ORIGINAL RESEARCH PAPER
Volume - 13 | Issue - 11 | November - 2024 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

MRI EVALUATION OF NON TRAUMATIC BONE LESIONS

Radiology

Dr. Asmita Ajay Deshmukh* Junior resident 3rd year, Department of Radiology, GMCH Chhatrapati Sambhajinagar Maharashtra, India. *Corresponding Author

Dr. Ajay Vare Associate professor, Department of Radiology, GMCH Chhatrapati Sambhajinagar Maharashtra, India.

Dr. Varsha Rote Kaginalkar Prof & HOD, Department of Radiology, GMCH Chhatrapati Sambhajinagar Maharashtra, India.

Dr. Anjali Pawar Dahiphale Associate professor Department of Radiology, GMCH Chhatrapati Sambhajinagar Maharashtra, India.

Dr. Prashant Titare Associate professor Department of Radiology, GMCH Chhatrapati Sambhajinagar Maharashtra, India.

ABSTRACT

Non-traumatic bone pathologies encompass a diverse array of conditions that can affect the bone's structural integrity and function. These include infectious processes such as osteomyelitis, inflammatory conditions like chronic recurrent multifocal osteomyelitis (CRMO), metabolic bone diseases such as osteoporosis and osteomalacia, and neoplastic lesions ranging from benign bone tumours to malignant bone sarcomas. Accurate diagnosis and staging of these conditions are crucial for appropriate clinical management, and MRI's detailed imaging capabilities play a vital role in this process. This was hospital based prospective observational study carried among patients undergoing MRI in evaluation of primary malignant bone tumours at tertiary care centre from October 2022 to October 2024. About 100 study participant enrolled in this study. Majority of the study participants 27(27%) belong to age group of 21-30 years & 66 (66%) were male. About 55(55%) were managed with surgical intervention. Chronic osteomyelitis was the most frequent diagnosis & the spine was the most common location, accounting for 16% of cases. Cortical involvement detection is highly sensitive (100%) and accurate (92.50%), ensuring nearly all cases are correctly identified. Soft tissue involvement has moderate sensitivity (72.90%) and lower accuracy (69.90%). Joint involvement has perfect specificity and PPV (both 100%), but lower sensitivity (50%), indicating it misses half the cases. Neurovascular involvement has the lowest sensitivity (27%) but excellent specificity and PPV (100%), though it is the least accurate overall (60.20%). We conclude that, MRI is excellent modality for precise assessment of extent of the tumour within medullary canal and extra-osseous soft tissue involvement. Its high contrast resolution gives good tissue characterisation. MRI is helpful in characterizing the histologic types of bone tumors, thus eliminating the need for biopsy or narrowing of the differential diagnosis.

KEYWORDS

MRI, Non traumatic bone lesion, Histopathological examination

INTRODUCTION:

Magnetic Resonance Imaging (MRI) has emerged as an indispensable tool in the evaluation of non-traumatic bone pathologies, providing unparalleled insights into the intricate anatomy and pathology of bone and surrounding soft tissues. Unlike other imaging modalities, MRI offers superior contrast resolution and the ability to visualize both bone marrow and soft tissue structures without the use of ionizing radiation. This attribute makes MRI particularly valuable for diagnosing and managing a wide range of non-traumatic bone conditions, including infections, neoplasms, metabolic disorders, and hematologic diseases.

Non-traumatic bone pathologies encompass a diverse array of conditions that can affect the bone's structural integrity and function. These include infectious processes such as osteomyelitis, inflammatory conditions like chronic recurrent multifocal osteomyelitis (CRMO), metabolic bone diseases such as osteoporosis and osteomalacia, and neoplastic lesions ranging from benign bone tumours to malignant bone sarcomas. Accurate diagnosis and staging of these conditions are crucial for appropriate clinical management, and MRI's detailed imaging capabilities play a vital role in this process. The primary advantage of MRI in evaluating non-traumatic bone pathologies lies in its ability to provide detailed images of bone marrow and soft tissue involvement, which are often not visible on plain radiographs or even CT scans. MRI is particularly sensitive in detecting bone marrow edema, an early indicator of various pathologies, and can differentiate between different types of tissue components based on their distinct signal characteristics on various MRI sequences. Furthermore, advanced MRI techniques, such as diffusion-weighted imaging (DWI) and dynamic contrast-enhanced imaging (DCE), have enhanced the diagnostic accuracy and functional assessment of bone lesions.

Infections like osteomyelitis can be challenging to diagnose early, yet MRI can detect marrow edema and abscess formation with high sensitivity. In the realm of neoplastic conditions, MRI excels in differentiating between benign and malignant tumours, assessing the extent of disease, and guiding biopsy and treatment planning. For metabolic disorders, MRI can identify characteristic changes in bone structure and composition, aiding in the diagnosis and monitoring of diseases like osteoporosis and Paget's disease.

Given the complex and varied presentation of non-traumatic bone pathologies, a thorough understanding of MRI techniques and their clinical applications is essential for radiologists and clinicians. This thesis aims to provide a comprehensive review of the role of MRI in the evaluation of non-traumatic bone pathologies, highlighting its diagnostic capabilities, advantages over other imaging modalities, and implications for patient management. Through detailed case studies and analysis of current literature, this work will underscore the critical importance of MRI in advancing our understanding and treatment of non-traumatic bone diseases.

METHODOLOGY

This was hospital based prospective observational study carried among patients undergoing MRI in evaluation of primary malignant bone tumours at tertiary care centre from October 2022 to October 2024. The calculated sample size was 100 with prevalence was 7%. Patients of all age groups with clinical examination finding suspicious for bony tumour or infection, bone lesion on radiograph or known case of primary malignant bone tumour include in study. Patient having history of metallic implants insertion, cardiac pacemakers and metallic foreign body in situ., contraindications to contrast media (e.g. severe renal impairment, hypersensitivity) were excluded. After Ethical Committee approval, study was started. Written informed consent taken from patients & detailed demographic profile, clinical examination, hematological, radiographic, Ct & previous MRI findings were noted. Then all patients undergo MRI evaluation with 1.5 Tesla Philips Machine and 3 Tesla. MRI features of different primary malignant bone tumors were recorded. This would be the end point of study. Any other complication if occurred were noted and appropriately treated. Pulse rate, Respiratory rate, Oxygen saturation continuously were recorded during the procedure. Adverse events such as Sensitivity to drug and complications related to intravenous contrast

administrations were recorded.

Data was entered in windows excel format. Frequency tables and measures of central tendency (mean) and measures of dispersion (Standard deviation) were obtained by using the statistical package SPSS software. Quantitative data is presented with the help of Mean and Standard deviation. Comparison among the study groups is done with the help of paired t test as per results of normality test. Qualitative data is presented with the help of frequency and percentage table. Association among the study groups is assessed with the help of chi Square test. 'p' value less than 0.05 is taken as significant.

RESULTS:

About 100 study participant enrolled in this study. Majority of the study participants 27(27%) belong to age group of 21-30 years & 66 (66%) were male. About 55(55%) were managed with surgical intervention. (Table 1)

Table 1 : Clinico-demographic Distribution Of Study Participants

Parameter		Frequency	Percent
Age group	10-20	24	24%
	21-30	27	27%
	31-40	16	16%
	41-50	13	13%
	51-60	17	17%
	>60	3	3%
Gender	Female	34	34%
	Male	66	66%
Surgery	No	45	45%
	Yes	55	55%

Chronic osteomyelitis was the most frequent diagnosis, accounting for 12% of cases, followed closely by osteochondroma at 11%. Less common diagnoses included leukemia at 5%, and conditions like giant cell tumor, aneurysmal bone cyst (ABC), fibrous dysplasia, and Brown's tumor each contributing 4%. (Fig 1)

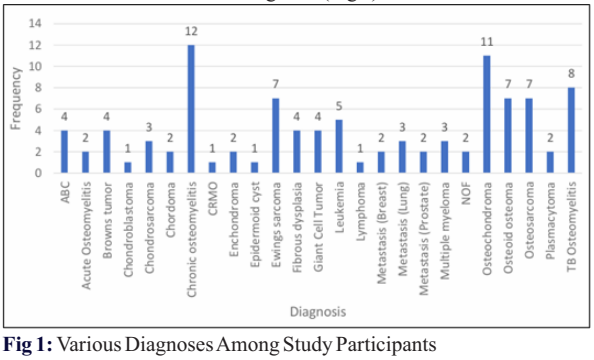

Fig 1: Various Diagnoses Among Study Participants

The spine was the most common location, accounting for 16% of cases, highlighting its susceptibility to such conditions. The proximal femur also showed a significant incidence, with 11% of lesions found there. Lesser affected areas included the pelvis and ribs, each with around 5-6% of cases. (Fig 2)

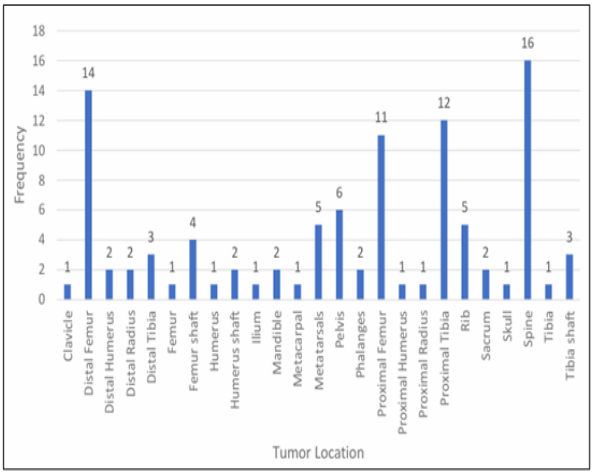

Fig 2: Lesion Location Among Study Participants

Table 2: Distribution Of Study Participants According To MRI & HP Findings

Findings	MRI		HP	
	Frequency	Percent	Frequency	Percent
Cortical Involvement	92	92%	74	74%
No Cortical Involvement	8	8%	26	26%
Soft Tissue Involvement	56	56%	45	45%
No Soft Tissue Involvement	44	44%	55	55%
Joint Involvement	38	38%	33	33%
No joint involvement	62	62%	67	67%
Neurovascular Involvement	17	17%	14	14%
No Neurovascular Involvement	83	83%	86	86%

On MRI about 92% lesion shows cortical involvement, 56% soft tissue involvement, 38% Joint involvement & 17% neurovascular involvement; in contrast to this on Histopathological examination only 74% showed cortical involvement, 45% soft tissue involvement, 33% Joint involvement & only 14% neurovascular involvement. (Table 2)

The diagnostic performance for various types of involvement in non-traumatic bone lesions shows varied results: Cortical involvement detection is highly sensitive (100%) and accurate (92.50%), ensuring nearly all cases are correctly identified. Soft tissue involvement has moderate sensitivity (72.90%) and lower accuracy (69.90%). Joint involvement has perfect specificity and PPV (both 100%), but lower sensitivity (50%), indicating it misses half the cases. Neurovascular involvement has the lowest sensitivity (27%) but excellent specificity and PPV (100%), though it is the least accurate overall (60.20%). (Table 3)

Table 3 : Diagnostic Performance For Various Types Of Involvement In Non Traumatic Bone Lesions

Involvement Type	Sensitivity	Specificity	PPV	NPV	Accuracy
Cortical Involvement	100%	25%	92.30%	100%	92.50%
Soft tissue Involvement	72.90%	25%	8710%	11.10%	69.90%
Joint Involvement	50%	100%	100%	58.80%	67.50%
Neurovascular Involvement	27%	100%	100%	52.90%	62.20%

DISCUSSION:

The aim of this study is to evaluate the effectiveness of Magnetic Resonance Imaging (MRI) in the detection, characterization, and management of non-traumatic bone lesions. This research seeks to explore the diagnostic capabilities of MRI in distinguishing between different types of bone lesions, such as benign, malignant, infective, and inflammatory lesions, with a particular focus on its ability to assess the extent of involvement, including cortical, soft tissue, joint, and neurovascular structures. The study also aims to correlate MRI findings with histopathological results to enhance the accuracy and reliability of diagnoses, thereby improving patient outcomes through more informed treatment planning.

The age distribution in this study highlights a predominant occurrence of non traumatic bone lesions in younger adults, particularly those aged 21-30 years, who accounted for 27% of the cases. This trend is consistent with the findings of **Lecouvet et al[1],** who reported that younger populations tend to present with bone lesions more frequently due to higher bone turnover and activity levels. The study also noted a decline in lesion frequency in older age groups, which may be attributed to the reduced metabolic activity in bones as individuals age. This pattern aligns with **Tang et al[2].**, who found that the metabolic nature of bone lesions often correlates with age, with younger individuals showing higher rates of certain benign conditions like osteochondroma and osteoid osteoma. The slight increase in lesions observed in the 51-60 years age group (17%) could reflect the onset of degenerative bone conditions, as suggested by **Arkun and Argın[3]**, who noted that age-related bone changes contribute to the prevalence of non-traumatic lesions in older adults.

Males were predominantly involved in this study, which was in line with study conducted by **Lecouvet et al[1], & Tanutit et al.[4]** This might be due to males are more prone to develop bone lesions, which could be due to factors such as higher physical activity levels, greater exposure to trauma, and biological differences in bone density.

The diverse range of diagnoses, with chronic osteomyelitis (12%) and osteochondroma (11%) being the most common, highlights the utility of MRI in identifying both common and rare bone pathologies. This finding is consistent with the study by **Tang et al**[2]., which demonstrated that MRI is crucial for characterizing the nature of bone lesions, effectively distinguishing between benign and malignant conditions. The presence of tuberculosis osteomyelitis (8%) and osteoid osteoma (7%) in the study population further underscores MRI's role in detecting infectious and neoplastic bone conditions. **Arkun and Argın**[3] emphasized that MRI is particularly valuable in differentiating true bone tumors from tumor-like conditions, which can mimic malignancies in imaging. This study's findings align with their observations, demonstrating MRI's superior diagnostic capability in identifying a wide spectrum of bone pathologies, including those that may present similarly in clinical practice.

The study revealed that 55% of the participants required surgical intervention, indicating the severity or complexity of their lesions. This finding aligns with the research by Gamal , who highlighted MRI's role in assessing conditions that necessitate surgical management, such as spinal trauma and bone marrow edema. **Arkun and Argın**[3] also emphasized the importance of MRI in guiding surgical decision-making, particularly in cases where the imaging findings suggest aggressive behaviour or a high risk of complications. This study supports their observations, highlighting the value of MRI in determining the appropriate clinical management of non-traumatic bone lesions, including the need for surgical.

The distribution of tumors, with the spine (16%) being the most common site, reflects the susceptibility of certain skeletal regions to non-traumatic lesions. This finding is consistent with the study by **Abdellatif et al**[5]**,** who reported that the spine is a frequent site for non-traumatic spinal lesions in children, particularly in cases of congenital and infectious conditions.

The high rate of cortical involvement (92%) observed in this study indicates that most lesions affect the bone's outer layer, which is critical for structural integrity. This finding aligns with the research by **Petritsch et al.**[6], who demonstrated that MRI is highly effective in detecting cortical bone involvement, particularly in cases of vertebral compression fractures. The study found that 56% of the cases exhibited soft tissue involvement, indicating the potential aggressiveness of the lesions. This observation is consistent with the findings of **Tang et al**[2]., Joint involvement was observed in 38% of the participants. This finding is supported by the research of **Crema et al.**[7]**,** who emphasized the role of MRI in assessing joint involvement, particularly in conditions affecting the knee. The study by **Spina et al.**[8] also underscored the importance of MRI in evaluating joint involvement in patients with multiple myeloma, where bone lesions can extend into adjacent joints, causing significant morbidity. The findings of this study align with these observations, indicating that joint involvement is a common and clinically relevant feature of non-traumatic bone lesions. Neurovascular involvement was detected in 17% of the cases, underscoring the importance of evaluating neurovascular structures in patients with bone lesions. This finding is consistent with the study by **Gamal**[9] **& Eiber et al.**[10]

The study revealed that 77% of the lesions had histopathological or microbiological involvement, indicating the importance of these evaluations in confirming the diagnosis. This finding aligns with the study by **Tang et al**[2].,, who emphasized the role of MRI in guiding biopsy and histopathological analysis, particularly in cases where the lesion's nature is unclear. The study by **Abdellatif et al**[5] also highlighted the importance of correlating MRI findings with histopathological results, particularly in pediatric patients with spinal lesions, where accurate diagnosis is crucial for effective treatment.

The comparison between MRI and histopathology findings in this study revealed varying degrees of agreement, with MRI showing higher detection rates for certain conditions. This finding is consistent with the research by **Lecouvet et al**[1]**,** who found that MRI is more sensitive than conventional imaging techniques in detecting bone marrow lesions, particularly in metastatic bone disease. Their study demonstrated that MRI's ability to visualize the entire lesion in vivo provides a more accurate assessment of lesion extent and involvement compared to histopathology, which relies on biopsy samples. The study by **Eiber et al.**[10] also highlighted the advantages of MRI, particularly when combined with PET, in providing a comprehensive evaluation of bone lesions, with higher sensitivity and specificity compared to other imaging modalities. The findings of this study support these conclusions, emphasizing the need for integrated imaging and histopathological approaches to ensure accurate diagnosis and treatment planning.

The diagnostic metrics revealed in this study, particularly the high sensitivity and accuracy of MRI in detecting cortical involvement, highlight MRI's effectiveness in assessing non-traumatic bone lesions. This finding is consistent with the research by **Tanutit et al.**[4],who reported that MRI has a sensitivity of 98.89% for distinguishing aggressive from non-aggressive bone tumors. Their study also found that MRI provides crucial information on lesion characteristics, such as ill-defined margins and cortical breaks, which are key predictors of aggressiveness. The study by **Petritsch et al.**[6] further supports these findings, demonstrating that MRI is highly effective in detecting bone marrow edema, which often accompanies cortical involvement in both traumatic and non-traumatic conditions. The findings of this study reinforce MRI's role as a critical diagnostic tool for evaluating non-traumatic bone lesions, particularly in assessing cortical and soft tissue involvement. The research by **Tang et al**[2]., who highlighted the high sensitivity and specificity of MRI in characterizing bone lesions and their surrounding structures. Their study demonstrated that MRI is particularly effective in detecting soft tissue involvement, which is crucial for staging and treatment planning in malignant tumors. The study by **Spina et al.**[8] also emphasized the importance of MRI in monitoring treatment response in multiple myeloma patients, where changes in lesion characteristics can significantly impact clinical outcomes. The findings of this study support these observations, indicating that MRI is a valuable tool for assessing various types of involvement in non-traumatic bone lesions, although its effectiveness may vary depending on the specific condition being evaluated.

CONCLUSION:

The impact of magnetic resonance imaging (MRI) in the evaluation of bone lesions has greatly enhanced detection and delineation compared with conventional modalities, with radiograph being the primary imaging modality used. MRI is excellent modality for precise assessment of extent of the tumour within medullary canal and extra-osseous soft tissue involvement. Its high contrast resolution gives good tissue characterisation. MRI is helpful in characterizing the histologic types of bone tumors, thus eliminating the need for biopsy or narrowing of the differential diagnosis, in order to decide whether biopsy, surgical intervention or simple observation are required for further management. MRI to be routinely incorporated into the diagnostic workup for patients presenting with non-traumatic bone lesions, especially in cases where conventional imaging methods are inconclusive. MRI should be used not only for initial diagnosis but also for monitoring treatment response and detecting recurrence. Clinicians should also consider using advanced MRI techniques, such as diffusion-weighted imaging (DWI) and dynamic contrast-enhanced (DCE) MRI, which have shown superior sensitivity in evaluating bone lesions. characterisation. MRI is helpful in characterizing the histologic types of bone tumors, thus eliminating the need for biopsy or narrowing of the differential diagnosis, in order to decide whether biopsy, surgical intervention or simple observation are required for further management.

REFERENCES:

1. Lecouvet FE, Larbi A, Pasoglou V, Omoumi P, Tombal B, Michoux N, et al. MRI for response assessment in metastatic bone disease. Eur Radiol. 2013;23:1986-1997.
2. Tang H, Ahlawat S, Fayad L. Multiparametric MR Imaging of Benign and Malignant Bone Lesions. Magn Reson Imaging Clin N Am. 2018;26(4):559 569.
3. Arkun R, Argın M. Pitfalls in MR Imaging of Musculoskeletal Tumors. Semin Musculoskelet Radiol. 2014;18:063-078.
4. Tanutit P, Pakdee W, Laohawiriyakamol T, Iamthanaporn K. Magnetic resonance imaging in differentiating between aggressive and non-aggressive bone tumors. Acta Radiol. 2022;64:625-637.
5. Abdellatif H, El-Refaey AY, Eid H. Role of Magnetic Resonance Imaging in Evaluation of Non-Traumatic Spinal Lesions in Children. Egypt J Hosp Med. 2023.
6. Petritsch B, Kosmala A, Weng AM, Krauss B, Heidemeier A, Wagner R, et al. Vertebral Compression Fractures: Third-Generation Dual-Energy CT for Detection of Bone Marrow Edema at Visual and Quantitative Analyses. Radiology. 2017;284(1):161-168.
7. Crema MD, Roemer FW, Marra MD, Burstein D, Gold GE, Eckstein F, et al. Articular cartilage in the knee: current MR imaging techniques and applications in clinical practice and research. Radiographics. 2011;31(1):37 61.
8. Spina F, Potepan P, Trecate G, Montin E, Montefusco V, Laffranchi A, et al. Results of a Prospective Study Comparing Whole-Body Diffusion-Weighted Magnetic Resonance Imaging with Skeletal X-Ray and Magnetic Resonance of the Spine for Assessing Bone Disease in Multiple Myeloma. Blood. 2012;120(21):2913-2913.
9. Gamal GH. Evaluation of spinal trauma by multi detector computed tomography and magnetic resonance imaging. Egypt J Radiol Nucl Med. 2014;45:1209-1214.
10. Eiber M, Takei T, Souvatzoglou M, Mayerhoefer M, Fürst S, Gaertner F, et al. Performance of Whole-Body Integrated 18F-FDG PET/MR in Comparison to PET/CT for Evaluation of Malignant Bone Lesions. J Nucl Med. 2014;55:191 197.