Thallium-201-Chloride Lung Imaging for Bronchogenic Carcinoma

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To evaluate the clinical utility of thallium-201-(^{201}Tl) chloride lung imaging for patients with suspected lung tumor or recurrent tumor before and/or after thoracic surgery, 33 men (aged 50 to 79; mean 62) with recurrent or suspected carcinoma of the lung underwent ^{201}Tl-chloride planar lung imaging. Planar lung images (anterior, posterior, and lateral views) were obtained 15 min after i.v. injection of 2–4 mCi of ^{201}Tl-chloride. Thallium-201 lung images were compared with concurrent computed tomography of the chest and correlated to the pathologic results from bronchial washing, bronchoscopic biopsy, lobectomy and/or pneumonectomy. In 23 of 33 patients, planar images were compatible with carcinoma manifesting focal areas of uptake. Ten of the 33 patients had diffuse lung uptake or focal area of lung uptake, while six patients had diffuse or focal uptake of the lung in a nonmalignant condition which interfered with interpretation. Six benign lesions included one in chronic inflammation, one in pneumonia, one in granulomatous inflammation, one in squamous metaplasia, and two in nonmalignancy. Three of the six patients' lung images showed focal areas of uptake and lung images of three others demonstrated diffuse lung uptake. Diffuse lung uptake in malignant lesions(s) of four patients interfered with scan interpretation. Four of these six patients with nonmalignant conditions and two of four patients with diffuse uptake in malignant lesion(s) had a history of smoking and/or obstructive lung disease, two had undergone recent thoracotomy and one postirradiation. These results suggest ^{201}Tl-chloride localized in the benign lesions of the lung and/or diffuse lung uptake may interfere with the interpretation of ^{201}Tl-chloride lung images.

Thallous ion is a biochemical analog of potassium and has the same pathway as potassium across cell membranes into myocardial cells (*1*). The exact mechanism of thallium-201 (^{201}Tl) uptake in tumors is still unclear. Experimental results suggest that ^{201}Tl avidity in neoplasms depends on increased vascularity, cellularity, and changes in the cell membrane (*1,2*).

Since ^{201}Tl is taken up by viable tumor cells and infectious foci usually do not show high avidity for thallium (*1,2*), ^{201}Tl-chloride has been used in the detection of tumor and tumor recurrence in brain tumors, lymphomas, thyroid tumors, and hepatomas (*3,6*). To evaluate the clinical utility of ^{201}Tl-chloride lung imaging for patients with suspected lung tumor before and/or after thoracic surgery, we performed ^{201}Tl lung imaging in 33 consecutive patients with suspected or known cancer.

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MATERIALS AND METHODS

Thirty-three men aged 50 to 79 (mean 62) with suspected or recurrent carcinoma of the lung were included in the study. Malignancy had been diagnosed by cytology of bronchial washing and/or histopathology of bronchoscopic biopsy, lobectomy, or pneumonectomy. Thallium-201 planar lung images, including anterior, posterior, and lateral views, were obtained 10–15 min after i.v. injection of 2–4 mCi of ^{201}Tl-chloride. Each image contained 500,000 counts. Thallium-201 lung images were compared with concurrent computed tomography (CT) of the chest and correlated with surgical pathologic findings. Surgical-specimen images were also obtained if pneumonectomy or lobectomy had been performed within 48 hr of the lung imaging.

Single-photon emission computed tomography (SPECT) imaging was obtained when planar images were negative. A gamma camera (Orbiter, Siemens, Des Plaines, IL) equipped with a high-resolution collimator was interfaced with a computer (PDP-11/34, Digital Equipment Corp., Marlboro, MA). The patient was placed in a supine position. The detector focusing on the chest was rotated every 3° for a total of 360°, and image data were collected for 20 sec at each stop. A 64 × 64 matrix was used for data acquisition, and the transaxial images were reconstructed by the use of Shepp and Logan filters. Coronal and sagittal images were assembled from the transaxial images.

RESULTS

Of the 33 patients, 3 underwent pneumonectomy, 11 lobectomy, 9 lung biopsy, and 10 bronchial washing. The results of final diagnosis consisted of 27 with malignant tumors and 6 with nonmalignant conditions. Twenty-five of the patients had bronchogenic carcinoma (Fig. 1), two patients had met-

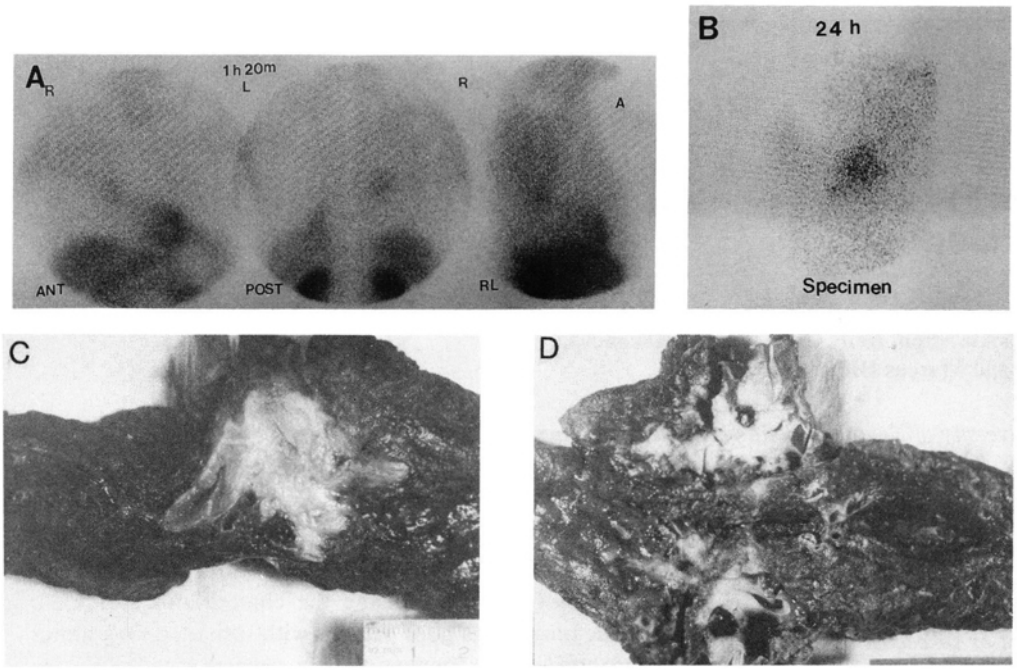

FIG. 1. (A) Thallium-201-chloride lung images of a 71-yr-old man show a large area of increased uptake, right lung medially. (B) Pneumonectomized right lung image shows a large area of increased activity in the middle portion of the removed lung. (C) and (D) A cut section of the pneumonectomized lung shows a large tumor mass near the hilum. This tumor was confirmed to be squamous carcinoma, poorly differentiated.

astatic lung carcinoma (Fig. 2). The six patients with nonmalignant conditions had one squamous cell metaplasia, one pneumonia, one granulomatous inflammation (Fig. 3), one chronic inflammation, and two were negative for malignancy (Fig. 4). Among the six nonmalignant patients were four having a smoking history and one having recent lobectomy (Table 1). Three patients with a smoking history showed diffuse lung uptake. Two patients with carcinoma of the esophagus who had negative findings by planar imaging were found to be positive by SPECT imaging (Fig. 2).

Diffuse lung uptake in 4 of the 27 patients with carcinoma of the lung masked ^{201}Tl uptake related to the malignant lesions or interfered with image interpretation (Table 2). Two patients had a history of smoking and/or obstructive lung disease. One had undergone recent thoracotomy and one patient's irradiation treatment was complicated with pleural effusions and pulmonary edema (Fig. 5). The planar image showed diffuse pulmonary uptake in the lung masking the tumor mass which was demonstrated by SPECT images. Another patient with negative planar images gave positive SPECT images.

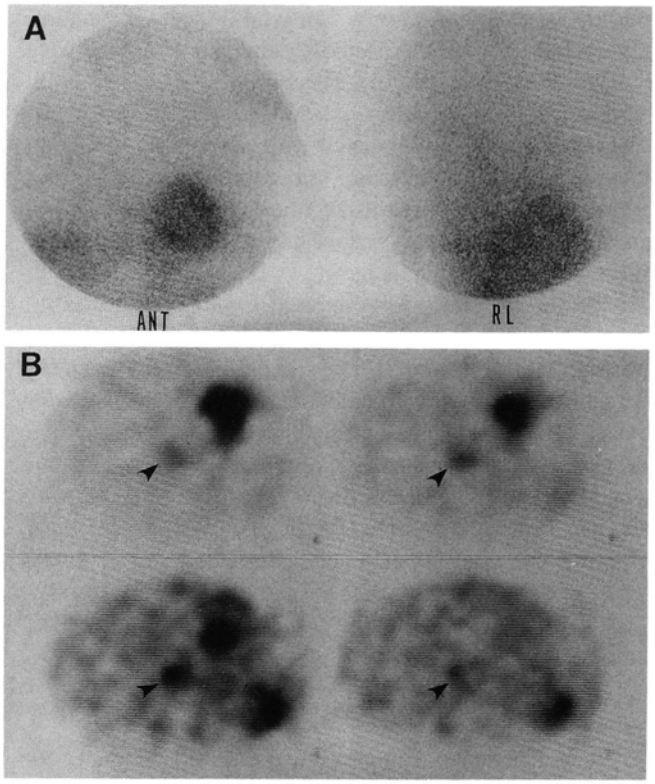

FIG. 2. (A) Planar images in a 50-yr-old man with cancer of the esophagus show no abnormal area of radiotracer uptake, while (B) SPECT images show a small focal area of increase in uptake (arrowhead) in the mediastinal region.

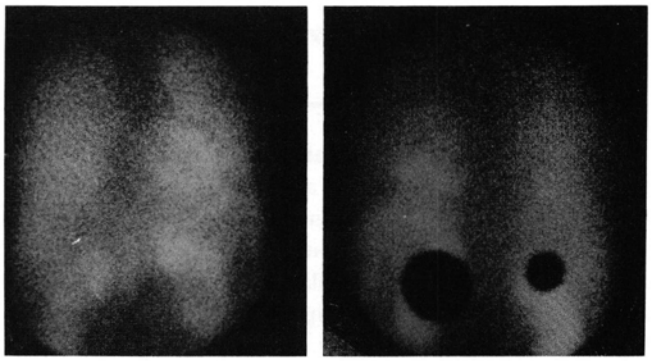

FIG. 3. Thallium-201-chloride planar lung images of a 63-yr-old man with a long smoking history and complicated emphysema show diffuse lung uptake without a focal area of radiotracer localization. The patient underwent lung biopsy which was confirmed to be granulomatous inflammation and negative for malignancy.

TABLE 1. Diffuse or Focal Lung Uptake in Nonmalignant Conditions Interfere with Interpretation

Patient	Age	^{201}Tl lung imaging	CT of the chest	Clinical data
1	63	Diffuse uptake in both lungs; no focal area of uptake.	Soft-tissue mass in superior segment of LLL.	LLL biopsy: granulomatous inflammation, emphysema and smoking history.
2	50	Diffuse uptake in right mid-lung.	Two nodules in RLL right hilar lesions.	Bronchial biopsy: pneumonia, smoking history.
3	56	Mild diffuse lung uptake 2 wk post LUL lobectomy.	A mass in LUL.	LUL lobectomy, large cell carcinoma. LLL lobectomy 2 wk later resulting in chronic inflammation, no tumor seen. Smoking history.
4	58	A large focal area of increase.	Infiltrated and consolidated lesion in RUL.	Squamous metaplasia.
5	51	Diffuse uptake in both lungs.	Old granulomatous lesion in left apex.	Bronchial washing, negative.
6	63	Diffuse uptake in both lungs (5 days after RUL biopsy).	Soft-tissue mass RUL (before lobectomy).	RUL lobectomy. No malignancy in the lung. Smoking history.

DISCUSSION

Although some researchers have suggested the absence of thallium avidity in infection, Lee et al. (*7*) reported that three patients with Kaposi's sarcoma in the lung showed either diffuse increased uptake or patchy increased pulmonary uptake. They concluded that if pulmonary opportunistic infection were superimposed, pulmonary images might be misinterpreted. Recently, unexpected ^{201}Tl-chloride accumulation in cerebral candidiasis has been reported and this uptake disappeared after treatment (*8*). In our study, a focal area of increase in pulmonary uptake was seen in various benign conditions. The mechanism of the lung uptake in those nonmalignant conditions is unknown.

Smoking and associated obstructive lung disease may explain diffuse increase in ^{201}Tl uptake. Diffuse or focal lung uptake was also revealed in the images of one patient who had recently undergone thoracotomy. One patient who had undergone irradiation of lung tumor had diffuse uptake which was explained by pulmonary edema.

CONCLUSION

Thallium-201-chloride has been localized in benign lesions. Diffuse lung uptake of ^{201}Tl in patients with a history of smoking, recent thoracotomy, or postirradiation complicated by pulmonary edema may result in problems with image interpretation. SPECT may be useful in those patients with

TABLE 2. Diffuse Lung Uptake in Malignant Lesion(s) Interferes with Interpretation

Patient	Age	^{201}Tl lung imaging	CT of the chest	Clinical data
7	51	Diffuse lung uptake. A focal lesion in right lung.	RUL and right lung base.	Squamous carcinoma, right pneumonectomy. Smoking history.
8	55	Diffuse lung uptake. A focus in LUL.	Left apical nodule.	Papillary adenocarcinoma lobectomy. Smoking history.
9	79	Diffuse lung uptake. Pericardial and pleural effusions.	A mass lesion in the near hilar on the right.	Irradiation to the lung tumor.
10	63	Diffuse lung uptake. A focus in left upper mediastinum.	RUL mass, mediasternal adenopathy.	Biopsy, adenocarcinoma.

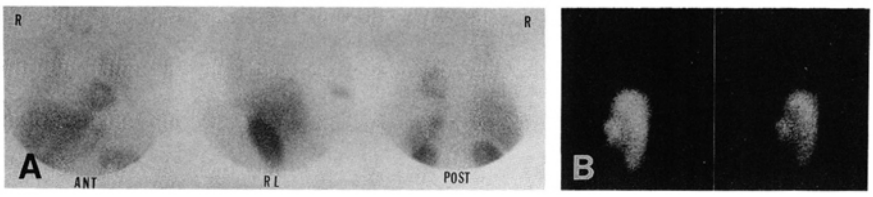

FIG. 4. (A) A 63-yr-old man had an open biopsy of the right lung with results of squamous cell carcinoma. Five days later, ^{201}Tl-chloride planar lung images show diffuse lung uptake in both lungs. (B) The patient underwent right lobectomy and images of the specimen show diffuse increased uptake in the lobe. The lung was negative for malignancy.

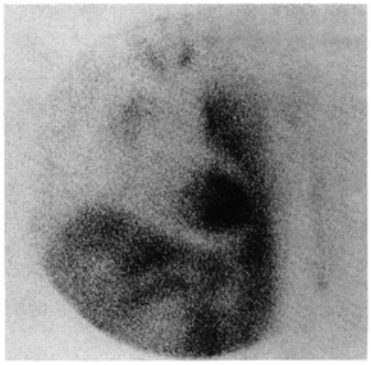

FIG. 5. Anterior planar image of 79-yr-old man with squamous cell carcinoma who had undergone irradiation treatment 3 yr previously shows diffuse pulmonary activity of the right lung and the right upper lung shifting of the mediastinum to the left side. A clear zone is shown between the LV wall activity and the activity of the left medial border of the left lung and the activity of upper border of the left hepatic lobe resulting from known massive pericardial effusion. The pulmonary activity is thought to be the result of pulmonary congestion and/or edema.

diffuse lung uptake in planar images or in negative results in planar images.

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