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The Effect of Dry Needling on the Healing Process of Neuropathic Diabetic Foot Ulcers: Case Study of Two Patients

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Abstract

Background: Diabetic foot ulcers (DFUs) are a severe complication of diabetes, primarily caused by peripheral neuropathy.

Objective: This case study reports the effect of dry needling (DN) on neuropathy and ulcer size in two patients with neuropathic DFUs.

Research Design and Methods: Two patients with DFUs unresponsive to conventional wound care received eight DN sessions. Evaluation tools included Michigan Neuropathy Screening Instrument (MNSI), Douleur Neuropathique 4 Questions (DN4), and neurothesiometer for neuropathy assessment. The ulcer area was measured using ImageJ software.

Results: Neuropathy symptoms improved notably according to MNSI, DN4, and neurothesiometer scores. Ulcer areas decreased significantly. In case 1, the ulcer area reduced by 65%, healing within two months. In case 2, a plantar ulcer healed after eight sessions of DN.

Conclusions: Eight DN sessions substantially reduced neuropathy and ulcer size, suggesting DN as a potential effective treatment for DFUs. Further studies with placebo control are warranted.

Keywords: Dry needling; Neuropathic diabetic foot ulcer

Introduction

The International Diabetes Federation (IDF) reports that diabetes affects over 550 million people globally [1]. Approximately 18 million individuals develop diabetic foot ulcers (DFU) annually [1]. Amputations occur globally about every 20 seconds due to diabetes [2]. Neuropathy, impacting around 60% of type 2 diabetes patients, is the leading cause of ulcers, leading to significant physical impairments and reduced quality of life [3]. Diabetic peripheral neuropathy (DPN) presents symptoms such as tingling, pain, and numbness, and can cause muscle atrophy and adversely affect mental health [4,5].

Existing treatments for DFU include surgical debridement, antibiotics, vascular assessment, offloading, and amputation. However, these methods are often inadequate and result in prolonged healing times. Consequently, there is a pressing need for alternative treatments to support the healing process [6]. One proposed approach is to further investigate the role of musculoskeletal disorders in the development and healing of DFU. Insufficient information is available about physiotherapeutic approaches, such as therapeutic exercise, electrotherapy, and manual therapy [7]. A specific treatment protocol has not yet been established for different types of ulcers and a new approach is required.

Dry needling (DN), a relatively new technique employed primarily by physiotherapists, has shown potential in addressing myofascial trigger points to improve functional outcomes and reduce pain associated with neuromuscular disorders [8]. Preliminary evidence suggests DN may offer benefits for individuals with neuropathic conditions [9], although its effectiveness for DFU and neuropathy remains under-researched. This case study reports the effects of DN on neuropathy and ulcer size in two patients. Both patients were fully informed about the intervention and consented, with treatment protocols approved by the Review Board, School of Rehabilitation and Ethics Committee of Tehran University of Medical Sciences (TUMS).

Case Presentation

Case 1

A 56-year-old male patient with a 20-year history of diabetes was admitted to the Diabetic Wound Care Clinic of TUMS suffering from an ulcer within the past two years. He presented with a persistent neuropathic foot ulcer on the plantar aspect of the right foot's fifth metatarsal, classified as a grade 2 ulcer according to the Wagner Classification System [10]. He had a fasting blood sugar of 156 mg/dL, an HbA1c level of 7.3%, and an Ankle Brachial Index (ABI) of 1.21. His medication regimen included 2000 mg daily of Metformin and 600 mg of Gabapentin. Despite conventional treatments such as dressing changes, debridement, and glycemic control, the ulcer, measuring 1.78 cm^2, remained unresponsive.

Case 2

A 56-year-old woman was admitted to the same clinic suffering from an ulcer for the past 7 months. This patient had a 16-year history of diabetes, a fasting blood sugar level of 160 mg/dL, an HbA1c level of 9%, and an ABI of 1.12, presented with a persistent Grade 2 neuropathic foot ulcer on the left foot. Despite similar treatments as offered to Case 1, her ulcer, measuring 1.3 cm^2, remained unresponsive. The patient was taking 1000 mg daily of Metformin and 300 mg of Gabapentin.

Examination

Both patients were assessed for DPN using the Michigan Neuropathy Screening Instrument (MNSI), the Douleur Neuropathique 4 Questions (DN4), and the Vibration Perception Threshold (VPT) with a neurothesiometer [11]. All tests for the neurological assessment were performed prior to the treatment, immediately following the first and the eighth session of DN, and two months after the final treatment session.

The MNSI is a reliable tool for assessing neuropathy in diabetic patients. It includes a patient-completed history questionnaire and a physical assessment conducted by a medical professional, focusing on various neuropathy symptoms and feet conditions. A score of 4 or more on section A of the MNSI is considered abnormal, while a score above 2 on section B indicates the presence of neuropathy. The DN4 is a reliable 10-item questionnaire for screening neuropathic pain. Scores of 4 or more indicate the presence of neuropathic pain with the Minimally Important Clinical Difference (MICD) reported to be 30% [12].

The VPT, assessed using the Horwell neurothesiometer, measures the threshold of vibration perception. The VPT is measured at the hallux apex, with values above 25 volts indicating high risk for neuropathic ulceration, 16 to 24 volts indicating intermediate risk, and below 15 volts indicating low risk [13]. The ulcer area was assessed using the reliable and valid ImageJ software [14].

Dry Needling Intervention

Upon admission, patients received conventional treatments combined with dry needling (DN), administered by an experienced physiotherapist using disposable sterilized stainless-steel needles (0.3 × 50 mm; Dong Bang AcuPrime Ltd, Korea). The patient was positioned in prone with the hips and knees in extension and the head in the mid-position. Dry needling was applied approximately at the motor point locations of the medial and lateral head of the gastrocnemius, the distal medial and lateral soleus, and the flexor hallucis longus muscles. Subsequently, the patient was positioned in side-lying and supine positions to needle the flexor digitorum longus, tibialis anterior, fibularis longus, and extensor hallucis longus muscles [15]. One minute of deep DN with a fast in-fast technique was administered to each point [8]. Next, the needles were left in place at each point for 10 minutes [16]. The DN sessions were conducted twice a week with a 48-hour interval between sessions [17]. Following the completion of eight DN sessions over four weeks, a follow-up assessment was scheduled for patients two months after their last treatment session.

Results

The results of Case 1 are listed in Table 1. After eight sessions of DN and a follow-up after 2 months, the MNSI section A score decreased from 10 to 8 to 5, reflecting a 20% and 50% improvement, respectively. The MNSI section B score dropped from 4 to 2.5 to 1.5, showing a 37.5% and 50% improvement. The DN4 score shifted from 7 to 5 to 4, indicating a 28.5% and 42.6% improvement. The Vibration Perception Threshold (VPT) improved from 28 to 21 to 15 volts. The ulcer area size reduced by 65%, from 1.78 to 0.63 cm^2, and healed completely by the two-month follow-up. Figure 1 shows the patient's foot ulcer before and after the treatment.

Table 1: Results of pre and post needling in case 1.

Results	T1	T2	T3
MNSI section A	10	8	5
MNSI section B	4	2.5	2
DN4	7	5	4
VPT(v)	28	21	15
Ulcer area (cm2)	1.78	0.63	0

VPT: Vibration Perception Threshold; T1: before DN; T2: after 8 sessions; T3: 2 months follow up.

Figure 1: The ulcer condition of case 1 in the 1st week (A), 4th week (B), and 12th week (C).

The results of Case 2 are listed in Table 2. After eight sessions of needling and a 2-month follow-up, the MNSI section A score decreased from 11 to 6 to 4, respectively, which indicates a 45.4%, and 63.6% improvement. The MNSI section B score decreased from 3.5 to 1.5 to 1.5, respectively, indicating a 57.1% improvement in both cases. The DN4 score showed an improvement from 7 to 3 to 2, respectively, which indicates a 57.1% and 71.4% improvement. The VPT improved from 28 to 21 to 15 volts, respectively. The size of the ulcer area reduced from 1.32 to 0 and completely healed after eight sessions of DN. No recurrence was observed after a 2-month follow-up. Figure 2 shows the patient's foot ulcer before and after the treatment.

Table 2: Results pre and post needling in case 2.

	T1	T2	T3
MNSI section A	11	6	4
MNSI section B	3.5	1.5	1.5
DN4	7	3	2
VPT(v)	26	21	18
Ulcer area (cm2)	1.32	0	0

VPT: Vibration Perception Threshold; T1: before DN; T2: after 8 sessions; T3: 2 months follow up.

Figure 2: The ulcer condition of case 2 in the 1st week (A) and 4th week (B).

Discussion

To the best of the authors' knowledge, this is the first attempt to evaluate the effects of DN on neuropathy intensity and ulcer size in patients with neuropathic DFUs. The outcomes in this case study suggest that DN is an effective approach in reducing neuropathy intensity and healing of DFUs. In the present study, the Michigan's mean scores showed a notable decrease in both cases, reflecting improvements in neuropathy intensity, mobility, and the function of the affected leg of the patients.

The DN4 questionnaire scores showed a significant decrease in the level of neuropathy. A 30% improvement is considered a meaningful clinical outcome, exceeding the MICD for DN4 [12]. The findings demonstrate that patients who initially reported severe neuropathy (VPT score above 25 volts) experienced significant improvements in their vibration perception scores at the 2-month follow-up. Specifically, the scores decreased to 15 and 18 volts for Cases 1 and 2, respectively, indicating that the initial severe sensory loss reduced to a moderate sensory loss [13].

Central sensitization, which increases neuronal excitability, can lead to allodynia and hyperalgesia, contributing to myofascial pain syndrome [18]. Dry needling targeting the motor points of these muscles may alleviated central sensitization and associated neuropathic symptoms, potentially enhancing DFU healing. The recurrence rate of DFUs is high, reaching 40% within a year and 65% within 5 years [19]. In these two patients, it is conceivable that myofascial dysfunctions may have contributed to neuropathic symptoms and delayed ulcer healing. By addressing these underlying musculoskeletal issues, DN may have reduced the recurrence rates and improved patient outcomes.

Conclusion

In both cases, the application of DN resulted in significant improvements in DFU healing. In the first case, there was a 65% reduction in ulcer area after eight DN sessions, with complete healing achieved after an additional two-month follow-up. The second patient achieved complete healing after eight DN sessions. These findings require validation through larger, more rigorous studies. Integrating DN into a multimodal physiotherapy program, including exercise therapy, may optimize patient outcomes and improve long-term results [20]. Further research is needed to evaluate the impact of DN on neuropathy intensity, ulcer healing, blood circulation, and other types of DFUs.

Disclosure Statement

Jan Dommerholt discloses that he teaches dry needling courses and receives royalties from published books on dry needling, which may be considered a potential conflict of interest in the subject matter or materials discussed in the article.

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