Radiologic Notes in Cardiology

Use of the Contrast Interface in Angiocardiography

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SUMMARY
The presence of a contrast interface indicates a difference in density between shadows of adjacent structures while the absence of an interface means that their radiodensities are similar. This is of considerable help in evaluating the presence or absence of opacified blood in any portion of the heart or great vessels on an angiocardiogram.

AN X-RAY picture is composed of shadows of various densities, ranging from white (radiopaque) through the various shadows of gray to black (radiolucent). Details are visible on the film because the density of one shadow differs from that of adjacent shadows. Thus, the heart is seen on a chest film because it is more opaque to the X-rays and, therefore, casts a whiter shadow than does the radiolucent air in the surrounding lungs. The border of the cardiac silhouette is formed by the interface between the two contrasting densities.

Because there is no demonstrable difference between the density of the blood and that of the cardiac tissues, the shadow of the heart is homogeneous and no internal details are seen on standard films. When the opacity of the blood within the heart is increased by the injection of a contrast agent, the shadow of the cardiac lumen becomes considerably more dense than that of the cardiac wall and the endocardial surface becomes visible as the line along which the two densities meet. Thus, by increasing the radiopacity of the blood over that of the soft tissues, we have caused a contrast interface to appear. As the opaque material is ejected from the heart in successive cardiac cycles and is replaced by nonopaque venous blood, the density of the intracardiac pool once more becomes the same as that of the heart wall, and the contrast interface disappears. In other words, the presence of a contrast interface indicates that there is a difference between the densities of two adjacent shadows, while the absence of such an interface means that the densities are essentially the same. This can be very helpful in the interpretation of an angiocardiogram for it may be the only detectable evidence indicating the presence or absence of contrast material within a cardiac chamber.

When an angiocardiogram is performed for delineation of the anatomy of the heart, the detection of contrast material is not the primary problem. If the cardiac structures are silhouetted against the blood in the lumen, contrast material obviously is present. However, in the evaluation of the presence of an intracardiac shunt by the use of the contrast material to label the blood on one side of the heart, the detection of opacified blood in the various chambers becomes the key to the angiocardiographic diagnosis. This is usually not difficult when there is a sizable pressure differential across a septal defect. The velocity of the shunted blood is great, and a jet can be visualized crossing the septum and spurring into the lower pressured chamber. However, when the shunt velocity is not great, and especially when the septum is not viewed on end, the diagnosis of a shunt depends on the detection of a significant change in the density of the cardiac chamber receiving the shunted blood as one observes the sequence of films.

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Right ventricular angiocardiogram, levocardiogram phase. Frontal projection. The inferior border of the opacified left atrium (LA) is sharply outlined (arrows) where it abuts on the shadow of the non-opacified right atrium (RA). The mitral valve (M) is obscured by contrast material in the left ventricle (LV). Diagnosis: normal angiocardiogram.

This situation is encountered most frequently with atrial septal defects.

If an angiocardiogram is planned specifically for the demonstration of an atrial septal defect with a left-to-right shunt, the patient is placed in a steep right posterior oblique position so that the atrial septum is viewed tangentially and, if possible, the contrast material is injected selectively into the left atrium. Such optimal studies are usually not available because angiocardiography is rarely needed in the study of a simple atrial defect. More commonly the possibility of an atrial septal defect must be evaluated in the presence of other anomalies, on frontal and lateral films after the injection of contrast material into the right side of the heart.

The left atrium is usually well visualized on late films after injection of contrast material into the right ventricle or pulmonary artery. It is seen in the frontal view as a sharply outlined, oval density with the opacified pulmonary veins converging to its lateral aspects (fig. 1). The superior margin of the opacified atrium is sharply contrasted with the more lucent structures of the posterior mediastinum. The inferior margin of the atrium can be divided in two. The right portion shows a well defined contrast interface as it abuts on the nonopacified right atrial shadow, while the left portion is formed by the mitral valve and is partly obscured by the overlapping, opacified outflow tract of the left ventricle. The interatrial septum is projected obliquely in this view and is not seen.

If there is a defect in the atrial septum, as the opacified blood from the pulmonary circulation fills the left atrium it also flows through the defect and opacifies the right atrium. The increase in the density of the right atrial shadow is often obvious (fig. 2). When the opacification of the left atrium is less than optimal, it may not be possible to determine with certainty, whether or not there is a change in the density of the right atrial shadow. The angiographic diagnosis then

Pulmonary arteriogram, levocardiogram phase. Frontal projection. As the left atrium (LA) becomes opacified, there is an obvious increase in the density of the right atrium (RA). The lower border of the left atrium abutting on the right atrium is effaced. Diagnosis: atrial septal defect, left-to-right shunt.
The significance of the contrast interface is not limited to the evaluation of intracardiac shunts but can be utilized for identification of the presence of opacified blood on any type of angiogram. For example, in the case of a dissecting aneurysm, it is of considerable importance to determine whether or not there is a free flow of blood within the false channel. The presence of such flow indicates a much graver prognosis than if the blood in the dissected channel is clotted. In the latter instance, extension of the aneurysm is less common and it may resolve, with fibrosis and obliteration of the dissected channel.

Blood flow in the false channel is evidenced by opacification of the widened aortic wall when the contrast material is injected into the true lumen. Communication of the two channels occurs through a tear in the intima and, therefore, it is important that the injection be made at the level of, or upstream to, the possible intimal tear. Because a significant number of dissections begin immediately above the aortic valve, it is advisable to position the tip of the catheter in the supravalvular region of the aorta in all cases.

In the right posterior oblique projection, the outer wall of the thoracic aorta is outlined by the air in the surrounding lungs. The dissection occurs within the medial layer of the aortic wall and usually extends along one side, almost never involving the wall circumferentially. When the true lumen is opacified, it appears eccentrically narrowed and displaced from the outer aortic wall (fig. 4A). If the false channel is clotted, the thickened aortic wall casts a homogeneous shadow which actually represents the intima, the clotted blood, the disrupted media, and the adventitia. The intima is outlined on one side, by the opacified blood in the lumen.

When there is flow in the dissected channel, it becomes opacified together with the true lumen. The intima and the inner layers of the disrupted media are then seen as a lucent line interposed between the two channels. Opacification of the false channel often lags behind

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**Figure 3**

Pulmonary arteriogram, levocardiogram phase. Frontal projection. The left atrium (LA) is opacified as evidenced by the contrast interface (arrows) between its upper margin and the mediastinum. The absence of a similar interface with the right atrium (RA) indicates the presence of opacified blood in that chamber even though its shadow does not appear dense. Diagnosis: atrial septal defect, left-to-right shunt.

depends on the appearance of the contrast interface between the two atria.

Since the radiodensity of blood and of soft tissues is essentially the same, the nonopacified right atrium and the posterior mediastinal structures cast shadows of a similar shade. If the upper border of the left atrium can be seen, it means that there is sufficient contrast material in the left atrial blood to significantly increase its density over that of the mediastinum. The inferior margin, abutting on the right atrium, therefore, should be equally well seen at this time. If this contrast interface is not present, the density of the right atrium must be similar to that of the left atrium, the degree of opacification of the blood in the two chambers must be the same, and, therefore, there is a left-to-right shunt into the right atrium (fig. 3).
Dissecting aneurysm. Supravalvular aortogram, right posterior oblique projection. (A) Injection of contrast material into the true lumen shows it to be eccentrically narrowed, beginning at a point just distal to the left subclavian artery (LSA). The outer border of the aortic wall (arrows) is outlined by air in the surrounding lungs. The thickened aortic wall appears homogeneous, and contrast material cannot be identified within the false channel. (B) A later film of the same series shows a well demarcated lucent line within the aortic shadow (arrows). This represents the inner wall of the dissected channel, indicating that there must be opacified blood on both of its sides and, therefore, that there is blood flow from the true to the false lumen.

that of the true one when the tear in the intima is small. In some cases, a relatively small volume of contrast material enters the false channel so that it is only faintly opacified. The change in the density of the aortic wall shadow may then be difficult to detect. The appearance of a lucent streak within the shadow of the aorta (fig. 4B) indicates that there is a contrast interface on either side of the intima and that the radiopacity of the blood in both channels must be greater than that of the soft tissues. Since the contrast material was injected only into the true lumen, its presence in the false channel indicates blood flow within the dissected aortic wall.
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