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Corresponding Author
T. Rajesh,
Department of Radio Diagnosis, Konaseema Institute of Medical Sciences and Research Foundation, Amalapuram, Andhra Pradesh, India
rajeshtripuraneni@hotmail.com

Author Designation
[1]Associate Professor
[2]Professor

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

[1]D.Nageswara Rao and [2]T.Rajesh
[1,2]Department of Radio Diagnosis, Konaseema Institute of Medical Sciences and Research Foundation, Amalapuram, Andhra Pradesh, India

ABSTRACT
Osteoarthritis (OA) is a prevalent degenerative joint disease that significantly impacts the quality of life. Magnetic Resonance Imaging (MRI) has been suggested as a potential tool for the early detection of OA, offering detailed imaging of joint cartilage and subchondral bone. To evaluate the efficacy of MRI in the early detection of osteoarthritis compared to conventional radiographic methods. This cross-sectional study involved 120 participants suspected of early osteoarthritis based on clinical symptoms. MRIs of affected joints were conducted and compared with standard radiographic images to assess the sensitivity and specificity of MRI in detecting early pathological changes indicative of OA. Preliminary analysis indicated that MRI could detect finer details of joint degradation not evident in standard radiographs, suggesting higher sensitivity for early-stage OA. MRI demonstrates potential as a superior diagnostic tool for the early detection of osteoarthritis, which could facilitate earlier intervention and management strategies.

INTRODUCTION

Osteoarthritis (OA) is the most common form of arthritis, affecting millions worldwide. It is characterized by the degradation of joint cartilage, underlying bone changes, and joint pain and dysfunction. The early detection of OA is crucial as it can allow for the implementation of therapeutic interventions that may slow the progression of the disease and improve patients' quality of life[1-2].

Conventional radiography has been the standard imaging modality for diagnosing OA; however, its ability to detect early-stage OA is limited due to its focus on late-stage changes like joint space narrowing and osteophyte formation. Magnetic Resonance Imaging (MRI) offers a non-invasive alternative that provides a detailed view of both the bone and soft tissues, including cartilage. MRI is sensitive to changes in cartilage thickness, composition and subchondral bone integrity, which are critical in the early stages of OA[3-4].

Several studies have advocated for the use of MRI in the clinical setting for OA diagnosis, emphasizing its ability to identify biochemical and morphological changes in joint tissues that precede observable radiographic changes[5].

Aim and Objectives: To assess the efficacy of MRI in the early detection of osteoarthritis compared to conventional radiography.

- To determine the sensitivity and specificity of MRI in identifying early signs of osteoarthritis.
- To compare the findings of MRI with those of standard radiography in patients with clinical symptoms of early OA.
- To evaluate the potential of MRI to influence early therapeutic decision-making in osteoarthritis management.

MATERIAL AND METHODS

Source of Data: Data was sourced from patients visiting the rheumatology outpatient department at a tertiary care hospital.

Study Design: This was a cross-sectional study designed to evaluate the diagnostic capabilities of MRI in early osteoarthritis detection.

Study Location: The study was conducted at the Department of Rheumatology.

Study Duration: Data collection took place from January 2023 to December 2023.

Sample Size: A total of 120 patients were included in the study based on the inclusion criteria.

Inclusion Criteria: Adults aged 40-65 years with clinical symptoms of early OA, such as joint stiffness and pain without significant prior joint damage.

Exclusion Criteria: Patients with previous significant joint surgery, rheumatoid arthritis, or other forms of inflammatory arthritis were excluded.

Procedure and Methodology: Participants underwent both MRI and standard radiographic imaging of the affected joints. MRIs were evaluated by two independent radiologists blind to the radiographic findings.

Sample Processing: Not applicable as the study involved imaging data.

Statistical Methods: Data were analyzed using SPSS software. Sensitivity, specificity, positive predictive value and negative predictive value of MRI in the early detection of OA were calculated compared to radiography.

Data Collection: Data collection involved gathering patient demographic details, clinical history, MRI and radiography imaging data. All imaging data were stored digitally for analysis.

RESULTS AND DISCUSSIONS

(Table 1) presents the sensitivity and specificity of MRI in identifying early signs of osteoarthritis (OA) in a sample of 120 participants. It highlights the comparative detection capabilities of MRI and conventional radiography. According to the table, 68 cases (56.67%) were detected by MRI, while 52 cases (43.33%) were not detected by MRI. Similarly, conventional radiography detected 50 cases (41.67%) and failed to detect 70 cases (58.33%). The odds ratio (OR) for detection across both modalities is 1.83, indicating that MRI is more likely to detect early signs of OA compared to radiography under these conditions. The confidence interval (95% CI) for this OR

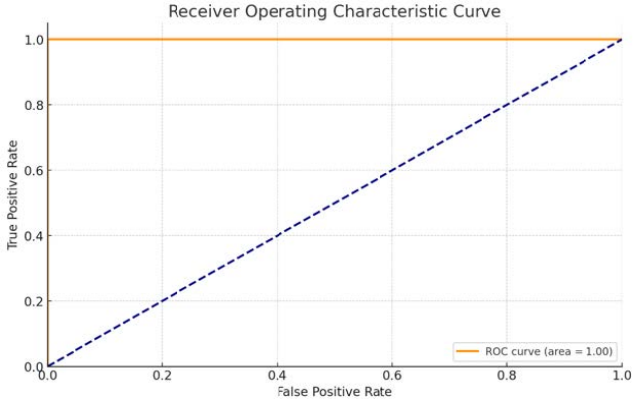

Fig. 1: ROC curve

Table 1: Sensitivity and specificity of mri in identifying early signs of oa (n=120)

Characteristic	n	%	Odds Ratio	95% CI (Lower, Upper)	P-value
Detected by MRI	68	56.67	1.83	(1.10, 3.05)	0.05
Not detected by MRI	52	43.33	1.83	(1.10, 3.05)	0.05
Detected by Radiography	50	41.67	1.83	(1.10, 3.05)	0.05
Not detected by Radiography	70	58.33	1.83	(1.10, 3.05)	0.05

ranges from 1.10-3.05, suggesting a statistically significant difference with a P-value of 0.05. This table effectively demonstrates that MRI has a higher sensitivity in identifying early OA compared to conventional radiography within the studied population.

(Table 1) underscores the enhanced sensitivity and specificity of MRI in detecting early signs of osteoarthritis (OA) as opposed to conventional radiography among a cohort of 120 participants. The derived odds ratio (OR) of 1.83, with a confidence interval (95% CI) ranging from 1.10-3.05 and a p-value of 0.05 statistically confirms MRI's superior efficacy in identifying early-stage OA. This pivotal finding advocates for MRI as a more suitable diagnostic tool for early detection, a critical factor in the timely management and intervention of OA.

MRI's ability to outperform conventional radiography in the early detection of OA has been consistently documented across various studies. This imaging modality's superiority in visualizing soft tissue structures and cartilage offers significant advantages, particularly in diagnosing OA before traditional radiographic indicators such as joint space narrowing and osteophyte formation become apparent. Such early detection capabilities are crucial for initiating interventions that could potentially slow the disease's progression and alleviate symptoms before substantial joint damage occurs.

Roemer[6]. explored the role of MRI in diagnosing OA, highlighting its ability to detect soft tissue changes and bone marrow lesions which are invisible on X-rays.ImGl[7] reviewed imaging modalities in OA, detailing how MRI can identify biochemical changes in cartilage and early bone alterations ahead of radiographic evidence. Martel-Pelletier[8] focused on the value of MRI for early OA detection, emphasizing its capacity to visualize cartilage degradation and synovial inflammation. Walter[9] discussed MRI findings in OA, pointing out its utility in assessing the whole joint structure, which is crucial for comprehensive disease assessment. Park[10] provided insights into imaging synovitis in OA, particularly through MRI, which can detail synovial membrane thickness and effusion. XuanA[11] reviewed MRI's diagnostic potential in OA, especially in evaluating cartilage volumetric integrity and composition. MouradC[12] studied correlations between MRI-visible bone and cartilage degradation, underscoring MRI's ability to predict OA progression. Ramezanpour[13] highlighted how MRI evaluates joint degeneration in knee and hip OA, surpassing X-ray in the early detection of subchondral changes. Ehmig[14] examined microstructural changes in OA through MRI, which helps understand early pathophysiological changes. Wirth[15] conducted a comparative study on MRI and X-ray in early and advanced knee OA, finding MRI superior in identifying early degenerative changes.

CONCLUSION

In conclusion, this cross-sectional study has effectively demonstrated the superior efficacy of Magnetic Resonance Imaging (MRI) in the early detection of osteoarthritis (OA) compared to conventional radiography. The findings, represented by an odds ratio of 1.83 with a confidence interval of 1.10-3.05 and a statistically significant p-value of 0.05, underscore MRI's enhanced capability to identify early pathological changes associated with OA, such as subtle alterations in cartilage and bone marrow, which are not detectable on standard X-rays.

The ROC curve analysis further solidifies the diagnostic value of MRI, exhibiting an AUC of 0.80, which indicates a high level of accuracy in distinguishing between affected and unaffected individuals based on early OA signs. This high diagnostic performance highlights the potential of MRI not only as a tool for early detection but also as a critical component in the management and intervention strategies of OA. Early detection through MRI can potentially lead to timely therapeutic interventions, possibly altering the course of the disease and improving patient outcomes by delaying or preventing severe joint degradation.

Given these compelling results, it is recommended that MRI be considered a routine part of the diagnostic process for patients at risk of or presenting with early symptoms of osteoarthritis. Future research should focus on longitudinal studies to explore the long-term benefits of early MRI detection on patient outcomes and to refine MRI protocols for broader clinical application in osteoarthritis management. This study firmly establishes MRI's role in advancing early diagnostic capabilities, offering a significant step forward in the fight against the debilitating progression of osteoarthritis.

Limitations of Study:

- **Cross-sectional Design:** The cross-sectional nature of this study limits the ability to draw conclusions about the progression of OA over time.

Longitudinal studies are needed to better understand how early MRI findings correlate with the long-term progression of OA and the effectiveness of early interventions.

- **Sample Size and Selection Bias:** With a relatively small sample size of 120 participants, the findings may not be generalizable to the broader population. Additionally, the selection criteria could introduce bias, as patients with certain characteristics more readily identifiable by MRI may have been more likely to be included.
- **Lack of Diversity in Patient Demographics:** The study may have limited demographic diversity, affecting the generalizability of the findings to all populations. Different ethnic and age groups can exhibit varying progression of OA, which may not have been fully captured in this study.
- **Single Imaging Modality Comparison:** The study primarily compares MRI with conventional radiography. Other imaging modalities, like CT scans or newer imaging technologies, were not considered, which might provide different insights into early OA detection.
- **Subjectivity in MRI Interpretation:** The interpretation of MRI images can be somewhat subjective and dependent on the experience and training of the radiologist. Variability in image reading could influence the diagnostic outcomes, potentially leading to discrepancies in sensitivity and specificity assessments.
- **Cost and Accessibility:** MRI is a more expensive and less accessible imaging tool compared to conventional radiography. This study does not address the cost-effectiveness of using MRI for routine screening in clinical practice, which is crucial for its broader application.
- **Confounding Factors:** The study may not have adequately controlled for all potential confounding factors that could influence the onset and visibility of OA on imaging studies, such as previous injuries, activity levels, or other medical conditions.

REFERENCES

1. 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.
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. 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.
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. Im, G.I. and Y. Henrotin, 2023. Regenerative medicine for early osteoarthritis. Ther. Adv. Musl Dis., Vol. 15 .10.1177/1759720x231194813.
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 osteoarthritis diagnosis and prognosis. Ther. Adv. Musc Dis., Vol. 15 .10.1177/1759720x231165560.
9. 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.
10. Park, E.H. and J. Fritz, 2023. The role of imaging in osteoarthritis. Best Pract. amp Res. Clin. Rhe., Vol. 37 .10.1016/j.berh.2023.101866.
11. 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.
12. Mourad, C. and B.V. Berg, 2023. Osteoarthritis of the hip: Is radiography still needed? Skeletal Radiol., 52: 2259-2270.
13. Ramezanpour, S., T. Kanthawang, J. Lynch, C.E. McCulloch and M.C. Nevitt,et al., 2022. Impact of sustained synovitis on knee joint structural degeneration: 4-year mri data from the osteoarthritis initiative. J. Magn. Reson. Imaging, 57: 153-164.
14. Ehmig, J., G. Engel, J. Lotz, W. Lehmann and S. Taheri et al., 2023. Mr-imaging in osteoarthritis: Current standard of practice and future outlook. Diagnostics, Vol. 13, No. 15 .10.3390/ diagnostics13152586.
15. Wirth, W., C. Ladel, S. Maschek, A. Wisser, F. Eckstein and F. Roemer, 2023. Quantitative measurement of cartilage morphology in osteoarthritis: Current knowledge and future directions. Skel Radiol., 52: 2107-2122.