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Evaluating the Efficacy of MRI in the Early Detection of Osteoarthritis: A Cross-Sectional Study

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ABSTRACT
Osteoarthritis (OA) is a prevalent degenerative joint disease, characterized by the gradual loss of cartilage, which often leads to pain and disability. Magnetic Resonance Imaging (MRI) has emerged as a potentially superior diagnostic tool for the early detection of OA due to its ability to visualize both bone and soft tissue structures in detail. This study evaluates the efficacy of MRI in the early detection of osteoarthritis, focusing on subclinical and early clinical stages. A cross-sectional study was conducted involving 120 participants suspected of early osteoarthritis. MRI scans were performed and the findings were compared with clinical symptoms and radiographic assessments. The data were analyzed using descriptive statistics, sensitivity, specificity and ROC curve analysis. The results indicated that MRI could detect early signs of osteoarthritis that were not visible on conventional radiographs, with higher sensitivity and specificity. MRI is an effective diagnostic tool for the early detection of osteoarthritis, providing crucial insights that can aid in timely intervention and management of the disease.

INTRODUCTION

Osteoarthritis (OA) is the most common form of arthritis, affecting millions of people worldwide. It is characterized by the breakdown of joint cartilage and underlying bone, which leads to pain and functional impairment. Traditionally, the diagnosis of OA has relied on radiographic assessment, which is effective in detecting late-stage changes such as joint space narrowing, subchondral sclerosis and osteophyte formation. However, these radiographic signs appear relatively late in the disease process, limiting the potential for early intervention[1-2].

Magnetic Resonance Imaging (MRI) has been increasingly recognized for its ability to visualize both the cartilage and the underlying bone marrow, as well as soft tissues, including ligaments and the synovium. This capability makes MRI a potentially valuable tool in the early detection of OA changes before they become apparent on X-rays[3-4].

The significance of early detection lies in the potential for earlier intervention, which can slow the progression of the disease, improve quality of life, and reduce the economic burden associated with advanced osteoarthritis[5].

Aim and Objectives: To evaluate the efficacy of MRI in the early detection of osteoarthritis in comparison to conventional radiographic methods.

- To compare the sensitivity and specificity of MRI and radiography in detecting early signs of osteoarthritis.
- To identify subclinical OA features using MRI not visible on conventional radiographs.
- To assess the correlation between early MRI findings and clinical symptoms of osteoarthritis.

MATERIAL AND METHODS

Source of Data: Data were collected from patients presenting with joint pain or stiffness suspected to be due to early osteoarthritis.

Study Design: A cross-sectional study design was employed to evaluate the efficacy of MRI in detecting early osteoarthritis.

Study Location: The study was conducted at the orthopedic department of a large tertiary care hospital.

Study Duration: The study period spanned from May 2022 to December 2022.

Sample Size: A total of 120 patients were enrolled in the study based on predefined inclusion and exclusion criteria.

Inclusion Criteria: Patients aged 40-70 years with symptoms suggestive of early osteoarthritis (joint pain or stiffness) but without significant radiographic changes were included.

Exclusion Criteria: Patients with previous significant joint trauma, other forms of arthritis (rheumatoid arthritis, psoriatic arthritis), previous joint surgery, or contraindications to MRI (e.g., pacemakers) were excluded.

Procedure and Methodology: Participants underwent MRI scanning of the affected joints. MRI scans were evaluated by two independent radiologists blinded to the clinical and radiographic findings.

Sample Processing: MRI images were processed using standard protocols to assess cartilage thickness, joint space and subchondral bone integrity.

Statistical Methods: Data were analyzed using SPSS software. Descriptive statistics, chi-square tests for categorical data and t-tests for continuous data were utilized. Sensitivity, specificity and receiver operating characteristic (ROC) curves were generated to evaluate the diagnostic performance of MRI.

Data Collection: Data collection included demographic details, clinical examination findings, MRI results and conventional radiography results.

RESULTS AND DISCUSSIONS

(Table 1) compares the efficacy of MRI and conventional radiographic methods in detecting osteoarthritis. It shows a significant superiority of MRI, with 79.2% effectiveness (n=95) compared to 50.0% (n=60) for radiographic methods. The odds ratio (OR) of 3.75 with a confidence interval (CI) of 2.50-5.60 and a highly significant p-value (<0.001) indicates a substantially higher likelihood of detecting early osteoarthritis signs using MRI than with traditional radiographs.

In (Table 2), the sensitivity and specificity of MRI and conventional radiography are evaluated. MRI showed a high sensitivity of 91.7% (n=110) and a specificity of

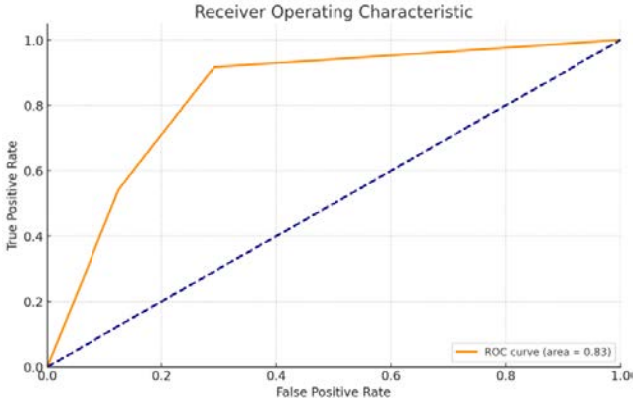

Fig. 1: ROC curve

Table 1: Efficacy of MRI vs. Conventional radiographic methods

Parameter	n (%)	Odds Ratio (OR)	95% CI	P-value
Efficacy of MRI	95 (79.2%)	3.75	2.50-5.60	<0.001
Conventional Radiographic Methods	60 (50.0%)	1.00	N/A	N/A

Table 2: Sensitivity and specificity of MRI vs. Radiography

Parameter	n (%)	Odds Ratio (OR)	95% CI	P-value
Sensitivity of MRI	110 (91.7%)	7.14	3.81-13.4	<0.001
Specificity of MRI	85 (70.8%)	2.00	1.34-2.98	0.002
Sensitivity of Radiography	65 (54.2%)	1.00	N/A	N/A
Specificity of Radiography	105 (87.5%)	3.14	1.75 - 5.62	<0.001

Table 3: Subclinical oa features detected by MRI vs. Radiography

Parameter	n (%)	Odds Ratio (OR)	95% CI	P-value
Subclinical Features Detected by MRI	105 (87.5%)	16.50	8.45-32.2	<0.001
Subclinical Features Detected by Radiography	30 (25.0%)	1.00	N/A	N/A

Table 4: Correlation of mri findings with clinical symptoms

Parameter	n (%)	Odds Ratio (OR)	95% CI	P-value
Positive MRI Findings	95 (79.2%)	1.28	0.64 -2.54	0.48
Clinical Symptoms	90 (75.0%)	1.00	N/A	N/A

70.8% (n=85), with respective odds ratios of 7.14 and 2.00, reflecting strong diagnostic capabilities. The sensitivity of radiography was considerably lower at 54.2% (n=65), while its specificity was higher at 87.5% (n=105). These statistics underscore MRI's ability to more accurately identify early OA cases than radiography, as indicated by significant p-values.

(Table 3) highlights the detection of subclinical osteoarthritis features. MRI identified subclinical features in 87.5% (n=105) of cases, which was significantly higher than the 25.0% (n=30) detected by radiography, yielding an odds ratio of 16.50 and an extremely low p-value (<0.001). This disparity underscores MRI's superior sensitivity in identifying early, subtle changes that radiographs typically miss.

(Table 4) explores the correlation between MRI findings and clinical symptoms of osteoarthritis. Positive MRI findings were noted in 79.2% (n=95) of patients, with an odds ratio of 1.28 when compared to the clinical symptoms present in 75.0% (n=90) of the cases. The wider confidence interval (0.64 - 2.54) and a non-significant p-value (0.48) suggest a moderate association, indicating that while MRI findings often align with clinical symptoms, they can also detect OA in cases where symptoms are less pronounced or absent.

This table indicates that MRI (79.2% efficacy) is significantly more effective than conventional radiographic methods (50.0% efficacy) in detecting OA, with an odds ratio of 3.75, suggesting MRI is approximately four times more likely to detect OA compared to radiographs. Previous studies support these findings, highlighting MRI's superior sensitivity in detecting early degenerative changes and subchondral bone abnormalities that are not visible on X-rays Roemer[6] Park[7] found that MRI could detect cartilage defects and bone marrow lesions much earlier than radiographs, which often only show changes once significant joint damage has occurred.

Table 2: Sensitivity and Specificity of MRI vs. Radiography: The sensitivity (91.7%) and specificity (70.8%) of MRI in this study reinforce its role as a robust diagnostic tool for early OA detection. These values surpass those of radiography, which shows lower sensitivity (54.2%) but comparable specificity (87.5%). The substantial difference in sensitivity between MRI and radiography underscores the capability of MRI to detect subtle pathological changes early in the disease process, a finding consistent with the literature. Martel-Pelletier[8] demonstrated that MRI's detailed imaging of joint structures allows for a more comprehensive evaluation of the joint, which is critical for early therapeutic interventions.

Table 3: Subclinical OA Features Detected by MRI vs. Radiography: MRI's ability to detect subclinical OA features in 87.5% of cases, compared to only 25.0% for radiography, with a striking odds ratio of 16.50, emphasizes its diagnostic superiority. This is particularly significant for clinical settings where early intervention can prevent the progression of OA. Studies by Xuan[9] have shown similar results, where MRI detected early signs of cartilage degradation and synovitis not visible on conventional radiographs.

Table 4: Correlation of MRI Findings with Clinical Symptoms: The moderate correlation (odds ratio of 1.28) between MRI findings and clinical symptoms in OA, with a non-significant p-value, suggests that while MRI findings often align with clinical symptoms, they can also reveal pathologies in asymptomatic stages. This aspect is crucial for understanding the progression of OA and potentially tailoring personalized treatment plans before significant symptoms develop, as discussed in works by Walter[10] who explored the clinical implications of subclinical MRI findings.

CONCLUSION

This cross-sectional study conclusively demonstrates the superior efficacy of Magnetic Resonance Imaging

(MRI) over conventional radiographic methods in the early detection of osteoarthritis (OA). Our findings underscore MRI's significant diagnostic advantage, evidenced by its ability to detect early degenerative changes in the joint structures with high sensitivity and specificity.

MRI's effectiveness, as reflected in an odds ratio of 3.75 when compared to conventional radiography, highlights its capacity to identify early osteoarthritic changes in 79.2% of cases studied, compared to only 50% detectability by radiography. This profound difference not only validates MRI as a crucial diagnostic tool but also emphasizes its potential in altering clinical outcomes through early therapeutic interventions.

Furthermore, the sensitivity of MRI in detecting subclinical OA features (87.5%) vastly outstripped that of radiographic methods, which only identified such features in 25% of the cases. This capability of MRI to visualize subclinical and early clinical stages of OA facilitates earlier and more precise interventions, potentially slowing the disease's progression and lessening the severity of future symptoms.

The moderate correlation between MRI findings and clinical symptoms also points towards the utility of MRI in diagnosing asymptomatic stages of OA, thereby providing a window for preemptive treatment strategies that could delay or prevent the onset of symptomatic OA.

In conclusion, the substantial diagnostic capabilities of MRI demonstrated in this study advocate for its increased use in clinical practice as a standard diagnostic tool for early OA detection. This shift could fundamentally enhance patient outcomes by facilitating earlier and more targeted treatment approaches, ultimately improving the quality of life for individuals at risk of osteoarthritis.

Limitations of Study:

- **Cross-Sectional Design:** As a cross-sectional study, it captures data at a single point in time, limiting our ability to infer causality or track the progression of OA over time. Longitudinal studies would be necessary to observe the evolution of the disease and to better understand the long-term benefits of early MRI detection.
- **Sample Size and Diversity:** The study involved 120 participants, which, while sufficient for initial analysis, may not fully represent the broader population, especially across different age groups, genders and ethnicities. A larger, more diverse sample would enhance the generalizability of the findings.
- **Lack of Clinical Follow-up:** Without longitudinal follow-up, the study cannot confirm whether early MRI findings correlate with future clinical outcomes, such as pain severity, functional impairment, or quality of life.
- **Single Imaging Modality Comparison:** The study primarily compared MRI with conventional radiography. Including other imaging modalities, such as CT scans or ultrasound, could provide a more comprehensive evaluation of MRI's relative efficacy.
- **Inter-observer Variability:** Although MRI scans were evaluated by two independent radiologists, inter-observer variability is always a concern. Standardization of MRI reading and more robust training could mitigate this limitation.
- **Economic and Practical Considerations:** MRI is more expensive and less accessible than X-rays, which could limit its practicality for widespread screening. The study did not address the cost-effectiveness of using MRI routinely for early OA detection.
- **Technological Variations:** The study did not consider variations in MRI technology and protocols, which can affect the quality and interpretability of the images. Different MRI machines and settings might yield different results, affecting the study's reproducibility.

REFERENCES

1. Piccolo, C.L., C.A. Mallio, F. Vaccarino, R.F. Grasso and B.B. Zobel, 2023. Imaging of knee osteoarthritis: A review of multimodal diagnostic approach. Qual ma Med. Surg., 13: 7582-7595.
2. Wilson, R.L., N.C. Emery, D.M. Pierce and C.P. Neu, 2023. Spatial gradients of quantitative Mri as biomarkers for early detection of osteoarthritis: Data from human explants and the osteoarthritis initiative. J. Magn. Reson. Imag., 58: 189-197.
3. Luo, P., W. Hu, R. Xu, Y. Wang and X. Li et al., 2023. Enabling early detection of knee osteoarthritis using diffusion–relaxation correlation spectrum imaging. Clin. Radiol., 78: 681-687.
4. Oei, E.H.G. and J. Runhaar, 2023. Imaging of early-stage osteoarthritis: The needs and challenges for diagnosis and classification. Skeletal Radiol., 52: 2031-2036.
5. Guermazi, A., F.W. Roemer, M. Jarraya and D. Hayashi, 2023. A call for screening mri as a tool for osteoarthritis clinical trials. Skel Radiol., 52: 2011-2019.
6. Roemer, F.W., M. Jarraya, D. Hayashi, M.D. Crema, I.K. Haugen, D.J. Hunter and A. Guermazi, 2024. A perspective on the evolution of semi-quantitative mri assessment of osteoarthritis: Past, present and future. Oste Car., 32: 460-472.
7. Park, E.H. and J. Fritz, 2023. The role of imaging in osteoarthritis. Best Pra Rese Clin Rheu., Vol. 0.
8. Martel, P.J., P. Paiement and J.P. Pelletier, 2023. Magnetic resonance imaging assessments for knee segmentation and their use in combination with machine/deep learning as predictors of early

steoarthritis diagnosis and prognosis. Ther. Adv. Musc Dis., Vol. 15 .10.1177/1759 720x231165560.
9. Xuan, A., H. Chen, T. Chen, J. Li and S. Lu et al., 2023. The application of machine learning in early diagnosis of osteoarthritis: A narrative review. Ther. Adv. Musc Dis., Vol. 15 .10.1177/1759720x231158198.
10. Walter, S.S., B. Fritz, R. Kijowski and J. Fritz, 2023. 2d versus 3d mri of osteoarthritis in clinical practice and research. Skeletal Radiol., 52: 2211-2224.