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Systematic Review

Impact of immobilization time on the recovery of ankle function after Achilles tendon rupture

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Abstract

Objective: To analyze the impact of immobilization time on the recovery of ankle function after Achilles tendon fracture.

Methods: Studies published between 2013 and 2023, extracted from databases including PubMed, Scopus, Web of Science, Embase, and Cochrane Library, were included.

Results: The analysis revealed that protocols with immobilization of 0-2 weeks resulted in better recovery of range of motion, muscle strength, and greater patient satisfaction, without a significant increase in complication rates or re-ruptures. In contrast, immobilization of 4-6 weeks was associated with greater joint stiffness and delayed return to sports activities.

Conclusion: The findings reinforce the benefits of early mobilization after Achilles tendon rupture and reinforce the need for a more individualized approach.

Level of Evidence I; Systematic Review.

Keywords: Achilles tendon; Immobilization; Functional rehabilitation.

Introduction

Achilles tendon rupture is among the most common tendon injuries in adults, especially in individuals aged 30-50 who engage in recreational sports activities. The Achilles tendon is the strongest and thickest in the human body, playing a critical role in walking, running, and jumping. Its rupture can lead to significant functional impairment, impacting the patient's mobility and quality of life. Treatment can be surgical or conservative, and both involve immobilization time to support tendon healing and reduce complications[1].

The ideal immobilization time after injury remains controversial in the orthopedic literature. Traditional protocols recommend prolonged immobilization to protect the scar structure and avoid excessive stress at the injury site, while recent approaches suggest that short immobilization reduces muscle atrophy, preserves range of motion (ROM), and improves functional recovery without increasing the risk of re-rupture[2].

The choice of immobilization time can influence residual muscle strength, proprioception, and timeline to return to functional activities. Prolonged immobilization is associated with adverse effects, including calf muscle weakness, shortening, and joint stiffness, which can compromise ankle biomechanics and increase the risk of further injury. Conversely, insufficient immobilization time may result in inadequate tendon healing and an increased risk of re-rupture. Given this scenario, a better understanding of the effects of immobilization time on the recovery of ankle function is required[3].

The objective of this study is to analyze the impact of immobilization time on the recovery of ankle function after Achilles tendon rupture, comparing different immobilization times in terms of muscle strength, ROM, proprioception, timeline to return to functional activities, and re-rupture rates. The findings may optimize rehabilitation protocols, helping to define the ideal immobilization time to maximize functional recovery and minimize associated complications.

Study performed at Hospital do Servidor Público Municipal de São Paulo, São Paulo, SP, Brazil.

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Methods

This integrative review synthesized evidence from different study designs to provide a comprehensive analysis of immobilization time and its impact on the recovery of ankle function after Achilles tendon rupture. The review was conducted in six stages: (1) problem identification; (2) definition of inclusion and exclusion criteria; (3) database search; (4) critical evaluation of methodological quality; (5) data analysis and synthesis; and (6) results presentation.

The question, formulated according to the PICO framework, was: What is the impact of immobilization time on the recovery of ankle function after Achilles Tendon rupture?

'Short immobilization' was defined as 0-2 weeks, and 'prolonged immobilization' as 4-6 weeks. Early functional rehabilitation protocols include, but are not limited to, short immobilization times and the early initiation of controlled exercises to regain mobility and strength, which differs from strategies that focus solely on reducing immobilization time.

Inclusion criteria were studies published between 2013 and 2023, in English, Portuguese, or Spanish, that evaluated the effect of immobilization time on recovery of ankle function after Achilles tendon rupture. Eligible designs included randomized clinical trials, cohort studies, systematic reviews, and meta-analyses. Exclusion criteria included opinion articles, case reports, narrative reviews without defined methodology, and studies lacking functional outcomes.

Searches were conducted in PubMed, Scopus, Web of Science, Embase, and the Cochrane Library databases, using both controlled and uncontrolled terms combined with Boolean operators (AND, OR). Main terms were: 'Achilles tendon rupture', 'ankle immobilization', 'functional recovery', 'early mobilization', 'rehabilitation', 'range of motion', 'muscle strength', and 're-rupture risk'.

Among the identified articles, 15 were screened based on title and abstract, 13 underwent full-text review, and only three strictly met the inclusion criteria, as described in Figure 1. Despite the small number, the selection prioritized methodological quality, assessed using the PEDro scale for randomized clinical trials, the Newcastle-Ottawa for observational studies, and the AMSTAR-2 checklist for systematic reviews. Although Mayer et al.[4] was included, despite methodological limitations, due to its unique focus on functional outcomes not addressed by the other articles.

The small sample size and methodological heterogeneity limit the generalizability of the results; however, the critical appraisal enables the identification of consistent trends and knowledge gaps that are essential for refining clinical protocols and guiding future research.

Results

Three studies met the inclusion criteria, evaluating the impact of immobilization time on recovery of ankle function after Achilles tendon rupture[4-6]. A retrospective study involving 266 patients divided into four immobilization groups (0, 2, 4, and 6 weeks) showed that shorter immobilization time (0-2 weeks) resulted in earlier return to light sports ($p < 0.001$), faster recovery of ROM, and improved single-leg jump performance, without significant differences in complication rates[5].

A meta-analysis of ten randomized controlled trials, including 570 patients, compared early functional rehabilitation to traditional plaster immobilization. Early functional rehabilitation was associated with a faster return to pre-injury sports levels in five of six studies, with higher patient satisfaction (OR = 3.13; 95% CI: 1.30-7.53; $p = 0.01$), and no significant increase in major complications ($p = 0.21$). Dynamometry and anthropometry measurements favored functional rehabilitation in the first 6-12 postoperative weeks; however, these differences became negligible by six months[6].

Mayer et al.[4] investigated muscle imbalances between the dorsiflexors and plantarflexors after conservative and accelerated treatment of Achilles tendon ruptures. Prolonged immobilization was associated with muscle loss, joint stiffness, and atrophy, while short mobilization preserved functional outcomes and mitigated these adverse effects.

Patients undergoing short immobilization time returned to light sports after a mean of 12 weeks, compared with 16 weeks in the prolonged immobilization ($p < 0.001$). ROM

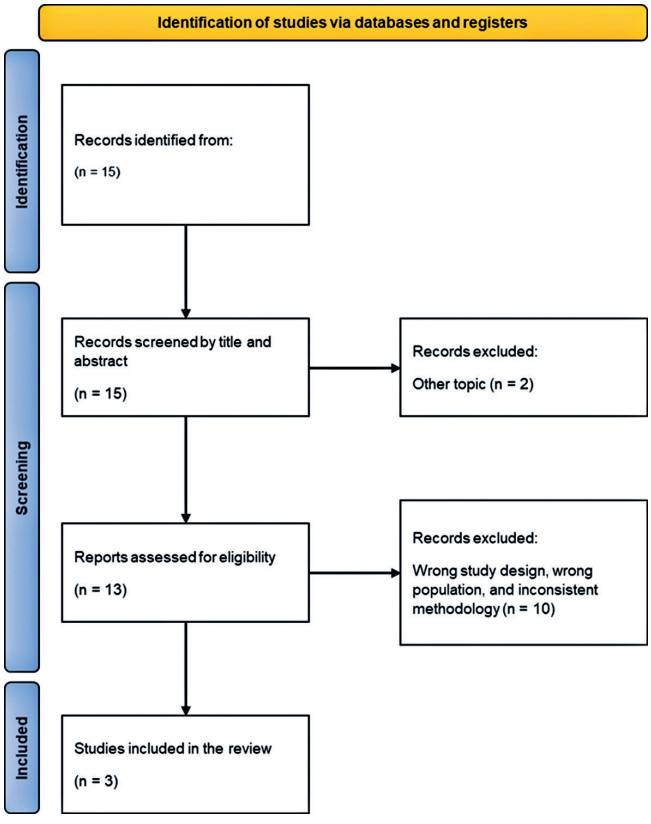

Figure 1. PRISMA flowchart.

recovery reached 90% of the contralateral side at eight weeks in short immobilization, compared to 12 weeks in prolonged immobilization ($p < 0.001$)[4-6].

Single-leg jump height reached 80% of the unaffected side at 14 weeks in the short immobilization groups, compared with 20 weeks in prolonged immobilization ($p < 0.001$). Patient satisfaction was also higher, with 85% rating the outcomes as good or excellent, compared with 70% in traditional immobilization (OR = 3.13; 95% CI: 1.30-7.53; $p = 0.01$)[4-6].

No significant difference was found in re-rupture rates among the groups ($p = 0.21$). After 12 months, patients undergoing early rehabilitation showed a 4.19% lower Limb Symmetry Index – Heel-Rise Work (LSI-HRW; $p = 0.041$). Complication rates, including superficial infections and deep vein thrombosis, were similar between protocols, with no statistically significant differences[4-6].

Mean scores on the American Orthopedic Foot and Ankle Society and Achilles tendon rupture scales were significantly higher in the short immobilization groups during the first 12 postoperative weeks ($p < 0.001$). No significant difference was found in return to work rates between the early functional rehabilitation and traditional immobilization groups ($p = 0.060$)[4-6].

No significant difference was found in the return to sports among the groups ($p = 0.306$). Dynamometry and anthropometry measurements favored functional rehabilitation in the first 6-12 postoperative weeks; however, these differences became negligible by six months. After 12 months, patients in early rehabilitation again showed a 4.19% lower LSI-HRW compared with traditional immobilization[4-6].

Discussion

The analysis showed that postoperative immobilization time has a significant impact on the recovery of ankle function after Achilles tendon rupture. Short immobilization was associated with a faster return to light sports (mean 12 vs. 16 weeks; $p < 0.001$), aligning with evidence that early functional rehabilitation improves mobility without compromising tendon healing[7-9].

The ROM was also more rapidly restored in short immobilization protocols, reaching 90% of the contralateral ROM at eight weeks, whereas in prolonged immobilization, it was observed only at 12 weeks ($p < 0.001$). Recent studies have shown that early mobilization promotes better restructuring of collagen fibers, contributing to the recovery of ankle function[10,11].

Muscle strength was significantly higher in the early functional rehabilitation groups. Single-leg jump height, an important indicator of muscle strength and coordination, reached 80% of the unaffected side in 14 weeks in the short immobilization groups, whereas in the prolonged immobilization groups, it took 20 weeks ($p < 0.001$). These findings are corroborated by studies that indicate that early use of the lower limb reduces the negative impact of muscle atrophy and improves biomechanical function[12,13].

Patient-reported outcomes were superior in the short rehabilitation group, with 85% of participants rating their results as good or excellent, compared to 70% in the prolonged immobilization group (OR = 3.13; 95% CI: 1.30-7.53; $p = 0.01$). These findings are consistent with the literature, which reports higher satisfaction and reduced psychological distress when early mobilization is employed[14].

One major concern regarding early mobilization is the risk of re-rupture; however, the included studies found no significant differences between short and prolonged immobilization ($p = 0.21$). These findings are consistent with meta-analytic evidence indicating that early functional rehabilitation does not increase re-rupture rates when applied properly. Likewise, complication rates, including superficial infections and deep vein thrombosis, were comparable across groups, supporting the safety of shorter immobilization protocols[15,16].

Long-term outcomes, including the LSI-HRW, showed that after 12 months, patients undergoing early rehabilitation had a 4.19% lower rate compared to prolonged immobilization ($p = 0.041$). These findings reinforce the effectiveness of early mobilization in preserving muscle function and preventing chronic sequelae[17].

Conclusion

The findings of this review reinforce the importance of early functional rehabilitation in ankle recovery after Achilles tendon rupture. The reduction in immobilization time, especially for periods of up to two weeks, is associated with a faster recovery of ROM, single-leg jump height, and muscle strength, in addition to providing greater patient satisfaction without increasing the risk of complications.

The analyzed literature suggests that more dynamic rehabilitation protocols, instead of prolonged immobilization, can optimize functional outcomes and accelerate the return to daily and sports activities. However, the choice of rehabilitation regimen should be individualized, considering factors such as age, pre-injury activity level, and associated comorbidities.

Although the results are promising, further studies are required with greater methodological rigor and long-term follow-up to validate the findings and establish more robust guidelines for managing Achilles tendon rupture. Thus, new research may contribute to a continuous refinement of rehabilitation protocols, ensuring better prognoses and quality of life for patients affected by this injury.

Authors' contributions: Each author contributed individually and significantly to the development of this article: YVF *(https://orcid.org/0009-0008-2541-8020) Conceived and planned the activities that led to the study, conducted the bibliographic review, formatted the article, participated in the review process, and approved the final version; JVGF *(https://orcid.org/0009-0003-6644-9281) Conceived and planned the activities that led to the study, interpreted the study results, participated in the review process, and approved the final version; VVSR *(https://orcid.org/0009-0001-0051-433); LSCS *(https://orcid.org/0009-0000-4450-6626) Contributed to the organization and analysis of data, assisted in writing and formatting the manuscript, participated in the review process, and approved the final version; data collection, statistical analysis. All authors read and approved the final manuscript. *ORCID (Open Researcher and Contributor ID).

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