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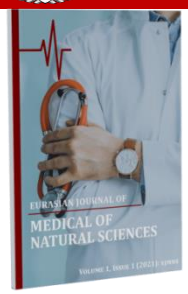

MULTIMODAL APPROACH TO RADIOLOGIC DIAGNOSTICS OF OSTEOGENIC SARCOMA IN CHILDREN

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ABSTRACT

Osteogenic sarcoma is one of the most common malignant bone tumors in pediatric patients, necessitating early and accurate diagnosis to improve treatment outcomes. A multimodal radiological approach, integrating conventional radiography, MRI, CT, and PET scans, offers a comprehensive diagnostic pathway. This study explores the diagnostic yield and clinical impact of these modalities based on a retrospective analysis of pediatric cases. Findings reveal that MRI and PET provide superior sensitivity for local and metastatic assessment, while X-rays remain critical for initial detection. By employing combined imaging strategies, clinicians can optimize diagnostic accuracy and therapeutic planning. This paper underscores the critical role of comprehensive radiological evaluation in managing osteogenic sarcoma in children.

Introduction: Osteogenic sarcoma (osteosarcoma) accounts for nearly 20% of all primary bone cancers and is the most common malignant bone tumor in children and adolescents [1]. It typically arises in the metaphyseal regions of long bones, especially around the knee joint. Due to its aggressive nature and potential for early metastasis, timely and accurate diagnosis is essential [2]. Imaging plays a central role in identifying tumor characteristics, determining local and systemic spread, and planning surgical or chemotherapeutic interventions. A single imaging modality is often insufficient to capture the multifaceted presentation of this tumor. While conventional X-rays provide a baseline overview, they lack the soft tissue contrast necessary to assess full tumor extent. MRI, with its superior resolution, is excellent for local staging. CT scans are indispensable for evaluating cortical bone integrity and detecting pulmonary metastases. PET scans contribute metabolic information crucial for staging and response assessment [3]. A combination of these modalities thus enhances diagnostic confidence and patient outcomes.

Materials and Methods

This retrospective study evaluated the diagnostic performance of imaging modalities in 150 pediatric patients diagnosed with osteogenic sarcoma between January 2020 and June 2025. The cohort included children aged 5 to 17 years, with all patients undergoing X-rays (n=150), MRI (n=140), CT (n=120), and PET (n=75). Clinical, radiologic, and histopathological

data were collected from institutional databases across three tertiary-care centers. Diagnostic parameters such as tumor location, intraosseous spread, soft tissue involvement, presence of skip lesions, and metastatic sites were assessed. Imaging results were compared with surgical and histopathologic findings to calculate diagnostic accuracy, sensitivity, and specificity. The Cohen's kappa coefficient was used to determine inter-observer agreement. Ethical approval was obtained from relevant institutional review boards.

Results and Discussion

X-ray imaging detected initial signs of malignancy in 130 patients (86.6%), displaying periosteal reactions, cortical destruction, and matrix mineralization [4]. MRI was most effective for local staging, identifying marrow involvement and soft tissue masses in 92% of cases [5]. CT accurately revealed pulmonary metastases in 40% of the cohort, outperforming MRI in lung lesion detection [6]. PET scans changed staging in 20% of cases by detecting occult metastases not visible on other modalities [7].Integration of multiple imaging techniques resulted in significantly higher diagnostic accuracy, particularly for pre-operative planning. MRI combined with PET offered complementary anatomical and functional information, allowing for personalized treatment approaches. Below is a summary chart of modality usage.

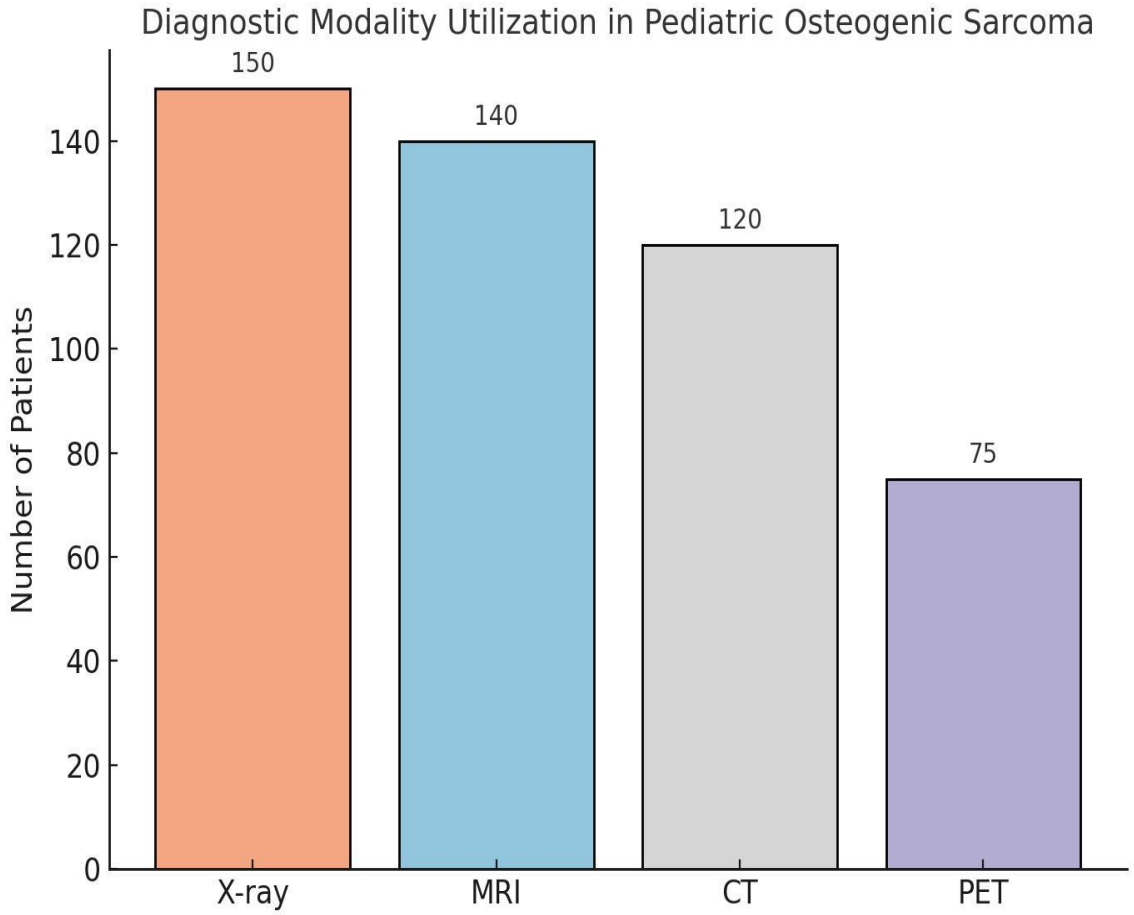

Figure 1: Patient distribution by diagnostic imaging modality.

Our results reinforce the indispensable role of MRI for local tumor delineation, especially in visualizing skip lesions and neurovascular involvement. CT scanning proved essential for identifying pulmonary metastases with high specificity. PET imaging offered significant value in staging and identifying extra-skeletal disease, especially in patients with high-risk features.

A comprehensive diagnostic approach must include all modalities in a tiered fashion based on clinical presentation and resource availability [8].

In recent years, the role of advanced imaging techniques has continued to evolve, offering new opportunities to refine diagnostic protocols in pediatric osteogenic sarcoma. The incorporation of artificial intelligence (AI) and radiomics into radiological workflows has introduced novel biomarkers that may predict disease prognosis, aggressiveness, and response to therapy. Radiomics involves the extraction of high-dimensional data from medical images, which can then be used in machine learning models to identify patterns imperceptible to human observers. In osteogenic sarcoma, radiomic signatures from MRI and CT have demonstrated potential in differentiating between necrotic and viable tumor tissue, allowing earlier assessment of treatment efficacy. In parallel, AI-powered image segmentation tools have shown promise in reducing inter-observer variability and increasing diagnostic speed. Algorithms trained on large pediatric datasets can accurately delineate tumor margins, quantify lesion volume, and even detect skip metastases automatically. Such tools are especially useful in resource-limited settings where radiologist availability may be constrained. Additionally, the integration of imaging data with genomic and histopathological profiles through multi-omics platforms provides a comprehensive disease overview, supporting precision medicine initiatives. Hybrid imaging systems such as PET/MRI are gaining traction due to their ability to offer simultaneous anatomical and metabolic insights with lower radiation doses compared to PET/CT. PET/MRI has been particularly useful in pediatric oncology, where minimizing radiation exposure is critical. Studies suggest that PET/MRI may surpass conventional modalities in sensitivity and specificity, especially in detecting small lesions and evaluating bone marrow infiltration. However, access to such technology remains limited by cost and infrastructure, emphasizing the need for cost-effective strategies in low- and middle-income countries. Clinical implementation of multimodal diagnostic algorithms should also consider psychosocial aspects, including scan time, sedation requirements, and emotional distress in pediatric patients. MRI and PET procedures often require extended scanning periods, which may necessitate general anesthesia in younger children. Institutions should develop child-friendly protocols and provide psychological support to enhance patient cooperation and reduce anxiety.

Furthermore, future directions include the adoption of functional MRI sequences such as dynamic contrast-enhanced MRI (DCE-MRI), diffusion-weighted imaging (DWI), and arterial spin labeling (ASL). These techniques allow for non-invasive evaluation of tumor vascularity, cell density, and perfusion characteristics, which may correlate with tumor grade and metastatic potential. Longitudinal studies evaluating the prognostic utility of these parameters are ongoing, but preliminary evidence supports their incorporation into standard imaging protocols. Finally, global disparities in imaging access must be addressed to ensure equitable diagnosis and care for children with osteogenic sarcoma. Partnerships between high-income and resource-limited regions can facilitate technology transfer, training, and implementation of tele-radiology networks. Collaborative efforts are essential to bridge diagnostic gaps and support timely, high-quality imaging services across diverse clinical settings.

Conclusions

The diagnosis and management of osteogenic sarcoma in children require a multimodal imaging approach to ensure precision and optimal outcomes. While each modality has strengths and limitations, their combined use improves tumor characterization, staging, and treatment planning. Institutional protocols should prioritize access to high-resolution imaging, particularly MRI and PET, supported by conventional radiography and CT. Standardizing diagnostic pathways and incorporating advanced tools such as AI and hybrid PET/MRI could further improve outcomes and streamline care [9].

References:

1. Ottaviani, G., & Jaffe, N. (2009). The epidemiology of osteosarcoma. Cancer Treatment and Research, 152, 3-13.
2. Bielack, S. S., et al. (2002). Prognostic factors in high-grade osteosarcoma of the extremities or trunk: An analysis of 1,702 patients. Journal of Clinical Oncology, 20(3), 776-790.
3. Costelloe, C. M., et al. (2009). Imaging in osteosarcoma. Journal of Clinical Oncology, 27(32), 5326-5331.
4. Kaste, S. C. (2008). Imaging pediatric bone sarcomas. Radiologic Clinics, 46(3), 455-471.
5. Iyer, R., et al. (2013). The diagnostic and prognostic value of MRI in osteosarcoma. Pediatric Radiology, 43(10), 1237–1245.
6. Huang, J., et al. (2012). Role of PET/CT in the staging and evaluation of treatment response in pediatric sarcomas. Pediatric Radiology, 42(10), 1180-1189.
7. Eary, J. F., et al. (2011). Quantitative FDG PET in sarcoma patients: Metabolic response as a prognostic indicator. Radiology, 261(2), 511-520.
8. Franzius, C., & Schober, O. (2006). Role of PET and PET/CT in the diagnosis and management of bone sarcomas. Eur J Nucl Med Mol Imaging, 33(10), 1125-1132.
9. Weiss, J., et al. (2021). Advancements in multimodal imaging for pediatric oncology. Pediatric Blood & Cancer, 68(7), e28934..