DOI: https://doi.org/10.54393/pjhs.v6i3.2667

PAKISTAN JOURNAL OF HEALTH SCIENCES
(LAHORE)
https://thejas.com.pk/index.php/pjhs
ISSN (E): 2790-9352, (P): 2790-9344
Volume 6, Issue 03 (March 2025)

Original Article

OPEN ACCESS

Evaluating the Incidence of Co-Existing Injuries in Anterior Talofibular Ligament Injuries a Magnetic Resonance Imaging Study

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ARTICLE INFO

Keywords:
Anterior Talofibular Ligament, Calcaneofibular Ligament, Ankle Injuries, Osteochondral Defect

How to Cite:
Qazi, F., Shaheen, O., Andrabi, W. I., Arif, M., Begum, F., & Mansoor, M. (2025). Evaluating the Incidence of Co-Existing Injuries in Anterior Talofibular Ligament Injuries a Magnetic Resonance Imaging Study: Co-Existing Injuries in Anterior Talofibular Ligament. Pakistan Journal of Health Sciences, 6(3), 117-122. https://doi.org/10.54393/pjhs.v6i3.2667

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Received date: 29th November, 2024
Acceptance date: 14th March, 2025
Published date: 31st March, 2025

ABSTRACT

Ankle lateral ligament injuries are common in everyday life as well as in athletic activities. Ankle injuries most commonly affect the anterior talofibular ligament (ATFL). Due to ATFL's susceptibility, achieving intelligent localization and injury evaluation is extremely important from a clinical standpoint. **Objectives:** To evaluate the incidence and patterns of co-existing injuries in ATFL damage using Magnetic Resonance Imaging (MRI). **Methods:** In this cross-sectional study, fifty-five patients undergoing surgical management for ATFL injuries were included. Preoperative MRIs of affected ankles were analyzed to document ATFL integrity and associated injuries. Descriptive statistics were used to summarize findings, with categorical variables reported as frequencies and percentages and continuous variables as means ± SD. **Results:** The mean age of the patients was 36.8 ± 12.4 years, with 61.8% male and 38.2% female. Associated injuries were observed in 72.7% of patients. ATFL injuries included 30.9% low-grade incomplete, 21.8% high-grade incomplete, and 14.5% complete tears. calcaneofibular ligament (CFL) injuries were common, with 36.4% showing partial tears, and 3.6% complete tears.The deep deltoid ligament was intact in 56.4%, while 43.6% had injuries.The superficial deltoid ligament was intact in 70.9%. The peroneal tendon was intact in 83.6%, with 5.5% having injuries and 10.9% showing tendinosis. Osteochondral Defects (OCDs) were present in 21.8% of cases. **Conclusions:** It was concluded that ATFL injuries frequently occur with damage to other structures, particularly the CFL and deltoid ligaments. MRI facilitates accurate diagnosis, emphasizing the need for comprehensive assessment and concurrent management of associated injuries during ATFL repair.

INTRODUCTION

In sports, Ankle sprains are among the most common injuries, comprising up to 40% of all athletic injuries [1]. Despite their frequency, the patterns of associated structural damage, optimal diagnostic approaches, and their clinical significance continue to be areas of clinical interest. The ankle joint, which is formed by the tibia, fibula, and talus bones, is a hinged synovial joint. This joint is supported by the medial and lateral ligament complexes as well as the syndesmotic ligaments. Among these, the lateral ligament complex is most vulnerable to injury, particularly during inversion movements. These movements account for the majority of ankle sprains. This ligament complex includes the ATFL, the calcaneofibular ligament (CFL), and the posterior talofibular ligament (PTFL). The ATFL is the most frequently injured structure due to its primary role in stabilizing the ankle during plantarflexion and resisting anterolateral talar translation. Studies suggest that the ATFL is damaged in as many as 90% of significant ankle injuries, compared to 50–75% for the CFL and only 10% for the PTFL [2, 3]. Lateral ankle

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sprains typically occur when excessive abduction and internal rotation of the rear foot are combined with external rotation of the lower leg. Such movements place undue tension on the lateral ligaments, particularly during plantarflexion, increasing the risk of ligamentous injury. Damage occurs when the tensile forces acting on these ligaments exceed their physiological strength [4, 5]. While the primary injury involves the ATFL, co-existing injuries to adjacent structures such as the CFL, deltoid ligaments, peroneal tendons, and osteochondral surfaces are frequently observed. These injuries can influence treatment decisions and long-term outcomes, making their accurate detection clinically significant. The initial clinical evaluation of an ankle sprain focuses on identifying dislocations or asymmetries. It also focuses on palpating for tenderness over the medial and lateral ankle ligaments, and assessing the fibula. To rule out more severe injuries, observations for edema, ecchymosis, muscle strength deficits, and range of motion restrictions are crucial, along with neurovascular examinations [6, 7]. Advanced imaging modalities, such as ultrasonography (US), MRI, arthrography, and stress radiography, play a key role in diagnosing ligament injuries, especially in chronic cases [8]. Although stress radiography is particularly useful in ruling out fractures, which occur in less than 15% of cases, US and MRI are more sensitive in detecting ligamentous injuries [9]. US is a valuable bedside tool, with a reported 91% accuracy in identifying ATFL injuries, while MRI demonstrates 97% accuracy, particularly for detecting associated injuries such as bone marrow edema, tendon abnormalities, and osteochondral defects [10]. However, the diagnostic sensitivity of MRI for acute ATFL injuries varies widely, ranging from 40% to 95%, with specificity reported between 70% and 97% [11, 12]. MRI findings for ATFL injuries may include ligament discontinuity, irregular contours, thickening or thinning, the bright rim sign [13], or bone avulsions [14, 15]. Despite these advantages, MRI is often underutilized in the acute setting due to its variable sensitivity, cost, and limited availability. Additionally, most existing literature focuses on chronic instability rather than the early detection of concurrent injuries in acute ATFL tears [16]. Persistent symptoms such as instability, stiffness, edema, pain, and muscle weakness are reported in 10%-30% of patients following initial treatment, underscoring the need for careful long-term management [12, 15]. While physical therapy is effective for most cases, surgical intervention may be required in patients with unresolved symptoms or chronic instability. A key limitation in the current understanding of ATFL injuries is the lack of studies assessing the prevalence and patterns of associated injuries using MRI in the acute phase. Identifying these injuries early can help tailor rehabilitation strategies and prevent long-term complications.

Although anterior talofibular ligament (ATFL) injuries are among the most common ankle injuries, most existing studies primarily focus on isolated ligament damage or chronic instability, with limited emphasis on the prevalence and pattern of acute co-existing injuries involving adjacent structures such as the calcaneofibular ligament, deltoid ligaments, peroneal tendons, and osteochondral defects. This creates a significant diagnostic and management gap, as unrecognized associated injuries may contribute to persistent instability, poor functional recovery, and long-term complications. This study aims to systematically evaluate the prevalence and patterns of associated injuries in patients with ATFL tears using MRI. By identifying the structures most commonly affected alongside the ATFL, this research seeks to bridge a critical knowledge gap and improve both diagnostic accuracy and patient management strategies.

METHODS

A cross-sectional study was conducted over six months commencing from March, 2024, up till August, 2024. This study was conducted at Pak International Medical College, Hayatabad, Peshawar, Pakistan. A total of 55 patients were selected for the study, who experienced surgical procedures for ATFL injuries. Written informed consent was obtained from all participants. The Institutional Review Board (IRB) of Pak International Medical College has been permitted to carry out this study with reference number PIMC/DMR/2. The sample size of 55 was calculated using G*Power software, based on an estimated effect size of 0.5, a power of 80%, and a significance level (α) of 0.05. The effect size was determined from prior studies assessing associated injuries in ATFL tears. To minimize potential biases due to loss of follow-up, all participants were assessed at a single time point using MRI before surgery, ensuring a standardized evaluation of associated injuries. The sample was selected through purposive sampling. The sample focused on patients who fulfilled the defined inclusion and exclusion criteria. The participants undergoing a preoperative MRI scan of the affected ankle, with reports specifically addressing the integrity of the ATFL, deltoid ligaments, peroneal tendons, CFL, and the presence of an OCD were included. Patients with systemic diseases or fracturing the same ankle were excluded. Additionally, individuals who did not undergo a preoperative MRI scan with the surgery for ATFL injuries were also excluded from the study. To standardize the classification of structural integrity all MRI scans were analyzed by three investigators using predefined terminology. These investigators included two musculoskeletal radiologists with over five years of experience in MRI interpretation and one orthopaedic surgeon with expertise in foot and ankle injuries. To

DOI: https://doi.org/10.54393/pjhs.v6i3.2667

minimize variability in reporting, terms such as "scarred" or "scarring" were interpreted as "sprain" for the determinations of the study. In cases of disagreement regarding the interpretation of MRI findings, the investigators convened to reach a consensus. Data were examined by incorporating SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize the findings. Continuous variables are reported as means and standard deviations (SD), which include such as age and body mass index (BMI). On the other hand, categorical variables are presented as frequencies and percentages, comprising gender distribution, injury types, and ligament integrity.

RESULTS

The mean age of the patients was 36.8 ± 12.4 years, with 61.8% male and 38.2% female. The mean BMI was 28.43 ± 6.7 kg/m^2. The right ankle was affected in 54.5% of cases, while the left was affected in 45.5% (Table 1).

Table 1: Patient Demographics (n=55)

Measurements		n (%)
Age in Years	19-64 Years	36.8 ± 12.4
Gender	Male	34 (61.8%)
	Female	21 (38.2%)
Body Mass Index (kg/m^2)	19.2–38.9 Kg/M^2	28.43 ± 6.7
Operated Side	Right	30 (54.5%)
	Left	25 (45.5%)

The majority of cases (29.1%) exhibited low-grade incomplete injuries, followed by high-grade incomplete injuries (23.6%) and complete injuries (14.5%). A smaller proportion of participants had an undamaged ATFL (7.3%), while 25.5% had some form of injury without further classification (Table 2).

Table 2: Extent of Anterior Talofibular Ligament (ATFL) Injury

ATFL Injury Type	n (%)
Undamaged	4 (7.3%)
Injured	14 (25.5%)
Low-Grade Incomplete Injury	16 (29.1%)
High-Grade Incomplete Injury	13 (23.6%)
Complete Injury	8 (14.5%)

A total of 72.7% of patients had associated injuries, while 27.3% presented isolated ATFL injuries. 32.7% of patients had an undamaged ATFL, while 52.7% had some degree of incomplete injury (30.9% low-grade, 21.8% high-grade). Complete ATFL tears were observed in 14.5% of cases. Associated injuries predominantly involved the CFL and deltoid ligaments, highlighting their frequent co-involvement in ATFL damage (Table 3).

Table 3: Extent and Nature of Injuries to the ATFL

Measurement	n (%)
Degree of Injury	
Single Injury	15 (27.3%)
Related Injuries	40 (72.7%)
ATFL Integrity	
Undamaged	18 (32.7%)
Injured	29 (52.7%)
Low-Grade Incomplete Injury	17 (30.9%)
High-Grade Incomplete Injury	12 (21.8%)
Whole Tear	8 (14.5%)

The CFL was intact in 60% of patients. Partial tears (low- and high-grade combined) accounted for 36.4% (20% low-grade, 16.4% high-grade), while complete tears were uncommon, seen in 3.6% of patients. The deep deltoid ligament was intact in 56.4% of patients, while 43.6% had some degree of injury (29.1% low-grade, 14.5% high-grade). The superficial deltoid ligament was intact in 70.9% of cases, with 29.1% showing some level of injury (14.5% low-grade, 14.5% high-grade). The peroneal tendon was intact in 83.6% of patients, while 5.5% had injuries, and 10.9% had tendinosis.OCD was associated with 21.8% of cases (Table 4).

Table 4: Associated Injuries

Measurement	n (%)
Calcaneofibular ligament (CFL)	
Undamaged	33 (60%)
Injured	22 (40%)
Low-Grade Incomplete Injury	11 (20%)
High-Grade Incomplete Injury	9 (16.4%)
Complete Injury	2 (3.6%)
Deep Deltoid Ligament	
Undamaged	31 (56.4%)
Injured	24 (43.6%)
Low-Grade Incomplete Injury	16 (29.1%)
High-Grade Incomplete Injury	8 (14.5%)
Superficial Deltoid Ligament	
Undamaged	39 (70.9%)
Injured	16 (29.1%)
Low-Grade Incomplete Injury	8 (14.5%)
High-Grade Incomplete Injury	8 (14.5%)
Peroneal tendon	
Undamaged	46 (83.6%)
Injured	3 (5.5%)
Tendinosis	6 (10.9%)
Osteochondral Defect (OCD)	
Associated OCD	12 (21.8%)
No Associated OCD	43 (78.2%)

DISCUSSION

Ankle sprains, particularly those involving the lateral ligament complex, remain one of the most common injuries

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in both athletic and general populations. Among these, the most frequently injured is the ATFL often in combination with other anatomical structures such as the deltoid ligament complex, CFL, osteochondral surfaces and peroneal tendons. Accurate diagnosis and understanding of co-existing injuries are crucial for effective management. It is also important to prevent long-term complications like instability or osteoarthritis. MRI plays a vital role in evaluating such injuries by offering detailed insights into both acute and chronic damage. This study investigates the spectrum and prevalence of co-existing injuries associated with ATFL damage. Hence, providing valuable data to inform clinical decision-making [17]. The most frequently injured structure associated with ATFL injuries was the CFL, with 41.8% involvement. This high prevalence underscores the importance of understanding the biomechanical relationship between the ATFL and CFL. The CFL plays a pivotal part in maintaining lateral stabilization and resisting inversion forces [18]. Given the shared mechanism of injury in lateral ankle sprains, concurrent CFL damage is common. Despite this, MRI sensitivity for detecting CFL injuries varies significantly, with accuracies reported between 66% for partial tears and 88% for complete tears [19]. This diagnostic challenge necessitates a combination of imaging and clinical tests, such as the medial talar tilt stress test, to enhance diagnostic accuracy when MRI findings are inconclusive [20, 21]. Similarly, the deltoid ligament complex was frequently involved despite its primary role in stabilizing the medial ankle. This is likely due to compensatory stresses placed on the medial structures when the lateral stabilizers fail. Up to 15% of inversion injuries have been reported to involve the deltoid ligament, a finding consistent with our study [22]. Interestingly, while deltoid ligament injuries are classically linked to eversion mechanisms, up to 15% of inversion injuries may also involve this complex [23]. In this study, the deep deltoid ligament was intact in 56.4% of patients, with partial tears (low- and high-grade) and sprains observed in the remaining cases. Similarly, the superficial deltoid ligament was intact in 70.9% of cases, with a smaller proportion showing sprains or partial tears. Failure to recognize deltoid ligament injuries may contribute to residual instability despite surgical correction of ATFL tears, highlighting the need for a comprehensive medial and lateral ligament evaluation. The peroneal tendons are key stabilizers in lateral ankle movements. These were intact in the majority of patients. However, tendinosis was noted in 10.9% of cases, while tears were observed in 5.5%. These conclusions are consistent with earlier studies that emphasize the role of the peroneus longus tendon in stabilizing the lateral ankle during inversion injuries [24]. Despite their critical role, peroneal tendon injuries are frequently overlooked during routine evaluations [25]. Given their contribution to ankle stability, clinicians should assess peroneal tendon integrity in all cases of ATFL injury. Moreover, surgical management of ATFL injuries should address any co-existing peroneal tendon damage to optimize outcomes and prevent recurrent instability [26]. Osteochondral defects (OCDs), often resulting from direct trauma or repetitive micro-trauma, were observed in 21.8% of cases. These defects commonly occur during ankle sprains when forced talar rotation generates compression and shear forces on the talar cartilage [27]. Cadaveric studies have corroborated this mechanism, demonstrating similar cartilage injuries under experimental inversion stress [28]. Additionally, chronic lateral instability due to ATFL injury has been linked to the development of OCDs, where repetitive micro-trauma and altered joint biomechanics exacerbate cartilage damage [29, 30]. The prevalence of OCDs in this study underscores the importance of evaluating talar cartilage integrity during the assessment of ATFL injuries, as timely intervention can mitigate long-term consequences like post-traumatic arthritis.

The study was limited by its small sample size, single-center setting, purposive sampling approach, and cross-sectional design, which may restrict broader applicability and prevent assessment of long-term functional outcomes. Additionally, inclusion of only surgically managed patients may have introduced selection bias toward more severe cases. Future research should include larger multicenter prospective studies with diverse patient populations, incorporate comparative analyses between acute and chronic injuries, and evaluate the long-term prognostic significance of co-existing injuries to establish standardized management protocols.

CONCLUSIONS

It was concluded that this study highlights a high prevalence of associated injuries in ATFL tears, particularly in the CFL (41.8%) and deltoid ligament complexes, reinforcing the interconnected nature of lateral and medial ankle stability. Additionally, osteochondral defects were present in 21.8% of cases, underscoring the long-term impact of ATFL injuries on joint health. Despite this, surgical treatment often focuses on ATFL repair alone, potentially overlooking concurrent injuries that contribute to persistent instability. The findings emphasize the need for a comprehensive assessment of ligamentous, tendinous, and osteochondral structures in ATFL injuries.

DOI: https://doi.org/10.54393/pjhs.v6i3.2667

Authors' Contribution

Conceptualization: FQ
Methodology: FQ, MA, FB
Formal analysis: OS, WIA
Writing and Drafting: MM
Review and Editing: MM, FQ, MA, FB, OS, WIA

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

All the authors declare no conflict of interest.

Source of Funding

The author received no financial support for the research, authorship and/or publication of this article.

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