INTRODUCTION

Skeletal system bone affection is high in case of generalized stages of disease. In case of I-II stage of disease the risk does not exceed 3.2%. That is why routine skeletal screening examination aimed at the detection of metastases in early disease patients with no clinical symptoms of bones affection is considered as unreasonable. Bone scan is usually used as a screening method in patients with common form of disease or upon availability of clinical data confirming bones affection. However bone scanning results are frequently uncertain due to low specificity of the method; also such method is not good at detection of lytic metastases. Roentgenologic research methods mostly affected areas are: vertebral column and pelvic bones. At the same time the risk of metastatic skeletal affection is high in case of generalized stages of disease; in case of I-II stage of disease the risk does not exceed 2.6%. That is why routine skeletal screening examination aimed at the detection of metastases in early disease patients with no clinical symptoms of bones affection is considered as unreasonable. Computer tomography allows detecting destruction foci only in case of considerable bone substance. Computer tomography is chosen more frequently as long as it provides exceptional image quality. Unique ultramicroroscaning technique (which exists only in NLS-method) with the use of spectral-entropy analysis allow determination of morphological affiliation of the formation according to its spectral-similarity to model processes, assess metastatic lesion of skeletal bones, surrounding soft tissues and lymphatic nodes, determine the presence and type of genetic aberrations in tumoral subclones which eventually will determine the scope of surgical treatment.

CONSIDERABLE ADVANTAGES OF 3D NLS-METHOD

The advantages of new 3D NLS-method are: direct display of bone marrow and the visualization possibility of its tumor infiltration before any bone alterations appear. Other considerable advantages of 3D NLS-method are: availability, usability and fast rate of examination. The latest technical achievements in this field led to the creation of special modes in 3D visualization (4D Tissue, DeepVision, FastVision) which provide exceptional image quality. Three-dimensional visualization (3D) provides capability to apply the so-called «Metatron»-4025 system with software program 3D NLS-Method, which allows visualization of all skeletal bones, surrounding soft tissues and lymphatic nodes. NLS-research started from the assessment of the whole body and then the following body parts were assessed at detailing: head and neck; torso and proximal shoulder parts; pelvic and proximal femora parts. Research protocol for each anatomical part included the following data: large-scale NLS-scanning in 3D mode at 3 mutually transverse planes; ultramicroroscaning the mode in the regions of interest with spectral-entropy analysis. Total time required for the research was approximately 30 minutes.

BONE SCANNING METHOD

Skeletal system bone scanning was performed with the use of two-detector gamma camera according to the standard method in anterior and back view in 2 hours after intravenous injection of 740 Mbq 99mTc-Technephore. Images were taken using low-energy high-resolution collimating optics; whole-body table movement speed was 12-16 cm/min. Scanning procedure took 15-20 min. After scanning, bone biopsy of flank bones with histopathological examination of received material was performed in 6 patients to verify metastatic lesions of pelvic bones.

3D NLS METHOD. Scanning was performed using «Metatron»-4025 system with software program which allows visualization of all skeletal bones, surrounding soft tissues and lymphatic nodes. NLS-research started from the assessment of the whole body and then the following body parts were assessed at detailing: head and neck; torso and proximal shoulder parts; pelvic and proximal femora parts. Research protocol for each anatomical part included the following data: large-scale NLS-scanning in 3D mode at 3 mutually transverse planes; ultramicroroscaning the mode in the regions of interest with spectral-entropy analysis. Total time required for the research was approximately 30 minutes.

DATA ANALYSIS

Focal or diffuse (homogeneous or heterogenous) chromogenecy increase of the foci was considered as a sign of metastatic lesion during spectral-entropy analysis. Results verification of spectral-entropy analysis was performed based on histological examination of trepanobioplates received after trepanobiopsy of bony tissue in the area of interest. The results of spectral-entropy analysis were confirmed by the histological methods in 99.1% of cases.

The probability of metastatic lesion (when performing bone scanning) was assessed according to the localization and quantity of super-active foci with consideration of radiopharmaceutical hyperfixation in them.

Skeletal system was divided into 10 anatomical parts to perform analysis of research results. These parts were: neck vertebrae, thoracic vertebrae, lumbar vertebrae, pelvic bones, cranial bones; proximal parts of thighs; proximal parts of humeri, collar bones and scapulae; ribs; breast bone. The research results were determined individually to each anatomical part in whole considering it as a single lesion regardless of the number of metastatic lesions in it. 3D NLS and bone scanning results for each part were ranked as positive, controversial or negative. Result verification was performed based on X-ray examination data, including helical computed tomography, histological inspection or clinical observation with the use of radiology methods.

Comparison of diagnostic effectiveness of 3D NLS and bone scan was performed by receiver operating characteristic curve method with the use of application statistical programs package SPSS 11.5 for Windows. As supplementary to it the detailing of detected lesions in skeletal system parts was performed for each method. Additional possibilities of 3D NLS method were considered in all cases.
RESULTS OF THE STUDY AND DISCUSSION

As can be seen from the above we used 3D NLS method allowing receiving images of proximal parts of femoral and humerus bones, pelvic bones and major part of axial skeleton, ribs and cranial bones with quality suitable for diagnostic purposes.

Metastatic lesion of the skeleton was verified in 30 (90.9%) out of 33 patients when using 3D NLS method and in 24 of patients (72.7%) when bone scanning method was used.

Multiple lesion of the skeletal system was diagnosed in 21 of patients; notably that multiple foci were also frequently detected within the limits of single anatomical part. Solitary lesion was diagnosed only in 3 patients, pelvic bones lesion was diagnosed in 2 patients and lumbar vertebra was diagnosed in 1 patient.

In total 330 skeletal parts were assessed in 33 of patients with the use of NLS-graphy and bone scanning, verification was performed in 200 parts which were used for the further analysis. Metastatic lesion was diagnosed in 126 parts out of 200, in 74 parts there was none.

NLS-graphy detected 114 out of 126 parts, controversial results were received in 2 cases (both did not confirm at verification), no false-positive results. In the mode of NLS-ultramicroscanning the majority of metastatic lesions visualized well.

Bone scanning detected 87 out of 126 parts, controversial results were received in 20 cases (16 of them did not confirm at verification), 1 case of false-positive result.

Response curves were modeled in coordinate axes «sensitivity» and «specificity». Diagnostic effectiveness of the test when using receiver operating characteristic (ROC) method is defined by the area under curve; notably that the bigger the area the more effective method is. Area under curve for NLS-graphy was 0.95±0.016 (95% DI 0.920–0.982), for Bone scanning–0.82±0.026 (95% DI 0.764–0.879). It shows the higher diagnostic efficiency of NLS-graphy in comparison to bone scanning. After the first assessment of results of NLS-graphy in 3D NLS-graphy was 0.951±0.016 (95% DI 0.920–0.982), the more effective method is. Area under curve; notably that the bigger the area the more effective method is.

High efficiency of NLS-graphy in detection of tumoral infiltration of bone marrow was demonstratively proved by our researches and it has determined the intention to change from NLS-visualization of separate skeletal system parts (where bone metastasis may supposedly locate according to the data of other research methods) to NLS-screening of bone metastases in the whole body. Originally such screening was performed by sequential NLS-scanning of 5–7 new parts spreading to the whole skeletal system. The first assessment of results of NLS-graphy in Russia (Andriyanov A. and others) showed that its diagnostic effectiveness surpasses bone scanning. The reason is clear since NLS-graphy allows metastases detection in bone marrow before any osteolytic and osteoblastic bone response appear, i.e. at an earlier stage than in bone scanning.

The recent years are characterized by an active development of new NLS-graphy technologies. In the first place it is 3D-ultramicroscanning technology initially intended for angiographic NLS-researches of nonperforating trepanobiopsy of flank bones; notably that in 3 out of 6 patients there were no changes on scintigrams.

Besides bone metastases the metastases of other localization were detected at NLS-graphy: multiple metastatic liver lesions were diagnosed in 8 patients, in 2 patients it was combined with cerebral affection and in 1 patient it was combined with lung metastases. Liver affection in all cases was confirmed by the spectral-entropy analysis.

Multiple metastatic lung lesions were also confirmed by NLS-graphy, although the number of detected foci during NLS was less. Metastatic cerebral affection detected during NLS-graphy owing to the massive perifocal edema was confirmed by the results of spectral-entropy analysis, in both cases the additional small metastatic foci were detected during NLS-ultramicroscanning.

Methods of parallel images creation during volumetric scanning (4D Tissues) provided further diagnostics quality improvement.

The assessment of received image quality showed that it has the best quality and it is quite usable for diagnostics concerning the majority of examined skeletal parts. The comparison of diagnostic effectiveness by ROC curve method showed the predominance of NLS-graphy screening over bone scanning method. The key advantage of NLS-graphy was the detection of the more spread metastatic affection in spine and pelvic bones.

Treatment of patients with bone metastases of breast cancer is possible by means of various methods, including radiation, drug or systemic treatment and also surgical, multimodality and combination therapy. Precise evaluation of metastatic lesions prevalence has important significance in choosing of correct treatment mode. According to the references data 41% of bone metastases are multiple in case of breast cancer and 37% of them are combined (i.e. other organs are also affected along with skeletal system). Performed research has demonstrated that NLS-graphy allows effective detection of metastatic lesions not only in skeleton but also in liver, brain and even lungs.
Three-dimensional computed NLS-graphy in renal cancer stage diagnosing

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INTRODUCTION

Difficulties of modern diagnosing and adequate surgical treatment of renal cancer (RC) are conditioned mainly by absence of certain specific clinical manifestations of renal cancer, continuous asymptomatic stage and late applying of patients to a clinic for specialized help. At the same time about 50% of renal tumors are diagnosed at asymptomatic stage during clinical studies not related to RC, these cases are called “radiologist tumour”. Among “accidentally” revealed tumors 85% are localized forms, when at the presence of clinical symptoms only 40–45% of tumors develop in a kidney.

Development of renal cancer surgical treatment technologies with a tendency to almost global introduction of laparoscopic and organ-preserving methods of surgery considerably increases requirements not to only well-timed diagnostics of RC, but to evaluation of its regional prevalence ratio mainly. The main objective of three-dimensional NLS-graphy of patients with renal cancer was in defining or specifying the main process stage and in some cases in invasion, presence of vascular affection symptoms and regional metastasis.

MATERIALS AND METHODS

We studied 335 patients suffering from renal cancer. In the structure of researched patients men prevailed men (57.6%) aged 61 – 70 (33%) and 71 – above 70 mm size. Symptoms of regional metastasis are systematized depending on a direction of primary tumor invasion, presence of vascular affection symptoms and regional metastasis.

RESULTS AND DISCUSSION

Criteria of NLS-evaluation of RC regional prevalence taking into account size of a tumor are systematized depending on a direction of primary tumor invasion, presence of vascular affection symptoms and regional metastasis.

RESULTS of NLS-study have proven that among symptoms of local distribution of RC the most frequent symptoms of invasion confirming extrarenal spread of primary tumor. In this category with almost the same frequency we registered symptoms related to invasion, presence of vascular affection symptoms and regional metastasis.

Criteria of NLS-evaluation of RC regional prevalence taking into account size of a tumor are systematized depending on a direction of primary tumor invasion, presence of vascular affection symptoms and regional metastasis.