COMPLEX ECHOGRAPHIC DIAGNOSIS OF SOFT TISSUE TUMORS

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Abstract. *Differential diagnosis of soft tissue neoplasms remains an urgent problem in oncology. From this position, we analyzed the possibilities of ultrasound tomography using Dopplerography in determining the criteria for the benign and malignancy of soft tissue neoplasms. Malignant tumors are characterized by either a multi-nodular formation, which can reach large sizes, irregular shape, with an asymmetrical outline, heterogeneous structure, with a reflection of reduced intensity and increased vascularization in it and high indices of peripheral resistance index. Benign neoplasms are characterized by the following signs: the presence of one node of small size (up to 3 cm), a regular rounded shape, with a clear outline.*

Keywords: *soft tissues, ultrasound, tumors, cancer.*

The problem of early diagnosis of tumors of the musculoskeletal system is still far from being solved. Traditional methods of examination, including a complex of various modifications of X-ray examinations, are associated with high radiation loads, high cost and are limited in their repeated use in terms of both diagnosis or evaluation of treatment results and subsequent dynamic follow-up for the purpose of early detection of disease recurrence. At the same time, already in the first reports on ultrasound examination (ultrasound) of soft tissues, it was noted that tomograms reveal details that are not determined by radiography.

Further studies have shown that the method of echography allows to determine the nature of the pathological process with high differential diagnostic accuracy, and the possibilities of ultrasound in detecting soft tissue tumors (STT) they're not only not less than, but in some cases exceed the sensitivity of the X-ray method, including CT [1,3,4].Doppler techniques open up completely new prospects in ultrasound diagnostics of volumetric soft tissue formations [5,6].

The publication was motivated by the aim to. Systematize data regarding the potential application of complex ultrasound tomography in the diagnosis of soft tissue neoplasm. Additionally, the goal was to figure out the informative value of the method in evaluating the effectiveness of therapy and early detention of relapses.

The purpose of the study. To improve the diagnosis of soft tissue tumors through the use of complex echo graphic studies.

Materials and methods of research. In order to clarify ultrasound semiotics, we analyzed the ultrasound results of 174 patients with soft tissue tumors observed from 2019 to 2023. In 126 (72%) patients, malignant neoplasms were detected, in 41 (24%) - benign tumors, in 7 (4%) - non-tumor changes. Modern ultrasound tomographs allow obtaining a detailed image of the tissues and structures of the musculoskeletal system. The use of multi-frequency sensors with the possibility of changing the operating scanning frequencies in the range from 5 to 13.5 MHz makes it possible to determine the presence of pathological changes in soft tissues - mainly when examining large arrays of soft tissues (hip, buttock area) and in overweight patients, convex transducer with low scanning frequencies (2-5 MHz) were used. As is known, the dimensions of the ultrasound image obtained are limited by the width of the sensor used. Therefore, with extensive changes, the

determination of the true boundaries of the tumor process, the ratio of the tumor to the surrounding areas with a length of up to 60 cm. The diagnostic search algorithm for ultrasound of the musculoskeletal system can be formulated quite briefly: a sequential study and analysis of the image from the skin level to the underlying bone structures in order to identify or exclude volumetric formation. When visualizing a volumetric formation, its localization is determined, its shape, size (in three mutually perpendicular planes) and the number of nodes, its outline, the internal structure and intensity of reflection of ultrasonic waves from it, the presence and thickness of the capsule. Be sure to fix the condition of the surrounding tissue neoplasm (edema, infiltration, thickening and / or violation of the integrity of the surface of bone structures) and, finally, study the degree of tumor vascularization and the condition of the main vessels (displacement, deformation, infiltration, the presence of blood clots).

To identify and assess the condition of the main vessels and the degree of vascularization of neoplasms, the energy Dopplerography mode was used. This technique is a modification of the color mapping mode differs from the original one in that it allows you to display a two-dimensional picture of the location and shape of vessels, highlighting them in one color against the background of a conventional image in B-mode. In this sense, it is close to the method of radiopaque angiography and allows you to observe vessels with low blood flow rates and small diameter. The method's benefits include a high frame rate, near total independence from the angle of Doppler scanning, enhanced sensitivity in comparison to other Doppler techniques, and the lack of uncertainty in spectrum measurement.

In order to determine the possibilities of Dopplerographic techniques in the diagnosis of malignant neoplasms of soft tissues and to identify the characteristics of the nature of blood flow, color and energy mapping techniques, as well as pulse-wave Dopplerography were used. The results of Dopplerography of 110 patients were analyzed. In 16 (13%) patients, the blood flow in the tumor was not visualized. Depending on the number of intra–tumor vessels, all observations were conditionally divided into the following groups: type I blood flow - with the presence of a single vessel; Type II blood flow – with the presence of 2 to 5 vessels, type III blood flow - with visualization of more than 5 vessels.

Results and discussion. When comparing the histological type of tumor and its size, it was found that synovial sarcoma was more often small (from 0 to 3 cm and from 3.1 to 6.0 cm). The largest number of patients with node sizes from 3.1 to 6.0 cm and more than 15.1 cm was traced in the group with liposarcoma. Patients with malignant fibrous histiocytoma (MFH) were found in all selected groups, but most often with tumor sizes from 6.1 to 9 cm and from 12.1 to 15 cm. A similar trend can be found in the analysis of other, rarer forms of soft tissue sarcomas. Given these data, it is impossible to distinguish any histological variant of the neoplasm by its size. However, malignant tumors of more than 9 cm are significantly more common ($p < 0.001$) .The majority of malignant tumors were represented by a single node -51.0% of patients. The multi-node structure of the neoplasm (3 or more nodes) was found in 35.0% of patients. Solid structure was more typical for such neoplasms as synovial sarcoma and rare sarcomas ($p <0.001$). MFH and liposarcomas represented the largest group in both single-node and multi-node variants of tumor development.

In this manner, malignant neoplasms of soft tissues are significantly more likely to have an irregular shape – 61% ($p < 0.05$), an irregular outline – 78% ($p < 0.01$), an inhomogeneous structure – 84% ($p < 0.01$) and are usually represented by a solid formation – 95% ($p < 0.01$), with a reduced intensity of reflection from the tumor – 75% ($p < 0.05$), the sign of clarity and indistinctness of the

contours of malignant neoplasms had no significant differences, since it occurred in almost the same number of cases – 56 and 44%, respectively. Solid-cystic or cystic structure is not characteristic of malignant soft tissue tumors and was determined only in 3% of patients with MFH and myogenic sarcoma.

Areas of increased intensity were observed in 17% of cases and during morphological examination corresponded to the growth of connective tissue. Calcification were represented by inclusions with an acoustic shadow and were visualized in 14% of observations. In most cases, when assessing the features of the ultrasound picture of various histological variants of malignant neoplasms of soft tissues, pathognomonic ultrasound signs were not detected. Only liposarcomas in 60% of the observations were characterized by an increased intensity of reflections from the structure of the formation.

By ultrasound tomography it is also possible to assess the prevalence of the tumor on the surrounding tissues, bones and the relationship to the main vessels. In our study, in 3 cases, ultrasound revealed the spread of soft tissue tumors to the bone, which was confirmed by morphological examination of postoperative material. In the distribution of patients, depending on the nature of vascularization, it was noted that a single tumor vessel was detected in 7.3% of cases. For most neoplasms, the image of 2 to 5 vessels was characteristic - 63.6%, visualization in the node of more than 5 vessels was noted in 29.1% of patients; type II blood flow was observed in all histological forms of tumors in the vast majority of cases - up to 100% in the group with neurogenic sarcomas; type III blood flow was detected in fewer cases, and its predominance in the group with lymphosarcoma is explained by the significant size of tumor nodes - from 9.1 to 12 cm. Significantly more often in patients with malignant soft tissue tumors, type II and III of blood flow were encountered ($p<0,001$). During pulse-wave Dopplerography, the velocity indices of blood flow and peripheral resistance indices were calculated and evaluated. In all histological types of tumors, there was a pronounced variation in absolute hemodynamic parameters. Therefore, it is not possible to identify the dependence of a certain histological variant on hemodynamic parameters. All malignant neoplasms were characterized by high numbers of peripheral resistance indices, which, apparently, can be explained by the peculiarity of the structure of tumor vessels, which are convoluted structures with multiple areas of stenosis and occlusion. Perhaps this explains the large variation in the absolute values of blood flow in the intracellular vessels, which does not contradict the literature data. It should be noted that the highest values of speed indicators were recorded in patients with neurogenic and angiogenic sarcomas - up to 68 and 60 cm/s, respectively.

When studying the ultrasound semiotics of benign soft tissue neoplasms in the In-mode, the results of the study of 41 patients were analyzed. It was revealed that benign neoplasms are more characterized by a relatively small size - up to 3 cm (34.3%), which was observed in neurofibroma, myxoma and giant cell tumors ($p <0,001$). Only desmoid and lipoma reached large sizes - 15 cm or more. The majority of patients with benign tumors were characterized by the presence of a single tumor node – 85.4%. The exception was patients with lipoma, where in one case 2 nodes were observed, and a multi-node form with the presence of three or more nodes was found only with desmoids.

When analyzing the data obtained, we noted a pattern of ultrasound signs characteristic of most benign tumors (excluding desmoid).

The diagnosis of soft tissue tumors causes certain difficulties and therefore requires special consideration with the analysis of errors and difficulties of the diagnostic process. Often, patients who have been diagnosed with a "soft tissue tumor" actually have a non-tumor disease. At the same time, there are quite a lot of pathological processes similar to soft tissue neoplasms. For this purpose, we initially identified the possibilities of ultrasound tomography in the visualization of soft tissue neoplasms with subsequent differential diagnosis of tumor and non-tumor changes.

The group of non-tumor diseases included patients with an inflammatory process (Myositis ossificans, ganglion cyst, villonodular tenosynovitis) and an organized hematoma. The inflammatory process is characterized by the absence of a tumor node, swelling of soft tissues and increased vascularization on ultrasound tomograms. Myositis ossificans, was a site of chronic inflammation of irregular shape, heterogeneous structure with areas of increased intensity and single vessels. Ganglion cyst was defined as a cystic formation with heterogeneous contents, partitions and single vessels in the capsule.

Villonodular tenosynovitis is classified as “non-tumor or doubtfully tumor processes resembling true neoplasms” (WHO). The process often affects large joints and, when morphologically examined, is characterized by a pronounced thickening of the synovial membrane of the joint with nodular and villous growths. On ultrasound tomograms, it is visualized in the form of a solid irregular formation with an uneven contour and an inhomogeneous structure, located in the joint area with a single vessel along the periphery. The organized hematoma on ultrasound tomograms was a rounded formation with a clear, even contour, an inhomogeneous cellular structure and the absence of blood flow in it. Its echogenicity depended on the duration of its existence and the appearance of fibrous and calcified inclusions in it. Of the patients who were examined for soft tissue diseases, in 98% of cases, the volume formation and its tumor and non-tumor affiliation were correctly determined. At the same time, true positive cases were recorded in 96%, and true negative ones – in 2% of cases, when a conclusion was made about non-tumor changes. Patients with non-tumor soft tissue changes (Myositis ossificans, ganglion cyst and villonodular tenosynovitis) were given erroneous conclusions (2%), who were included in the group with false positive results.

Analyzing the errors of the ultrasound results, it should be explained by their combination of atypical ultrasound signs – the presence of irregular nodular formation, heterogeneous structure and visualization of vessels in it, which is characteristic of the tumor process. False negative conclusions were not expressed in any case. Thus, the sensitivity of ultrasound tomography in the diagnosis of soft tissue neoplasms was 100%, specificity – 57%, and accuracy -98%.

Using the described complexes of ultrasound signs, 85% of patients with benign and malignant neoplasms gave the correct conclusion. False positive cases were identified in patients with a newly diagnosed diagnosis of soft tissue desmoid due to the similarity of the ultrasound pattern inherent in malignant neoplasms. False negative data were obtained in observations when small formations of regular rounded or oval shape, with a smooth contour and homogeneous structure, with no blood flow were determined. The presented picture was interpreted as benign, but morphological verification revealed the malignant nature of these tumors. The indicators of diagnostic informativeness of ultrasound tomography in the diagnosis of malignant soft tissue tumors were: sensitivity - 92%, specificity - 65%, accuracy - 85%

Conclusions. Complex ultrasound examination is a highly informative diagnostic method in patients with formations in the soft tissues of the neck, trunk and extremities. It allows not only

to identify a tumor node, assess its size, localization, relationship with surrounding structures, but also, when using Dopplerography and elastography, to speak with a high degree of probability about the benign or malignant nature of growth, and in some cases, to approach the morphological characteristics of the neoplasm. Reduced echogenicity of the tumor, false capsule, inhomogeneity of the echostructure, irregular bumpy borders, intensive blood supply, high coefficient of stiffness during elastography, deep location, in our opinion, can be regarded as signs pathognomonic specifically for malignant non-organ neoplasms of soft tissues.

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