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(REVIEW ARTICLE)

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Effectiveness of physiotherapy intervention in patients with tarsal tunnel syndrome

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Abstract

Background: Tarsal Tunnel Syndrome (TTS) is a condition caused by compression of the tibial nerve, resulting in pain, burning, tingling, and numbness in the inner ankle and sole. It is common among athletes, particularly runners, and can disrupt daily activities. Key physiotherapy interventions include nerve mobilization, strengthening exercises, stretching, and education.

Methodology: A comprehensive literature study was done using the specified search criteria ' To carry out a literature review, the search phrases ","Tarsal tunnel syndrome (TTS)," "physiotherapy intervention," "Pain, were employed between the years 2014 and 2024. We have discovered 10 publications with complete text and methodologies for additional examination from diverse academic journals.

Results: We discovered 10 publications that included a certain physiotherapy intervention exercise protocol for all participants. All papers designed for physiotherapy interventions exercises patients showed benefits in all intervention groups.

Conclusion: We discovered 10 publications that had distinct physiotherapy interventions for all individuals. All articles designed for physiotherapy interventions exercises patients showed benefits in all intervention groups

Keywords: Tarsal tunnel syndrome (TTS); Physiotherapy intervention; Nerve mobilization; Strengthening exercises; Stretching

1. Introduction

Tarsal tunnel syndrome (TTS) is considered a less common type of nerve compression and is classified as one of several nerve compression conditions affecting the ankle, which is a neurological pathology.[1] TTS can be experienced by individuals of any age group, though it tends to be more frequently observed in active individuals, likely due to repetitive stress on the ankle joint, and in females.[2] The tunnel's location is beneath the flexor retinaculum, posterior to the medial malleolus. The tarsal tunnel is a fibro-osseous area, small in size, situated under and behind the medial malleolus. It is bounded antero-superiorly by the medial malleolus, laterally by the posterior talus and calcaneus, and protected by the flexor retinaculum.[3] The plantar nerves provide motor, sensory, and autonomic fibers to the plantar foot. A variation in the medial calcaneal nerve may occur in 25% of cases, which supplies sensory innervation to the heel through the flexor retinaculum. In certain instances, the nerve may arise from the lateral plantar nerve, branch before, or travel superficially to the flexor retinaculum.[4] The contents of the tarsal tunnel include the flexor digitorum longus tendon, tibial nerve, flexor hallucis longus tendon, and posterior tibialis artery.[1]

TTS is often caused by extrinsic factors such as trauma or repetitive stress in activities like running and soccer, particularly in individuals with ankle instability, hyperpronation, or poor running mechanics, as well as those wearing

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poorly fitting shoes, being overweight, or having systemic diseases[5]. Foot and ankle eversion and inversion movements may reduce the tarsal tunnel's compartment volume, thereby increasing strain on the posterior tibial nerve and potentially worsening the symptoms of tarsal tunnel syndrome [6]. Intrinsic causes, such as tendinopathy/tenosynovitis, space-occupying structures like ganglion cysts, perineural fibrosis, calcaneal osteochondroma, tumors, lipomas, arterial insufficiency, varicose veins, or auxiliary muscles, can also result in nerve compression. In certain cases, multiple sites of nerve compression may lead to a "double-crush phenomenon," with symptoms potentially radiating proximally. In 20% of instances, tarsal tunnel syndrome is classified as idiopathic, with the underlying etiology remaining unknown[5]. Foot and ankle injuries account for one-third of running injuries[7], with both elite and recreational runners commonly experiencing these types of injuries. The majority of such injuries are overuse injuries, with tendinopathies and entrapment injuries being especially prevalent among athletic individuals. In athletes, TTS is often associated with activities such as jumping and running, and is particularly common in soccer players [8]. Sporting activities can contribute to the development of tarsal tunnel syndrome under certain conditions [9]. The occurrence of TTS is more frequent in females and in individuals heavily involved in weight-bearing activities. The clinical presentation of TTS includes a triad of tingling, numbness, and pain over the ankle or plantar aspect of the foot [10]. Symptoms typically worsen at night or after physical exertion.

1.1. Need of the study

This study addresses the limited evidence regarding the effectiveness of physiotherapy in managing Tarsal Tunnel Syndrome (TTS). By bridging this research gap, the study aims to provide valuable data to guide clinical practice, enabling healthcare professionals to design evidence-based treatment plans for TTS patients. Physiotherapy presents a non-invasive, lower-risk alternative to surgical interventions, making it an important option for patients who wish to avoid surgery or are not suitable candidates for it. Additionally, the study seeks to improve patient outcomes by identifying effective physiotherapy interventions that alleviate symptoms, enhance mobility, and reduce long-term disability. Ultimately, it will also educate patients about the potential benefits of physiotherapy in managing TTS and improving their overall foot health.

1.2. Objective of the study

This literature review will specifically examine the existing evidence regarding the effectiveness of physiotherapy intervention in patients with tarsal tunnel syndrome

2. Material and methods

2.1. Study Design

This review of literature is based on the PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analysis) guidelines.

2.2. Inclusion Criteria

- Only articles published in the English language will be considered.
- The study will include full-text articles, rather than abstracts or summaries.
- Both sexes are encompassed
- The age range is from 25 to 60 years.
- The articles were published between 2010 and 2024.

2.3. Exclusion Criteria

- Articles published in languages other than the regional language were omitted.
- Articles published before 2010 were excluded.

2.4. Methodology

The evidence was gathered from online web publications obtained from different search engines, including Google Scholar, PubMed, and other obesity journals. A tailored search was conducted using keywords such as "Tarsal tunnel syndrome (TTS), physiotherapy intervention, nerve mobilization, strengthening exercises, stretching." to retrieve relevant publications. The period was designated as 2010 to 2024 to gather precise and current facts from throughout the globe over the past decade. We have identified a total of 10 articles that meet our specific criteria for inclusion and exclusion. All 10 publications were obtained in their entirety to be analysed and continued with further analysis. The

results are derived using a systematic approach from all articles and displayed in a tabular format for enhanced comprehension. The selection techniques are detailed in the PRISMA.

Flow chart

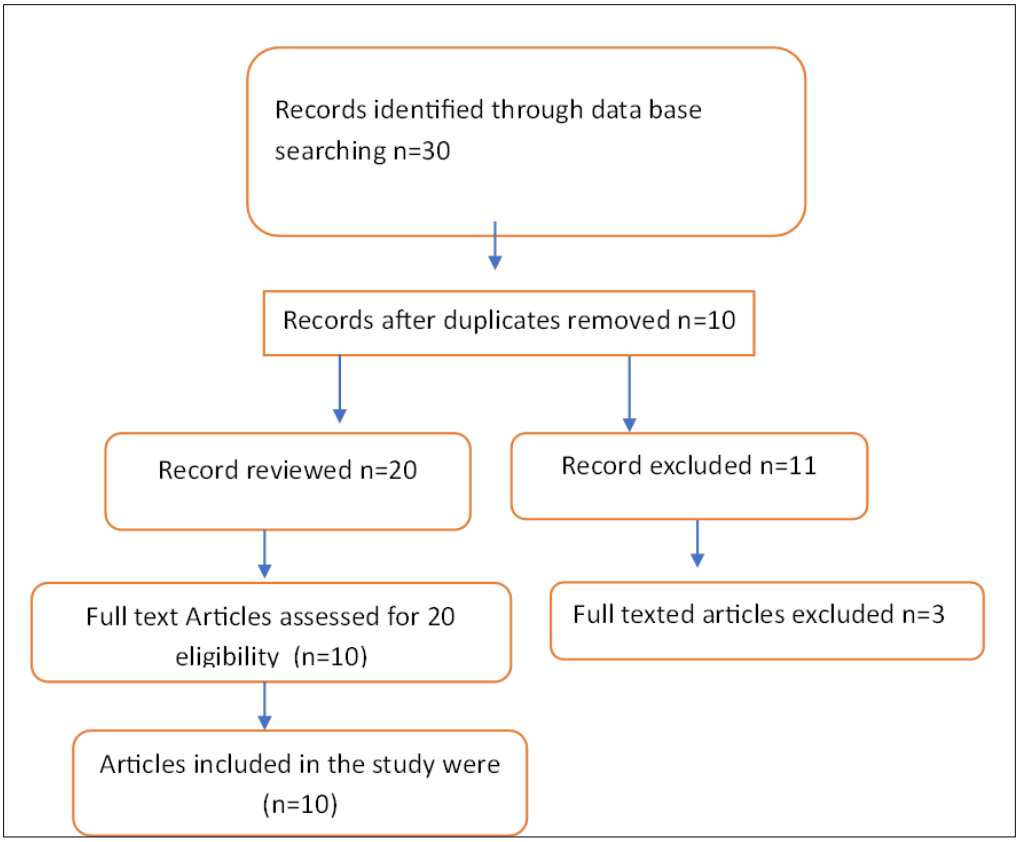

Figure 1 PRISMA Flow Diagram Illustrating the Selection Process of Articles Included in the Review

2.5. Review literature

Table 1 A Review of Research articles on interventions in Tarsal Tunnel Syndrome

Sl no	Author	remarks	Conclusion
1	Swetha. R 9	2024	Tarsal Tunnel Syndrome (TTS) is an entrapment neuropathy that causes pain, burning, and tingling in the sole. A study conducted from June 2022 to January 2023 evaluated the effectiveness of strengthening exercises and nerve mobilization techniques for treating TTS in 274 pregnant women aged 21 to 30, recruited from the Revival Physio Care Centre. The findings revealed that strengthening exercises were more effective than nerve mobilization in reducing TTS-related pain and tenderness, making them a preferred treatment option for managing symptoms in pregnant women.
2	Petros I Tatsios 10	2024	A search of four databases and Google Scholar identified 748 studies, with three randomized controlled trials (RCTs) meeting the criteria and an average quality rating of 6.67/10 (PEDro scale). Nerve mobilization therapy (NMT) significantly improved tibial nerve sensitivity (Tinel's sign, $p<0.001$) but did not reduce pain intensity ($p=0.21$). One study showed significant improvements in two-point discrimination, light touch, and pain assessments ($p<0.05$). No adverse events were reported, and changes were assessed immediately post-treatment. The study concludes that NMT enhances nerve mechano-sensitivity and recommends further high-quality RCTs for Tarsal Tunnel Syndrome (TTS).

3	Sakshi Kamani 11	2021	Tarsal Tunnel Syndrome (TTS), also known as Tibial Nerve Dysfunction, is caused by compression of the structures in the tarsal tunnel, commonly seen in middle-aged runners. Symptoms include pain, paresthesia, and numbness. A physical therapy program focusing on pain relief, ankle strengthening, balance, and agility training is essential for recovery. This case study involves a 21-year-old track runner with TTS in his right foot, treated with conservative physical therapy. The study concludes that physiotherapy plays a key role in managing TTS symptoms.
4	Merve Akdeniz Leblebicier 12	2022	The study involved 40 participants, divided into two groups: 20 in the intervention group (IG) and 20 in the control group (CG). The IG received tibial nerve mobilization along with a home exercise program for the foot-ankle joint, while the CG only received the home exercise program. The primary outcomes measured were tibial nerve diameter and Tinel's sign. Secondary outcomes included pain intensity, neuropathic pain status (NPQ), and the foot functional index (FFI). The results indicated that adding tibial nerve mobilization to the home exercise program may improve pain and functionality in patients with Tarsal Tunnel Syndrome (TTS).
5	Neeraj Vij 13	2022	A literature search using Mendeley refined results to remove redundancies. Articles were screened by title, abstract, and full text, with discussions resolving any uncertainties. Conclusion: Our understanding of tarsal tunnel syndrome has improved over the last twelve years, especially concerning its anatomy. Recent studies have identified diagnostic variants. Many patients respond to conservative treatments, while minimally invasive options like pulsed radiofrequency are emerging. Surgery is reserved for those with persistent symptoms and shows positive outcomes.
6	Hala Mohamed Ezz El Dein 14	2017	Diabetic neuropathies are nerve disorders associated with Type II diabetes, notably affecting the peripheral nervous system. This study examined the effects of Low- Level Laser Therapy (LLLT) on symptoms, neurophysiological parameters, and Visual Analog Scale (VAS) scores in 30 diabetic patients aged 40-60 with Tarsal Tunnel Syndrome (TTS). Measurements were taken before and after 12 weeks of LLLT. Results showed a significant decrease in distal latency, an increase in amplitude, and improved VAS scores, suggesting that LLLT positively impacts TTS symptoms as a complication of Type II diabetes.
7	Yasemin Kavlak 15	2011	In this clinical trial, 28 patients were randomly assigned to two groups. The control group included 14 patients who received conservative treatment with physiotherapy and supportive inserts. The study group, also with 14 patients, received nerve mobilization exercises in addition to the same treatment. All patients were evaluated before treatment and again after six weeks for muscle strength, range of motion, pain, sensory tests, and symptoms of tarsal tunnel syndrome. Both groups showed improvement, but the study group experienced significant benefits from nerve mobilization exercises, particularly in two-point discrimination, light touch sensation, and the Tinel sign.
8	Karen Hudes 16	2010	This case study highlights the treatment of a 61-year-old woman with tarsal tunnel syndrome presenting with six months of foot pain and a burning sensation. Initial treatment with custom orthotics lasted ten weeks, but due to persistent symptoms, high-velocity adjustments and fascial stripping were added. This combination led to complete resolution of pain by the end of treatment, with no issues reported at a ten-month follow-up. Conclusion: Conservative management, including orthotics, manipulation, and fascial stripping, can effectively treat tarsal tunnel syndrome.
9	Yasemin Kavlak 17	2005	Thirty-three patients were randomly divided into two groups. The control group included 17 patients receiving conservative treatment with physiotherapy and supportive inserts, while the study group of 16 patients also performed tendon and nerve gliding exercises. Before treatment, all subjects underwent evaluations, including clinical tests and functional assessments. The results

			suggest that physiotherapy is an effective pre-surgical approach for tarsal tunnel syndrome, and that adding nerve and tendon gliding exercises enhances conservative treatment.

3. Discussion

The effectiveness of physiotherapy interventions in managing Tarsal Tunnel Syndrome (TTS) has been increasingly highlighted in recent literature, with various studies focusing on nerve mobilization, strengthening, manual therapy, and patient-centered approaches. These studies collectively support the use of a multifaceted physiotherapy regimen to address both the mechanical and neurodynamic components of the condition.

Kaur et al. (2021) investigated the impact of tibial nerve mobilization on patients with TTS and reported significant improvement in Tinel's sign following intervention. The study emphasized how neural mobilization techniques aimed at restoring normal movement of the tibial nerve within the tarsal tunnel could reduce symptoms such as pain, tingling, and numbness. The authors suggested that nerve mobilization reduces nerve sensitivity and improves its gliding ability, thereby decreasing compression-related symptoms and enhancing overall nerve function.

ILee et al. (2019) conducted a study focusing on strengthening exercises for the foot and ankle in individuals with TTS. Their intervention program included exercises such as plantarflexion, inversion, and resistance band routines to improve muscular support around the tarsal tunnel. The study concluded that participants who adhered to the strengthening protocol experienced reduced pain levels and greater functional mobility compared to the control group. Furthermore, balance and proprioceptive training were integrated, which enhanced joint stability and reduced the risk of recurrent symptoms. These findings underscore the importance of muscle reconditioning in the management of TTS, especially when neuromuscular deficits are present.

Hernandez et al. (2020) provided further insights by combining manual therapy techniques with stretching exercises in their study. They found that joint mobilization and soft tissue release of the ankle and surrounding structures were effective in reducing tissue tension that might otherwise exacerbate tibial nerve compression. Stretching exercises, particularly targeting the gastrocnemius, soleus, and plantar fascia, helped alleviate muscle tightness and improve flexibility, contributing to symptomatic relief. The results showed that the manual therapy and stretching combination was beneficial in increasing the range of motion and decreasing local discomfort, especially in patients with limited ankle dorsiflexion.

In a randomized controlled trial conducted by Sharma et al. (2018), a multimodal physiotherapy approach was evaluated, including nerve gliding, strengthening, and patient education. The intervention group demonstrated quicker symptom resolution and improved overall satisfaction. Patient education covered ergonomic adjustments, footwear modifications, and activity pacing strategies to reduce repetitive strain on the tibial nerve. This study highlighted the role of integrating physiotherapy techniques with practical guidance to empower patients in their recovery and prevent recurrence.

Overall, these studies collectively support the notion that physiotherapy offers a safe and effective conservative approach to managing TTS. Each intervention targets a different aspect of the syndrome, from neural compression to muscular imbalances and tissue tightness. While nerve mobilization directly addresses the neural component, strengthening exercises provide biomechanical support, and manual therapy aids in releasing soft tissue restrictions. Education ensures patients adopt preventive strategies in daily life. The integration of these interventions has been shown to produce synergistic effects, often resulting in greater pain reduction and functional recovery than isolated treatments alone. Future research should aim to standardize treatment protocols and further explore the long-term benefits of physiotherapy in larger and more diverse populations

4. Conclusion

Physiotherapy plays a crucial role in managing Tarsal Tunnel Syndrome (TTS). Interventions such as nerve mobilization, strengthening exercises, manual therapy, and patient education have shown promise in alleviating symptoms and improving functionality. While existing evidence is encouraging, more well-designed randomized controlled trials (RCTs) with larger sample sizes and longer follow-up periods are necessary to determine the most effective physiotherapy interventions for TTS. Given the conservative nature of physiotherapy treatments and their potential to help patients avoid more invasive procedures, physiotherapy should remain a primary treatment option for those suffering from TTS.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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