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PROLONGED RETENTION OF RADIOACTIVITY FOLLOWING PERFUSION LUNG SCAN IN ASTHMATIC PATIENTS

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Abnormalities of the perfusion lung scan during acute asthmatic episodes are well known. Prolongation of the biological half-life of ^{131}I-macroaggregated albumin (MAA) has not been previously reported. Evaluation of the biological clearance of MAA from the lungs in 14 patients with asthma (7 males and 7 females) showed substantial prolongation in 12 patients. This phenomenon is not specific to asthma but has been observed in patients taking steroids, immunosuppressive therapy, viral pneumonia, and chronic interstitial lung disease.

During an acute episode of asthma there is an alteration in the distribution of ventilation and blood flow in the lung [Wilson, et al (*1*)]. Areas of diminished perfusion have been demonstrated using both ^{131}I-labeled macroaggregated albumin (^{131}I-MAA) and radioxenon (*2–6*). These abnormalities are apparently related to the severity of the pulmonary obstruction.

In one patient who was admitted to our hospital for the fourth time with asthma and left lower lobe atelectasis, a perfusion lung scan was performed with ^{131}I-MAA and was found to have substantial radioactivity to persist for 72 hr following the original injection (Fig. 1).

To determine if this prolonged retention of radioactivity was unique to this unusual patient or occurred in other asthmatic patients, we have studied the disappearance rate of ^{131}I activity from the lung regions in 14 patients with a clinical diagnosis of bronchial asthma.

METHODS

Lung scans with ^{131}I-MAA were performed in 14 patients with asthma. The group consisted of seven males and seven females ranging in age from 18 to 49 years. The severity of their symptoms ranged from only occasional wheezing to status asthmaticus. Six of the 14 patients required prednisone therapy in either a daily or alternate day regimen. The ^{131}I-MAA, freshly prepared and assayed (Squibb Albumotope LS; particle size, 10–90 microns), was injected in a dose of 6 μCi/kg body weight with a minimal dose of 300 μCi and a maximum of 500 μCi. All injections of ^{131}I-MAA were carried out with the patient supine and during deep respirations.

Counting and imaging was carried out using a standard Nuclear-Chicago Pho/Gamma HP scintillation camera with diverging collimator and the patient upright. Body background was then taken from the thighs with the bladder empty. This background area has approximately the same attenuation characteristics as the chest in our laboratory as measured by a linear profile scanning technique with both emission and transmission measurements. Particular care was taken to ensure that patients were hydrated and studied with the bladder empty. All patients and controls were taking KI in doses of 500 mg t.i.d. 24 hr before and for 4 days after the i.v. injection of ^{131}I-MAA. Due to the known incompleteness of KI blockade, any patient or control whose thyroid or bladder was imaged was rejected from the study.

The initial count for the lung scan taken at 15 min post i.v. injection of ^{131}I-MAA following body background subtraction was taken as the net lung count and as 100%. Subsequent net counting rates were obtained similarly corrected for ^{131}I decay and recorded as a percentage of the original net counting rate. Counting errors were not permitted to be greater than $\pm$3% in a 10-min period.

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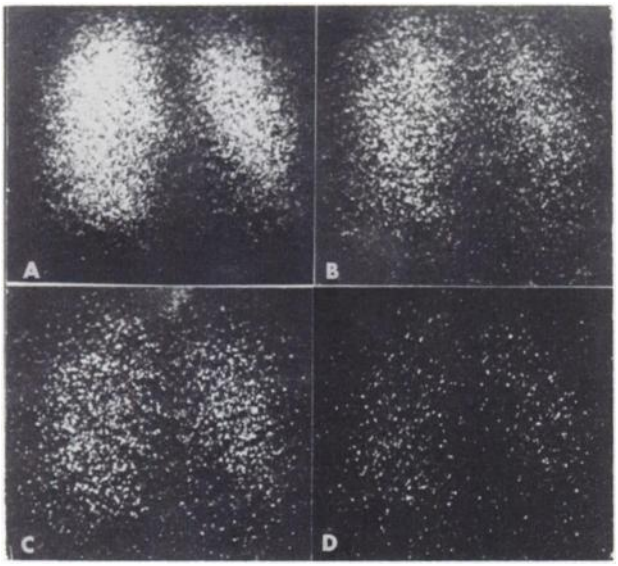

FIG. 1. Residual radioactivity is shown initially (A), at 24 hr (B), 48 hr (C), and 72 hr (D).

Patients with chest pain studied to exclude pulmonary embolism were supine for all procedures. If these patients were found to be free of pulmonary disease on followup, they were included as controls.

The relationships between the detector head and the patients were maintained as constant as possible at each measurement time.

Significant counting rates from hepatic uptakes of ^{131}I-MAA derivatives were not noted, but the hepatic bed was excluded as far as possible from the counting areas.

The $t_{1/2}$ was calculated as the time required for the net pulmonary counting rate to fall to 50% of the initial value. Controls, five females and two males, showed a $t_{1/2}$ value of 8.74 ± 1.96 ($N = 7$), ($\bar{x} \pm 2$ s.d.) hr. This confirmed 6 years' experience in our laboratory of less than 25% of initial counting rate in patients undergoing followup evaluation of lung scans at 24 hr. It also agrees with data reported by DeLand (*7*), Wagner (*8*), and Taplin (*9*).

RESULTS

The amount of radioactivity present initially was normalized to the control population by expressing all data as percent initial count remaining. In 12 of the 14 asthmatic patients scanned using ^{131}I-MAA the rate of disappearance of radioactivity was prolonged (Fig. 2). No correlation existed between the rate of disappearance of radioactivity and the severity of the asthma or treatment with corticosteroids.

DISCUSSION

Intravenously injected ^{131}I-MAA particles are deposited in the small pulmonary vessels. Their half-life in the lung has been reported to be 4.5–10 hr [Wagner, et al (*8*), and Taplin, et al (*9*)]. The MAA particles are broken down in the lung and then reenter the circulation; the mechanism by which these particles are degraded is not known. The smaller circulating ^{131}I-MAA particles are then phagocytized by the reticuloendothelial organs, primarily the liver. Within 24–48 hr, 50–75% of the radioactivity appears in the urine as free iodide.

The abnormality which accounts for the prolonged retention of ^{131}I activity by the lung of asthmatic patients is unknown. Murphy, et al (*10*) previously demonstrated in mice that the ^{131}I-MAA particle does not evoke a cellular response or lead to pathological change in the lung. Our results would indicate that the defect is not in the mode of arrival of the ^{131}I-MAA particle in the lung but arises after the radioactive particle is deposited. It would appear, therefore, that the abnormality is the result of a decreased ability of the asthmatic subject to degrade this particle.

The significance of this finding and its relationship to asthma is as yet unknown. This observation does

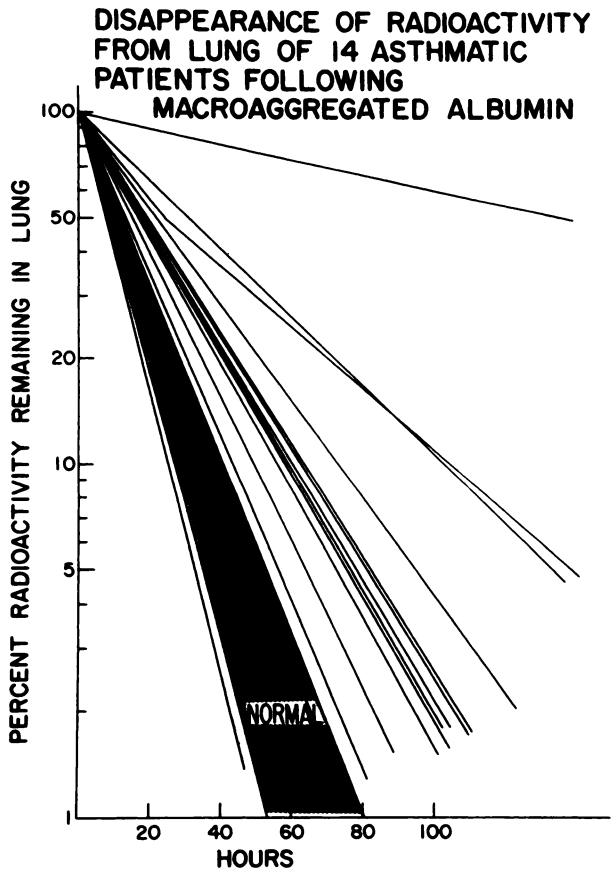

FIG. 2. Each line in graph represents disappearance of radioactivity from lung in one patient. Determination of normal value is explained in text.

have, however, a clinical implication. If repeat lung scans are being performed in asthmatic subjects, it would be important to obtain a baseline estimate of residual counting rate in the chest before a radiotracer particle is re-injected. Also, because of prolonged retention of radioactivity, consideration should be given to a reduced dose or a radiopharmaceutical with a shorter half-life. Prolonged retention has been found in asthmatic patients, but evidence cannot be produced to indicate that the abnormality is unique to these patients. Prolonged retention of radioactivity has been observed in our experience in patients taking immunosuppressive therapy and has occurred in patients with other pulmonary or systemic diseases (*11*).

REFERENCES

1. WILSON AF, SURPRENANT EL, BEALL GN, et al: The significance of regional pulmonary function changes in bronchial asthma. *Am J Med* 48: 416–423, 1970

2. WOOLCOCK AJ, MCRAE J, MORRIS JG, et al: Abnormal pulmonary blood flow distribution in bronchial asthma. *Aust Ann Med* 15: 196–203, 1966

3. MISHKIN FS, WAGNER HN: Regional abnormalities in pulmonary arterial blood flow during acute asthmatic attacks. *Radiology* 88: 142–144, 1967

4. HENDERSON LL, TAUXE WN, HYATT RE: Lung scanning of asthmatic patients with ^{131}I-MAA. *South Med J* 60: 795–804, 1967

5. BENTIVOGLIO LG, BEEREL F, BRYAN AC, et al: Regional pulmonary function studied with xenon 133 in patients with bronchial asthma. *J Clin Invest* 42: 1193–1200, 1963

6. HECKSCHER T, BASS H, ORIOL A, et al: Regional lung function in patients with bronchial asthma. *J Clin Invest* 47: 1063–1070, 1968

7. DELAND FH: The fate of macroaggregated albumin used in lung scanning. *J Nucl Med* 7: 883–895, 1966

8. WAGNER HN, SABISTON DC, MCAFEE JG, et al: Diagnosis of massive pulmonary embolism in man by radioisotope scanning. *N Engl J Med* 271: 377–384, 1964

9. TAPLIN GV, JOHNSON DE, DOVE EK, et al: Suspensions of radio-albumin aggregates for photo scanning the liver, spleen, lung and other organs. *J Nucl Med* 5: 259, 1964

10. MURPHY ES, CERVANTES CR, MAASS RE: The fate of macroaggregates of radio-albumin in the lung. *Am J Clin Pathol* 48: 18–22, 1967

11. TYSON IB, BIRNBAUM M: Unpublished data