

COMBINED SPECT/CT TECHNOLOGY APPLIED FOR DIAGNOSING, AND DIFFERENTIAL DIAGNOSTICS OF MALIGNANT AND BENIGNANT LUNG DISEASE

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Summary. The abilities of the technologies SPECT and SPECT/CT in diagnostic, staging of the lung cancer (LC) and benign and malignant lung lesions in the differential diagnostic are presented in the article.

^{99m}Tc-MIBI SPECT and SPECT/CT in patients with LC afford detecting and visualizing not only primary tumor, but metastatic mediastinal lymphatic nodes too. It affords to evaluate abundance and stage of the LC more accurately.

Key words: lung cancer, SPECT, SPECT/CT, ^{99m}Tc-MIBI.

Foreword Lung Cancer is the most common malignant tumor in the world: About 1.2 million of new cases are diagnosed annually. According to the data of the national cancer-register of Ukraine, in 2011 the lung cancer incidents among men amounted to 13,305 cases per annum (20.2% of all the malignant neoplasms) and 3,108 among women (4% of all the malignant neoplasms) [1]. In about 30% of the patients the tumor is detected at stage I or stage II; in 15 to 20% it is detected at stage IIIA, being potentially resectable, while in the rest of the patients the tumor is unresectable and relates to stage IIIB, or there are distant metastases (stage IV). Since the stage predefines survivability and therapy tactics, it is extremely important to accurately determine the lung cancer stage [9]. The stage evaluation procedures include holding of the chest organs CT in order to evaluate the primary tumor proliferation, as well as precise assessment of the mediastinal lymphatic glands' state [2,4,8,9]. Sensitivity and specificity of the CT for mediastinal staging of the lung cancer are rather low (73% and 60%, respectively), being based on the lymphatic glands' sizes. Where, the highest sensitivity is recorded with the lymphatic glands' size constituting 25 mm and more. Error of N1,2 factor determining before the patients treatment reaches 36 to 38% [3,5,7].

Subject to high lung cancer disease and death incidence in the developed industrial countries, and since in many patients the disease is first detected at the late stages, nowadays, implementing of the new diagnostic methods allowing reduction of the death incidence due to lung cancer detection at the earlier stages, is quite and urgent task. The broad implementing in the clinical practice of the radiologic

diagnostics is triggered by combination of the obtained results' accuracy with physiological simplicity, noninvasive nature of the examinations and absence of allergic reactions to the injected radiopharmaceuticals, low ray loads as compared to roentgen examinations [4,6].

The goal of our study was exploring the opportunities of using the Single-Photon Emission Computed Tomography SPECT/CT for the cancer lung diagnosing and staging, as well as differential diagnostics of benignant and malignant neoplasms in the complexes diagnostic cases, where the traditional diagnostic methods give no complete information.

Materials and Methods

21 patients with space-occupying lesions in the thoracic cavity were examined - 6 women and 15 men 49 to 72 years old (the average age constituted 61.2 ± 5.8 years old). In 9 patients the central lung cancer was diagnosed, in 6 patients – the peripheral lung cancer and 6 patients had cavernous areas in the lungs requiring differential diagnostics between the benignant (inflectional) and malignant processes. 6 patients were subjected to SPECT and 15 patients – to SPECT/CT of thoracic cavity. Initially, the CT was completed. The radiological method data was compared to the CT data and the results of the intraoperative histologic examination. 8 patients had malignant adenoma, 6 – epidermoid carcinoma, 2 – large cell carcinoma, 3 – tuberculoma, 1 – lung abscess and 1 metastatic affection of lungs.

The SPECT and SPECT/CT was carried out using the gamma camera Infinia Hawkeye made by GE, comprising 1-slice computer tomograph and Infinia gamma camera. Under the SPECT the general purpose tubular collimator was used with 128×128 pixels matrix, 60 projections, exposure - 30 sec. per exposure. The gamma camera detector was rotating 360° around the patient's thorax. The X-ray computer tomography was completed using the 1-slice computer tomograph, voltage 140 kV, current 2.5 mA, tomographing time 2 to 5 minutes, the layer thickness -10 mm [3,7]. ^{99m}Tc -MIBI preparation was made according to the manufacturer's manual; ("Polatom", Poland), using ^{99m}Tc column effluent, as obtained from molybdenum generator ^{99}Mo , as a radioactive label [2,3]. ^{99m}Tc -MIBI was bolus injected with activeness of 370-555 MBC into the ulnar veins. 30 minutes after the injection the patients were subjected to the thorax organs SPECT. According to the SPECT data, using Xeleris software the axial, frontal and sagittal sections of ^{99m}Tc -MIBI distribution in the thorax organs was held. The

radiopharmaceuticals distribution was assessed at all the sections of the SPECT and the SPECT/CT, examining the same consequently (the repeat length under the SPECT was 0.4 to 0.8 cm, under the CT – 1.0 cm). When analyzing the obtained scintigrams the nature of the radiopharmaceuticals accumulation in the lungs and mediastinal septum was studied, the ratio of ^{99m}Tc -MIBI relative accumulation in the affected area was studied as compared to the surrounding tissues (the background) and the symmetric areas of counter- lateral [7].

Results and Discussion

The SPECT and SPECT/CT in 15 patients clearly showed the areas of the radiopharmaceuticals increased concentrations at the axial and frontal sections. Under the peripheral lung cancer such foci had a round or oval form with more or less distinct frontiers. The focus/background ratio achieved 200% or more, which coincided with the detected neoplasms through CT. Thus, figure 1 shows the scintigram of the patient G., 60 years old with diagnosis: left lung cancer, T1, N0-1, M0. Goal of the scintigram with ^{99m}Tc -MIBI – clarifying the disease stage (affection of the mediastinum lymphatic glands) in order to define the therapy tactics. Conclusion: Singular neoplasm in the lower lobe of the left lung (segment 15). No areas of radiopharmaceuticals abnormal fixation (including mediastinum) were detected, which corresponds to stage T1, N0, M0.

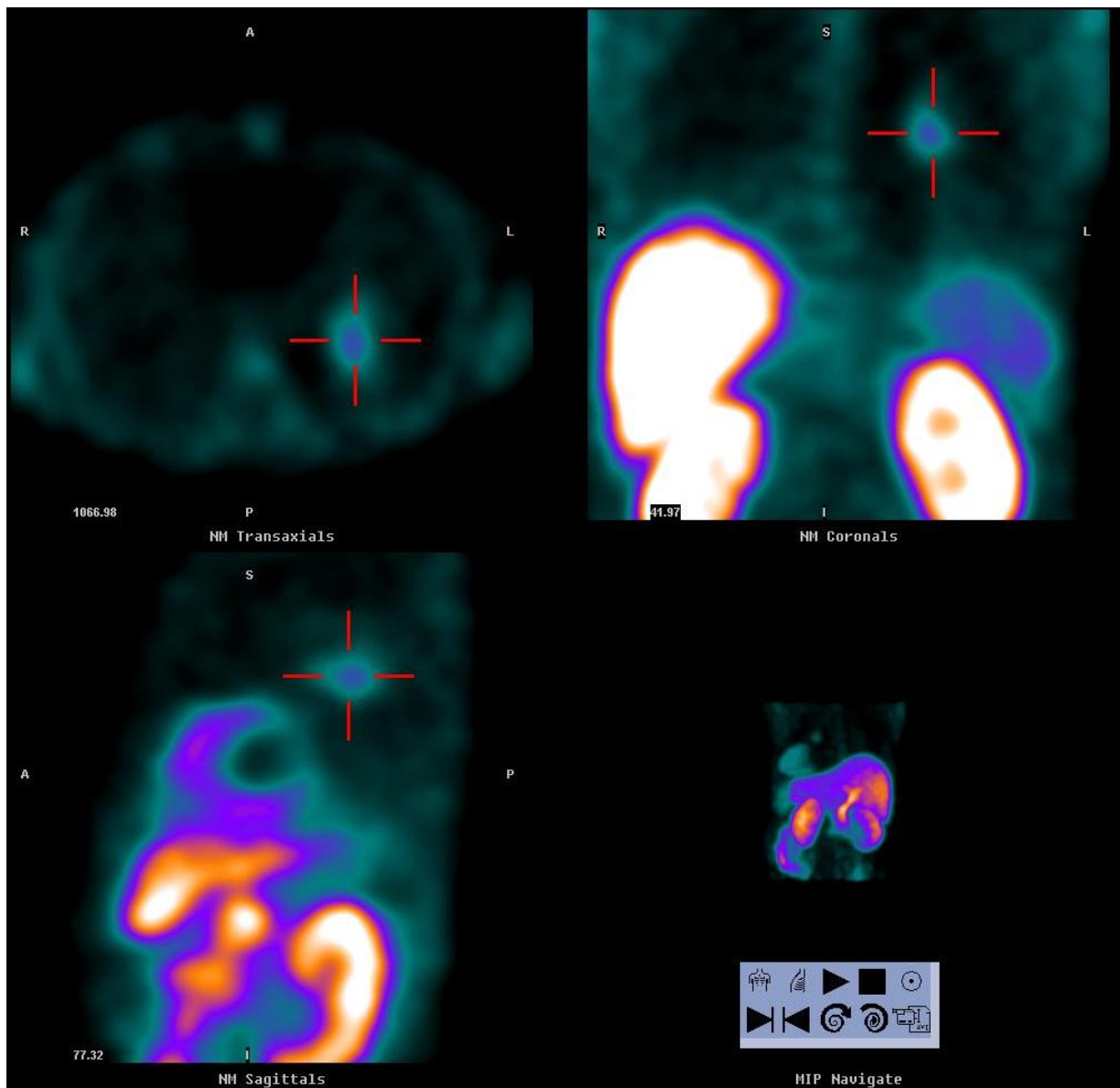
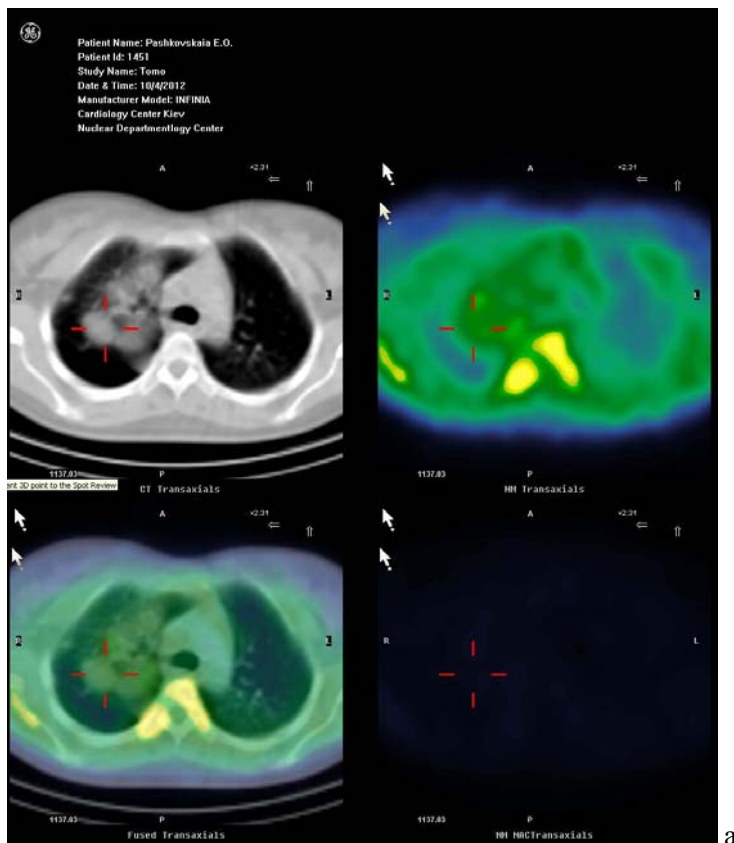


Fig. 1. Scintigram of the patient G., 60 years old, with diagnosis: peripheral left lung cancer. The scintigrams show the focus of ^{99m}Tc -MIBI (250%) increased concentration in the left lung, which corresponds to malignant neoplasm.

Under the central lung cancer the pathological focus had a cloud type or oval form with unclear and uneven frontiers and rather high percentage of the radiopharmaceuticals inclusion (250-400%). Thus, figures 2a and 2b show the scintigrams of the patient P., 30 years old with diagnosis: focal neoplasms of the right lung and mediastinum (accidental finding through radiography of the thorax cavity). The CT failed to differ between the primary neoplasm from the metastatic lung disease. The bronchography and bronchoscopy data failed to provide enough information. The patient was offered mediastinoscopy to obtain histological material and determine the nature of neoplasm, which she refused to undergo.

Thus, the clinical and radiological differentiation of the infectious process from the primary or metastatic lung disease failed. Scintigraphy with ^{99m}Tc -MIBI – area of inhomogeneous pathologically increased concentration of radiopharmaceuticals in the right lung and mediastinum, corresponding to the foci identified through the CT. Conclusion: malignant lung disease (confirmed by biopsy, according to bronchoscopy with biopsy at one of the clinics in Germany - large-cell carcinoma of the lungs).



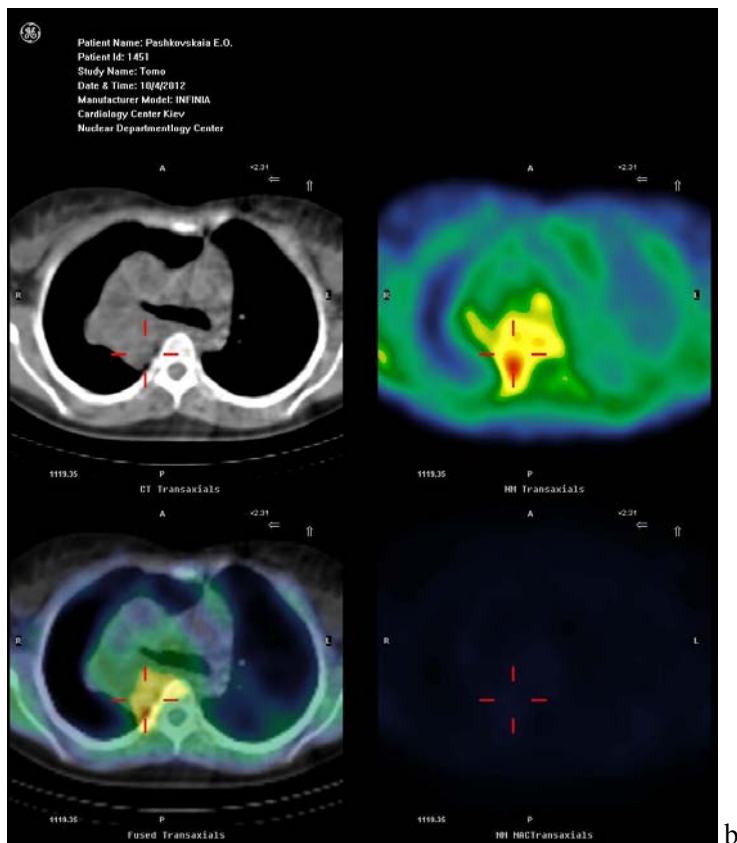
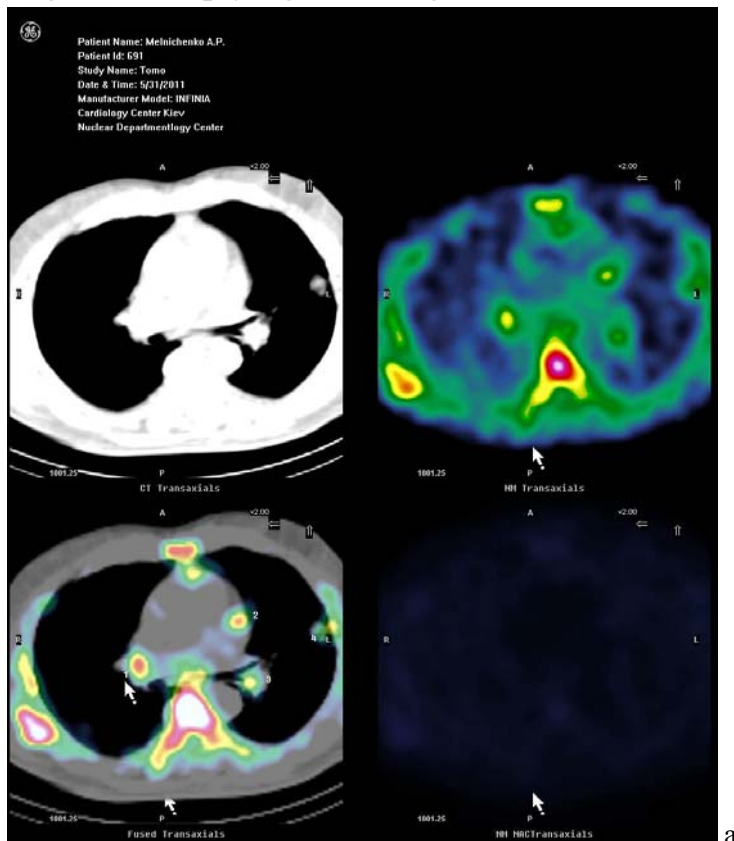


Fig. 2. Scintigram of the patient P., 30 years old with diagnosis: central left lung cancer. The scintigrams show the focus of a cloud type with unclear frontiers ^{99m}Tc -MIBI and ^{99m}Tc -MIBI (400%) increased concentration.

Another important are of the lung scintigram with ^{99m}Tc -MIBI is determining affection of the mediastemum lymphatic glands with pathological process (lung cancer restaging). lymphatic glands are traditionally evaluated with X-ray CT or mediastinoscopy. However, the sensitivity and specificity of CT is rather low being subject to the size of the lymphatic glands, while mediastinoscopy is quite an invasive and not always safe method of diagnosing. Therefore, under the lung cancer staging one of the most important diagnostic methods is scintigraphy. In 6 patients with lung cancer the areas were identified with the pathologically increased concentration of radiopharmaceuticals in section of the mediastemum lymphatic glands (the CT – showed lymphatic glands bigger than 1 cm), and the focus/background ratio constituted 200 to 250%. According to SPECT/CT data in these patients the lymphatic gland condition (level of the radiopharmaceuticals concentration), their size, location and the presence of conglomerates was determined, along with assessing the lymphatic glands' condition. Thus, figures 3a

and 3b show the scintigrams of the patient M., 75 years old with diagnosis: peripheral focal neoplasm in the left lung (suspicion of the left lung). Goal of the scintigram with ^{99m}Tc -MIBI – clarifying the disease nature and its proliferation. Conclusion: Focal neoplasm of segment 13 in the upper lobe of the left lung (fig. 3a), involving mediastinum lymphatic glands and roots of lung from both sides (fig. 3b) complying with stage T1, N3, Mx.



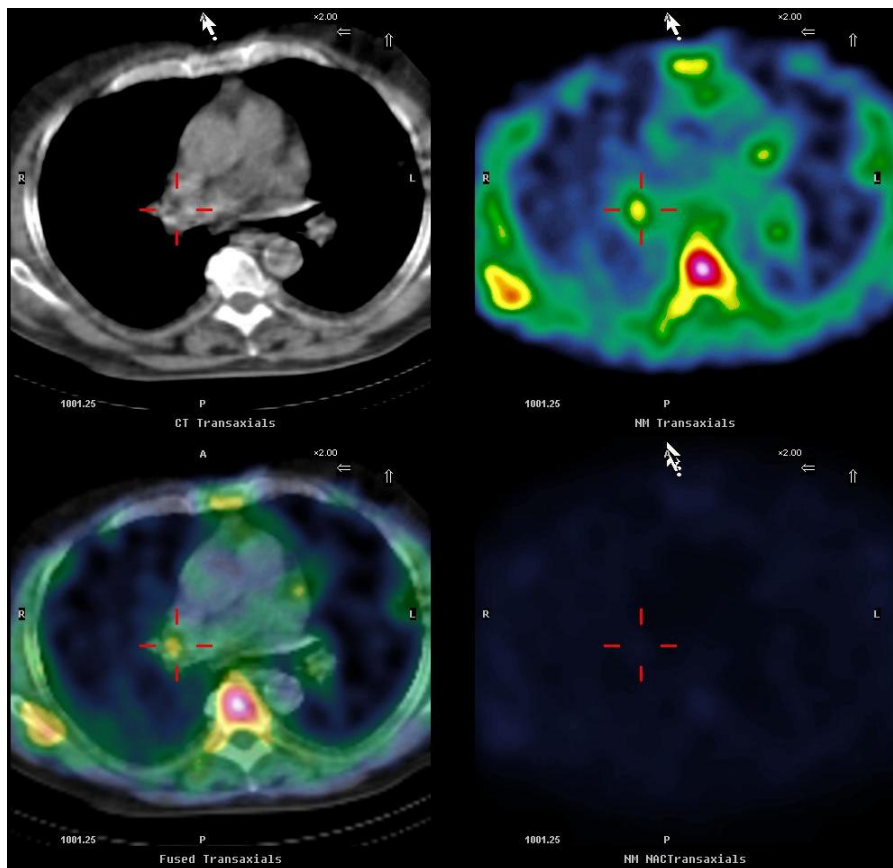


Fig. 3. Scintigram of the patient M., 75 years old with diagnosis: peripheral lung cancer. The scintigrams show focal neoplasm of the left lung with ^{99m}Tc -MIBI concentration at the level of 270% and affection of the mediastinum lymphatic glands (the anterior and posterior groups).

Analyzing the obtained results, it can be concluded that the CT allowed detecting the enlarged mediastinal lymphatic glands, to evaluate their location and structure, but it is impossible to establish the nature of the changes identified therein. The SPECT and SPECT / CT in this group of patients allowed detecting not only the primary tumor, but also the mediastinal lymphatic glands affected by metastatic disease, which facilitated to a more accurate assessment of tumor process proliferation and holding a differential diagnosis between benign and malignant processes. Thus, SPECT with ^{99m}Tc -MIBI is a sensitive noninvasive method for evaluating the mediastinum lymphatic glands involvement under the preoperational staging of the lung cancer. Its diagnostic accuracy is significantly higher than the CT allowing to avoid invasive procedures such as mediastinoscopy. Thus, in all the patients the lung cancer diagnosis was confirmed by the SPECT and SPECT/CT of the thorax cavity with ^{99m}Tc -MIBI.

In 4 patients, the level of radiopharmaceuticals concentration in suspicious areas did not exceed the background activity, the focus/background ratio was 110 to 130%. In 4 of the infectious process was confirmed (3 - tuberculoma, 1 - lung abscess). Figure 4 shows the SPECT scintigram of the patient H., 70 years old with diagnosis: acute abscess of the upper lobe of the right lung. Goal of the scintigram with ^{99m}Tc -MIBI – differential diagnostics with lung cancer. Scintigraphically no pathological concentration sites in the sections of both lung fields were found. Conclusion: No scintigraphic evidences of malignant focal neoplasms of lungs were detected.

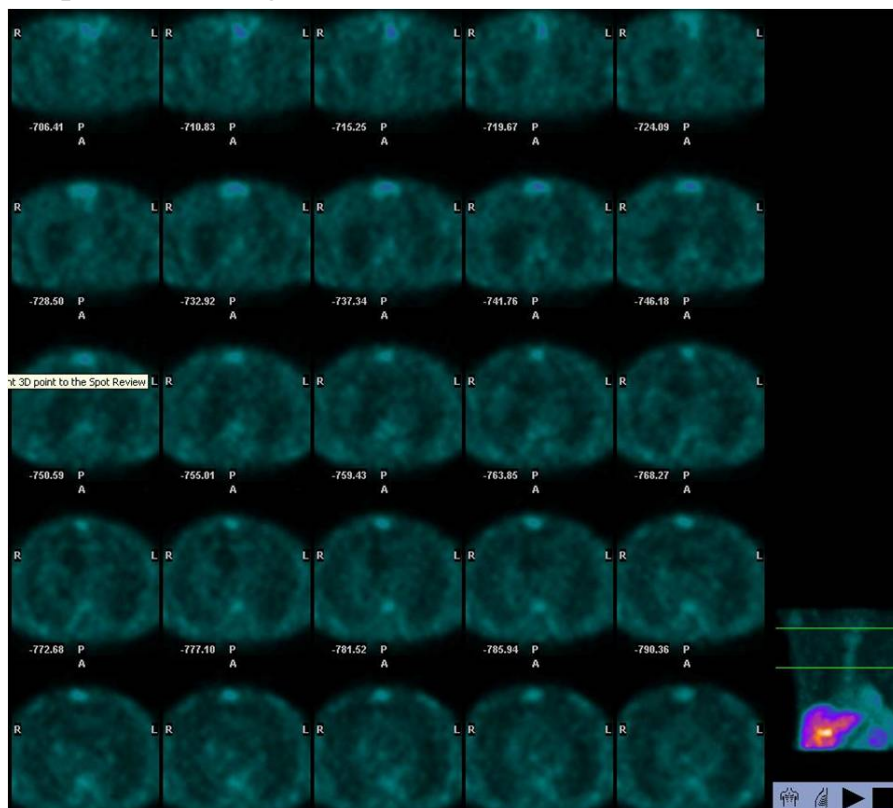


Fig. 4. SPECT scintigrams (axial sections) of the patient H., 70 years old with diagnosis: acute abscess of the upper lobe of the right lung. The scintigrams show absence of ^{99m}Tc -MIBI increased concentration, which corresponds to absence of malignant neoplasms.

High information content of the presented technique is also observed under the metastatic lung disease. Thus, figure 5 shows the scintigram of the patient C., 56 years old with diagnosis: Stomach cancer. Metastatic lung disease? The history: - pulmonary tuberculosis (2010). The clinical and radiological differentiation of the infectious process from the metastatic lung disease failed. Scintigraphy with ^{99m}Tc -MIBI - multiple areas of radiopharmaceuticals pathological concentration in both

lungs, corresponding to foci, revealed under the CT. Conclusion: multiple lung metastases.

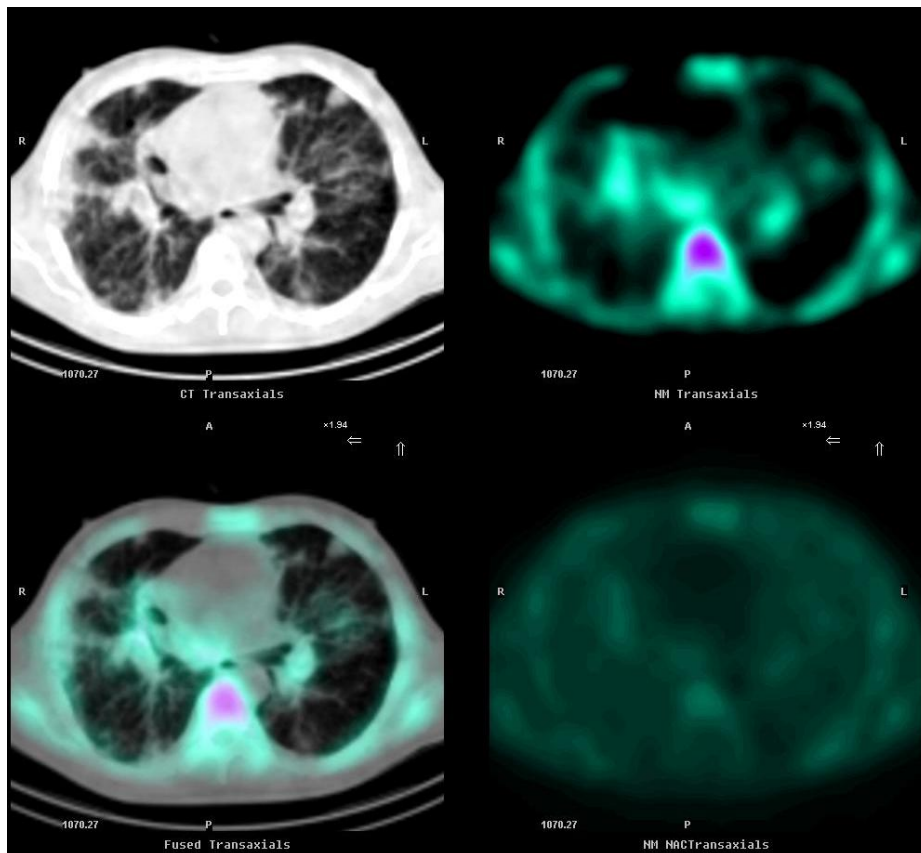


Fig. 5. Scintigram of the patient T., 56 years old with diagnosis: stomach cancer. The scintigrams show multiple areas of ^{99m}Tc -MIBI increased concentration, which corresponds to multiple lung metastases.

Conclusions

The use of the SPECT and SPECT / CT with ^{99m}Tc -MIBI in patients with lung cancer allow identifying and visualizing not only the primary tumor but also the mediastinal lymphatic glands affected by metastases, which allows to evaluate more accurately proliferation of the lung cancer and its stage. In complex diagnostic cases of differential diagnosing the infectious and neoplastic lung lesions, scintigraphy is the method of choice in each case.

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