Color Scintiphotographic Radionuclide Angiography: An Aide to Isotope Ventriculography

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Various anatomic cardiac structures can be evaluated very simply by means of radionuclide angiography. Data acquisition of the initial radionuclide injection should be performed on all patients undergoing equilibrium-radionuclide ventriculography. With the use of a gamma camera, a computer, and color display, the acquired data can be separated into individual frames and color enhanced. Superimposition of these color frames provides a more accurate clinical evaluation of these procedures.

Dynamic radionuclide angiography permits the evaluation of numerous congenital and acquired lesions of the heart and great vessels and can be a valuable addition to isotope ventriculograms. The simplicity of intravenous injection techniques lends itself to repeated measurements to assess the effects of therapy or to follow the course of a disease process (*1–4*). Using a gamma camera in conjunction with an analog-to-digital converter, a computer, and color display, we are able to acquire data in the form of pictures or frames obtained from gamma radioactivity at different time intervals. Any number of these acquired frames can be stored into different areas of computer memory. This acquired data can be retrieved and color can be added to any of the individual frames, which can then be separated or superimposed to delineate anatomic relationships between different regions of the heart.

Materials and Methods

Instrumentation: Our institution uses a Picker Dynacamera, model 4/11, with an 11-in. diameter field of view (Picker Medical Products, Cleveland, OH) and a Medical Data Systems Simultaneity computer. The simultaneity computer has 32K-word memory and dual magnetic disk drives (Medical Data Systems, Inc., Ann Arbor, MI).

Position Technique: The patient is positioned supine on the imaging table. The gamma camera is positioned over the left anterior axillary line in a 45° left anterior oblique (LAO) position. This projection provides separation of the left and right ventricular chambers, because it lines up parallel with the interventricular septum and is valuable in assessing chamber size and ejection fractions (*3,5*). The ejection fraction is calculated using the equilibrium blood-pool–time-activity curve.

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Injection Technique: 2 ml of stannous pyrophosphate is injected for in vivo labeling of radionuclide to red blood cells (*6*). Using 2 syringes, a 19-gauge butterfly needle and a male-adapter lock, a bolus of 20 mCi of [^{99m}Tc] pertechnetate (0.5–1.0 ml) is injected followed immediately with a bolus push of 10-ml normal saline. Pediatric doses are calculated and corrected according to surface area—50% adult dose/m^2 surface area (*7*). The medial basilic vein of the right arm is preferred for injections.

A Typical Clinical Situation: A 73-year-old woman with a heart murmur initially detected nine years earlier was referred to the University of Iowa Hospitals and Clinics for evaluation of aortic valve disease. She had a history of aneurysms of the thoracic and abdominal aorta. On admission, her blood pressure was 140/60, pulse 80 beats/min in normal sinus rhythm, and respirations 12/min. Cardiac auscultation revealed a grade III/VI systolic ejection murmur that was present on the entire left sternal border and radiated to the carotids bilaterally. A grade IV/VI diastolic decrescendo murmur was loudest at the upper left sternal border and radiated to the apex. A grade II/VI diastolic rumble was also audible at the apex. There were no audible gallops. Chest x-ray demonstrated cardiomegaly, a left pleural effusion, and a tortuous enlarged aortic root. Specific chamber sizes could not be evaluated. The electrocardiogram showed left ventricular hypertrophy, and the echocardiogram showed shuddering of the anterior leaflet of the mitral valve consistent with aortic insufficiency. The echocardiogram was otherwise technically inadequate. Other laboratory data included normal CBC, prothrombin time, serum potassium, BUN, and creatinine. She was assessed as a cardiac functional class IV.

The patient was brought to our cardiac imaging laboratory for evaluation of her anatomic and pathophysiologic condition. An isotope ventriculogram was recommended. The patient was positioned supine. Two ml of stannous pyrophosphate was injected; the camera head was angled 45° in a LAO position to the precordium along the left anterior axillary line. Twenty mCi of [^{99m}Tc] pertechnetate with 10-ml normal saline as a bolus push was administered in the medial basilic vein of her right arm. At this time, 200 scintigraphic images were obtained at 0.1 sec/frame with a total of 20-sec acquiring time. A gated isotope ventriculogram was performed immediately following the radionuclide angiogram.

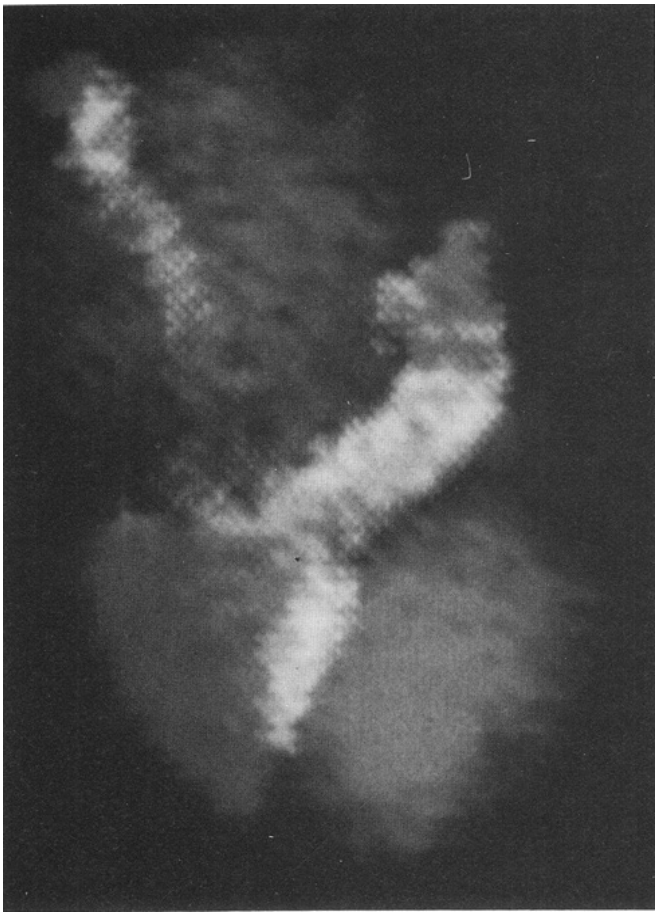

FIG. 1. Superimposition of the two color memories (reproduced here in black and white) demonstrates a large left ventricle and a very large aneurysm.

Results and Discussion

After all frames were acquired, they were viewed in gray scale. Selected sequential frames of the right atrium, right ventricle, and pulmonary artery were extracted, superimposed on each other, and rewritten into an area of computer memory. Similarly, the frames of the left atrium, left ventricle, and ascending aorta were acquired, superimposed, and stored in computer memory. Colors were then added to the computer memories—blue for the right side of the heart, red for the left side. These two color memories were then retrieved and superimposed on each other. Figure 1 demonstrates a large left ventricle and a very large aneurysm involving the ascending aorta. The pulmonary artery was deviated laterally by the aneurysm. There was diffuse hypofunction of the left ventricle, and the left ventricular ejection fraction equaled 11%. The similar color image (not shown) vividly displays these anomalies.

At our institution, we find that dynamic acquisition of radionuclides during injection for a radionuclide ventriculogram can be a very valuable supplement to the equilibrium study and that the addition of color contrast enables more definitive areas of discrimination, thus elevating the accuracy of the clinical evaluation of these studies.

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