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Magnetic Resonance Imaging in Accuracy Diagnostic of Knee Joint Disorders

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Abstract

Knee joint problems are prevalent throughout many age groups and considerably affect mobility and standard of living. Magnetic Resonance Imaging (MRI) has become Invasive and very efficient method for diagnosing and assessing different knee diseases, this study aimed to assess the diagnostic capabilities efficacy of MRI on assessment of various knee joint disorders. This prospective study involved 60 patients (32 men, 28 females) on the age 20 to 80 years, who had knee problems those underwent the MRI test at Baghdad University Hospital from November 2024 to April 2025. MRI images were assessed for various knee diseases. Statistical analysis was performed utilizing SPSS v25, employing Chi-square and correlation tests to investigate correlations among variables. The largest age group was 20–40 years, comprising 40%. The male demographic represented a little greater percentage (53.3%). Twelve categories of knee abnormalities were discovered, with tears occurring most frequently at 18.3% and gout least frequently at 3.3%. A notable connection was identified between gender and defect type ($r = 0.795$, $p = 0.028$), and the Chi-square test indicated statistical significance ($p = 0.025$). Defect sites were diverse, with the joint representing the most often impacted region (36.6%). The relationship between gender and location was significant ($r = 0.852$, $p = 0.019$). The right knee was most frequently affected (43.3%), followed by the left knee (36.6%) and bilateral instances (20%), with a statistically significant correlation noted ($p = 0.044$). MRI is an essential diagnostic for the precise assessment of knee joint pathologies. The research reveals substantial correlations among gender, defect type, location, and afflicted side, highlighting the importance of MRI in clinical decision-making and precise treatment planning.

Keywords: Knee joint, MRI, musculoskeletal imaging, knee pathology, tear, osteoarthritis.

Introduction

The knee joint is a multifaceted, weight-bearing articulation often subjected to mechanical stress, rendering it susceptible to many illnesses, including acute injuries, degenerative diseases, and inflammatory ailments[1,2]. The precise diagnosis of these conditions is essential for effective treatment and enhanced clinical outcomes. MRI has emerged as a fundamental tool in assessing knee joint pathologies, due to its enhanced soft tissue contrast, non-invasive characteristics, and multiplanar imaging capabilities. In contrast to traditional radiography or CT, MRI allows detailed viewing of cartilage, ligaments, menisci, tendons, synovium, and bone marrow[3,4].

MRI is increasingly essential for identifying disorders like meniscal tears, Anterior Cruciate Ligament (ACL) injuries, osteochondral lesions, synovitis, and early osteoarthritis. Its sensitivity to initial biochemical and structural alterations in cartilage and bone marrow enables the early identification of degenerative joint disease and permits proactive therapy techniques[5,6] . Multiple investigations have shown the enhanced sensitivity and specificity of MRI in detecting meniscal and ligamentous injuries, hence reinforcing its status as the recommended imaging modality for knee evaluation[7,8].

Technological innovations, including 3D reconstruction, fat suppression methods, and contrast-enhanced imaging, have significantly boosted the diagnostic capabilities of MRI. These advancements have not only augmented accuracy but also facilitated superior visualization for surgical planning, post-operative assessment, and tracking of disease development[9,10]. Notwithstanding these benefits, precise interpretation of MRI necessitates a comprehensive grasp of knee anatomy and pathology, along with cognizance of possible traps such as artifacts and anatomical variances that might result in diagnostic inaccuracies[11]. Furthermore, exorbitant costs and restricted accessibility persist as practical obstacles in certain healthcare environments, highlighting the necessity for judicious usage and priority[12].

Nonetheless, the diagnostic significance of MRI in identifying knee joint problems is unequivocal. This study seeks to investigate the function of MRI in the precise identification of knee joint diseases, emphasizing its technological advantages, clinical uses, and limits. Through, an examination of contemporary literature and case data, the underscore significance of MRI as a crucial diagnostic instrument and its influence on e vidence-based decision-making in the treatment of knee diseases[13].

The aim of this study was to analyze the diagnostic efficacy of MRI in evaluation various knee joint disorders.

Methodology

Patients: This prospective research encompassed 60 patients, comprising males and females, aged 20 to 80 years. The research was conducted in the Diagnostic Radiology Department of Baghdad University Hospital from November 1, 2024, until April 1, 2025. Patients were referred for MRI assessment of potential knee problems. All subjects granted informed consent before inclusion.

Inclusion Criteria: Patients aged 20 to 80 years, regardless of gender, patients exhibiting knee-related symptoms, including pain likely attributable to knee pathology, patients having a pertinent medical or traumatic history concerning the knee.

Criteria for Exclusion: It is guaranteed the patient safety and MRI compatibility, the subsequent exclusion criteria were implemented the individuals exhibiting normal knee examinations or lacking MRI indications, Patients possessing cardiac pacemakers or other implanted electronic or metallic devices. Patients experiencing claustrophobia and who refused to provide informed consent, patients with unstable or excessive involuntary movements that hinder adequate imaging.

MRI Examination Protocol: All patients received knee MRI examinations on a 1.5 Tesla Philips MRI scanner at Baghdad University Hospital. Imaging was conducted via a knee coil. Standard knee MRI pulse sequences utilized included T1-weighted, T2-weighted, proton density (PD), and fat-suppressed sequences in sagittal, coronal, and axial planes, tailored for the assessment of soft tissue and cartilage.

Statistical Analysis: The data were analyzed using the Statistical Package for the Social Sciences (SPSS), version 25. Descriptive statistics were utilized to characterize the distribution of knee joint abnormalities based on age group, gender, and anatomical location. The Chi-square test was utilized to assess relationships among categorical variables, including defect type, sex, and defect location. Pearson's correlation coefficient was employed to evaluate the magnitude and orientation of correlations among chosen variables. A p-value less than 0.05 was considered statistically significant.

Results and Discussion

The finding of this research according to the age group was divided into four groups. The highest group was (20 – 40) years with (40%), followed by (41 – 60) years with (36.7%), then (61 – 70) years with (11.7%), and the lowest group was (71+) with (3.3%). These data are presented and the sample contains male 32 (53.3%) cases were higher than female 28 cases (46.7%) (Table-1) (Figure-1, 2).

Table-1: Distribution data of age and gender group.

Age	No. of Cases	Percentage
20-40	24	40.0%
41-60	22	36.7%
61-70	7	11.7%
71+	2	3.3%
Gender		
Male	32	53.3%
Female	28	46.7%

There were 12 types of Knee defects, the highest defect was Tear 11 (18.3%) cases and the lowest was Gout 2 (3.3). The male showed higher of Knee defects than female with correlation (0.795) and significant at level (0.028), The value of the Chi-square test 9.112 at a significant level (0.025) (Table-2) (Figsure-3, 6-9).

Table-2: Shows the Knee defects according to the genders.

Knee Defects Cases	Male	Female	Total/ %	Correlation Significant	Chi-Square / Significant
Tear	7	4	11 (18.3)	0.795 / 0.028 * * = significant	9.112 / 0.025
Tendonitis	4	3	7 (11.6)		
Cut	4	1	5 (8.3)		
Partial cut	4	1	5 (8.3)		
Arthritis	2	5	7 (11.6)		
Osteochondritis	4	1	5 (8.3)		
Osteoarthritis	2	3	5 (8.3)		
Swollen	2	3	5 (8.3)		
Fluid	3	1	4 (6.6)		
Gout	1	1	2 (3.3)		
Edema	2	2	4 (6.6)		
Total	35	25	60		

This study shows the distribution of data according to location defect, it was divided into seven locations; the males were higher than female cases. The highest defect was in the joint 22 (36.6%) cases, with LCL being the lowest 3 (5%) cases. The

correlation between gender and location of defect was 0.852 (p = 0.019), the value of the Chi-square test (13.773) at a significant level (0.015) (Table-3) (Figure-4). Overall, the right knee was involved in 26 cases (43.3%), the left knee in 22 cases (36.6%), and both knees in 12 cases (20%). The value of the Chi-square test (7.876) at a significant level (0.044) (Table-4) (Figure-5).

Table-3: Distribution Data According to location of defect.

Location of Defect	Male	Female	Total/ %	Correlations/ Significant	Chi-square / Significant
Joint	12	10	22 (36.6)	0.852/ 0.019	13.773/ 0.015
Front of the knee	4	5	9 (15)		
ACL	7	3	10 (16.6)		
Around joint	4	4	8 (13.3)		
MCL	3	1	4 (6.6)		
PCL	3	1	4 (6.6)		
LCL	2	1	3 (5)		
Total	35	25	60		

Table-4: Affected Knee according Side.

Knee Side	Male	Female	Total (%)	Correlations/ Significant	Chi-square / Significant
Right (R)	18	8	26 (43.3)	0.723 / 0.027	7.876 / 0.044
Left (L)	12	10	22 (36.6)		
Both (R/L)	5	7	12 (20)		
Total	35	25	60		

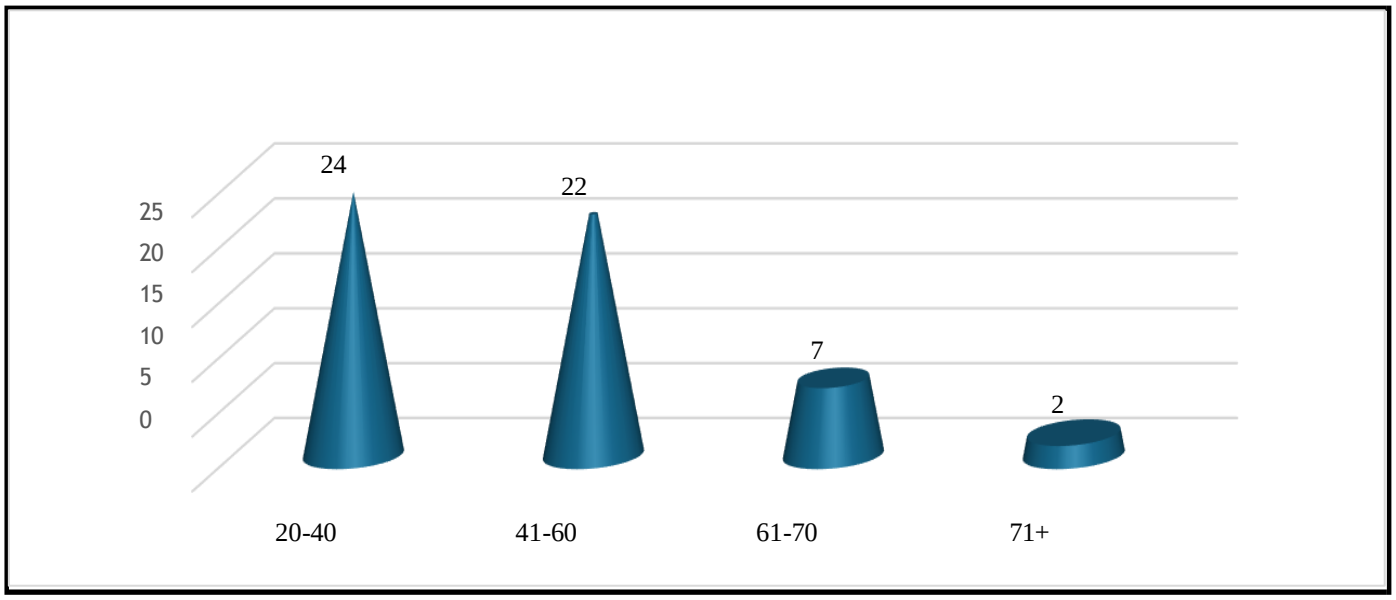

Figure-1: Distribution of patients according to the ages.

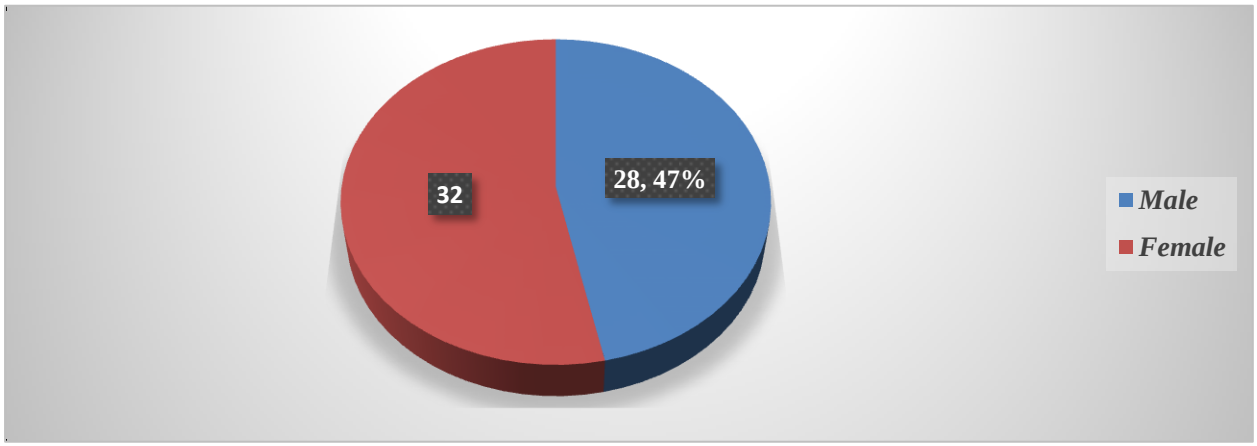

Figure-2: Distribution of patients according to the gender.

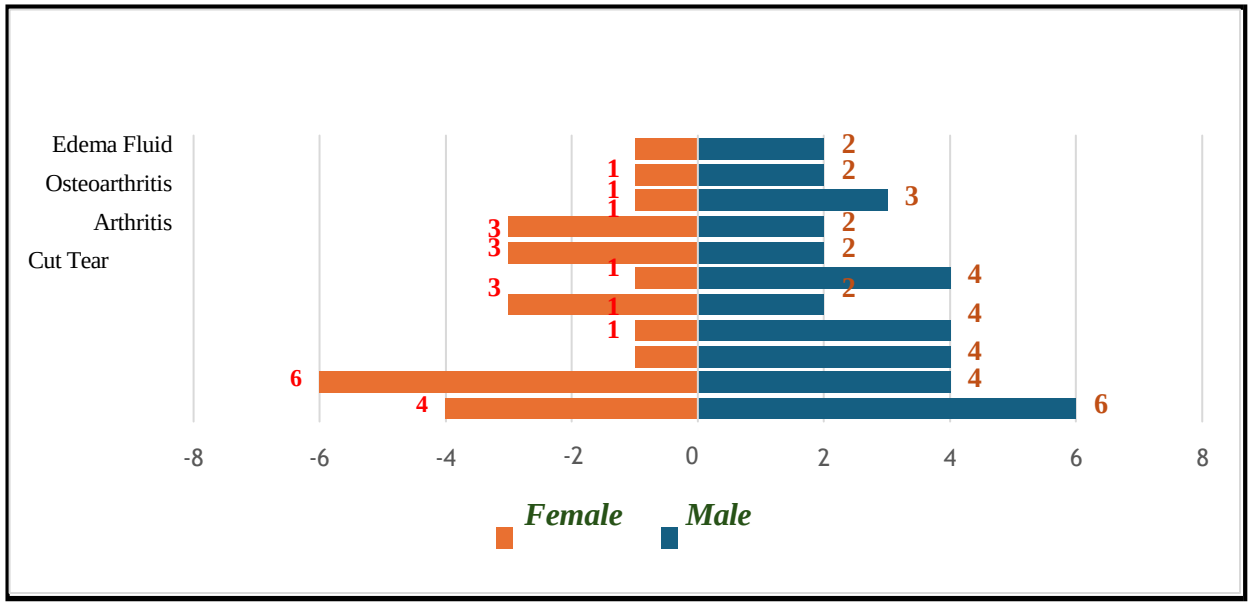

Figure-3: Distribution of patients according to defect type in both genders.

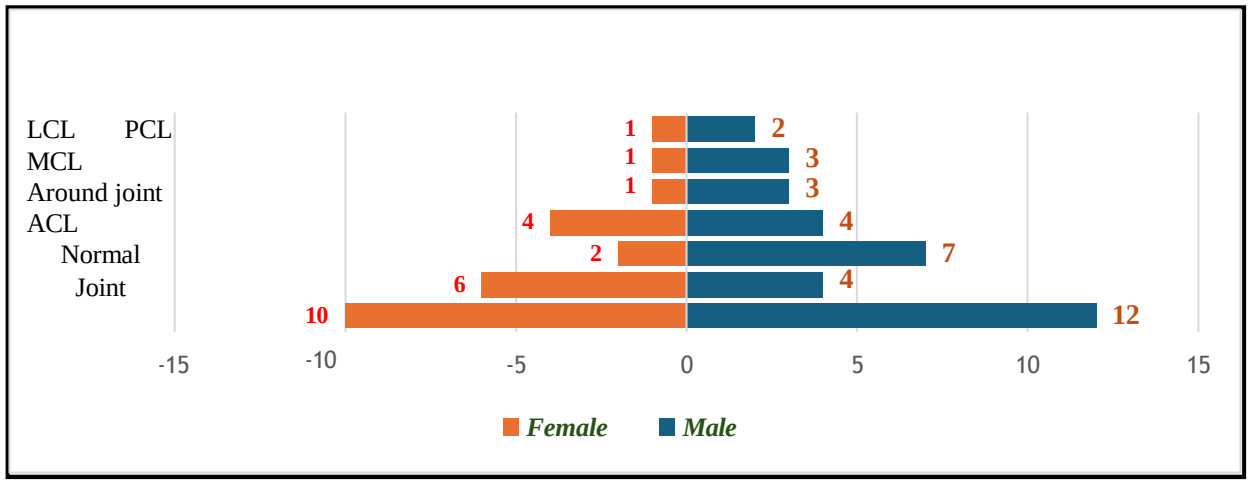

Figure-4: Distribution of abnormalities at MRI in both genders.

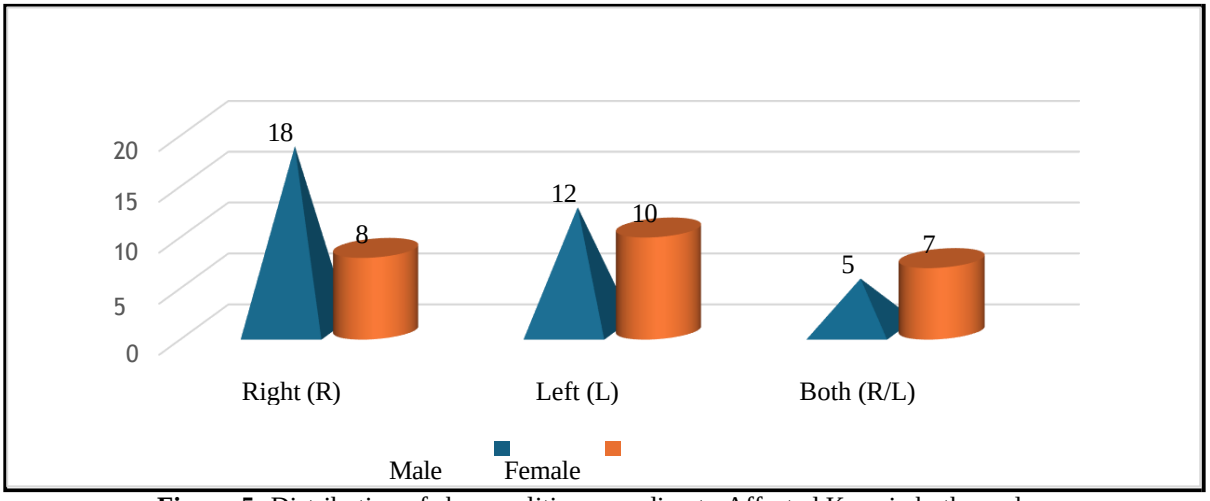

Figure-5: Distribution of abnormalities according to Affected Knee in both genders.

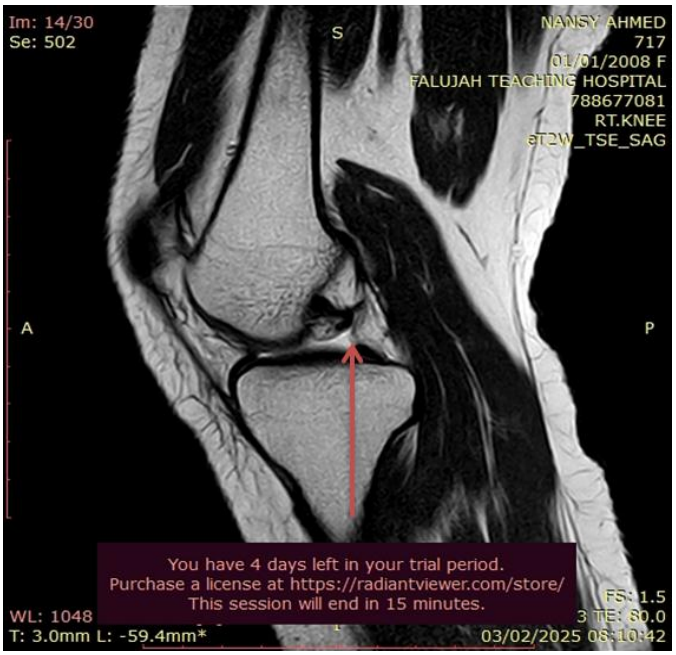

Figure-6: T2 WI MRI Knee joint of a patient showing PCL cutting (arrow).

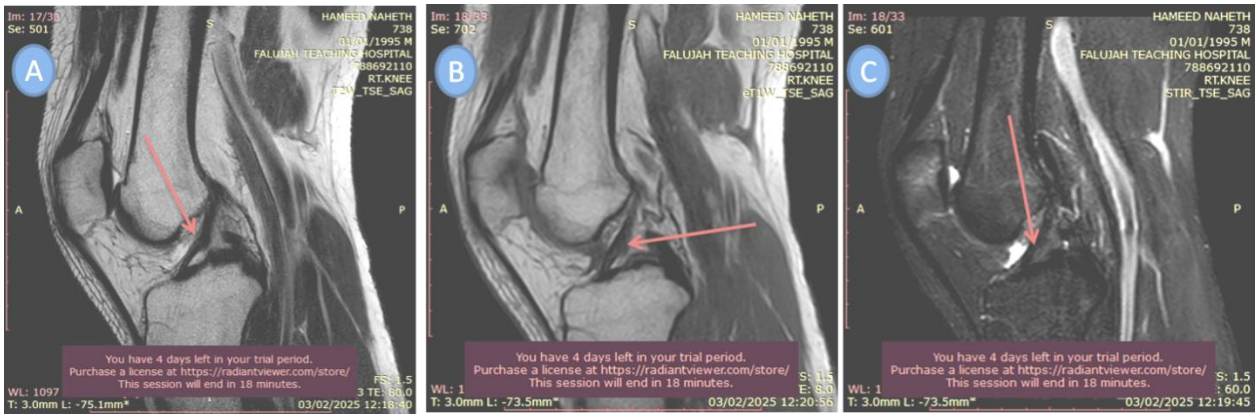

Figure-7: In each of A: T2, B: T1, C: STIR showing ACL tearing (arrow) of MRI Knee joint.

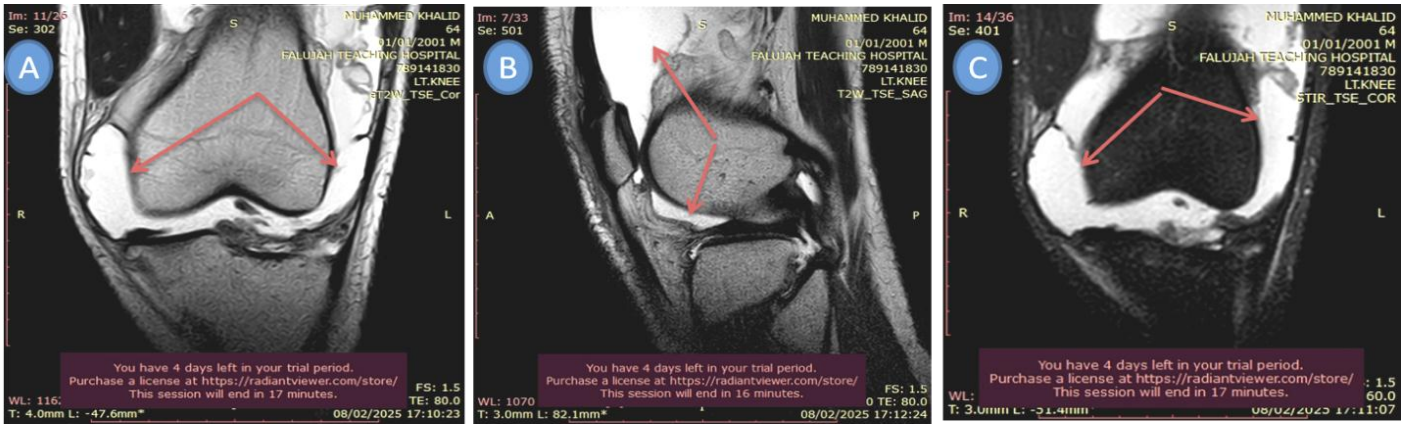

Figure-8: In each of A: T2 coronal, B: T2sagittal, C: STIR coronal showing fluid around knee joint (arrow) of MRI Knee joint.

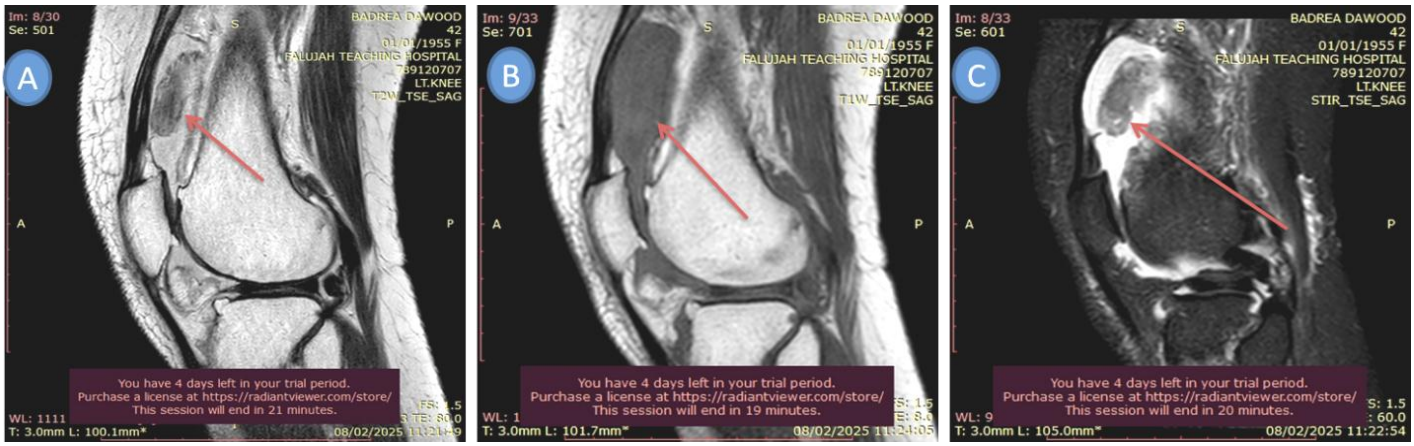

Figure-9: A: T2w sagittal, B: T1w sagittal, C: STIR sagittal, MRI Knee of a patient showing lesion Surrounding swelling is noted (arrow).

Discussion: These findings emphasize the necessity of addressing both age and gender in the assessment of knee joint diseases. This study revealed a distinct age-related pattern in the distribution of knee joint diseases, predominantly affecting younger to middle-aged persons. The 20–40-year age cohort included the biggest percentage of patients (40%), this trend aligns with existing data suggesting that younger persons are more susceptible to traumatic and sports-related injuries, encompassing ACL tears and meniscal damage, owing to elevated physical activity levels and work pressures[1,2]. In contrast, individuals aged 41 to 60 are more prone to exhibit early degenerative changes, including cartilage loss and osteoarthritic modifications, which frequently arise during this transitional age phase[3]. The diminished prevalence noted in older age cohorts (11.7% for ages 61–70 and 3.3% for those 71 and older) may indicate various contributing factors, such as decreased physical activity, underreporting of joint symptoms, or restricted referrals for MRI imaging in elderly patients owing to comorbidities or conservative treatment approaches[4].

Male patients constituted a marginally greater percentage (53.3%) than female patients (46.7%). This slight male preponderance corresponds with prior research indicating elevated prevalence of knee injuries in males, particularly those involved in strenuous labor or sporting pursuits[5].The nearly equal proportion underscores the increasing acknowledgment of knee pathologies in females, especially degenerative joint illnesses, perhaps driven by hormonal, anatomical, and biomechanical disparities[6].

This study revealed twelve distinct forms of knee joint disorders observed via MRI, with ligament rips being the most prevalent, impacting 18.3% of the sample population. This discovery corresponds with other prior studies demonstrating that ligamentous injuries—especially of the ACL and menisci—rank among the most prevalent knee diseases, especially in highly active persons[14-16]. Conversely, gout was the least common diagnosis (3.3%), aligning with the understanding that gout is predominantly diagnosed by clinical evaluation and laboratory tests, with MRI utilized seldom in complex or unusual cases[17].

A gender-based analysis indicated that male patients demonstrated a greater incidence of knee abnormalities (35 instances) than female patients (25 cases). The correlation coefficient (r = 0.795) and p-value (0.028) demonstrate a statistically significant relationship between male gender and

heightened incidence of knee deformities. This may indicate heightened exposure to occupational and sports-related stresses in men, a result consistently observed in musculoskeletal imaging investigations[18,19]. Furthermore, Chi-square analysis revealed a significant association between gender and defect type ($\chi^2 = 9.112$, df = 10, p = 0.025), underscoring the existence of gender-specific patterns in knee pathology. Ligament tears, tendonitis, and osteochondritis were more prevalent in males, whereas arthritis and edema were more commonly detected in females. These disparities may be affected by biomechanical, anatomical, and hormonal variables, since female patients often exhibit distinct joint mechanics and are more susceptible to degenerative or inflammatory disorders such as osteoarthritis and rheumatoid arthritis[20].

The present study analyzed the distribution within the knee joint abnormalities according to their anatomical location and demonstrated considerable heterogeneity based on both location and gender. Of the seven detected areas, the joint space was the most impacted, with 22 instances (36.6%), followed by the ACL at 16.6%, and the anterior region of the knee at 15%. The LCL was the least frequently affected structure, with merely 3 instances (5%). This trend aligns with previous research that has recognized the joint compartment, including the tibiofemoral and patellofemoral regions, as prevalent injury sites due to their substantial mechanical stress during routine movement and physical exertion[21,22]. The elevated incidence of ACL involvement aligns with its recognized susceptibility to both contact and non-contact injuries, especially in athletic and traumatic contexts[23,24].

Significantly, men had a greater incidence of abnormalities across virtually all anatomical locations. The relationship between gender and defect site was robust (r = 0.852) and statistically significant (p = 0.019). Furthermore, Chi-square analysis validated a significant correlation between gender and defect site ($\chi^2 = 13.773$, df = 6, p = 0.015). The data indicate that males are more often impacted by structural knee injuries, maybe due to increased engagement in physically strenuous activities, heightened trauma exposure, or variations in joint biomechanics[25,26].

The examination of afflicted knee sides within the research cohort revealed a greater incidence of right knee involvement (43.3%), succeeded by left knee involvement (36.6%) and bilateral involvement (20%). This pattern indicates that unilateral knee diseases are more prevalent than bilateral ones, with a minor predominance of right-sided involvement. The Chi-square test demonstrated a statistically significant link ($\chi^2 = 7.876$, p = 0.044), while the correlation coefficient (r = 0.723) suggested a modest relationship between gender and the injured knee side.

The prevalence of right-sided knee injuries may indicate functional laterality, as the right leg is generally dominant in most persons, rendering it more susceptible to overuse and damage during physical exercise. Previous musculoskeletal investigations have revealed same findings, indicating that limb dominance contributes to the increased prevalence of right-sided joint injuries[27]. Males had a greater incidence of right-sided injuries, whereas females revealed a somewhat elevated frequency of bilateral involvement. This may be associated with underlying systemic or degenerative disorders, such as osteoarthritis, which often impact both knees over time and are more common in older female demographics[28].

Conclusion

This research, grounded on extensive statistical analysis, validates the prevalence of joint abnormalities among various age demographics and genders. The results underscore the importance of gender disparities in defect kinds, defect sites, and knee involvement.MRI is an essential diagnostic for the precise assessment of knee joint pathologies. The research reveals substantial correlations among gender, defect type, location, and afflicted side, highlighting the importance of MRI in clinical decision-making and precise treatment planning. Future study should investigate the fundamental risk variables to enhance diagnostic and therapeutic techniques.

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