USE OF SIMULTANEOUS TRANSMISSION-EMISSION SCANNING IN THE DIAGNOSIS OF PERICARDIAL EFFUSION

Chan Hee Park, Carl M. Mansfield, and Jean Olsen

Thomas Jefferson University Hospital, Philadelphia, Pennsylvania

Radioisotope blood pool scanning was first performed by Rejali and his associates in 1958 (*1*). Since that time several methods using radionuclides have been reported (*2–10*). These have included transmission-emission scanning.

In 1966 Kuhl, et al introduced transmission-emission scanning for accurate keying of the emission image to patient anatomy (*11*). A small radioactive source of either ^{241}Am or ^{125}I was used to form the transmission image. The transmission and emission images were recorded with separate pulse-height analyzers. More recently ^{99m}Tc has been used as an external point source or a uniform sheet source for obtaining transmission images on dual-head rectilinear scanners (*12*) and scintillation cameras (*13*).

The purpose of this paper is to describe a simple technique of simultaneous transmission-emission scanning using only one pulse-height analyzer on a dual-head scanner in the diagnosis of pericardial effusion.

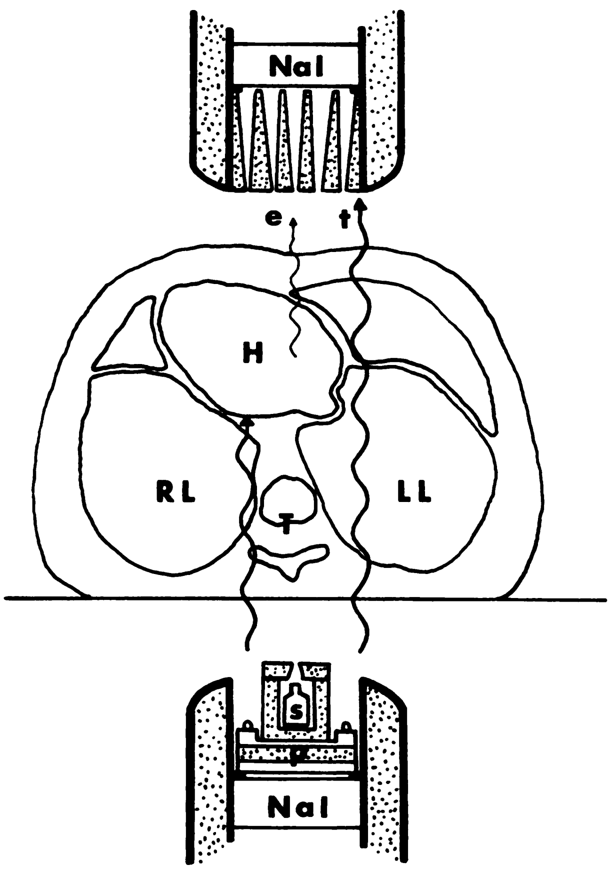

FIG. 1. Cross-section view of simultaneous transmission-emission scanning apparatus. e is emitted photon, t is transmitted photon, H is heart, S is $Na^{99m}TcO_4$ external source, and p is "protector."

METHODS

Twenty-one patients being evaluated for brain pathology with no previous cardiac history served as controls. Fifteen patients had clinical evidence of pericardial effusion. The transmission image was obtained with an external point source produced by a bottle of 4–6 mCi of $Na^{99m}TcO_4$ in a thick lead container with a small hole in its top (Fig. 1). Five to 10 mCi of $Na^{99m}TcO_4$ were injected intravenously for the emission imaging. The Ohio-Nuclear Model 84 FD dual 5-in. scanner was used. The collimator of the lower detector was removed, and the external point source was placed on the probe after placing a protector over the crystal. (The disk-shaped protector measured 5¾ in. in diam and was made of a lead sheet covered with plywood on both sides (Fig. 1). The pulse-height analyzer of the upper detector was used for the emission and transmission images. The window was 120–160 keV.

All patients received 500 mg of potassium perchlorate orally 30 min before an intravenous injection of $Na^{99m}TcO_4$. Doses for the emission and transmission images can be adjusted to obtain similar counting rate over the heart and lungs for a satisfactory scan. Several techniques have been useful. However, the following procedure has been employed recently. A counting rate is obtained over the lung with the transmission source in place. Then ^{99m}Tc-pertechnetate is injected slowly until a similar counting rate is obtained over the heart. The scan was started immediately and was usually completed in

Received Oct. 4, 1971; revision accepted Dec. 14, 1971.

For reprints contact: Chan Hee Park, Dept. of Radiation Therapy and Nuclear Medicine, Thomas Jefferson University Hospital, Philadelphia, Pa. 19107.

FIG. 2. Patient MC. Scan shows clear "halo" due to pericardial effusion. 325 cc of fluid was removed by pericardiocentesis. S is stomach.

less than 5 min. Most scans were performed with 2:1 minification at a speed of 750 cm/min.

RESULTS

None of the scans in the control group showed a clear halo around the cardiac blood pool. A few normal scans demonstrated a clear zone near the cardiophrenic angles due to pericardial fat pads. Occasionally a clear zone can be seen normally in the region of the left pulmonary artery. Patients with positive scans showed a clear halo around the cardiac blood pool.

Eight of the eight patients with a proven diagnosis of pericardial effusion by pericardiocentesis or surgery had a positive scan. An example of one of these patients is seen in Fig. 2. One patient with a positive echocardiogram had a negative scan. There were six patients who had no additional diagnostic procedure other than chest x-ray and were excluded from this study.

DISCUSSION

The diagnosis of pericardial effusion can be made by clinical examination, electrocardiogram, echocardiogram, intravenous CO_2 study, contrast angiocardiography, pericardial paracentesis, and blood pool scanning. Among these, blood pool scanning is a simple, reliable, and safe means of substantiating the clinical diagnosis of pericardial effusion (*1*).

The method of comparing the transverse heart size on blood pool scan and supine chest roentgenogram taken at 6 ft is not accurate because of geometric distortion (*11*). To avoid this problem, transmission-emission scanning was developed (*11*). A simultaneous transmission-emission scan can be performed with an external point source if one is able to move the scanning detector and the external point source under the patient in the same direction at the same time. This is possible with any commercially available dual-head scanner.

Various radionuclides such as low-energy ^{125}I (30 keV), intermediate-energy ^{241}Am (60 keV), and high-energy ^{99m}Tc (140 keV) have been used as an external source for transmission scanning (*11–13*). It may be necessary to use different radionuclides in transmission scanning of the chest for patients of various thicknesses. For example, the 140 keV of ^{99m}Tc was too energetic for good differential absorption in a 6½-week-old baby. However, it did not penetrate oversize patients very well. Good-quality transmission images of the chest were obtained with ^{99m}Tc in most of our patients. In this study technetium was considered to be the material of choice for the emission source.

SUMMARY

A technique for simultaneous transmission-emission scanning in the detection of pericardial effusion is described. The method is simple, quick, reliable, and accurate.

ACKNOWLEDGMENT

This work was supported in part by NIH Training Grant #ST01-CA-5109-09.

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