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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

THE ROLE OF THE MAGNETIC RESONANCE IMAGING IN THE COMPLEX DIAGNOSIS OF PRIMARY MALIGNANT MUSCULOSKELETAL TUMORS

Specialty: 3225.01 – Radiological diagnosis and therapy
3224.01 – Oncology

Field of science: Medicine

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GENERAL CHARACTERISTICS OF THE RESEARCH

Relevance and degree of completion of the topic. The share of malignant musculoskeletal tumors in the overall structure of oncological diseases is characterized by low values. Thus, about 1-2% of cases of malignant tumors are bone sarcomas (BS), and 0.7-1% are soft tissue sarcomas (STS). There is no significant difference in the incidence of these pathologies in different countries and regions of the world, and the incidence rate per 100,000 in the population is low, ranging from 1 to 3 [1, 2,3].

It should be noted that though there has been a significant improvement in the diagnosis and treatment of these pathologies with the use of modern and highly informative diagnostic methods, as well as the use of effective chemotherapy regimens and preventive treatments in recent decades, BS and STS remain some of the most complex and relevant areas of the clinical oncology due to their clinical features, aggressive course, and early metastasis and also in terms of diagnosis and treatment [4,5,6].

A diagnostic error occurs in 60-85% of cases in the early stages of BS[7]. The detection of BS and STS, the investigation of more optimal diagnostic methods to determine the prevalence of the tumor

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[1] Qazıyev, A.Y. Azərbaycanda bədxassəli şişlərin epidemiologiyası, tibbi, demoqrafik və sosial-iqtisadi aspektləri: / – tibb elmləri doktoru dis. avtoreferatı. / – Bakı, 2005. - 39 s.

[2] Алиев, Д.А. Заболеваемость злокачественными новообразованиями в Азербайджанской республике в 2016 году / Д.А.Алиев, Ф.А.Марданлы, Р.А. Гусейнова [и др.] // Azərbaycan Onkologiya Jurnalı, – Bakı. – 2017. № 2, – s. 66-69.

[3] Siegel, R. Cancer statistics, 2017 / R. Siegel, K. Miller, A. Jemal // A Cancer Journal for Clinicians, – New York: – 2017. Vol. 67(1), – p. 7-30.

[4] Петрова, Г.В. Злокачественные новообразования костей и суставных хрящей в России / Г.В.Петрова, В.В.Старинский, О.П.Грецова // Онкология. Журнал им. П.А. Герцена, – Москва: – 2017. – № 6, – с. 49-52.

[5] George, A. Early symptoms of bone and soft tissue sarcomas: could they be diagnosed earlier? / A. George, R. Grimer // The Annals of The Royal College of Surgeons of England, – London: – 2012. Vol. 94(4), – p.261-266.

[6] Grimer, J. Earlier diagnosis of bone and soft-tissue tumours / J. Grimer, T. Briggs // Journal of Bone and Joint Surgery, – Needham: – 2010. Vol. 92, – p. 1489-1492.

[7] Əmiraslanov, Ə.T.Sümük şişləri. / Ə.T.Əmiraslanov, A.Y.Qazıyev. – Bakı: Təbib, "Azərbaycan Ensiklopediyası" NPB, – 1997. – 480 s.

process, the expansion and systematization of the existing methods, as well as the detection of specific radiation diagnostic semiotics of various forms of malignant tumors of bone and soft tissues have great importance [8,9,10,11].

Based on the above, it can be noted that the optimization of the diagnosis of bone and soft tissue malignancies, the study of the role and opportunities of this or another examination method in the complex diagnosis, and the choice of informative examination methods are of great importance in modern clinical oncology, and the solution of this task requires the expansion of relevant scientific research.

Due to the widespread use of diagnostic radiology methods in the diagnosis of musculoskeletal tumors, including radiography (RG), computed tomography (CT), ultrasound (US), and magnetic resonance imaging (MRI), this direction is always at the center of attention as a priority. Although a lot of research has been conducted in this area, there are not enough studies in the field of complex diagnostics to determine the role and opportunities of this or another method of examination, especially MRI. Therefore, the study of MRI signs of bone and soft tissue tumors and the role and opportunities of MRI in the complex diagnosis of these pathologies was considered relevant by us and provided the basis for the current study.

The object and subject of the research. The objects of the research were 165 patients with malignant and benign tumors and tumor-like lesions of the musculoskeletal system (bone and soft tissues),

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[8] Семенов, И.И. Методы диагностики и оценки степени распространения процесса при саркомах мягких тканей / И.И.Семенов, А.Н.Зайцев, П.И.Крживицкий [и др.] // Практическая онкология, – Санкт-Петербург: – 2013. Т.14, № 2, – с. 87–96.

[9] Тепляков, В.В. Ошибки в диагностике и лечении сарком мягких тканей / В.В.Тепляков, А.В.Бухаров, А.Н.Урлова [и др.] // Саркомы костей, мягких тканей и опухоли кожи, – Москва: – 2012. № 1, – с. 29–35.

[10] Colleen, M. FDG PET/CT of primary bone tumors / M.Colleen, H.Hubert, E. John // American Journal of Roentgenology, – Leesburg: – 2014. Vol. 202(6), – p. 521-531.

[11] Yücetürk, G. Prevalence of bone and soft tissue tumors / G.Yücetürk, D.Sabah, B.Keçeci [et al.] // Acta Orthopaedica Traumatologica Turcica, – İstanbul: – 2011. Vol.45 (3), – p.135-143.

and the subject of the research was the analysis of the results of clinical, morphological, and radiology exams (RG, CT, ultrasound, MRI) in patients with malignant and benign tumors, and tumor-like lesions of the musculoskeletal system, and the characteristics of the signals obtained in different regimes of MRI semiotics and MRI.

The purpose and tasks of the research. The main goal was to study the role and opportunities of MRI in the complex diagnosis (clinical, radiological, morphological) of primary malignant musculoskeletal tumors.

To achieve the solution of the issues envisaged in the research work, the following main tasks were set:

1. Clinical and pathomorphological characterization of the primary malignant musculoskeletal tumors;
2. Characterization and comparative evaluation of the signals obtained in different regimes of MRI semiotics and MRI, depending on the location of the tumor in primary malignant musculoskeletal tumors;
3. Study of the correlation between the results of MRI and other radiation diagnostic methods on the same symptoms in the diagnostic semiotics of primary malignant tumors of the musculoskeletal system and between different symptoms in the MRI semiotics;
4. Characterization of complex radio-diagnostic semiotics of primary malignant tumors of the musculoskeletal system; based on the determination and comparative evaluation of diagnostic parameters of various radiological diagnostic methods, determination of MRI informatics and its place in the diagnostic algorithm;
5. Comparative assessment of the possibility of using MRI, CT, and ultrasound in the complex radiation diagnosis of soft tissue sarcomas;
6. Study of MRI semiotics of soft tissue sarcomas depending on the histological type of tumor, comparative characterization of signals obtained in different regimes of MRI and informativeness of MRI.

Research methods. Outpatient cards, medical histories, results of the clinical examination, RG, CT, ultrasound, MRI, and morphological examinations of the patients were analyzed in the research work. MRI scans were performed with "Philips Achieva 1.5T", and "Philips Ingenia 1.5T" devices. A computer-electronic database of the obtained results was created, calculations were made in EXCEL-2013 spreadsheet and SPSS-20 Software package.

Main points presented to the defense of the dissertation:

1. Features of the magnetic resonance imaging semiotics of primary malignant musculoskeletal tumors, and diagnostic value of the symptoms depend on the location of the tumor (in bone and soft tissue).

2. Differentiation of the diagnostic indicators of diagnostic radiology methods in the case of different localizations of primary malignant musculoskeletal tumors requires a differentiated approach to the selection and application sequence of one or another examination method in the diagnostic process.

3. The main role in the diagnostic algorithm of soft tissue sarcomas belongs to MRI. Thus, MRI has higher informativeness in the diagnosis of these localized tumors compared to other radiological methods. If there are contraindications to MRI, ultrasound may be sufficient for local imaging of the tumor.

Scientific novelty of the research. In primary malignant tumors of the musculoskeletal system, depending on the location of the tumor in the bone and soft tissue, the signals obtained in different MRI modes were characterized and compared between malignant and benign tumors. In the radiation diagnostic semiotics of primary malignant musculoskeletal tumors, the correlation between the results of MRI, and other diagnostic radiology methods based on the same signs was studied. The correlation between various signs in the MRI semiotics of primary malignant musculoskeletal tumors was studied. Based on the study and comparative evaluation of the diagnostic parameters of diagnostic radiology methods (RG, CT, US, MRI) depending on the localization and histological form of the neoplasm in primary malignant musculoskeletal tumors, the role of MRI in the complex diagnosis of these tumors was determined and the possibilities of its application were studied.

Theoretical and practical significance of the research. The study of the role of MRI in the complex diagnosis of primary malignant musculoskeletal tumors allowed determining the indications for the use of this exam method, depending on the localization of the tumor in bone and soft tissue. MRI allows describing the tumor locally, clarifying whether the tumor spreads to surrounding structures and adjacent joints, assessing the condition of regional lymph nodes, give a broad description of the malignant tumor process. The research showed that MRI significantly outperformed CT, and ultrasound due to its diagnostic informativeness in soft tissue sarcomas, which also necessitates the widespread use of MRI in these localized tumors. All above mentioned necessitates the use of MRI in the differential diagnosis of these localized sarcomas, as well as in the selection of the volume of planned surgery and evaluation of the effectiveness of treatment.

Approbation of the research. The main materials and results of the dissertation were reported and discussed at the international scientific-practical conference “Actual problems of medicine 2019" dedicated to the 100th anniversary of the establishment of the Faculty of Medicine at Baku State University (Baku, April 2019), at the international scientific-practical congress “Actual problems of medicine-2021” dedicated to the 100th anniversary of the honored scientist, professor Tamerlan Aziz Aliyev (Baku, October 2021), at the joint interdepartmental meeting of the staff of the Departments of Oncology, Radiation Diagnostics and Radiation Therapy, Cytology, Embryology and Histology, III Surgical Diseases, and Oncology Clinic of Azerbaijan Medical University on December 29, 2021, at the joint meeting of the Dissertation Council FD 1.02 under the National Oncology Center, the scientific seminars on 3225.01 - "Radiation Diagnosis and Therapy" and 3224.01 - "Oncology" on May 11, 2022 (Protocol № 1).

Application of the obtained results. The results of the research are applied in the practical activities of the Public legal entity of Nakhchivan Diagnostic and Treatment Center and are used in the teaching process of the Department of Radiation therapy and diagnostics of AMU.

Name of the organization where the dissertation was performed. The research was performed at the Oncology Department of the Azerbaijan Medical University.

Publications. 16 scientific works including 7 articles, and 9 theses on the topic of the dissertation, were published.

Total volume and structure of the dissertation. Dissertation consists of an introduction (10.557 characters), literature review (54.207 characters), materials and methods (11.990 characters), 3 chapters covering personal research (32.092 + 56.224 + 19.563 characters), chapter of discussion of obtained results (18.647 characters), conclusions, practical recommendations (4.657 characters), and reference list. The dissertation is illustrated with 19 tables, 48 figures, and 13 graphs. The reference list consists of 161 sources. The total volume of the dissertation consists of 184 pages and 207.937 characters with computer typing.

MATERIALS AND METHODS OF THE RESEARCH

The current research included materials of 165 patients with malignant and benign tumors and tumor-like lesions of musculoskeletal systems (bone and soft tissues) examined and treated at the Oncology Clinic of the Azerbaijan Medical University. Diagnostic radiology exams, including MRI, were performed in some patients at the Radiation diagnostics department of Nakhchivan Autonomous Republic Hospital. The research was conducted both retrospectively and prospectively.

Patients were divided into 2 groups with bone (92 patients - 55.7%) and soft tissue (73 patients - 44.3%) pathologies. Both groups were also subdivided into main (bone sarcomas and soft tissue sarcomas), and comparison groups (benign bone tumors and tumor-like neoplasms, benign soft tissue tumors).

Clinical examination, RG, CT, US, MRI, as well as morphological examinations were performed in the research.

Anamnestic data collected from patients involved in the research, as well as clinical signs according to the characteristics of pain and palpable tumor, were analyzed.

RG was performed in 124 (75.2±3.4%), CT in 78 (47.3±3.9%), MRI in 85 (51.5±3.9), and US in 73 (44.2±3.9%) patients.

RG examinations were carried out by digital RG-diagnostic devices "Medical Econet", and FLEXAVISION SHIMADZU equipped with digital device "AQFA CR-25.0". RG was performed in straight, lateral and oblique standard projections. RG examination revealed a pathological focus, analyzed the characteristics of the tumor, including the location of the tumor, the number of tumor foci, tumor shape, contour, periosteal reaction, changes in the surrounding tissue, the condition of the bone marrow.

CT was performed on "Toshiba Asteion" with a thickness of 2-8 mm (thickness between 2-4 mm if necessary), with 20-35 incisions. The shape, size, condition, structure of neoplasm, condition of the surrounding tissues were assessed by Computed tomography examination, and the density was determined with the use of Haunsfield unit (HU).

Ultrasound scan was performed using "Medison", "SDR-1550 Philips" and "Toshiba" universal echo scanners. This method was used in the examination of soft tissues. Through this examination, the size, shape, contour, structure of the pathological process were studied, and the nature of the neoplasm was determined by assessing the echogenicity. The condition of regional lymph nodes was also assessed using ultrasound.

MRI examinations were performed with PhilipsAchieva 1.5T", and "Philips Ingenia 1.5T". Axial, coronal, sagittal T1, T2, STIR, PD regimes of tumor localization were applied with and without contrast in the examination.

The number of tumor foci, tumor shape, size, contour, border, structure, and condition of the surrounding tissues were analyzed by MRI.

Morphological examinations were performed in the research. The following methods were used for staining incisions: hematoxylin-eosin, using the Van Gieson's method, hematoxylin-picrofuxin, methyl blue eosin, buffered 0.05%-litionine, toluidine blue.

Examination of micropreparations was carried out under the microscope Motic (Germany), appropriate analysis and differential diagnosis were performed.

The values obtained as a result of the study were processed in the EXCEL-2010 spreadsheet and SPSS-20 package program using the analysis methods of variation (average indicators), discriminant (Pearson Chi-Square, diagnostic tests), and correlation (ρ-Spearman).

RESULTS AND DISCUSSION OF THE RESEARCH

The following objective clinical signs of primary malignant musculoskeletal tumors manifested the highest diagnostic value: in BS – painful palpable tumor (incidence frequency in the main and comparison groups was 42.4% and 3.8%, respectively; χ^2 = 14.27; p = 0.001), rough surface of the tumor (72.7% and 23.1%; χ^2=19.74; p<0.001), irregular shape (71.2% and 19.2%; χ^2=21.175; p<0.001), precise contours (72.7% and 46.2%; χ^2=6.824; p=0.033), impaired peripheral function (62.1% and 7.7%; χ^2=20.06; p<0.001); in STS – painful palpable tumor (40.7% and 10.5%; χ^2=6.027; p=0.049), limited mobility of tumor (74.1% and 31.6%; χ^2=18.96; p<0.001), solid-elastic consistency (64.8% and 47.4%; χ^2=19.678; p=0.001), rough surface (72.2% and 26.3%; χ^2=13.68; p=0.001), imprecise contours (77.8% and 21.1%; χ^2=21.68; p<0.001).

Macroscopic and microscopic analysis of pathological materials was performed in the patients involved in the research, a histological form of tumor lesion was determined and the diagnosis was confirmed histologically. The patients were divided into 4 groups. I group included (BS – main group) 21 patients with osteosarcoma (12.7%), 2 patients with parosteal osteosarcoma (1.2%), 16 patients with giant cell tumors (9.7%), 7 patients with Ewing's sarcoma (4.2%), 4 patients with Primitive neuroectodermal tumors (PNET) of bone (2.4%), 3 patients with malignant bone lymphoma (1.8%), 8 patients with chondrosarcoma (4.8%), 5 patients with malignant fibrous histiocytoma (MFH) of bone (3.0%); II group included (benign bone tumors and tumor-like neoplasms – comparison group) 6 patients with osteoid-osteoma (3.6%), 6 with bone cysts (3.6%), 1 with chondromyxoid fibroma (0.6%), 10 with osteochondroma (6.1%), 3 with fibrous dysplasia (1.8%); III group included (STS – main group) 28 patients with MFH of soft tissue (17%), 11 with synovial sarcoma

(6.7%), 4 with liposarcoma (2.4%), 5 with rhabdomyosarcoma (3.0%), 6 patients with other malignant mesenchymal tumors (3.6%); IV group included (benign soft tissue tumors - comparison group) 4 patients with hemangioma (2.4%), 3 with fibromatous (1.8%), 1 with elastofibroma (0.6%), 8 with lipoma (4.8%), 3 with schwannoma (1.8%).

Radiological diagnostic semiotics was studied and the results were analyzed by conducting diagnostic radiology examinations in the patients included in the research. An ultrasound scan was applied to all patients with soft tissue pathology. The echogenicity of malignant tumors was usually low (hypoechogenic - 53.7 ± 6.8% of cases) or mixed (25.9 ± 6% of cases), rarely anechogenic (16.7 ± 5.1%), rarely hyperechogenic (1.9 ± 1.8%) and isoechogenic (1.9 ± 1.8%); In benign processes, 63.2 ± 11.1% of cases were hypoechogenic, 5.3 ± 5.1% were mixed echogenicity, 10.5 ± 7.0% were anechogenic, 15.8 ± 8.4% were hyperechogenic, 5.3 ± 5.1% were isoechogenic, no statistically significant difference was obtained between the groups (p=0.059). Signs of intensification of vascular imaging in the pathological focus were observed in 16.7 ± 5.1% of patients with STS, and in 10.5% ± 7.0% of patients belonging to the comparison group (p = 0.787).

MRI was performed in 26 patients with BS included in the research (39.4±6%), 11 patients belonging to the comparison group of bone pathology (42.3 ± 9.7%), 39 patients with STS (72.2 ± 6.1%), 9 patients belonging to the comparison group of soft tissue pathology (47.4 ± 11.5%).

Comparative characterization of MRI semiotics of the patient groups included in the research was performed and the following results were obtained.

The pathological process was detected in the form of multiple foci in only 1 patient with BS (3.8 ± 3.8%), 2 patients with STS (5.1 ± 3.5%), 2 patients from the comparison group (22.2 ± 13.9%). Thus, there was no statistically significant difference between the groups in this indicator in both bone pathologies (p = 0.510) and soft tissue pathologies (p = 0.094).

The size of BS fluctuated between 2.6-20 cm (average size - 9.2

cm), and the size of the STS fluctuated between 2.5 and 31.5 cm (average size - 7.82 ± 0.79 cm).

In 2 patients with BS (7.7 ± 5.2%) the contour of the pathological focus was smooth and in 24 (92.3 ± 5.2%) patients, it was rough; in the comparison group-smooth in 7 patients (63.6 ± 14.5%), rough in 4 patients (36.4 ± 14.5%) (χ^2 = 13,142; p <0.001); It was smooth in 12 patients with STS (30.8 ± 7.4%), rough in 25 (64.1 ± 7.7%); in the comparison group-smooth in 3 patients (33.3 ± 15.7%) and rough in 6 patients (66.7 ± 15.7%) (χ^2 = 0.484; p = 0.785). The contour of the pathological focus was divided into precise and imprecise. These signs were observed in 11 (42.3±9.7%) and 15 patients (57.7 ± 9.7%) with BS, in 9 (81.8±11.6%) and 2 patients (18.2±11.6%) (χ^2=4.859; p=0.028) in the comparison group, 33 (84.6 ± 5.8%) and 6 patients (15.4 ± 5.8%) with STS, 6 (66.7 ± 15.7%) and 3 patients (33.3 ± 15.7%) in the comparison group (χ^2 = 1.546; p = 0.214), respectively.

The shape of the pathological focus was observed oval or round in 4 patients with BS (15.4 ± 7.1%), irregular in 22 (84.6 ± 7.1%); in the comparison group, it was oval or round in 8 patients (72.7 ±13.4%), irregular in 3 patients (27.3 ± 13.4%) (χ^2 = 11,599; p = 0.001); oval or round in 17 patients with STS (43.6 ± 7, 9%), irregular in 17 (43.6 ± 7.9%), multilobular in 5 (12.8 ± 5.4%); in the comparison group, it was oval or round in 4 patients (44.4 ± 16.6), irregular in 3 patients (33.3 ± 15.7%), multilobular in 2 patients (22.2 ± 13.9%) (χ^2 = 0.629; p = 0.730).

The structure of the tumor detected on MRI (with T2 signal intensity) was heterogeneous in the majority of patients, both in BS (19 patients - 73.1 ± 8.7%) and STS (24 patients - 61.5 ± 7.8%). In the comparison groups, the incidence frequency of homogeneous and heterogeneous tumors was close; Thus, in the comparison group of bone pathologies, these indicators were 6 (54.5 ± 15%), and 5 (45.5 ± 15%), respectively, and in the comparison group of soft tissue pathologies, they were 4 (44.4 ± 6.6%), and 5 (55.6 ± 6.6%), respectively. However, no statistically significant differences were observed between the groups on bone pathologies (p = 0.108) or soft tissue pathologies (p = 0.741).

Changes in tumor structure (with T2 signal intensity) were also grouped according to necrotic process monitoring. In patients with BS, changes with necrosis were observed in 10 (38.5±9.5%), without necrosis in 7 (26.9±8.7%), mixed changes in 9 (34.6±9.3%) patients; in the comparison group, changes were observed with necrosis in 5 patients (45.5±15%), without necrosis in 6 patients, mixed changes were not observed; In STS patients, the changes with necrosis were found in 7 patients (17.9 ± 6.1%), without necrosis in 13 (33.3 ± 7.5%), mixed type changes in 19 (48.7 ± 8%) patients; in the comparison group, changes with necrosis were detected in 1 patient (11.1 ± 10.5%), without necrosis in 6 (66.7 ± 15.7%), and mixed type changes in 2 patients (22.2 ± 13.9%).

There was an intensification of vascular imaging in the pathological focus in 9 patients with STS (23.1 ± 6.7%), and in 2 patients in the comparison group (22.2 ± 13.9%).

The periosteal reaction was found in 16 patients with BS (61.5 ± 9.5%), changes in the cortical layer in 19 (73.1 ± 8.7%), changes in the bone marrow in 11 (42.3 ± 9.7%), and pathological fractures were observed in 8 (30.8 ± 9.1%) patients. In the comparison group, these indicators were: 3 patients - 27.3 ± 13.4%, 9 patients - 81.8 ± 11.6%, 3 patients - 27.3 ± 13.4%, respectively, and no pathological fracture was revealed.

In BS, the soft tissue component of the pathological process was found in 18 patients (69.2 ± 9.1%), and in 1 patient (9.1 ± 8.7%) in the comparison group ($\chi^2 = 11.191$; p=0.001). In STS, the invasion of the pathological process to the bone was found in 10 patients (25.6 ± 7.0%) but this was not observed in the comparison group.

In BS and STS, the invasion to the adjacent joint was observed in 7 (26.9±8.7%) and 4 patients (10.3±4.9%), respectively; Regional lymph node enlargement was observed in 7 (26.9±8.7%), and 11 patients (28.2±7.2%), neurovascular compression in 4 (15.4±7.1%) and 4 patients (10.3±4.9%), and invasion to the neurovascular bundle was revealed in only 1 patient with BS (3.8±3.8%).

No significant difference was found (p>0.05) between bone sarcomas (96.2 ± 3.8% hypointense in T1, 92.3 ± 5.2% hyperintense in T2 and proton density regimes) and the comparison group (90.9 ±

8.7% hypointense in T1, 81.8 ± 11.6% hyperintense in T2, and proton density (PD) regimes) according to the signals obtained in different MRI regimes. However, the results obtained in the soft tissue sarcomas (97.4 ± 2.5% hypointense in T1, 74.4 ± 7.0% hyperintense in T2, 15.4 ± 5.8% hypointense and 79.5 ± 6.5% hyperintense in PD regime), and in the comparison group, (11.1 ± 10.5% hypointense in T1, 55.6 ± 16.6% hyperintense, and 44.4 ± 16.6% hypointense in T2, and 55.6 ± 16.6% hypointense and 44.4 ± 16.6% hyperintense in PD regime) differed statistically in T1 (χ^2=37.228; p<0.001) and proton density regimes (χ^2=6.842; p=0.033) (Table1)

Table 1

Comparison of the signal intensity obtained in different regimes of MRI between patient groups

Characteristics of signs		Bone tissue			Soft tissue		
		Main group	Comparison group	χ^2; p	Main group	Comparison group	χ^2; p
T1 weighted image	Hypointense	25 96.2%	10 90.9%	χ^2=0.416; p=0.519	38 97.4%	1 11.1%	χ^2=37.228; p<0.001
	Isointense	1 3.8%	1 9.1%		1 2.6%	2 22.2%	
	Hyperintense	–	–		–	6 66.7%	
T2 weighted image	Hypointense	2 7.7%	2 18.2%	χ^2=0.882; p=0.348	8 20.5%	4 44.4%	χ^2=2.502; p=0.286
	Isointense	–	–		2 5.1%	–	
	Hyperintense	24 92.3%	9 81.8%		29 74.4%	5 55.6%	
Proton-density weighted image	Hypointense	2 7.7%	2 18.2%	χ^2=0.882; p=0.348	6 15.4%	5 55.6%	χ^2=6.842; p=0.033
	Isointense	–	–		2 5.1%	–	
	Hyperintense	24 92.3%	9 81.8%		31 79.5%	4 44.4%	

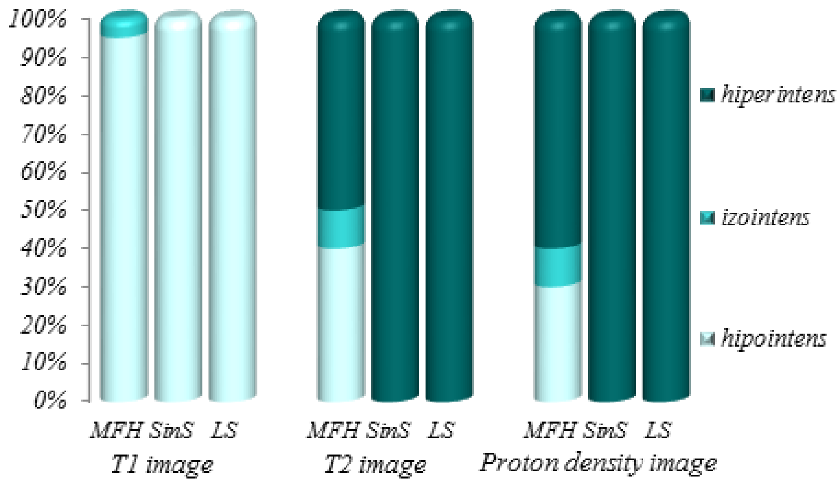
The following results were obtained in the comparative characterization of MRI semiotics of different histological types of tumors in BS and STS.

In osteogenic sarcoma, the hypointense signal was obtained from neoplasm in the majority of patients in T1 weighted image (85.7 ± 13.2%), and the hyperintense signal was found in all patients in T2 weighted and PD weighted images.

The hypointense signal was obtained in all patients with giant cell tumors in T1 image, the hyperintense signal was obtained in most patients (77.8 ± 13.9%) in T2, and PD weighted images.

In malignant tumors of the bone marrow (Ewing's sarcoma, PNET, malignant bone lymphoma), the hypointense signal was seen in all patients in T1 weighted image, and the hyperintense signal was obtained in T2, and PD weighted images.

In MFH of soft tissue, hyposignal was obtained in the majority of patients (95.0 ± 4.9%), in T1, T2 (hypointense - 40.0 ± 11.0%, hyperintense - 50.0 ± 11.2%), and PD images (hypointense - 30.0 ± 10.2%, hyperintense - 60.0 ± 11.0%), the results were similar. In synovial sarcoma and liposarcoma, hypointense in T1, and hyperintense in T2, and PD images were found in all patients (100%) (graph 1).



Note: MFH – malignant fibrous histiocytoma;
SinS – synovial sarcoma; LS - liposarcoma

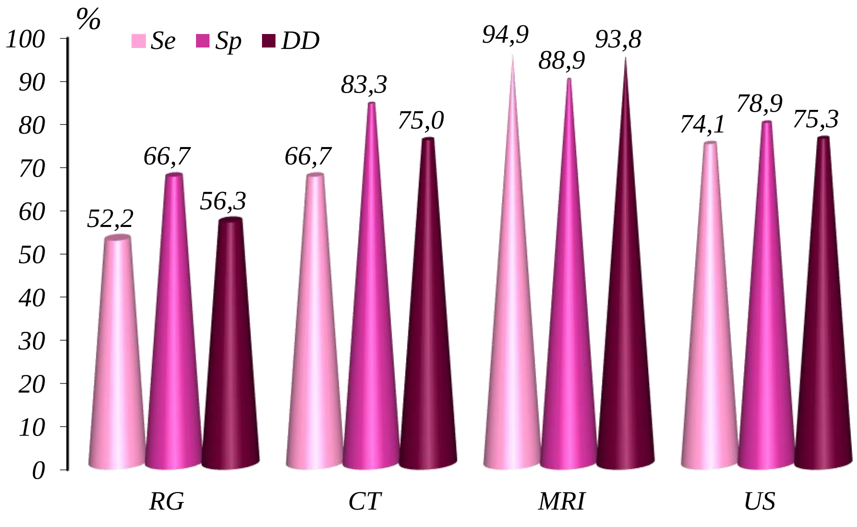
Graph 1. Comparative characteristics of MRI semiotics of different histological forms of soft tissue malignant tumors

Contrast examination was performed in some patients. Heterogeneous contrast was observed in 4 patients with BS (66.7 ± 19.2%), 3 patients belonging to the comparison group of bone pathology (60 ± 21.9%), 5 patients with STS (83.3 ± 15.2%), and 100% in both patients belonging to the comparison group of soft tissue pathology, to whom this method was applied.

In BS and STS, the interrelation between observed features of neoplasm was determined on MRI and the correlation coefficient was calculated. In BS, an MRI examination revealed a direct correlation between the size of neoplasm and its rough contour ($r=0.573$, $p<0.01$), irregular shape ($r=0.601$, $p<.01$), heterogeneous structure ($r=0.366$, $p<0.05$), periosteal reaction ($r=0.448$, $p<0.01$), changes in cortical layer ($r=0.367$, $p<0.05$), pathological fractures ($r=0.351$, $p<0.05$), soft tissue component ($r=0.464$, $p<0.01$), the tracking frequency of changes ($r=0.388$, $p<0.05$) in regional lymph nodes. This pattern showed that as the tumor grew in size, the symptoms became more pronounced.

In the study of the correlation between the results of MRI, and other diagnostic radiology methods on the same signs in the characterization of the radiological diagnostic semiotics of primary malignant musculoskeletal tumors, a direct correlation was observed on several identical signs. Thus, the mentioned method is compatible with CT in the characterization of radiological diagnostic signs such as the size of bone sarcomas ($r = 0.982$, $p <0.01$), their contour ($r=1.000$, $p<0.001$), shape ($r=1.000$, $p<0.001$), structure ($r=0.809$, $p<0.01$), occurrence of periosteal reactions ($r = 0.899$, $p <0.01$), and the method is compatible with ultrasound scan in the characterization of radiological diagnostic signs such as the size of soft tissue sarcomas ($r=0.879$, $p<0.01$), their contour ($r=0.754$, $p<0.01$), shape ($r=0.840$, $p<0.01$), structure ($r=0.517$, $p<0.01$), the change in vascular image ($r=0.627$, $p<0.01$).

Diagnostic indicators were calculated based on the results of the histological examination to confirm or deny the diagnoses made by means of examination methods, their informativeness was determined and compared. The efficiency of RG for BS (based on diagnostic accuracy) was 65.2±5.0%, CT - 90.9±3.5%, MRI - 81.1±6.4%. The efficiency of RG for STS was 56.3±8.8%, CT- 75.0±12.1%, ultrasound - 75.3±5.0%, MRI-93.8±3.5%. We should note that the diagnostic indicators of MRI for STS (94.9±3.1% (Se), 88.9±10.5% (Sp), 93.8±3.5% (DA)) prevailed the obtained indicators from CT (66.7±19.2% (Se), 83.3±15.2% (Sp), 75.0±12.1% (DA)), and ultrasound (74.1±6.0% (Se), 78.9±9.4% (Sp), 75.3±5.0% (DA)) by a large margin. In this case, the diagnostic accuracy of CT and ultrasound was approximately the same. Thus, the informativeness of MRI in STS outperformed the other examinations by a large margin. Although CT (DA – 90.9 ± 3.5%) was more informative than MRI (DA – 81.1 ± 6.4%) in the diagnosis of BS, the difference between the diagnostic parameters of these methods was less than the observed difference in the diagnosis of STS (graph 2).



Graph 2. Diagnostic indicators of radiation examination methods in the diagnosis of soft tissue sarcomas

The following results were obtained from the analysis of diagnostic indicators of MRI examination of individual histological forms of STS: MRI sensitivity (Se) was 85.0 ± 8.0%, specificity (Sp) was 92.9 ± 4.9%, and diagnostic accuracy (DA) was 89.6 ± 4.4% in MFH. In synovial sarcoma these indicators were 50.0 ± 17.7% (Se), 87.5 ± 5.2% (Sp), 81.3 ± 5.6% (DA), and in liposarcoma 100.0% (Se), 95.6 ± 3.1% (Sp), 95.8 ± 2.8% (DA), respectively. As seen, the highest diagnostic accuracy (DA) was recorded in the liposarcomas.

A diagnostic algorithm was built based on the results obtained after calculating all the diagnostic parameters of radiation examination methods for both bone and soft tissue.

RG is a diagnostic radiology method that should be used first in the diagnosis of BS and is a guide to select the subsequent methods. Thus, this method is fast, simple, and cost-effective, and is of particular importance for the identification of the first symptoms in the analysis of musculoskeletal tumors, and, consequently, the choice of subsequent tactics. CT scan should be used in the next step.

As an alternative to CT, MRI should be used to determine the tumor invasion to the adjacent joint and the compression to the neurovascular bundle in BS. This situation is of particular practical importance, especially when it is impossible to clarify the relationship of the tumor to the surrounding structures through CT. MRI is also important in BS to assess the structure of the soft tissue component of the tumor and the condition of the surrounding soft tissues, as well as to detect the invasion of the tumor into the bone marrow and to determine the stage of the disease.

It is not possible to get detailed information during the use of RG in the diagnosis of soft tissue tumors. The results of our research show that the radiological image of soft tissue tumors is not typical. Only a few, mostly clinical symptoms give reason to suspect soft tissue sarcoma. Soft tissue tumors are difficult to differentiate by RG because they have a similar density to the muscle.

In patients with suspected soft tissue tumors, ultrasound should be the first choice. At a later stage, MRI should be applied. According to the results of our research, most STSs are hypointense in T1 image, hyperintense in T2, and PD images on MRI. As the diagnostic accuracy of USM and CT in the diagnostics of STS is approximately the same, if there are any contraindications to MRI, it is advisable to perform local imaging of the tumor, as well as solid-cystic differentiation with ultrasound as an easy and cost-effective method.

Using the diagnostic algorithm of primary malignant musculoskeletal tumors allows predicting the clinical and morphological features of the tumor, which is important for solving the problem of planning the choice of treatment tactics.

CONCLUSIONS

1. High diagnostic values of objective clinical signs of primary malignant musculoskeletal tumors are the followings: in BS - painful palpable tumor (incidence frequency in the main and comparison group was 42.4% and 3.8%;, respectively, $p=0.001$), rough surface of the tumor (72.7% and 23.1%; $p<0,001$), irregular shape (71.2% and 19.2%; $p<0.001$), precise contours (72.7% and 46.2%; $p=0.033$), impaired peripheral function (62.1% and 7.7%; $p<0.001$); in STS - painful palpable tumor (40.7% and 10.5%; $p=0.049$), limited mobility of the tumor (74.1% and 31.6%; $p<0.001$), solid-elastic consistency (64.8% and 47.4%; $p=0.001$), rough surface (72.2% and 26.3%; $p=0.001$), imprecise contours (77.8% and 21.1%; $p<0.001$) [14, 15].
2. No significant differences were found ($p>0.05$) between BS (96.2±3.8% hypointense in T1, 92.3±5.2% hyperintense in T2, and PD images) and the comparison group (90.9±8.7% hypointense in T1, 81.8±11.6% hyperintense in T2, and PD images) according to the signals obtained in different regimes of MRI. However, there were significant differences between the results obtained in STS (97.4±2.5% hypointense in T1, 74.4±7.0% hyperintense in T2, 15.4±5.8% hypointense and 79.5±6.5% hyperintense in PD image) and the comparison group (11.1±10.5% hypointense in T1, 55.6±16.6% hyperintense and 44.4±16.6% hypointense in T2, and 55.6±16.6% hypointense, and 44.4±16.6% hyperintense in PD image) in T1 ($p<0.001$) and in PD ($p<0.05$) [8, 9, 11].
3. In MFH (malignant fibrous histiocytoma), hyposignal was obtained in the T1 image in most patients (95.0 ± 4.9%), and the results were found to be close to each other in T2 (hypointense –

40.0±11.0%, hyperintense – 50.0±11.2%), and PD images (hypointense – 30.0±10.2%, hyperintense – 60.0±11.0%). Whereas, in synovial sarcoma and liposarcoma, hyposignal in T1, and hypersignal in T2 and PD images were observed in all patients (100%). Among the different histological forms of STS, the highest diagnostic accuracy of MRI was recorded in liposarcomas (95.8±2.8%) [1, 6, 10, 11].

4. In BS, an MRI examination revealed a direct correlation between size and rough contour of neoplasm ($r=0.573$, $p<0.01$), irregular shape ($r = 0.601$, $p <0.01$), heterogeneous structure ($r = 0.366$, $p<0.05$), as well as periosteal reaction ($r = 0.448$, $p <0.01$), changes in the cortical layer ($r = 0.367$, $p <0.05$), pathological fractures ($r = 0.351$, $p <0.05$), soft tissue component ($r = 0.464$, $p <0.01$), the frequency of changes in the regional lymph nodes ($r = 0.388$, $p <0.05$) [8].
5. In the characterization of the radiological diagnostic semiotics of primary malignant musculoskeletal tumors, a direct correlation was observed between the results of MRI and other relevant diagnostic radiology methods on several identical features. Thus, MRI is compatible with CT in the characterization of radiation diagnostic signs such as the size of BS ($r=0.982$, $p<0.01$), contour ($r=1.000$, $p<0.001$), shape ($r=1.000$, $p<0.001$), structure ($r=0.809$, $p<0.01$), existence of the periosteal reaction ($r=0.899$, $p<0.01$). MRI is compatible with ultrasound scan in the characterization of radiation diagnostic signs such as the size of STS ($r=0.879$, $p<0.01$), contour ($r=0.754$, $p<0.01$), shape ($r=0.840$, $p<0.01$), structure ($r=0.517$, $p<0.01$), intensification of vascular image ($r=0.627$, $p<0.01$) [16].
6. The diagnostic indicators of MRI for STS (94.9±3.1% (Se), 88.9±10.5% (Sp), 93.8±3.5% (DA)) prevailed those obtained from CT (66.7±19.2% (Se), 83.3±15.2% (Sp), 75.0±12.1% (DA)) and ultrasound (74.1±6.0% (Se), 78.9±9.4% (Sp), 75.3±5.0% (DA)) by a large margin. In this case, the diagnostic accuracy of CT and ultrasound was approximately the same. In the diagnosis of BS, CT (DA- 90.9 ± 3.5%) was superior to MRI (DA - 81.1 ± 6.4%) in

terms of informativeness, but the difference between the diagnostic indicators of these methods was less than the difference observed in STS [3, 11, 13].

PRACTICAL RECOMMENDATIONS

1. In the primary malignant musculoskeletal tumors, the analysis of the tumor should be performed following the diagnostic algorithm. Due to its fast and easy implementation, as well as its cost-effectiveness, first of all, RG should be performed when BS is suspected, and ultrasound should be performed when STS is suspected. In the next stage, CT should be used in the diagnosis of BS, and MRI in the diagnosis of STS.
2. It is recommended to use MRI as an alternative to CT to determine the invasion of neoplasm to the adjacent joint and the compression to the neurovascular bundle in BS. This situation is of particular practical importance, especially when it is not possible to clarify the relation of the tumor to the surrounding structures through CT.
3. Since the diagnostic accuracy of ultrasound and CT is approximately the same in the diagnosis of STS, it is recommended to perform local imaging of the tumor with ultrasound in case of contraindications to MRI.
4. Using the diagnostic algorithm of primary malignant musculoskeletal tumors allows predicting the clinical and morphological features of the tumor, which is important for solving the problem of planning the choice of treatment tactics.

List of published scientific works on the topic of the dissertation:

1. Hüseynova, A.R. Yumşaq toxumaların bədxassəli fibroz histiositomasının diaqnostikasında maqnit-rezonans tomoqrafiya // A.R.Hüseynova, A.Y.Qazıyev / Cərrahiyyə, elmi-praktik jurnal, 2018, №4, s. 61-65
2. Hüseynova, A.R. Yumşaq toxuma şişlərinin kompleks şüa diaqnostikasında ultrasəs müayinəsinin tətbiqi // A.R.Hüseynova, A.Y. Qazıyev / Azərbaycan Tibb Jurnalı, 2019, №1, s. 30-35

3. Hüseynova, A.R. Yumşaq toxuma sarkomalarının diaqnostikasında şüa diaqnostikası metodlarının imkanları / Azərbaycan Onkologiya Jurnalı, 2019, №1, s.65-70
4. Hüseynova, A.R. Sümük iliyinin bədxassəli şişlərinin kompleks şüa diaqnostikasında maqnit-rezonans tomoqrafiyanın imkanları // A.R.Hüseynova, A.Y.Qazıyev, A.Ə.Əmiraslanov / Tibbin görən gözü. Şüa diaqnostikasının aktual problemlərinə həsr olunmuş beynəlxalq elmi praktiki konfransın materialları, Bakı, 30-31 mart, 2019, s. 93
5. Hüseynova, A.R. Nəhənghüceyrəli şişin maqnit-rezonans tomoqrafik əlamətləri // A.R. Hüseynova, A.Y. Qazıyev / Tibbin görən gözü. Şüa diaqnostikasının aktual problemlərinə həsr olunmuş beynəlxalq elmi praktiki konfransın materialları, Bakı, 30-31 mart, 2019, s. 94
6. Hüseynova, A.R. Sinovial sarkomanın diaqnostikasında maqnit-rezonanas tomoqrafiyanın rolu // A.R. Hüseynova, A.Y. Qazıyev / Bakı Dövlət Universiteti nəzdində tibb fakültəsinin yaradılmasının 100 illik yubileyinə həsr edilmiş “Təbabətin aktual problemləri 2019” beynəlxalq elmi-praktik konfransın materialları. Bakı, 18-19 aprel, 2019, s. 92
7. Hüseynova, A.R. Osteogen sarkomanın kompleks şüa diaqnostikasında maqnit-rezonanas tomoqrafiyanın tətbiqi // A.R.Hüseynova, A.Y.Qazıyev / Bakı Dövlət Universiteti nəzdində tibb fakültəsinin yaradılmasının 100 illik yubileyinə həsr edilmiş “Təbabətin aktual problemləri 2019” beynəlxalq elmi-praktik konfransın materialları. Bakı, 18-19 aprel 2019, s. 93
8. Hüseynova, A.R. Sümük və yumşaq toxuma şişlərinin maqnit-rezonans tomoqrafik əlamətlərinin müqayisəli tədqiqi // A.R.Hüseynova, A.Y. Qazıyev / Azərbaycan Onkologiya Jurnalı, 2019, №2, s.111-116
9. Hüseynova, A.R. Sümük şişlərinin maqnit-rezonanastomoqrafik semiotikası / Azərbaycan Təbabətinin Müasir Nailiyyətləri, 2019, №4, s. 139-144
10. Hüseynova, A.R. Liposarkomanın diaqnostikasında maqnit-rezonans tomoqrafiyanın tətbiqi // Azərbaycan Tibb Universitetinin

İnsan anatomiyası və tibbi terminologiya kafedrasının yaradılmasının 100 illik yubileyinə həsr olunmuş Beynəlxalq elmi-praktik konfrans materiallarının toplusu. Nəzəri, klinik və eksperimental morfologiya jurnalı, 2019, Cild 1, № 3-4, s. 151-152

11. Гусейнова, А.Р. Применение магнитно-резонансной томографии в диагностике опухолей мягких тканей // А.Р. Гусейнова, А.Ю. Казиев, В.А. Дадашова / Медицинскиеновости, 2020, №1, стр. 72-75
12. Гусейнова, А.Р. Возможности МРТ в диагностике сарком костей // А.Р.Гусейнова, А.Ю.Казиев / Тезисы XI Съезда онкологов и радиологов стран СНГ и Евразии, 23-25 апреля 2020 г. Казань, Россия. Евразийский Онкологический Журнал. 2020, том 8, №2. Приложение, стр. 724-725
13. Гусейнова, А.Р. Применение магнитно-резонансной томографии в комплексной лучевой диагностике сарком мягких тканей // Актуальные проблемы биомедицины-2020: Сборник тезисов XXVI Всероссийской конференции молодых ученых с международным участием. Санкт – Петербург, 26-27 марта 2020 г., стр. 444-446
14. Hüseynova, A.R.Yumşaq toxuma şişlərinin klinik-patomorfoloji səciyyələndirilməsi // A.R.Hüseynova, A.Y.Qazıyev, H.K.Muradov / Azərbaycan Tibb Jurnalı, 2020, №1, s. 49-56
15. Hüseynova, A.R. Dayaq-hərəkət aparatının birincili bədxassəli şişlərinin diaqnostikasında klinik əlamətlərin əhəmiyyəti // A.R.Hüseynova, A.Y. Qazıyev / Azərbaycan Tibb Universitetinin 90 illik yubileyinə həsr olunmuş "Təbabətin aktual problemləri – 2020" mövzusunda Beynəlxalq elmi-praktik konfransın materialları: 19-20 dekabr 2020-ci il, Bakı, Azərbaycan, səh. 49-50
16. Hüseynova, A.R. Dayaq-hərəkət aparatının birincili bədxassəli şişləri zamanı MRT ilə digər şüa diaqnostik müayinələrin nəticələri arasında korrelyasion əlaqələr // A.R.Hüseynova, A.Y.Qazıyev / Əməkdar elm xadimi, professor Tamerlan Əziz oğlu Əliyevin anadan olmasının 100 illiyinə həsr olunmuş "Təbabətin aktual problemləri-2021" mövzusunda Beynəlxalq elmi-praktik konqresin materialları, 6-8 oktyabr 2021, Bakı, Azərbaycan, s.46.

Abbreviations

BS – bone sarcoma
STS – soft tissue sarcoma
RG – radiography
CT – computed tomography
US – ultrasound scan
MRI – magnetic resonance imaging
Se – sensitivity
Sp – specificity
DA – diagnostic accuracy
MFH – malignant fibrous histiocytoma

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