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ORIGINAL ARTICLE

Correlation between MRI and conventional radiographic findings in evaluation of osteoarthritis.

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ABSTRACT… Objective: To evaluate the diagnostic accuracy of X-rays in detecting osteoarthritis (OA) in comparison to MRI. **Study Design:** Cross-sectional study. **Setting:** The Fauji Foundation Hospital, Rawalpindi. **Period:** August, 2023 to March, 2024. **Methods:** Total 350 patients consented to clinical interviews, physical examinations, standing radiographs, and MRIs. Standing, semi-flexed posteroanterior radiographs of the knees were obtained with proper alignment to accurately detect joint space narrowing. Manual measurements of joint space width were conducted by a blinded orthopedic surgeon using the Kellgren-Lawrence grading system. Data analysis was performed using SPSS 23, with frequencies, percentages, means, and standard deviations calculated for relevant variables. Diagnostic accuracy was assessed using a 2x2 table. **Results:** Of the 350 patients, 61.1% were up to 60 years old, and 38.9% were over 60 years old. Among those with positive MRI results, 70.1% also had a positive X-ray, while 29.6% did not. Cohen's Kappa was 0.377, indicating fair to moderate agreement. Sensitivity was 54.3%, specificity 82.4%, positive predictive value 70.1%, and negative predictive value 70.4%, with an overall diagnostic accuracy of 70.3%. **Conclusion:** X-rays demonstrated high specificity and moderate predictive values, but low sensitivity, suggesting that some OA cases may be missed if relying solely on X-rays.

Key words: Diagnostic Accuracy, MRI, Osteoarthritis, Obesity, Sensitivity, Specificity, X-ray.

INTRODUCTION

Osteoarthritis (OA) is the most common form of arthritis worldwide, comprising 62% of all arthritis cases from 2017 to 2018. This rise is influenced by differences between rural and urban areas and between high- and low- to moderate-income regions. With the global population aging and obesity rates increasing, OA prevalence is expected to grow, highlighting the need for comprehensive strategies to address this significant health challenge.[1]

Affecting joints such as the hands, hips, knees, feet, and spine, OA manifests primarily through the symptom of pain, prompting individuals to seek medical attention and subsequently receive a diagnosis[2-3], with certain studies suggesting even higher rates, reaching 654 million in individuals aged 40 years and older. As the global population ages and obesity rates surge, the prevalence of OA is anticipated to rise, underscoring the imperative for comprehensive strategies to address this escalating health challenge.[4]

Osteoarthritis (OA) exhibits a notable age-related prevalence, with rates escalating across age groups. Moreover, gender differences are evident, with a higher prevalence in females (8.1 percent) compared to males (5.8 percent).[3] Symptomatic hip and knee OA are reported by nearly 10 percent of males and 14 percent of females in the 50 to 69 years age category, with these figures rising to 18 percent for males and 25 percent for females in the 70 years and older age group. These findings emphasize the age and gender dynamics in OA prevalence, underscoring the importance of tailored interventions for different demographic groups.[2,3,5]

Recent data on osteoarthritis (OA) in Pakistan[6]

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from a comprehensive study involving 300 participants provide valuable demographic and prevalence insights. The cohort, with a mean age of 48.96 years (±6.804), indicates a focus on a middle-aged population. Notably, the majority of participants were female (n=208), outnumbering male participants (n=92), which aligns with the recognized higher prevalence of osteoarthritis among women. The study revealed a substantial prevalence of OA in middle-aged adults, affecting 170 out of 300 participants (56.7%). This underscores the noteworthy burden of osteoarthritis within this specific demographic group, emphasizing the need for targeted interventions and healthcare strategies to address this prevalent health concern in Pakistan.

Various risk factors have been identified in association with OA. The cardinal symptoms of OA encompass joint pain, stiffness, and limitations in mobility. Typically, these symptoms manifest in one or a few joints, particularly in individuals of middle age or older. Beyond the joint-related symptoms, individuals with OA may experience additional manifestations, including sequelae such as muscle weakness and impaired balance.[8] Additionally, comorbidities such as fibromyalgia may coexist in patients with OA, further contributing to the complexity of this musculoskeletal condition.[9-10]

Until recently, the assessment of osteoarthritis through imaging primarily relied on conventional radiography. The utilization of radiography in both clinical practice and research, however, has been accompanied by notable challenges. Despite improvements in techniques for obtaining reproducible serial radiographs of joints, the most promising avenue for advancing our understanding of osteoarthritis and its therapeutic approaches resides in magnetic resonance imaging (MRI). Distinctively capable of examining the joint as a holistic organ, MRI surpasses conventional radiography by providing direct visualization of essential intra-articular structures such as articular cartilage, synovium, and menisci, all critical to the functional integrity of joints. While substantial strides have been made in MRI assessment of articular cartilage, much of this progress emanates from relatively small cross-sectional studies, underscoring the need for further comprehensive investigations in this domain.[11]

METHODS

In this study, patients were enrolled in the Fauji Foundation Hospital, Rawalpindi during August, 2023 to March, 2024 and written informed consent was taken. Consent regarding examination, and radiological investigations were also taken where required. To protect their privacy, we removed all personal data from the research records. The local ethical committee approved the study (ref. no. 738/RC/FFHRWP, dated 24 July, 23), considering the informed consent ethically acceptable and the study's methods appropriate.

We took a standing, slightly bent x-ray of the knee for all patients using the same procedure. The knees were bent 7° to 10° to align the medial tibial plateau parallel to the x-ray beam. This alignment ensured accuracy, and a slight bend of 7° to 10° was enough. Both feet were rotated until the tibial spines aligned with the femur's intercondylar notch. This alignment was crucial for accurately detecting joint space narrowing in knee osteoarthritis and has been used in many clinical trials. We found this position best for reproducibility and sensitivity. Traditional x-rays taken with the knee straight often underestimated the severity of the disease.

We manually measured the joint space width to minimize technical errors. These initial x-rays were analyzed by a blinded observer, the main researcher, who had no patient information. We trusted that an experienced orthopedic surgeon could accurately assess these weight-bearing x-rays as part of routine practice. We examined the x-rays for osteophytes, sclerosis, subchondral cysts, and joint space narrowing based on Spahn criteria. The degree of knee osteoarthritis was determined using the Kellgren-Lawrence grading system, which considers these signs.

Data analysis was done using SPSS 23. Categorical variables like age groups, obesity, family history of OA, OA diagnosed on x-ray and

MRI, were analyzed to determine frequency and percentages; while for the continuous variables were analyzed to determine the mean and standard deviations. Diagnostic accuracy and various parameters were calculated using the 2 x 2 table. Outcome variables were stratified for age, gender, family history and obesity and post -stratification chi square test was applied, to determine the effect of these on the outcome taking p value of less than 0.05 as statically significant.

RESULTS

Of 350 patients, 61.1% aged up to 60 years and 38.9% aged more than 60 years. In terms of gender distribution, 66% of the patients are male, while 34% are female. The prevalence of obesity in the sample is 48.6%, with 51.4% categorized as non-obese.

Additionally, 46.3% of patients report a family history of OA, while 53.7% do not have a family history of the condition. The age distribution reveals a diverse representation of both (upto 60) and (>60 years) individuals in the sample, suggesting a broad demographic coverage. The gender distribution indicates a higher representation of males, contributing to 66% of the sample.

The prevalence of obesity, while relatively high at 48.6%, also highlights that a significant portion of the sample is non-obese. The presence of a family history of OA is reported by almost half of the patients, showcasing the potential genetic influence on the condition in this population. These findings provide a snapshot of the demographic and health-related characteristics of the patient sample, offering valuable insights for further analysis and investigation into the factors associated with osteoarthritis in different age groups, genders, and familial contexts. The dataset's comprehensive coverage allows for a nuanced exploration of potential correlations and patterns within the context of osteoarthritis. (Table-I)

The data was organized into a 2x2 contingency table, comparing the results of X-Ray and MRI for patients diagnosed with osteoarthritis. For patients with a positive MRI result (osteoaarthritis present), 70.1% also had a positive X-Ray result, while 29.6% had a negative X-Ray result. Conversely, for patients with a negative MRI result (no osteoarthritis), 29.9% had a positive X-Ray result, and 70.4% had a negative X-Ray result. The overall agreement between X-Ray and MRI, as measured by Cohen's Kappa, is reported as 0.377. Cohen's Kappa is a statistical measure that assesses the level of agreement between two categorical variables beyond what would be expected by chance. In this context, a Kappa value of 0.377 suggests a fair to moderate level of agreement between X-Ray and MRI in diagnosing osteoarthritis. (Table-II)

The comparison of osteoarthritis (OA) diagnosis via X-ray and MRI revealed key diagnostic metrics. Sensitivity, which measured the ability of X-rays to correctly identify those with OA as confirmed by MRI, was approximately 54.3%. This indicated that X-rays correctly identified just over half of the true OA cases detected by MRI, with 82 true positives and 69 false negatives. Specificity, which measured how well X-rays identified those without OA, was approximately 82.4%. This high specificity suggested that X-rays were effective in ruling out OA when it was not present, as confirmed by MRI, with 164 true negatives and 35 false positives.

The positive predictive value (PPV), which indicated the likelihood that patients with a positive X-ray result truly had OA, stood at about 70.1%. This meant that when an X-ray indicated OA, there was a 70.1% chance that the diagnosis was accurate, based on 82 true positives and 35 false positives. The negative predictive value (NPV), which indicated the probability that patients with a negative X-ray result did not have OA, was around 70.4%. This showed that when an X-ray did not indicate OA, there was a 70.4% chance that the patient truly did not have the disease, based on 164 true negatives and 69 false negatives. The overall diagnostic accuracy of X-rays in detecting OA, compared to MRI, was approximately 70.3%, reflecting 246 correct diagnoses out of 350 total cases. While X-rays showed high specificity and

moderate predictive values, their sensitivity was relatively low, indicating that many OA cases might have been missed when relying solely on X-ray diagnosis.

Variables		No. of Patients	%
Age	Upto 60	214	61.1%
	More than 60	136	38.9%
Gender	Male	231	66%
	Female	119	34%
Obesity	Yes	170	48.6%
	No	180	51.4%
Family history of OA	Yes	162	46.3%
	No	188	53.7%

Table-I. Showing the details of various demographic parameters of the patients enrolled in the study. (n=350)

		X-Ray		Total	Kappa
		Yes	No		
MRI	Yes	82(70.1%)	69(29.6%)	151(100%)	0.377
	No	35(29.9%)	164(70.4%)	199(100%)	
Total		117	233	350	

Table-II. Showing the diagnostic value and details of agreement between X-Ray and MRI for the diagnosis of osteoarthritis of the patients enrolled in the study. (n=350)

Diagnostic Parameters	Value	Calculation
Sensitivity	54.3%	82 / (82 + 69)
Specificity	82.4%	164 / (164 + 35)
Positive Predictive Value (PPV)	70.1%	82 / (82 + 35)
Negative Predictive Value (NPV)	70.4%	164 / (164 + 69)
Diagnostic Accuracy	70.3%	(82 + 164) / 350

Table-III

DISCUSSION

Osteoarthritis (OA) is a prevalent and burdensome musculoskeletal condition affecting millions of individuals worldwide. The provided data underscores the significant impact of OA on public health, with a global prevalence of approximately 595 million individuals, and a notable rise in high-income regions. The increasing prevalence of OA is multifactorial, influenced by demographic shifts, including an aging population and rising obesity rates.[12]

In a study, epidemiology of osteoarthritis (OA) was accessed in Israel from 2013 to 2018, using a nationally representative primary care database. By the end of 2018, prevalence of OA was estimated to be 115.3 per 1000 persons. The incidence of OA increased over time, peaking between ages 60-70, and then plateauing in men while declining in women at older ages. These findings underscore the rising burden of OA and emphasize the importance of timely preventive and therapeutic interventions, urging further research to identify modifiable risk factors for effective management.[13]

One of the critical findings is the age and gender dynamics in OA prevalence. OA exhibits a clear age-related prevalence, with rates escalating with advancing age. Furthermore, females tend to have a higher prevalence of OA compared to males. This demographic insight emphasizes the importance of tailored interventions and healthcare strategies to address the specific needs of different demographic groups. The study conducted in Pakistan provides valuable insights into the demographic characteristics and prevalence of OA in the region. The high prevalence of OA among middle-aged adults, particularly females, underscores the significant burden of the condition in this specific demographic group. These findings emphasize the need for targeted interventions and healthcare strategies to address OA effectively in Pakistan. The agreement between X-ray and MRI diagnostic methods for OA is presented, indicating a fair to moderate level of agreement between the two modalities.

Knee osteoarthritis (OA) is influenced by various factors, including modifiable and unmodifiable factors. In a meta-analysis, pooled estimates revealed a negative association between knee OA prevalence and education level, supported by several previous studies. However, no statistically significant difference in prevalence was found between rural and urban areas, contrary to some previous findings. In cohort studies, the pooled estimates showed a lower incidence of knee OA in smokers compared to non-smokers, which contrasts with previous systematic reviews. Possible explanations include confounding factors

like body mass index (BMI) and the presence of multiple comorbidities among smokers. Further prospective studies are needed to elucidate the dose-response relationship between smoking and knee OA incidence.[14]

A recent study comparing weight-bearing radiographs and MRI for diagnosing knee osteoarthritis (OA) found that MRI demonstrated higher specificity (88.6% vs. 60.0%), positive predictive value (81.0% vs. 56.2%), negative predictive value (81.6% vs. 77.8%), and overall accuracy (81.4% vs. 66.1%) compared to radiographs. While radiographs showed slightly higher sensitivity (75.0% vs. 70.8%), logistic regression analysis revealed that adding radiographs to MRI did not enhance diagnostic accuracy.[15]

Based on the study mentioned earlier, weight-bearing radiographs demonstrated a sensitivity of 75% and a specificity of 60% for diagnosing knee osteoarthritis. While MRI may offer higher diagnostic accuracy, radiographs still provide valuable information in settings where MRI is not available. Despite its limitations, such as lower sensitivity, radiography can aid in the diagnosis of osteoarthritis, particularly when MRI is inaccessible. Therefore, in resource-limited settings, weight-bearing radiographs remain a useful tool for initial assessment and management of knee osteoarthritis.

A meta-analysis of 16 studies, encompassing 1220 patients (1071 with OA, 149 without), revealed MRI's overall sensitivity for detecting osteoarthritis (OA) as 61% (95% CI 53-68), with specificity at 82% positive predictive value (PPV) at 85%, and negative predictive value (NPV) at 57% The receiver operating characteristic (ROC) analysis yielded an area under the curve (AUC) of 0.804, indicating moderate diagnostic accuracy. Heterogeneity was significant across parameters ($I^2 > 83\%$). Sensitivity improved to 74% and specificity decreased to 76% when using histology as the reference standard, and to 69% sensitivity and 93% specificity when using arthroscopy. Overall, MRI's high specificity and moderate sensitivity suggest it's more adept at ruling out OA than confirming it. However, it falls short of current clinical diagnostic standards, with standard clinical algorithms coupled with radiographs proving most effective in diagnosing OA.[16]

Overall, this study contributes valuable insights into the prevalence, demographic characteristics, and diagnostic methods of OA, particularly in the context of Pakistan. The findings underscore the need for comprehensive strategies to address the rising burden of OA, taking into account demographic variations and utilizing advanced diagnostic techniques for accurate assessment and management of the condition.

CONCLUSION

The comparison of diagnostic methods revealed that X-rays, while demonstrating high specificity (82.4%) and moderate predictive values (PPV 70.1%, NPV 70.4%), had a relatively low sensitivity (54.3%). This indicates that X-rays were effective at ruling out OA but less reliable in identifying all true OA cases when compared to MRI. Consequently, relying solely on X-ray diagnosis may lead to missed OA cases, underscoring the importance of comprehensive diagnostic approaches for accurate detection and management of osteoarthritis.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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5	Amna Khalid	Data analysis & interpretation.	
6	Huma Khaliq	Data analysis.	
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