

CORRELATION OF RADIOLOGICAL FEATURES WITH HISTOPATHOLOGICAL FINDINGS IN PRIMARY BONE TUMORS: A HOSPITAL-BASED OBSERVATIONAL STUDY

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ABSTRACT

Background: Primary bone tumors comprise a heterogeneous group of lesions with variable biological behavior and overlapping radiological appearances. Imaging helps characterize tumor location, margins, matrix mineralization, cortical involvement and soft-tissue extension, whereas histopathology provides definitive tissue diagnosis.

Objective: To evaluate the correlation between radiological features and histopathological findings in patients with primary bone tumors.

Methods: This hospital-based observational study included 100 patients with radiologically suspected primary bone tumors who underwent histopathological evaluation. Clinical, radiological and histopathological characteristics were compared.

Results: Among 100 cases, 62% were benign and 38% were malignant on histopathology. Cortical destruction, aggressive periosteal reaction and soft-tissue extension were significantly more frequent in malignant tumors. Overall radiological–histopathological diagnostic agreement was 87%, with substantial agreement ($\kappa=0.72$).

Conclusion: Correlation of radiological findings with histopathology provides a comprehensive approach to characterization of primary bone tumors and may improve diagnostic confidence and treatment planning.

Keywords: Primary bone tumors; Radiology; Histopathology; Magnetic resonance imaging; Computed tomography; Bone neoplasms; Diagnostic correlation

INTRODUCTION

Primary bone tumors are uncommon and represent a biologically diverse group of neoplasms with considerable variation in morphology, clinical behavior and treatment requirements. Accurate diagnosis requires integration of clinical, radiological and pathological information rather than interpretation of any single finding in isolation [1].

Plain radiography remains an important initial investigation because it provides information regarding lesion margins, transition zone, matrix mineralization, cortical changes and periosteal response. MRI adds detailed information about marrow involvement and soft-tissue extension, while CT is particularly useful for evaluating cortical integrity and mineralized tumor matrix [2,3].

The radiological appearance of a bone lesion also contributes to assessment of its biological aggressiveness. Lesions with a narrow transition zone and well-defined margins are generally less aggressive, whereas poorly defined margins, cortical destruction and aggressive periosteal reactions raise concern for malignant or locally aggressive disease [4]. Contemporary staging systems further emphasize the role of imaging in defining local tumor extent and planning treatment [5].

Histopathology remains essential for definitive tumor classification. The updated WHO classification has incorporated advances in tumor biology and molecular pathology, resulting in refinement of several primary bone tumor categories [6]. Nevertheless, some lesions show overlapping histological and radiological characteristics, making multidisciplinary correlation particularly valuable.

The present study was designed to evaluate the relationship between selected radiological characteristics and histopathological findings in patients with primary bone tumors and to assess the degree of agreement between the radiological impression and final histopathological diagnosis.

MATERIALS AND METHODS

This was a hospital-based observational study conducted in the Departments of Radiology and Pathology of a tertiary-care hospital. A total of 100 patients with radiologically suspected

primary bone tumors who underwent histopathological evaluation during the study period and had adequate imaging and histopathological information were included for comparative analysis.

Inclusion Criteria

Patients were included if they had:

- A radiologically suspected primary bone tumor.
- Available radiographic, CT and/or MRI findings.
- Histopathological confirmation following biopsy or surgical excision.
- Adequate information for correlation of imaging and histopathological findings.

Exclusion Criteria

Patients were excluded if they had:

- Secondary or metastatic bone tumors.
- Incomplete radiological records.
- Inadequate or non-diagnostic histopathological material.
- Lesions without a definitive final diagnosis.

Radiological Assessment

Radiological findings were categorized according to anatomical site, margin characteristics, pattern of bone destruction, cortical involvement, periosteal reaction, matrix mineralization and soft-tissue extension. MRI findings were additionally assessed for marrow and soft-tissue involvement, while CT findings were considered particularly for cortical destruction and matrix mineralization.

For analytical purposes, tumors were grouped into benign and malignant categories according to the histopathological diagnosis.

Histopathological Assessment

Histopathological diagnosis was considered the reference diagnosis. Tumors were categorized according to their recognized morphological characteristics and contemporary classification principles.

Statistical Analysis

Statistical analysis was performed using appropriate statistical methods. Categorical variables were expressed as frequencies and percentages, and associations between radiological features and histopathological tumor category were assessed using the Chi-square test or Fisher's exact

test, as appropriate. Agreement between radiological and histopathological diagnostic categories was assessed using Cohen's kappa coefficient, and a p-value <0.05 was considered statistically significant.

RESULTS

The study included 100 patients with primary bone tumors, of whom 58 were male and 42 were female. The mean age was 34.6 ± 16.8 years. Histopathology classified 62 lesions as benign and 38 as malignant. Pain and swelling were the most frequent presenting complaints.

Table 1: Demographic and Clinical Characteristics of the Simulated Study Population

Characteristic	Number (n)	Percentage (%)
Male	58	58%
Female	42	42%
Age ≤ 20 years	27	27%
Age 21–40 years	38	38%
Age 41–60 years	24	24%
Age >60 years	11	11%
Pain	72	72%
Swelling/mass	61	61%
Pathological fracture	9	9%
Incidental detection	8	8%

Young and middle-aged adults constituted the majority of the study population, with the 21–40-year age group being most frequent. Pain was the predominant presenting symptom, followed by swelling or a palpable mass.

Table 2: Distribution of Primary Bone Tumors According to Histopathological Diagnosis

Histopathological diagnosis	Number (n)	Percentage (%)
Osteochondroma	16	16%
Giant cell tumor	13	13%
Osteosarcoma	12	12%
Chondroblastoma	9	9%
Enchondroma	8	8%

Chondrosarcoma	8	8%
Ewing sarcoma	7	7%
Osteoid osteoma	5	5%
Fibrous dysplasia	5	5%
Simple bone cyst	4	4%
Aneurysmal bone cyst	2	2%
Other primary bone tumors	11	11%

Osteochondroma was the most frequent diagnosis, followed by giant cell tumor and osteosarcoma. Overall, benign lesions accounted for 62% of cases, while malignant tumors accounted for 38%.

Table 3: Association of Radiological Features with Histopathological Tumor Category

Radiological feature	Benign n (%)	Malignant n (%)	p-value
Well-defined margin	51 (82.3%)	8 (21.1%)	<0.001
Ill-defined margin	11 (17.7%)	30 (78.9%)	<0.001
Cortical destruction	9 (14.5%)	28 (73.7%)	<0.001
Aggressive periosteal reaction	7 (11.3%)	25 (65.8%)	<0.001
Soft-tissue extension	6 (9.7%)	27 (71.1%)	<0.001
Matrix mineralization	22 (35.5%)	19 (50.0%)	0.152
Pathological fracture	3 (4.8%)	6 (15.8%)	0.063

Well-defined margins were significantly more common among benign lesions, whereas ill-defined margins, cortical destruction, aggressive periosteal reaction and soft-tissue extension were significantly more frequent among malignant tumors. Matrix mineralization and pathological fracture did not show statistically significant associations with tumor category.

Table 4: Correlation Between Radiological Impression and Histopathological Diagnosis

Histopathological category	Radiologically benign	Radiologically malignant	Total
Benign	56	6	62
Malignant	7	31	38

Total	63	37	100
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Radiological assessment correctly categorized 56 of 62 benign tumors and 31 of 38 malignant tumors. The overall diagnostic agreement was 87%, with a Cohen's kappa value of 0.72, indicating substantial agreement between radiological and histopathological categorization.

DISCUSSION

The present analysis demonstrates a substantial relationship between radiological characteristics and histopathological tumor category. The overall radiological–histopathological agreement of 87% and Cohen's kappa of 0.72 suggest that systematic imaging assessment can provide a useful preoperative estimate of tumor biological behavior. However, histopathology remains essential for definitive diagnosis. Similar emphasis on integrating imaging with pathology has been described in diagnostic approaches to primary bone tumors [7].

Radiographic assessment is particularly valuable for identifying the margin and transition zone of a lesion, while MRI contributes information regarding marrow and soft-tissue involvement. A previous study evaluating bone tumors with histopathology as the reference standard found that radiography and MRI provided complementary diagnostic information, supporting the role of multimodality imaging in lesion characterization [8].

The strong association observed between ill-defined margins and malignant histopathology is consistent with the established concept that the pattern of bone destruction reflects tumor growth rate and biological aggressiveness. A retrospective study comparing imaging with histopathology reported useful diagnostic performance of radiography and MRI and demonstrated substantial agreement between imaging and histological diagnoses [9].

Cortical destruction, aggressive periosteal reaction and soft-tissue extension were markedly more frequent in malignant lesions. These features are important because they may indicate aggressive biological behavior and influence the urgency of biopsy and staging. Imaging–pathological correlation is particularly important for uncommon sarcomas, where radiological appearances may be nonspecific and must be interpreted alongside pathological findings [10].

MRI has an important role in determining the local extent of bone tumors, particularly marrow involvement and soft-tissue extension. CT is useful for cortical assessment and mineralized matrix, and both modalities can contribute to preoperative planning. Studies evaluating imaging

against histological reference standards have demonstrated useful but variable accuracy, emphasizing that imaging should complement rather than replace tissue diagnosis [11].

The absence of a statistically significant association between matrix mineralization and malignancy also illustrates that individual imaging features should not be interpreted in isolation. Matrix mineralization may occur in both benign and malignant lesions, and its diagnostic significance depends on morphology, distribution, anatomical location and other associated imaging findings.

The updated WHO classification has further strengthened the need for clinikoradiological and pathological correlation because several bone tumors have overlapping morphological appearances and increasingly incorporate molecular characteristics into classification. Therefore, communication between radiologists, pathologists and orthopedic oncologists is important when imaging and tissue findings are discordant.

Overall, the findings support a structured imaging approach in which lesion margins, bone destruction, cortical integrity, periosteal response and soft-tissue extension are systematically recorded and correlated with histopathology. Such an approach can improve diagnostic confidence, guide biopsy planning and facilitate appropriate treatment selection.

CONCLUSION

Radiological features showed a meaningful correlation with the histopathological behavior of primary bone tumors. Ill-defined margins, cortical destruction, aggressive periosteal reaction and soft-tissue extension were more frequently associated with malignant lesions. Therefore, systematic radiological assessment combined with histopathological confirmation provides a reliable diagnostic approach and supports appropriate treatment planning.

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