Effectiveness of Strengthening Exercises and Nerve Mobilization for Tarsal Tunnel Syndrome among Pregnant Women

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Abstract-

Background

Tarsal tunnel syndrome is a lower extremity compressive neuropathy that is also referred to as posterior tibial nerve dysfunction neuropathy. Varicosities, pedal edema, diabetes, ligament laxity, and arch drop are associated problems that commonly occur in the third trimester of pregnancy and result in the posterior tibial nerve being compressed in the tarsal tunnel. The most common symptoms are pain, sensory disturbances, which include numbness, burning, and tingling sensations in the sole of the foot, and reduced functional ability. Strengthening exercises and nerve mobilization techniques can be used to reduce pain and improve functional ability. So, the purpose of this study is to find the effectiveness of strengthening exercises and nerve mobilization in reducing pain and improving functional ability in tarsal tunnel syndrome among pregnant women.

Methods

This experimental study recruits 60 pregnant women in third trimester as convenient sampling from SMCH hospital. The participants those met the criteria were allocated randomly to experimental group (nerve mobilization and strengthening exercise) and conventional group (strengthening exercise). The visual analogue scale and foot function index were used as outcomes measures and the significance was set as $p < 0.05$.

Result

The participants in the experimental group showed a significant improvement $p < 0.0001$ in pain and foot functions compared with participants in the conventional group.

Conclusion

The findings concluded that there was a definite and positive effect of nerve mobilization along with strengthening exercises on pain reduction and functional ability in pregnant women with tarsal tunnel syndrome.

Keywords: Nerve mobilization, strengthening exercises, Tarsal tunnel syndrome, stretching exercises

Introduction

Tarsal tunnel syndrome is a neuropathy caused by entrapment of tibial nerve. Impacting the lateral, medial plantar and medial calcaneal nerves which are branches of the posterior tibial nerve. Either separately or together beneath the flexor retinaculum of medial malleolus of ankle [1,2] . Tarsal tunnel syndrome is a rare but serious disorder that often goes undiagnosed, resulting in a variety of symptoms affecting the foot's plantar aspect [3]. The foot's sole is innervated by tibial nerve; hence symptoms typically affect the entire bottom of the foot rather than just part of a heel. There are several areas where the posterior tibial nerve branches are entrapped may be the premise of TTS variable clinical appearance [4]. Compression of the tarsal tunnel structures results in TTS, also known as tibial nerve impairment or posterior tibial nerve neuropathy, it resembles carpal tunnel syndrome of the wrist. It is a lower extremity compressive neuropathy [5]. The medial malleolus is surrounded by a tiny fibro-osseous space called the tarsal tunnel. There are several important structures in tarsal tunnel which contains tibialis posterior tendon, as well as the Flexor digitorum longus and Flexor hallucis longus muscles and posterior branch of tibial nerve [6]. The medial plantar nerve controls movement in the lumbricals, abductor hallucis, flexor digitorum brevis, and flexor hallucis brevis as well as providing sensation to the medial half of the foot and the first 3.5 digits. The medial calcaneus and lateral heel receive sensory innervation from the lateral plantar nerve [7].

In general, this syndrome exhibits idiopathy anywhere from 18% to 57% of the time. TTS most frequently develops due to bony alterations, ligament injury (typically the medially situated deltoid ligament). TTS may also be brought on by systemic diseases including synovitis and inflammatory arthropathies like rheumatoid arthritis, acromegaly, diabetes mellitus, hypothyroidism, sclerosis. Myxedema, which develops in hypothyroidism, can cause tarsal tunnel syndrome because it causes the tissues in the tarsal tunnel to swell more than usual. The posterior tibial nerve is chronically compressed in people with diabetes mellitus, they are more likely to develop tarsal tunnel syndrome, which can result in diabetic foot ulceration. There are two types of etiologies for tarsal tunnel syndrome: intrinsic and extrinsic: - Poorly fitted shoes, injury, edema, systemic arthropathies, and diabetes are extrinsic causes [8]. Tendinopathy, tenosynovitis, tarsal coalition, hypertrophied flexor retinaculum osteophytes, and space-occupying lesions

are intrinsic causes [9]. Varicosities, pedal edema, ligament laxity, and arch drop have all been associated to pregnancy which may results in TTS.

TTS symptoms were more common in people between the ages of 21 and 30. Compared to primiparous females, multiparous females were more prone to develop. TTS was seen in 34.48 percent of primiparous women and 45.65 percent of multiparous women [10]. TTS can manifest in a variety of ways and is complicated by the possibility of total or partial compression, which could result in motor and sensory fiber involvement. Most commonly they may experience insidious onset of pain as pins needles and sharp shooting pain, burning, numbness in the foot which may radiate into the lower leg, muscle weakness, over pronation, foot swelling, gait abnormality (limping gait), paresthesia or loss of sensation [11]. Worsening of pain mostly occurs during and after weight bearing activities and reduces with rest and elevation. Prolonged standing or walking exacerbates pain, dysesthesia arises during night and disturbs sleep [12].

Tarsal tunnel syndrome is diagnosed with a neurological special test- Tinnel sign, dorsiflexion-eversion test, tibial nerve stress test, high frequency ultrasonography (HF-USG), Electromyography (EMG), Nerve conduction studies (NCS), Range of motion, Manual muscle testing, MRI [13]. Positive Tinnel sign occurs when pain is reproduced by percussion on posterior tibial nerve. Symptoms may also produce while performing passively maximally dorsi-flexing, and everting the ankle, while all of these symptoms are present among the usual signs of tarsal tunnel syndrome.

The pathogenesis of TTS determines conservative treatment for mild to moderate pain and inflammation should be reduced as acute phase of treatment. Rest, cryotherapy, oral analgesics such as acetaminophen, NSAID's, tricyclic antidepressants and gabapentin, can help relieve pain [14]. Shock wave therapy strapping, low level laser therapy, medial longitudinal arch support, ultrasound, Laser, splints, nerve mobility or gliding, stretching of plantar fascia, achilles tendon, calf and strengthening exercises. Biomechanical anomalies can also be corrected by orthotic shoes, which offload the tarsal tunnel. Medial heel wedge might lessen traction on tibial nerve [15]. Treatments for the patients with tarsal tunnel syndrome includes those that aims to reduce pain and improving muscle strength, flexibility, and soft tissue mobility. Restoring soft tissue mobility is achieved through nerve mobilization. It uses proper nerve tissue motions to reduce stress in the nerves. Nerve mobilization technique which is used to help people recover from injuries or improve their performance in activities. It may be possible to reduce discomfort and enhance function with gentle movements that "glide" and move the nerves. It enhances the strength. This technique reduces pain and improve sensations to the region where nerve supplies [16].

Exercises for tarsal tunnel syndrome should target strengthening the muscles that cause supination. By doing this, over pronation is avoided. Pronation should be slowed down in particular by strengthening the tibialis posterior muscle and the peroneal muscles eccentrically. Exercises that include stretching and strengthening are crucial for the treatment and minimizing Tarsal Tunnel Syndrome. These exercises emphasize soft movements to ease discomfort while strengthening and increasing ankle flexibility. Stretching the calf can help relieve stress and stiffness by relaxing up the muscles around the ankle. Range of motion can be increased through stretching, which enables the muscles to lengthen and contract more forcefully. It can also aid in preventing cramps and tightness by enhancing muscular contraction [17].

Methods

A total of 68 pregnant women diagnosed with tarsal tunnel syndrome were assessed for eligibility. Among them, 8 participants were removed from the study because they didn't meet the inclusion criteria [two participants with pain severity less than 5, three of them having other comorbidities, and three participants with a Tinel sign that was negative]. A total of 60 participants were selected based on inclusion and exclusion criteria. The study setup was done at Saveetha Physiotherapy OPD, Saveetha Medical College and Hospital, Thandalam. They were informed about the treatment procedure, and written informed consent was obtained.

60 participants were allocated into two groups (conventional group -30, experimental group -30). All the participants were initially evaluated with a visual analogue scale and foot function index as baseline assessments before applying the interventions. Later, the interventions for both groups were given separately. Post-test values were measured using the visual analogue scale and foot function index. The results obtained and the collected data were tabulated and analyzed.

Results

A statistically significant difference was observed in favor of the post intervention values in experimental group for the pain and functional ability. Table1 shows the mean value of pre-test and post-test values of EXPERIMENTAL GROUP [7.63 is reduced to 4.60] and CONVENTIONAL GROUP [8.03 is reduced to 6.10] which were measured by Visual analogue scale. Table 2 compares the post values of experimental Group and Conventional Group which were measured by Visual analogue scale. The findings were extremely statistically significant, with the p-value of less than 0.0001.

Table 1: Comparison of pre-test and post-test values of VAS SCORE for Experimental group and Conventional group

VAS SCORE		Mean	Standard deviation	t value	p value
Experimental group	Pre test	7.63	0.85	19.5396	< 0.0001
	Post test	4.60	0.89		
Conventional Group	Pre test	8.03	0.76	12.1948	<0.0001
	Post test	6.10	0.66		

Table 2: Comparison of post-test values of VAS for Experimental Group & Conventional Group

Parameter	Post Test Values				t value	p value
	Experimental Group		Conventional Group			
	Mean	Standard deviation	Mean	Standard deviation		
VAS	4.60	0.89	6.10	0.66	7.3842	< 0.0001

Table 3: Comparison of pre-test and post - test values of FFI for Experimental Group&Conventional Group

FFI		Mean	Standard deviation	t value	p value
Experimental Group	Pre test	189.10	19.48	28.2182	< 0.0001
	Post test	78.77	23.72		
Conventional Group	Pre test	194.47	25.29	19.6201	< 0.0001
	Post test	106.73	6.80		

Table 4: Comparison of post - test values of FFI for Experimental group and Conventional group

Parameter	POST TEST VALUES				t- value	P-value
	Experimental group		Conventional group			
	Mean	SD	Mean	SD		
FFI	78.77	23.72	106.73	6.80	6.2068	<0.0001

Table 3 shows the mean value of pre and post - test values of experimental group [189.10 is reduced to 78.77] and conventional group [194.47 to 106.73] which were measured by Foot Functional index. Table 4 compares the post values of EXPERIMENTAL and CONVENTIONAL GROUP which were measured by Foot Function Index. The findings were extremely statistically significant, with the p-value of less than 0.0001. From the result, it was observed that EXPERIMENTAL GROUP treated with Tibial nerve mobilization along with strengthening exercises had showed significant improvement in pain reduction and functional ability among pregnant women with tarsal tunnel syndrome.

Discussion

The aim of this study is to compare the efficiency of strengthening exercises versus nerve mobilization in pregnant women with tarsal tunnel syndrome. Visual analogue scale and Foot function index were used as an outcome measure for the assessment of pain and functional abilities. Pre-test and post-test value of the participants were identified separately and their respective mean value are calculated for both groups. The information obtained is tabulated and subjected to paired and unpaired statistical analysis. Mean

and standard deviation are used for all parameters. To examine statistical differences between Pre-test and Post test values. Paired t test was used. To examine statistical differences in Post test values between two groups (experimental and conventional) an unpaired t test is used. There was a statistical difference in post-test values between experimental group who received tibial nerve mobilization along with strengthening exercises and conventional group who received strengthening and stretching exercises. Regarding to our study results the tibial nerve mobilization along with strengthening exercises which are given to the patients with tarsal tunnel syndrome was determined as most effective than strengthening and stretching exercises.

Participants who received nerve mobilization along with strengthening exercises improved more reduction in pain severity and functional abilities. Participants who received strengthening and stretching exercises noticed only a considerable improvement in their scores for the intensity of their symptoms. The differences between pre and posttest values of Experimental and Conventional group were quite significant.

Kavlak and Uygur et al, in 2011 conducted a study on 28 patients with tarsal tunnel syndrome and they were allocated into two groups, control group was treated with conservative treatment and study group was treated with tibial nerve mobilization along with conservative treatment for six weeks. Their conservative treatment plan includes medial arch supports, gastrocnemius stretching, strengthening exercises for weak muscles, application of ice. After intervention they were assessed for range of motion, pain intensity, muscle strength, sensory tests and they concluded that both the groups had showed improvement from the conservative management. Additional tibial nerve mobilization to conservative treatment showed a significant decrease in Tinel's sign and improvement in light touch and 2-point discrimination. Numerous studies have emphasized the need of reducing excessive pronation, which is typically the reason for reduction in the tarsal tunnel's compartment volume, in order to reduce Tarsal tunnel syndrome. They attempted to achieve neutral foot position in their study by employing wedges [18].

In a similar study performed by Merve Akdeniz Leblebicier and Dilan Bulut et al, in 2022 on 40 participants with tarsal tunnel syndrome and they were splitted into 2 groups (Interventional - 20 and control - 20). Interventional group received nerve mobilization along with home exercises for foot and ankle joint and control group was treated with home exercises for foot and ankle joint. The goal of their study is to compare clinical changes following tibial nerve mobilization therapy. Based on their study findings tibial nerve mobilization exercise, which was used on the patients, was shown most efficient than home exercise intervention. According to their findings of the study tibial nerve mobilization therapy along with home exercise therapy which was used on the patients was shown to be most effective than home exercise therapy alone in improving symptoms especially in reducing pain and functionality. While Tinel's sign, VAS, numerical pain rating questionnaire and foot function index clinical evaluation indicators have seen improvements as a result of tibial nerve mobilization [19].

Since it is a neuropathic pain patient's pain may be assessed using neuropathic pain questionnaire which has been limited in this study and can be used in further studies. Diameter of the nerve also can be measured in future studies.

Conclusion

As a conclusion, it is clear that both strengthening exercises and tibial nerve mobilisation have an effect on reducing tarsal tunnel syndrome. However, the tarsal tunnel syndrome is not completely curable as it is recurring during pregnancy; thus, strengthening exercises and tibial nerve mobilisation help minimise the severity of the symptoms of tarsal tunnel syndrome. So, from the above results, it can be concluded that tibial nerve mobilisation along with strengthening exercises is more effective than stretching and strengthening exercises in reducing pain and improving functional ability among pregnant women with tarsal tunnel syndrome.

REFERENCES:

1. Calvo-Lobo C, Painceira-Villar R, López-López D, García-Paz V, Becerro-de-Bengoa-Vallejo R, Losa-Iglesias ME, Palomo-López P. Tarsal tunnel mechanosensitivity is increased in patients with asthma: a case-control study. Journal of Clinical Medicine. 2018 Dec 12;7(12):541.
2. Gondring WH, Trepman E, Shields B. Tarsal tunnel syndrome: assessment of treatmentoutcome with an anatomic pain intensity scale. Foot and ankle surgery. 2009 Sep 1;15(3):133-8.
3. Ahmad M, Tsang K, Mackenney PJ, Adedapo AO. Tarsal tunnel syndrome: a literaturereview. Foot and Ankle Surgery. 2012 Sep 1;18(3):149-52
4. Coppieters MW, Alshami AM, Babri AS, Souvlis T, Kippers V, Hodges PW. Strain and excursion of the sciatic, tibial, and plantar nerves during a modified straight leg raising test. Journal of Orthopaedic Research. 2006 Sep;24(9):1883-9.
5. Cimino WR. Tarsal tunnel syndrome: review of the literature. Foot & ankle. 1990 Aug;11(1):47-52
6. Zuckerman SL, Kerr ZY, Pierpoint L, Kirby P, Than KD, Wilson TJ. An 11-year analysis of peripheral nerve injuries in high school sports. The Physician and Sportsmedicine. 2019 Apr 3;47(2):167-73.
7. Rinkel WD, Cabezas MC, van Neck JW, Birnie E, Hovius SE, Coert JH. Validity of the Tinel sign and prevalence of tibial nerve entrapment at the tarsal tunnel in both diabetic and nondiabetic subjects: a cross-sectional study. Plastic and reconstructive surgery. 2018 Nov 1;142(5):1258-66.
8. Hong CH, Lee YK, Won SH, Lee DW, Moon SI, Kim WJ. Tarsal tunnel syndrome caused by an uncommon ossicle of the talus: A case report. Medicine. 2018 Jun;97(25).
9. Komagamine J. Bilateral tarsal tunnel syndrome. The American Journal of Medicine. 2018 Jul 1;131(7):e319.
10. Sawant RA, Gijare S, Malwade M. Prevalence of Tarsal Tunnel Syndrome During Third Trimester of Pregnancy. Indian

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11. KL M. Dalley FA. Agur AMR. Clinically Oriented Anatomy. Philadelphia. LippincottWilliams and Wilkins. 2010;6:671-819.
12. Patel AT, Gaines K, Malamut R, Park TA, Toro DR, Holland N. Usefulness of electrodiagnostic techniques in the evaluation of suspected tarsal tunnel syndrome: an evidence-based review. Muscle & Nerve: Official Journal of the American Association of Electrodiagnostic Medicine. 2005 Aug;32(2):236-40.
13. Ratra A, Grimes J. Acute tarsal tunnel syndrome in a pregnant woman following surgical repair of bimalleolar fracture: A case report and review of the literature. Journalof Orthopaedics and Allied Sciences. 2016 Jan 1;4(1):49
14. Mansfield CJ, Bleacher J, Tadak P, Briggs MS. Differential examination, diagnosis andmanagement for tingling in toes: Fellow's case problem. Journal of Manual & Manipulative Therapy. 2017 Oct 20;25(5):294-9.
15. Alfaro-Santafé J, Gómez-Bernal A, Lanuza-Cerzócimo C, Alfaro-Santafé JV, Pérez- Morcillo A, Almenar-Arasanz AJ. Effectiveness of Custom-Made Foot Orthoses vs. Heel-Lifts in Children with Calcaneal Apophysitis (Sever's Disease): A CONSORT- Compliant Randomized Trial. Children. 2021 Nov;8(11):963.
16. Lew JT, Stearns M. Tibial Neuropathy. InStatPearls [Internet] 2022 Jul 1.StatPearlsPublishing.
17. Alshami AM, Souvlis T, Coppieters MW. A review of plantar heel pain of neural origin:differential diagnosis and management. Manual therapy. 2008 Apr 1;13(2):103-11.
18. Kavlak Y, Uygur F. Effects of nerve mobilization exercise as an adjunct to theconservative treatment for patients with tarsal tunnel syndrome. Journal of manipulative and physiological therapeutics. 2011 Sep 1;34
19. Leblebicier MA, Yaman F, Saracoglu I, Ozkaya DB. The effects of tibial nerve mobilization in patients with tarsal tunnel syndrome: A randomized controlled trial. European Journal of Integrative Medicine. 2022 Dec 1;56:102201.