Non-linear diagnostics of purulent-destructive diseases of lungs and pleura

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Basing on the results of non-linear diagnostic examination of thorax of 267 patients suffering from purulent-destructive diseases of lungs and pleura we studied NLS-semiotics of lung abscess (112 patients), abscessed pneumonia (79 patients), pleural empyema (54 patients) and pulmonary gangrene (22 patients). We offered NLS-classification of lung abscesses based on a condition of their spontaneous drainage by bronchi, developed differential-diagnostic criteria of acute purulent and gangrenous abscesses. We singled out three NLS-variants of pulmonary gangrene: with large liquid-containing cavity, with numerous lesser cavities, with pyopneumothorax.

INTRODUCTION

Traditional roentgenologic methods still remain the basic in diagnostics of pulmonary organs diseases, but non-linear diagnostic research (NLS) of thorax organs opens conceptually new prospects for evaluation of lungs and pleura changes. Information about a pathological process is presented in a form of threedimensional image with strict differentiation of various in spectral properties biological structures, at the same time application of ultramicroradiochemical scanning makes possible to study researched object in every detail. The study is not related to radiation exposure, it does not require expenses for additional equipment if a standard set of NLS-diagnostic devices is available.

We have carried out comparative analysis of 62 acute purulent abscesses and 32 gangrenous abscesses and defined criteria for their differential diagnostics, which were: efficiency of spontaneous drainage, presence of hyperchromogenic wall and necrotized sequesters of lung tissue and filled with purulent exudate with various efficiency of spontaneous drainage and presence of a wall. On NLS-graphy early stage NLS-study preceded roentgenography or replaced them. Further on both diagnostic methods were applied simultaneously, but frequently NLS-study preceded roentgenography or replaced some part of it.

RESULTS OF THE STUDY AND DISCUSSION

NLS-SEMIOSTICS OF LUNG ABSCESES

Pathomorphological basis and common NLS-symptoms in patients with lung abscess was the presence of intrapulmonary cavity, the main diagnostic criteria of which were related to changing of chromogenity of internal content and wall. Spectral-entropic analysis helped to evaluate the content and its distribution in the cavity and thus to evaluate the efficiency of abscess spontaneous drainage through bronchi and decide if it was a purulent or a gangrenous form. Virtual visualization of walls was possible at chronic course of an abscess, thickness of walls and character of a contour were taken into consideration at differential diagnostics with cavernous form of peripheral lung cancer.

We singled out 4 types of acute lung abscess depending on efficiency of its spontaneous drainage through bronchi: blocked abscess, an abscess with insufficient spontaneous drainage, an abscess with free spontaneous drainage and an abscess with air pocket. These variants represent consecutive development steps of a nidal purulent-destructive process in a lung. Offered classification is based on differences in a structure of abscesses, namely on qualitative ratio of hyperchromogenic purulent exudate (6 points at Fleindler’s scale) and achromogeneity of air inclusions (1 point) and a character of their spatial distribution in the cavity.

Blocked abscess was visualized as roundish necroplasm with hyperchromogenic liquid content in which we detected isochromogenic suspensions (4-5 points at Fleindler’s scale), loosely distributed throughout a cavity of destruction (suppurative detritus), without achromogenic inclusions (air) distribution in dynamics. When there were pleural fluids we evaluated amount and structure of a fluid content with study of all inclusions (suspensions, threads) and condition of pleura. According to results of ultramicroradiochemical scanning we judged about diagnostic value of each mentioned criterion.

At the initial stage NLS-study of thorax was carried out after roentgenography with following comparison of results. Further on both diagnostic methods were applied simultaneously, but frequently NLS-study preceded roentgenography or replaced some part of it.

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MATERIALS AND METHODS OF THE STUDY

We have examined 267 patients suffering from purulent-destructive diseases of lungs and pleura, who were treated in University College London Hospital, in 2009 – 2011. In accordance with a nosology all patients were divided into 4 groups named by the main disease: lung abscess (112 patients – 94 among them with acute abscess, 18 – with chronic one), abscessed pneumonia (79 patients), pleural empyema (94 patients) and pulmonary gangrene (22 patients). NLS-graphy data was verified by the results of surgical interventions, thoracic punctures with microbiological analysis of a punctate.

Thorax research was carried out using “MetaTron”-400S system (the IPPR Russia) with 4.9GHz high-frequency sensors in accordance with procedure created in the hospital. At visualization of pathological neoplasms we defined their localization, size, chromogenity, spectral structure; applying spectral-entropic analysis (SEA) we evaluated changes of NLS-picture in dynamics. When there were pleural fluids we evaluated amount and structure of a fluid content with study of all inclusions (suspensions, threads) and condition of pleura. According to results of ultramicroradiochemical scanning we judged about diagnostic value of each mentioned criterion.

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structure due to diffuse distribution of lesser chromo-
genous areas of air heads against the background of prevailing isochromogenic content with heteroge-
nous suspensions in lower parts of a cavity.

At the advanced stage we detected cavity of destruction with solid walls, properly drained by bronchi and containing mainly air, sequestrums and small amount of purulent exudate (7 patients). On NLS-graphy it was characterized by heterogeneous neoplasm with prevailing long agronomic objects with small amount of fluid in lower parts. Also agronomic moderately chromogenic abscess wall of equal thickness with distinct external and indistinct internal walls was visualized.

Acute purulent processes are characterized by smaller than gangrenous abscesses size, often insufficient spontaneous drainage with heterogeneous diffuse distribution of agronomic inclusions of air against isochromogenic background, absence of walls and sequestrums. At adequate treatment we detected a positive dynamics in form of abscess cavity decreasing with simultaneous decreasing of fluid content amount and replacing by air. Further on a cicatrix was formed at the spot.

Chronic lung abscesses are characterized by the same regularities of NLS-picture as acute ones. Diagnostical criteria are the quantitative ratio of purulent exudate and agronomic air inclusions and their spatial distribution in a cavity. We singled out 4 types of chronic abscess depending on efficiency of its spontaneous drainage through bronchi: with out access to bronchi (pseudo-tumorous), with insufficient spontaneous drainage, with free spontaneous drainage and an abscess with air pocket.

The main difference between chronic abscess and acute one was a presence of moderately chromogenic wall which was more distinctly visualized at the level of air content in the upper part of a cavity and less distinctly – in the lower part against the background of hyperchromogenic purulent exudate with suspensions. A wall had homogenous chromogenic structure (4 points at Fleindler’s scale), even thickness (up to 8 mm), distinct external and indistinct internal contours.

The greatest diagnostic difficulty was represented by pseudo-tumorous form of chronic abscess, which had, as a rule, homogenous hyperchromogenic structure because of dense purulent content and distinct contour imitating peripheral lung cancer. Etiology of a nidus was defined by SEA results and confirmed by puncture biopsy.

NLS-SEMIOTICS OF ABDOMINAL PNEUMONIA

In the group of patients suffering from abscessed pneumonia a pathomorphological basis of a picture was presence of interalveolar exudation and inflammatory infiltration. Fibrinous exudate in alveoli allowed to visualize on their surface a vis-
ceral pleura, on the internal surface of thoracic wall – a parietal pleura. Pleural fluid led to appearance of a hyperchromogenic space with separation of pleural slips between a lung surface and thoracic wall. Fi-
brinous pleural imbrications were of form of isochro-
monic imbrications with uneven jugged surface. Presented picture of pleomorphic fever was a back-
ground against which destructive changes of pulmo-
nary tissue developed. Their NLS-semiotics depended on size and efficiency of spontaneous drainage of decay cavities, that is why the same stages as of lung abscesses were singled out.

Closed decay cavities at abscess forming pneumo-
nia were visualized rarely, because at destruction of a lung tissue burst of purulent exudate into bronchi happened early. At a rule, destruction rudi were of form of several lesser (size up to 2 cm) closely located hyperchromogenic areas of irregular shape with un-
even and indistinct contours. Further on at this spot a single cavity with air and fluid contents was formed. It had no own walls and was limited by infiltrated pa-
renchyma of lung itself.

At insufficient spontaneous drainage, in a cavity prevailed hyperchromogenic exudate with separate achromogenic air inclusions, diffusely or parietally located along a border with a lung tissue. Due to mura!
ginous exudates, a contour of the destruction area was outlined by short achromogenic lines.

At free spontaneous drainage in decay cavities there was air mainly, that is why they were visual-
lized as achromogenic areas in the structure of hy-
perchromogenic pneumonic infiltrate. Strictly lim-
ted major air cavities had a form of achromogenic arc, lesser ones – homogenous achromogenic areas of oval shape.

Presence of a small amount of detritus and puru-
 lent secretion mixed with air in the destruction cavity provided isochromogenic mosaic-like structure and indistinct contours to its content.

NLS-SEMIOTICS OF PLEURAL EMPYEMA

In the group of patients suffering from pleural em-
 pyema there were 54 patients with purulent exudate in a pleural cavity. In 40 patients we registered tinted exudate of oval shape with paracostal localization, often along posterior or lateral surface of thorax. In 11 patients pleural empyema was of diffused character, in 6 of them pyopneumothorax was diagnosed. In 39 patients lung peria- and metastemopneumonic genesis, in 8 patients – posttraumatic, it 7 reason was not found. The main diagnostic criterions of pleural empyema was hyperchromogenic suspension caused by puru-
 lent detritus. In the majority of cases it was spread throughout the whole volume of empyemic cavity, had high density, heterogeneous character and it could imitate a solid neoplasm. To differentiate it with a tumor a spectral-entropic analysis must be applied. There were no isochromogenic fibrinous fibers in an empyemic cavity. It was limited by thickened pleura slips (up to 8 mm) with uneven surface.

In single cases purulent content in pleural cavity had lamellar character with hyperchromogenic areas of various shapes. Heterogeneous structure of pleu-
 ral empyema with more chromogenic regions, with one
tof masses with uneven contours was registered at hemopleura suppuration, when partially decayed thrombotic clots were found in purulent content.

At pyopneumothorax we detected major diffusely located achromogenic areas corresponding to a sepa-
rate air heads in purulent exudate. Depending on size they had a form of both point inclusions and quite ex-
tensive neoplasms, Free air in pleural cavity caused appearance of achromogenic line above fluid content.

NLS-SEMIOTICS OF PULMONARY GANGRENE

NLS-semiotics of pulmonary gangrene differed by significant diversification of a picture due to spreading of purulent-destructive process to the whole lung with involvement of pleura and, as a result, a combina-
tion of various NLS-symptoms. Analysis of NLS-image was carried out taking into account the whole clini-
cal picture. After taking as a basis of classification the leading symptom we nominally singled out three NLS-variants of gangrene. At the first variant (11 pa-
 tients) in a lung against the background of massive inflammatory infiltration we detected a major cavity of destruction with mainly liquid content, NLS-picture was analogous to gangrenous abscess with insufficient spontaneous drainage of air, its wall was not visualized, it was limited by lung parenchyma, in certain areas the line between them was indistinct.

At the second variant (7 patients) in the picture prevailed (total) thickening (accompanied by decr-
 easing of chromogeneity) of a lobe or the whole lung with presence of multiple roundish achromogenic areas due to lesser cavities of destruction. In 3 patients, apart from air cavities, there were hyper-
 chromogenic fluid-containing cavities of decay (6 point), in one patient they prevailed in the structure of gangrenous lung. In 8 of 18 patients with first two variants of gangrene a pleural empyema with the typi-
cal picture appeared.

The third variant of lung gangrene (4 patients) had a course with development of pyopneumothorax, when a massive pleural fluid with heterogeneous
purulent-destructive process in a lung (acute purulent disease) and depends, first of all, on focal or diffuse nature of pathological changes in a lung. NLS-semiotics of pathological changes in a lung is based on primary examination and dynamic monitoring. Radiologically safe method of purulent-destructive process in a lung was characterized by one of above mentioned variants: a major cavity with purulent content of multiple lesser nidi of destruction. Thus, NLS-research of thorax is an informative, radiologically safe method of purulent-destructive process in a lung and pleura diseases diagnostics, allowing to not only acquire additional information, but to carry out primary examination and dynamic monitoring. NLS-semiotics of pathological changes in a lung is diverse and depends, first of all, on focal or diffuse character of lung affection. Analysis of NLS-picture makes possible to define a character and severity a purulent-destructive process in a lung (acute purulent or gangrenous abscess, abscess forming pneumonia, gangrene), its spreading to pleural cavity (empyema, pyopneumothorax). The common factor, which determines NLS-picture of purulent cavity at abscess and abscess forming pneumonia, is a condition of its spontaneous drainage, which is evaluated by quantity and character of distribution of achromogenic air, which is quite diverse due to the greatest severity of destructive changes and is formed by focal and diffuse changes in a lung, although its clinical course may be characterized by prevalence of one of these variants.

REFERENCES


INTRODUCTION

Cervix carcinoma incidence rate growing is marked in the recent years both in Russian Federation and generally in the world. Increasing of cervix carcinoma incidence rate in women is a disturbing fact, because this group of patients is not only a significant part of reproductive female population, but socially active group also. The main role in treatment of cervix carcinoma patients belongs to surgical intervention and ray therapy. Nowadays, methods of combined and integrated treatment are developed and introduced into a practice.

Application of advance technologies for treatment requires support of a modern diagnostics. A group of hardware visualization is represented by the following methods: ultrasound research, computed tomography, magnetic-resonance imaging. Recently developed method of three-dimensional non-linear (NLS) diagnostics has several unquestionable advantages over other methods. 3D NLS-diagnostics method is safe for a patient and a doctor in regard to radiation exposure, has sufficient accuracy and high reliability of acquired results. 3D NLS-study of patients suffering from cervix carcinoma may be used both for diagnostics of an oncological process and for monitoring during treatment process in order to correct promptly or evaluate efficiency of treatment measures. Application of modern devices for NLS-diagnostics allows to evaluate condition and a structure of uterine cervix, dissemination of a process into uterine body, ovaries and urinary bladder, NLS-study of abdominal cavity and retroperitoneal space organs allows to evaluate dissemination of a process, detect presence of metastatic affection of liver, retroperitoneal lymph nodes. Spectral-entropic analysis (SEA) of a tumor makes possible to understand pathogenic mechanisms of tumor growth and to develop anti-tumor strategy. NLS-method makes possible to acquire multidimensional picture of a researched object and its vascular tree in real-time mode simultaneously.

Combined NLS-diagnostics of cervix carcinoma with application of ultramicroscanning with SEA allows to evaluate size and character of a tumor, which to a considerable extent defines treatment tactics at every stage of the treatment.

The objective of the study is to define possibilities of 3D NLS-research with ultramicroscanning and SEA in evaluation of patients with cervix carcinoma treatment efficiency.

MATERIALS AND METHODS OF THE STUDY

The study was carried out with participation of patients suffering from cervix carcinoma of 2nd and 3rd stage, treated in Omsk regional oncologic dispensary. During the study we used “Metatron”-4025 systems with 4,96Hz high-frequency sensor and “Metapathia GR Clinical” professional software with features of three-dimensional visualization and evaluation of microscans.

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At the first stage of the study all cervix carcinoma patients were subjected to survey transabdominal ultrasonic check-up of small pelvis organs in V-mode after preliminary natural filling of an urinary bladder. Invasion of urinary bladder was checked. At the second stage of the study we carried out three-dimensional NLS-study of small pelvis organs. Three-dimensional NLS-graphy helped to detect presence of uterine cervix damages and evaluate condition of endocervix. Lateral virtual cross-cut gave images of anterior and posterior walls of an uterus; frontal cross-cuts gave full picture of left and right sides of an uterus condition and condition of parametrial tissue. In three-dimensional angiography mode we studied spatial, virtual picture of vascular structures of uterine cervix. Simultaneous 3D-visualization of the whole organ allowed to get clear idea of...