Sports Medicine and Rehabilitation Journal

Review Article
Published: 26 Feb, 2018

The Effects of Dry Needling on Temporomandibular Disorder: A Systematic Review

Joe Girard, Kasey Parkman and Christie Nat*

Department of Orthopaedic and Physical Therapy, Franklin Pierce University, USA

Abstract

Background: Temporomandibular Joint Disorders (TMD) is a painful condition that affects a significant portion of the population. TMD is generally considered to have a Myofascial component. Dry needling is a technique used by some physical therapists in treating neuromuscular and Myofascial pain conditions. It is not known whether dry needling is effective in treating TMD.

Objective: The purpose of this systematic review is to examine the effects of dry needling on TMD.

Methods: This systematic review indexed the following databases: Medline, CINAHL, Sports Discus, Cochrane and Physiotherapy Evidence Database (PEDro). Articles were included if they examined the clinical effects of dry needling in TMD disorders. Acupuncture- based treatment, or studies utilizing non-biomedical paradigms were not included in this systematic review. Methodological quality was graded by the PEDro scale.

Results: Four studies satisfied the eligibility criteria and were included in this review. Methodological scores based on the PEDro scale were 5 to 8 out of 10. All of the included studies (100%) scored 4 or higher on the PEDro scale. DN had a significant effect on increasing pain pressure threshold ($p<0.05$) and decreasing pain levels ($p<0.05$). DN also increased pain free jaw opening ($p<0.001$).

Conclusion: Moderate evidence suggest that DN may be an effective and well-tolerated, short term intervention for decreasing pain and increasing function in patients with TMD. Larger studies are needed to further substantiate the effects of DN in patients with TMD.

Introduction

Temporomandibular Disorders (TMD) is a condition that affects an estimated 5% to 12% of the population [1]. TMD includes a variety of conditions associated with pain and dysfunction of the Temporomandibular joint (TMJ) and the masticatory muscles [2]. In the past decade, the annual TMD management cost in the USA alone has doubled to four billion dollars [1].

TMD presents with various symptoms including: Pain in the TMJ or Masticatory Muscles with or without limited jaw movements; catching or locking of the jaw; and TMJ sounds [3]. In 97% of cases, patients presenting with TMD claim that pain is their chief complaint and their main reason for seeking treatment [3]. The symptoms associated with TMD may lead an individual to change their normal daily activities such as, taking time off from work and impeding their ability to partake in social interactions. This can have a negative impact on their quality of life [4]. Physical therapy is among the most common treatments used for individuals with TMD [2,5]. Physical therapists use a variety of techniques to decrease pain and dysfunction in those presenting with TMD including: Joint mobilizations, Biofeedback, Postural correction, Education, Therapeutic exercise, and Electrotherapy [2]. Dry Needling (DN) is a therapeutic intervention used by physical therapists and other bio-medical clinicians that can be utilized for TMD treatment.

Dry needling, as defined by the American Physical Therapy Association (APTA), is "a skilled intervention that uses a thin filiform needle to penetrate the skin and stimulate underlying Myofascial Trigger Points (MTrPs), muscular and connective tissues, for the management of Neuromusculoskeletal pain and movement impairments [6]. DN is also used to improve activity and participation by reducing Neuromusculoskeletal related pain and dysfunction [6,7]. DN is also defined as an intramuscular procedure and identified as 'Intramuscular Manual Therapy' (IMT) or 'Trigger Point Dry Needling' (TDN) [7]. DN has become widely and safely practiced by many physical therapists throughout the world, including many in Australia, New Zealand, UK, USA and Canada [7-9].

OPEN ACCESS

Correspondence:
Joe Girard, Department of Orthopaedic and Physical Therapy, Franklin Pierce University, 670 N Commercial Street, Manchester, New Hampshire, 03101, USA, Tel: 603-496-7891; E-mail: girardj@franklinpierce.edu

Received Date: *11 Jan 2018*
Accepted Date: *19 Feb 2018*
Published Date: *26 Feb 2018*

Citation:
Girard J, Parkman K, Nat C. The Effects of Dry Needling on Temporomandibular Disorder: A Systematic Review. Sports Med Rehabil J. 2018; 3(1): 1030.

Table 1: Summary of Studies.

Purpose	Population	Measures	Intervention	Results
To compare effects of DN versus sham DN in reducing Myofascial pain of Temporomandibular muscles.	52 Adults, male and female, mean age, 33 ± 12.7 years of age, with pain symptoms of at least six weeks and MTrPs in temporomandibular muscles.	PPT *via* algometer, pain intensity *via* VAS, jaw opening *via* millimeter ruler.	Experimental: DN applied to MTrPs. Control: sham DN applied away from MTrPs. All interventions 3 × with 7 day intervals.	The DN group had significant increase in PPT *via* algometer compared to control group (P<0.05). Both groups showed decrease in VAS and jaw opening, without significant difference between groups for these measures.
To investigate the effects of DN versus sham DN over MTrPs in masseter muscle in patients with TMD.	12 adult females, mean age: 25 ± 6 years of age with a diagnosis of myofascial TMD dysfunction and symptoms of at least 6 months.	Pain intensity *via* numeric pain rating scale (NPRS), PPT *via* algometer and pain free maximal jaw opening *via* millimeter ruler.	Experimental group: DN to MTrPs. Control group: sham DN (no subcutaneous penetration). Each subject attended 2 sessions at least 7 days apart.	The DN group showed significant effects across all measures compared to sham DN group (P<.001).
To determine if DN to MTrPs in lateral pterygoid would significantly reduce pain and improve function compared to a medication intervention control group.	48 male and female adults, mean age: 34.3 ± 15.25 years of age, with chronic myofascial pain and MTrPs in lateral pterygoid.	Pain intensity at rest and with mastication *via* VAS, mandibular functional jaw opening/ mandibular ROM *via* therabite ruler.	Experimental group: DN to lateral pterygoid 1×/ week for 3 weeks. Control group: methocarbamol and paracetamol combination therapy every 6 hours for 3 weeks.	Both groups had significant pain reduction at rest and mastication with greater change in DN group (p<0.05). DN group showed significant increase in jaw opening at day 70 (P<0.05).
To compare effectiveness of DN compared to sham DN and compared to counseling in treatment of MTrPs in orofacial area.	30 patients diagnosed with active MTrPs in orofacial area, mean ages (years): DN group: 33.4 ± 15.25, sham DN group 24.7 ± 1.7 counseling group (gold standard) 41.6 ± 14.26.	Pain intensity *via* VAS, pain free jaw opening *via* millimeter ruler.	DN group: DN to orofacial MTrPs, Sham DN: to MTrPs without epidermal penetration. Gold standard: counseling regarding jaw relaxation. All subjects received 3 sessions for 3 weeks.	DN group had significant reduction in pain compared to the other groups (DN versus gold standard 0.008, DN versus sham DN <0.001). DN showed significant increase in jaw opening compared to sham DN (0.008) but not gold standard group.

Dry needling can be further categorized into Deep Dry Needling (DDN) or Superficial Dry Needling (SDN) [6,7]. One definition of DDN *vs*. SDN, held by the American Physical Therapy Association, considers DDN to activate the Latent Twitch Response (LTR) of MTrP, whereas SDN does not activate LTR and is thought to activate superficial mechanoreceptors [6]. Other descriptions indicate that SDN involves 5 mm to 10 mm insertion of the filiform needle above the MTrP or painful area, without penetrating the MTrP, where DDN causes deeper insertion of the needle into the MTrP [7]. There is overlap with the terms DN and DDN, though SDN is usually separately indicated.

Some clinicians consider DN to be a form of acupuncture; an intervention originating from Traditional Chinese Medicine (TCM). TCM uses a theoretical framework based on Yin/Yang Theory and qi meridian flows and is significantly different health-paradigm and conceptual framework when compared to bio-medicine or "western medicine [8]. TCM acupuncturists use filiform needles, sometimes multiple needles, inserted into relevant acupuncture points, guided by their method of clinical decision making, for the relief of pain and dysfunction, including the treatment of TMD [8,10]. It is probable that certain acupuncture points, particularly ah-shi points, correlate with MTrP [8,11]. Although TCM acupuncture and DN (as practiced by physical therapists and other bio-medically trained clinicians) share some similarities only in the use of filiform needles applied MTrPs, they utilize completely different medical paradigms and are utilized under different professional practice acts.

Western Medical Acupuncture (WMA) is another bio-medically based needling intervention that is defined as "a therapeutic modality using the insertion of fine needles using current principles of anatomy, physiology, pathology; and the principles of evidence based medicine. It is mainly used to treat musculoskeletal pain, including Myofascial Trigger Point Pain [7,12]. WMA, when used to treat neuromuscular conditions is similar in theory and technique, to DN as practiced by many physical therapists and other bio-medically based clinicians [7].

There are many theories describing the mechanism of DN. Dry Needling may have different mechanisms based on the targeted tissue [6]. The most codified and prevalent theory is that DN affects MTrPs by increasing the motor endplate acetylcholine stores [6,13]. Myofascial pain syndrome caused by muscular trigger points can result in local and generalized pain [14,15]. An MTrP occurs in skeletal muscle and is a specific irritable point that can be palpated as a nodule or taut band. If pressure is placed on the hypersensitive area, there is a characteristic referral pattern that occurs [14,15]. Theoretically, DN more specifically Deep Dry Needling (DDN) causes a localized twitch response in the MTrP [6-8]. DN also might increase local blood flow to the hypoxic taut muscle band and interrupt peripheral and central sensitization mechanisms *via* gate control theory or other mechanisms [13]. Additionally, DN might induce a cascade of endogenous opioid release as well as exciting the release of neurotransmitters such as Noradrenaline and Serotonin [13]. The final result of the neurophysiologic cascade can potentially cause analgesic effects as well as potentially restoring normalized motor end plate activity [7,13]. Effects of SDN are not fully known and are thought to be stimulation of the mechanoreceptors and possible superficial neural fibers and might also positively affect fibroblasts and stimulate beneficial cellular responses [6].

There are multiple research studies, systematic reviews and meta-analysis that have supported the use of DN for patients living with musculoskeletal pain conditions [7,16-19]. A Cochrane review in 2005 noted that dry-needling appeared to be "a useful adjunct to other therapies" for chronic low back pain [16]. A 2017 meta-analysis that examined the effects of trigger point dry needling performed by

physical therapists on musculoskeletal pain conditions concluded that "dry needling performed by physical therapists is more effective than no treatment, sham dry needling and other treatments for reducing pain and improving Pressure Pain Threshold (PPT) in patients with musculoskeletal pain conditions [17]. A 2016 systematic review that examined the use of DN in treatment of the lower quarter found that "DN is effective in reducing pain in lower quarter MTrPs in the short term [18]. A 2013 meta-analysis that examined DN techniques in pain management in upper quarter anatomical areas recommended "dry needling, compared to sham dry needling or placebo, for decreasing pain immediately after treatment and up to four weeks, in patients with upper quadrant Myofascial pain [19]. Despite the growing body of research examining the effects of DN, it is not known what effect DN has on TMD. The purpose of this systematic review is to examine the effect of dry needling, on TMD.

Methods

Search strategy

The literature search was performed in two stages. Both stages involved two independent, systematic searches of the following databases: Medline, Cinahl, Sports Discuss, Cochrane and Physiotherapy Evidence Database (PEDro). The first stage searched for relevant studies published between January 2006 and August 2016. The initial search terms were: "Dry Needling and Temporomandibular Disorder," "Dry Needling and Jaw Pain," "Dry Needling and Pterygoid," "Dry Needling and Masseter," "Dry Needling and Orofacial Pain." A ten year time frame was chosen to ensure inclusion of the most recent, relevant research. Based on limited search results a decision was made to broaden the search. The next stage used a literature search of the same databases with the inclusion of the following search terms: "Trigger Points and Dry Needling," "Myofascial Trigger Points and Dry Needling," "Myofascial Needling and Temporomandibular Disorder," "Intramuscular Needling and Temporomandibular Disorder," "ah shi points and Temporomandibular Disorder," "ah shi points and Dry Needling," "Myofascial Trigger Points and Temporomandibular Disorder," "Medical Acupuncture and Temporomandibular Disorder," "Medical Acupuncture and Trigger Points," "Medical Acupuncture and Myofascial Trigger Points and "Acupuncture and Temporomandibular Disorder." The timeline was extended to June 2017 to enable inclusion of the latest data. The original search was updated to the new time frame (Figure 1) outlines the combined search strategy.

Study selection

Relevant titles and abstracts were screened independently by two separate reviewers during both stages. Titles and abstracts were considered relevant if they addressed the clinical effects of DN in the treatment of TMD. For selection, studies had to be performed within a bio-medical framework to ensure that the results were applicable to clinicians who practice DN in a bio-medical context such as physical therapists. This selection parameter was met if studies utilized a bio-medically based screening or diagnostic method for TMD or MTrPs or other TMD relevant factors. "Acupuncture and Temporomandibular Disorder" search term was included as authors thought it would broaden the field of potential studies, although studies that utilized TCM acupuncture would be excluded. Search terms that included "Medical Acupuncture" were included because medical acupuncture, by definition, is an inherently bio-medically based practice [7,12]. Studies that examined clinical effects of TCM acupuncture on TMD and/or studies that were TCM paradigm based were not included in this systematic review. For the purposes of this systematic review, the definition of DN and DN interventions, such as DN, DDN and SDN, was left to the individual study authors based on current practice variation.

Inclusion criteria

To be included in the review, the studies had to meet the following inclusion criteria: Randomized controlled trials that addressed the treatment of TMD through the direct or adjunct use of DN performed within a bio-medical paradigm, published in peer-reviewed journals, written in the English language and publication between years of 2006 and June 2017. Additionally, studies had to have a methodological quality score of at least 4/10 on the Physiotherapy Evidence Database Scale (PEDro) which indicates "fair to good" methodological quality [20].

Exclusion criteria

Studies were excluded if they included any patients younger than 18 years of age; utilized TCM based acupuncture or clinical paradigm, or did not meet any of the inclusion criteria.

Methodological quality

The PEDro scale was used independently by two reviewers to qualitatively analyze all included articles. Scoring discrepancies would be decided by a third reviewer. The reliability of the individual scale items on the PEDro scale range from "fair" to "excellent," while the total PEDro reliability score is "fair" to "good," with an intra-class correlation co-efficient of 0.55 [20,21]. The PEDro scale is an 11-item scale that was designed to rate the methodological quality of randomized controlled trials. The total PEDro score ranges from 0-10 and is obtained by summing the satisfied items from 2-11. Each satisfied response contributes one point to the total PEDro score. A higher score on the PEDRO scale indicates higher methodological quality. If an item is not satisfied, then no points are rewarded for that item [22]. Item 1 is related to external validity and is therefore excluded from the scoring. Items 2-9 measure internal validity while the measurements obtained for items 10-11 ensure that there is sufficient information to make results interpretable (Table 1) [23].

Results

A total of seven-hundred and seventy-eight potential studies were identified through the independent database searches while one study was identified through a hand search. After removal of duplicates and in eligible studies from the abstracts and citations, twelve full text articles were analyzed and assessed for eligibility. Of the twelve full text articles, only four met full inclusion criteria and were included in this review. The most reasons for non-inclusion were that studies were not randomized controlled trials, did not utilize DN or did not treat TMD (Table 1).

Methodological analysis

Two of the studies included in this review received a PEDro score of 8/10 [24,25], one study scored 6/10, [26] and one study scored 5/10 [27]. All of the included studies (100%) scored higher than 4/10 on the PEDro scale which indicates "fair to good" methodological quality [21,24-27]. None of the included studies (100%) met criterion number six "blinded therapists" [24-27]. All four studies (100%) met the following criteria: two "random allocation," four "groups similar at baseline," eight "measure of key outcome from more than 85% of subjects," ten "between group statistical comparison for at least one key outcome," and eleven "point measures and measures of variability

Table 2: Summary of Studies.

PEDro Criteria	Diracoglu, Vural, Karan and Aksoy	Fernandez-Carnero, La Touche, Ortega-Santiago, Galan del Rio, Pesquera, Ge and Fernandez de lasPenas	Gonzalez-Perez, Infante-Cossio, Granados-Nunez, Urresti-Lopez, Lopez-Martos and Ruiz-Canela-Mendez	Da Silva Faria
Eligibility criteria specified	Yes	Yes	Yes	Yes
Random allocation	Yes	Yes	Yes	Yes
Allocation concealed	No	Yes	No	No
Groups similar at baseline	Yes	Yes	Yes	Yes
Blinded subjects	Yes	Yes	No	No
Blinded therapists	No	No	No	No
Blinded assessors	Yes	Yes	No	Yes
Measure key outcome-85% subjects	Yes	Yes	Yes	Yes
Intention to treat analysis was completed	Yes	No	No	No
Between group statistical comparison	Yes	Yes	Yes	Yes
Point measure and variability	Yes	Yes	Yes	Yes
PEDro score out of 10	08-10	08-10	05-10	06-10

Physiotherapy Evidence Database (PEDro) Scores

for at least one key outcome" (Table 2) [24-27].

Subjects

A total of 142 participants were assessed in the four included studies. All subjects were over the age of 18 with mean ages from 24.7-41.6 years old. The participants had either a diagnosis of temporomandibular dysfunction; chronic Myofascial pain and/or Myofascial trigger points in the lateral pterygoid, masseter and/or temporalis.

Experimental interventions

A variety of interventions were used in the four studies. Interventions included: DN to MTrPs, study defined sham DN, Methocarbamol (380 mg)/ Paracetamol (300 mg) combination drug therapy, and an educational and counseling program about relaxation of mastication muscles and healthy oral habits.

Results by study

Diracoglu, Vural, Karan and Aksoy investigated the effects of DN compared to sham DN for relieving Myofascial pain of the Temporomandibular Muscles [24]. Fifty-two subjects with two or more Myofascial trigger points in the temporomandibular muscles were randomly assigned to a DN experimental group or to a sham DN control group. The experimental group received DN with intramuscular stimulation which was applied on the located trigger points to the depth allowed by the needle guide tubes. The control group received sham DN which was defined as needle insertion not deeper than subcutaneous stratum and away from located MTrPs. Both groups used the same gauge needles, 0.2 mm × 30 mm, and received treatment three times with seven day intervals. Treatments were performed by the same physician with same treatment time for all needle insertions.

The performance measures used were: Pain Pressure Threshold (PPT) through the use of a pressure Algometer, pain intensity rated using a 10 cm Visual Analog Scale (VAS), and unassisted jaw opening without pain using a ruler. Of the fifty-two patients that started the study, fifty completed the study. This study found that in the experimental DN group, the pain pressure threshold increased and the VAS scores decreased post-treatment ($p<0.05$). There were no differences noted for unassisted jaw opening without pain. The sham DN group also showed increased pain pressure threshold and decreased VAS scores post-treatment ($p<0.05$) while the unassisted jaw-opening without pain values remained the same. When directly comparing the two groups, the pain pressure threshold showed significant differences ($p<0.05$) in favor of the experimental DN group. There were no significant differences between groups in the VAS or unassisted jaw-opening categories.

Fernandez-Carnero, La Touche, Ortega-Santiago, Galan del Rio, Pesquera, Ge and Fernandez de lasPenas, examined short term effectiveness of DDN compared to sham DN over active trigger points in the masseter muscle in patients with TMD [25]. Twelve participants took part in the study. Each subject attended two treatment sessions that were at least seven days apart and at the same time of the day. The subjects received one intervention that was assigned in a random fashion at each visit. The DDN experimental intervention consisted of DDN technique with a 0.26 mm × 25 mm needle that was inserted directly into the MTrP in the masseter and held until a LTR was elicited. After the LTR, the needle was withdrawn and re-inserted until a total of five LTRs were elicited. The sham DN procedure used a 0.26 mm × 13 mm needle with penetration into only a few millimeters of the skin and did not induce a LTR. Both procedures were performed by the same physical therapist. The performance measures that were used were: Pain Pressure Threshold over the masseter muscle and mandibular condyle, and pain free maximal jaw opening. This study found that there was a significantly greater ($p<0.001$) increase in PPT levels in the mandibular condyle and masseter muscle after the DDN experimental group when compared to the sham DN group. There was also an increase in pain free maximal jaw opening after DDN when compared with sham DN ($p<0.001$).

Da Silva Faria evaluated the effectiveness of DN compared to sham DN or counseling in the treatment of active MTrPs in the orofacial area [26]. Thirty patients participated in this study that all had a diagnosis of Myofascial pain and active MTrPs in the masseter

and/or temporalis. The DN therapy was applied to the MTrPs and when the needle, 20 mm ×13 mm penetrated the MTrP a movement "up and down" was repeated 3-5 times (without completely removing the needle). This was repeated to several MTrPs. The sham DN was applied to the MTrPs by pricking the skin, without dermal penetration with a blunted needle. The size of the sham blunt needle was not specified. The counseling gold standard group received an educational and counseling program that focused on relaxation of the mastication muscles and healthy oral habits. Every patient received three treatment sessions for three consecutive weeks.

The performance measures used were: pain intensity assessed using the VAS, and Pain Free Jaw Opening (PFJO) measured using a millimeter rule. Patients receiving real DN experienced a statistically significant decrease in jaw pain compared to both groups after the 2nd and 3rd consultation (p=<0.001). One month after treatment, DN continued to show a statistically significant decrease in jaw pain compared to counseling (p=0.008) and sham Dry Needling (p=<0.001). PFJO scores increased significantly when compared to sham DN after the 3rd consultation (p=0.015) and one month after last consultation (p=0.008), but not when compared to the counseling gold standard group.

Gonzalez-Perez, Infante-Cossio, Granados-Nunez, Urresti-Lopez, Lopez-Martos and Ruiz-Canela-Mendez examined whether DDN of MTrPs in the Lateral Pterygoid Muscle (LPM) would significantly reduce pain and improve function, compared with methocarbamol/ paracetamol medication [27]. Forty-eight subjects with chronic myofascial pain located in the LPM participated in this study. The DDN experimental group received DDN of the LPM once per week for 3 weeks. The needle was 40 mm × 25 mm caliber with a plastic guide tube. The needle was inserted into an MTrP to provoke an LTR or jump response. Manual compression hemostasis was applied for one minute post needle removal. The control group was given two tablets of methocarbamol (380 mg)/ paracetamol (300 mg) combination drug therapy every six hours for three weeks.

The performance measures used were: pain intensity at rest and upon mastication using the 10 cm VAS, mandibular range of motion (depression, protrusion and lateral movements) measured by a Therabite ruler and a 100 point scale TMJ function scale based on pain (max 40 points), function (45 points), and mastication (15 points). This study discovered a significantly greater reduction of pain in the DDN group compared with the control group on day 28 (p<0.001) and day 70 (p=0.011). Mandibular protrusion in the DDN group was significantly better than the control group on day 28 (p=0.031) and day 70 (p=0.001). The TMJ functionality scale showed that median scores in the DDN group improved at a rate of 56% from day 0-70 while the control group improved by 35%. No subjects in the DDN group experienced adverse events while 41% of the control group experienced side effects, of which the most common was drowsiness.

Discussion

The purpose of this systematic review was to examine the effects of DN in TMD. To our knowledge, this is the first systematic review to specifically investigate this phenomenon. A 2014 review highlighted the effects of DN in the upper quarter and craniofacial area and reported that DN might be effective in reducing pain in these respective anatomical regions, but that review did not methodologically analyze the included studies [28]. One of the most clinically relevant findings in this systematic review is that two of the included studies found significant effect for DN in increasing PPT in the TMJ area and three studies found an overall decrease in objective pain scores in the TMJ area with DN. This suggests that DN can improve pain tolerance and decrease pain level in the TMJ area, at least in a short term time frame. This concurs with other systematic reviews and meta-analysis that show similar beneficial effect of DN in other anatomical regions [17-19,29]. A 2017 meta-analysis examining the effects of DN performed by physical therapists in patients with musculoskeletal pain concluded that DN can be effective in the short term for increasing PPT and decreasing pain [17]. All of the DN interventions in this systematic review targeted MTrPs in the general TMJ area. DN interventions directed at MTrPs are widely used and have reported beneficial effects in treating MTrP related pain in other systematic reviews and meta-analysis [17-19,29]. This suggests that MTrPs, regardless of anatomical location, are susceptible to DN techniques.

Three studies in this systematic review found significant effects for DN in either increasing PFJO or increasing standard TMJ Range of Motion (ROM) [25-27]. MTrP directed DN has been shown to increase ROM at other joints such as the cervical spine and shoulder [30,31]. The neurophysiologic effects of stimulation and subsequent de-activation of MTrPs might decrease muscle tension in muscles harboring MTrPs which, upon release, could positively affect ROM at the related joint. Pain-reducing effects of DN MTrP stimulation might also assist with objective increases in ROM.

All of the included studies that used a sham DN control utilized a needle technique that pricked or pierced the epidermis but did not pierce sub-dermal layers. These sham DN could be considered a form of SDN [7,32,33]. All of the included studies found significant benefit of MTrP directed DN compared to SDN for most outcome variables. Given that one probable mechanism for DN is activating a neuro-physiological cascade by stimulating MTrPs, it is logical to assume that DN to MTrPs will have greater clinical benefit when compared to SDN that avoids sub-dermal penetration. Yet, the included studies showed that even SDN to dermal tissue had significant benefit for some outcome measures, though not to the level that MTrP directed DN exhibited. Currently, there is a paucity of research directly examining the effects of SDN, although this limited evidence suggests SDN may have a beneficial role in the treatment of Myofascial pain, however more research is needed to substantiate earlier findings [32,33]. Mechanism for efficacy of SDN could be related to stimulation of mechanoreceptors, mediation of superficial C and A delta fibers, and possibly affect fibroblast activity, although the exact mechanism is unknown [6,7].

One study found that the DN group had superior results over a pharmaceutical (*via* oral administration) control group [27]. In addition to greater clinical efficacy, the DN group had significantly less side effects compared to the medication control group which had reported side effects of 41%. Additionally the DN group demonstrated longer treatment effects with maintained functional Oromandibular motion findings at day seventy. The medication control group did not show maintained functional findings beyond day twenty-eight. There is a paucity of randomized trials that compare DN to oral administered pharmaceutical therapy and this could be an area for future research.

In the included studies, DN was found to be well tolerated. Additionally DN subjects were found to have reported low (or no) side effects compared to the pharmaceutical control group. This is in accord with other DN research findings, which indicate that DN is a

generally safe and well tolerated intervention [7,8,34].

There are strengths to this systematic review. The first is the clinical focus on TMD and TMJ related musculature. Although many meta-analysis and reviews that generally examine effects of DN exist, a systematic review that focuses on DN in the treatment of TMD is beneficial to a clinician who is researching the effects of DN in this area. A second key strength is the strict focus on DN in a bio-medical paradigm. This is beneficial to physical therapists and other bio-medical paradigm clinicians because the included studies are embedded in the same paradigm.

A weakness in this review is that in all the included studies, the DN intervention was MTrP directed. Although the preponderance of DN research focuses on MTrPs, DN has also been successfully utilized in other tissue and clinical conditions such as in tendinopathy [7,35]. A 2015 systematic review highlights significant clinical improvement in applying tendon directed DN to patients with lateral Epicondylitis [35]. DN can also affect scar tissue, ligaments, nerve tissue, bone, joint capsule and Myotendinous and Osseotendinous zones [7,36]. Another weakness of the included studies is the lack of DN dosage standard. Research on optimal DN dosage is generally lacking in medical literature [7,11]. While a lack of standardized dosage allows a broad degree of autonomy, this heterogeneity of intervention makes it difficult to decide on clear practice guidelines [7]. There are several limitations to this systematic review. All of the included studies had relatively small sample sizes, which decreases the statistical power of each study and increase the likelihood of a Type II Error. Additionally despite the author's efforts, it is possible that relevant studies were missed in the search or extraction resulting in retrieval and extraction bias. Certain studies could be excluded from publication resulting in publication bias.

Conclusion

Moderate evidence suggests that DN may be an effective and well-tolerated, short term intervention for decreasing pain and increasing PPT in patients with TMD. DN may be effective in increasing functional jaw motion. DN is generally safe and well tolerated. Larger studies are needed to further substantiate the effects of DN in patients with TMD.

Acknowledgement

Risa Evans-Assistance with editing.

References

1. Schiffman E, Ohrbach R, Truelove E, Look J, Anderson G, Goulet JP, et al. Diagnostic criteria for temporomandibular disorders (DC/TMD) for clinical and research applications: Recommendations of the international RDC/TMD Consortium Network and Orofacial Pain Special Interest Group. J Oral Facial Pain Headache. 2014;28(1):6-27.
2. Medlicott M, Harris S. A systematic review of the effectiveness of exercise, manual therapy, electrotherapy, relaxation training, and biofeedback in the management of temporomandibular disorder. Phys Ther. 2006;86(7):955-73.
3. Isong U, Gansky SA, Plesh O. Temporomandibular joint and muscle disorder-type pain in U.S. adults: The national health interview survey. J Orofac Pain. 2008;22(4):317-22.
4. Lövgren A, Häggman-Henrikson B, Visscher CM, Lobbezoo F, Marklund S, Wänman A. Temporomandibular pain and jaw dysfunction at different ages covering the lifespan-A population based study. Eur J Pain. 2016;20(4):532-40.
5. Shaffer SM, Brismée JM, Sizer PS, Courtney CA. Temporomandibular disorders. Part 2: Conservative management. J Man Manip Ther. 2014;22(1):13-23.
6. American Physical Therapy Association. Description of dry needling in clinical practice: An educational resource paper. APTA, editor. Alexandria: American Physical Therapy Association, Virginia, USA; 2013.
7. Dunning J, Butts R, Mourad F, Young I, Flannagan S, Perreault T. Dry needling: A literature review with implications for clinical practice guidelines. Phys Ther Rev. 2014;19(4):252-65.
8. Zhou K, Ma Y, Brogan MS. Dry needling versus acupuncture: The ongoing debate. Acupunct Med. 2015;33(6):485-90.
9. American Physical Therapy Association. Physical therapists & the performance of dry needling: An educational resource paper. Alexandria, VA: APTA Department of Practice and APTA State Government Affairs; 2012.
10. Wu JY, Zhang C, Xu YP, Yu YY, Peng L, Leng WD, et al. Acupuncture therapy in the management of the clinical outcomes for temporomandibular disorders: A PRISMA-compliant meta-analysis. Medicine (Baltimore). 2017;96(9):6064.
11. Liu L, Skinner MA, McDonough SM, Baxter GD. Traditional chinese medicine acupuncture and myofascial trigger needling: The same stimulation points?. Complement Ther Med. 2016;26:28-32.
12. White A. Editorial Board of Acupuncture in Medicine. Western medical acupuncture: A definition. Acupunct Med. 2009;27(1):33-5.
13. Cagnie B, Dewitte V, Barbe T, Timmermans F, Delrue N, Meeus M. Physiologic effects of dry needling. Curr Pain Headache Rep. 2013;17(8):348.
14. Simons DG, Travell JG, Simons LS. Travell and Simons' Myofascial Pain and dysfunction: The trigger point manual upper half of body, vol 1. 2nd ed. Baltimore: Williams & Wilkins, Maryland, USA; 1999.
15. Gerwin RD. Myofascial trigger point pain syndromes. Semin Neurol. 2016;36(5):469-73.
16. Furlan AD, Van Tulder MW, Cherkin DC, Tsukayama H, Lao L, Koes BW, et al. Acupuncture and dry-needling for low back pain. Cochrane Database of Systematic Reviews. 2005;(1):1351.
17. Gattie E, Cleland JA, Snodgrass S. The effectiveness of trigger point dry needling for musculoskeletal conditions by physical therapists: A systematic review and meta-analysis. J Orthop Sports Phys Ther. 2017;47(3):133-49.
18. Morihisa R, Eskew J, McNamara A, Young J. Dry needling in subjects with muscular trigger points in the lower quarter: A systematic review. Int J Sports Phys Ther. 2016;11(1):1-14.
19. Kietrys DM, Palombaro KM, Azzaretto E, Hubler R, Schaller B, Schlussel JM, et al. Effectiveness of dry needling for upper-quarter myofascial pain: A systematic review and meta-analysis. J Orthop Sports Phys Ther. 2013;43(9):620-34.
20. Maher CG, Sherrington C, Herbert RD, Moseley AM, Elkins M. Reliability of the PEDro scale for rating quality of randomized controlled trials. Phys Ther. 2003;83(8):713-21.
21. de Morton NA. The PEDro scale is a valid measure of the methodological quality of clinical trials: A demographic study. Aust J Physiother. 2009;55(2):129-33.
22. Macedo LG, Elkins MR, Maher CG, Moseley AM, Herbert RD, Sherrington C. There was evidence of convergent and construct validity of physiotherapy evidence database quality scale for physiotherapy trials. J Clin Epidemiol. 2010;63(8):920-5.
23. Physiotherapy Evidence Database. PEDro scale. 1999.
24. Diraçoglu D, Vural M, Karan A, Aksoy C. Effectiveness of dry needling for the treatment of temporomandibular myofascial pain: A double-blind,

randomized, placebo controlled study. J Back Musculoskelet Rehabil. 2012;25(4):285-90.

25. Fernández-Carnero J, La Touche R, Ortega-Santiago R, Galan-del-Rio F, Pesquera J, Ge HY, et al. Short-term effects of dry needling of active myofascial trigger points in the masseter muscle in patients with temporomandibular disorders. Journal of Orofac Pain. 2010;24(1):106-12.
26. da Silva Faria CA. Dry needling in the management of myofascial trigger points in the orofacial area. J Oral Facial Pain. H. 2014.
27. Gonzalez-Perez LM, Infante-Cossio P, Granados-Nunez M, Urresti-Lopez FJ, Lopez-Martos R, Ruiz-Canela-Mendez P. Deep dry needling of trigger points located in the lateral pterygoid muscle: Efficacy and safety of treatment for management of myofascial pain and temporomandibular dysfunction. Med Oral, Patol Oral CirBucal. 2015;20(3):326-33.
28. Kietrys DM, Palombaro KM, Mannheimer JS. Dry needling for management of pain in the upper quarter and craniofacial region. Curr Pain Headache Rep. 2014;18(8):437.
29. Liu L, Huang QM, Liu QG, Ye G, Bo CZ, Chen MJ, et al. Effectiveness of dry needling for myofascial trigger points associated with neck and shoulder pain: A systematic review and meta-analysis. Arch Phys Med Rehabil. 2015;96(5):944-55.
30. Mejuto-Vázquez MJ, Salom-Moreno J, Ortega-Santiago R, Truyols-Domínguez S, Fernández-de-las-Peñas C. Short-term changes in neck pain, widespread pressure pain sensitivity, and cervical range of motion after the application of trigger point dry needling in patients with acute mechanical neck pain: A randomized clinical trial. J Orthop Sports Phys Ther. 2014;44(4):252-60.
31. Osborne NJ, Gatt IT. Management of shoulder injuries using dry needling in elite volleyball players. Acupunct Med. 2010;28(1):42-5.
32. Baldry P. Superficial versus deep dry needling. Acupunct Med. 2002;20(2-3):78-81.
33. Edwards J, Knowles N. Superficial dry needling and active stretching in the treatment of myofascial pain-A randomised controlled trial. Acupunct Med. 2003;21(3):80-6.
34. McCutcheon L, Yelland M. Iatrogenic pneumothorax: Safety concerns when using acupuncture or dry needling in the thoracic region. Phys Ther Rev. 2011;16(2):126-32.
35. Krey D, Borchers J, McCamey K. Tendon needling for treatment of tendinopathy: A systematic review. Phys Sportsmed. 2015;43(1):80-6.
36. Lewit K. The needle effect in the relief of myofascial pain. Pain. 1979;6(1):83-90.