Transmission-Emission Scanning: An Aid in Detecting Space Occupying Lesions of the Left Upper Quadrant

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Five cases are presented in which lesions affecting the spleen were suspected either clinically or on routine 99mTc-sulfur colloid liver scans. Using 99mTc, transmission-emission scans were performed on these patients; these scans were all abnormal. Subsequent diagnostic studies confirmed three real lesions. The other two patients had intrathoracic abnormalities producing the abnormal scans. The technique, advantages, and limitations of transmission-emission scanning for detecting space-occupying lesions of the left upper quadrant area are discussed.

1. Introduction

Transmission scanning was first reported by Kuhl, et al.1 as a helpful method of improving anatomic orientation and interpretation of radionuclide emission scans. In general, the transmission image is obtained with the patient in the same position as during conventional scanning. Using a dual probe scanner, the patient is positioned between a small radioactive source such as 99mTc, 241Am, or 131I and the image detector which moves with the source. Air spaces in the patient's body allow increased transmission so that lungs, stomach, and sometimes bowel are clearly shown as dark areas. The body contour and solid organs exhibit decreased transmission and are shown as lighter areas. This difference in degree of transmission makes clear the relationship between the lungs and the liver and spleen.

There have been several reports on the clinical application of transmission-emission imaging of the liver, spleen and lungs was done using an Ohio Nuclear dual five inch detector rectilinear scanner. A four mCi source of 99mTc-pertechnetate in a tuberculin syringe was inserted into the center hole of the upper detector collimator. The lower detector was used to form the image. A 109 hole 3 inch focusing medium energy collimator was used. Patients were placed in the supine position after the intravenous administration of 3 to 4 mCi 99mTc-sulfur colloid. The distance from the patient to the lower detector was constant at 3 cm.

2. Method

Simultaneous transmission-emission imaging of the liver, spleen and lungs was done using an Ohio Nuclear dual five inch detector rectilinear scanner. A four mCi source of 99mTc-pertechnetate in a tuberculin syringe was inserted into the center hole of the upper detector collimator. The lower detector was used to form the image. A 109 hole 3 inch focusing medium energy collimator was used. Patients were placed in the supine position after the intravenous administration of 3 to 4 mCi 99mTc-sulfur colloid. The distance from the patient to the lower detector was constant at 3 cm.

3. Cases

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Case 1
A 48 year old white male was admitted to our hospital with a history of 40 pound weight loss in an 18 month period. He had low grade fever (37°–38°). Chest X-rays showed only a bilateral small pleural effusion. 99mTc-sulfur colloid liver-spleen scan showed a normal liver, but the spleen was crescentic in shape and rotated horizontally in the posterior view. The spleen was abnormally low compared to the height of the liver. This suggested a lesion in or near the spleen (Fig. 1A). The posterior transmission-emission scan obtained the same day revealed an abnormal space between the splenic image and that of the left lung (Fig. 1B). Celiac arteriography showed a flattened splenic mass with an avascular area at the superior lateral portion of spleen. This coincided with the space shown by the transmission-emission scan.

Case 2
A 48 year old white male alcoholic was admitted with a six month history of worsening left upper quadrant pain aggravated by big meals. Physical examination revealed a left upper quadrant mass thought to be a pancreatic pseudocyst. An abnormally high left diaphragm was found in the chest radiograph.
to be avascular, but it was thought to be part of the spleen (Fig. 2D). At operation a large splenic cyst was found in the superior aspect of the spleen.

Case 3

A 51 year old white female noted malaise approximately eleven weeks before admission. Jaundice and pruritus appeared seven weeks before admission. Upper GI disclosed a mass behind the stomach pushing it and the duodenal anteriorly. A $^{99m}$Tc-sulfur colloid liver-spleen scan was normal. At laparotomy a stony, hard carcinoma in the head of the pancreas was found. There was also a small cyst in the tail of the pancreas. This patient's condition was thought to be inoperable and only a biopsy was done. The biopsy revealed adenocarcinoma. About one week after laparotomy patient started to complain of left upper quadrant abdominal pain and developed a spiking fever ($38^\circ$—$39^\circ$). Two weeks after operation, a posterior transmission-emission scan was done because a subdiaphragmatic abscess was suspected. The scan showed a large space between the left lung and the splenic image. The spleen was displaced downwards and rotated medially (Fig. 3). A diagnosis of left subphrenic abscess was made on the basis of the scan. The patient refused surgical intervention and was placed under massive antibiotic therapy. The pa-
tient was subsequently discharged upon her request with a final clinical diagnosis of adenocarcinoma of the pancreas with left subphrenic abscess as a postlaparotomy complication.

Case 4

A 56 year old white female with shortness of breath had been treated for congestive heart failure over the past five to six months. She responded to diuretics but continued to have difficulty with reaccumulation of a left pleural effusion. Because of this she was admitted to our hospital for further evaluation and therapy. She had had a thyroidectomy 20 years ago and had been on thyroid replacement for hypothyroidism. Radiographs of the chest showed a large left pleural effusion and a possible pericardial effusion. A 99mTc-sulfur colloid liver-spleen scan was done to rule out hepatic malignancy. The scan was normal except for the spleen, which in the posterior view was low in position compared to the liver. A posterior transmission-emission scan was performed the same day and showed a large space between the left lung and the spleen (Fig. 4A). This large space was thought to be due to the large left pleural effusion in combination with a large pericardial effusion. The pericardial effusion was proven by pericardiocentesis and subsequent chest X-rays (Fig. 4B). The final clinical diagnosis was congestive heart failure with pericardial and left pleural effusion, possibly related to hypothyroidism.

Fig. 4A Posterior transmission-emission scan shows a large space between the left lung and the spleen.

Fig. 4B Chest radiograph after pericardiocentesis shows a pneumohydropericardium and a left pleural effusion.

Case 5

A 55 year old white female was admitted to our hospital for further evaluation of med-

Fig. 5A 99mTc-sulfur colloid liver-spleen scan shows a normal liver, but the spleen is low in relation to the liver.

Fig. 5B Posterior transmission-emission scan shows a space between the spleen and the left lung.
lanoma which was diagnosed in another hospital by biopsy of a right inguinal node. The 99mTc-sulfur colloid liver-spleen scan that was done to rule out metastases showed a normal liver but the spleen was low in relation to the liver (Fig. 5A). A posterior transmission-emission scan was done to evaluate the relation between the spleen and the left lung. This was thought to be due to an enlarged heart (Fig. 5B). A blood pool scan using 113mIn labeled transferin was done the following day and confirmed that the defect was due to the heart (Fig. 5C).

4. Discussion

Transmission scanning is a useful radioisotopic technique to improve visualization of anatomical relationships and to aid interpretation of the conventional emission scan. Before transmission scanning, roentgenograms were superimposed on scan images in an attempt to provide anatomic correlation. However, this method did not provide sufficient accuracy. In 1966, Kuhl, et al.\(^1\) reported in detail clinical applications of transmission scanning for forming images of body structures. This technique has also been used by Anger\(^2\) in the whole body scanner Mark II. Subsequently, transmission scintiphotography using the Pho-Gamma camera was reported by McRae and Anger\(^3\). They investigated 99mTc as a transmission source, and they proved that the 140 keV gamma rays from 99mTc were useful for imaging air containing spaces within the body such as lungs because of less selective absorption in bone compared to lower energy gamma rays. Volpe, et al.\(^4\) emphasized the clinical usefulness of this technique in the diagnosis of subdiaphragmatic abscess.

Combined liver-spleen and lung scans can be done by several methods\(^5\)\^-\(^7\). The use of 131I-MAA necessitates an additional injection, increased scanning time and increased patient radiation. 99mTc-MAA has recently been introduced for this purpose. This agent still has the disadvantages of an additional injection and a higher patient radiation dose than when transmission-emission scanning is done. The estimated whole body radiation dose for transmission scanning with 99mTc is estimated as less than 1 mR per hour\(^8\).

At our institution 99mTc-sulfur colloid liver-spleen scans are routinely done using an Ohio 5 dual probe rectilinear scanner. Anterior and posterior projections are made simultaneously with the patient supine. The patient is then placed in the left lateral decubitus position and simultaneous lateral views are obtained. In our experience the image of the spleen and its position can be altered not only by pathology in this area, but also by other factors. It is important to use a constant positioning routine because of varying appearances of the spleen, pathology in this area could otherwise easily be missed. Our criteria for suspecting pathology in the left upper quadrant are:

1) An abnormal difference in relative height of liver and spleen on the posterior view.
2) Better visualization of the spleen on the anterior than the posterior view, especially if anterior displacement of the spleen is confirmed by the left lateral scan.
3) Rotation of the spleen out of its normal craniocaudad orientation.
4) A crescentic impression upon the superior and/or lateral aspects of the spleen.
5) Strong clinical suspicion of a space-occupying lesion in the left upper quadrant area.

If any of the above criteria is met, a
transmission-emission scan is performed immediately so that the need for reinjection of radionuclide is avoided. Thus the use of this scanning technique provides an accurate, rapid tool for screening out changes caused by normal variants. Efficient use of confirmatory diagnostic studies is facilitated when an abnormality is confirmed.

What factors cause changes in the conventional 99mTc-sulfur colloid liver-spleen scan? The spleen is normally best visualized in the posterior and left lateral positions due to its location in the posterior-lateral left upper quadrant. However, the spleen is not well fixed in place and moves with changes in body position. Its position can be altered by the degree of inspiration or by adjacent organs i.e. a distended stomach. Therefore, in a given individual, the spleen may appear not in its usual location. We have encountered some cases in which the spleen appeared abnormally low compared to the liver on the posterior view, but there was no pathology. Our suggested explanation for this is that in some individuals with highly domed diaphragms, the splenic image is more inferior and posterior than usual. In this situation a transmission-emission scan will be normal in spite of the lower position of the spleen.

Proper imaging of the spleen depends on its being within the focal plane of the collimator. Therefore it is important that the spleen must be evaluated in the views in which it lies closest to the collimator's focal plane. Otherwise the image will be magnified and imprecise.

Correlation of tele-roentgenograms with scans may be misleading in the evaluation of organ size and location, but is necessary to rule out the presence of supradiaphragmatic pathology mimicking a left upper quadrant lesion as in cases 4 and 5. Poor correlation of X-ray and scan images can be accounted for by the following:

1) The X-ray and the scan images are magnified to different degrees.
2) Chest films are usually made with the patient erect and in full inspiration.
This displaces diaphragm and upper abdominal viscera inferiorly. Scans are predominantly made during expiration with the patient supine.

In our experience 99mTc-transmission-emission scanning has proven to be a valuable and convenient method of screening for suspected pathology in the left upper quadrant. One must be careful to exclude left supradiaphragmatic abnormality such as left pleural effusion, pericardial effusion, left lower lung pneumonia, cardiomegaly, etc. when interpreting spleen-lung-transmission-emission scans. The differential diagnosis of a space occupying left upper quadrant lesion might include:

1) Diaphragmatic tumors
2) Fluid (abscess blood) collections
3) Pseudocyst or tumor in the tail of the pancreas
4) Tumor of the stomach fundus
5) Splenic lesions (subcapsular hematoma, abscess, cyst, tumor).

The abnormal transmission-emission scan, correlated with clinical findings, will aid in efficiently selecting the appropriate diagnostic studies by which the etiology of the left upper quadrant lesion can be determined.

References

4) Volpe, J.A. (Major), McRae, J., and Johnston, G.: Transmission scintigraphy in the evaluation of subphrenic abscess. Am. J. Roentgenol., Rad. Ther-


要 旨

トランスミッション-エミッション-スキャンニング
左上腹部領域の病巣検出の診断法

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臨床上ならばに $^{99m}$ Tc-sulfur colloid 肝スキャン上で肺葉に影響を及ぼす病巣が疑われた5症例を観察したが全例に $^{99m}$ Tc を用いての transmission-emission スキャンニングを施行し，左上腹部病巣の診断を試みたが全例異常所見を得た。5 例中 3 例に真の病巣が確認されたが他の 2 例は胸郭内異常によるものであった。本法で解剖学的部位間関の情報を簡単に得ることができ，比較的診断困難な左上腹部の病巣検出に役立つことが判明した。

左上腹部病巣検出のための本法の方法，利点，並びに限界について論じた。

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