Technique

Echocardiographically Directed Angiography in Congenital Heart Disease
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Two-dimensional echocardiography has profoundly influenced the performance of other diagnostic procedures in patients with congenital heart disease. Detailed anatomic information is usually available prior to catheterization, and this information can be employed to facilitate the collection and understanding of additional anatomic and physiologic data. While echocardiography has affected the selection of angiography during catheterization, its potential for guiding camera position has not been widely exploited. Integration of the two techniques can improve the quality of the diagnostic information obtained, particularly in patients with unusual cardiac position or complex cardiac anatomy.

Prior to anticipated catheterization, the patient is examined in detail by ultrasound using subxiphoid, apical, parasternal, and suprasternal views. Based on the anatomic information obtained, the angiographic aspects of the catheterization are planned. Optimal visualization of many cardiac structures, particularly septal defects or obstructing ridges and membranes, requires that the x-ray beam be nearly perpendicular to the structure of interest, in order to demonstrate the margins. Consequently, if the structures of interest can be imaged by ultrasound, appropriate planes can be marked on the patient's chest to ensure optimal angiography. For example, if an apical four-chamber echocardiographic view optimally demonstrates the ventricular septal defect in a patient with complete common atrioventricular canal, then the cineangiographic camera should be positioned perpendicular to that echocardiographic plane to delineate the margins of the lesion. To facilitate identification of the appropriate plane, a simple device may be fashioned for attachment to an ultrasound probe which can inscribe a curved line on the patient's chest when the desired echocardiographic image is obtained (Fig. 1). The device shown is comprised of a hose clamp and a flexible straightedge designed for drafting (Fig. 2). A second aid, made from an identical straightedge and a pointer (Fig. 2), is helpful for positioning the angiographic equipment during catheterization (Fig. 3). While the devices shown in these figures are useful, a freehand approximation of the relevant plane may be drawn on the chest at the time of ultrasound examination and the camera position estimated at the time of catheterization.

Examples of echocardiographically positioned cineangiograms are shown in Figs. 4 and 5. The camera position in Fig. 4 is intermediate between a long axial oblique and a hepatoclavicular view. The position in Fig. 5 is intermediate between a hepatoclavicular and a sitting-up view. In each case, the anatomic details are well delineated, despite unorthodox heart orientation and defect location.

Bargeron et al. [2] and Fellows et al. [2] emphasized the utility of angled angiography to demonstrate anatomic details of congenital heart disease. However, for angled views to successfully demonstrate intracardiac structures, the contrast medium must outline the structure when viewed along the axis of the x-ray beam. If the cameras are not appropriately aligned, overlying contrast will obscure the desired features. Most angiographers position the radiographic equipment according to recommended angles (e.g., 70° left anterior oblique and 20° cranial angulation for left ventricular outflow tract obstruction or membranous ventricular septal defects). However, these angles will only be useful if the cardiac position and intracardiac anatomy are...
Fig. 1. The appropriate echocardiographic sector is identified, and the flexible ruler attached to the ultrasound transducer is conformed to the patient's chest. The ultrasound plane is then marked on the patient's chest with a felt-tipped pen.

Fig. 2. A flexible ruler attached to an ultrasound probe (right) is used to identify and mark echocardiographic planes on the patient's chest. An identical ruler with an attached pointer (left) is employed in the catheterization laboratory to direct the cineangiographic cameras.

Fig. 3. The flexible ruler with attached pointed is positioned along the predetermined echocardiographic plane to align the cineangiographic cameras.

Fig. 4. Echocardiographically aligned cineangiogram of a single posterior muscular ventricular septal defect. The camera position is 55° left anterior oblique and 25° cranial angulation.

Fig. 5. Echocardiographically directed cineangiogram of a patient with complete atrioventricular canal with transposed great arteries in asplenia syndrome and mesocardia. The camera position is 15° left anterior oblique and 35° cranial angulation. The single atrioventricular valve and deficiency of the inflow portion of the ventricular septum are well demonstrated.