Journal of Carcinogenesis
Covering Genesis to Therapeutics

Journal of Carcinogenesis, ISSN: 1477-3163
2025; Vol 24: Issue 4s, https://carcinogenesis.com/

Modified X-Ray Scoring System for Bone Tumors at Dr. Soetomo General Hospital: A Diagnostic Tool for Differentiating Benign and Malignant Lesions

Melina Rosita Tanadi[1], Rosy Setiawati[1,2], Paulus Rahardjo[1, 2], Ferdiansyah[3, 4]

[1]Department of Radiology, Dr. Soetomo General Academic Hospital, Surabaya,

ORCID: 0000-0003-1643-9600 / Email ID: melinarosita@gmail.com

[2]Department of Radiology, Faculty of Medicine – Airlangga University, Surabaya, Indonesia

[3]Orthopedic and Traumatology Department, Dr. Soetomo General Academic Hospital, Surabaya

ORCID: 0000-0002-1821-4811 / Email ID: paulus.r.rahardjo@gmail.com

[4]Orthopedic and Traumatology Department, Faculty of Medicine, Airlangga University, Indonesia

ORCID: 0000-0001-8757-9251 / Email ID: ferdiansyah@fk.unair.ac.id

***Corresponding Author:**

S. Rosy

Department of Radiology, Faculty of Medicine, Airlangga University, Mayjend Prof. Dr. Moestopo 6-9, Surabaya, Indonesia, Surabaya, East Java, 60286, Indonesia

Email ID: rosy-s@fk.unair.ac.id

ORCID: 0000-0001-8442-7287

ABSTRACT

Background: Bone tumors, though rare (5% of global malignancies), pose significant diagnostic challenges in resource-limited settings due to morphological complexity, delayed presentation, and reliance on subjective radiographic interpretation. Existing scoring systems like the Lodwick classification and Radiological Evaluation Score for Bone Tumors (REST) lack specificity for advanced-stage cases prevalent in regions like Indonesia, where delayed diagnoses worsen morbidity. REST has notable limitations, including variabilities between observer interpretations, such as cortical erosion and soft tissue swelling, and low AUC values in specific parameters. This study introduces the Modified X-ray Scoring System (MXSS), a novel diagnostic tool integrating seven radiologic parameters tailored to address these gaps.

Methods: A retrospective cross-sectional analysis of 142 histopathologically confirmed bone tumor cases (2021–2023) was conducted. MXSS evaluated tumor characteristics, mineralization, cortical erosion, margin, transitional zone, periosteal reaction, and soft tissue bulging. Diagnostic performance was assessed via ROC analysis, as well as sensitivity, specificity, and inter-observer reliability.

Results: MXSS achieved an AUC of 0.936 (95% CI: 0.889–0.983). Sensitivity and specificity were 91.9% and 92.5%, respectively, with excellent inter-observer reliability (ICC = 0.992). Key findings include its granular parameterization (e.g., detailed margin and periosteal reaction subcategories), adaptability to late-stage tumors, and applicability in settings lacking MRI/CT.

Conclusion: MXSS is a validated, objective tool for differentiating benign and malignant bone tumors, particularly in resource-limited contexts. Its integration into tele-radiology platforms could revolutionize triage in rural clinics, reducing diagnostic delays and unnecessary interventions.

Keywords: *Bone tumor, scoring system, X-ray, diagnostic accuracy, ROC analysis*

How to Cite: Melina Rosita Tanadi, Rosy Setiawati, Paulus Rahardjo, Ferdiansyah, (2025) Modified X-Ray Scoring System for Bone Tumors at Dr. Soetomo General Hospital: A Diagnostic Tool for Differentiating Benign and Malignant Lesions, *Journal of Carcinogenesis*, *Vol.24, No.4s*, 1-9

1. INTRODUCTION

Bone tumors account for 5% of global malignancies but are associated with disproportionately high morbidity due to delayed diagnosis, particularly in low- and middle-income countries (LMICs) like Indonesia [1], [2]. In such regions, limited access to advanced imaging modalities like MRI and CT, coupled with subjective radiographic interpretation, often leads to misdiagnosis, delayed referrals, and unnecessary biopsies[3], [4].

Existing systems like the Lodwick classification (1980) focus on tumor aggressiveness in osteolytic/ destruction patterns but lack granularity for populations presenting with advanced-stage disease like osteoblastic and mixed patterns [5], [6]. Similarly, REST, while effective, suffers from variability in parameters like cortical erosion and soft tissue swelling, with suboptimal AUC values for certain criteria [7] . Neither system addresses the high prevalence of metastatic-like presentations in Indonesian patients, where tumors often mimic infections due to delayed care [8]. These limitations underscore a critical research gap: the need for a standardized, context-specific tool that balances diagnostic accuracy with practicality in resource-constrained environments.

The Modified X-ray Scoring System (MXSS) addresses these challenges through seven radiologic parameters refined for the Indonesian context, where tumors often present late with complex morphologies [9]. MXSS's theoretical foundation lies in its emphasis on margin clarity and periosteal reaction patterns—features strongly correlated with malignancy in late-stage tumors[10], by minimizing subjectivity through detailed scoring criteria (e.g., distinguishing "geographic type 1C" from "moth eaten" and "permeative" margins), introducing subcategories for periosteal reactions (e.g., benign vs. aggressive) and excluding low-specificity parameters (e.g., pathologic fractures), MXSS enhances reproducibility, a critical advantage in regions with heterogeneous radiologic expertise. This study validates MXSS against histopathology and benchmarks it against REST, highlighting its potential to reduce diagnostic delays, improve referrals, and improve survival rates in LMICs.

Bone tumor diagnosis hinges on radiographic features reflecting biological behavior. Aggressive tumors typically show ill-defined margins, broad transition zones, and "sunburst" periosteal reactions due to rapid osteoclastic activity and matrix disruption[11]. Conversely, benign lesions often display sclerotic margins and narrow transition zones indicative of slow growth[6]. MXSS operationalizes these principles into a quantifiable framework, assigning weighted scores to parameters predictive of malignancy.

2. PATIENT SAMPLING AND METHODOLOGY

The Study Design is a retrospective analysis of 142 patients (total sampling) with histopathologically confirmed bone tumors (2021–2023) in Dr. Soetomo General Hospital. Inclusion Criteria were primary bone tumors confirmed by histopathology (FNAB, core biopsy, or open biopsy) [12]. Pre-treatment X-rays were available in the hospital's PACS system. Exclusion Criteria were metastatic lesions, infectious/inflammatory bone diseases, or incomplete data.

Data Collection:

Two blinded musculoskeletal radiologists independently evaluated radiographs using the MXSS. This scoring system is based on seven parameters that sum up into a single score as seen in Table 1. The results of the score were split into suspected benign or malignant bone tumors.

The MXSS quantifies tumor aggressiveness through seven parameters (total score: 0–11). Each parameter reflects critical radiologic features associated with malignancy. For example, moth-eaten margins (score = 3) and aggressive periosteal reactions (score = 2) are strong indicators of malignancy, aligning with the Lodwick classification's emphasis on destructive growth patterns [5], [6]

Table 1. The MXSS evaluation of seven parameters (total score: 0–11)

Parameter	Score	Criteria
Tumor Charcteristic	0-1	Osteoytic (0); Osteoblastic/mixed (1) [7]
Mineralization	0-1	Absent (0); Osteoid / chondroid matrix (1) [13]
Cortical Erosion	0-2	None (0); Partial (1); Total (2) [14]
Margin	0-3	Well-defined with sclerosis (0); well-defined without sclerosis (1); ill-defined (2); moth-eaten/permeative (3)[10]
Transition Zone	0-1	Narrow (0); Wide (1) [15]
Periosteal Reaction	0-2	None (0); Benign (solid/uninterrupted) (1); Aggressive (sunburst / codman's triangle) (2) [16]

Soft Tissue Bulging	0-1	Absent (0); Present (1) [17]

Statistical analysis included: ROC curve analysis determined best cut-off scores [18], sensitivity, specificity, PPV, and NPV were calculated [19], inter-observer reliability was assessed using ICC[20]. Correlations between the MXSS scores and the histopathology results were analyzed to confirm the system further. This resulted in a cut-off value after considering all parameters when the P-value is less than 0,05 for it to be considered significant. The turning point of the Youden Index marks the cut-off point for benign/malignant tumors.

3. RESULTS

Interclass correlation coefficient (ICC) between two observers is 0,992 (95% CI 0.989- 0,994), p value <0.000, showing excellent agreement between the observers. A total of 142 samples with the distribution of patients is provided in Table 2. Revealing that bone tumors are most prevalent in patients between the ages of 20 and 40 (50%). The predominance of tumors in males (57.7%) aligns with global trends (Siegel et al., 2018). Bone tumors occur most often in the Femur (31%), followed by the Tibia (22,5%) and the humerus (17,6%). It is most frequently found in long bones. Furthermore, there are fewer malignant tumors (43,6%) compared to benign tumors (56,3%) in our samples, but the most frequent bone tumor in our study is osteosarcoma, which accounts for 39 samples (27,5%)

Table 2. Distribution of the samples of MXSS

No	Variable	Sample (n=142)
1.	**Age**	
	0-10	10 (7%)
	11-19	40(28,2%)
	20-40	71 (50%)
	>40	21 (14,8%)
2.	**Gender**	
	Male	82 (57,7%)
	Female	60 (42,3%)
3.	**Bone Location**	
	Calcaneus	2 (1,4%)
	Sakrum	1(0,7%)
	Scapula	1 (0,7%)
	Tibia	32 (22,5%)
	Ulna	9 (6,3%)
	Femur	44 (31%)
	Fibula	4 (2,8%)
	Humerus	25 (17,6%)
	Metacarpal	4 (2,8**%)**
	Pelvis	3 (2,1%)
	Phalang	4 (2,8%)
	Pubis	3 (2,1%)
	Radius	10 (7,0%)
4.	**Histopathology Result**	

Malignant	62 (43,6%)
Benign	80 (56,3%)

Score cut-offs were evaluated using the Youden index, the highest sensitivity and specificity in the score value 4,75 with the Youden index (Sensitivity-(1-Specificity)): 0,844. Samples with a total score of less than 4 were suggestive of benign, and those with a total score of 4 or more were suggestive of malignant.

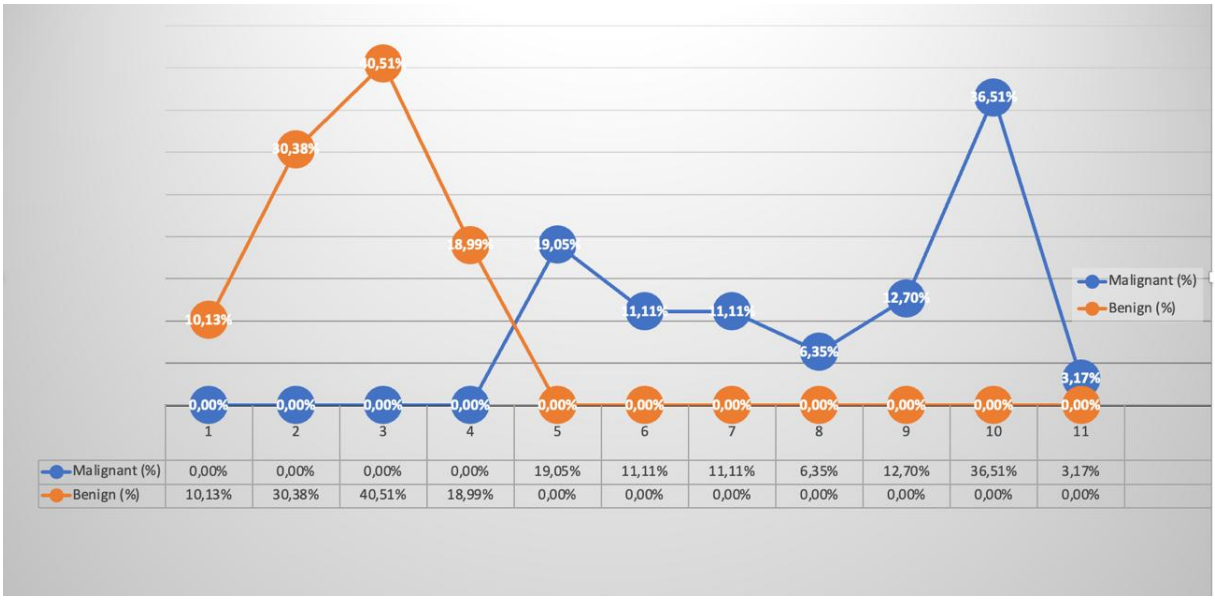

Figure 1. Distribution of Modified X-Ray Scoring System

Obtained with benign PA results, the analysis of scores from two observers averaged (mean) falls within the score range of 1–4, with the highest percentage at a total score of 3.03 ± 1.28. Meanwhile, for malignant tumor PA results, the scores from two observers averaged fall within the score range of 4–11, with an overall mean score of 7.89 ± 2.47 (mean ± standard deviation).

Table 3. Correlation of Each Parameter with Histopathology Results

Variable		Benign (n:80)	Malignant (n:62)	P Value (Chi-Square Test)
Gender	Male	51,2 %	48,8%	0,151 (n.s)
	Female	63,3%	36,7 %	
Tumor Characteristics	Osteolytic	72,4%	27,6%	0,000
	Osteoblastic/mixed	30,9%	69,1%	
Mineralization	Absent	71,6%	28,4%	0,000
	chondroid/ osteoid	39,7%	60,3%	
Cortical Erosion	none	64,3%	35,7%	0,358 (n.s)
	partial	57,5%	42,5%	
	Total	40%	60%	
Margin	Well-defined with sclerosis	96,4%	3,6%	0,000

	well-defined without sclerosis	93,5%	6,5%	
	ill-defined	35,3%	64,7%	
	Moth-eaten/permeative	7,8%	92,9%	
Transisional zone	narrow	89,4%	10,6%	0,000
	wide	7 %	93%	
Periosteal Zone	none	73,1%	26,9%	0,000
	Benign type	85,7%	14,3%	
	Aggressive type	0%	100%	
Soft Tissue Bulging	absent	75%	25%	0,001
	present	46,8%	53,2%	
MXSS		Mean = 3,03 ± 1,28	Mean= 7,89 ± 2,47	0,000

Each factor included in the scoring system was correlated with the histopathological results (benign or malignant) (Table 3), which showed that all parameters were significantly correlated ($p < 0.05$) except for cortical erosion. However, the correlation with histopathological results became significant when the factors were combined into the MXSS. Statistical analysis was performed to evaluate the performance of the scoring system. The ROC curve can be seen in Figure 2, the area under the curve (AUC) represents how much the data represents the scoring system. AUC value of 0.936 suggests MXSS reliably distinguishes benign/malignant tumors in 93.6% of cases. AUC: 0.936 (95% CI: 0.889–0.983), showing excellent discriminative power (Fig. 2), Sensitivity: 91.9% (malignant tumors correctly found), Specificity: 92.5% (benign tumors correctly ruled out), PPV: 90.4%, NPV: 93.6%.

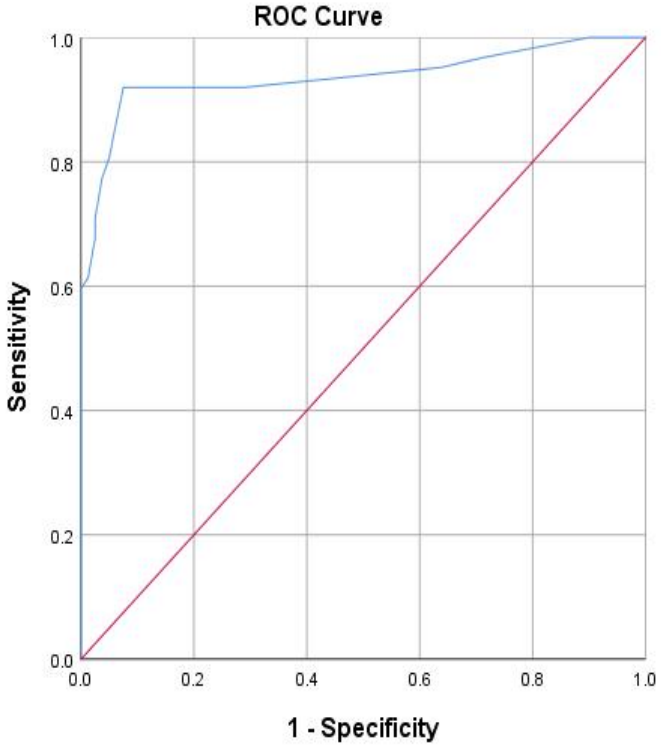

Figure 2. ROC Curve, Sensitivity, and Specificity of Modified X-Ray Scoring System

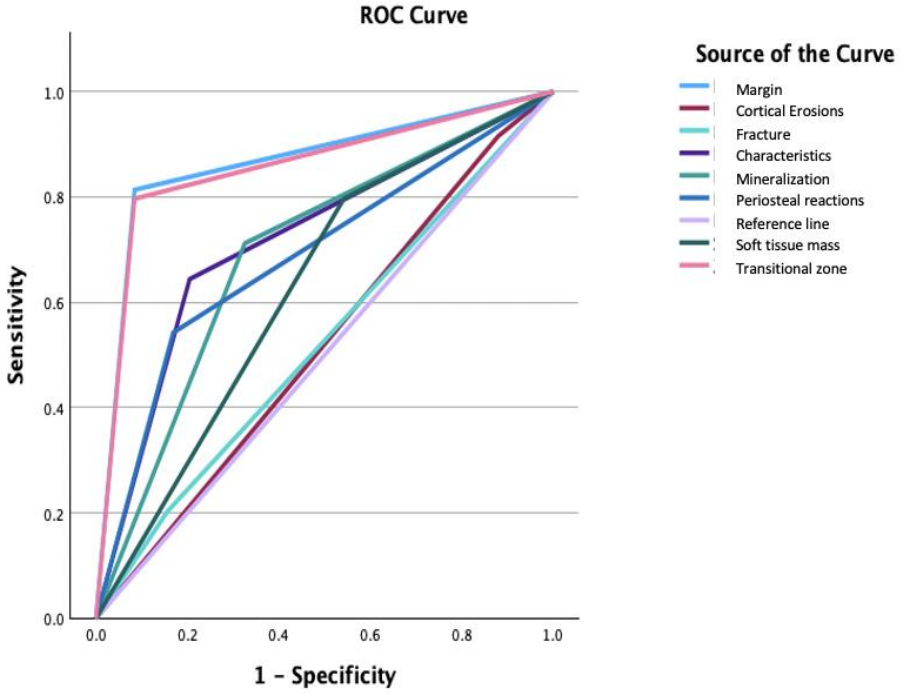

Figure 3. ROC Curve, Sensitivity, and Specificity of radiological factors analyzed in Modified X-Ray Scoring System

AUC for each radiological parameters were analyzed (Fig.3): characteristics of bone tumor (AUC 0,726, 95% CI 0,639-0,812), mineralizations (AUC 0,68, 95% CI 0,591-0,77), cortical erosions (AUC 0,577, 95%CI 0,483-0,672), margin (AUC 0,934, 95% CI 0,889-0.98), transitional zone (AUC 0,918, 95% CI 0,864-0,972), periosteal reaction (AUC 0,770 95% CI 0,686 -0,854), soft tissue bulging (AUC 0,635, 95 % CI 0,544 -0,726).

In Figure 4 is one of the samples of benign histopathology results of GCT in the left Tibia, it has been evaluated using MXSS, and the total score was 3 of 11, with the interpretation of a suggestive benign bone tumor, and Figure 5, also on of the malignant samples with histopathology result of osteosarcoma, evaluated using MXSS with the result 10 of 11 (suggestive malignant bone tumor).

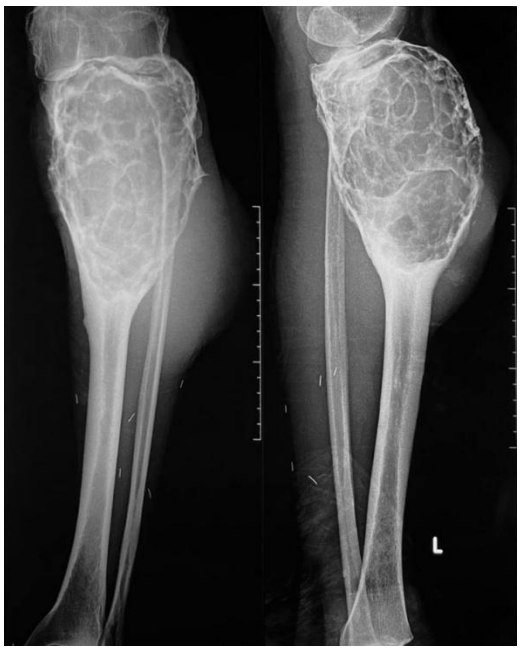

Figure 4. Sample of Histopathology result for Benign Epimetadiaphysis Proximal in the Left Tibia

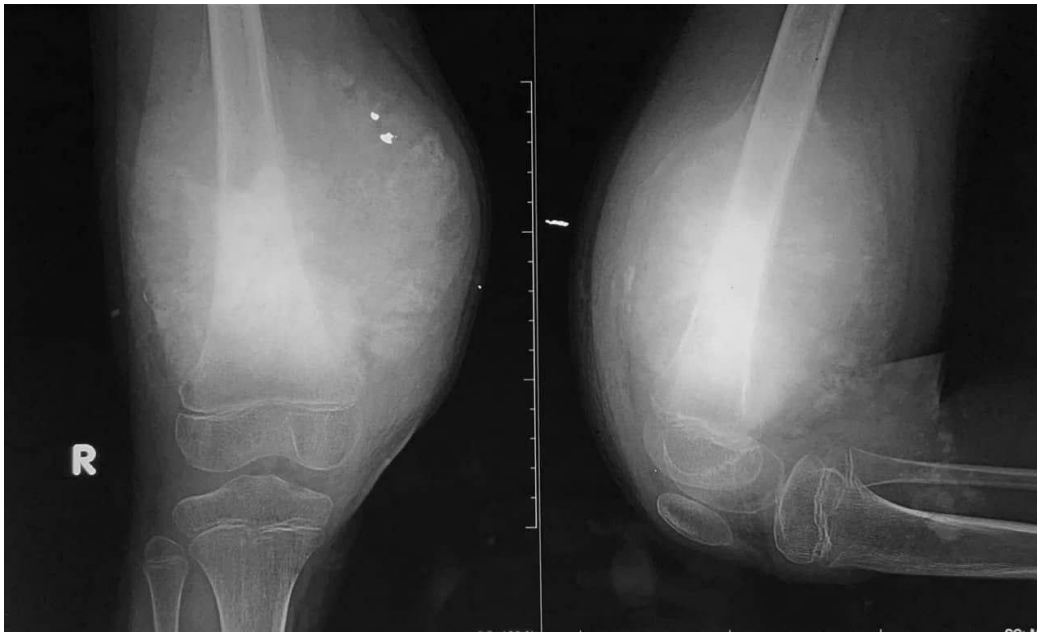

Figure 5. Sample Histopathology Result of Malignant Osteosarcoma for Metadiaphysis Distal on the Right Femur

4. DISCUSSIONS

A scoring-based approach in this study offers advantages in improving diagnostic accuracy, reducing the risk of clinical errors, and providing clinicians with more structured guidance in determining appropriate diagnostic and therapeutic steps [21]. We included seven parameters in the radiographic findings of bone tumor (tumor characteristic, mineralization, cortical erosion, margin, transitional zone, periosteal reaction, soft tissue bulging). MXSS scores of less than 4 were more likely to be benign, and those with total scores ≥ 4 or more were suggestive of malignant. Gerber et al.'s study reported there were many inconclusive interpretations for evaluating aggressive and non-aggressive characteristics in bone lesion radiograph [22]. MXSS given the high accuracy, PPV, and NPV, this scoring system can be a reliable tool to support decision making and improve patient outcomes.

We also report the distribution of our samples. In this study, tumor locations are frequently found in long bones, particularly the Femur (31%) and Tibia (22.5%), reflecting the typical prevalence of bone tumor sites in the clinical population [21] . This location is often a predilection site for bone tumors because this area experiences significant mechanical stress and has active metabolism, especially in the epiphysis and metaphysis of long bones [23]. Both benign and malignant bone tumors are more frequently found in young individuals and early adults. A study from Koyejo et al (2022) found that the most common age range for primary bone tumors was 21-30 years old, which is consistent with this study, which shows the 20-40 year age group has the most significant proportion of both benign and malignant bone tumors [24]. These findings align with the study stating that malignant bone tumors often occur during periods of active growth, which is thought to be related to increased osteoblastic activity during growth phases, creating a supportive environment for the proliferation of abnormal cells [7].

The current study shows excellent inter-observer reliability in interpreting benign and malignant bone tumors, showing that this scoring system is highly applicable and easy to implement. Radiologic parameters in this scoring system, margin and transition zone; ill-defined margins (score ≥2) and wide transition zones (score = 1), and periosteal reaction were strong predictors of malignancy ($p < 0.005$) and had a high AUC. These findings align with the Lodwick classification as the most frequently applied classification, where permeative destruction correlates with high-grade tumors [5], [6]. In this study, periosteal reaction with aggressive patterns (e.g., sunburst, Codman's triangle) was also correlated with malignancy. This is consistent with studies emphasizing periosteal reactions as markers of rapid tumor growth [10], [11]. Malignant bone tumors typically exhibit rapid and aggressive growth, which often outpaces the periosteum's ability to form new bone to contain the lesion. This response can result in typical periosteal reaction, such as onion skin, codman's triangle appearance, and in highly aggressive bone tumor, vertical calcification can make appearance of sunburst and hair-on-end [25] Cortical Erosion (Partial or total erosion) showed weaker correlation ($p = 0.358$), due to overlap in early-stage lesions [14] . The rationale for including cortical erosion in our study is that, from a previous study of the Lodwick classification system, cortical erosion is considered part of the lesion margin and cannot be independently

demarcated from it. [6]

The ROC curve in this study showed an area under the curve (AUC) of 0.936 (95% CI, 0.889–0.983) for MXSS, indicating excellent diagnostic accuracy. This study's correlation between radiological characteristics and histopathology emphasizes the importance of parameters such as ill-defined margins, wide transition zones, and complex periosteal reactions in distinguishing between benign and malignant tumors in this scoring system. MXSS minimizes subjectivity by standardizing margin and periosteal reaction assessments, enabling prompt referrals for biopsy or advanced imaging [26], [27]. For example, a score ≥4 triggers immediate referral for action, while scores <4 may avoid unnecessary MRI in resource-limited clinics [28]. A limitation of this study is parameter variability in cortical erosion; the interpretation is still subjective. This study also excludes secondary bone tumors as they will not fully represent the spectrum of bone lesions encountered in clinical practice.

5. CONCLUSION

MXSS, as a novel diagnostic tool, provides a standardized, accessible method for differentiating bone tumors, addressing critical gaps in regions with limited imaging resources. The scoring system was proven to be statistically significant in differentiating bone tumors for the given dataset. Integration into a mobile application could extend the MXSS utility to rural clinics, enabling triage and reducing diagnostic delays. Clinics in rural areas could use MXSS to prioritize referrals to tertiary centers. AI Integration in this study, by developing automated scoring algorithms, can minimize subjectivity [29]

6. CONFLICT OF INTEREST

There is no conflict of interest regarding the publication of this manuscript.

7. FUNDING

The authors did not receive financial support for the manuscript or publication.

AUTHOR'S CONTRIBUTIONS

Conceptualization, MRT, RS. Methodology, MRT, RS. Formal analysis, MRT Investigation, MRT, RS, PR. Writing original draft preparation, MRT. Writing—review and editing, MRT, RS. Visualization, MRT, RS, PR, F. Supervision, RS, PR, F. Project administration, MRT, RS, PR. All authors have read and agreed to the published version of the manuscript.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the use of artificial intelligence tools, specifically ChatGPT and perplexity.ai. The AI was solely used to improve language clarity and presentation. All scientific content and interpretation are the responsibility of the authors.

REFERENCES

[1] R. L. Siegel, K. D. Miller, and A. Jemal, "Cancer statistics, 2018," CA Cancer J Clin, vol. 68, no. 1, pp. 7–30, Jan. 2018, doi: 10.3322/caac.21442.

[2] R. Petca, Gavriliu S, and Burnei G, "Retrospective Clinicopathological Study of Malignant Bone Tumors in Children and Adolescents in Romania-Single Center Experience," 2016.

[3] C. Errani, S. Tsukamoto, and A. F. Mavrogenis, "Imaging Analyses of Bone Tumors," JBJS Rev, vol. 8, no. 3, 2020, doi: 10.2106/JBJS.RVW.19.00077.

[4] T. T. Miller, "Bone tumors and tumorlike conditions: Analysis with conventional radiography," Mar. 2008. doi: 10.1148/radiol.2463061038.

[5] M. Benndorf, F. Bamberg, and P. M. Jungmann, "The Lodwick classification for grading growth rate of lytic bone tumors: a decision tree approach," Apr. 01, 2022, Springer Science and Business Media Deutschland GmbH. doi: 10.1007/s00256-021-03868-8.

[6] G. S. Lodwick, A. J. Wilson, C. Farrell, P. Virtama, and F. Dittrich, "Determining growth rates of focal lesions of bone from radiographs.," Radiology, vol. 134, no. 3, pp. 577–583, Mar. 1980, doi: 10.1148/radiology.134.3.6928321.

[7] A. A. Salunke et al., "A proposed 'Radiological Evaluation Score for Bone Tumors' (REST): An objective system for assessment of a radiograph in patients with suspected bone tumor," Musculoskelet Surg, vol. 106, no. 4, pp. 371–382, Dec. 2022, doi: 10.1007/s12306-021-00711-0.

[8] R. Oemiati, E. Rahajeng, and A. Yudi Kristanto, "Prevalensi Tumor dan Beberapa Faktor yang Mempengaruhinya di Indonesia Tumor's Prevalence and Influence's Factors in Indonesia," Badan

Penelitian dan Pengembangan Kesehatan, vol. 39, no. 4, pp. 190–204, 2011.

[9] H. A. Sjakti, I. A. Putri, and E. Windiastuti, "Survival rate of pediatric osteosarcoma in Indonesia: a single center study," Paediatr Indones, vol. 62, no. 1, pp. 27–31, Dec. 2021, doi: 10.14238/pi62.1.2022.27-31.

[10] B. D. Ragsdale, R. A. Campbell, and C. L. Kirkpatrick, "Neoplasm or not? General principles of morphologic analysis of dry bone specimens," Int J Paleopathol, vol. 21, pp. 27–40, Jun. 2018, doi: 10.1016/j.ijpp.2017.02.002.

[11] S. Subramanian and V. K. Viswanathan, "Lytic Bone lesions," in Statpearls, Treasure Island: StatPearls, 2022.

[12] World Health Organization, WHO Classification of Tumours of Soft Tissue and Bone, 4th ed., vol. 5. Lyon: International Agency for research on Cancer, 2013.

[13] K. Motamedi and L. L. Seeger, "Benign bone tumors," Nov. 2011. doi: 10.1016/j.rcl.2011.07.002.

[14] D. Chiba et al., "Prediction of pathological fracture of the femoral shaft with an osteolytic lesion using a computed tomography-based nonlinear three-dimensional finite element method," Journal of Orthopaedic Science, vol. 21, no. 4, pp. 530–538, Jul. 2016, doi: 10.1016/j.jos.2016.04.003.

[15] C. M. Costelloe and J. E. Madewell, "Radiography in the initial diagnosis of primary bone tumors," Jan. 2013. doi: 10.2214/AJR.12.8488.

[16] A. E. T. Wenaden, T. A. Szyszko, and A. Saifuddin, "Imaging of periosteal reactions associated with focal lesions of bone," Apr. 2005. doi: 10.1016/j.crad.2004.08.017.

[17] N. Goyal, M. Kalra, A. Soni, P. Baweja, and N. P. Ghonghe, "Multi-modality imaging approach to bone tumors - State-of-the art," Jul. 01, 2019, Elsevier B.V. doi: 10.1016/j.jcot.2019.05.022.

[18] K. Hajian-Tilaki, "The choice of methods in determining the optimal cut-off value for quantitative diagnostic test evaluation," Stat Methods Med Res, vol. 27, no. 8, pp. 2374–2383, Aug. 2018, doi: 10.1177/0962280216680383.

[19] R. Trevethan, "Sensitivity, Specificity, and Predictive Values: Foundations, Pliabilities, and Pitfalls in Research and Practice," Front Public Health, vol. 5, Nov. 2017, doi: 10.3389/fpubh.2017.00307.

[20] T. K. Koo and M. Y. Li, "A Guideline of Selecting and Reporting Intraclass Correlation Coefficients for Reliability Research," J Chiropr Med, vol. 15, no. 2, pp. 155–163, Jun. 2016, doi: 10.1016/j.jcm.2016.02.012.

[21] A. Shrivastava and M. K. Nag, "Enhancing Bone Cancer Diagnosis Through Image Extraction and Machine Learning: A State-of-the-Art Approach," Surg Innov, vol. 31, no. 1, pp. 58–70, Feb. 2024, doi: 10.1177/15533506231220968.

[22] E. Gerber, Q. Said-Hartley, R. Gamieldien, T. Hartley, and S. Candy, "Accuracy of plain radiographs in diagnosing biopsy-proven malignant bone lesions," South African Journal of Radiology, vol. 23, no. 1, Dec. 2019, doi: 10.4102/sajr.v23i1.1768.

[23] G. J. Ribeiro et al., "Solitary bone tumor imaging reporting and data system (BTI-RADS): initial assessment of a systematic imaging evaluation and comprehensive reporting method," Eur Radiol, vol. 31, no. 10, pp. 7637–7652, Oct. 2021, doi: 10.1007/s00330-021-07745-9.

[24] T. Koyejo, O. Olusunmade, and O. Olufemi, "Epidemiology of primary bone tumours in Nigeria: a systematic review," SA Orthopaedic Journal, vol. 61, no. 3, pp. 167–171, 2022, doi: 10.17159/2309-8309/2022/v21n3a5.

[25] J. Plant and S. Cannon, "Diagnostic work up and recognition of primary bone tumours: a review," EFORT Open Rev, vol. 1, no. 6, pp. 247–253, Jun. 2016, doi: 10.1302/2058-5241.1.000035.

[26] A. Y. Aihara, "Imaging evaluation of bone tumors," Radiol Bras, vol. 49, no. 3, pp. VII–VII, Jun. 2016, doi: 10.1590/0100-3984.2016.49.3e2.

[27] Dr. M. Bhagat and Dr. P. Sharma, "Utility of Magnetic Resonance Imaging in the Assessment of Primary Bone Tumors," Scholars Journal of Applied Medical Sciences, vol. 11, no. 02, pp. 410–414, Feb. 2023, doi: 10.36347/sjams.2023.v11i02.022.

[28] A. Ghasemi and S. Ahlawat, "Bone Reporting and Data System (Bone-RADS) and Other Proposed Practice Guidelines for Reporting Bone Tumors," RöFo - Fortschritte auf dem Gebiet der Röntgenstrahlen und der bildgebenden Verfahren, vol. 196, no. 11, pp. 1134–1142, Nov. 2024, doi: 10.1055/a-2262-8411.

[29] A. Jajodia et al., "Application of the Kaiser score to increase diagnostic accuracy in equivocal lesions on diagnostic mammograms referred for MR mammography," Eur J Radiol, vol. 134, p. 109413, Jan. 2021, doi: 10.1016/j.ejrad.2020.109413.