

Comparative Study of Immobilization vs. Non-Immobilization in the Treatment of Anterior Talofibular Ligament Injuries

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Abstract: The anterior talofibular ligament (ATFL) is the most frequently injured ligament in ankle sprains, yet optimal management strategies remain debated. This research seeks to synthesize the current knowledge surrounding ATFL injury treatments by comparing two common approaches: immobilization and functional non-immobilization care. Specifically, this research seeks to determine the necessity of restricting activity after an ATFL injury. Immobilization, especially of the ankles and legs, can significantly affect the patients' quality of life and increase the risk of secondary injuries due to limited movement. The long-term risk and benefits of both approaches are critically examined to offer insights into best practices in treatment and rehabilitation.

Keyword: Immobilization; Functional non-immobilization care; Anterior Talofibular Ligament (ATFL); Ankle sprains

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1. Introduction

Anterior talofibular ligament injuries are common among professional athletes and recreationally active individuals, caused by excessive outward twisting of the ankle joint. Since anterior talofibular ligament plays an important role in maintaining the overall stability of the ankle joint, the post-injury recovery and rehabilitation become extremely important for patients with anterior talofibular ligament injuries^[1]. For professional athletes, the level of recovery can directly impact their sports career. However, in contrast to the crucial role of the anterior talofibular ligament in maintaining motor function, there is a lack of unified standards in the medical system for treating ATFL injuries, as well as insufficient awareness of the importance of rehabilitation for ligament injuries among the public. As a whole, the lack of a standard medical treatment plan, insufficient social awareness, and low attention to ATFL injuries are the primary factors hindering effective treatment.

In sports rehabilitation science, existing studies have examined the recovery outcomes of functional treatment and immobilization for acute foot ankle injuries. However, there is no specific study that solely focuses on the treatments and rehabilitation of ATFL injury. This study aims to fill that gap by investigating the recovery outcome of patients with ATFL injury who receive functional training versus immobilization treatment. The findings will help refine treatment protocols and provide a scientific basis to redefine the rehabilitation standards for ATFL injuries^[2]. The detailed introduction of each

treatment is provided in the supplement information section.

In this research, we mainly use two test to measure the level of recovery: single leg balance test (measurement of proprioception) and jump test (coordination and muscle strength). The specific procedure and methodology of each test will be described in detail in the Methodology part ^[3].

2. Literature review

Meticulous works done by scholars and specialists in the field of sports medicine and rehabilitation sciences have examined the effect of functional training and immobilization on the recovery and rehabilitation of many types of ankle ligament injuries, including injuries of ATFL and LAF (lateral ankle sprain). Keene et al. (2014) conducted a meta-analysis involving 1610 participants who received functional training, immobilization, or both for ankle ligament injuries that showed no significant difference in terms of pain scores and functional improvement ^[4].

However, Karlsson et al. (2012) demonstrated that functional training, which applies stress to the injured ligament, stimulates the synthesis and deposition of replacement collagen with higher tensile strength than the collagen formed after prolonged immobilization. This suggests that functional training outperforms traditional fixed immobilization in terms of functional and structural recovery ^[5].

Moreover, highlighted that functional training also plays positive role in the prevention of sports injuries, especially acute ankle injury. The study concluded that participants receiving functional training showed significant improvement in cadence, total in both sides, and distance traveled per minute, indicating better motor fitness and coordination, which negatively correlated with the possibility of injury. demonstrated that functional training can detect functional impairments and movement asymmetries by analyzing human motion patterns, while targeted exercises facilitate tissue remodeling ^[6].

Perera et al. (2025) also examined the consequences of immobilization in ankle sprain treatment, often considered the traditional and conventional treatment for acute ankle injury and fracture. Their MRI case study found that 18 days of immobilization of the ankles of patients with acute ankle sprain significantly reduced the range of motion of the ankle joint, and it caused atrophy of different muscles, including the popliteus, the hamstrings, and the quadriceps, to varying degrees. The MRI scan also indicates an increase in fascia thickness, which is inversely proportional to the range of motion and the flexibility of the ankle joint ^[7]. Perera et al. (2025) concluded that immobilization may negatively affect the flexibility and functionality of the ankle joint ^[7].

3. Methodology

This study conducted a comparative case study to evaluate the recovery of patients with ATFL injuries. Specifically focusing on three cases: patients who only received strict immobilization after injury, patients who started functional training immediately after injury, and a patient who received functional training three weeks after immobilization. The first two groups will be based on the findings of the meta-analyses conducted by Vilchez-Cavazos et al. (2025) and Keene et al. (2014), which compare immobilization and function rehabilitation approaches ^[4,11].

For the third case, recovery will be measured through two standardized tests: the single-leg balance test, which quantifies proprioception by measuring time to balance, and the single-leg jump test, that measures coordination and muscle strength based on jump height and landing control. These two tests were conducted at different time points after the removal of immobilization, based on safety consideration and to prevent secondary injury.

These two tests were selected due to their widespread recommendation and accepted standard for evaluating sports-related performance after ligament injuries. Moreover, these two tests do not require any specialized field or equipment, making them practical to administer. The detailed description and discussion about the procedures and purposes of each test are outlined below. The detailed description of the procedures is listed below:

3.1. Single-leg balance test

The single-leg balance test is an assessment of proprioception. Proprioception is the ability of the body to adjust muscle forces in response to external stimuli. Proprioception is essential for motor control as it enables the body to adapt to unexpected changes in the external environment by providing real-time sensory feedback, particularly when visual input is insufficient or delayed. Additionally, proprioception contributes to movement planning by integrating environmental constraints, such as selecting optimal postural control strategies to prevent falls. Without this rapid and precise feedback, motor performance would be less efficient and more prone to errors, highlighting the critical role of proprioception in ensuring smooth, coordinated, and adaptive movement and preventing injuries^[8].

The single-leg balance test is performed on a firm, level floor. The participants will be barefoot or wear standard athletic shoes. The starting position involves standing upright with hands on hips or arms crossed over the chest, then lifting one foot off the ground and flexing the knee to 90 degrees. Participants should keep their eyes open and focused on a fixed point at eye level. The non-stance leg must not touch the stance leg. The timer starts when the raised foot leaves the ground and stops if the participant moves their stance foot, touches the raised foot down, loses balance requiring support, or reaches the maximum test duration of 30 seconds.

For a more challenging assessment, the test can be repeated with eyes closed to isolate proprioceptive function. Three trials will be performed for each leg, with 30–60 seconds of rest between trials. Performance will be measured by the total time maintained in the proper position before any balance errors occur. Advanced versions may incorporate an unstable foam surface or cognitive dual-tasks, like solving simple math problems while conducting the single-leg test, for further challenge. Standardized instructions and environmental conditions will be maintained throughout testing to ensure reliable results^[9].

Safety precautions will be implemented to prevent falls, particularly for elderly or injured populations. For further analysis, the center of pressure displacement can be measured using force plates to measure postural control.

3.2. Single-leg jump test

The single-leg jump test is a comprehensive assessment tool used to evaluate lower-body explosive power, neuromuscular control, limb asymmetry, dynamic stability, and the patients' willingness to accept weight on the involved side^[10]. Rehabilitation training not only aims to restore the normal structure and original function of the limbs and body system^[10], but also to reestablish the mind-body connection. Single-leg jump test can measure the patients' willingness to accept weight on the involved side, revealing a patient's readiness to bear weight and engage in sports. The test begins with a standardized warm-up consisting of dynamic movements such as leg swings, bodyweight squats, and submaximal practice jumps to prepare the musculoskeletal system for maximal effort. Following the warm-up, the patients assume a starting position by standing on one leg with hands placed on the hips to minimize upper-body influence.

The participants initiate the jump with a self-selected countermovement, involving a rapid descent into knee and hip flexion to utilize the stretch-shortening cycle. Upon reaching the desired depth, they explosively drive upward through the stance leg, extending the ankle, knee, and hip simultaneously to maximize vertical displacement. The non-test leg remains passive to prevent contribution to force production, ensuring that performance metrics reflect unilateral capability. During the airborne phase, the participants maintain a stable body position before landing on the same leg, where they must demonstrate control by holding the landing for at least two seconds without excessive movement or loss of balance.

Each testing session will include 3–5 maximal effort trials per leg, with rest periods of 30–60 seconds between jumps to minimize fatigue-related performance decrements. Data collection will encompass both quantitative and qualitative metrics, including jump height (in cm), peak force and power output (measured using force plate analysis), ground contact time (for reactive strength assessment), and landing stability (evaluated through kinematic analysis or clinician observation).

To ensure reliability, standardized instructions will be provided, and environmental conditions such as surface type and footwear are controlled.

4. Discussion

4.1. Patients receiving functional training or immobilization

The management of ATFL injuries involves a critical decision between functional treatment and immobilization. Both approaches have distinct advantages and risks, as highlighted by the systematic reviews of Vilchez-Cavazos et al. (2025) and Keene et al. (2014) ^[4,11].

For patients receiving only functional training or only plaster immobilization, no experimental results or data are available due to limitations in time and resources. To address this gap, we examined two meta-analyses done by Vilchez-Cavazos et al. (2025) and Keene et al. (2014) ^[4,11]. For acute ankle sprains, Vilchez-Cavazos et al. (2025) found no significant differences between functional treatment (e.g., elastic bandaging) and immobilization (e.g., casts) in terms of pain relief, functional improvement, or complications such as reinjury and instability ^[11]. This suggests that either approach may be appropriate, depending on patient preferences, clinical context and availability of medical and rehabilitative resources. However, the high heterogeneity among studies ($I^2 > 90\%$) and varying follow-up durations call for cautious interpretation of these findings.

In contrast, Keene et al. (2014) focused on postoperative ankle fractures and reported more significant outcomes ^[4]. Early ankle movement (e.g., removable splints) showed no clear long-term functional benefit over immobilization (1-year follow-up: SMD = 0.04, $p = 0.77$), but it significantly reduced the risk of venous thromboembolism (Peto OR = 0.12, $p = 0.02$). Conversely, early movement was associated with having higher risks of deep surgical site infections (Peto OR = 7.08, $p = 0.02$) and fixation failures (Peto OR = 6.56, $p = 0.004$). These findings emphasize the trade-offs between promoting early mobility and ensuring surgical stability, particularly in high-risk patients.

The divergent results between these studies may arise from differences in injury severity and postoperative healing requirements. While functional treatment for sprains prioritizes proprioception and early weight-bearing, postoperative fracture management must balance mobility with the mechanical integrity of internal fixation. Clinically, this implies that functional treatment is a viable first-line option for sprains. Future research should address the limitations of existing trials, such as small sample sizes and methodological heterogeneity, to refine treatment protocols for both conditions ^[12].

4.2. Patients receiving functional training after immobilization

This study also examined a case where a patient received four weeks of functional therapy following three weeks of immobilization, aiming to maximize rehabilitation outcomes. This patient had been practicing ballet for over ten years and possessed good physical fitness and motor skills. Single-leg balance test was conducted immediately after the immobilization was relieved and in each following week until week five. However, the single-leg jump test was conducted after two weeks of functional training for the concerns of safety and to minimize the probability of secondary injury.

Immediately after the brace removal, the patient received a five-minute mini-training session on how to exert force on the affected side. Observation revealed that the patient developed mild pressure ulcers and yellow discoloration in the areas where the skin came into contact with the plaster brace. After the training, the single-leg balance test was conducted, and the result of the single-leg balance test indicated extreme asymmetry of the affected side and the unaffected side. The patient could only balance on the affected side for 4 seconds, experiencing severe pain and mental stress. For the unaffected side, the patient could easily balance for more than 30 seconds. In this case, the difference between the two sides reached 153%, indicating the loss of a significant amount of proprioception of the affected side. Loss of proprioception and asymmetry are associated with a greater probability of sports injuries.

In order to regain proprioception and reestablish the muscular function of the affected side, the patient received five weeks of physical therapy and rehabilitation training. The primary objective was to release muscle tension and fascial adhesions caused by prolonged immobilization. After two sessions of manual therapy, the range of motion (ROM) in the affected side was largely restored to a level comparable to the unaffected side, although pain persisted. Meanwhile, functional training was also implemented. The initial phase of functional training primarily involved resistance band-assisted closed-chain exercises. The elastic band provided multidirectional resistance (frontal, sagittal, and transverse

planes) at the ankle joint, aiding in the restoration of neuromuscular coordination ^[13].

The resistance band exercise for ankle dorsiflexion and plantarflexion primarily strengthens the tibialis anterior during toe pulls (dorsiflexion) and the gastrocnemius-soleus complex during toe presses (plantarflexion), with secondary engagement of the extensor digitorum longus and posterior tibialis. In ankle injury rehabilitation, this movement plays a key role by rebuilding strength in weakened muscles, restoring a controlled range of motion, and retraining proprioceptive stability—all of which are critical for recovering functional mobility after sprains, strains, or post-immobilization stiffness. The adjustable resistance of the band allows progressive loading to safely improve tendon and ligament resilience while minimizing reinjury risk during early to mid-stage rehab (**Figure 1**).



Figure 1. Resistance band exercise for the ankle dorsiflexion and plantarflexion.

This exercise involves placing a resistance band between both feet while keeping the heels stationary and rotating the toes outward, primarily targeting the peroneal muscles (peroneus longus and brevis) on the outer lower leg. It strengthens ankle stability by improving eversion strength and resistance to inversion—key for rehabilitating and preventing lateral ankle sprains. The controlled movement enhances proprioception and muscle endurance while promoting balanced recovery in cases of chronic instability or post-injury weakness. Adjusting band tension allows progressive loading tailored to different rehab stages (**Figure 2**).

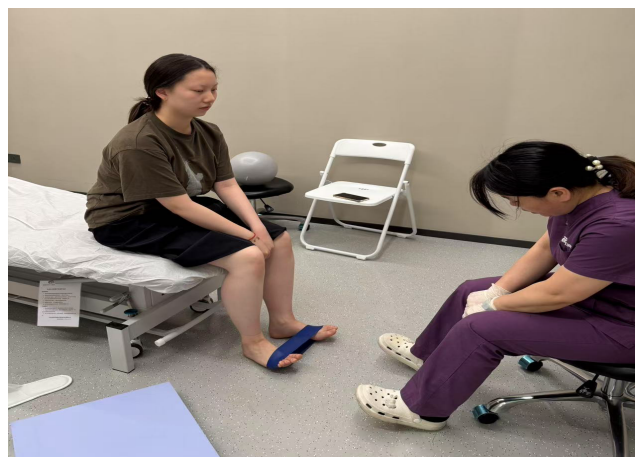


Figure 2. Bilateral ankle eversion resistance band training for peroneal muscle strengthening.

Following the restoration of proprioception, the focus of advanced functional training shifted toward reconditioning physical fitness, muscle strength, power, and movement coordination to prepare for a return to sport (RTS). As detailed in the Introduction, BOSU ball-assisted training demonstrated significant efficacy in restoring these functional capacities (**Figure 3**).

After two weeks of functional training and physical therapy, the single-leg jump test was conducted. The detailed results of the two tests are shown in the table below.



Figure 3. Advanced functional training facilitated by BOSU ball.

Table 1. Result of single-leg jump test

	Week 2	Week 3	Week 4	Week 5
Affected Side/cm	25	30	55	78
Unaffected Side/cm	85	87	84	89
Percentage Difference of Two Sides	89%	78%	42%	13%

Table 2. Result of single-leg balance test

	Week 1	Week 2	Week 3	Week 4	Week 5
Affected Side/s	2	4	15	28	>30
Unaffected Side/s	>30	>30	>30	>30	>30
Percentage Difference of Two Side	175%	152%	67%	6.9%	0%

5. Conclusion

The meta-analysis and the case study highlight the risks of immobilization, such as muscle atrophy and reduced mobility. In contrast, functional training demonstrates potential in restoring neuromuscular control and stability.

These findings suggest that functional training may offer superior rehabilitation benefits, particularly for professional athletes. However, the choice between immobilization and functional training should be individualized, taking into account injury severity, patient needs, and available resources. Future research with larger samples and standardized protocols is needed to refine treatment guidelines for ATFL injuries.

6. Supplement information

6.1. Functional training

Functional training is a training method that focuses on multi-joint and compound movements, aiming to improve an individual's overall physical fitness and functional performance by imitating or enhancing movement patterns in daily life and exercise. Unlike traditional strength training, which often isolates individual muscles, this approach emphasizes movement patterns that mimic daily activities and sports, improving stability, flexibility, coordination, and strength in dynamic environments. Originally rooted in physical therapy and medical rehabilitation, functional training helps restore and optimize athletic ability, benefiting both injury recovery and general fitness. Today, with growing emphasis on health and sports performance, functional training has gained widespread application in athletics, rehabilitation, and general fitness.

Recent research highlights its role in preventing and rehabilitating injuries, particularly in areas like ankle stability. Studies suggest that targeted functional exercises can reduce acute ankle sprains and improve neuromuscular control, offering a proactive approach to injury prevention.

BOSU ball (both sides up ball) is a critical piece of equipment in functional training. It facilitates reestablishing proprioception, coordination, and neuromuscular control after injuries by providing an unstable hemispherical plane. A common training plan for the rehabilitation of acute ankle ligament injury is the BOSU ball functional training exercise. Specifically, this exercise involves standing on a BOSU ball with both feet in a semi-squat position to challenge balance and proprioception. While maintaining stability, the patients repeatedly throw a yoga ball downward, allowing it to bounce back from the floor before catching it. This dynamic movement enhances neuromuscular control, coordination, and reactive stability in the lower extremities.

6.2. Immobilization

Immobilization is the standard and conventional method to treat fractures and severe ankle ligament injuries. For ATFL injuries, immobilization prevents secondary damage due to intense movement and stretching of the joints. The standard duration of immobilization for ATFL injuries is 3 weeks, because the recovery period of ligaments is three months. (H. Wang, personal communication, May 8, 2025) Following this period, recovery progress tends to decelerate significantly, nearing stagnation. As a result, the first three weeks post-injury are considered a critical phase, requiring mindful care and extra attention.

Conversely, immobilization can lead to adverse complications, including pressure sores, blood clots, muscle atrophy, body asymmetry, and compromised proprioception. The primary cause of these complications is mechanical unloading. Moreover, the inconvenience in daily life that restrictive immobilization brings to patients may potentially increase the risk of secondary injury.

7. The author's personal story and reflection

This research is critical to me as I suffered from an ATFL injury. According to my doctor approximately 80% of patients adhere to directions, especially those who care about their health and understand medical recommendations. But around 20%—especially post-op patients—may ignore instructions. For example, doctors often limit patients' mobility after surgery, but some patients believe they have already recovered and resume normal activities, which can lead to complications. A common perspective persists that "if there is no fracture, no treatment is needed." This misconception can cause negative long-term effects.

In comparison to professional athletes, individuals such as female dancers, farmers, and building workers are also people who are prone to ATFL injuries. Importantly, they receive much less attention from society and the public than professional athletes and sports stars. This disparity often results in insufficient access to medical and rehabilitation resources. I hope that this research contributes to addressing these systemic gaps and promotes equitable access to rehabilitation for all individuals affected by ATFL injuries.

Disclosure statement

The author declares no conflict of interest.

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