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Original Article

Effectiveness of neurokinetic therapy on pain and plantar fascia thickness among patients with plantar fasciitis

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Abstract

Objectives: Identify the effectiveness of neurokinetic therapy on pain and plantar fascia thickness in patients with plantar fasciitis.

Methods: An experimental study was performed on 80 patients with plantar fasciitis after screening based on selection criteria. The patients were randomly allocated into two groups: the neurokinetic therapy group (n = 40) and the foot core exercises group (n = 40). In both groups, the treatments were given for two weeks, five days each week. The pre-and post-test results were assessed. A statistical analysis was performed on the gathered data.

Result: A significant statistical difference was observed between the groups; the post-test mean value of the Foot Function Index scale in the neurokinetic therapy group was 129.12, while in the foot core exercises group was 141.42. Additionally, the post-test mean value of the therapeutic ultrasound in the neurokinetic therapy group was 3, whereas in the foot core exercises group was 3.38. These values yielded a p-value of less than 0.001.

Conclusion: This study demonstrated an improvement in both groups. However, the neurokinetic therapy group showed a significant improvement in pain, functionality, and plantar fascia thickness compared to the foot core exercises group.

Level of evidence IV; Experimental study.

Keywords: Plantar Fasciitis; Therapeutic ultrasound; Heel spur; Calcaneus; Fibromatosis; Plantar.

Introduction

Plantar fasciitis is also referred to as plantar fasciosis. This condition often triggers an inflammatory reaction brought on by the degradation of the plantar fascia[1]. Even though the term "fasciitis" implies an inflammatory origin, the condition was believed to stem from the wear and tear on the plantar fascia. As a result, some prefer to use the term "plantar fasciopathy" to describe the condition[2]. The lifetime incidence of plantar fasciitis stands at 10%, impacting individuals of all age groups. However, patients aged between 40 and 60 years old exhibited the highest prevalence, with a significant association between plantar fasciitis development and being overweight[1,3,4]. During activities involving dynamic motions such as walking, running, and sprinting, midfoot motions were notably more extensive in women than men. Females often exhibit a greater strain rate in plantar aponeurosis than men, from when the heel makes contact until the entire body's center of mass reaches its lowest position vertically[5]. The primary factors contributing to plantar fasciitis were mechanical overuse and age-related degenerative alterations in the plantar fascia[6]. The initial symptom of plantar fasciitis was the discomfort or aching sensations upon initially standing and bearing weight after arising from sleep. The primary areas of pain were the heel and

Study performed at the Saveetha College of Physiotherapy, Saveetha Institute of Medical and Technical Sciences, Chennai, Tamilnadu, India.

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the underside of the foot. The pain was often described as a burning, dull, and throbbing sensation, which becomes more pronounced during walking, especially in uncomfortable flat shoes or when walking barefoot[2,7-9]. Plantar fasciitis could be confirmed when the plantar fascia thickness exceeds 4.0 mm (approximately 0.16 inches) in combination with reduced echogenicity or the fascia's margins become less distinct farther away from the calcaneus's anteroinferior edge[10]. The Windlass test was the sole specific objective examination to diagnose plantar fasciitis.

Foot core exercises were performed to maintain correct foot alignment, manage the arch's position, and trigger the proprioceptive receptors on the bottom of the foot to improve stability. Exercises such as toe spreads, foot doming, and towel curls, which had demonstrated their effectiveness in strengthening the muscles associated with the arch, might be considered potential strategies for improving stability[11]. Stretching is a training technique that intentionally elongates or extends a specific body part. It served a therapeutic purpose by alleviating cramps and enhancing day-to-day activities by promoting flexibility[12].

As described in David Weinstock's book, the Motor Control Center (MCC) was stimulated by muscle or functional deficiencies. Neurokinetic therapy (NKT) is a method that comprehends and applies motor control treatment to recognize movement patterns effectively[13]. Neurokinetic therapy was a manual muscle testing approach designed to activate the motor control center within the cerebellum, which was integral to the mind-body connection and the resolution of injuries, stress, and pain. It addressed the issue's root, effectively reprogramming dysfunctional movement patterns. The MCC within the cerebellum processes data, sending it to the limbic framework (fulfilling needs) and then to the cerebral cortex (making decisions). Subsequently, the information was relayed to the musculoskeletal system (executing actions)[14].

Therapeutic ultrasound (TUS) demonstrated notable improvements in foot function and increased active range of motion in ankle dorsiflexion, serving as key indicators of an effective therapy method that can expedite recovery among those experiencing plantar fasciitis[11]. Using TUS to measure plantar fascia thickening and record inflammatory results is a highly useful diagnostic technique[15].

The primary objective of this study is to identify the effectiveness of neurokinetic therapy on pain and plantar fascia thickness among patients with plantar fasciitis.

Methods

An experimental study was performed on patients diagnosed with plantar fasciitis who met the inclusion criteria, underwent a preliminary assessment involving Foot Functional Index (FFI) and TUS, and enlisted in the physiotherapy outpatient department at a city multi-specialty hospital. This study was conducted after the patients signed the informed consent form and the approval by the Institutional Review Board (IRB).

The study included 80 patients randomly divided into two groups using the concealed envelope method. The inclusion criteria consist of females aged 30 to 50 who exhibited a positive Windlass test, experienced medial plantar calcaneal discomfort, and reported pain during the initial steps after waking up. Patients submitted to recent physical treatment for plantar fasciitis, recent heel steroid injections or anti-inflammatory medication, had a history of calcaneal fracture, foot deformity, gait abnormalities, prior foot and ankle surgery, heart disease, paralysis, amyotrophic lateral sclerosis, and deep vein thrombosis were excluded from the study. Patients with systemic conditions affecting the feet, such as ankylosing spondylitis, rheumatoid arthritis, psoriatic arthritis, gout, and either type I or II diabetes, were also excluded from the study.

Neurokinetic therapy

Forty patients with plantar fasciitis were assigned neurokinetic therapy with TUS for 30 minutes per day. Neurokinetic therapy targeted the gastrocnemius and soleus muscles (calf muscles) for 25 minutes daily. The procedure involved testing the plantar flexors and dorsiflexors, stimulating the MCC if weakness was detected, and retesting until successful reprogramming. Gastrocnemius and soleus muscles were treated with resistance to plantar flexion in supine and prone lying positions.

Therapeutic ultrasound was administered following neurokinetic therapy with parameters set at a frequency rate of 1 MHz, an intensity level of 1.5 W/cm^2, applied for five minutes in continuous mode.

Foot core exercises

Another group of 40 patients with plantar fasciitis was assigned foot core exercises with TUS and stretching. Stretching of plantar fascia and calf muscles was performed for both legs, followed by foot core strengthening exercises and therapeutic ultrasound.

Outcome measures

Measures included the FFI questionnaire and TUS, assessing the impact of foot abnormalities on pain, functional constraints, and activity limitations and detecting changes in the plantar fascia thickness and ultrasound reflection.

Statistical analysis

Upon completing the data collection phase, the gathered information underwent tabulation and comprehensive analysis through various statistical methods. The Mann-Whitney Wilcoxon test was specifically used to examine closely and identify any significant changes between the distinct groups within the dataset. Concurrently, the paired t-test was employed to analyze and comprehend the significance of alterations occurring within each group.

Result

Demographic data

Demographic data was collected and assessed through descriptive and inferential statistical analyses.

The statistical values within the groups were examined using the Wilcoxon Signed Rank test. The median pre-and post-test values of FFI for the neurokinetic therapy group were 186.50 and 132.50, respectively. The value of Z statistic (based on positive ranks) was -5.512. The group showed a t-value of -820, with a p-value less than 0.001 (Table 1).

The mean pre-and post-test values of FFI for the foot core exercise group using paired t-test were 185.52 and 141.42, respectively. The FFI standard deviation of the pre-and post-test was 14.70 and 10.71, respectively. The mean difference was 44.10, while the standard deviation difference was 14.79. The t-value for the FFI was 18.84, and the p-value was < 0.001. The confidence interval for the mean difference, calculated with a 95% two-tailed significance level, ranged from 39.368 to 48.832 (Table 2).

Mean pre-and post-test values for the neurokinetic therapy group were 5.55 and 3.00, respectively. Standard deviations for pre-and post-test were 0.67 and 0.38. T-value was 26.51, and p-value was < 0.001. The 95% confidence interval for the mean difference ranged from 2.358 to 2.748.

Mean pre-and post-test values for the foot core exercise group were 5.76 and 3.38, respectively. Standard deviations for pre-and post-test were 0.65 and 0.39. T-value was 29.70, and the p-value was < 0.001. The 95% confidence interval for the mean difference ranged from 2.214 to 2.537 (Table 3).

Table 1. Pre-and post-test FFI values for the neurokinetic therapy group

Group		Median	t-test	z-value	p-value
Neurokinetic therapy group	Pre-test	186.50	-820	-5.512	< 0.001
	Post-test	132.50			

Table 2. Pre-and post-test FFI values for the foot core exercises group

Group		Mean ± SD	t-test	p-value
Foot core exercises group	Pre-test	185.52 ± 14.70	18.84	< 0.001
	Post-test	141.42 ± 10.71		

Table 3. Pre-and post-test TUS values for both groups

Group		Mean ± SD	t-test	p-value
Neurokinetic therapy group	Pre-test	5.55 ± 0.67	26.51	< 0.001
	Post-test	3.00 ± 0.38		
Foot core exercises group	Pre-test	5.76 ± 0.65	29.706	< 0.001
	Post-test	3.38 ± 0.39		

Post-Post-FFI was assessed using the Mann-Whitney Rank Sum test. Median values for FFI were 132.50 for the neurokinetic therapy group and 142 for the foot core exercise group. The Mann-Whitney U statistic was 467.500, and the t-value was 1287.500. The substantial median difference between groups was statistically significant (p = 0.001) (Table 4).

Using the equal variance test (Brown-Frorsythe), the mean difference was -0.386. Assuming equal variances (Student's t-test) resulted in a t-value of 4.435 with 78º of freedom. With equal variances not assumed (Welch's t-test), the t-value was -4.435 with 77.880º of freedom. The mean difference between groups was statistically significant (p < 0.001), indicating meaningful disparity (Table 5). The results suggest that the findings within and between groups were statistically significant, with a p-value < 0.001. Thus, neurokinetic therapy had significant effectiveness in improving pain relief, functionality, and plantar fascia thickness among patients with plantar fasciitis.

Discussion

This study was designed to identify effective therapeutic interventions, and it sought to evaluate the potential benefits of two distinct approaches: neurokinetic therapy and foot core exercises.

Fouda et al. performed a study incorporating radial shock wave therapy and TUS in addition to conventional physical therapy. They demonstrated notable efficacy in enhancing foot function and the active range of motion for ankle dorsiflexion in patients suffering from persistent plantar fasciitis. The TUS employed in the study had specific parameters, including a 1.5 W/cm^2 intensity at 1 MHz of frequency and five minutes of cm2 continuous application using longitudinal motions along the entire plantar fascia with a 5-transducer head. Notably, the same parameters applied in the study yielded significant improvements, reinforcing the positive outcomes[16].

The study by Nisha et al. demonstrated significant improvements in both pain and disability when employing neuro-

Table 4. Post-post-test FFI values for both groups

Post-post-test	Median	t-test	u-value	p-value
Neurokinetic therapy group	132.50	1287.500	467.50	< 0.001
Foot core exercises group	142			

Table 5. Comparison between the post-post-test TUS values for both groups

Post-post-test	Mean ± SD	t-test	p-value
Neurokinetic therapy group	3.00 ± 0.38	-4.435	< 0.001
Foot core exercises group	3.38 ± 0.39		

kinetic therapy compared to traditional exercises for cervical radiculopathy. The study highlighted several key effects, including muscle activity initiation and tissue viscoelasticity enhancement[14]. The study proposed that using dynamic myosin fiber activity alongside neurobiological training, guided by neurokinetic treatment principles, could improve the neuromuscular system in patients with plantar fasciitis. This approach may offer a more effective way to manage pain and dysfunction associated with the condition.

In their study, Yadav et al. demonstrated that self-stretching exercises and foam rolling designed for the plantar fascia contributed to alleviating pain and improving joint motion[17]. Zanon et al. showed the effectiveness of targeted stretching exercises for relieving chronic plantar fasciitis pain and improving performance. The results highlighted the efficacy of these stretching routines in significantly minimizing pain and enhancing performance abilities among patients with chronic plantar fasciitis[18].

Taddei et al. found that a foot core exercise program reduced the risk of running-related injuries in recreational runners after four to eight months of training[19]. Grecco et al. demonstrated shockwave therapy's effectiveness for plantar fasciitis, highlighting its physiological impacts on dense tissues like the plantar fascia and Achilles tendon. The study found that initial plantar fascia thickness ranged from 4.5 to 6.8 mm, indicating significant pain and functional limitations[20]. After neurokinetic therapy with TUS, there was a notable decrease in thickness associated with reduced pain and discomfort in plantar fasciitis.

Limitations of this study included its exclusive focus on women in the sub-acute phase and the inclusion of patients with bilateral plantar fasciitis. In the future, it's recommended to involve patients with persistent plantar fasciitis, investigate the integration potential of neurokinetic therapy with other treatments, and focus on particular occupational groups, maintaining consistent intervention strategies for plantar fasciitis.

Conclusion

The study compared the effectiveness of neurokinetic therapy and foot core exercises for treating plantar fasciitis. Both groups showed improvements in pain, functionality, and plantar fascia thickness. However, the neurokinetic therapy group, with therapeutic ultrasound, demonstrated greater reductions in pain, functional disability, and plantar fascia thickness compared to the foot core exercise group. Decreased plantar fascia thickness suggested potential therapeutic benefits for pain relief and improved functional outcomes in individuals with plantar fasciitis.

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References

1. Sharma R, Chaudhary NK, Karki M, Sunuwar DR, Singh DR, Pradhan PM, et al. Effect of platelet-rich plasma versus steroid injection in plantar fasciitis: a randomized clinical trial. BMC Musculoskeletal Disorders. 2023;24(1):172.
2. Amoako-Tawiah P, Love H, Madathilethu JC, LaCourse J, Fortune AE, Sims JM, et al. Use of orthotics with orthotic sandals versus the sole use of orthotics for plantar fasciitis: Randomised controlled trial. World J Orthop. 2023;14(9):707-19.
3. Rekha K, Parveen R, Kumaresan A. A comparative study of plantar fascia tissu e stretching and achilles tendon stretching for chronic heel pain. Int J Appl Ling Stud. 2015;8(1):81 4.
4. Pires EA, Miziara CS, Sposeto RB, Fonseca FC, Godoy-Santos AL, Fernandes TD. Impact of chronic plantar fasciitis on work-related activity: a literature review. J Foot Ankle. 2020;14(1):94-9.
5. Matsumoto Y, Ogihara N, Kosuge S, Hanawa H, Kokubun T, Kanemura N. Sex differences in the kinematics and kinetics of the foot and plantar aponeurosis during drop-jump. Scientific Reports. 2023;13(1):12957.
6. Jha DK, Wongkaewpotong J, Chuckpaiwong B. Effect of age and BMI on sonographic findings of plantar fascia. J Foot Ankle Surg. 2023;62(1):125-8.
7. Charles R, Fang L, Zhu R, Wang J. The effectiveness of shockwave therapy on patellar tendinopathy, Achilles tendinopathy, and plantar fasciitis: a systematic review and meta-analysis. Frontiers in Immunology. 2023;14:1193835.
8. Alanazi M, Khan R, Muqri A, Alnosaier Z, Dalak M, Alajlani S, et al. Plantar fasciitis in primary care: a review. IJMDC. 2022;6(7):1002-5.
9. Tamilarasi S, Kumaresan A, Alagesan J. To Study the Effectiveness

of Dry Needling on Functional Performance with Plantar Fascitiis. IJPOT. 2024;18(5):890-5.

10. Boussouar A, Meziane F, Crofts G. Plantar fascia segmentation and thickness estimation in ultrasound images. Computerized Medical Imaging and Graphics. 2017;56:60-73.
11. Boob M, Phansopkar P. Effect of foot core exercises vs ankle proprioceptive neuromuscular facilitation on pain, range of motion, and dynamic balance in individuals with plantar fasciitis: a comparative study. F1000Research. 2023;12:765.
12. Crawford F. How-effective is therapeutic ultrasound in the treatment of heel pain. Ann Rheum Dis. 1996;55(4):265-7.
13. Weinstock D. Neurokinetic therapy: An innovative approach to manual muscle testing. North Atlantic Books; 2012.
14. Girdhani N, Suresh PR. Effectiveness of neurokinetic therapy in Mecfhanical Neck Pain patients with Conditional Cervical Neuropathy. Intern J Sci Res.2020;8(9):180-4.
15. Karabay N, Toros T, Hurel C. Ultrasonographic evaluation in plantar fasciitis. J Foot Ankle Surg. 2007;46(6):442-6.
16. Fouda KZ, Ali ZA, Elshorbagy RT, Eladl HM. Effect of radial shock wave and ultrasound therapy combined with traditional physical therapy exercises on foot function and dorsiflexion range in plantar fasciitis: a prospective randomized clinical trial. Eur Rev Med Pharmacol Sci. 2023;27(9):3823-32.
17. Yadav SU, Malik SH, Bansal SA. Effect of foam rolling along with self-stretching on pain and range of motion in plantar fasciitis patient-a quasi-experimental study. J Clin Diagn Res. 2022;16(5): YC05-YC08.
18. Zanon RG, Brasil AK, Imamura M. Continuous ultrasound for chronic plantar fasciitis treatment. Acta Ortop Bras. 2006;14(3):137-40.
19. Taddei UT, Matias AB, Duarte M, Sacco IC. Foot core training to prevent running-related injuries: a survival analysis of a single-blind, randomized controlled trial. Am J Sports Med. 2020; 48(14):3610-9.
20. Grecco MV, Brech GC, Greve JM. One-year treatment follow-up of plantar fasciitis: radial shockwaves vs. conventional physiotherapy. Clinics. 2013;68(8):1089-95.