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ORIGINAL ARTICLE

# Frequency of meniscal injury in patients with anterior cruciate ligament injury using magnetic resonance imaging.

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**ABSTRACT… Objective:** To determine the frequency of meniscal injuries in patients with anterior cruciate ligament (ACL) injury using magnetic resonance imaging (MRI) at Al-Noor Institute of Radiology/Al-Noor Diagnostic Center Shadman, Lahore. **Study Design:** Cross-sectional study. **Setting:** Al-Noor Institute of Radiology, Lahore. **Period:** August 2023 to February 2024. **Methods:** A total of 105 patients aged 18-50 were enrolled using non-probability sequential sampling. Exclusion criteria included muscular dystrophy, open wounds, metabolic bone disorders, rheumatoid arthritis, and prior surgeries. MRI scans were performed using 1.5 Tesla equipment, and meniscal injuries were assessed using standard grading protocols. Statistical analysis was conducted using SPSS version 25. **Results:** Among 105 ACL-injured patients, meniscal injuries were more common in older patients (73.1% in ages 31-50 vs. 49.1% in ages 18-30, p=0.012), males (67.9% vs. 37.5% in females, p=0.007), and those with a BMI >25 (70.5% vs. 47.7% with BMI ≤25, p=0.018). **Conclusion:** Our study highlights that age, male gender, and higher BMI significantly increase the risk of meniscal injuries in ACL-deficient patients. Early MRI diagnostics and targeted interventions are recommended for managing these risks effectively.

**Key words:** ACL Deficiency, Demographic Analysis, Meniscal Injury, MRI Diagnostics, Risk Factors.

## INTRODUCTION

The knee is supported by two ligaments known as the cruciate ligaments. The anterior cruciate ligament, often referred to as the ACL, is one of the two ligaments that contribute to knee stability.[1] A thick band composed of connective tissue and collagenous fibers, it originates in the anteromedial portion of the intercondylar region of the tibial plateau. It is a band composed of both components. Following this, it extends posterolaterally to attach to the medial aspect of the lateral femoral condyle. This is the location where two important landmarks can be found: the lateral intercondylar ridge, which delineates the anterior boundary of the anterior cruciate ligament (ACL), and the bifurcate ridge, which divides the two ACL bundles. When measured in length, the anterior cruciate ligament measures 32 millimeters, and its breadth ranges from 7 to 12 millimeters. The first of its two bundles is an isometric anteromedial bundle, while the other is a posterolateral bundle that displays flexible length changes. Both of these bundles are considered to be part of the same structure.[1] In flexion, the anteromedial bundle is the most tight, and it is largely responsible for anterior tibial translation (85% of stability). On the other hand, the posterolateral bundle is the most taut in extension, and it predominantly contributes to medial-lateral and rotational stability (secondary constraint).[2-4]

The anterior cruciate ligament (ACL) and the posterior cruciate ligament (PCL) intersect inside the knee, preventing excessive anterior or posterior movement of the tibia in relation to the femur during flexion and extension. Histologically, the ACL consists of 90% type I collagen and 10% type III collagen. The middle geniculate artery is the conduit via which the major blood supply is

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obtained. The nerve is responsible for innervating the neurological system. The posterior articular nerve, a branch of the tibial nerve, is seen here.[5]

In roughly half of all knee injuries, the ACL is the ligament that sustains the greatest damage. The yearly incidence that is recorded in the United States alone is around one in every three thousand five hundred persons. In the United States, around 400,000 reconstructions of the ACL are carried out on a yearly basis.[6] On the other hand, there is no consistent surveillance practice, therefore the statistics could not be reliable.

In spite of the fact that there is no discrimination based on age or gender, it has been hypothesized that women are more likely to have an anterior cruciate ligament injury due to a variety of variables.[7] It has been claimed that the ratio of females to males in the athletic population is 4.5 to 1. In female athletes, anterior cruciate ligament (ACL) ruptures are more likely to occur in the supporting leg as opposed to the kicking leg, unlike in male players.[7]

Most ACL tears in athletes occur during non-contact pivoting injuries when the tibia translates anteriorly and the knee is slightly flexed and valgus. Direct contact to the lateral knee may potentially cause damage. Skiers, soccer players, and basketball players are prone to non-contact injuries.[8] Football players suffer the highest contact injuries.[9]

Acute ACL ruptures may be accompanied by various intra-articular and extra-articular injuries.[10-12] Meniscal tears are included; lateral meniscus injuries occur in over fifty percent of acute ACL tears, whereas the medial meniscus is more often implicated in chronic instances. The PCL, LCL, and PLC may potentially sustain injuries along with an ACL injury. Chronic ACL deficit seems to adversely affect the knee, resulting in chondral injuries and complicated irreparable meniscal rips. For instance, bucket handle rips of the medial meniscus. Injury to the meniscus occurs due to trauma or sports activity predominantly.[13] MRI is the gold standard modality for the diagnosis of meniscal tears.[14]

ACL injuries are frequently coupled with meniscal injuries among patients especially young athletes and their prompt diagnosis can alter the course of treatment implying significant impact on patient recovery.[15] Ashraf El Mansori et al. reported that 55% of ACL injuries are associated with meniscal injuries with medial meniscal (MM) tears being the most common.[16]

The rationale of this study is the limited local data availability regarding the association of meniscal injuries in the setting of ACL injuries. This MRI based diagnostic study will help gather local data to establish guidelines to help the patients attain the best possible outcome via noninvasive means.

## METHODS

Through the use of magnetic resonance imaging (MRI), this cross-sectional research was carried out with the purpose of determining the prevalence of meniscal injuries in patients who had suffered injuries to the ACL. Following the clearance of the research summary, the research was carried out at the Al-Noor Institute of Radiology/Al-Noor Diagnostic Centre in Shadman, Lahore, throughout a period of six months (August'23 to Febuary'24). The study was conducted at the Radiology Department. On the basis of a sample size calculation, a total of 105 patients were recruited. This calculation assumed that the predicted incidence of meniscal injuries in patients who had suffered an anterior cruciate ligament injury was 55%, that the confidence interval was 95%, and that there was a margin of error of 10%. The method of non-probability sequential sampling was used in order to enroll patients who were qualified for the study.

Patients between the ages of 18 and 50 who had ACL injuries that were verified by MRI and had a history of trauma participated in the study. The inclusion criteria included both male and female patients. Patients with muscular dystrophy, open wound injuries, metabolic bone abnormalities (such as osteomalacia, osteoporosis, or osteopenia), rheumatoid arthritis, and patients who had already had surgery served as the grounds for exclusion from the study.

After receiving clearance from the institutional review board and the ethical committee (20-2022), informed written consent was obtained from each and every participant. We used a standardized questionnaire to gather data on both the demographic and clinical aspects of the study. All patients were subjected to magnetic resonance imaging (MRI) scans utilizing 1.5 Tesla equipment, and the results were reported in accordance with recommended protocols. According to the operational definition, these meniscal injuries were reported based on the historical grading of meniscal tears, which was graded between two and three. A record was kept for each individual patient about the outcome variable, which was the existence of meniscal damage. SPSS version 25.0 was used in order to carry out the statistical analysis here.

## RESULTS

Of the 105 patients, the age of the patients was divided into two groups: 18-30 years and 31-50 years. In the younger age group (18-30 years), there were 53 patients, comprising 50.5% of the total sample. The older age group (31-50 years) included 52 patients, making up 49.5% of the sample. This nearly even distribution between the two age groups provides a balanced representation of younger and older patients in the study, the average characteristics of the patient population. The mean age of the patients was 31.30 years, with a standard deviation of 9.42. In terms of gender distribution, the majority of the patients were male, with 81 males (77.1%) and only 24 females (22.9%). This significant male predominance reflects the gender distribution of the patient population in this study, indicating that more men sought or required treatment for the condition under investigation. BMI, another important categorical variable, was divided into two categories: patients with a BMI of up to 25 and those with a BMI greater than 25. A larger proportion of patients (61%, n=64) fell into the category of a BMI up to 25, indicating that a majority of the patients had a normal or healthy weight. Meanwhile, 39% (n=41) of the patients had a BMI greater than 25, which places them in the overweight category. Regarding height of the patients 163.79+6.26 cm was the mean+sd. The average weight of the patients was 71.00 kg+6.87 kg. Finally, the mean BMI was 26.12+2.86, indicating that, on average, the patients in this study were slightly overweight.

Table-II illustrates the frequency of meniscal injuries among patients with ACL injuries, as detected through MRI at Al-Noor Institute of Radiology/Al-Noor Diagnostic Center, Shadman, Lahore. The table compares the occurrence of meniscal injuries across different age groups, genders, and BMI categories, while also presenting the statistical significance of these associations. The frequency of meniscal injuries was compared between two age groups: 18-30 years and 31-50 years. Among patients aged 18-30, 49.1% (n=26) were found to have a meniscal injury, while 50.9% (n=27) did not. In contrast, among patients aged 31-50, a higher percentage, 73.1% (n=38), had a meniscal injury, while 26.9% (n=14) did not. The statistical analysis revealed a significant association between age and meniscal injury (p=0.012), indicating that older patients were more likely to have meniscal injuries compared to their younger counterparts.

In terms of gender, men were significantly more likely to have meniscal injuries than women. Among the 81 male patients, 67.9% (n=55) had a meniscal injury, while 32.1% (n=26) did not. In contrast, only 37.5% (n=9) of the 24 female patients had a meniscal injury, while 62.5% (n=15) did not. The difference between men and women in terms of meniscal injuries was statistically significant, with a p-value of 0.007, suggesting a notable gender-related disparity in the prevalence of meniscal injuries among patients with ACL injuries.

BMI was another significant factor associated with meniscal injuries. Patients with a BMI of up to 25 had a lower frequency of meniscal injuries, with 47.7% (n=21) having a meniscal injury and 52.3% (n=23) not having one. However, in patients with a BMI greater than 25, the frequency of meniscal injuries was much higher, with 70.5% (n=43) having a meniscal injury, while only 29.5% (n=18) did not. The association between BMI and meniscal injury was statistically significant,

with a p-value of 0.018, suggesting that patients with a higher BMI were more likely to experience meniscal injuries. We further analyzed the associations between meniscal injuries and demographics like age, BMI and gender. Our sample revealed older patients, males cases, and those with an increased BMI to have more meniscal injuries suggesting that clinical and demographic factors have a pivotal role in the development of meniscal injuries.

| Categorical Variables | | No. of Patients | % |
|---|---|---|---|
| Age | 18-30 | 53 | 50.5 |
| | 31-50 | 52 | 49.5 |
| Gender | Male | 81 | 77.1 |
| | Female | 24 | 22.9 |
| BMI | Upto 25 | 64 | 61 |
| | >25 | 41 | 39 |
| **Continuous variables** | | **Mean** | **SD** |
| Age | | 31.30 | 9.42 |
| Height(cm) | | 163.79 | 6.26 |
| Weight(kgs) | | 71.00 | 6.87 |
| BMI | | 26.12 | 2.86 |

**Table-I. Demographics of the patients (n=105)**

| | | Meniscal Injury | | | |
|---|---|---|---|---|---|
| | | Yes | No | Total | P-Value |
| Age | 18-30 | 26 | 27 | 53 | 0.012 |
| | | 49.1% | 50.9% | 100.0% | |
| | 31-50 | 38 | 14 | 52 | |
| | | 73.1% | 26.9% | 100.0% | |
| Gender | Male | 55 | 26 | 81 | 0.007 |
| | | 67.9% | 32.1% | 100.0% | |
| | Female | 9 | 15 | 24 | |
| | | 37.5% | 62.5% | 100.0% | |
| BMI | Upto 25 | 21 | 23 | 44 | 0.018 |
| | | 47.7% | 52.3% | 100.0% | |
| | >25 | 43 | 18 | 61 | |
| | | 70.5% | 29.5% | 100.0% | |

**Table-II. Frequency of meniscal injuries in patients with ACL injuries using MRI in Al-Noor Institute of Radiology/Al-Noor Diagnostic Center, Shadman, Lahore**

## DISCUSSION

Our study highlights the frequency and associated factors of meniscal injuries in patients with ACL injuries using MRI diagnostics, and it reveals that demographic factors like age, gender, and BMI significantly correlate with the likelihood of meniscal injury. These results provide insight into patient characteristics that influence the risk of meniscal tears in ACL-compromised knees, which can guide clinical decision-making in treatment planning for ACL injuries.

Our results are consistent with the findings of Ashraf El Mansori[16], who observed that meniscal injuries in ACL-deficient knees are more prevalent in patients with advanced age, higher BMI, prolonged time from injury (TFI), and increased posterior tibial slope (PTS). El Mansori's study concluded that these factors contribute significantly to the incidence of meniscal tears, especially in the medial meniscus. Similarly, our study identified older age and higher BMI as factors increasing the risk of meniscal tears in ACL-injured patients. This consistent observation across studies underscores the role of age-related degeneration and biomechanical changes associated with a higher BMI as significant contributors to meniscal injuries in patients with ACL injuries.

Moreover, gender differences observed in our study, with males showing a higher incidence of meniscal injuries, are echoed in Bakri's findings. Bakri's retrospective study[17] of ACL-injured patients noted a predominance of men among those experiencing ACL ruptures, similar to our study's gender distribution. This trend may be partly explained by the increased participation of males in high-impact sports and activities that place strain on the ACL, thereby raising their risk of associated meniscal injuries. Notably, Bakri's study found that medial meniscal tears are more prevalent in ACL-deficient knees, which aligns with our study's results where the medial meniscus was more frequently affected than the lateral meniscus.

Our study's results further align with El Mansori[16] and Xinwang Zh's[18] work in terms of tear locations within the meniscus. El Mansori's research emphasized that the posterior horn of the medial meniscus is a common site for injury in ACL-deficient patients, a finding reinforced by Xinwang Zh[18], who also observed a high incidence of posterior horn tears in a younger population. This pattern of posterior horn involvement might be

attributed to the altered biomechanics following ACL rupture, which increases the stress on the posterior region of the meniscus. These findings support our hypothesis that meniscal tears are more likely to occur in specific anatomical regions, such as the posterior horn, due to structural changes resulting from ACL deficiency. These findings contribute to the growing understanding of the need for targeted approaches when assessing and managing meniscal injuries in patients with ACL ruptures.

BMI was also found to be a significant risk factor for meniscal injuries in our study, with higher BMI values associated with an increased likelihood of tears. This association is consistent with Xinwang Zh's study in which overweight or obese individuals with cruciate ligament injuries showed a greater risk of associated meniscal damage. The additional weight in these patients likely increases the load on the knee joint, particularly on the meniscal structures, which are key for load-bearing. The meniscus in ACL-compromised knees is already under additional stress due to changes in knee stability, and the added load from excess weight could further exacerbate meniscal degeneration. This observation suggests that weight management could be a crucial factor in preventing meniscal tears among ACL-injured patients, especially for those with elevated BMI.

The results of our research have important repercussions for clinical practice, especially with regard to the prevention and early repair of meniscal injuries in individuals who are weak in the anterior cruciate ligament (ACL). Given the association between increased age and BMI with meniscal tear risk, it would be prudent for clinicians to advise older or overweight ACL-injured patients on preventive measures, such as weight management and modifying activity levels. Furthermore, our observation of a high incidence of posterior horn tears supports the necessity of comprehensive MRI evaluations in ACL-deficient knees, especially in high-risk populations. Detailed MRI evaluations could aid in detecting early meniscal pathology and implementing timely interventions to preserve knee joint function.

The findings regarding gender and tear patterns suggest that tailored rehabilitation programs might be beneficial. Male patients, for example, could benefit from specific strength and conditioning exercises aimed at reducing the biomechanical stresses that contribute to meniscal injuries, particularly in sports and activities known to place strain on the ACL and meniscus. Additionally, an awareness of the increased risk of medial meniscus tears in male patients with ACL injuries may prompt clinicians to adopt targeted preventative strategies that could mitigate injury risk.

While our study provides valuable insights, certain limitations should be considered. We were unable to establish a cause-and-effect connection between the risk factors and meniscal injuries due to the cross-sectional design of our investigation. Longitudinal studies following ACL-injured patients over time could provide a more detailed understanding of how factors like age, BMI, and TFI influence meniscal tear development. Secondly, our study's focus on patients from a single diagnostic center may limit the generalizability of our findings to broader populations. Future research should involve multi-center studies with larger, more diverse patient populations to validate these findings and explore additional factors that may contribute to meniscal injuries.

Lastly, while our study highlights significant associations, future studies should examine the impact of physical therapy interventions and other non-invasive treatments on reducing meniscal tear risk in ACL-injured patients with higher BMI and advancing age. Exploring the efficacy of such interventions could provide a clearer understanding of the potential for lifestyle modifications to mitigate meniscal injury risks in high-risk groups.

## CONCLUSION

In summary, our study emphasizes the significant role of demographic and clinical factors such as age, gender, and BMI in the frequency and patterns of meniscal injuries in ACL-deficient patients. These findings align

closely with previous research, supporting the hypothesis that meniscal tears are more likely in older, overweight, and male patients with ACL injuries. Our results underscore the importance of early MRI diagnostics and tailored clinical interventions to manage meniscal injury risks. As this field progresses, multi-center, longitudinal research and preventative approaches tailored to high-risk groups could further enhance patient outcomes and inform evidence-based practices for managing meniscal injuries in ACL-deficient knees.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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| 1 | **Maria Ghafoor Malik:** Data collection, entry and paper writing. |
| 2 | **Shahid Waheed:** Data collection, paper writing. |
| 3 | **Safdar Ali Malik:** Discussion writing and review of manuscript. |
| 4 | **Khalid Javed:** Data analysis and review of manuscript. |
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| 6 | **Aamna Gilani:** Data entry. |