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ASSOCIATION BETWEEN MRI SCORING AND ODI IN PATIENTS PRESENTING WITH CRUCIATE LIGAMENT INJURIES

Original Research

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ABSTRACT

Background: Cruciate ligament injuries, particularly those affecting the anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL), are a frequent cause of knee pain and functional disability, leading to a significant number of clinical consultations and rehabilitation needs. Accurate assessment of the extent of ligament damage is crucial for early intervention and effective treatment planning. Magnetic Resonance Imaging (MRI) is considered the gold standard for diagnosing soft tissue injuries of the knee, while the Oswestry Disability Index (ODI) provides a validated measure of functional impairment.

Objective: To investigate the association between MRI scoring and ODI in patients presenting with cruciate ligament injuries.

Methods: A cross-sectional study was conducted at ALNOOR Diagnostic Center, Lahore, over a duration of four months. A total of 100 patients aged 18–65 years, presenting with knee pain and confirmed cruciate ligament injury on MRI, were included. Patients' functional status was assessed using the ODI questionnaire. MRI scans were performed using a 1.5 Tesla scanner and scored based on findings related to joint effusion, ligament retraction, fiber disruption, meniscal involvement, and joint space narrowing. Data were analyzed using SPSS version 25, and Pearson correlation was used to assess the relationship between MRI scores and ODI scores.

Results: Among the 100 patients, 76 (76%) were male and 24 (24%) female. ACL injuries were present in 88 patients, with 65 males (73.8%) and 23 females (26.1%). PCL injuries were found in 12 patients, 11 males (91.6%) and 1 female (8.3%). The majority of cases were aged 38–47 years (n=42), followed by 48–57 years (n=30). ODI scores showed moderate disability in 59 patients (21–40%), while 58 patients had Grade III MRI injury (31–50%). A strong positive correlation was observed between MRI score and ODI score ($r = 0.875$, $p < 0.001$).

Conclusion: The study revealed a significant correlation between MRI-based structural grading and functional disability measured by ODI, indicating that higher MRI injury grades are associated with greater impairment. Middle-aged males showed a higher prevalence of ACL injuries, emphasizing the need for early detection and preventive strategies.

Keywords: Anterior Cruciate Ligament, Correlation, Disability Evaluation, Magnetic Resonance Imaging, Oswestry Disability Index, Posterior Cruciate Ligament, Soft Tissue Injuries.

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INTRODUCTION

The knee joint, although anatomically classified as a hinge joint, demonstrates far greater complexity due to the intricate network of ligaments, nerves, and connective tissues that allow for movement across all three anatomical planes—sagittal, frontal, and transverse. Among these stabilizing components, the anterior and posterior cruciate ligaments play a central role in maintaining the joint's integrity during dynamic motion. Of particular importance is the anterior cruciate ligament (ACL), which provides essential resistance against anterior tibial translation and rotational stress. Structurally, the ACL consists of two non-isometric bundles—anteromedial and posterolateral—comprising a dense meshwork of collagen fibers, glycoproteins, proteoglycans, and elastic fibers, which enable the ligament to withstand substantial tensile forces (1,2). ACL injuries represent a significant orthopedic concern worldwide. In the United States alone, nearly 200,000 individuals present annually with ACL-related trauma, with approximately half requiring surgical reconstruction due to the severity of their injuries (3,4). Similarly, epidemiological data from Norway indicate an incidence rate of 35 ACL injuries per 100,000 individuals, highlighting the widespread nature of the condition. While athletes are disproportionately affected due to the physical demands of sports, non-athletic populations are also vulnerable. Daily activities, particularly those involving sudden pivoting, twisting, or deceleration, can pose a risk, especially in individuals with predisposing anatomical or biomechanical factors (5,6).

Given the profound impact of ACL injuries on mobility and quality of life, understanding the correlation between structural damage and functional disability is imperative. Radiological imaging, particularly Magnetic Resonance Imaging (MRI), is a cornerstone in evaluating ligamentous injuries, while the Oswestry Disability Index (ODI) has been widely validated as a reliable tool to assess functional impairment, particularly in spinal pathologies (7,8). However, limited research has explored the utility of ODI scores in conjunction with MRI findings in the context of knee joint injuries (9) The present study addresses this gap by hypothesizing that the extent of structural damage identified via MRI is positively correlated with patient-reported disability as measured by ODI scores. Establishing this correlation may enhance clinical prognostication, guide individualized rehabilitation protocols, and align radiological severity with real-world functional outcomes. Therefore, the objective of this study is to evaluate the relationship between MRI-detected structural damage of the ACL and corresponding functional disability assessed by the Oswestry Disability Index.

METHODS

This study employed a cross-sectional design and was conducted over a period of four months at Al Noor Diagnostic Centre, Lahore. The target population comprised individuals with ligamentous injuries of the knee, including anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), medial collateral ligament (MCL), or lateral collateral ligament (LCL) tears. A total sample of 100 participants was calculated using the Fisher formula: n=(Z1−α/2+Z1−β)2+3/Δ2n = (Z_{1−α/2} + Z_{1−β}) ^2 + 3 / Δ^2 where Δ = 0.5 ln ((1 + ρ)/(1 − ρ)) with ρ = 0.30, Z1−α/2=1.96Z_{1−α/2} = 1.96 (α = 0.005), and Z1−β=1.089Z_{1−β} = 1.089 for a statistical power of 86%. The "+3" correction factor was included to account for small-sample bias. Although this formula is based on correlation analysis, it is worth noting that the power (86%) and alpha (0.005) levels seem mismatched with conventional practice, where α is typically set at 0.05. Nonetheless, the overall calculation aligns with the study's correlational objectives. Participants were selected using a convenience sampling method. Inclusion criteria encompassed males and females aged 18 to 65 years with an MRI-confirmed tear of one or more major knee ligaments (ACL, PCL, MCL, or LCL). Eligible individuals presented with clinical symptoms such as knee pain, swelling, or joint instability and had either undergone surgical or non-surgical management or were currently in conservative rehabilitation. Only those who provided informed written consent and willingly shared their MRI findings were included in the study.

Exclusion criteria were rigorously applied to ensure the accuracy and reliability of MRI interpretation. Individuals below 18 or above 65 years of age, those with contraindications to MRI (e.g., metallic implants, pacemakers, neurostimulators, cochlear implants, or claustrophobia), or those with severe comorbid conditions such as advanced osteoarthritis or inflammatory arthropathies were excluded. Cases involving complex multifilament injuries or fractures were also excluded to prevent interpretive ambiguity on MRI scans. Pregnant women or those suspecting pregnancy, individuals with cognitive impairment, and those unable or unwilling to comply with study protocols or follow-up assessments were also not considered eligible (9,10). Data collection included demographic profiling and clinical assessment. The degree of structural damage was assessed using MRI scans, while functional disability was evaluated using the

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Oswestry Disability Index (ODI), a validated instrument primarily used for spinal conditions but adapted in this context to explore its potential relevance to knee joint disability. Data were analyzed using SPSS version 25. Descriptive statistics were used to present categorical data as frequencies and percentages. To assess the relationship between structural damage on MRI and functional disability scores, Pearson's correlation coefficient was calculated. A correlation value of $r = 0$ indicated no association, $r = +1$ a perfect positive correlation, and $r = -1$ a perfect negative correlation. Ethical approval for this study was obtained from the relevant Institutional Review Board (IRB), and all procedures were conducted in accordance with the ethical standards of the Helsinki Declaration. Informed written consent was obtained from all participants prior to data collection, ensuring confidentiality and voluntary participation.

RESULTS

A total of 100 patients who met the inclusion criteria and presented with knee pain at Al Noor Diagnostic Centre were enrolled in the study. Of these, 76 were male and 24 were female. Anterior cruciate ligament (ACL) injuries were more prevalent, observed in 88 patients, while posterior cruciate ligament (PCL) injuries were noted in 12 patients. Among males, 65 had ACL injuries and 11 had PCL injuries, whereas among females, 23 had ACL injuries and only 1 had a PCL injury. Age-wise analysis revealed that the highest frequency of ACL injuries (n=36) occurred in the 38–47-year age group, followed by 26 cases in the 48–57-year age bracket. PCL injuries were most common (n=6) in the 38–47-year age group as well, suggesting that middle-aged individuals are more susceptible to cruciate ligament injuries.

Functional disability was assessed using the Oswestry Disability Index (ODI) before MRI evaluation. The majority of patients (n=59; 58.4%) had moderate disability (ODI score 21–40%), while 27 patients (26.7%) were categorized as having severe disability (41–60%). Minimal disability (0–20%) was reported in 11 patients (10.9%), and crippling pain (61–80%) was found in 3 patients (3.0%). Subsequent MRI evaluations included analysis in sagittal, axial, and coronal planes and were assessed for joint effusion, ligament retraction, fiber disruption, meniscal injury, and joint space narrowing. Injury severity was graded from Grade 0 to Grade V, where Grade V denoted the most extensive damage. Grade I injuries were absent in all cases. The majority of patients (n=58; 57.4%) had Grade III injuries (31–50% structural damage), followed by Grade II injuries (n=36; 35.6%). Grade IV injuries (51–70%) were found in 5 patients (5.0%), while only 1 patient (1.0%) had a Grade V injury, indicating near-complete ligament disruption. A strong positive correlation ($r = 0.875$, $p < 0.001$) was identified between the ODI score and MRI-determined injury grade, indicating that as the severity of ligament damage increased, so did the level of functional impairment. Linear regression analysis further supported this finding, revealing a statistically significant relationship ($F = 318.73$, $p < 0.001$) between MRI findings and ODI scores. The regression model explained a substantial proportion of the variance in disability scores ($R^2 = 0.765$), confirming that MRI grading could be a reliable predictor of patient-reported disability.

Table 1: Gender Wise Distribution of Anterior and Posterior Ligament Injury

Gender	Anterior Cruciate Ligament Injury	Posterior Cruciate Ligament injury
Female	23	1
Male	65	11
Total	88	12

Table 2: Age wise distribution of incidence of Type of Injury

		Type of Injury		Total
		Anterior Cruciate Ligament Injury	Posterior Cruciate Ligament Injury	
Age	18-27y	2	0	2
	28-37y	13	1	14
	38-47y	36	6	42
	48-57y	26	4	30
	58-67y	11	1	12
Total		88	12	100

Table 3: Frequency and Percentage wise Distribution of Patients with ODI Score

ODI Score = Patient Score X 100 / Total Score		Frequency(n)	Percentage (%)
ODI Score Percentage and its Description	0–20% Patient having Minimal disability	11	10.9
	21-40% Patient falling in this had Moderate disability	59	58.4
	41-60%Patient was facing Severe disability	27	26.7
	61-80% Patient in this group had Crippling knee pain	3	3.0
	Total	100	100.0

Table 4: Frequency and Percentage wise Distribution of Patients with MRI Score

MRI Score = Patient Score X 100 / Total Score		Frequency(n)	Percentage (%)
MRI Score	Grade II 11-30%	36	35.6
	Grade III 31-50%	58	57.4
	Grade IV 51-70%	5	5.0
	Grade V 71-100%	1	1.0
	Total	100	100.0

Table 5: Correlation Analysis between MRI Score and ODI Score

		MRISCORE	ODISCORE
MRISCORE	Pearson Correlation	1	.875**
	Sig. (2-tailed)		.000
	N (Total values)	100	100
ODISCORE	Pearson Correlation	.875**	1
	Sig. (2-tailed)	.000	
	N (Total Values)	100	100

Table 6: Analysis of Variance for the Relationship Between ODI and MRI Scores

ANOVA					
Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	8199.124	1	8199.124	318.730	.000b
Residual	2520.986	98	25.724		
Total	10720.110	99			

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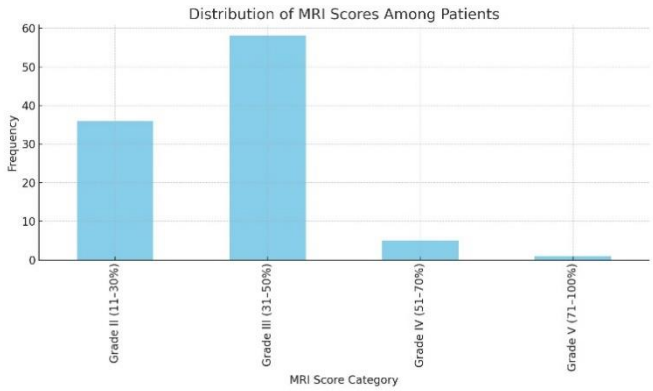


Figure 1 Distribution of MRI Scores Among Patients

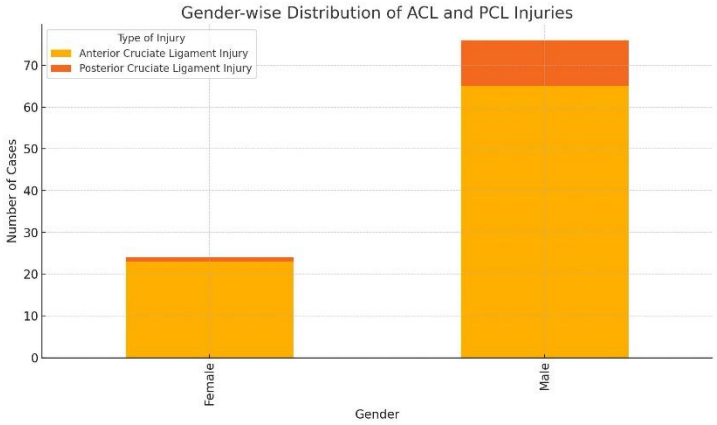
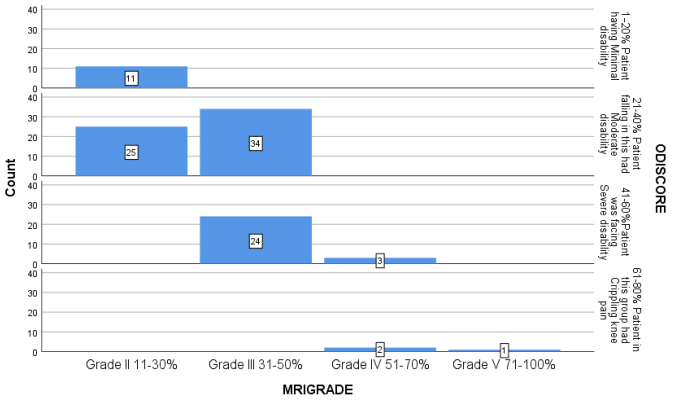
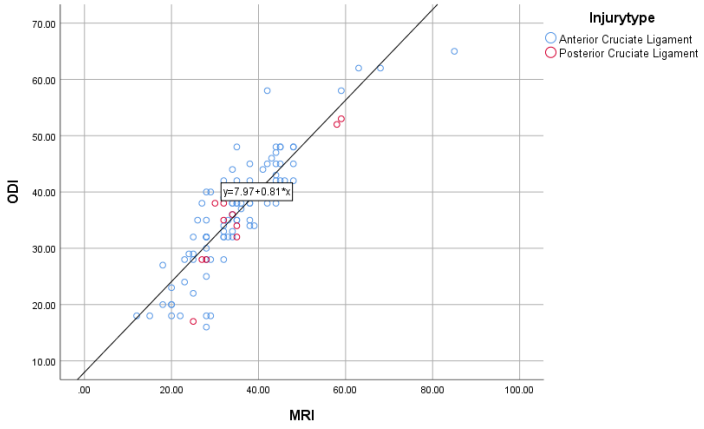


Figure 2 Gender-wise Distribution of ACL and PCL Injuries





DISCUSSION

Knee pain remains one of the most frequent musculoskeletal complaints leading patients to seek emergency care or orthopedic consultation, with cruciate ligament injuries representing a significant proportion of these cases. In line with global epidemiological patterns, the current study identified anterior cruciate ligament (ACL) injuries in a majority of cases, accounting for 88% of patients, while posterior cruciate ligament (PCL) injuries were identified in only 12%, reinforcing previous observations that PCL injuries are considerably less common, typically comprising just 1–6% of knee injuries (10). These findings reaffirm the clinical significance of ACL injuries and the need for early diagnosis and tailored rehabilitation to prevent long-term functional disability. Although the Oswestry Disability Index (ODI) has traditionally been employed in evaluating functional disability due to lower back pain, its adaptability to other musculoskeletal contexts has gained increasing recognition (11,12). This study supports the use of the ODI in assessing disability in individuals with cruciate ligament injuries of the knee, with most patients exhibiting moderate (21–40%) or severe (41–60%) disability levels. These findings are supported by earlier investigations that demonstrated the index's capacity to reflect functional impairment across varied orthopedic conditions (13,14). The present study further adds to the body of evidence suggesting the ODI's versatility in non-spinal settings when appropriately contextualized.

The demographic analysis revealed a higher incidence of cruciate ligament injuries in the 38–47 year age group, followed by individuals aged 48–57 years. This trend aligns with previous research indicating increased vulnerability in middle-aged individuals due to a combination of physical exertion and degenerative changes in joint tissues (15,16). Younger adults (18–27 years) displayed the lowest incidence, likely attributable to better joint integrity and reduced exposure to degenerative risk factors, as similarly noted in past literature (17,18). These patterns underscore the need for age-specific prevention and management strategies, particularly for middle-aged

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populations who may remain physically active yet are susceptible to degeneration-related injuries. MRI assessment proved instrumental in characterizing the extent of ligamentous injury, with 57.4% of patients exhibiting Grade III injuries and 35.6% falling into Grade II. Only one patient presented with a Grade V injury, indicating extensive ligament disruption. This distribution is consistent with earlier studies that highlighted the diagnostic reliability and predictive capacity of MRI in evaluating the severity of soft tissue damage (18). Notably, the positive correlation ($r = 0.875$, $p < 0.001$) between MRI-based grading and the ODI underscores the diagnostic and prognostic potential of MRI in assessing not only anatomical damage but also its functional repercussions.

While the Knee Injury and Osteoarthritis Outcome Score (KOOS) is widely accepted as a knee-specific patient-reported outcome tool (19,20), this study presents compelling evidence supporting the ODI as a valid alternative for functional assessment in patients with cruciate ligament injuries. Previous research has emphasized the relationship between radiological findings and patient-reported outcomes (21), and the current findings contribute to this narrative by confirming a strong linkage between structural severity on imaging and the patient's perceived disability. This correlation could have practical implications in streamlining assessment tools in clinical settings where time and resources may be limited. One of the major strengths of this study lies in its integration of both radiological data and patient-reported outcomes, providing a comprehensive overview of injury severity and its functional impact. The cross-sectional design allowed for the concurrent analysis of these parameters in a real-world clinical setting. However, certain limitations must be acknowledged. The use of convenience sampling introduces potential selection bias, and the relatively small sample size may limit the generalizability of findings. Moreover, while the ODI provided valuable insights, the absence of a knee-specific functional scale for comparative analysis may restrict the depth of interpretability. Additionally, the reliance on a single imaging modality, although MRI is considered the gold standard, excludes potentially contributory findings from arthroscopic or clinical evaluations.

Future research should consider employing longitudinal designs to track functional recovery over time and validate the predictive utility of MRI grades on rehabilitation outcomes. Comparative studies utilizing multiple functional assessment tools, including KOOS and IKDC (International Knee Documentation Committee score), could offer more nuanced insights. Broader, multicentric recruitment would enhance generalizability, and stratified analyses by gender, occupation, and physical activity levels could further elucidate population-specific risk factors and outcomes. In summary, the study reinforces the epidemiological predominance of ACL injuries over PCL injuries, validates the ODI as a functional outcome measure in knee ligament pathology, and confirms the diagnostic and prognostic relevance of MRI in assessing cruciate ligament damage. These findings contribute meaningful data to the evolving landscape of orthopedic assessment and hold implications for optimizing diagnostic protocols and rehabilitation planning.

CONCLUSION

This study concludes that there is a strong positive correlation between MRI-detected cruciate ligament injuries and the level of functional disability as measured by the Oswestry Disability Index. The findings emphasize that structural damage observed on imaging reflects the extent of patient-reported limitations, underlining the clinical value of integrating radiological assessment with functional outcome measures. Additionally, the notable rise in anterior cruciate ligament injuries among middle-aged males highlights a pressing need for targeted preventive strategies and early intervention protocols. These insights contribute to improving diagnostic precision, guiding individualized treatment plans, and ultimately enhancing patient quality of life.

AUTHOR CONTRIBUTION

Author	Contribution
Mohsin Hameed*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Hafiz Ahmad Talal	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Samra Nasrullah	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Awais Yousif	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published

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Author	Contribution
Iffat Zahra	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Abdul Ghaffar	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Izza Javaid	Contributed to study concept and Data collection Has given Final Approval of the version to be published

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