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Complex Radiation Imaging Of Bone Tumors In Children In Terms Of Differential Diagnosis

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Abstract: Bone tumors in children represent a heterogeneous group of diseases, differing in biological activity, clinical course, and prognosis. Due to the widespread overlap of symptoms and radiological manifestations between inflammatory processes, benign neoplasms, and malignant tumors, childhood requires the most accurate and comprehensive diagnostic approach. Multimodal diagnostics - the combined use of clinical, radiation, laboratory, and morphological methods - is a key tool for reducing the number of diagnostic errors and timely selection of the correct treatment strategy.

Keywords: Bone tumors, ultrasound, x-ray methods, MSCT.

Introduction: Bone tumors in children are a rare but clinically significant condition. According to literature data, malignant bone neoplasms account for only a small proportion of all oncological diseases in childhood and adolescence. In particular, osteosarcoma, one of the most common primary malignant bone tumors, has an annual incidence of approximately 4.0 cases per 1,000,000 children aged 0–14 years and 5.0 cases per 1,000,000 in the 0–19-year age group. Among all pediatric oncological diseases, osteosarcoma accounts for approximately 2–3%.

The second most common primary malignant bone tumor after osteosarcoma is Ewing sarcoma (the Ewing tumor family). This is a rare disease, with an annual incidence of 1–2 cases per 1,000,000 children. According to the literature, Ewing sarcoma accounts for approximately 1–2% of all pediatric malignant tumors.

Differential diagnosis of bone tumors in children presents significant challenges due to the characteristics of the growing skeleton, variability of clinical manifestations, and similarity of radiographic patterns between neoplastic and inflammatory diseases. Early detection and correct interpretation of imaging findings are critically important, as delayed diagnosis may worsen prognosis in patients with aggressive primary bone sarcomas.

A multimodal approach combining several independent diagnostic strategies is considered the standard by modern pediatric oncologists for accurate characterization of the pathological process.

METHODS

The material for this study included data from 42 patients who were examined and/or treated at the Scientific and Practical Medical Center of Pediatric Oncology, Hematology, and Immunology between 2024 and 2025. Patient age ranged from 5 to 17 years. The gender distribution included 28 boys (67%) and 14 girls (33%). In all children, the clinical diagnosis was histologically confirmed.

RESULTS

Based on the study results, patients were divided into the following diagnostic groups: osteosarcoma — 17 patients, Ewing sarcoma — 15 patients, and acute

osteomyelitis — 10 patients. The mean age of the patients was 11.5 ± 0.6 years.

Osteosarcoma is one of the most common malignant tumors of long tubular bones (32 cases), predominantly affecting the lower extremities. The proximal tibia and distal femur were most frequently involved. According to localization, tumors were classified as intramedullary, intracortical, periosteal, parosteal, and extraosseous.

Radiography, CT, and ultrasound were used to assess the type of bone destruction, pattern of ossification, tumor margins, condition of the cortical layer, type of periosteal reaction, presence of an extraosseous component, and possible joint involvement.

In most cases, osteosarcoma was localized in the tibia and less frequently in the femur. Tumor size often exceeded 8 cm, indicating delayed presentation. CT more often revealed centrally located tumors with small- and large-focal bone destruction. CT proved more informative than radiography in assessing various types of periosteal reaction and allowed detailed evaluation of medullary canal involvement. In addition, CT frequently detected tumor invasion into adjacent joints and pathological fractures.

The most common ultrasound features of osteosarcoma included extensive cortical bone destruction, which was total in most cases; periosteal elevation at an angle to the bone shaft with frequent early diffuse infiltration; pronounced diffuse heterogeneous tumor structure with areas of decreased and increased echogenicity, often accompanied by reactive calcification; and high tumor vascularization in both central and peripheral regions.

Clinical data from 15 patients with Ewing sarcoma of long tubular bones were analyzed. Radiographic examination was performed in all patients (100%). Computed tomography was also conducted in all cases (100%). Ultrasonography was performed in 10 patients (66.7%).

In this study, Ewing sarcoma predominantly affected the bones of the lower extremities, most commonly the femur followed by the tibia, primarily involving proximal segments. In several cases, two segments of the same bone were involved due to extensive tumor spread. More than 70% of patients were admitted to specialized centers with tumors larger than 8 cm, although 66% sought medical care within 1–6 months after symptom onset, reflecting the high malignancy of the tumor.

The tumor represented an aggressive process composed of small round cells with intense vascularization, contributing to frequent hemorrhage and necrosis. Radiography revealed bone destruction with an “onion-skin” periosteal reaction, indistinct cortical margins, and extraosseous soft tissue with smooth contours; the layered structure was manifested by lower echogenicity of superficial components. CT visualized destructive masses with areas of lucency and sclerosis, irregular margins, marked cortical destruction, and periosteal reaction.

Ultrasound demonstrated that most patients (4 of 5) had superficial cortical destruction, one patient showed complete destruction, and one had cortical thinning with outward displacement. Periosteal elevation with diffuse infiltration was observed in 5 patients, and angular periosteal elevation in 1 patient. Tumor structure was most often diffusely heterogeneous with areas of reduced echogenicity and reactive calcification; less commonly, a combination of decreased and increased echogenicity was noted, and in only one case visualization of internal components was difficult. Vascularization was high, involving both central and peripheral tumor regions. Clinical and imaging features of acute osteomyelitis were analyzed in 10 patients. On ultrasound and CT, most patients demonstrated cortical bone destruction with blurred margins, periosteal thickening, and subperiosteal inflammatory infiltrates, often accompanied by soft tissue changes such as edema and inflammatory infiltration. The structure of bone involvement was predominantly heterogeneous due to necrosis, sequestration, and inflammatory changes. Vascularization of affected areas was moderate to pronounced, reflecting active inflammation. Clinically, all patients presented with pain, local hyperemia, swelling, and signs of intoxication. In some cases, imaging findings mimicked malignant tumors, including bone destruction, periosteal reaction, and soft tissue involvement. Therefore, differentiation between acute osteomyelitis and bone tumors was extremely difficult and required a comprehensive approach incorporating clinical evaluation, laboratory findings, and, when necessary, biopsy.

CONCLUSION

The present study demonstrates that lesions of long tubular bones in children, including osteosarcoma, Ewing sarcoma, and acute osteomyelitis, share similar imaging features such as cortical bone destruction, periosteal reaction, and soft tissue involvement. Ewing sarcoma and osteosarcoma are characterized by aggressive growth, high vascularization, and pronounced structural heterogeneity, whereas acute osteomyelitis manifests with inflammatory infiltrates, edema, necrosis, and sequestration.

The similarity of radiographic, CT, and ultrasound

features of inflammatory and neoplastic processes complicates differential diagnosis. The obtained data emphasize the necessity of a comprehensive diagnostic approach that includes clinical assessment, laboratory investigations, ultrasound, CT, and biopsy when required, to accurately determine the nature of bone lesions and select appropriate treatment strategies.

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