jnm/ CONCISE COMMUNICATIONS

LUNG UPTAKE OF ^{99m}Tc-SULFUR COLLOID IN ORGAN TRANSPLANTATION

William C. Klingensmith III, Thomas W. Ryerson, and Jacques L. Corman

University of Colorado Medical Center and Veterans Administration Hospital, Denver, Colorado

Lung uptake of ^{99m}Tc-sulfur colloid is frequently seen in patients with liver transplants and has been reported in a patient with a spleen and bone marrow transplant. The absence of lung uptake in dogs with renal transplants suggests that lung uptake is not associated with transplantation in general.

Lung uptake of ^{99m}Tc-sulfur colloid during liver scans may occur secondary to technical factors (*1–7*) or in association with rejection of liver transplants (*8–11*). Recently, we reported lung uptake of this colloid in a patient with a spleen and bone marrow transplant (*11*). Time-activity curves from this patient showed gradually increasing lung uptake over time suggestive of a reticuloendothelial mechanism. The question arose whether lung uptake of ^{99m}Tc-sulfur colloid was associated with transplantation in general or only with transplantation of organs containing large numbers of intravascular macrophages such as the liver and spleen. To investigate this question a number of dogs and two patients with renal transplants were studied with ^{99m}Tc-sulfur colloid. In addition, a series of patients with liver transplants were studied to quantitate the frequency of lung uptake in this condition.

METHODS AND MATERIALS

The ^{99m}Tc-sulfur colloid was prepared by the method of Patton, et al (*12*) and all studies were done using a Nuclear-Chicago Pho/Gamma HP camera. The presence of lung uptake was determined from an anterior chest scintigram. The presence of more activity over the lung fields than over the heart indicates lung uptake (*11*).

Three groups of dogs were studied: eight normal controls, four renal transplants with their own kidneys intact, and four renal transplants with their own kidneys removed. The same four dogs were used in the two renal transplant groups. After each dog had been studied with its kidneys intact, the transplanted kidney and its own two kidneys were removed and a new kidney was transplanted. All transplanted organs were grafted to the internal iliac artery, and no immunosuppressives were given.

The two patients with renal transplants had liver scans as part of a diagnostic investigation of fever and were studied retrospectively. Their anterior scintigrams included enough of the lower lung fields and heart to allow evaluation for lung uptake.

Seven consecutive patients with liver transplants were evaluated for lung uptake with anterior chest scintigrams.

RESULTS

None of the eight control dogs showed lung uptake. The four dogs with renal transplants and their own kidneys intact were studied two to three times a week for 3 weeks for a total of 40 studies. Then, after transplantation of a new kidney and removal of the other three kidneys, each dog was studied once or twice more for a total of seven studies before dying several days after the second transplant. None of the dogs in these two groups showed evidence of lung uptake. At autopsy or surgery all transplanted kidneys showed typical gross changes of rejection and all anastomotic vessels were patent.

Neither of the two patients with renal transplants showed evidence of lung uptake. In addition, we have noted in the literature a liver scan on a patient with a renal transplant which showed no evidence of lung uptake (*13*).

Of the studies on the seven liver transplant patients, two were normal, two showed increased bone

Received Feb. 12, 1973; revision accepted Apr. 23, 1973.

For reprints contact: William C. Klingensmith III, USAF Medical Center, Box 1000, Scott AFB, Ill. 62225.

marrow uptake without lung uptake, two showed both increased bone marrow uptake and lung uptake, and one showed a mottled liver without bone marrow or lung uptake.

DISCUSSION

Lung uptake of ^{99m}Tc-sulfur colloid is frequently found in patients and dogs with liver transplants, particularly during rejection (*8–11*). None of these previous reports quantified the frequency of lung uptake. Our series of seven consecutive patients with liver transplants showed lung uptake on anterior chest scintigram in two cases. Although increased bone marrow uptake was present in both cases, lung uptake may occur in the absence of other abnormalities (*11*).

We have recently investigated the mechanism of lung uptake with time-activity curves in a patient with a spleen and bone marrow transplant and in a patient with a malignant lymphoma (*11*). The results showed gradual lung uptake of ^{99m}Tc-sulfur colloid over time suggestive of a reticuloendothelial mechanism.

Simple compensatory uptake by the lung secondary to liver disease seems unlikely. Decreased uptake by the liver would result in increased uptake by the bone marrow and lung, but the ratio of uptake between these two organs should remain the same. Thus in the absence of reticuloendothelial abnormalities outside the liver, the bone marrow would take up more colloid than the lung. The patient with the spleen and bone marrow transplant and several of the patients with liver transplants showed marked lung uptake without increased bone marrow uptake (*8,10,11*).

Animal studies have shown that macrophages normally migrate from the liver, spleen, and bone marrow to the lung where some of them pass through the capillary walls and provide a source of alveolar macrophages (*14*). It has also been shown in animals that macrophages migrate to the lung in unusually large numbers in response to certain types of stress and continue to phagocytize colloid after reaching the pulmonary capillaries (*15–19*).

This study was done to investigate whether lung uptake of ^{99m}Tc-sulfur colloid is associated with transplantation in general or only with transplantation of organs containing large numbers of intravascular macrophages. We have observed lung uptake in patients as early as 3 days after liver transplantation, and it has been reported in dogs as early as 5 days after liver transplantation (*8*). Although the renal transplant dogs in the present study were followed for only a limited time, 3½ weeks each, it is felt that the absence of lung uptake on all 47 studies despite rejection suggests that renal transplantation is not associated with lung uptake and therefore transplantation in general is not associated with lung uptake.

The increased lung uptake of ^{99m}Tc-sulfur colloid in patients with liver or spleen and bone marrow transplants may be secondary to interactions between the host and the macrophages of the transplanted organ resulting in migration of these macrophages to the pulmonary capillaries. Because the kidney has very few intravascular macrophages, such a migration could not occur in renal transplants.

ACKNOWLEDGMENTS

This work was supported by the US Veterans Administration Research Grant No. 01/1103.1/69-01 and the University of Colorado Medical Center Research Grant No. 91155.

REFERENCES

1. DWORKIN HJ, NELIS A, DOWSE L: Rectilinear liver scanning with technetium-99m-sulfur colloid. *Am J Roentgen* 101: 557–560, 1967

2. FRENCH RJ: The preparation of a technetium colloid and an indium colloid for liver scanning. *Br J Radiol* 42: 68–69, 1969

3. COHEN MB: Reducing particle size in ^{99m}Tc-sulfur colloid preparations. *J Nucl Med* 11: 767, 1970

4. WEINSTEIN MD, SMOAK W: The authors' reply. *J Nucl Med* 11: 767–768, 1970

5. CUNNINGHAM RE: Communication from AEC to licensees: *Aluminum Flocculation in Technetium ^{99m} Labeled Sulfur Colloid Preparation,* July 24, 1970

6. HANEY TA, ASCANIO I, GIGLIOTTI A, et al: Physical and biological properties of a ^{99m}Tc-sulfur colloid preparation containing disodium edetate. *J Nucl Med* 12: 64–68, 1971

7. STAUM MM: Incompatibility of phosphate buffer in ^{99m}Tc-sulfur colloid containing aluminum ion. *J Nucl Med* 13: 386–387, 1972

8. GROTH CG, BROWN DW, CLEAVELAND JD, et al: Radioisotope scanning in experimental and clinical orthotopic liver transplantation. *Surg Gynec Obstet* 127: 808–816, 1968

9. BROWN DW, STARZL TE: Radionuclides in the postoperative management of orthotopic human organ transplantation. *Radiology* 92: 373–376, 1969

10. STARZL TE: *Experience in Hepatic Transplantation.* Philadelphia, WB Saunders, 1969, p 321

11. KLINGENSMITH WC, RYERSON TW: Lung uptake of ^{99m}Tc-sulfur colloid. *J Nucl Med* 14: 201–204, 1973

12. PATTON DD, GARCIA EN, WEBBER MM: Simplified preparation of technetium 99m sulfur colloid for liver scanning. *Am J Roentgen* 97: 880–885, 1966

13. SPENCER RP, LANGE RC, SCHWARTZ AD, et al: Radioisotopic studies of changes in splenic size in response to epinephrine and other stimuli. *J Nucl Med* 13: 211–214, 1972

14. IRWIN DA: Kupffer cell migration. *Can Med Assoc J* 27: 353–356, 1932

15. SIMPSON ME: The experimental production of macrophages in the circulating blood. *J Med Res* 43: 77–144, 1922

16. EASTON TW: The role of macrophage movements in the transport and elimination of intravenous thorium dioxide in mice. *Am J Anat* 90: 1–28, 1952

17. NICOL T, DILBEY DLJ: Elimination of macrophage cells of the reticuloendothelial system by way of the bronchial tree. *Nature* 282: 192–193, 1958

18. MACCALLUM DK: A study of macrophage-pulmonary vascular bed interaction in malaria infected hamsters. *J Reticuloendothel Soc* 6: 253–270, 1969

19. SCHNEEBERGER-KEELEY EE, BURGER EJ: Intravascular macrophages in cat lungs after open chest ventilation. An electron microscopic study. *Lab Invest* 22: 361–369, 1970