jnm/ CONCISE COMMUNICATION

RADIONUCLIDE ANGIOGRAPHY WITH ^{99m}Tc-LABELED RED BLOOD CELLS FOR THE DETECTION OF AORTIC ANEURYSM

U. Yun Ryo, Jong I. Lee, Hilary Zarnow, Michael P. Schwartz, and Steven Pinsky

Michael Reese Hospital and Medical Center, Chicago, Illinois

After infusion of ^{99m}Tc-labeled autologous red blood cells, scintiphoto images of the heart and aorta were obtained from patients with suspected aortic aneurysm. Images of the heart chambers and the great vessels were clearly visualized on the static scintiphotos obtained up to 2 hr after the injection.

A dissecting aneurysm at the aortic arch in a critically ill patient and abdominal aortic aneurysms in asymptomatic patients were detected by scintiphoto. These findings were confirmed by subsequent contrast aortography or ultrasonic scan. Images can be taken repeatedly after a single injection of ^{99m}Tc-RBC and the procedure does not require a data-processing system. Radionuclide angiography using ^{99m}Tc-labeled autologous red blood cells and a gamma camera appears to be a very effective and simple procedure for the detection of abnormalities in major blood vessels.

Technetium-99m pertechnetate has been utilized extensively for radionuclide angiography (*1,2*). This radionuclide diffuses rapidly out of the circulating blood (*3*) thus requiring a system for dynamic data acquisition. Even with the aid of data-processing equipment, anatomic resolution is not satisfactory especially beyond the level of the left ventricle.

Utilizing a gamma camera, radionuclide angiography can be developed as a convenient and effective technique for detecting abnormalities in major vessels when a radiopharmaceutical that stays in the circulating blood for a sufficient time is available.

The authors have performed radionuclide angiography using ^{99m}Tc-labeled autologous red blood cells in four patients with suspected aortic aneurysm. Scintiphoto scans for aortic aneurysm were positive in all the patients. These findings were confirmed by subsequent contrast angiogram or ultrasonic scan in three of the patients.

Although radionuclide angiogram can by no means compete with contrast angiography in resolution of structure, it appears that proper utilization of the procedure can provide sufficient information to be used either in a diagnostic approach or in a therapeutic evaluation.

METHOD

Ten to 15 ml of venous blood were drawn from a patient into a syringe that contained 2–4 ml of acid citrate dextrose solution. Red blood cells were centrifuged from plasma and labeled with ^{99m}Tc according to the technique described by Eckelman, et al (*4*), obtaining labeling yield of 40–60%. The stability of ^{99m}Tc-RBC in the circulating blood was measured in two patients, showing 98% of labeled RBC in the circulating blood at 90 min and 50% at 24 hr. A patient was positioned in front of a gamma camera (Searle Radiographics Pho/Gamma HP) with a low-energy parallel-hole collimator. Technetium-99m-RBC, 5–10 mCi, resuspended in physiologic saline was infused slowly into the patient through the antecubital vein.

Serial images of the dynamic flow of labeled RBC were recorded on Polaroid film. One to 2 min after the end of the injection the heart chambers and great vessels were clearly visible on the static scintiphotos in which a minimum of 500k counts were accumulated. Serial views could be obtained from an area of interest.

RESULT

Patient 1. A 60-year-old man noticed a mass in his abdomen 9 days prior to this study and was referred to our hospital by his family physician. On

Received Mar. 19, 1974; revision accepted May 29, 1974.

For reprints contact: U. Y. Ryo, Nuclear Medicine Division, Michael Reese Hospital and Medical Center, 2929 S. Ellis Ave., Chicago, Ill. 60616.

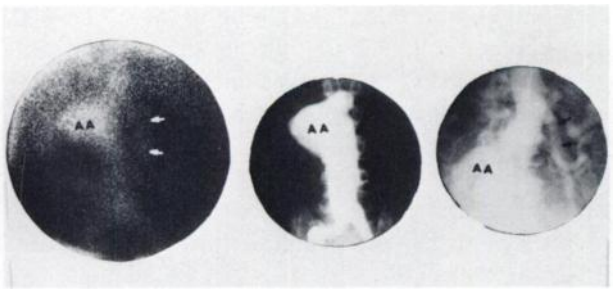

FIG. 1. Demonstration of abdominal aortic aneurysm by scintiphoto with ^{99m}Tc-RBC and contrast angiogram. (Left) Scintiphoto of abdominal aorta shows large aneurysm (AA) and unusually prominent superior mesenteric artery (arrows). Both were confirmed by subsequent contrast angiography (middle, right).

physical examination a pulsatile mass with an estimated diameter of 6 cm was palpable in the upper abdomen. With an initial impression of an abdominal aortic aneurysm, a radionuclide angiogram was obtained which showed a large aneurysm (Fig. 1). The scintiphoto finding was confirmed by a subsequent contrast aortogram and the aneurysm was excised surgically. The unusual, large vascular image of the left of the abdominal aorta in the scintiphoto scan was identified on the contrast angiogram as a large superior mesenteric artery (Fig. 1).

Patient 2. The second patient was an 80-year-old man who felt a mass in his upper abdomen. A diagnosis of an abdominal aortic aneurysm was made by his family physician and the patient was referred to this hospital for confirmatory studies. Radionuclide angiography was performed and an aneurysm was noted in the midportion of abdominal aorta on the scintiphoto (Fig. 2). The aneurysm was again confirmed by ultrasonic scan. The patient was discharged without surgical correction.

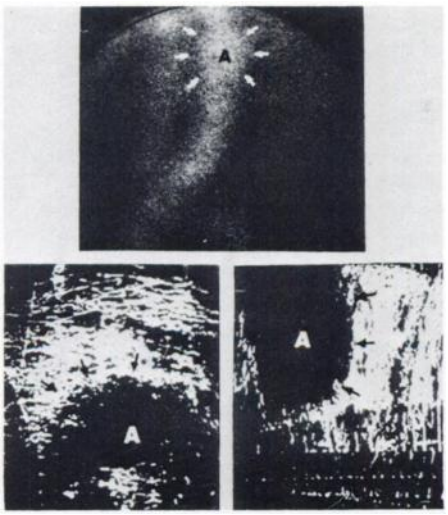

FIG. 2. Demonstration of abdominal aneurysm by scintiphoto with ^{99m}Tc-RBC and ultrasonic scan. Scintiphoto of abdominal aorta (top picture) shows round aneurysm (A). Aneurysm was confirmed by subsequent ultrasonic scans. (Bottom left) horizontal axis; (right) vertical axis.

Patient 3. A 65-year-old semicomatose man was brought to the emergency room with a history of sudden onset of a severe chest pain. He was in shock with a systolic blood pressure of 60 mmHg. Chest radiography showed a widened mediastinum and the clinical impression was a dissecting aneurysm of the thoracic aorta. The patient was considered to be too ill for contrast angiography so radionuclide angiography was performed. A left anterior oblique view of the aortic arch showed a narrowing of the distal third of the arch (Fig. 3). Two days later when the patient improved clinically, contrast angiography was carried out. Although it was suboptimum in quality, the angiograph showed the configuration of a true and false lumen in the distal third of the aortic arch and the proximal part of the descending aorta (Fig. 3). The patient died before surgical intervention and consent for autopsy was not obtained.

Patient 4. A 76-year-old man noticed a pulsatile mass in his abdomen and was referred to this hospital for an evaluation of a probable abdominal aortic aneurysm. This patient who had an episode of anaphylactic reaction during an intravenous pyelogram was referred to nuclear medicine for a radionuclide angiogram. A large spindle-shaped aortic aneurysm appeared in the distal end of abdominal aorta on a scintiphoto (Fig. 4). Possibility of surgical excision of the aneurysm was discussed; however, the patient discharged himself from the hospital.

DISCUSSION

When ^{99m}Tc-pertechnetate is used as an agent for radionuclide angiography, sequential images of dynamic flow should be obtained and stored using a data-store playback system. However, even with computer-assisted data processing, structural resolution of the left heart and aorta is often unsatisfactory.

Bosnjakovic, et al (*5*) demonstrated the usefulness of ^{99m}Tc-sulfur colloid for detection of a cardiovascular abnormality and Park, et al (*6*) reported a unique case of successful radionuclide angiocardiography with ^{99m}Tc-MAA. None of these radiopharmaceuticals however, is suitable for imaging the heart and great vessels when repeated scintiphotos in different positions are required.

Theoretically, labeled red blood cells are an ideal agent for radionuclide cardiovascular study because labeled red cells will remain in the circulation a long time provided the cells are not denatured during the labeling procedure. Hedge, et al (*7*) were successful in labeling both intact and heat-damaged red blood

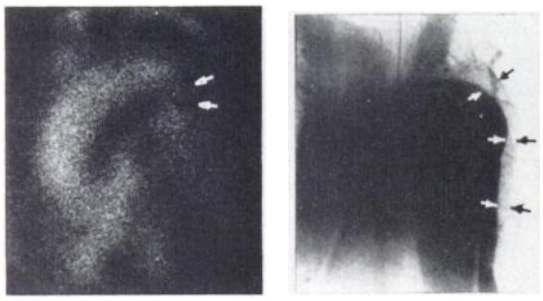

FIG. 3. Demonstration of dissecting aneurysm of aortic arch (arrows) by scintiphoto with ^{99m}Tc-RBC (left) and contrast angiogram (right).

FIG. 4. Demonstration of spindle-shaped abdominal aortic aneurysm (arrows) by scintiphoto with ^{99m}Tc-RBC.

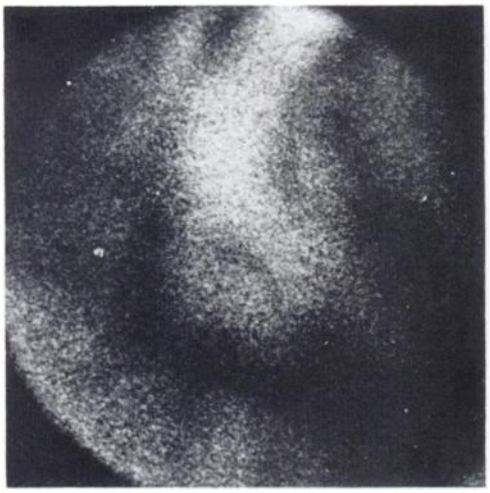

FIG. 5. Demonstration of heart chambers, aorta, and pericardial effusion by scintiphoto with ^{99m}Tc-RBC.

cells and demonstrated tight binding of ^{99m}Tc with the red blood cell membrane. Mahon, et al (*8*) compared ^{99m}Tc-RBC with other blood-pool scanning agents available and reported that an image of the placenta was best obtained with ^{99m}Tc-RBC.

Factors that affect the efficiency of RBC labeling with ^{99m}Tc and the biologic effect of the labeling procedure on the cell membrane should be studied. Injected ^{99m}Tc-RBC stayed in the circulation long enough to visualize the heart chambers and great vessels for several hours in the present study suggesting that the labeling procedure did not greatly damage the cell membrane.

The radioactivity injected as ^{99m}Tc-RBC varied from 5 mCi (Patient 2) to 10 mCi (Patient 3). In the four cases described, scintiphoto images provided sufficient information to confirm the clinical impression, "aortic aneurysm".

Figure 5, a scintiphoto of the heart of Patient 3, clearly shows each cardiac chamber and a large pericardial effusion. Radionuclide angiography or static imaging of the cardiovascular system using ^{99m}Tc-labeled autologous RBC as the agent appears to be a convenient and effective procedure for detecting structural abnormality in the heart and/or the major arteries. Particularly in patients who are allergic to contrast medium or in those too ill for contrast angiography, radionuclide angiography with the ^{99m}Tc-labeled RBC is the procedure of choice.

Haubold, et al (*9*) estimated whole-body radiation exposure to be less than 20 mrads/mCi ^{99m}Tc-RBC infused. The whole-body radiation dose calculated by authors using unpublished data from this laboratory, 4.5 hr as an effective half-life of ^{99m}Tc-RBC (*10*), was 2.7 mrads/mCi ^{99m}Tc-RBC.

REFERENCES

1. MASON DT, ASHBURN WL, HARBERT JC, et al: Rapid sequential visualization of the heart and great vessels in man using the wide field Anger scintillation camera. Radioisotope angiography following the injection of Technetium 99m. *Circulation* 39: 19–28, 1969

2. GRIEP RJ, WISE G, MARTY R: Detection of carotid artery obstruction by intravenous radionuclide angiography. *Radiology* 97: 311–316, 1970

3. LATHROP KA, HARBER PV: Biologic behavior of ^{99m}Tc from ^{99m}Tc-pertechnetate ion. *Prog Nucl Med* 1: 145–162. Basel, Karger, and Baltimore University Park Press, 1972

4. ECKELMAN W, RICHARDS P, HAUSER W, et al: Technetium-labeled red blood cells. *J Nucl Med* 12: 22–24, 1971

5. BOSNJAKOVIC VB, BENNETT LR, GREENFIELD LD, et al: Dual-isotope method for diagnosis of intracardiac shunts. *J Nucl Med* 14: 514–521, 1973

6. PARK HM, SMITH ET, SILBERSTEIN EB: Isolated right superior vena cava draining into left atrium diagnosed by radionuclide angiocardiography. *J Nucl Med* 14: 240–242, 1973

7. HEGDE UM, WILLIAMS ED, LEWIS SM, et al: Measurement of splenic red cell volume and visualization of the spleen with ^{99m}Tc. *J Nucl Med* 14: 769–771, 1973

8. MAHON DF, SUBRAMANIAN C, MCAFEE JG: Experimental comparison of radioactive agent for studies of the placenta. *J Nucl Med* 14: 651–659, 1973

9. HAUBOLD U, PABST HW, HÖR G: Scintigraphy for the placenta with ^{99m}Tc-labeled erythrocytes. In *Medical Radioisotope Scintigraphy*, vol 2, Vienna, IAEA, 1969, pp 665–674

10. RYO UY, MOHAMMEDZADEH A, PINSKY SM: Stability of ^{99m}Technetium labeled red blood cells: unpublished