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The effect of dry needling on gastrocnemius muscle stiffness and strength in participants with latent trigger points

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ABSTRACT

Abnormal muscle stiffness is a potential complication after injury and identifying interventions that modify muscle stiffness may be useful to promote recovery. The purpose of this study was to identify the short-term effects of dry needling (DN) on resting and contracted gastrocnemius muscle stiffness and strength of the triceps surae in individuals with latent myofascial trigger points (MTrPs). In this randomized controlled trial, 52 individuals received two DN treatment sessions to latent MTrPs and 50 individuals received two sham needling sessions. Resting and contracted muscle stiffness were assessed both at the treatment site and a standardized central site in the medial gastrocnemius head immediately post-treatment and one week after the last session. There were significant group by time interactions for resting muscle stiffness at the site of the MTrP ($p = .03$), but not at the central site ($p = .29$). Post-needling between group comparison indicated that the DN group had significantly lower resting muscle stiffness at the site of the MTrP than the sham group after adjusting for baseline differences. There were no significant between group differences in contracted muscle stiffness or muscle strength. Identifying strategies that can reduce aberrant muscle stiffness may help to guide management of individuals with neuromuscular pain-related conditions.

Level of evidence: Therapy, level 2.

1. Introduction

A myofascial trigger point (MTrP) is defined as "a discrete, hyperirritable nodule in a taut band of skeletal muscle which is palpable and tender during physical examination." (Shah et al., 2015). Myofascial pain is commonly associated with a variety of musculoskeletal conditions and has been estimated to affect approximately 85% of people at some point in their lives (Maher et al., 2013). MTrPs have been identified in postural muscles possibly due to sustained low-level muscle contractions involved with retaining postural stability (Kaergaard and Andersen, 2000; Treaster et al., 2006). MTrPs are often classified as either active or latent, with active MTrPs being associated with spontaneous pain in the immediate tissue and/or distant sites in specific referred pain patterns, and latent MTrPs only causing local and referred pain when pressure is applied to the MTrP. Both active and latent MTrPs are thought to result in decreased motion, muscle stiffness, and muscle dysfunction (Shah et al., 2015). In addition, resultant muscle fatigue and overload of the unaffected motor units surrounding latent MTrPs has been demonstrated (Ge et al., 2012). Muscles with MTrPs have been shown to exhibit increased stiffness compared to normal muscle (Ballyns et al., 2012), which may have clinical consequences such as inhibition of muscle strength.

Muscle stiffness measures have recently been advocated to be the best method of estimating individual muscle force and used to quantify local alternations of muscle impairments (e.g. myofascial trigger points) (Hug et al., 2015; Maher et al., 2013). Muscle stiffness is most commonly quantified as the slope of a strain-stress curve of a material in the elastic deformation region of interest, or Young's modulus, and is an intrinsic biomechanical muscle property (Klauser et al., 2014). If a structure demonstrates highly elastic properties, it is classified as very stiff (Baumgart, 2000; Klauser et al., 2014). Muscle stiffness is challenging to assess due to the influences of both active and passive tissues. However, an objective clinical measurement of muscle stiffness may help guide treatment and monitor treatment effectiveness. The MyotonPRO has been shown to demonstrate good to excellent reliability utilizing healthy individuals and is a noninvasive way to characterize mechanical

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stiffness of skeletal muscle (Agyapong-Badu et al., 2016; Chuang et al., 2012; Korhonen et al., 2005).

Dry Needling (DN) has been shown to be beneficial in decreasing pain, improving range of motion, increasing strength and improving function (Haser et al., 2017; Llamas-Ramos et al., 2014; Nunez-Cortes et al., 2017; Rossi et al., 2017). DN is utilized to treat pain associated with trigger points and to manage neuromuscular impairment (Bandy et al., 2017), and has been shown to affect passive mechanical muscle properties (Ortega-Cebrian et al., 2016). The few studies that have evaluated changes in muscle stiffness after DN have reported conflicting results. Using shear-wave elastography, Maher et al. (2013) found an immediate reduction in upper trapezius stiffness after DN. Alternatively, following a DN intervention to the gastrocnemius muscle, Baraja-Vegas et al. (2019) observed an increase in muscle stiffness when measured with tensiomyography. Finally, the only study to date to use to use the MyotonPRO to measure changes in muscle stiffness following DN found no change in quadricep muscle stiffness after DN (Ortega-Cebrian et al., 2016). These variable results suggest that the effect of DN on muscle stiffness may depend upon the muscle treated and/or the methodology used.

The immediate and short-term effects that DN has on muscle stiffness of the gastrocnemius muscle, as measured by the MyotonPRO, has yet to be assessed. Muscle stiffness has been shown to be a risk factor for muscle injury (Kumagai et al. (2018). Identifying interventions that decrease muscle stiffness may help to guide the management of individuals with changes in muscle tissue secondary to pain and/or injury. Therefore, the primary purpose of this study was to identify the short-term effects of DN on resting gastrocnemius muscle stiffness in individuals with latent MTrPs. The secondary purpose of this study was to identify the effects of DN on contracted muscle stiffness and strength of the triceps surae. We hypothesized that compared to a sham group, individuals receiving DN would exhibit a decrease in resting gastrocnemius muscle stiffness both at the site of a latent trigger point and at a central site within the same muscle. We also hypothesized that contracted muscle stiffness and isometric muscle strength would increase more in individuals receiving DN than those receiving sham DN.

2. Methods

This randomized controlled trial included 102 healthy individuals. Eligible individuals were between the ages of 18–50 years of age, with at least one MTrP in the gastrocnemius muscle as defined by a taut palpable band that was painful to palpation.

Participants were excluded if they had been treated with DN to the lower extremity within the previous 30 days; had a history of systemic disorders in which DN would be contraindicated (bleeding disorders or anticoagulant medication use); had a calf injury within the previous six months; experienced difficulty in the task of raising up onto their toes symmetrically; had a previous fracture of the spine or lower extremity that would affect their gait pattern or strength of the gastrocnemius; or current pregnancy.

The study was approved by the Institutional Review Board of Regis University, and all participants provided informed consent in accordance with the World Medical Association Declaration of Helsinki (ethical principles for medical research involving human subjects). This clinical trial was prospectively registered at ***ClinicalTrial.gov (NCT03689283).

2.1. Randomization

Participants were randomized to the DN group or the sham group based on a computer-generated randomization list with randomly varying block sizes of 10 and prepared prior to beginning enrollment by a coinvestigator uninvolved with data collection. Treatment allocation was placed in opaque sealed envelopes prior to enrollment. The envelopes were opened after all baseline assessments and procedures were completed. Both the participants and the assessors were blinded to group allocation, and after completion of the study, participants were asked which group they believe they were allocated.

2.2. Intervention

All individuals received treatment based on their group allocation after completing all baseline measures. Measures were repeated immediately following treatment (assessment 1). To assess for consistency of the immediate muscle response as well as for a more sustained short-term response after DN, individuals returned approximately one week later and completed measures again both before (assessment 2) and immediately following (assessment 3) their treatment. The fourth and final assessment (assessment 4) was completed approximately 2 weeks after the baseline assessment.

The participant removed shoes and socks and was positioned in prone with the feet unsupported over the edge of the table and knees positioned in full extension. Consistent with previous research, a standard site, four fingerbreadths (primary investigator SRA) below the popliteal crease in the belly of the medial gastrocnemius muscle was identified and marked with a skin marker for all participants (Kelly et al., 2018). Latent MTrPs of the gastrocnemius were then identified for all individuals and marked with a skin marker. The identification of the latent trigger points consisted of two criteria: the presence of a taut band and a hypersensitive spot. The identification is consistent with international consensus on diagnostic criteria of myofascial trigger points (Fernandez-de-Las-Penas and Dommerholt (2018). If individuals had greater than 3 latent MTrPs, only the 3 most painful MTrPs were utilized for the study. The needles used were 0.30 × 50-mm Myotech needles. The intervention was performed by 1 of 2 physical therapists with greater than 5 years of clinical experience performing DN. Participants randomized to the DN group received needling at the site of the marked MTrP(s) (with a maximum of 3 sites). “Clean technique” was used throughout the treatment procedure which included hand washing, clean latex-free exam gloves, and cleaning the participants’ skin with an alcohol swab prior to treatment (Baima and Isaac (2008). Each needle insertion lasted approximately 5–10 s using a “pistoning” (in and out motion) technique in an attempt to elicit as many local twitch responses as possible (Itoh et al., 2006). The same procedure was followed for individuals in the sham group using a sham needle which did not penetrate the skin. The sham needle was manipulated to simulate the same technique (a pistoning motion) used for DN. The sham needle utilized was spring loaded and caused a pricking type sensation when pushed against the skin without the skin being penetrated. This mechanism invokes a similar sensation to dry needling although has less physiological effect than true needling. A recent systematic review found these tactile sensations to be effective for blinding (Braithwaite et al., 2019). Adverse events after each intervention session were tracked.

2.3. Demographic and outcome measures

Participants completed a patient demographics form prior to any tests being performed.

The MyotonPRO (Myoton AS, Tallinn, Estonia) was used to assess resting and contracted muscle stiffness of the gastrocnemius muscle at baseline and at each follow-up assessment. This noninvasive tool was used to characterize mechanical stiffness of skeletal muscle (Chuang et al., 2012; Korhonen et al., 2005). The MyotonPRO applies a mechanical impulse to the skin, which is then transmitted to the underlying soft tissue and muscle (0.58 N for 15 ms). This mechanical impulse causes the muscle to respond by a damped natural oscillation, which is recorded by an accelerometer in the form of an acceleration signal. The acceleration signal is used to calculate Young’s modulus and other viscoelastic parameters. Tissue stiffness (elasticity) is most commonly quantified as Young’s modulus, which is defined as the slope of the

stress-strain curve of a material in the elastic deformation region of interest. Significant correlations have been found for gastrocnemius muscle stiffness and Young's modulus as quantified by shear wave ultrasound elastography ranged from 0.463 to 0.544. The intra-operator reliability of the MyotonPRO ranges from good to excellent ($ICC_{(3,1)}$ = 0.787 to 0.928) (Feng et al., 2018). Another study demonstrated the intra-examiner reliability of the MyotonPRO for assessing gastrocnemius muscle stiffness in resting and in a contracted state ranged from 0.95 to 1.0 (Kelly et al., 2018). The standard error of measurement for lower extremity muscles measured in various position ranged from 3.8 N/m to 11 N/m (Pinsker et al., 2013). Participants were assessed in a relaxed state (positioned in prone) (Fig. 1) and also in a contracted state (performing a bilateral heel raise). To ensure symmetrical load during the contracted state, individuals stood with a scale under each foot so that equal weight was maintained throughout the measure. To ensure the amplitude of motion was consistent between trials, the heel height was measured and used for each subsequent assessment. The measures were performed 3 times and averaged.

Gastrocnemius strength was assessed at baseline and at each follow-up assessment with a hand-held dynamometer (HHD) (Hoggan Scientific LLC; Salt Lake City, UT). The patient was positioned in a prone position with shoes and socks removed with feet unsupported over the edge of the table and knees in full extension. The trunk and lower extremities were anchored to the table using two straps, one just proximal to the popliteal crease and one across the pelvis at the level of the greater trochanters. With the ankle positioned in a neutral position for an isometric contraction, the dynamometer pad was placed at the first metatarsal head and the HHD was anchored to the wall (Fig. 2) (Kelly et al., 2018). Participants were asked to perform a contraction with as much force as possible for no longer than 6 s. The average of three trials and the peak force generated were recorded. HHD to measure strength of ankle plantarflexors has been shown to be a reliable assessment tool. The ICC and 95% CI have been reported to be excellent ($ICC_{2,2}$ 0.98; 95% CI, 0.95–0.99) and the measurement error is low (SEM 8.9 N; SEM% 3.2) (Davis et al., 2017). The minimal detectable change (MDC) has been reported to by 24.7 N (MDC% 8.9) (Davis et al., 2017).

Fig. 1. Gastrocnemius muscle stiffness assessed in prone.

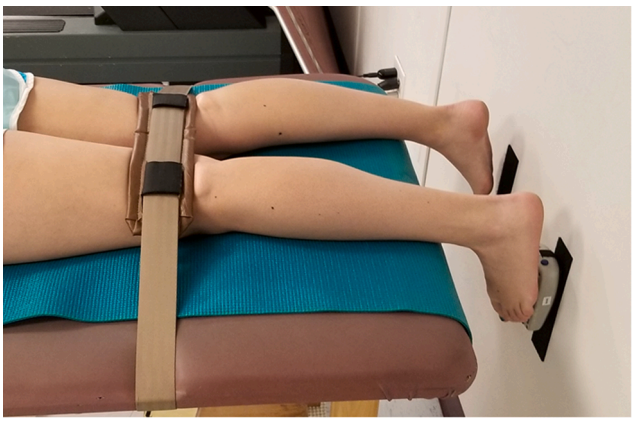

Fig. 2. Gastrocnemius-soleus muscle strength assessed with handheld dynamometer.

2.4. Data analysis

A priori power analysis was performed using G*Power 3 (Faul et al., 2007), with resting muscle stiffness at the primary outcome. With power set to 80% and an alpha set to 5%, complete data on 92 participants would result in an ability to detect an effect size of 0.70 between groups. Allowing for a 10% attrition rate resulted in a total of 102 participants to be recruited for this study (Albin et al., 2019).

All analyses were performed using SPSS Version 26.0 statistical software (IBM Corporation, Armonk, NY). Baseline characteristics were summarized and assessed for potentially important differences. The primary outcome (dependent variable) was resting muscle stiffness and secondary outcomes were contracted muscle stiffness and gastrocnemius muscle strength. These dependent variables included muscle stiffness at the standard site and at the MTrP site. Linear mixed modeling was used to compare changes across time in the DN group versus the sham group. Group, time, and the group-by-time interaction were modeled as fixed effects. Treatment effects were estimated using separate random-intercept and slope linear mixed models for each outcome variable. For each model, a covariance structure (autoregressive, unstructured, scaled identity) was used, based on best model fit and ability of the model to reach convergence. The baseline score was used as a covariate in each model. Linear mixed models with significant interactions were followed by adjusted pairwise comparison of each outcome adjusted for baseline scores. Separate analyses were performed for each dependent variable using 2-tailed significance tests, alpha of 0.05. All individuals enrolled completed the study and received the treatment to which they were assigned.

3. Results

From August 2018 to December 2019, fifty-two participants were randomized to the DN group and 50 participants were randomized to the sham group. No participants were lost to follow-up, therefore intention to treat analysis was performed without imputing data. Fig. 3 illustrates a flow diagram of the study. Baseline characteristics of the participants are provided in Table 1 and were similar between groups. There was a significant group by time interaction for resting muscle stiffness at the site of the MTrP ($p = .03$), but not at the central site ($p = .29$). In addition, there was a significant interaction for contracted muscle stiffness at the central site ($p < .01$), but not at the MTrP site ($p = .38$). Results of the post-needling comparison indicated that the DN group had significantly lower resting muscle stiffness at the site of the MTrP than did the Sham group, both at the second assessment (prior to the second treatment) and the third assessment (immediately after the second treatment) after adjusting for baseline differences (Table 2, Fig. 4). Additionally, at the second assessment, the DN group had significantly

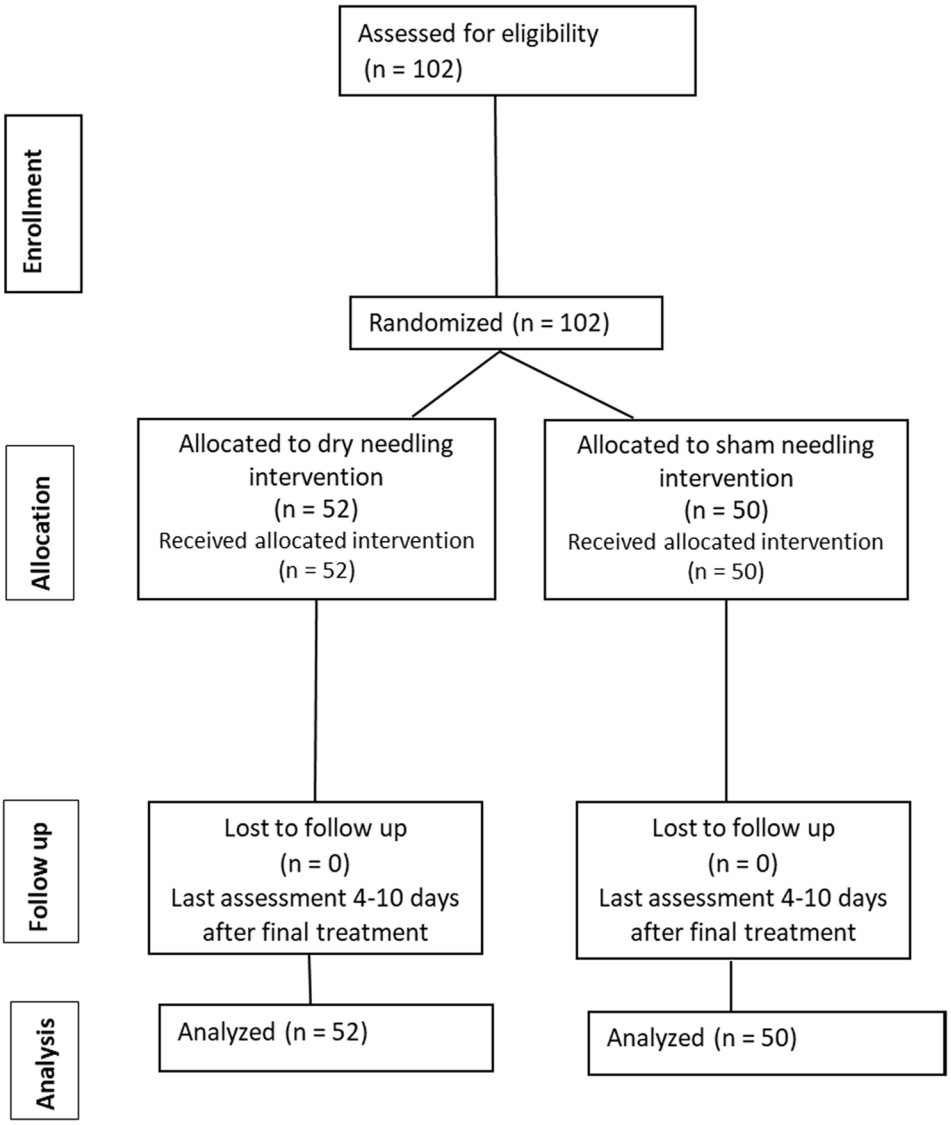

Fig. 3. Flow diagram of study.

Table 1
Baseline Demographics.*

	Dry Needling Group (n = 52)	Sham Group (n = 50)
Age, y	25.1 ± 3.6	27.0 ± 5.0
Sex (male), n (%)	19 (36.5)	25 (50)
BMI, kg/m^2	23.4 ± 4.7	23.6 ± 2.9
Affected side (right), n (%)	34 (65.4)	34 (68)
Dominate side (right), n (%)	44 (84.6)	43 (86)

Abbreviations: BMI, body mass index.
* Values are mean ± SD unless otherwise indicated.

lower resting muscle stiffness at the central site than the sham group after adjusting for baseline differences (Table 2, Fig. 5). From Fig. 4, it appears that the DN group, but not the sham group, exhibited a reduction in resting muscle stiffness immediately after treatment that was maintained throughout the remainder of the study. There were no other significant differences between the groups in the resting state or between the groups in the contracted state at either the central site or the trigger point site (Tables 2 and 3). There were no significant between group differences for calf muscle strength.

The most common adverse events consisted of bruising and soreness. Adverse events occurred in both groups, following both the first and second sessions: 37 (71.2%) individuals in the group that received DN and 9 (18%) in the sham needling group after the first session, and 31 (59.6%) in the DN group and 7 (14%) in the sham group after the second session. One participant exhibited lightheadedness after the intervention session; however, this individual had received sham DN.

Seventy-eight percent of individuals experienced a twitch response with the first DN treatment, while 90% experienced a twitch response with the second DN treatment.

To assess the level of blinding of study participants, at the completion of the study individuals were asked what group they thought there were randomized. Forty-nine out of 50 (98%) individuals in the DN group and 28 out of 49 (56%) of individuals in the sham group guessed they were randomized to the DN group.

4. Discussion

Abnormal muscle stiffness has been shown to be a risk factor for muscle injury (Kumagai et al., 2018). Identifying interventions that decrease muscle stiffness may help supplement management of individuals with changes in muscle tissue secondary to pain and/or injury.

Table 2
Outcome Measures of Resting Muscle Stiffness for Each Group.

Outcome/Visit	Sham Group *	DN Group*	Between-Group Difference†,‡	P Value
Resting Muscle Stiffness – Central Site, N/m				
Baseline	302.68 ± 65.13	297.56 ± 72.48		
Assessment 1 (after first treatment)	299.14 ± 61.23	290.46 ± 64.23	4.35 (−4.85, 13.55)	.35
Mean change from baseline†	−3.54 (−10.14, 3.06)	−7.10 (−14.81, 0.62)		
Assessment 2 (before second treatment)	311.30 ± 69.60	289.42 ± 66.25	17.45 (4.64, 30.25)	<.01
Mean change from baseline†	8.62 (−1.10, 18.34)	−8.14 (−17.38, 1.11)		
Assessment 3 (after second treatment)	300.90 ± 63.23	287.42 ± 65.37	9.40 (−3.84, 22.64)	.16
Mean change from baseline†	−1.78 (−11.92, 8.36)	−10.14 (−20.41, 0.14)		
One week follow-up	296.98 ± 59.50	289.23 ± 68.61	3.53 (−8.42, 15.48)	.56
Mean change from baseline†	−5.70 (−15.26, 3.86)	−8.33 (−17.12, 0.47)		
Resting Muscle Stiffness – Trigger Point, N/m				
Baseline	289.72 ± 63.79	281.65 ± 47.31		
Assessment 1 (after first treatment)	284.48 ± 55.58	273.62 ± 47.47	4.16 (−4.66, 12.97)	.35
Mean change from baseline†	−5.24 (−13.16, 2.68)	−8.04 (−13.61, −2.47)		
Assessment 2 (before second treatment)	299.28 ± 65.16	276.17 ± 44.38	17.16 (2.44, 31.89)	.02
Mean change from baseline†	9.56 (−4.01, 23.13)	−5.48 (−14.04, 3.08)		
Assessment 3 (after second treatment)	293.30 ± 58.93	273.83 ± 40.17	14.17 (0.64, 27.69)	.04
Mean change from baseline†	3.58 (−9.45, 16.61)	−7.83 (−16.57, 0.92)		
One week follow-up	284.90 ± 50.48	284.73 ± 49.46	−4.49 (−19.57, 10.59)	.56
Mean change from baseline†	−4.82 (−18.76, 9.12)	3.08 (−8.15, 14.31)		

* Values are mean ± SD unless otherwise indicated.
† Values in parentheses are 95% confidence interval.
‡ Adjusted for baseline scores of outcome variable.

Therefore, the primary purpose of this study was to identify the short-term effects of DN on resting gastrocnemius muscle stiffness in individuals with latent MTrPs. The secondary purpose of this study was to identify the effects of DN on contracted muscle stiffness and strength of the triceps surae. To further explore these effects, we evaluated muscle stiffness both at the MTrP (site that was needled) and at a standardized central site within the gastrocnemius muscle. Generally, our results suggest that DN decreases resting muscle stiffness both at the MTrP and more regionally within the gastrocnemius muscle, however it does not change contracted muscle stiffness or muscle strength.

4.1. Effect of DN on resting muscle stiffness

We hypothesized that compared to a sham needling group, individuals receiving DN would exhibit a larger decrease in resting

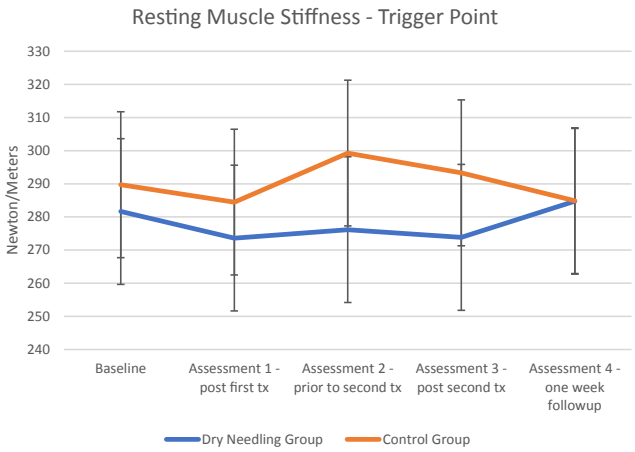

Fig. 4. Muscle stiffness measured in N/m at each time point measured in the resting state at the trigger point site. Abbreviations: tx, treatment.

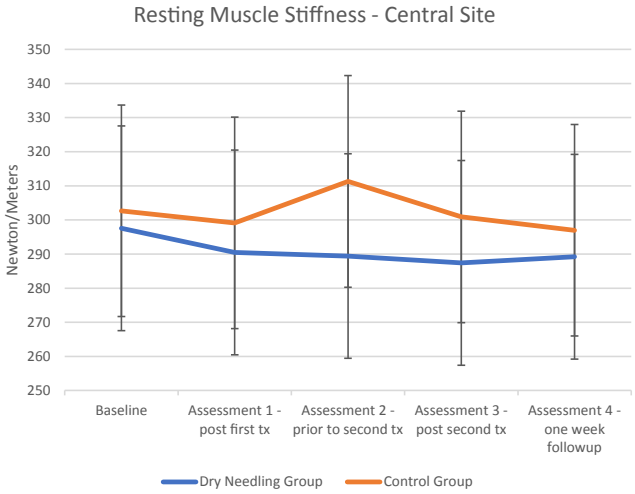

Fig. 5. Muscle stiffness measured in N/m at each time point measured in the resting state at the central site. Abbreviations: tx, treatment.

gastrocnemius muscle stiffness both at the site of a latent MTrP and at a standardized central site within the same muscle. The results of this study demonstrated decreased resting muscle stiffness at both sites, which is consistent with other investigations of DN in the other muscle groups. Reduction in muscle stiffness (when measured with shear wave elastography) has been observed following DN to the trapezius muscle (Maher et al., 2013). Similar to this reduction in muscle stiffness, reduced resting muscle activity has also been observed when measured with surface EMG. Specifically, in individuals with anterior cruciate ligament reconstruction, a decrease in resting muscle activation of the vastus lateralis muscle was observed following DN to the quadriceps muscle group (Ortega-Cebrian et al., 2016). Interestingly, there were no significant changes noted in muscle stiffness in the rectus femoris or vastus medialis, but decrement and resistance of the vastus medialis significantly decreased post-needling (Ortega-Cebrian et al., 2016). Alternatively, other investigators have found the opposite effect. Following a DN intervention to the gastrocnemius muscle Baraja-Vegas et al. (2019), observed an increase in muscle stiffness (when measured with tensiomyography), along with the presence of intramuscular edema at the latent trigger point (Baraja-Vegas et al., 2019).

Table 3
Outcome Measures of Contracted Muscle Stiffness for Each Group.

Outcome/Visit	Sham Group*	DN Group*	Between-Group Difference†,‡	P Value
Contracted Muscle Stiffness – Central Site, N/m				
Baseline	544.08 ± 220.89	466.67 ± 190.16		
Assessment 1 (after first treatment)	539.48 ± 219.85	461.77 ± 166.32	3.82 (−20.05, 27.69)	.75
Mean change from baseline†	−4.60 (-21.12, 11.92)	−4.90 (-22.15, 12.34)		
Assessment 2 (before second treatment)	565.56 ± 230.68	467.04 ± 183.95	28.07 (−8.46, 64.60)	.13
Mean change from baseline†	21.48 (−5.40, 48.36)	0.37 (−24.95, 25.67)		
Assessment 3 (after second treatment)	550.28 ± 240.69	461.48 ± 181.94	18.96 (−22.82, 60.74)	.37
Mean change from baseline†	6.20 (−26.08, 38.48)	−5.19 (−32.42, 22.03)		
One week follow-up	524.98 ± 220.37	450.15 ± 183.09	7.90 (−30.74, 46.55)	.69
Mean change from baseline†	−19.10 (−49.18, 10.98)	−16.52 (−42.74, 9.70)		
Contracted Muscle Stiffness – Trigger Point, N/m				
Baseline	557.54 ± 193.55	471.94 ± 166.32		
Assessment 1 (after first treatment)	540.76 ± 189.82	455.37 ± 148.12	17.71 (−24.65, 60.07)	.41
Mean change from baseline†	−16.78 (−30.77, −2.79)	−16.58 (−35.72, 2.56)		
Assessment 2 (before second treatment)	572.44 ± 199.51	472.27 ± 142.55	32.97 (−7.36, 73.30)	.11
Mean change from baseline†	14.90 (−18.03, 47.83)	0.33 (−26.62, 27.27)		
Assessment 3 (after second treatment)	555.74 ± 195.97	480.06 ± 140.92	10.44 (−30.35, 51.23)	.61
Mean change from baseline†	−1.80 (−33.97, 30.37)	8.12 (−21.17, 37.40)		
One week follow-up	534.54 ± 197.91	470.17 ± 148.59	−0.16 (−44.66, 44.34)	.99
Mean change from baseline†	−23.00 (−59.64, 13.64)	−1.77 (−31.52, 27.98)		

* Values are mean ± SD unless otherwise indicated.
† Values in parentheses are 95% confidence interval.
‡ Adjusted for baseline scores of outcome variable.

4.2. Effect of DN on contracted muscle stiffness and gastrocnemius strength

We also hypothesized that DN may create a neurophysiologic response that may increase contracted muscle stiffness and isometric muscle strength of the gastrocnemius. There were no significant differences between the groups in either muscle stiffness in a contracted state or gastrocnemius-soleus strength, which is consistent with some previous lower extremity studies. A recent systematic review found a majority of studies failed to demonstrate increased force productions as a result of DN (Mansfield et al., 2019). This lack of change may be due to the many variables influencing force production such as muscle length, passive force and neuromuscular fatigue, or needling technique (Hug et al., 2015). Specifically related to gastrocnemius muscle output, Bandy et al. (2017) found changes in vertical height jump after DN to the gastrocnemius immediately after treatment. However, they did not utilize a pistoning technique during the DN treatment, which may have resulted in substantially different treatment intensity than that of the current study.

4.3. Limitations and directions for future research

This study assessed the short-term effect of two sessions of DN on muscle stiffness in individuals with latent MTrP in the gastrocnemius muscle. A primary limitation in this study is that the participants were asymptomatic individuals with latent MTrPs, as opposed to patients with pain and active MTrPs. Although multiple studies have found effects from DN on latent MTrP (Baraja-Vegas et al., 2019; Maher et al., 2013), the assumption that latent MTrPs respond similarly to active MTrPs might not be accurate. Another potential limitation of this study is that blinding was only partially successful, as 56% of individuals in the sham group guessed they were in the DN group and 98% of individuals in the DN group guessed correctly they were in the DN group. As is consistent with other DN studies, it is inherently challenging to blind individuals in the needling group. In addition, the individuals in this study were young adults, and the effects of DN on muscle stiffness may not be generalizable to older adults.

MTrPs can be a source of peripheral nociceptive input leading to peripheral and central sensitization (Dommerholt, 2011). Given individuals with injury often exhibit aberrant muscle stiffness, future studies should assess the effects of DN in individuals with lower extremity injuries. Since muscle function is often impaired in individuals with pain, it is possible that contracted stiffness would increase (representing more contraction) following DN is symptomatic individuals. The current study of gastrocnemius changes after DN could be repeated using clinical populations with achilles tendinopathy, plantar heel pain, or even after acute ankle sprain. Lastly, the authors recognize it is challenging to determine the presence of MTrPs and reliability is variable (Myburgh et al., 2008; Rozenfeld et al., 2017). However, the identification of MTrPs utilized in this study is consistent with international consensus on diagnostic criteria of myofascial trigger points (Fernandez-de-Las-Penas and Dommerholt, 2018).

5. Conclusion

This study suggests that resting muscle stiffness of the gastrocnemius measured at the MTrP site is reduced approximately one week following an initial session of DN and immediately after a second session of DN. Resting muscle stiffness is also reduced in the gastrocnemius muscle in a relaxed state at a central site approximately one week after an initial session of DN. However, DN had no effect on muscle stiffness in a contracted state or on muscle strength in this study.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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