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MYOFASCIAL PAIN AND TREATMENT: Case Report

The effects of dry needling and neurodynamic exercise on idiopathic peripheral neuropathy: A case report

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ABSTRACT

A single patient (male, 67) with a medical diagnosis of idiopathic peripheral neuropathy (G60.9) was referred to physical therapy. The patient presented with signs and symptoms consistent with peripheral neuropathy, including bilateral single leg balance deficits, sensation impairments, and antalgic gait. Treatment consisted of dry needling (DN) with electrical stimulation and a home exercise program involving a neurodynamic exercise to be performed daily. Dry needling included the use of thin filiform needles to stimulate the underlying structures directed at eliciting a change within the tissues. The needles were left in situ and connected to an electrical stimulation unit. The neurodynamic exercise used in this case study was designed to target the distal branches of the sciatic nerve. The patient was directed to complete 3 sets of 10 repetitions in the slumped position and moving between ankle plantar flexion and dorsiflexion. The patient was treated for a total of 4 visits over a 5-week period. The Foot and Ankle Ability Measure (FAAM), Numeric Pain Rating Scale (NPRS), Romberg Test, and sensation testing were collected at baseline and then again after the 4th treatment. A Global Rating of Change (GROC) score was obtained at the end of treatment. After the 4th visit, functional self-report scores were not improved (93.75%–86.9% at completion), while NPRS decreased to 2 from a baseline rating of 4. The eyes closed portion of the Rhomberg balance test improved from 5 s on the right limb to 15 s and from 8 s to 20 s on the left limb. Sharp/dull sensation testing of the L4 dermatome also improved from 2 out of 5 correctly selected on the left lower limb to 5 out of 5. At the S1 level, sensation improved on the left lower limb from 2 out of 5 to 4 out of 5 and from 2 out of 5 on the right lower limb to 5 out of 5. The patient's GROC score was rated as quite a bit better (+5). The outcomes of this case study suggest that clinicians may consider the addition of DN with electrical stimulation and neurodynamic exercises to the treatment of this patient population given the sizeable and rapid improvements in pain, balance, and sensation testing following only 4 treatments.

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An estimated 8% of the general population in the United States has some form of peripheral neuropathy (PN) (Gregg et al., 2004), a condition that develops as a result of prolonged exposure to a hypoxic environment, and can lead to degeneration and segmental demyelination in the peripheral nervous system. Most cases of PN are the result of gradual degradation within the microcirculation, as is the case with diabetes mellitus. Direct trauma or repetitive micro-trauma can also precipitate PN, as in carpal tunnel syndrome, leading to a similar cascade of nerve ischemia, hypoxia, edema, increased vascular permeability, and blockage of axoplasmic flow (Kernich, 2001). Common associated symptoms of PN include numbness, tingling, burning, or even total loss of sensory function. These sensory changes can lead to limitations within activities of daily living, balance, gait mechanics, as well as overall quality of life (Cade, 2008; Mols et al., 2014).

Management options for PN vary depending on the underlying cause and severity of the sensory disturbance. Diabetes mellitus (DM) is the most commonly occurring cause of PN. First-line pharmacological treatment for diabetic-induced PN includes serotonin and norepinephrine reuptake inhibitors (SNRIs) and tricyclic antidepressants (Iyer and Tanenberg, 2013; Rojas et al., 2017). Common physical therapy treatments in patients with diabetic PN include patient education, balance training, cardiovascular conditioning, strengthening exercises, and orthotic bracing to aid in gait abnormalities (Cade, 2008; Kluding et al., 2012; Van Deursen et al.,

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1998). Patients typically report that exercise training leads to improved functional and work capacities with increased independence, but does not appear to improve sensation deficits and associated pain (Yoo et al., 2015).

Management of PN related to macro- or micro-traumatic onset includes both surgical and non-surgical interventions directed at restoring adverse effects of nerve compression. Surgical management of carpal tunnel syndrome, the most common form of PN from micro-traumatic causes, includes transection of the transverse carpal ligament allowing for increased space within the tunnel, and restoration of nerve function in the absence of compressive forces. Non-surgical intervention of carpal tunnel syndrome includes activity modification, pharmacotherapy, and physical therapy (Hans et al., 2010). Physical therapy management for this condition comprises patient education, manual therapy directed at improving carpal and radioulnar joint mobility, neural mobilizations, DN, ergonomic assessment, and modalities (Ditmars and Houin, 1986; Michlovitz, 2004, 2008; Muller et al., 2004). Overall, physical therapy interventions have been shown to be an effective approach in improving pain and associated impairments in patients with carpal tunnel syndrome (Grade B recommendations for neurodynamic exercise and manual therapy based on Sackett's Levels of Evidence, (Muller et al., 2004; Sackett et al., 2000).

One apparent difference in the evidence-based physical therapy treatments provided for DM- and carpal tunnel syndrome-related PN is the emphasis on neurodynamic exercises. Neurodynamic treatment techniques are directed at the neural structures through positioning and movement of the nerve within the neural tube. Abnormalities in nerve conduction velocities (NCV) and sensory changes associated with the median nerve have long been described in the literature in patients with carpal tunnel syndrome. A systematic review by Ballestero-Pérez et al. (2017) investigated the effectiveness of nerve gliding exercises on carpal tunnel syndrome. In looking at studies that included neural mobilizations, subjects had reported greater and faster pain relief, decreased sensitive distal latency and time summation, and increased pinch grip strength (Ballestero-Pérez et al., 2017). The nervous system must be able to adapt to mechanic loads via elongation, sliding, cross-sectional change, angulation, and compression. If the nervous system is unable to accommodate such demands, an inflammatory process occurs resulting in nerve ischemia, fibrosis, edema, and a hypoxic environment (Ellis and Hing, 2008). Changes to nerve homeostasis can alter neurodynamics and lead to pain and functional limitations. While neurodynamic techniques appear to be beneficial in patients with carpal tunnel syndrome, the evidence is lacking for use in patients with various other forms of PN.

Another apparent difference in the evidence-based physical therapy treatments provided for DM- and carpal tunnel syndrome-related PN is the emphasis on DN or acupuncture. A randomized controlled trial (RCT) was published by Yang et al. (2009) comparing the effectiveness of acupuncture versus oral steroids in patients with carpal tunnel syndrome. Patients in the acupuncture group demonstrated a significant improvement in nerve conduction studies compared to the steroid group (Yang et al., 2009). In a follow up study by Yang in 2011 these patients maintained significantly better improvement in Global Symptom Score, distal motor latencies, and distal sensory latencies when compared to the steroid group throughout the 1-year follow-up period (Yang et al., 2010). In a RCT by Chung et al. (2016), night splinting and electroacupuncture was found to be a superior treatment to night splints alone in patients with carpal tunnel syndrome in regards to visual analog scores, microfilament testing, and the Disabilities of the Arm Shoulder and hand (DASH) score (Chung et al., 2016). The findings of Yang et al., in 2009 and 2010 provide rationale for using peri-neural DN in persons with PN associated with carpal tunnel syndrome, although it is not known if similar effects would occur in persons with other forms of PN.

Idiopathic peripheral neuropathy (IPN) is a complex disease process with many uncertainties, and as a result, conventional treatment approaches may not resolve patient symptoms and restore function. Traditional treatment for patients with IPN is widely anecdotal, with no peer-reviewed evidence to our knowledge on effective treatment strategies outside of pharmacological intervention. Therefore, the purpose of this case report is to describe the methods and application of electrical DN and neurodynamic exercises in a patient with IPN who had undergone previous conventional treatment modalities with no benefit.

1. Subjective examination

The patient was a retired 67-year-old Caucasian male with a two-year history of bilateral IPN who had failed previous conservative management. The diagnosis of PN was made via physician examination and nerve conduction velocity testing. The onset was gradual over a 6–9 month period, with pain becoming constant and stable leading up to his referral for physical therapy. At the time of referral, the patient's chief complaints were numbness and tingling in the feet bilaterally, accompanied by warm and sometimes burning sensations that began in the toes and progressed up to the mid-shin. Unsteadiness during periods of prolonged standing and walking also occurred with regularity. A random fluctuation in symptom intensity was reported throughout a typical day, with a consistent increase in warm sensation after walking for greater than 45 min. The patient did not complain of any recreational limitations, but did report diminished desire to perform daily household chores and community based activities involving grocery shopping and occasional leisure walking secondary to worsening symptoms with increased activity.

The patient received previous care for PN, including several episodes of physical therapy and chiropractic management within the previous 12 months, with no reported benefit. Medication management included 50 mg Ultram as needed, which was reported as helpful in reducing, but not fully alleviating, symptoms. The Numerical Pain Rating Scale (NPRS) was rated as 2/10 at best, 4/10 on average, and 7/10 at worst. The NPRS uses an 11–point scale ranging from 0 ("no pain") to 10 ("the worst pain you can imagine"). A 2.0-point change on this scale has been identified to be the MCID in adults with various types of pain (Hawker et al., 2011). The patient's stated goals were to reduce warm and burning sensations, be able to walk for greater than 2 h without increase in symptoms, and to improve overall quality of life.

2. Physical examination

The patient's pertinent postural deviations included forward head position, rounded shoulders, and increased thoracic kyphosis. Hip and pelvis were level with mild pes cavus, bilaterally. Hip and lumbopelvic range of motion were symmetrical and pain-free. Observational gait analysis revealed abnormal gait mechanics with decreased step and stride length as well as increased base of support. Abnormal findings occurred during static balance testing. The patient was asked to stand on each limb independently and maintain balance as long as possible up to 30 s. He was then asked to repeat the test but with his eyes closed. Balance scoring with eyes open was considered normal as he was able hold position without loss of balance for 30 s. The patient was able to maintain balance with eyes closed for only 5 s on his right limb and 8 s on his left limb before having to place the opposite limb on the ground. Typical ankle range of motion with normal mobility, as well as full excursion of gastrocnemius and soleus complex, was demonstrated bilaterally. Neurological examination revealed diminished bilateral sharp/dull sensation testing over the L4 and S1 dermatomes and covertly positive neural tension testing of lower extremities. Neural tension testing in the slump position did not reveal overt symptom reproduction during neural tensioning, but did result in the patient complaining of changes in his burning sensation. Manual muscle testing and reflex testing were normal.

3. Clinical reasoning

Previous authors have attempted to classify patients with pain based on categories of pain mechanism (Gifford and Butler, 1997). The proposed categories include: nociceptive pain, peripheral neurogenic pain, central sensitization, affective mechanisms, and autonomic and motor mechanisms. Nociceptive pain is the most common pain presentation in the rehabilitation setting, as this is a direct result of a specific inciting factor and often resolves with time and natural history of healing. Peripheral neurogenic pain often follows a predictable pain pattern centered on dermatomes, myotomes, and sclerotomes. Pain quality is often described as burning or shooting, with associated complaints of paresthesia. Central sensitization is often characterized as an abnormal pain presentation with persistent symptoms long after initial injury. Hyperalgesia is often present with poor tolerance to activity. An affective mechanism is caused solely from psychological and emotion manifestation absent from mechanical origin. Finally, autonomic and motor mechanisms arise from the sympathetic nervous system (SNS), where symptom presentation often includes pain with associated sweating and swelling due to SNS disruption. Based on the above mentioned categories, our patient did not present with findings consistent with the nociceptive, sympathetic, affective, or central sensitization mechanisms. Rather, the patient showed evidence for classification into a peripheral neurogenic pain category based on subjective complaints consistent with nerve pathology, as well as sensory and neurodynamic impairments discovered during the neurologic examination.

Due to the lack of a positive response to previous physical therapy including general exercise, and given the chronicity of the condition, an alternative treatment approach was offered to the patient. Based on the evidence for the successful use of peri-neural needling in patients with carpal tunnel syndrome, and considering the similar mechanisms underlying the various forms of PN, we decided to use peri-neural needling directed at the patient's lower leg and foot. In addition to peri-neural needling, we considered neurodynamic exercises pertinent to the restoration of homeostasis based on their theorized benefit of restoring relative movement of neural tissues as they course through the lower limb. Cleland et al. concluded that slump stretching, in addition to lumbar spine mobilization and exercise, was beneficial in reducing short-term disability, improving pain, and promoting centralization of symptoms in patients with non-radicular low back pain (Cleland et al., 2006). Even though lumbopelvic and hip sources of referred pain were sufficiently screened for and ruled out in this patient, we included neural tension exercises based on neurodynamic symptomology and chronicity of symptoms.

4. Therapeutic intervention

The patient was educated on the potential positive effects of DN and consented to receive four 30-min treatment sessions over a five week period at a frequency of once a week. Treatment consisted of both DN with and without electrical stimulation along the pathway of the superficial peroneal nerve, intermediate dorsal cutaneous nerve, deep peroneal nerve, sural nerve, and lateral dorsal cutaneous nerve (Figs. 1–3). Our protocol was modified from a semi-standardized protocol with the goal of targeting desired neural pathways to elicit a positive effect (Dunning et al., 2014). A total of eight sterile SEIRIN® needles (0.25×30 mm and 0.16×15 mm; SEIRIN® Corporation, Shizuoka, Japan) were inserted in each limb. Thirty millimeter (mm) needles were inserted in the lower leg and 15 mm needles were used on the foot. Needles inserted on the lateral aspect of the leg and foot were advanced until a bony backdrop was achieved. Needles placed on the anterior surface of the leg were advanced 20 mm of the available 30 mm. Once the needles were in situ, electrical stimulation was applied at the most

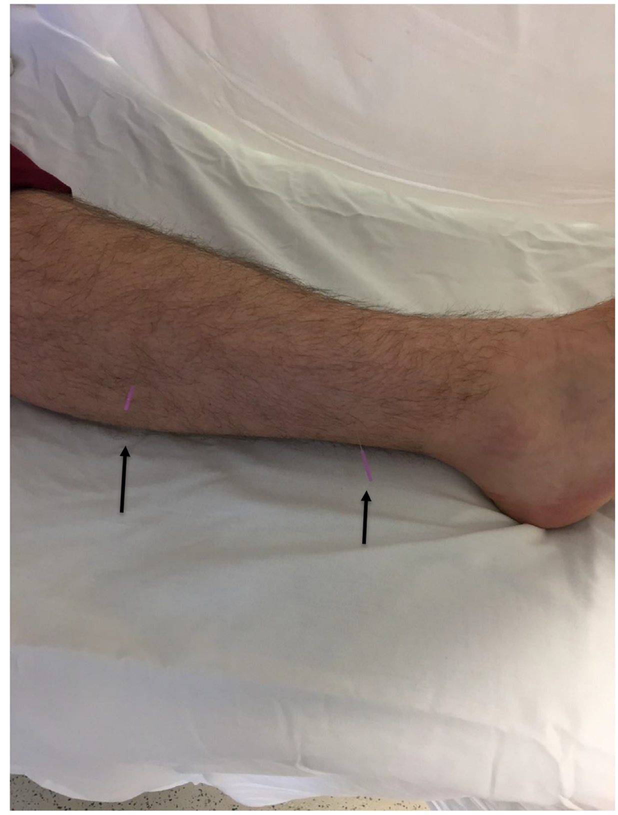

Fig. 1. Needle placement for Superficial Peroneal Nerve.

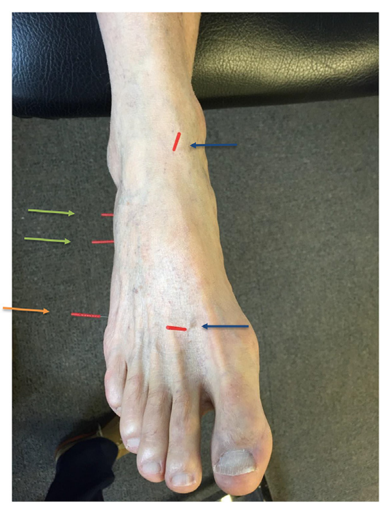

Fig. 2. Needle placement for Intermediate Dorsal Cutaneous Nerve, Sural Nerve, and Lateral Cutaneous Nerve.

Fig. 3. Needle placement for Deep Peroneal Nerve.

proximal and most distal point of three neural pathways. The neural pathways selected for electrical stimulation were the deep peroneal nerve, superficial peroneal nerve, and the lateral dorsal cutaneous nerve, which were identified as the areas in which the patient had the greatest sensation complaints. The ES-130 stimulation device (ITO CO., LTD. Physiotherapy and Rehabilitation Omura Miki-city, Japan) was set at a frequency of 2 Hz. Each of the three channels were set to an intensity described as strong but comfortable, with the average intensity setting ranging between 7 and 9 milliamps. Since only one electrical stimulation unit was available, the duration of stimulation was limited to 10 min per leg to allow each leg to receive an equal stimulus during the 20 min that the needles were left in-situ.

The patient also received a home exercise program involving a neurodynamic exercise to be performed at a dosage of 3 sets of 10 one time every day. The patient was encouraged to extend his knee as far as he could until lower leg and foot symptoms appeared to increase and then immediately return to resting position.

5. Outcomes

Subjective reports and daily average NPRS were taken upon arrival to each treatment. The patient reported incremental improvement in concordant sign symptoms at each visit, with complete resolution of “burning” and “warmth” following the 2nd treatment and continued resolution through discharge. Immediately following the 4th treatment (5th week) objective tests and outcome measures were completed (Table 1). A Global Rating of Change (GROC) form was also completed at this time. Improvements were noted during single leg balance with eyes closed [R: 15 s; L: 20 s], sensation testing improved to a point that is considered normal (at least 4 out of 5 correctly noted during sharp/dull testing over the L4 and S1 dermatome), and observational gait analysis improved with greater stride length and more consistent base of support throughout gait cycle. The patient rated his improvement as “Quite a Bit Better” (+5) despite reporting a slight reduction in function as assessed by the FAAM. The patient admitted to inconsistencies performing the neurodynamic exercises at home, with an average frequency of only three times a week. Adverse effects were minimal and typical for DN, consisting of very mild bleeding at the needle insertion site.

Table 1
NPRS - Numeric Pain Rating Scale; GROC - Global Rating of Change.

	Baseline	Final
Foot and Ankle Measure	93.75%	86.9%
Pain intensity (NPRS)	4/10	2/10
Romberg (sec) R/L		
Eyes Open	30/30	30/30
Eyes Close	5/8	15/20
Perceived Change (GROC)	–	+5 Quite a Bit Better
Sharp/Dull (Out of 5)	R/L	R/L
L4 Dermatome	4/2	4/5
L5 Dermatome	5/5	5/5
S1 Dermatome	2/2	4/5

6. Discussion

This case report described the examination and treatment of a patient with IPN in both lower extremities. The patient's chief complaints were numbness and tingling, burning sensations, and increased warmth in both lower extremities. The patient denied aggravating or alleviating factors and complained of constant symptoms with varying intensities. He had failed prior physical therapy intervention directed at general exercise including balance and strength training. Given the literature on the effectiveness of DN (DN) in similar PN conditions, most notably carpal tunnel syndrome, DN was selected as the primary treatment modality and supplemented with a prescribed home exercise program. Following the first treatment, the patient described dramatic improvement in “warmth” sensation with a decrease in baseline tingling intensity by a reported 60%. While he continued to report subjective improvement, the first treatment resulted in the greatest improvement, with more incremental improvement following subsequent treatments. Overall, the patient reported or demonstrated meaningful improvements in all subjective and objective measures except for function, as measured by the FAAM. It is possible that recall bias on this self-report functional measure may have led to a small reduction in the patient's final score, since the patient did not report any actual functional declines at any point during treatment.

Traditional physical therapy treatment for patients with IPN is widely anecdotal and focused on restoring balance and improving strength. However, vascular and neural impairments often remain unchanged despite improvements in balance and strength. Microvascular, macrovascular, and neurologic degradation contribute to the sensory impairments and pain associated with IPN (Cade, 2008; Mols et al., 2014). Evidence from the DN and acupuncture literature suggests that improvements can be achieved in sensory and motor nerve conduction velocities, as well as stimulation of microcirculation, in patients with carpal tunnel syndrome (Khosrawi et al., 2012; Sim et al., 2011; Yang et al., 2009, 2010). Inoue et al. (2008) found a significant increase in tissue vasodilatation following both acupuncture and electroacupuncture in patients with low back pain and lower limb symptoms in the sciatic nerve (Inoue et al., 2008). Dunning and colleagues reported that electroacupunture may be more advantageous than manual manipulation of indwelling needles due to the constant ability of electro-acupuncture to stimulate the neuromuscular junctions for nerve regeneration and healing (Dunning, 2015; Dunning et al., 2014).

The nervous system is a complex network designed to adapt to ever changing loads. If the nervous system is unable to sufficiently accommodate loading, adverse neural tension can progress to a more serious nerve insult. Repetitive compression or traction forces on any portion of the peripheral nervous system can result in both intraneural and extraneural pathology (Butler, 1991; Walsh, 2005). Prolonged exposure to nerve irritants can lead to sensory changes, including paresthesia, muscle weakness, and changes in deep tendon reflexes. The theorized benefit of neural gliding is thought to occur on a microvascular level, including the movement of noxious fluids out of neural tissue, increased neural vascularity, and improvements in axoplasmic flow (Coppieters and Butler, 2008). Potential improvements in our patient's neuro- and microvascular homeostasis could have occurred, therefore, from either the DN treatments or neurodynamic exercises. Considering the low frequency of reported neurodynamic exercise compliance, and the rapid, significant improvement reported after the initial DN session, we believe that the DN with electrical stimulation provided the greatest benefit to our patient.

7. Conclusion

Our findings suggest that the addition of DN with electrical stimulation may be beneficial as an adjunct treatment in patients with IPN to mitigate sensory impairments and to potentially improve upon neural and vascular function. Despite the limitations of the study to make cause and effect conclusions, the degree of improvement achieved over a very short period of time should not be overlooked. The subjective and objective improvements within this case study support the need for additional research to explore the benefit of DN on IPN and further applications of DN for neuropathic pain outside of the traditional targeting of trigger point and other musculoskeletal applications.

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