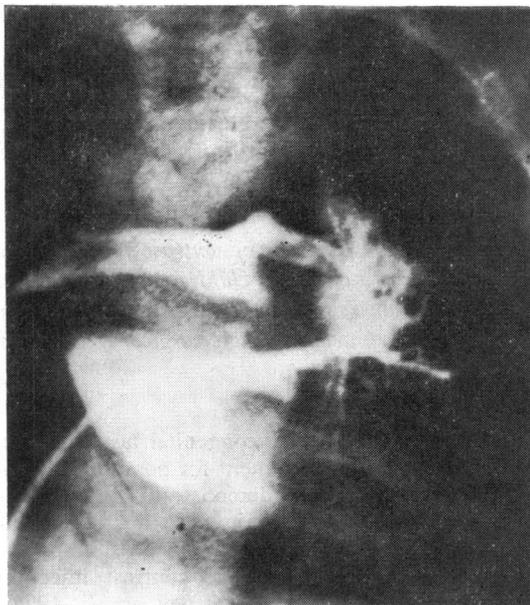


Fig. 2 Opacification of the right and left pulmonary arteries and of the short main pulmonary trunk is seen before significant extravasation has occurred.

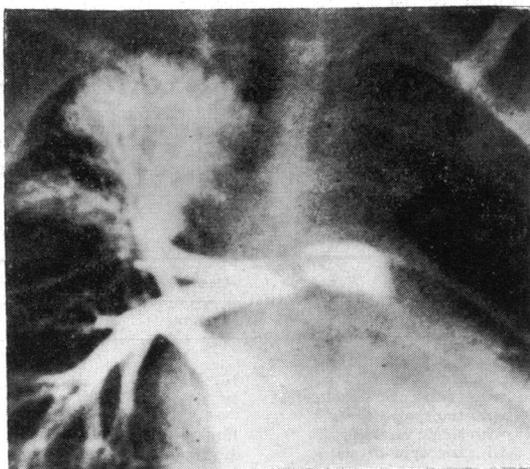


Fig. 1 Opacification of the pulmonary arteries after some extravasation has occurred in the lungs. The right pulmonary artery and its branches are clearly seen and the main left pulmonary artery is also opacified.



Fig. 3 The site of communication can be identified lying beyond the hilum of the lung and fills a minute pulmonary artery.

There were six subjects in whom a pulmonary artery did not opacify. One baby of 4 days had a persistent truncus arteriosus and the injection proved subsequently to have been into a high pressure site. This was an inoperable situation and the child died; at necropsy it was found that, while the left pulmonary artery was very small, the right was larger and there was severe pulmonary vascular disease in the right lung (the side on which the venous injection had been made). In 4 children the failure could be attributed to technical reasons (catheter recoil in 1 and too proximal a catheter position in 3, so that most of the contrast flooded back to the left atrium). In one child aged 10 months with pulmonary atresia, ventricular septal defect, and persistent ductus arteriosus, there was no pulmonary arterial opacification despite a good injection.

In no child was harm seen to ensue from the investigation. In 1 girl of 9 years, there was a transient area of pulmonary oedema seen radiologically at the injection site 25 minutes later; at 5½ hours only traces remained, and at 19 hours the opacity had gone. She was asymptomatic throughout. We believe this occurrence was the result of failure to withdraw the catheter from the near-wedge position immediately after injection, a procedure that we now regard as essential.

Until recently, we were unaware of previous reports of the use of a similar technique. However, we have found that its use in 2 patients was described by Takamiya *et al.* (1973) at the 13th International Congress of Radiology in Madrid. These authors also tested the method experimentally in dogs and concluded that a dose of 0.8 ml/kg body weight, very similar to our own, was suitable. No pathological changes were observed in

the lungs. More recently, Porstmann (1976) demonstrated the method at a postgraduate meeting in Stockholm. In a personal communication to R.A. (1976) he expressed the opinion that extravasation of contrast medium was essential for pulmonary arterial opacification to occur. However, this view was not based on cineangiographic observations and certainly does not agree with our own experience.

More experience is required in the use of this method, but we have already shown that it is a valuable additional technique for demonstrating the anatomy of the pulmonary arteries in children in whom determination of the feasibility of surgical treatment is dependent on this knowledge.

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Requests for reprints to Dr. S. P. Singh, Dudley Road Hospital, Dudley Road, Birmingham B18 7QH or to Dr. R. Astley, Department of Radiology, Birmingham Children's Hospital, Ladywood Mid-
dleway, Birmingham B16 8ET.