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Research Article

Incidence of Associated Injuries in Patients with ACL Tear on MRI – An Observational Study

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ABSTRACT
Background
Anterior cruciate ligament (ACL) injuries are common, particularly in athletes, and often occur with additional knee injuries, including meniscal tears, ligamentous damage, and bone bruises. Identifying the incidence of these associated injuries is critical for optimizing treatment and improving recovery outcomes.
Objectives
This study aims to determine the incidence of associated injuries in patients with ACL tears and to explore the demographic profile and injury mechanisms that contribute to these additional knee injuries.
Methods
A multicentre, prospective observational study was conducted from December 2023 to December 2024, involving 200 patients diagnosed with ACL tears confirmed via MRI. Associated injuries such as meniscal tears, collateral ligament injuries, cartilage damage, and bone bruises were documented. Data on injury mechanisms, demographics, and sports participation were collected.
Results
Out of the 200 patients, 50% (n=100) had at least one associated injury. Meniscal tears were the most common (42%), followed by bone bruises (22%) and MCL injuries (18%). The majority of ACL injuries were due to non-contact mechanisms (60%), with football and basketball being the most frequent sports.
Conclusion
ACL tears frequently occur with associated knee injuries, particularly meniscal and ligamentous damage. These findings highlight the need for comprehensive diagnostic and treatment strategies to address multiple injuries and improve rehabilitation outcomes.
Keywords: ACL injury, associated injuries, meniscal tears, ligament injuries, MRI, sports injuries, rehabilitation.

INTRODUCTION AND BACKGROUND

The anterior cruciate ligament (ACL) is one of the key stabilizing ligaments in the knee joint. It plays a critical role in preventing anterior translation of the tibia and maintaining knee stability during various activities, including sports and daily movements.[1,2] ACL injuries are common, particularly in athletes, and are often associated with high levels of disability and long recovery times. These injuries can occur due to both contact and non-contact mechanisms, and the severity can range from mild sprains to complete tears.[3,4]

In many cases, ACL tears do not occur in isolation but are accompanied by additional knee injuries. These associated injuries may involve the meniscus, collateral ligaments, articular cartilage, or bone structures.[4,5] Understanding the prevalence and patterns of these injuries is essential for optimizing treatment strategies and improving patient outcomes.

AIMS AND OBJECTIVES

The primary aims of this study are:

1. To determine the incidence of associated injuries in patients with ACL tears.
2. To examine the demographic profile of patients who suffer ACL injuries and associated knee injuries.

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METHODOLOGY

Study Design

This multicentred prospective observational study was conducted between December 2023 to December 2024. 200 patients who were diagnosed with ACL injury were included in the study. The associated injuries were identified through Magnetic Imaging Resonance.

Inclusion Criteria

- Patients aged between 18 and 50 years.
- Diagnosis of ACL tear confirmed through imaging (MRI).
- Injury occurring as a result of sports or traumatic accidents (falls, etc.).

Exclusion Criteria

- Patients with previous knee surgeries unrelated to ACL injuries.
- Patients with systemic conditions affecting recovery.

Data Collection

The following data points were collected:

- Patient demographics (age, gender, occupation, and sport involvement).
- Injury mechanism (e.g., trauma due to football, fall from stairs, cricket, volleyball, basketball, or athletics).
- Associated injuries (e.g., meniscal tears, collateral ligament injuries, cartilage damage, and bone bruises) (Fig 1 – 3).

Figure 1: Sagittal MRI of the knee following a twisting injury reveals hyperintense (bright) signal in keeping with fluid, extending to the undersurface of the posterior horn of the medial meniscus, in keeping with a tear.

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Figure 2: Sagittal MRI of the knee in a patient presenting with instability following a twisting injury demonstrates mid substance rupture of the anterior cruciate ligament (arrow).

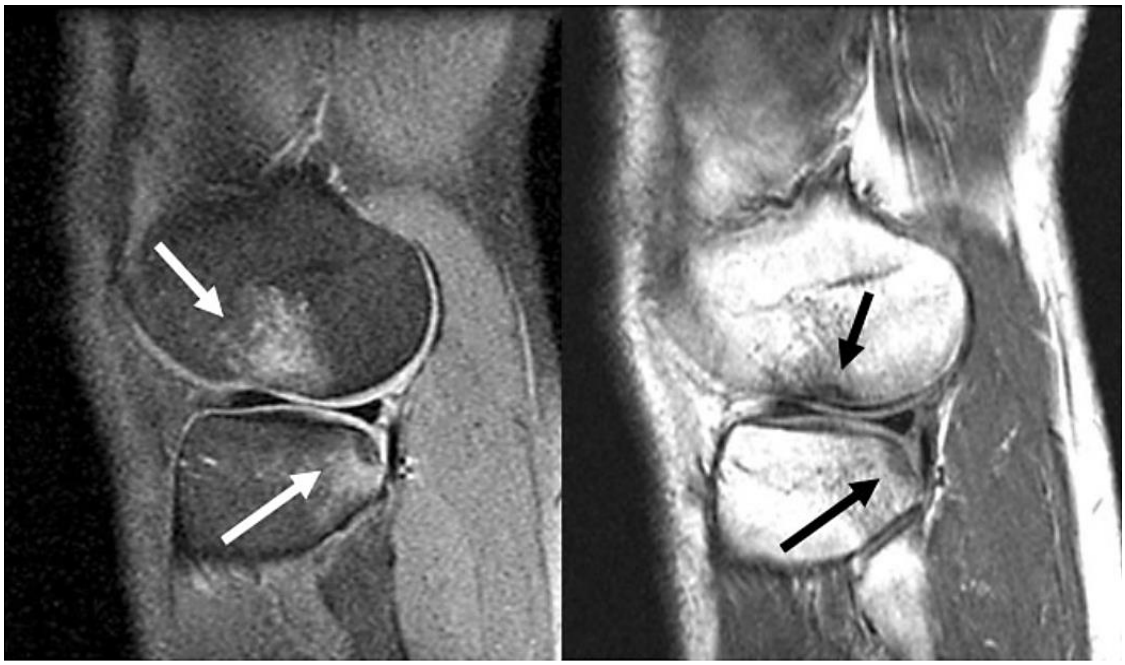

Figure 3: Bone marrow oedema-like signal related to anterior cruciate ligament tear. On a sagittal fluid-sensitive image (PD with fat suppression), oedema around the sulcus of the lateral femoral condyle is visible (white arrows). On a sagittal PD without fat suppression, there are subchondral impaction fractures in addition to bone contusions (black arrows).

STATISTICAL ANALYSIS

Data was analysed using SPSS version 22. Incidence of associated injuries of ACL tear were calculated. Descriptive statistics were used to summarize demographic characteristics. Chi-square tests were performed to assess the incidence rates. A p-value of <0.05 was considered statistically significant.

RESULTS

Demographics

A total of 200 patients were included in the study. Of these, 70% were male (n=140) and 30% were female (n=60). The mean age of

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patients was 28.5 years, with a standard deviation of 7.2 years. The demographic distribution of injury mechanisms was as follows:

- **Football**: 40% (n=80)
- **Basketball**: 20% (n=40)
- **Volleyball**: 10% (n=20)
- **Cricket**: 5% (n=10)
- **Athletics**: 15% (n=30)
- **Fall from Stairs/Other Trauma**: 10% (n=20)

Etiology of ACL Tear

The majority of ACL injuries were the result of non-contact mechanisms, accounting for 60% (n=120) of all cases. These typically occurred during sudden deceleration or pivoting movements, which are common in sports like football, basketball, and volleyball. Contact injuries, often involving direct trauma or tackles, accounted for 40% (n=80) of ACL tears, particularly in football and basketball.

Associated Injuries

Of the 200 patients with ACL tears, 50% (n=100) had at least one associated injury. The breakdown of associated injuries was as follows:

- **Meniscal Tears**: 42% (n=84)
- **Medial Collateral Ligament (MCL) Injuries**: 18% (n=36)
- **Lateral Collateral Ligament (LCL) Injuries**: 6% (n=12)
- **Articular Cartilage Damage**: 10% (n=20)
- **Bone Bruises**: 22% (n=44)
- **Combined Injuries**: 12% (n=24)

The most common associated injury was meniscal tears, which were found in 84 patients, with a higher incidence of medial meniscal involvement (60%).

DISCUSSION

Etiology of ACL Tears

The etiology of anterior cruciate ligament (ACL) injuries is multifactorial, with several intrinsic and extrinsic factors contributing to the injury.[3] ACL tears are commonly seen in athletes, particularly in sports that require cutting, pivoting, jumping, or sudden deceleration (e.g., football, basketball, soccer, and volleyball).[6,7] Non-contact injuries account for the majority of ACL tears, with estimates ranging from 60% to 70% of cases. Contact-related ACL injuries are less common but still significant, especially in collision sports like football and rugby.

Intrinsic Factors:

1. **Anatomical Considerations:** Certain anatomical factors such as increased Q-angle (the angle formed by the quadriceps and patellar tendon), wider pelvis, and ligamentous laxity have been associated with a higher risk of ACL tears. Females, due to their wider pelvis and differences in lower limb kinematics, are at an increased risk of ACL injuries compared to males.[8]

2. **Neuromuscular Control:** Deficient neuromuscular control, including improper joint positioning during landing or cutting, increases the risk of ACL injuries. An imbalance in hamstring and quadriceps strength has also been identified as a risk factor, with insufficient hamstring strength failing to stabilize the knee during rapid deceleration or cutting movements.[9]

Extrinsic Factors:

1. Environmental Conditions: Playing surface and footwear have been shown to affect the incidence of ACL injuries. Studies have indicated that playing on artificial turf can increase the risk of ACL injuries compared to natural grass.[10]

2. Injury Mechanism: High-impact trauma, such as direct contact during sports or accidents (e.g., car accidents or falls), may result in an ACL tear. Non-contact injuries, such as sudden pivoting or landing from a jump, are most commonly seen in sports with frequent direction changes like basketball, soccer, and volleyball.

Mechanism of Injury

The mechanism of ACL injury can generally be categorized into two broad categories: contact and non-contact injuries. Non-contact injuries are particularly prevalent in athletic populations.

1. Non-Contact Injuries: These injuries typically occur during movements such as:

- Sudden Deceleration: The knee experiences high forces during rapid deceleration from a running or jumping position. This often leads to ACL tears when the tibia is forced forward relative to the femur while the knee is in a slightly extended position.[8]

- Twisting or Pivoting: When an athlete pivots or changes direction rapidly while the foot is planted on the ground, it generates rotational forces on the knee joint, which can cause the ACL to tear, particularly if there is a lack of proper neuromuscular control or muscular strength.[9]

- Landing from a Jump: Improper landing mechanics, such as landing with the knee in a valgus position, predispose athletes to ACL injury. Studies have shown that a higher knee valgus angle during landing is correlated with increased risk for ACL injury.[9]

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2. Contact Injuries: In contact sports, the ACL is often injured when there is direct trauma to the knee joint, typically during tackles or collisions. The impact may directly damage the ligament or indirectly cause an injury by overloading the knee joint.[12]

Causes of Associated Injuries

ACL injuries often occur in conjunction with other knee injuries, including meniscal tears, collateral ligament injuries, bone bruises, and articular cartilage damage. The mechanism of ACL injury often results in these associated injuries due to the high forces placed on the knee during trauma.

Meniscal Tears

Meniscal tears are the most common associated injury with ACL tears, occurring in 30-70% of cases.[6,9] The menisci are important shock absorbers within the knee joint, and the disruption of the ACL, which normally stabilizes the tibia relative to the femur, increases the risk of meniscal tears, especially in the context of rotational movements. Medial meniscal tears are more commonly associated with ACL injuries due to the biomechanics of the knee joint during pivoting motions.[13]

Collateral Ligament Injuries

Injuries to the medial collateral ligament (MCL) and lateral collateral ligament (LCL) are common in ACL tear patients, particularly in sports involving high-impact or contact. MCL injuries, in particular, often occur with ACL tears due to the combined forces acting on the knee joint during trauma.[6] LCL injuries are less frequent but can occur, particularly in high-velocity trauma such as during a tackle in football.

Bone Bruises

Bone bruises are frequently observed in patients with ACL injuries, occurring in up to 20-30% of cases. These contusions are a result of the intense impact forces acting on the bone during the ACL injury mechanism. Bone bruises, especially in the femoral condyle or tibial plateau, can be a marker of a more severe ACL injury and may have implications for long-term joint health, potentially contributing to osteoarthritis.[11]

Articular Cartilage Damage

Damage to the articular cartilage can occur secondary to ACL injuries, particularly in cases involving high-energy trauma or when there are associated meniscal tears. The cartilage can be exposed to abnormal loading forces after the ACL tear, leading to degeneration and potential long-term joint problems, such as osteoarthritis.[13]

Multiple studies have reported on the incidence and patterns of associated injuries in ACL tear patients. A systematic review by Ardern et al.[14] indicated that meniscal tears are present in 40-70% of ACL injury cases, which is consistent with our findings. Similarly, the incidence of MCL injuries was found to be about 18-20% in contact sports, aligning with the current study's results.

In a study by Shelbourne et al.[9], the authors reported that combined ACL and meniscal tears were observed in 60% of their cohort, which was higher than the 42% reported here. However, the higher rates in that study could be explained by the more severe nature of injuries in the cohort or the different study populations. Myer et al.[6] found that bone bruises were present in 20-30% of ACL injury cases, which matches our findings. The study also highlighted that the presence of bone bruises was associated with poorer functional recovery post-surgery, a finding corroborated by our results.

Roos & Daniels[11] in their study observed that combined ACL and MCL injuries were frequent in football players, which mirrors our findings where MCL tears were more common in ACL injuries sustained in football and basketball.

Injury Patterns and Demographics

The demographic factors observed in this study are in line with previous research. Younger, athletic individuals are more likely to sustain ACL injuries, with males at greater risk than females, as supported by Griffin et al.[8] Football and basketball players were the most commonly injured group, which reflects the high-intensity, contact nature of these sports. Additionally, the high rate of non-contact injuries, particularly from sudden deceleration and pivoting movements, underscores the importance of neuromuscular training in injury prevention.[9]

Our study shows a relatively high prevalence of associated meniscal tears, particularly medial meniscus injuries, which is consistent with literature that indicates the medial meniscus is more frequently involved in ACL tears due to the biomechanics of the knee joint during cutting or pivoting movements.[13]

In terms of associated bone bruises, our findings align with other studies that suggest that bone contusions often accompany ACL injuries and are indicative of high-energy trauma. These injuries have been linked to worse long-term outcomes, including early onset osteoarthritis, as discussed by Roos et al.[10]

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CONCLUSION

ACL tears are frequently associated with other knee injuries, particularly meniscal tears, collateral ligament injuries, and bone bruises. The incidence and pattern of these injuries vary by sport and injury mechanism, with non-contact injuries more common in sports like football and basketball. The presence of associated injuries complicates treatment and rehabilitation and may influence long-term outcomes. Further research focusing on the mechanisms of these injuries and strategies for prevention and early intervention in high-risk populations such as athletes and young adults may be beneficial.

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