NLS-DIAGNOSTICS OF LUNG CANCER

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Lung cancer is one of the most widely spread in structure of human oncological diseases. It has continuous hidden course and clinically presented only when disease symptoms are quite apparent and only surgical treatment is possible. Due to this fact improvement of lung cancer diagnostics should be done in two following directions: search of methods for early tumor process detection at pre-clinical development stage and optimization and shortening of pre-operative tumor diagnostics period. Main diagnostic method is roentgenology of chest together with tomography. Roentgenological semiotics of lung cancer depends on form of primary tumor and composed of shadow pattern of tumor itself, caused by tumor airway conductance disorders and secondary metastatic changes in lungs, mediastinum and pleura. Modern computer technologies (computed tomography and its modifications, magnetic resonance imaging) made possible to extend significantly potentials of pathological changes in lungs visualization, but in practice they remain rather expensive and not readily available. At this background new method of hardware diagnostics – NLS-examination of chest remains unclaimed; it is considered to have low information value due the fact that majority of experts are unaware of all potentials of modern NLS-diagnostic devices.

MATERIAL AND METHODS

Objective of this study is to evaluate diagnostic potentials of NLS-research and identifying of NLS-graphic semiotics of lung cancer various forms. NLS-research was carried out by hardware-software system «Metatron»-4025 with «Metapathia GR Clinical» software that allows us to carry out 3D visualization of organs and histological substrates, carry out spectral-entropy analysis (SEA) of affection nidus tissues and lymph nodes in order to identify non-invasively their pathomorphological character. All researches were verified by results of operative interventions and date of histological examination of surgical and biopsy material.

To evaluate potentials of NLS-graphy in pathological neoplasm detection and verification of affection nidus, we carried out roentgenography of chest in two projections prior to NLS-research in majority of cases.

With three-dimensional NLS-graphy we evaluated size, chromogeneity, structure of nidus, outlines and its interaction with surrounding tissues. In all cases we examined pleural cavity to detect pleural effusion and evaluate its volume. We carried out supra- and parasternal examination of upper mediastinum to exclude metastatic affection of intraaortic-pulmonary and paratracheal lymph nodes. If it was necessary we examined lymph nodes of supraclavicular and front-neck area.

NLS-graphy with SEA detected symptoms of malignant process in lungs in 146 patients, in 63 of them peripheral cancer of lung was diagnosed, in 61 – obturator atelectasis of lung lobe or segment (in 11 of them we located tumor itself in root of lung), in 9 patients we detected tumors of non-epithelial nature. Exudative pleurisy of tumorous etiology was diagnosed in 30 patients, in 17 of them it was monitored together with other spectral signs of malignant process, in 13 patients it was the only presentation of lung cancer detected by evaluation of spectral similarity with etalon blast processes.

RESULTS AND DISCUSSION

NLS-graphic semiotics of lung cancer includes direct and indirect signs. Direct sign is direct 3D visualization of tumor, indirect ones are obturator atelectasis of lung lobe or segment, hyperchromic (5-6 points according to Fleindler's scale) mediastinal or supraclavicular lymph nodes and exudative pleurisy. At peripheral cancer we detected malignant neoplasm itself, at central, as a rule – lobar atelectasis caused by endobronchial obstruction. Hyperchromic lymph nodes or pleural effusion evidenced degree of tumorous process spreading.

We categorized NLS picture of peripheral cancer into three main groups: typical (38% – 60.3% of patients),
with disintegration (19% – 30.2% of patients) and corticopleural (6% – 9.5% of patients). The most frequent of them – typical form is characterized by homogeneous, mainly hyperchromic (5 – 6 points) structure and distinct, smooth or wavy, polycyclic outlines. Diameter of neoplasms ranged from 1.5 to 30 centimeters, in majority of cases not exceeding 5 – 7 cm, and, therefore, zone of tumor contiguity to chest wall ranged greatly – from one intercostal space to half of chest. In 5 patients (13.2%) tumor was characterized by very low, hyperchromic, heterogeneous structure making an impression of tumor’s liquid character. Solid character of neoplasm was detected by 3D NLS-graphy of histopictures with application of SEA. Tumors of moderate chromogeneity were detected rarely and had heterogeneous structure due to presence of areas differing from background in chromogeneity. Together with smooth and polycyclic outlines at typical peripheral cancer we detected crenulated, «ray» outlines with spicular or oblong processes. Indistinctness of outlines was detected only in areas of tumor invasion into chest and mediastinum at the level its lateral parts.

NLS-picture of peripheral cancer with disintegration is very diversified and characterized by macroscopic structure of tumor. Depending on disintegration space content we singled out three NLS-graphic variants of this form: with air space (in 11 patients), with liquid space (in 3 patients) and abscess-like form (in 5 patients). All tumors with disintegration are characterized significant heterogeneity of structure due to presence of hyper- and moderately chromogenic liquid inclusions or achromogenic areas with air-dependent reverberations with the background of tumorous tissue. Outer outlines of disintegrated tumors NLS-graphically similar to outlines peculiar for typical form of peripheral cancer.

At first variant of cavernous cancer, position, size and number of linear achromogenic signals, with the background of hyper- and medium chromogenic tumor tissue, were defined by localization, form and number of air, almost «dry», cavities of disintegration. If there was one large central cavity of approximately roundish form we registered achromogenic, arciform or uneven signal in central part of neoplasm. Cavity of irregular form with deep «pockets» was represented at NLS-picture as branching achromogenic line or few separate achromogenic sections, which interconnected with each other at scanning. Few small cavities caused appearance of isolated from each other achromogenic sections in various parts of tumor. Off-center positioning of disintegrating cavity lead to significant difference in tumor walls thickness, located around achromogenic cavity.

Disintegrating peripheral cancer with liquid containing cavities was detected not so often as the one with air cavities. Liquid in disintegration cavity was located in form of moderately and hyperchromogenic areas (4 – 5 points), more frequently multiple, centrally located, of irregular form with uneven and sometimes indistinct outlines. Surrounding tumorous tissue was characterized by increased chromogeneity (up to 6 points according to Fleidner’s scale), due to necrosis, probably. Such picture is typical for early stage of multicentric disintegration.

Abscess-like form (with air and liquid in cavity) of peripheral cancer represented as the most difficult in diagnostic aspect, because in tumor structure there were both achromogenic inclusions of air and hyperchromogenic liquid. NLS-picture of intrapulmonary neoplasm was formed by quantitative ratio of these components. At large amount of liquid, homogeneous moderately chromogenic space prevailed, but more often disintegrating granulated detritus, fibrin and necrotic suppurative masses caused appearance of heterogeneous suspension with the background of hyperchromogenic liquid. After adequate draining of disintegration cavity through bronchus, air prevailed, but small amount of liquid with suspension settled at the bottom.

In these cases cavernous neoplasm was characterized by heterogeneous NLS-structure due to large amount of separate linear achromogenic signals of air in upper parts of cavity and hyperchromogenic liquid content with heterogeneous coarse-grained suspension in lower parts. Between them there might be area with heterogeneous tesselation structure due to achromogenic air bubbles mixed with hyperchromogen liquid with suspension. Such content of cavernous neoplasm is typical for lung abscesses and required differential diagnostics, which was even more complicated by abscess formation when disintegration cavity was infected. Evaluation of cavernous neoplasm walls had main diagnostic importance in this situation. Apparently hyperchromogenic (6 points) wall with indistinct internal outlines, 10 millimeters thick, is typical for abscesses. At lung cancer with disintegration wall was characterized by heterogeneous thickness, with uneven outlines, outgrowths, often medium-chromogenic (4 – 5 points); not changing at dynamic monitoring.

Survey radiograph of chest at peripheral cancer of superior lobe of right lung.
1 – tumor in form of round shade
2 – Ghon’s calcined focus
The most rarely detected was cortico-pleural form of peripheral cancer, typical for Pancoast tumor. NLS-analysis spotted it in form of homogeneous hyperchromogenic mass of irregular oval or triangular form with typical considerably uneven, sometimes indistinct, «torn» outlines. Tumor was localized in cortical layer of lung and widely adjoined chest wall, spreading into it in some area. Detected by SEA malignant tumors of light non-epithelium nature (angioleiomyoma, lymphosarcoma, sarcoma, metastases of renal cell carcinoma) were large and had conglomerate structure, represented by hyper- and, not so often, medium-chromogenic nidi of heterogeneous structure with uneven tuberous outlines. Only in case of lung sarcoma we detected homogeneous hyperchromogenic structure. All neoplasms spread into surrounding organs. Metastases of lung cancer into lung tissue NLS-graphically did not differ from typical form of peripheral cancer; they were only smaller (diameter up to 2 – 3 centimeters).

NLS allowed us to detect accurately spreading of peripheral cancer into soft tissues of chest wall, ribs, diaphragm and liver. In these cases hyperchromic tumorous tissue replaced normal structure of organ, spreading into it to some extent. Usually NLS-diagnostics of tumor spreading into surrounding structures wasn't difficult owing to SEA of these structures.

NLS-semiotics of lung central cancer was mainly composed of indirect NLS-symptoms: obturator atelectasis of lung lobe and segment and exudative pleurisy. Tumor itself in lung root was diagnosed rather poorly (in 11 patients – 18%) due to diagnostics difficulties of tumor without necrosis nidi as typical catabolic process even at quite large size and atelectasis of a lobe or whole lung. In absence of lobar atelectasis even large exobronchial plexuses were not detected due to the same reason.

At scanning we paid great attention to study lung atelectasis NLS-graphic picture in order to identify its typical differential-diagnostic signs. Comparison of two groups of patients with obturative and compression atelectases we found out that airless lung tissue NLS-graphically looks the same, regardless of atelectasis etiology. It is detected as practically homogeneous hyperchromogenic structure of approximately triangular form. Distinctive feature of atelectasis in comparison with inflammatory infiltration at pneumonia was homogeneity of airless lung tissue, in structure of which achromogenic signals of air in bronchi or respiratory parts of lungs are missing.

Compression atelectasis of inferior edge or whole inferior lobe is caused by compression of lung tissue by marked pleural effusion. According to our data it appeared starting from pleural content of 450 – 500 ml. Area of atelectasis increased in proportion to amount of liquid in pleural cavity. Compression atelectasis had wedge-shaped of triangular form with base facing lung root, smooth distinct outlines with the background of moderately chromogenic liquid and indistinct tessellated border.

Obturator atelectasis, differing from compression atelectasis, was frequently detected without pleural effusion. At exudative pleurisy area of such atelectasis did not depend on amount of pleural content. We faced diagnostic difficulties in detecting of atelectasis etiology only when there were massive pleural effusions of more than 1.5 liters. Theoretically, in such conditions lobar atelectasis could be both a consequence of bronchus obturation by tumor and compression of inferior lobe by effusion. Etiology was identified after pleural tapping: preserving of airless lung tissue in the same amount evidenced obturative origin of atelectasis.

In all cases of visualization central cancer had appearance of hyperchromogenic neoplasm (5 – 6 points according to Fleindler's scale) with uneven, indistinct outlines, located in lung root and comparable, according to NLS-picture, to atelectasic lung tissue, which hampered its differentiating from airless lung. We identified borders of tumor more precisely if there was peripheral
hypochromogenic area. It was impossible to distinguish primary tumor from conglomerate of significantly enlarged metastatic lymph nodes in lung root even by SEA, though it had no great diagnostic value, because it was detected in inoperable patients due to process spreading.

In 8 patients (13.1%) suffering from lung central cancer we detected spreading of tumor into mediastinum, pericardium and great vessels. Spreading into mediastinum was detected by absence of distinct medial outline of tumor, when it widely «went into» mediastinum. Growing of tumorous tissue into pericardium was detected by SEA according to spectral similarity of this zone with tumor process.

Presence of hyperchromogenic neoplasm with uneven outlines, with the background of moderately chromogenic effusion in pericardium cavity, also definitely evidenced spreading into pericardium.

Exudative pleurisy at malignant lung tumors did not have pathognomonic NLS-picture. It was characterized by homogeneous moderately chromogenic pleural content; components of effusion are not numerous and represented, as a rule, by fine fibrin fibers. Pleura is thin; and only at metastasis we located hyperchromogenic parietal neoplasms with distinct uneven outlines.

Final stage of NLS-research at lung cancer is scanning of superior anterior mediastinum in order to evaluate condition of paratracheal and intraaorticpulmonary lymph nodes. Affected with metastases mediastinal lymph nodes were detected in 15 cases, however purposeful search of them was carried out in all patients and it became obligatory stage of NLS-examination of oncological patients. They were located in space between arch of aorta and pulmonary artery in form of multiple roundish or oval neoplasms of apparent chromogeneity (5 – 6 points according to Fleindler’s scale).

If there was extensive metastasis we detected enlarged supraclavicular, subclavicular and front-neck lymph nodes, which was confirmed according to SEA results.

CONCLUSION
NLS-research is informative radiologically-safe additional diagnostic method of malignant tumors of lungs. NLS-seniotics of lung cancer includes direct (tumor) and indirect (obturator atelectasis, metastases into mediastinum lymph nodes, exudative pleurisy) symptoms of malignant process. We offered classification of peripheral lung cancer into three groups, according to NLS-graphy, depending on macroscopic structure. Central cancer of lung is characterized by presence of lobar obturator atelectasis, which may be regarded as indirect sign of large exobronchial tumors in lung root, which are poorly diagnosed straight as typical catabolic processes beyond necrosis disintegration stage.