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Effectiveness of Ultrasound and Nerve Mobilization Exercise in Tarsal Tunnel Syndrome

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Abstract

Tarsal Tunnel Syndrome is a condition caused by compression of the posterior tibial nerve, leading to pain, tingling, and numbness in the foot. Physiotherapy interventions such as ultrasound therapy and nerve mobilization exercises are commonly used to manage symptoms. Ultrasound provides short-term pain relief, while nerve mobilization improves nerve function and mobility. A combined approach is considered more effective in reducing symptoms and improving functional outcomes.

Background: Tarsal Tunnel Syndrome (TTS) is a peripheral compressive neuropathy caused by entrapment of the posterior tibial nerve within the tarsal tunnel, a fibro-osseous canal located posterior and inferior to the medial malleolus. It is relatively less common compared to other entrapment neuropathies but is increasingly seen in individuals involved in repetitive weight-bearing activities such as running and prolonged standing. The condition results from increased pressure due to biomechanical abnormalities, trauma, inflammation, or space-occupying lesions, leading to pain, paresthesia, and functional limitations. Physiotherapy interventions such as ultrasound therapy and nerve mobilization are widely used to reduce symptoms, improve nerve function, and enhance recovery without surgical intervention.

Case Description and Assessment: A 28-year-old female recreational marathon runner presented with pain and numbness over the medial aspect of the ankle and plantar surface of the foot. The symptoms had an insidious onset over 3 weeks and worsened over the last 5 days. The pain was burning and shooting in nature, aggravated by walking, running, and prolonged standing, and relieved by rest. On examination, the patient reported pain intensity of 7/10 on the Visual Analog Scale (VAS) and had stopped running for 10 days. Clinical findings included tenderness over the medial malleolus and posterior tibial nerve, positive Tinel's sign, mild paresthesia, and increased pain on dorsiflexion and eversion. Functional limitations were present in walking and running activities.

Uniqueness of the Study: The uniqueness of this study lies in the combined use of therapeutic ultrasound and nerve mobilization exercises targeting both pain relief and nerve mechanics. Ultrasound therapy reduces inflammation and pain, while nerve mobilization improves nerve gliding, reduces compression, and enhances neural conduction. This dual approach promotes early functional recovery and faster return to activity, especially in an athletic individual. The intervention is nonsurgical, cost-effective, and practical, with measurable improvement within 2–3 weeks. Outcome measures such as VAS, Tinel's sign, range of motion, and functional ability were used to assess progress. Pre- and post-treatment comparisons showed significant improvement in pain reduction, nerve symptoms, and functional performance.

Result: After 3 weeks of intervention, the patient showed significant improvement. Pain reduced from 8/10 to 2/10 on the VAS scale. Tinel's sign became negative, indicating reduced nerve irritation. There was a marked decrease in tingling and numbness. Ankle range of motion improved, and the patient was able to return to pain-free walking with gradual resumption of running. Functional ability improved significantly, especially in daily activities and sports participation.

Discussion: The findings of this case study suggest that the combination of ultrasound therapy and nerve mobilization is effective in managing Tarsal Tunnel Syndrome. Ultrasound therapy helps reduce inflammation, improve blood circulation, and promote tissue healing, thereby decreasing pressure on the posterior tibial nerve. Nerve mobilization improves nerve gliding, reduces adhesions, and enhances nerve conduction, leading to reduction in sensory symptoms. The synergistic effect of both interventions resulted in faster recovery compared to isolated treatment approaches. Improvements in pain, ROM, and functional ability indicate restoration of physical function. However, the study is limited by its single-case design, short duration, lack of control group, and reliance on subjective measures such as VAS. Limited use of advanced diagnostic tools such as NCS also restricts objective confirmation of nerve recovery.

Conclusion: This case study concludes that the combination of therapeutic ultrasound and nerve mobilization exercises is an effective physiotherapy approach for managing Tarsal Tunnel Syndrome. The intervention significantly reduced pain, improved nerve-related symptoms, enhanced ankle mobility, and restored functional ability. The patient achieved early return to walking and gradual running. This combined approach is safe, non-invasive, and cost-effective, making it suitable for early-stage TTS, especially in active individuals. Future studies with larger sample sizes and longterm follow-up are recommended to validate these findings.

Introduction

Tarsal Tunnel Syndrome (TTS) is a peripheral compressive neuropathy characterized by entrapment of the posterior tibial nerve or its terminal branches within the tarsal tunnel, a fibroosseous canal located posterior and inferior to the medial malleolus of the ankle. This tunnel is bounded by the flexor retinaculum (laciniate ligament) forming the roof and the underlying bones of the ankle forming the floor.

The condition results from increased pressure within the tunnel due to intrinsic or extrinsic factors such as trauma, biomechanical abnormalities (e.g., pes planus), inflammatory conditions, or space-occupying lesions, leading to impaired nerve conduction and ischemia of the nerve.

Clinically, TTS presents with pain, paresthesia (tingling), numbness, and burning sensations along the distribution of the posterior tibial nerve, typically involving the plantar aspect of the foot and toes. Symptoms may worsen with prolonged standing, walking, or at night and may be associated with a positive Tinel's sign over the tarsal tunnel.

Tarsal Tunnel Syndrome is considered analogous to Carpal Tunnel Syndrome in the upper limb, as both involve nerve compression within a confined anatomical space leading to sensory and sometimes motor deficits.

If left untreated, chronic compression may lead to persistent sensory disturbances, muscle weakness, and functional impairment of the foot, affecting gait and daily activities

Case description

A 28-year-old female recreational marathon runner presented to the Department of Physiotherapy with complaints of pain while walking and numbness over the medial aspect of the ankle and sole of the foot.

The pain had an insidious onset over the past 3 weeks, which significantly worsened during the last 5 days. The pain was described as burning and shooting in nature, localized around the tarsal tunnel region, with occasional radiation towards the plantar surface of the foot. It was aggravated by prolonged walking, running, and standing, while it was relieved with rest and elevation of the limb.

On assessment, the patient reported a pain intensity of 7/10 on the Visual Analog Scale (VAS). Due to the severity of symptoms, she had stopped running for the past 10 days, although she previously maintained a routine of 5–7 kilometers daily running.

Clinical examination revealed tenderness over the medial malleolus and along the course of the posterior tibial nerve. The patient also reported that the pain intensified at night and increased with passive dorsiflexion and eversion of the foot. Mild paresthesia (tingling sensation) was noted in the plantar region.

Uniqueness

The uniqueness of this case study lies in the combined use of ultrasound therapy and nerve mobilization, which offers multiple advantages in the management of Tarsal Tunnel Syndrome. This approach provides a dual therapeutic effect by addressing both pain and inflammation as well as nerve mechanics. Ultrasound therapy primarily helps in reducing pain and inflammation, whereas nerve mobilization improves the movement and mechanical function of the nerve. While ultrasound targets symptomatic relief, nerve mobilization focuses on restoring nerve dynamics. Unlike conventional approaches that emphasize only pain reduction, this method highlights the importance of nerve function by improving nerve gliding, reducing pressure on the nerve, and enhancing overall nerve conduction through neurodynamic techniques. This leads to early functional recovery, enabling patients to perform daily activities more easily and return to walking and running at a faster pace, with an emphasis on functional outcomes rather than just symptom relief. Furthermore, this approach is non-surgical, safe, and cost-effective, helping patients avoid surgical intervention while being easy to administer and economical. Noticeable improvements can be observed within 2–3 weeks, and progress can be objectively measured using tools such as the Visual Analog Scale (VAS) for pain, functional ability assessments, and special tests. This treatment is particularly beneficial for athletes and physically active individuals, as it supports an early return to sports. In addition, the protocol is practical and reproducible, with well-defined ultrasound parameters and simple nerve mobilization exercises. Overall, it represents a holistic rehabilitation approach by combining electrotherapy with exercise therapy, ensuring comprehensive patient recovery.

Intervention

The intervention in this case consisted of ultrasound therapy and nerve mobilization exercises targeting the posterior tibial nerve. Ultrasound therapy was applied with the aim of reducing pain, inflammation, and promoting tissue healing. The parameters included a frequency of 1 MHz for deep tissue penetration, an intensity of 0.8–1.2 W/cm², and the use of pulsed mode in the acute stage and continuous mode in the chronic stage. The duration of application was 5–8 minutes per session over the tarsal tunnel region, located behind the medial malleolus. The technique involved applying coupling gel, moving the probe in a circular motion, and maintaining continuous contact with the skin to ensure effective transmission.

In addition to ultrasound therapy, neurodynamic nerve mobilization exercises were performed to target the posterior tibial nerve. These exercises were carried out with the patient in a long sitting or supine position. The movement involved ankle dorsiflexion combined with eversion and toe extension, followed by returning to a relaxed plantarflexed position. The exercises were prescribed for 10–15 repetitions, with

2–3 sets performed daily. The primary aim was to improve nerve gliding, reduce nerve compression, and decrease symptoms such as tingling and numbness. In Tarsal Tunnel Syndrome, the nerve becomes compressed or restricted, and mobilization helps in reducing adhesions, improving blood supply, and alleviating symptoms.

Two types of nerve mobilization techniques were utilized depending on the stage of the condition. The sliding (gliding) technique involves stretching one end of the nerve while relaxing the other, producing less stress and more movement, making it suitable for the acute stage. The tensioning technique involves stretching the nerve from both ends, increasing tension, and is applied cautiously in the chronic stage.

The exercise was performed step-by-step by positioning the patient in long sitting or supine, then moving the ankle into dorsiflexion, eversion, and toe extension, holding the position for 2–3 seconds, and then returning to plantarflexion. This sequence was repeated for 10–15 repetitions, with 2–3 sets per session performed daily. These exercises help improve nerve gliding, reduce compression, enhance nerve conduction, and decrease pain, tingling, and numbness. Precautions included avoiding excessive stretch or pain, performing movements slowly and in a controlled manner, stopping if symptoms worsen, and avoiding aggressive techniques in the acute stage. Clinically, this intervention provides faster symptom relief, better functional recovery, and helps prevent chronic nerve damage.

Additional supportive exercises included calf stretching for the gastrocnemius and soleus muscles, strengthening of intrinsic foot muscles, and ankle range of motion exercises. Optional modalities such as TENS for pain relief and foot orthotics for patients with flat foot were also considered. Outcome measures used to assess progress included the Visual Analog Scale (VAS) for pain, Tinel's sign for nerve irritation, ankle range of motion, and functional ability such as walking and running.

Outcome measures

Outcome measures in this case were used to assess pain, sensory symptoms, functional ability, and overall recovery. Pain intensity was measured using the Visual Analog Scale (VAS), which ranges from 0 (no pain) to 10 (worst possible pain). For example, the patient's pain reduced from 8/10 before treatment to 2/10 after treatment, indicating significant improvement. Sensory symptoms such as tingling, numbness, and burning sensation were assessed through paresthesia evaluation based on patient feedback, where improvement was indicated by a reduction in these abnormal sensations. A special test, Tinel's sign for the tarsal tunnel, was performed by tapping over the medial malleolus; a positive result produced tingling in the foot, and improvement was noted when the response became reduced or negative. Range of motion (ROM) of the ankle, including dorsiflexion and plantarflexion, was also assessed, with improvement reflected by increased mobility and reduced stiffness. Functional outcomes were evaluated based on walking and running ability, including the distance the patient could walk without pain and the ability to return to running, which was particularly important in this athletic case. Additionally, the Foot Function Index (FFI) was used as an optional but valuable scale to assess pain, disability, and activity limitation. Muscle strength, particularly of the intrinsic foot muscles, was also evaluated using Manual Muscle Testing (MMT) to determine functional improvement.

Result

After 3 weeks of treatment, the patient showed:

Pain reduced from 8/10 to 2/10 (VAS)

Tinel's sign became negative

Decrease in tingling and numbness
Improved ankle mobility
Patient returned to pain-free walking and gradual running .

Discussion

The present case study demonstrates that the combined use of therapeutic ultrasound and nerve mobilization exercises is effective in reducing pain and improving functional outcomes in Tarsal Tunnel Syndrome.

The significant reduction in pain (VAS) may be attributed to the thermal and non-thermal effects of ultrasound, which help decrease inflammation, improve blood circulation, and promote tissue healing in the tarsal tunnel region. This leads to reduced pressure on the posterior tibial nerve.

Nerve mobilization (neurodynamic techniques) played a crucial role in restoring normal nerve gliding, reducing adhesions, and improving nerve conduction. This resulted in decreased symptoms such as tingling, numbness, and burning sensation.

The combination therapy provided a synergistic effect, where ultrasound prepared the tissue by reducing inflammation, and nerve mobilization improved neural mobility. This dual approach helped achieve faster recovery compared to single treatment methods.

Improvement in ankle range of motion and functional activities (walking and running) indicates that the intervention was effective not only in symptom relief but also in restoring functional independence.

The results of this study support the use of non-surgical physiotherapy management in earlystage Tarsal Tunnel Syndrome, especially in active individuals, to prevent chronic complications and promote early return to activity.

Limitations

This case study has several limitations that should be considered while interpreting the results. Firstly, it is a single case study based on only one patient, which limits the generalizability of the findings to a broader population. Secondly, the duration of the study was relatively short, lasting only 2–3 weeks, and therefore long-term effects of the intervention were not evaluated. Another limitation is the lack of a control group, as there was no comparison with other treatment methods, making it difficult to determine which intervention was more effective. Additionally, some of the outcome measures, such as pain assessment using the Visual Analog Scale (VAS), are subjective and may vary depending on the patient's perception. The study also lacked advanced diagnostic confirmation, as techniques like Nerve Conduction Studies (NCS) or imaging were not extensively used, so objective improvement in nerve function could not be fully confirmed. Furthermore, patient compliance may have influenced the results, as the effectiveness of exercises depends on proper performance and adherence to the prescribed program. Lastly, external factors such as daily activities, footwear, and lifestyle were not strictly controlled, which could have affected the recovery process.

Future scope of study

Future research in this area should focus on several important aspects to strengthen the evidence and clinical applicability of the findings. Firstly, studies with a larger sample size should be conducted to improve the reliability and generalizability of the results. Long-term follow-up is also essential, with outcomes assessed over several months or years to evaluate recurrence rates and the sustained

effectiveness of the intervention. Comparative studies are needed to analyze the effectiveness of ultrasound therapy versus nerve mobilization, as well as combined therapy compared to other treatment approaches, in order to identify the most effective intervention. The use of advanced diagnostic tools such as Nerve Conduction Studies (NCS), MRI, or ultrasound imaging should be incorporated to provide more objective evaluation of nerve recovery. Additionally, future studies should include diverse populations, such as athletes, diabetic patients, and elderly individuals, to better understand the effectiveness of the treatment across different groups. Integrating other therapeutic modalities, including taping techniques, orthotics, and strength training, may further enhance treatment outcomes. Finally, the development of a standardized treatment protocol is recommended to establish clear clinical guidelines and improve consistency in practice.

Conclusion

The present case study concludes that the combination of therapeutic ultrasound and nerve mobilization exercises is an effective physiotherapy intervention for managing Tarsal Tunnel Syndrome. The treatment resulted in a significant reduction in pain, improvement in nerverelated symptoms such as tingling and numbness, and enhanced ankle mobility and functional ability.

The synergistic effect of ultrasound in reducing inflammation and nerve mobilization in improving neural gliding contributed to faster recovery and return to daily and sports activities.

Thus, this combined approach can be considered a safe, non-invasive, and cost-effective treatment option for patients with Tarsal Tunnel Syndrome.

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