1-1-2016

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Recommended Citation

Jackson, MD, Rowe, K, Davenport, TE. Trigger point dry needling for musculoskeletal pain and disability: a systematic review of comparative effectiveness research. Orthopaedic Physical Therapy Practice. 2016;28(3):178-187. © 2016, Orthopaedic Section, APTA, Inc.

Trigger Point Dry Needling for Musculoskeletal Pain and Disability: A Systematic Review of Comparative Effectiveness Research

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ABSTRACT

Background: Dry needling (DN) has been proposed to reduce pain and improve function related to myofascial trigger points (MTrPs). Several primary studies and systematic reviews have been conducted to examine the effect of DN versus placebo. However the comparative effectiveness of DN and established interventions has yet to be established. **Purpose:** The purpose of this systematic review was to determine whether DN was more effective than other established therapies to treat MTrPs. **Data Sources:** MEDLINE Complete, EBSCO, CINAHL, SportDiscus and Cochrane library databases were searched. **Study Selection:** Randomized controlled trials that used DN directed to MTrPs and used at least one other intervention method were included. Studies that had a placebo or sham group were excluded. **Data Extraction:** Of 394 records screened, 8 studies met the established criteria. The quality of each study was assessed using the PEDro scale. **Data Synthesis:** When DN was compared to standard therapy programs, 3 of the 4 studies found that DN was more effective in reducing pain and 1 found no difference. When DN was compared to stretching, DN reduced pain more effectively. Dry needling was not significantly more effective than high-power pain threshold ultrasound (US), laser, nonsteroidal antiinflammatory drugs, and percutaneous electrical nerve stimulation (PENS). **Limitations:** Included studies were relatively small and some lacked sound methodology. **Conclusions:** The results are mixed on the effectiveness of DN over standard rehab. More large scale, high quality studies are needed before definitive decisions can be made about the role of DN in physical therapy practice.

INTRODUCTION

Myofascial trigger points (MTrPs) are palpable,[1] hyperirritable[1] localized areas of tenderness within taut bands of skeletal muscle, which may be commonly associated with musculoskeletal pain.[2,3] When MTrPs are compressed it can lead to local tenderness, referred pain[2] and can also produce a local twitch response (LTR), or muscle fasciculation.[3] There are two main types of MTrPs: active and latent. Active MTrPs are active without any external elicitation and produce both local and referred pain and can lead to local muscle weakness.[3,4] Active MTrPs are the main source of pain, while latent MTrPs do not produce symptoms unless externally elicited, such as by pressure.[4]

The exact pathology of MTrPs is unknown,[5] and their clinical evaluation and relevance is still quite controversial.[2] Although the exact physiology of these MTrPs is unknown, the underlying cause of MTrPs can be from a variety of sources including poor muscle balance, poor posture, overuse, or a direct injury.[6] Because MTrPs are prevalent in patients presenting with musculoskeletal pain,[4] there are a variety of interventions that have been established as common practice including stretching, spray and stretch, ultrasound, transcutaneous electrical nerve stimulation, laser therapy, injection of local anesthetic and dry needling (DN).[4,6] Dry needling is an technique involving insertion of a fine needle into specific MTrPs without the use of any medication.[4] The use of DN is thought to help in the reduction of pain derived from MTrPs by providing a localized stretch to the shortened sarcomeres.[8] This helps the sarcomeres to reset to their resting length thus reducing the taut bands of skeletal muscle and reduce the pain related to MTrPs.[8] It is also thought that DN can help with hypoxia by causing an increase in skin and muscle blood flow from the needle insertion itself. Dry needling can also help with pain reduction by stimulating A-delta nerves, which can lead to opioid mediated suppression of pain.[8]

A growing body of placebo-controlled literature supports the effectiveness of DN compared to sham needling. In a systematic review by Kietrys et al[9] in 2013, the authors examined the current literature for studies that compared DN to sham or placebo or other interventions. Based on the evidence, the authors concluded that DN is recommended compared to a sham or placebo intervention for the reduction of pain in the treatment of upper quarter myofascial pain syndrome. Three of the articles the authors examined showed positive results in favor of DN over sham or placebo for immediate pain reduction and two of the articles examined showed results in favor of DN over sham or placebo for reduction in pain at 4 weeks postintervention. However comparative effectiveness studies are less common and no systematic reviews showing only the comparative effectiveness literature have been published. Although DN may show effectiveness over sham needling in some studies,[7] results are still mixed in this area. Dunning et al[10] state that several studies that use the in-and-out technique of DN have shown some benefit in pain relief. However, the authors also point out that no high-quality, long-term studies support the use of DN. Perhaps most notably, the comparative effectiveness of DN relative to other interventions has yet to be summarized. The purpose of this systematic review was to assess the methodological quality of the comparative effectiveness literature involving DN in order to determine the relative clinical benefit of this emerging intervention.

METHOD

Data Sources and Searches

Relevant randomized controlled trials were identified by searching MEDLINE complete, CINAHL Plus with Full Text, and SPORTDiscus with Full Text with the search terms DN and randomized controlled

trials, and DN and the publication type set to randomized controlled trials. Articles were last searched on October 24, 2014. Abstracts were reviewed, and if needed, full text were obtained to make decisions about articles that fit the above identified inclusion and exclusion criteria.

Study Selection

Types of Studies. Randomized controlled trials that used the technique of DN and at least one other comparison group were included. In addition the articles had to describe a study of DN directed to MTrPs. Articles were excluded if they were not printed in English.

Types of Participants. The participants in the trials had to have an identified area of an MTrP in order to be included in this study, no restrictions were made based on age or gender.

Types of Interventions. In order to be included, the trials must have an included: (1) the intervention of DN and (2) another type of intervention that was targeted at treating these identified MTrP. In addition the articles could not use a sham or placebo DN.

Types of Outcomes Measures. Trials were used that included a dependent variable measurement involving pain as an outcome measure, in order to create a basis for uniform comparison across studies. Other outcome measures used in the articles were taken into consideration as well and examined, however, the only requirement was to have at least one outcome measure that addressed pain.

Data extraction and assessment

Two authors worked on the article collection and data extraction. The review was not blinded to any of the information including the journal, author, or outcome measures. The PEDro scale was used to assess the methodological quality of the studies used. Article scores were obtained from the PEDro database when available. When no scores were available, authors used the PEDro scale to rate the article by consensus.

Data synthesis and analysis

No meta-analysis synthesis was used on the data collected from these articles. In this case, the dependent variable measurements were heterogeneous enough among the few included studies, and so a narrative literature synthesis was conducted rather than a meta-analysis.

RESULTS

The literature search originally revealed 394 articles through the databases used and through screening and the use of the inclusion and exclusion criteria, 8 articles were ultimately deemed appropriate for inclusion (Figure 1). These articles examined the effects of DN versus various other intervention options including manual therapy, stretching, high-powered ultrasound (US), non-steroidal anti-inflammatory drugs (NSAIDs), and standard rehabilitation therapy. In addition, these articles used different outcome measures that focused on pain, range of motion, electromyography (EMG), sleep quality, and patient-reported outcomes (Table 1).

Outcome Measure: Pain

Ziaeifar et al[8] compared manual therapy MTrP release by a therapist to DN (Table 2). The outcome measures were taken before the treatment sessions and after one week. In the DN group, needling was performed repeatedly until there were no more LTRs. In the manual therapy group, the therapist applied gradually increasing pressure to the MTrP until the tension and the tenderness in the MTrP was released. The results from this study showed that both the standard intervention group and the experimental group significantly improved after intervention when compared to before intervention measurements in both the visual analogue scale (VAS) and the pressure algometer. In addition, there was also a significant between group difference in regards to pain intensity as measured by the VAS but not in regards to the pressure algometer. These results show that both the standard intervention and the DN significantly reduced pain intensity, however, the DN did in fact have more of an effect on reducing pain intensity than the standard intervention.

In a study done by DiLorenzo et al, 101 patients were randomized to receive either the clinic's standard rehabilitation therapy alone or therapy combined with DN[11] (see Table 2). The outcome measurements were taken on day 1 and then again 24 hours after every subsequent intervention for the DN group. The measurements for the standard group were taken on day 1 and then on days 9, 15, and 21. The results showed that VAS scores improved significantly for both groups at the first measurement period; in addition, there was a significant between group difference in favor of DN. For the next measurement period, the DN group showed significant improvement but the standard group did not, and there was a significant between group difference in favor of DN. For the last group measurement period, both groups again showed a significant VAS score improvement, and again there was a significant between group difference in favor of DN. These results would suggest that DN was more effective than the standard intervention at reducing pain. However, it is unclear from the results presented if the between group comparisons are in fact for the same time period because different data recording periods were used for both groups. In addition, it is unclear if the significant improvement that the DN group made for every measurement period was the result of comparing the new measurement to the baseline or to the previous session's measurement. While it does appear that DN made significant improvements in pain reduction, it is difficult to compare these results to the standard rehabilitation procedure without knowing this additional information.

Bahadir and colleagues[12] completed a small study (n=20) that randomly assigned patients to receive either DN or high–power pain threshold ultrasound (HPPTUS; see Table 2). Both groups received EMG evaluations. The HPPTUS group therapy was repeated two times followed by stretching. After the EMG evaluation, the DN group had the intervention applied and then rested before performing stretching. Both groups were instructed to continue stretching at home. All reported outcome measures were taken before the intervention, after a 30-minute rest, after the intervention was performed for the HPPTUS group, 1 hour after the original EMG evaluation in the DN group, and then again 5 days after the original EMG measure. The results from this study in regards to pain showed that there was a significant decrease in VAS scores in the HPPTUS at the initial-immediate assessment and the initial-last assessment, and there was a significant decrease in the DN group at the initial-last assessment but not the initial-immediate assessment. These results suggest that the HPPTUS was more effective than DN in reducing pain in the short term (immediately after intervention), but not after a delayed amount of time (5 days postintervention).

Pérez-Palomares and colleagues[13] conducted a study that randomly assigned 121 patients with low back pain patients to receive either percutaneous electrical nerve stimulation (PENS) to DN (see Table 2). The PENS group received 9 treatment sessions and the DN group received treatment for 3 sessions. The VAS pain and quality of sleep were mea-

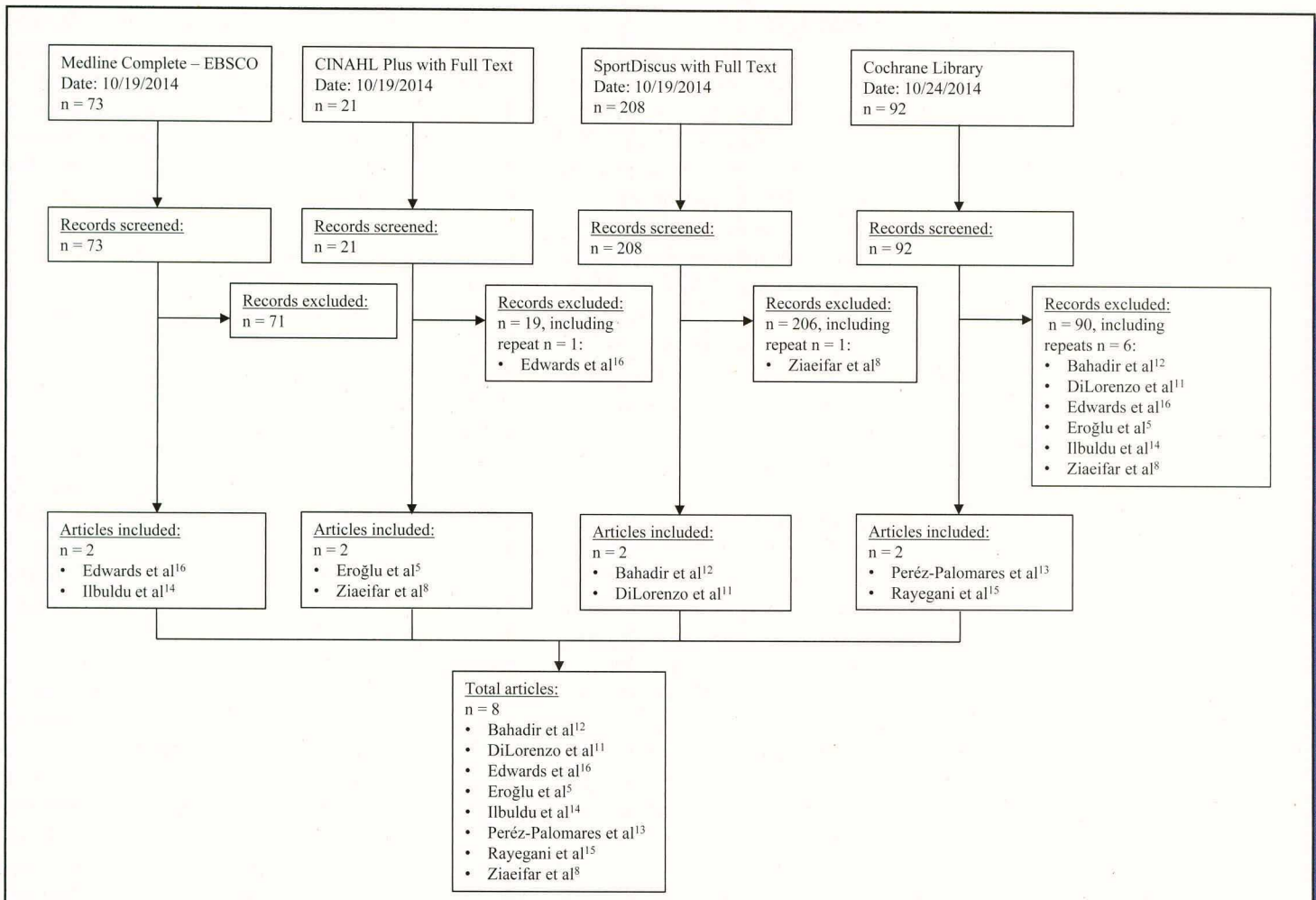

Figure. Search results.

Table 1. Outcomes Measures in Included Studies

Author	Outcome Measure
Eroğlu et al[5]	• Pain: Visual Analog Scale (VAS) Pain Pressure Threshold (PPT)-algometer) • Quality of Life Scale (Nottingham Health Profile) • Range of Motion (Active ROM neck: flexion, extension, bilateral lateral flexion, bilateral rotation/ shoulder: abduction, adduction, flexion, extension, internal and external)
Ziaeifar et al[8]	• Pain (VAS, PPT-algometer) • Disabilities of Arm, Shoulder and Hand (DASH)
DiLorenzo et al[11]	• Pain (VAS) • Quality of life, Functional Mobility (Rivermead Mobility Index) • Sleep Questionnaire to address daytime rest & sleep quality
Bahadir et al[12]	• Pain (VAS) • EMG • ROM (Active ROM lateral flexion)
Pérez-Palomares et al[13]	• Pain (VAS, PPT-algometer) • Sleep quality (VAS) • Quality of life (Oswestry Disability Index)
Ilbuldu et al[14]	• Pain Intensity (VAS, analgesic usage, algometer) • Cervical ROM (Flexion, extension, bilateral rotation, bilateral lateral flexion) • Quality of life (Nottingham Health Profile)
Rayegani et al[15]	• Pain (VAS, algometer) • Quality of life (SF 36)
Edwards et al[16]	• Pain (Short form McGill Pain Questionnaire, included a VAS, PPT-algometer)

sured at the beginning, before the second DN and sixth PENS interventions, and at the end of therapy. Algometry and quality of life were measured only at the beginning and end of intervention. The results found that in regards to pain, when the initial VAS score was subtracted from the final score there was no significant difference between the groups. In addition, when algometry difference was found, again by calculating the initial minus the final assessment, there was no significant difference between any of the body regions measured between the groups. These results suggest that there is no difference in pain results between the therapies of PENS and DN, suggesting DN is no more effective than PENS. However, it is possible that the PENS could in essence act in a somewhat similar fashion to DN as the needle is inserted below the skin in order to apply the electrical current. This insertion of the needle could potentially serve the same purpose as when the needle is inserted in the technique of DN.

Eroğlu et al[5] also conducted a study of 60 subjects that examined DN, comparing it to oral flurbiprofen and lidocaine injection (Table 2). Measurements for VAS pain, algometry, neck range of motion and patient-reported outcomes were taken preintervention and on the third and fourteenth days of intervention. The patients in the oral flurbiprofen group were given 100 mg tablets 2 times per day for 7 days. The patients in the lidocaine group and DN were given the same needling procedure except the lidocaine group also received an injection of 0.2 ml of 2% lidocaine solution through the needle. In addition, all of the patients were given a home exercise program (HEP) and instructed to follow it. The authors[5] found that all groups showed significant improvement in algometry and VAS pain, and in addition, there was no significant between group differences for any of the outcome measures. These results show that DN was no more effective than oral flurbiprofen or lidocaine injection in reducing pain associated with MTrPs.

A study by Ilbuldu et al[14] compared the effectiveness of DN to that of laser and placebo laser. In this study, 60 patients were randomized into DN, laser, or the placebo laser group (Table 2). The DN group received 4 intervention sessions, and the laser group received treatment for 12 sessions. The placebo group received probe intervention with the machine turned on and set but no beam applied. In addition all the groups received instruction in stretching and were required to exercise regularly. Patients were also given paracetamol tablets as needed for pain and the number of tablets used throughout the study was recorded. Outcome measures included VAS pain scale, algometry, cervical ROM, and the Nottingham health profile. Measurements were taken preintervention, postintervention (4 weeks), and at a 6-month follow-up. The results for pain showed that the VAS pain for rest and activity decreased in all groups postintervention and at the 6-month follow-up. In addition, there was a significant between group difference in favor of the laser group at the postintervention measurement for VAS rest and activity but this disappeared at the 6-month follow-up. In regards to algometry, there was a significant between group difference in favor of the laser group for pain threshold at the postintervention measure but again this disappeared at the 6-month follow-up. There was no difference for pain tolerance between any of the groups. The analgesic usage was also shown to be significantly less in the laser group postintervention, but again, not at the 6-month follow-up. These results suggest that laser is more effective than DN at reducing many aspects of pain postintervention in the short term but not in the long term (6-month follow-up).

Rayegani et al[15] conducted a study where 28 subjects were randomly assigned to receive either DN or physiotherapy (see Table 2). The DN group consisted of a session of needling, and afterwards patients were advised to apply ice and Capsaicin cream. The physiotherapy group had 10 sequential sessions of therapy that included superficial heat, TENS, US, and upper trapezius (UT) stretching by a therapist. In addition, both groups were instructed to stretch daily for a month. Outcome measures, VAS pain, algometry, and the SF-36 questionnaire, were taken preintervention and one week and one month after the last intervention session. The results in regards to pain showed that at the one week follow-up there was significant reduction in rest, night and activity pain in both the physiotherapy and DN groups. In addition, there was a significant increase in pain pressure threshold as measured through algometry in both groups as well. There were no significant differences between groups. At the one month follow-up, there was again a significant reduction in activity, rest and night pain; a significant increase in pain pressure threshold in both groups; and there was no significant difference between groups. These results show that while both interventions are effective in reducing pain in subjects with myofascial pain syndrome, there is no difference between DN and physiotherapy in regards to pain reduction; thus DN is no more effective than physiotherapy in reducing pain.

A study by Edwards et al,[16] randomly assigned 40 patients into 3 groups of 13 or 14 subjects to receive either DN and active stretching, stretching alone, or no intervention (Table 2). The outcome measures (the Short Form McGill Pain Questionnaire (SFMPQ) and algometry) were measured preintervention, after 3 weeks, then 6 weeks from the commencement of intervention. Participants in the DN group received a varying number of DN sessions. After needling, stretching was performed and patients were instructed to continue these stretches at home. The patients in the stretching group received instruction in stretching exercises and were instructed to continue these at home. The results showed that there was no significant difference between groups at the 3-week measurement. However, at the 6-week measurement, the DN and stretching group showed significantly improved scores on the SFMPQ compared to the no intervention group and significantly improved pain pressure threshold compared to the stretching alone group. These results suggest that DN is more effective than stretching alone at reducing pain pressure threshold; however, the fact that there is no significant difference in the SFMPQ suggests that DN has a limited role in reducing pain over stretching alone.

Outcome Measure: Electromyography

In 20 subjects, Bahadir et al[12] compared DN to HPPTUS. This was the only study reviewed that used EMG activity as an outcome measure (see Table 2). The number of LTRs in the HPPTUS group decreased significantly both from initial EMG measurement (taken before intervention), immediate EMG measurement (taken after the intervention on the same day), and final EMG measurement (taken on the fifth day). The number of recordings of spontaneous electrical activity (SEAs) decreased significantly from the initial to immediate assessment but not from the initial to the final assessment. In the DN group, the number of LTRs and SEAs did not decrease significantly from the initial to the immediate assessment or from the initial to the final assessment. While the HPPTUS group did experience a more significant reduction in LTRs and SEAs than the DN group, it is possible that the EMG needle insertion itself may have had a similar effect to DN. In addition, the number of sessions of HPPTUS carried out was greater than that of DN, which could also account for this discrepancy.

Table 2. Summary of Findings for Included Studies

Study	Type of Study	Evidence Rating	Conditions	Sample Characteristics
Ziaeifar, Arab, Karimi, & Nourbakhsh[8]	Randomized Controlled Trial	4/10	3 times/week for 1 week, for both the treatment (TCT) and the experimental group (Dry Needling or DN).	33 patients with myofascial trigger point MTrP in the upper trapezius (UT) muscle. Intervention group: 17 participants mean age 26.5 ± 8.57, mean weight 56 ± 5.92 kg, mean height 163.7 ± 4.49 cm. Experimental group: 16 participants, mean age 30.06 ± 9.87, mean weight 60.37 ± 6.96 kg, mean height 165.3 ± 7.56 cm.
DiLorenzo, Traballesi, Morelli, Pompa, Brunelli, Buzzi, & Formisano[11]	Randomized Controlled Trial	6/10	Both DN and standard rehabilitation groups, received standard rehabilitation therapy. The DN group received 4 sessions of DN, each 5-7 days apart.	101 patients that were post-cerebrovascular accident (CVA) and were experiencing shoulder pain on the hemi-paretic side due to MTrP, 54 patients in DN group and 47 patients in control group. Mean age DN group 69.56 ± 6.21, control group 67.43 ± 9.05. Gender males: females DN group 14:40, control group 14:33. Post stroke mean duration (weeks) DN group 3.50, control group 3.57.
Bahadir, Majlesi, & Unalan[12]	Randomized Controlled Trial	2/10	3 consecutive days for the High-powered pain threshold ultrasound (HPPTUS) group and then home stretching exercises for 2 consecutive days, and 1 treatment and 4 consecutive days of home stretching exercises for the DN group.	23 female patients with MTrP in the UT muscle (3 participants dropped out so only 20 finished the study).
Rayegani, Bayat, Bahrami, Raeissadat, & Kargozar[15]	Randomized Controlled Trial	4/10	DN group consisted of 1 session followed by 1 month of home stretching program. Physiotherapy group consisted of 10 sequential sessions of superficial heat, Transcutaneous Electrical Nerve Stimulation (TENS) Ultrasound (US), UT stretching by a therapist and 1 month of home stretching program.	28 participants with MTrP in the UT muscle. DN group 14 participants, mean age 32 ± 10. Physiotherapy group 14 participants, mean age 38.6 ± 4.2
Ilbuldu, Cakmak, Disci, & Aydin[14]	Randomized Controlled Trial	6/10	3 Laser sessions/week for 4 weeks and home stretching program for Laser group. 3-placebo Laser sessions/week for 4 weeks and home stretching program for placebo group. 1 session/ week for 4 weeks and home stretching program for dry needling group.	60 females between the age of 18-50 with MTrP in UT muscle, mean age placebo group 32.35 ± 6.88, DN 35.29 ± 9.18, Laser 33.90 ± 10.36

Outcome Measures	Important Results
Pain intensity: Visual Analog Scale (VAS), Pain Pressure Threshold (PPT), Disability of the Arm, Shoulder and Hand (DASH) questionnaire	There was a significant difference from pretreatment to posttreatment for VAS, PPT, & DASH for both TCT (P = 0.000, 0.001, & 0.006 respectively) & DN (P = 0.000, 0.000, & 0.001 respectively). In addition there was a significant difference between DN & TCT group posttreatment for the VAS (P = 0.01) but not for PPT or DASH.
Pain (VAS), duration of hospitalization, Functional Mobility (Rivermead Mobility Index), Sleep Questionnaire to address daytime rest & sleep quality	H^0= baseline VAS scores. H^1, H^+ and H^3 = subsequent VAS assessments. VAS pain scale decreased significantly for the DN group from entry throughout each successive measurement, P-values H^1 <0.001, H^+ 0.005, H^3 0.05; however for the standard rehabilitation group the VAS scores were significant for H^1 and H^3 both with a P = 0.05, but H^+ did not have a significant reduction with a P = 0.25. In addition there was a significant between group difference for each time period, H^1 P <0.001, H^+ P <0.001, and H^3 P <0.001. Sleep questionnaire reported that the DN group had 85.19% of the participants responds yes to question 1 (did you rest well in wheelchair or bed during the last 2 weeks?) and 68.08% of the standard rehabilitation group responded yes as well, with a P = 0.034. In addition 92.59% of the DN group and 74.47% of the standard rehabilitation group responded yes to question 2 (did you sleep well during the last 7 nights?) with a P = 0.039. RMI effectiveness [100 x (discharge scale score – initial scale score)/(maximum scale score – initial scale score)] for DN group was 50.01% ± 15.38% and for standard rehabilitation was 47.54% ± 17.34%.
Pain (VAS), Electromyography (EMG), Range of Motion (ROM), (Active ROM lateral flexion)	There was a significant decrease in VAS for HPPTUS from initial to immediate assessment and initial to last assessment (P = 0.007 & 0.005). For the DN group there was only a significant decrease from the initial to last assessment but not the initial to immediate assessment (P = 0.007 & 0.785). There was a significant improvement in ROM for HPPTUS from initial to immediate and initial to last assessment (P = 0.011 & 0.007). However, for the DN group there was only a significant decrease from the initial to last assessment but not the initial to immediate assessment (P = 0.005 & 0.783). There was a significant difference for LTR from initial to immediate and initial to last assessment for HPPTUS (P = 0.009 & 0.015), but none for the DN (P = 0.160 & 0.129). There was a significant difference only for initial to immediate assessment for HPPTUS not the initial to last (P = 0.016 & 0.123) and none for DN (P = 0.109 & 0.564). In addition there was a significant between group difference in favor of the HPPTUS for VAS (P = 0.009) and number of LTRs (P = 0.015) but not for ROM (P = 0.136) or number of SEAs (P = 0.123)
Pain (VAS & algometer), Quality of life (SF-36)	There was a significant reduction in rest, night, & activity pain in the physiotherapy and DN group at the 1 week follow-up, as well as significant increase in PPT. For the SF-36 scale at 1 week in the physiotherapy group there was significant improvement in social functioning, role limitation due to physical problems and physical functioning (P <0.05) but no significant changes in vitality, role limitation due to emotional problems, general health, and mental health. For the DN group no significant changes were observed in the SF-36 scale. At 1 month follow-up both groups had significant decrease in activity, rest and night pain and significant increase in PPT, bodily pain, physical functioning, role limitation due to physical problems and social functioning (P <0.05. There were no significant between group differences for any of the outcomes (P >0.1).
Pain Intensity (VAS, analgesic usage, algometer), Cervical ROM (Flexion, extension, bilateral rotation, bilateral lateral flexion), Functional status (Nottingham Health Profile)	Decrease in rest and activity subgroups of VAS at posttreatment. Significant decrease VAS rest (P < 0.05) and activity (P = 0.001) in laser group compared to DN and placebo groups at posttreatment, but this disappeared at the 6 month follow-up. Significant increase in pain threshold in laser compared to DN and placebo (P < 0.001) at the posttreatment, but again this disappeared at the 6-month follow-up. Significant difference in analgesics used, fewer in laser group (P < 0.05) at post treatment, but not at 6-month follow-up (P > 0.05). Significant increase in flexion at posttreatment in DN & laser groups, but no difference at the 6-month follow-up (P >0.05). Significant increase in extension in laser group compared to DN and placebo group (P < 0.001), but no difference at the 6-month follow-up (P > 0.05). There were no differences in rotation. Significant difference in right and left lateral flexion in laser group compared to DN and placebo group (P < 0.001 & < 0.01) at post treatment, but not at 6-month follow-up. For the Nottingham Health Profile, there was a significant difference in pain and physical activity subgroups at posttreatment (P < 0.001 & < 0.05) for laser compared to DN and placebo groups, but this disappeared at the 6-month follow-up. There were no other significant differences in any of the subgroups in the Nottingham Health Profile.

(Continued on page 184)

Table 2. Summary of Findings for Included Studies *(Continued from page 183)*

Study	Type of Study	Evidence Rating	Conditions	Sample Characteristics
Edwards & Knowles[16]	Randomized Controlled Trial	6/10	DN group received a stretching home exercise program (HEP) and a varied amount of DN sessions over a 3-week period depending on patient condition and convenience of patient and therapist (mean number treatment sessions 4.6). Stretching group received a HEP in stretching and performed this program for 3 weeks and received follow up sessions to check up on stretching form (mean number treatment session 2.9). In addition the DN and stretching group received instruction in posture. After the 3 weeks of intervention, both groups had a 3-week period of no intervention. The control group received no treatment.	40 subjects aged 18 and over and with identifiable MTrP. Mean age DN group 57 ± 12, Stretch group 55 ± 17, control group 57 ± 19.
Eroğlu, Yilmaz, Bodur, & Ates[5]	Randomized Controlled Trial	7/10	All groups received instruction in a stretching HEP. The DN group received 1 session of DN, the LI group received needling and injection of lidocaine, and the OF group received 2x100mg/day tablets of oral flurbiprofen for 7 days.	60 patients, 7 males & 53 females. Mean age DN group 33.75 ± 8.10, LI group 32.85 ± 9.06, OF group 34.55 ± 8.30.
Pérez-Palomares, Olivan-Blazquez, Magallon-Botaya, De-la-Torre-Beldarrain, Gaspar-Calvo, Romo-Calvo, Garcia-Lazaro, & Serrano-Aparicio[13]	Randomized Controlled Trial	5/10	Percutaneous Electrical Nerve Stimulation (PENS) group received 9 sessions, 3 sessions (lasting 30 minutes) per week on alternate days for 3 weeks. DN group received 3 sessions, 1 per week with at least an 8-day latent period between sessions, for 3 weeks. Each session was followed by the spray and stretch technique, where each muscle was passively stretched in 3 sequences and vapocoolant spray was applied to the pain reference zone in 3 sweeps for each sequence.	122 patients, 91 females & 31 males. PENS group and DN group percentages: gender male 18.8% & 32.8% respectively, female 81.3% & 67.2% respectively (P-value 0.08); age less than 40 34.4% & 50.0% respectively, 40-60 45.3% & 31.0% respectively, greater than 60 20.3 % & 19.0& respectively (P-value 0.18).

Outcome Measure: Range of Motion

Three studies examined ROM as an outcome measure (see Table 2). Bahadir and colleagues[12] examined ROM in the cervical region in a group of 20 subjects. The results from this study[11] show that the HPPTUS group had significant improvement in ROM from preintervention to immediately postintervention, but the DN group did not. In addition, both groups showed significant improvement in ROM from initial intervention to 5 days postintervention. These results suggest that both interventions can be helpful in increasing ROM in cervical lateral flexion after an extended period (5 days), but only HPPTUS shows immediate improvements. However, both of these groups underwent an EMG evaluation that involved needle insertion, which could in essence behave like DN.

Eroğlu et al[5] also conducted a study with 60 subjects using ROM as an outcome measure. The results from this study showed that the neck ROM for lateral flexion and rotation increased significantly on the third and fourteenth days in all groups, regardless of intervention. In addition the authors found there was no between group difference.[5] These results suggest that DN is no more effective than the previously established interventions of NSAIDs (oral flurbiprofen) or lidocaine injection.

One other study that met the search criteria was included for review. This study was done by Ilbuldu et al[14] where the effectiveness of DN was compared to that of laser and placebo laser. The results showed that there

Outcome Measures	Important Results
Pain: Short- Form McGill Pain Questionnaire (SFMPQ), PPT-algometer)	No significant difference between groups at 3 weeks after trial started. At 6 weeks after trial started, the DN group was significantly different compared to the control group in SFMPQ (P = 0.043), and was significantly different compared to the stretch group in PPT scores (P = 0.011). There was a significant difference in PPT and SFMPQ in the DN group.
Pain (VAS), Quality of Life Scale (Nottingham Health Profile [NHP]), ROM (AROM neck: flexion, extension, bilateral lateral flexion, bilateral rotation/ shoulder: abduction, adduction, flexion, extension, IR, ER)	Treatment: Algometric Sensitivity F_n 0.58, P-value 0.55, VAS-pain score F_n 2.073, P-value 0.13, Lateral Flexion right F_n 0.854, P = 0.42, Lateral Flexion left F_n 1.29, P = 0.27,Roation right F_n 2.174, P = 0.11, Rotation left F_n 1.92, P = 0.14. Time: Algometric Sensitivity F_n 108.28, P <0.001, VAS-pain score F_n 73.97, P<0.001, Lateral Flexion right F_n 38.74, P <0.001, Lateral Flexion left F_n 26.83, P-value <0.001, Rotation right F_n 23.76, P <000.1, Rotation left F_n 17.30, P <0.001. Interaction: Algometric Sensitivity F_n 1.22, P = 0.29, VAS-pain score F_n 0.41, P = 0.76, Lateral Flexion right F_n 0.685, P = 0.56, Lateral Flexion left F_n 0.55, P-value 0.67, Rotation right F_n 0.40, P = 0.79, Rotation left F_n 0.70, P = 0.56. Nottingham Health Profile: Treatment: NHP-pain F_n 0.67, P = 0.49, NHP-physical activity F_n 0.02, P = 0.97, NHP-fatigue F_n 1.13, P = 0.32, NHP-sleep F_n 1.91, P = 0.14, NHP-social isolation F_n 1.76, P = 0.30, NHP-emotional reactions F_n 0.83, P = 0.42. Time: NHP-pain F_n 53.79, P <0.001, NHP-physical activity F_n 27.00, P <0.001, NHP-fatigue F_n 34.10, P <0.001, NHP-sleep F_n 38.23, P <0.001, NHP-social isolation F_n 5.99, P = 0.002, NHP-emotional reactions F_n 39.35, P<0.001. Interaction: NHP-pain F_n 0.17, P = 0.93, NHP-physical activity F_n 0.73, P = 0.56, NHP-fatigue F_n 3.06, P = 0.02, NHP-sleep F_n 1.78, P = 0.13, NHP-social isolation F_n 1.33, P = 0.25, NHP-emotional reactions F_n 1.38, P = 0.23.
Pain (VAS, PPT-algometer), Quality of Life Scale (Oswestry Disability Index), & Sleep Quality (VAS)	PENS & DN groups VAS pain (Initial-final): 2.38 (±2.27) & 2.35 (±2.58) respectively (P = 0.94); VAS sleep quality (Initial-final): 1.72 (±2.67) & 1.85 (±2.66) respectively (P = 0.68). PENS & DN groups PPT (Initial-final): right deep paraspinals 0.91 (±4.39) & 1.04 (±4.45) respectively (P = 0.93); left deep paraspinals 1.75 (±4.6) & 2.06 (±3.35) respectively (P = 0.83); right quadratus lumborum 0.89 (±3.10) & 1.73 (±3.47) respectively (P = 0.33); left quadratus lumborum 0.76 (±2.77) & 1.64 (±2.91) respectively (P = 0.12); right gluteus medius 0.77 (±3.27) & 0.87 (±2.76) respectively (P = 0.32); left gluteus medius 058 (±2.46) & 1.77 (±3.44) respectively (P = 0.14). PENS & DN group Oswestry Disability Index (Initial-final): personal care 0.38 (±0.97) & 0.34 (±0.82) respectively (P = 0.94); lifting weight 0.59 (±1.42) & 0.06 (±0.96) respectively (P = 0.03); walking 0.17 (±0.98) & 0.15 (±0.57) respectively (P = 0.86); sitting 0.21 (±0.89) & 0.33 (±1.05) respectively (P = 0.51); standing 0.25 (±0.84) & 0.41 (±0.82) respectively (P = 0.26); social life 0.72 (±1.10) & 0.72 (±3.03) respectively (P = 0.178). Number of patient with more than 40% reduction in VAS pain: PENS 28 (53.85%) & DN 24 (46.15%).

was a significant increase in flexion at postintervention in the DN and laser groups, but this disappeared at the 6-month follow-up. In addition, ROM for extension was significantly increased compared to the DN and placebo groups at postintervention measurement, but again this disappeared at the 6-month follow-up. There was no significant difference in rotation for any of the groups or follow-ups. In regards to lateral flexion, both left and right were increased in laser group compared to the DN and placebo groups at 4 weeks but at 6 months there was no difference. These results would suggest that laser was more effective than DN to help increase cervical ROM in the short term, but there was no difference between the two interventions in the long term (6 months).

Outcome Measure: Quality of Sleep

Two studies examined the quality of sleep as an outcome measure (see Table 2). In the study by Pérez-Palomares and colleagues[13] where PENS was compared to DN in 121 subjects with low back pain, a VAS scale was used to identify quality of sleep. The final score was subtracted from the initial score and compared across groups; there was no significant difference between the PENS group and the DN group. This would suggest there is no benefit of DN over PENS in regards to sleep quality.

Another study by DiLorenzo et al[11] also examined quality of sleep using a sleep questionnaire that consisted of 2 questions. These questions were answered only at the last visit

with a yes or a no response. The authors[11] found that 85.2% of the DN group felt that they rested well in the wheelchair or bed during the last 2 weeks (question 1) compared to 68.1% of the standard rehabilitation group, which was a significant between group difference. In addition there was also a significant between group difference for question 2 which asked the question, "Did you sleep well during the last 7 nights?" For this question, 92.6% of the DN group answered "yes" whereas only 74.5% of the standard rehabilitation group answered "yes." These results would suggest that the addition of DN to the standard rehabilitation program did have positive effects that helped the patients to sleep better.

Outcome Measure: Patient-reported Outcomes

Pérez-Palomares and colleagues[13] also examined patient-reported outcomes in their study that compared PENS to DN (see Table 2). The authors[13] used the Oswestry Disability Index. As with their other outcome measure comparisons, the final measurements were subtracted from the initial measurements. In the subcategories of personal care, walking, sitting, standing, and social life, there was no significant difference found between groups. However, in the area of lifting weight, there was significant difference in favor of the DN group. This would suggest there is a slight benefit of DN over PENS in quality of life, specifically in the lifting weight subcategory of the Oswestry Disability Index.

In the study by Eroğlu et al,[5] the authors used the Nottingham Health Profile, which included the subcategories of pain, physical ability, fatigue, sleep, social isolation, and emotional reactions, as a measure of quality of life (see Table 2). The authors found that all groups showed a significant improvement in the quality of life measure in all subcategories. When between group comparisons were made, it was found that the only significant difference was for the subcategory of fatigue on the third and fourteenth day measurements. This difference was found for the lidocaine group, and since this is not an intervention that physical therapists can administer, which is the focus of this paper, the difference was not considered. These results suggest that in terms of quality of life, DN is no more effective than oral flurbiprofen.

Ziaeifar et al[8] also used a patient-reported outcome measure in their study. In this case they used the DASH (Disability of Arm, Hand, and Shoulder; see Table 2). The authors found that there was a significant change in DASH scores from preintervention to postintervention in both groups. There was no significant difference between groups, suggesting that DN has no greater benefit than MTrP compression therapy in regards to aspects of quality of life measured by the DASH.

DiLorenzo et al[11] examined patient-reported outcomes through the use of the Rivermead Mobility Index (RMI; see Table 2). The authors[11] calculated the effectiveness of RMI through the use of the equation [100 x (discharge scale score – initial scale score)/ (maximum scale score – initial scale score)]. The authors[11] did not comment on the significance of the different values calculated, only that the effectiveness was 50.0% for the DN group and 47.5% for the standard rehabilitation group. From this it appears that there was no significant difference between the groups and thus DN was no more effective than the standard rehabilitation intervention.

The study by Ilbuldu et al[14] examined the effectiveness of DN compared to that of laser and placebo laser (see Table 2). The patient-reported outcome used was the Nottingham Health Profile. In the subcategories of pain and physical activity, a significant difference was noted postintervention in favor of the laser group over the placebo laser and the DN groups. However, this difference disappeared at the 6-month follow-up. In addition, for the subcategories of fatigue, sleep, social isolation, and emotional reaction there were no significant differences at postintervention or the 6-month follow-up. These results would suggest that the laser was more effective in helping to reduce pain and increase physical activity in the short term but not the long term, which coincides with the results from the outcome measures that the authors used to address pain including analgesic usage, VAS pain scale, and algometry.

Rayegani et al[15] used the SF-36 in their study as the measure of patient-reported outcomes (see Table 2). The results showed that there was significant improvement in the subcategories of social functioning, role limitation due to physical problems, and physical functioning in the physiotherapy group. However, in this same group, no significant improvement was found in the subcategories of vitality, role limitation due to emotional problems, or general and mental health. In contrast, the DN group showed no changes in any of these subcategories. There were no significant differences between the groups. At the 1-month follow-up, there was a significant increase in bodily pain, physical functioning, role limitation due to physical problems, and social functioning in both groups with no significant difference between groups. These results show that DN is not more effective at improving quality of life in the short term as measured by the SF-36 and in some areas, physical therapy may even be more effective.

DISCUSSION

This systematic review was undertaken to summarize the relative effect of DN compared to other interventions that physical therapists may use to treat symptoms and disablement related to MTrPs. Dependent variable measurements of the included studies were pain, EMG activity, ROM, sleep quality, and quality of life. In regards to the outcome measure of pain, there were only 3 studies that showed that DN was better than the intervention to which it was compared.[8,11,16] However, notably, DN was more effective in 3 of the 4 studies that examined manual therapy interventions.[8,11,15,16] However, when compared to other modalities, DN was no more or less effective in reducing pain in all 4 of the studies examined.

In regards to ROM measurement and EMG activity (specifically reduction of LTRs), DN was not found to be more effective in any of the studies. When examining sleep and quality of life, the results of the studies are again somewhat mixed but most favor the result of DN being no more or less effective than other interventions.

Considering all results it appears that DN by far has the greatest effect on pain reduction. It is still unclear if DN is more effective than other common interventions used. However it does appear that DN is more effective in reducing pain over manual therapy. This would support the argument for the use of DN in the clinic as a method for pain reduction. Lastly it is important to note that these studies were of relatively small size and had varying levels of quality in regards to their methodologies, with PEDro scores ranging from 2/10 to 7/10. Thus, it is important for more research to be conducted in this area, specifically a high quality, large scale study that compares DN to a standard rehabilitation intervention.

ACKNOWLEDGEMENT

The authors thank Rachel Eng, PT, DPT, for her insightful review and comments on an early draft of this manuscript.

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