Open Journal of Therapy and Rehabilitation, 2025, 13(4), 175-190
https://www.scirp.org/journal/ojtr
ISSN Online: 2332-1830
ISSN Print: 2332-1822

Effect of Dry Needling on Shoulder Abduction and External Rotation Strength

Mark Hecimovich[1], Dietrich Wagner[1], Doug King[2,3,4]

[1]Department of Kinesiology and Athletic Training, University of Northern Iowa, Cedar Falls, Iowa, USA
[2]Auckland Bioengineering Institute, The University of Auckland, Auckland, New Zealand
[3]Traumatic Brain Injury Network (TBIN), Auckland University of Technology, Auckland, New Zealand
[4]Department of Science and Technology, University of New England, Sydney, Australia
Email: mark.hecimovich@uni.edu

How to cite this paper: Hecimovich, M., Wagner, D. and King, D. (2025) Effect of Dry Needling on Shoulder Abduction and External Rotation Strength. *Open Journal of Therapy and Rehabilitation*, **13**, 175-190.
https://doi.org/10.4236/ojtr.2025.134015

Received: September 6, 2025
Accepted: October 31, 2025
Published: November 3, 2025

Abstract

Purpose: Dry needling (DN) may impact strength, but research is limited and focused on symptomatic individuals. This study aimed to measure the effect of DN on shoulder external rotation and abduction strength with asymptomatic individuals in the absence of myofascial trigger points in the area needled. **Methods:** 20 (10 males, 10 females; age range: 20 - 23) participants acted as the intervention and control group, with one side of the body receiving DN technique and the other as the control (non DN side). Baseline strength measurements were conducted, followed by DN session one 24 to 48 hours later. DN session two was performed 48 hours after the first, with post-intervention measurements taken immediately afterward. After five to seven days, participants returned for the second post-intervention and measurements of strength. **Results:** There were observable differences for abduction of the DN arm (non-dominant) when comparing the baseline (19.1 ± 5.6) with post-test 1 (p = 0.0180; d = −0.50) and post-test 2 (p = 0.0238; d = −0.47) for the whole cohort. This was similar for female participants when comparing baseline with post-test 1 (p = 0.0209; d = −0.75) and post-test 2 (p = 0.0470). There were observable differences for external rotation of the DN arm (non-dominant) for males when comparing post-test 1 with post-test 2 (20.1 ± 4.3 vs. 21.7 ± 3.9; p = 0.0311; d = 0.67). **Conclusion:** The results revealed increases in muscle strength in shoulder abduction, notably the female participants. This may provide the impetus for future research on the impact of DN on strength in the absence of myofascial trigger points with consideration to its influence on other mechanisms.

Keywords

Myofascial Trigger Points, Dry Needling, Complementary Therapies, Motor Activity, Strength

1. Introduction

The manual medicine disciplines, such as physical and occupational therapy, athletic training, and chiropractic, rely on a range of therapies including, but not limited to, high-intensity laser therapy [1], kinesio-taping [2], joint mobilization [3], myofascial release [4], and dry needling [5]-[9]. Some of these techniques are relatively new whilst others have been utilized for many years. Dry needling, a subcutaneous treatment intervention using fine filiform needles [10], is growing in popularity amongst these manual therapists [5]-[9]. It differs from acupuncture, a traditional Chinese medicine therapy, by not subscribing to its theory on the effect of the body's energy called "Qi," which circulates along channels referred to as meridians [11]. Most often, dry needling is used in the treatment of myofascial trigger points [9], which are palpable and painful nodules formed in a taut band of muscles [12] and presumably the source of pain, reduced strength and range of motion [13].

Currently, myofascial trigger points are divided into two types: 1) active, in which they are painful on their own but when palpated, they increase and reproduce the pain the patient is experiencing as well as producing a referral pattern, and 2) latent, in which the trigger point does not produce pain on its own and is painful only when palpated [12]. Simons [14] describes an integrated hypothesis for myofascial trigger points by suggesting they develop because of the motor endplates, the connection area between the motor nerve and the skeletal muscle cell [15], releasing a disproportionate amount of acetylcholine which, in turn, results in the shortening of the sarcomere. Others have suggested a variety of causes including, but not limited to, the central modulation hypothesis [16] and the muscle spindle hypotheses [17] respectively. Regardless, it is thought that dry needling may effectively reduce both the local pain brought on by a trigger point and the referred pain, which may influence muscle activation [18] thereby presumably influencing strength as well. However, dry needling's effect on strength yields limited empirical evidence for its use [19]. Conversely, studies by Ceballos-Laita *et al.* [20] and Schneider *et al.* [21] did report findings of increased strength in the hip and gluteal regions. Furthermore, there is no evidence on the effect of local dry needling and its systemic impact. In other words, does it impact on the body physiologically at the insertion site or the body universally?

Overall, dry needling is a therapeutic approach that warrants ongoing investigation. Furthermore, the influence of dry needling on the myofascial trigger point is debatable and theoretical [13] with its effects on several key components previously mentioned as well as motor end-plate noise[22] and influence on inflammatory markers [22]. Accordingly, the relationship between the myofascial trigger point and dry needling is the primary reason for its utilization and supposable effectiveness. Therefore, it is not surprising that most research centers on its effect on pain, strength, and range of motion, most often with a symptomatic cohort of participants who possess active or latent myofascial trigger points. This further emboldens the theoretical belief of the influence of dry needling on the myofascial trigger point. Therefore, it may be prudent to test this theoretical belief with research focused on dry needling's effect on strength in the absence of myofascial trigger points, as this may or may not demonstrate that its effect on strength, and possibly range of motion and pain, is not due to its impact on the myofascial trigger point.

The main question is whether the current hypothesis on the effect of dry needling on pain, range of motion and strength is due to its alteration in the myofascial trigger point or if it is a manifestation of something yet to be determined. Furthermore, studies examining its effect on these areas utilize individuals with some degree of health issue: pain, weakness, and diminished range of motion. Therefore, to better understand this question, it is helpful to utilize dry needling with a cohort of healthy individuals to assess its effectiveness on one single component, strength, in the absence of pain and myofascial trigger points. Thus, this novel research aims to measure the effect of dry needling on a specified area of the shoulder and its impact on external rotation, as well as abduction strength, with an asymptomatic cohort of individuals. This study also measured if there were differences between the male and female participants. It is hypothesized that dry needling on a cohort of healthy individuals will not influence strength, nor will there be a difference in sex. Finally, this study did not investigate the underlying physiological mechanism on its impact of strength, either locally or systemically.

2. Methods

2.1. Study Design

This was a quasi-experimental study as the participants were not randomly assigned (e.g., which shoulder is the intervention side) and utilized a pre-test and post-test design. This study was approved by the Institutional Review Board. All participants completed a Health History Questionnaire (HHQ) and signed a Consent Form.

2.2. Participants

This study consisted of 20 university students (10 females, 10 males, 20 - 23 years old). They were recruited at the university using flyers and word-of-mouth. All participants acted as the intervention and control group, with one side of the body receiving the dry needling technique and the other as the control (no dry needling side). Allocation or randomizing of the intervention side of the body for each participant (left or right) was done by using the non-dominant side of the body as research [23] has shown significant differences in shoulder power (internal rotation) with the dominant limb having greater power and thus less susceptible to change.

This cohort was considered to represent a group of individuals who most likely possess the least number of exclusionary issues, as noted below. Furthermore, if a participant did present with either an active or latent myofascial trigger in the areas where the needles were placed, they were excluded from the study. As this study measured the effect of dry needling and its impact on strength in the shoulder region, the participants needed to be relatively sedentary but otherwise healthy and asymptomatic. The operational definition for sedentary for this study is that the participant was not involved in any casual or planned exercise protocol consisting of stretching and strengthening. However, if a participant was currently engaged in a sport or activity in the absence of a strength and conditioning protocol they were permitted to participate. For this study, asymptomatic is defined as experiencing no pain in the shoulders and shoulder blade (scapular) regions while at rest and with activities. If a participant experienced a previous shoulder or shoulder blade issue, they would be permitted to participate if they had been asymptomatic for the past two months, were not currently diagnosed with shoulder pathology, or had prior shoulder surgery. Exclusion criteria consisted of: active or latent myofascial trigger point in the area to be dry needled, spontaneous bleeding or bruising, irregular heartbeat, tendency to bleed (take anticoagulant therapy); compromised immune system; previous adverse reaction to acupuncture or dry needling therapy; seizures induced by previous medical procedures; unstable diabetes; unstable angina; congenital cardiac failure; recent radiotherapy; varicose veins; malignancy; hematoma in the shoulder region; pregnancy; eczema or psoriasis; peripheral neuropathy; recurrent infections; epilepsy—stable or unstable; schizophrenia; chronic edema or lymphedema; clinically diagnosed depression; chronic fatigue; acute cardiac arrhythmias; open skin/skin lesion; allergy to nickel or chromium; HIV; hepatitis B or C; and laminectomy.

3. Procedures

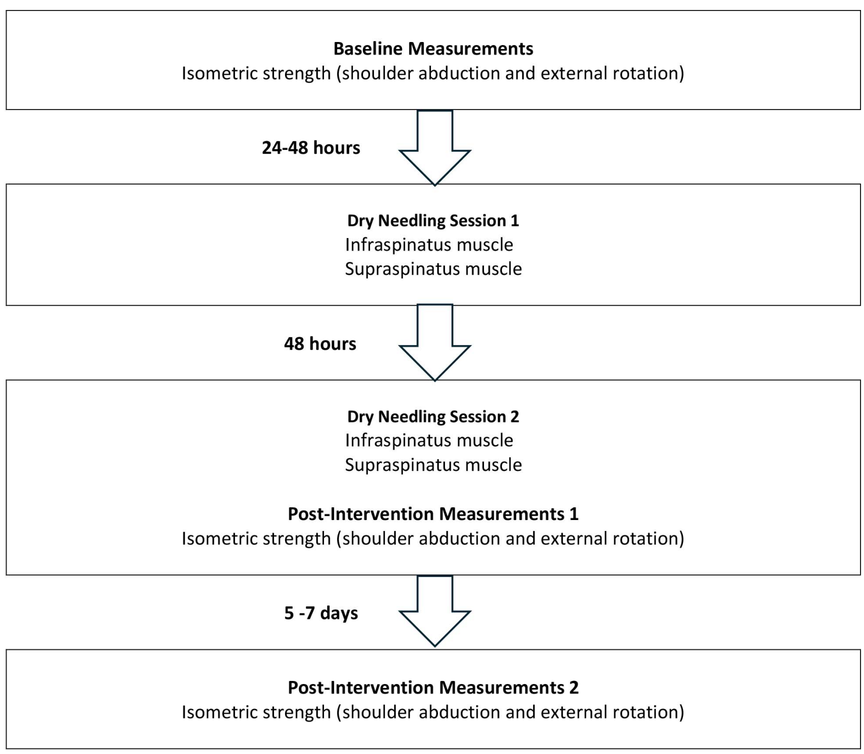

Figure 1. Timeline for procedures.

An initial meeting with potential participants was scheduled prior to beginning all procedures with a Health History Questionnaire (HHQ) used to determine eligibility for inclusion into the study and included a list of the contraindications noted above. At this time, the baseline muscle strength measurements and subsequent dry needling sessions were scheduled, with the first dry needling session being no more than 48 hours after the baseline measurements. Participants were asked to refrain from shoulder stretching and strengthening routines throughout the project. It was advised that participants refrain from eating or drinking 30 minutes prior to the dry needling session and not have consumed alcohol for at least 24 hours. Please refer to **Figure 1** for the procedural timeline.

3.1. Strength Measurements

For this study, muscle strength was measured at three different times throughout the study. A hand-held dynamometer (Lafayette Hand-Held Dynamometer, Lafayette Instrument, Lafayette, IN), was used for shoulder abduction and external rotation with placement of the dynamometer based on accepted muscle testing procedures [24]. A recent study [25] reported the intra-rater reliability for shoulder rotational strength, without external support, with the use of a dynamometer at 0.757 to 0.947 and inter-rater reliability of 0.720 and 0.954. In that study, they investigated the concurrent validity of the hand-held-dynamometer against an isokinetic dynamometry with reported results revealing correlation coefficients from 0.664 to 0.792, for internal and external rotation, respectively, providing evidence of moderate to good correlation.

3.2. Dry Needling Interventions

Dry needling sessions were conducted by the primary investigator who is a registered, certified athletic trainer with current CPR/FA certifications and is certified in dry needling techniques. The belly of each muscle was the focus of the disposable stainless-steel filiform needle (0.3 × 40 mm; Seirin; Weymouth, MA), and it was held in place for one minute unless the participant requested it be removed.

3.3. Baseline Measurements for Isometric Strength Testing

A hand-held dynamometer, recording the force in kg, was utilized. The strength testing consisted of using a maximal isometric hold for 5 seconds, with three of the seconds being at maximal isometric contraction (consideration for a ramp up and ramp down) [25] and performed for two trials. The average of the two was recorded as a baseline.

For external rotation, the participant was in a supine position with the arm abducted to 90 degrees and 0 degrees of external rotation. The end piece of the hand-held dynamometer was placed at the distal aspect of the forearm, just above the wrist joint. The primary investigator stabilized the upper arm. The participant was instructed to push as hard as possible against the end piece for five seconds of maximal isometric contraction. Two trials were conducted with a 10-second rest between measurements [25]. For abduction, the hand-held dynamometer was positioned just above the elbow joint and with the arm in extension. The primary investigator stabilized the arm for it to move in only abduction with no accessory motion from the elbow and shoulder. The participant was instructed to push as hard as possible against the end piece for five seconds of maximal isometric contraction. Two trials were conducted with a 10-second rest between measurements [25].

3.4. Dry Needling Sessions for the Infraspinatus and Supraspinatus

For the infraspinatus, the border of the scapula was palpated and clearly outlined with a water-soluble marking pen to prevent the needle from being inadvertently inserted into the lung field/parietal pleura. Once this had been outlined, the location of the muscle was palpated just inferior to the spine of the scapular. The needle was inserted perpendicular to the scapula (see **Figure 2**).

Figure 2. Insertion of the Infraspinatus Muscle.

For the supraspinatus, the medial aspect was the site of needle insertion. This was identified by locating the spine of the scapula and palpating superior to this until the muscle is fully palpable. The needle was inserted in a medial-to-lateral manner at a 30 to 45-degree angle, with the needle angled toward the supraspinous fossa (see **Figure 3**).

Figure 3. Insertion of the Supraspinatus Muscle.

Once the dry needling session was complete, the participant was asked to sit up and relax for five minutes and allowed them to leave if they were feeling no adverse effects such as dizziness, headache, or nausea. The participant was then scheduled for a second session two days (minimum of 48 hours) later (Please refer to **Figure 1**). A second session consisted of the same protocol but did not occur if there was bruising or pain in the area. If this occurred, the participant was allowed at least three days' rest before the next session.

3.5. Post Intervention 1 and 2 Measurements for Isometric Strength Testing

Post-intervention isometric strength testing measurement 1 occurred immediately after the second dry-needling session. The post-intervention isometric strength testing measurement 2 was scheduled five to seven days after the second dry-needling session. Both measurements consisted of the same protocol as outlined above (Please refer to **Figure 1**).

3.6. Outcome Measures

The identified independent variables were the dry needling intervention (on a single limb) with the dependent variables and outcome measures being shoulder isometric strength in abduction and external rotation.

3.7. Statistical Analysis

All the data collected were entered into a Microsoft Excel spreadsheet (Microsoft corporation v.2505) and analysed with Statistical Package for Social Sciences (SPSS v.30.0; IBM SPSS Inc., Chicago, IL, USA for windows). Data were checked for normality and homogeneity of variance using a Shapiro-Wilk's test of normality ($W_{()} = 0.9703$; $p = 0.7611$) and was identified to be normally distributed. Data were therefore assessed with a paired sample *t*-test to evaluate changes between the baseline and post needling assessments. Cohen's *d* effect sizes were also computed to complement interpretation of results, with effect sizes being interpreted as negligible/very small (d < 0.20), small (d = 0.20 to 0.49), medium (d = 0.50 to 0.79), or large (d > 0.80) [26] [27]. Data are reported as means and standard deviations (±SD). Statistical significance was set at $p < 0.05$. To adjust for family-wise error to temper Type I error risk, the Bonferroni correction of the adjusted *p*-value was set at $p < 0.0010$.

4. Results

4.1. Abduction

There were observable differences identified for abduction of the non-dominant arm when comparing the baseline (19.1 ± 5.6) with post-test 1 ($t_{(19)} = -2.26$; $p = 0.0180$; $d = -0.50$) and post-test 2 ($t_{(19)} = -2.12$; $p = 0.0238$; $d = -0.47$) (see **Table 1**). This was similar for female participants when comparing baseline with post-test 1 ($t_{(9)} = -2.37$; $p = 0.0209$; $d = -0.75$) and post-test 2 ($t_{(9)} = -1.87$; $p = 0.0470$). There were notable differences identified between male and female participants for dominant arm abduction at baseline (23.8 ± 4.0 vs. 17.3 ± 2.8; $t_{(9)} = 4.99$; $p = 0.0004$; $d = 1.58$), post-test 1 (22.8 ± 3.2 vs. 18.9 ± 3.7; $t_{(9)} = 2.74$; $p = 0.0114$; $d = 0.87$) and post-test 2 (23.4 ± 3.4 vs. 18.5 ± 3.7; $t_{(9)} = 2.94$; $p = 0.0083$; $d = 0.93$).

Table 1. Baseline and post needling results of strength for external rotation and abduction of rotator cuff muscles in dominant and non-dominant arms for males, females and combined results by the mean and standard deviations. (±SD)

	Stngth_Abd_ND_Baseline	Stngth_Abd_ND_T1	Stngth_Abd_ND_T2	Stngth_ER_ND_Baseline	Stngth_ER_ND_T1	Stngth_ER_ND_T2
	mean ± SD	mean ± SD	mean ± SD	mean ± SD	mean ± SD	mean ± SD
Total	19.1 ± 5.6	21.4 ± 4.5	20.6 ± 5.6	17.6 ± 5.5	18.2 ± 4.9	18.2 ± 4.8
Male	23.4 ± 4.1[b]	24.1 ± 3.0	24.5 ± 5.3[b]	20.1 ± 4.1	20.1 ± 4.3	21.7 ± 3.9[b]
Female	14.9 ± 3.1a	18.7 ± 4.2	16.8 ± 2.3[a]	15.1 ± 5.8	16.4 ± 4.9	14.7 ± 2.6[a]
	Stngth_Abd_D_Baseline	**Stngth_Abd_D_T1**	**Stngth_Abd_D_T2**	**Stngth_ER_D_Baseline**	**Stngth_ER_D_T1**	**Stngth_ER_D_T2**
	mean ± SD	mean ± SD	mean ± SD	mean ± SD	mean ± SD	mean ± SD
Total	20.6 ± 4.8	20.9 ± 3.9	20.9 ± 4.3	18.9 ± 5.0	19.5 ± 4.8	18.2 ± 4.4
Male	23.8 ± 4.0[b]	22.8 ± 3.2	23.4 ± 3.4	20.7 ± 3.1	21.3 ± 4.4	20.5 ± 4.9
Female	17.3 ± 2.8[a]	18.9 ± 3.7	18.5 ± 3.7	17.2 ± 6.0	17.7 ± 4.7	16.0 ± 2.3

SD = Standard deviation; Significant difference ($p < 0.0010$) than (a) = Male; (b) = Female.

4.2. External Rotation

There were observable differences identified for external rotation of the non-dominant arm for males when comparing post-test 1 with post-test 2 (20.1 ± 4.3 vs. 21.7 ± 3.9; $t_{(9)} = -2.13$; $p = 0.0311$; $d = 0.67$) (see Table 1). There was a significant difference identified when comparing male and female non-dominant arm post-test 2 (21.7 ± 3.9 vs. 14.7 ± 2.6; $t_{(9)} = 5.20$; $p = 0.0003$; $d = 1.64$).

5. Discussion

This novel preliminary research aimed to measure the effect of dry needling on shoulder strength in external rotation and abduction with an asymptomatic homogenous cohort of individuals. It was hypothesized that dry needling would not influence strength in this cohort of healthy individuals nor show a difference in sex.

Interestingly, the results for dry needling (see Table 1) on the whole cohort of participants did yield notable differences for abduction strength of the dry needling side (non-dominant arm) from baseline (19.1 ± 5.6) to post-test 1 (21.4 ± 4.5) and post-test 2 (20.6 ± 5.6). This was also seen for the female participants as their baseline measurements (14.9 ± 3.1) saw increases in the post-test 1 (18.7 ± 4.2) and post-test 2 (16.8 ± 2.3), albeit a drop between post-test 1 and post-test 2. There was minimal change from baseline to post-test 1 and 2 for the males. No significant differences were noted on the non-dry needling side (dominant arm) between baseline and both post-tests for the whole cohort and in male and females. For external rotation, there were no significant changes over time for the whole cohort, however, there were observable notable differences, an increase in strength, identified for the dry needling side (non-dominant arm) for males between post-test 1 with post-test 2 (20.1 ± 4.3 vs. 21.7 ± 3.9; $p = 0.0311$; $d = 0.67$).

The results between male and female shoulder abduction showed revealed notable differences for the non-dry needling arm (dominant arm) at baseline (23.8 ± 4.0 vs. 17.3 ± 2.8; $t_{(9)} = 4.99$; $p = 0.0004$; $d = 1.58$), post-test 1 (22.8 ± 3.2 vs. 18.9

± 3.7; $t_{(9)} = 2.74$; $p = 0.0114$; $d = 0.87$) and post-test 2 (23.4 ± 3.4 vs. 18.5 ± 3.7; $t_{(9)} = 2.94$; $p = 0.0083$; $d = 0.93$). For external rotation there was a significant difference identified when comparing male and female dry needling arm (non-dominant arm) post-test 2 (21.7 ± 3.9 vs. 14.7 ± 2.6; $t_{(9)} = 5.20$; $p = 0.0003$; $d = 1.64$).

The strength gains noted need to be better understood prior to any conclusion can be made on whether dry needling was the primary factor, including the limitations that are outlined below. However, in the absence of palpable myofascial trigger points in the focused area of the needle insertion, the physiological hypothesis, as noted in the introduction [14]-[17], of possibly why dry needling can impact strength (as well as range of motion and pain) cannot be applied. Nonetheless, the influence of dry needling on strength is interesting and used in treating myofascial trigger points [9] that may impact strength [13]. Unfortunately, there is a paucity of empirical evidence to support this notion. Interestingly, and somewhat relevant to the current study are three studies [28]-[30] with one on a single subject case report [25] of a 22-year-old gymnast several months post shoulder surgery who presented with tightness and weakness in shoulder flexion (grade 4/5), abduction (grade 4/5), and external rotation (grade 4/5). Myofascial trigger points, both active and latent, were located, and additionally, infraspinatus thickness was assessed with the use of diagnostic ultrasound. Following a dry needling session, an increase in external rotation strength of approximately 30% and an increase in infraspinatus thickness of 25% were reported. The fascinating component of the findings was the immediate increase in muscle thickness, indicating that dry needling's influence on strength may be via another mechanism aside from the myofascial trigger points, potentially influencing muscle thickness. The authors suggested that the factors underlying a muscle's response to dry needling are unknown, possibly from the variations in the dry needling technique. Conversely, a study by Sanchez-Infante *et al.* [29] that evaluated the effect of dry needling on latent myofascial trigger points on muscle stiffness, soreness and thickness on the upper trapezius muscle. The results demonstrated no differences in muscle thickness over the one single dry needling session. In both the single subject case report and the Sanchez-Infante *et al.* [29] study, muscle strength was not assessed. A recent study by Cao *et al.* [30] had as one of its aims to assess the changes in the upper trapezius muscle via multimodal ultrasound and histological analysis after a single dry needling session on myofascial trigger points. Notably, the findings revealed reduced thickness of the upper trapezius muscle post-dry-needling with the authors suggesting that this finding may reflect decreased mechanical tension following treatment and adding that further mechanistic studies are needed to confirm this relationship. Similarly to above, this study also utilized participants with myofascial trigger points. With thought to these three studies the impact of dry needling on muscle thickness and therefore possibly strength, with or without myofascial trigger points, it is important that future research examine dry needling's effect on muscle and tendon/fascia thickness as a stand-alone procedure to determine if there is a mechanistic effect with aid of musculoskeletal ultrasound to measure changes in thickness [28] [31]. This is particularly relevant due this current research as the increase in strength was not the result of a myofascial trigger point as confirmed by the primary investigator who has more than twenty years of experience in soft tissue palpation and application of myofascial treatment procedures.

Other research on its impact on strength has been mixed. For example, an umbrella review [32] on dry needling for musculoskeletal pain, which also included its impact on function, with muscle strength as a component, concluded that aside from cervical pain that may have impacted strength [19], there was insufficient evidence on its use and long-term effects. A systematic review and meta-analysis by Mansfield *et al.* [19] on the effects of dry needling on muscle force production at the shoulder region demonstrated very low quality of evidence and no effect in the studies reviewed. However, the studies reviewed by Mansfield *et al.* [19] were not comprised of healthy asymptomatic individuals; thus, their study results cannot be equally compared to the results of this current study. For example, the Mansfield *et al.* [19] review included a study [33] that utilized the Constant-Murley score [34], which measures abduction strength in the scapular plane against resistance and did show a statistical difference but did not exceed minimal clinical importance. Furthermore, that study incorporated a personalized physical therapy program with or without dry needling and active myofascial trigger points. Another study in the Mansfield *et al.* [19] systematic review included one by Calvo-Lobo *et al.* [35] that used older adults with nonspecific shoulder pain with grip strength as one of its measures. The results in that study demonstrated improvement in strength (latent extensor carpi radialis trigger points being associated with latent supraspinatus trigger points) after one-week post-intervention that included trigger point dry needling in the infraspinatus muscle.

Despite the limited evidence on dry needling impact with shoulder strength, it has been shown to influence strength in other areas of the body. A study by Haser *et al.* [36] showed significant improvements in knee extensor and hip flexion muscular endurance that extended four weeks post-intervention with a cohort of younger (aged 18 to 19) and healthy elite-level soccer players. Contrast this to the Ceballos-Laita *et al.* [20] study on participants with hip osteoarthritis that reported improved muscle hip strength in flexion, extension, adduction, abduction, and internal and external rotation compared to both control and sham groups with dry needling intervention. Additionally, Schneider *et al.* [21] assessed the effectiveness of dry needling on latent myofascial trigger points located on the gluteus medius muscle and its effect on strength with results showing significant increases in strength of the muscle as measured with a hand-held dynamometer immediately after the intervention. Uniquely, the participants in that study were asymptomatic, which was defined as having no lumbar spine, sacroiliac/pelvis, and lower extremity pain.

Future research should incorporate dry needling with other therapeutic approaches typically used to increase strength to compare different therapeutic approaches. One suggestion is measuring the combination effect of dry needling with blood flow restriction in an otherwise healthy population or post-ACL knee replacement, as strength is often a primary outcome measure. More research needs to determine the extent to which trigger points influence strength. In other words, how do trigger points lead to changes in strength and components such as excitability, contractibility, extensibility, and elasticity [10]. If they, indeed, do lead to strength deficits and these deficits respond to trigger point therapy a cause-and-effect conclusion could be assumed. However, this needs to be firmly established. The result of this study provides evidence that the gains made in strength by dry needling were not due to its effect on a myofascial trigger point, and the underlying cause of this effect needs to be further investigated.

Interestingly, a case series [37] reported on ten individuals with chronic shoulder symptoms, including tendinopathy, who were subjected to two to eight dry needling sessions in a physical therapy clinic. The results demonstrated reduced pain and disability. However, in this study, the authors applied the needles to pain spots and/or thickened areas within the tendon, suggesting a less focused application of the needles. This is important as the practical application of using dry needling in the absence of myofascial trigger points may be beneficial, especially with tendon pathology. The results from this case series [37] and the Cross *et al.* [28], Sánchez-Infante *et al.* [29], and Cao *et al.* [30] studies noted above warrant further investigation of how dry needling impacts muscle changes and subsequent strength. This is further supported by the Moosaei Saein *et al.* [38] study that showed a reduction in plantar fascia thickness, with this being possibly attributed to the effect of the muscle on the fascia. Therefore, dry needling may be effective due to other possible mechanisms, which provides the impetus for its application on asymptomatic individuals in this research project.

Lastly, there are two areas that also may need to be examined in future research. Firstly, why dry needling impacted the strength of shoulder abduction (the supraspinatus muscle) more so than the external rotation (infraspinatus muscle) is perplexing. Both muscles are classified as triangular [39] and the method of muscle testing for each was standard. Perhaps participants can conceptualize abduction easier than external rotation and thus are able to support themselves more appropriately. Secondly, should there be variations between sex and muscles response to dry needle insertion. Although each sex did show significant changes with dry needling, with female participants from baseline and post-test 1 and post-test 2 and for external rotation for males when comparing post-test 1 with post-test 2, would there be an expectation that the changes be similar. However, this is an area that can be influenced by muscle fiber composition, contractile function, and physiological differences by thyroid hormone, estrogen, and testosterone hormones [40], and therefore future research needs to account for these in order to gain a clearer understanding of the how dry needling impacts strength.

6. Conclusion

The impact of dry needling therapy to myofascial trigger points on pain, range of motion and strength is established in the literature. Less clear are both the myofascial trigger point and the physiological mechanism of how a needle inserted within it can impact these three areas. Furthermore, in the absence of a myofascial trigger point, could a dry needle insertion into a muscle result in an increase in range of motion and strength, specifically regarding this current research, strength? The results from this study did reveal increases in muscle strength in shoulder abduction, most notably in the female cohort of participants. This may provide the impetus for future research on the impact of dry needling on strength in the absence of myofascial trigger points with consideration to its influence of muscle and tendon/fascia thickness. This may lead to dry needling being an option as a preventative measure with all populations, especially those prone to eventual dysfunction that includes diminished strength. Additionally, it may be used as an addendum procedure with other similar techniques used to increase strength, such as joint mobilizations, proprioceptive neuromuscular facilitation, or general massage.

7. Limitations and Future Directions of Research

The limitations of this study include using a convenience sample and not applying sample size calculation. This is especially problematic if the changes between pre- and post-dry needling strength are minimal, and thus, significance may not be appreciated. Another limitation (delimitation) is the use of a specific population (aged 20 - 23 years old), but this is less of an issue as too broad of an age range with a smaller sample size, for example, spreading it out with various age groups (19 - 24, 30 - 40, 50+ years old), would make detection of significant changes even more unlikely. Limiting the targeted muscles only to the supraspinatus and infraspinatus represents another limitation. However, this delimitation is based on safety and reduced patient risk. This study did not conduct inter-rater or test-retest reliability measurements and therefore the certainty of location exactness and the confirmation of an absence of a myofascial trigger point is one area that needs to be done in the follow-up study. Other pertinent limitations include: a lack of a secondary assessor on the muscles to provide agreement on whether there was or was not a myofascial trigger point; due to the cross over design, using the opposite arm for comparison may have influenced the results due to the physiological influence on the neurological system as a whole, as compared to the specific site of application; and the chance that myofascial trigger points in close proximity to the site of needle insertion were influential on the changes recorded. Additionally, there may have been the potential for cross-educational effects as there is evidence showing that unilateral motor/muscle practice improves muscle motor/muscle output in both exercised and unexercised similar muscles [41]-[43]. Whether one or multiple dry needling sessions or muscle testing effect strength bilaterally would need further investigation.

Acknowledgements

We would like to thank Jamie Straka for his help on the project. The authors would like to thank all study participants.

Statement of Ethics

This study protocol was reviewed and approved by the Institutional Review Board at the University of Northern Iowa, approval number IRB-FY24-167. All participants completed a Health History Questionnaire (HHQ) and signed a Consent Form.

Funding Sources

The authors declare to funding was provided for this research.

Author Contributions

MH devised the project, the main conceptual ideas. MH, and DW worked out technical details, submission to the Institutional Review Board, and performed procedures and data collection. DK primarily and MH secondarily performed the analysis and numerical calculations. MH, DW, and DK all contributed equally to the writing of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Pekyavas, N.O. and Baltaci, G. (2016) Short-term Effects of High-Intensity Laser Therapy, Manual Therapy, and Kinesio Taping in Patients with Subacromial Impingement Syndrome. *Lasers in Medical Science*, **31**, 1133-1141. https://doi.org/10.1007/s10103-016-1963-2

[2] Thelen, M.D., Dauber, J.A. and Stoneman, P.D. (2008) The Clinical Efficacy of Kinesio Tape for Shoulder Pain: A Randomized, Double-Blinded, Clinical Trial. *Journal of Orthopaedic & Sports Physical Therapy*, **38**, 389-395. https://doi.org/10.2519/jospt.2008.2791

[3] Courtney, C.A., Steffen, A.D., Fernández-de-las-Pñas, C., Kim, J. and Chmell, S.J. (2016) Joint Mobilization Enhances Mechanisms of Conditioned Pain Modulation in Individuals with Osteoarthritis of the Knee. *Journal of Orthopaedic & Sports Physical Therapy*, **46**, 168-176. https://doi.org/10.2519/jospt.2016.6259

[4] McKenney, K., Elder, A.S., Elder, C. and Hutchins, A. (2013) Myofascial Release as a Treatment for Orthopaedic Conditions: A Systematic Review. *Journal of Athletic Training*, **48**, 522-527. https://doi.org/10.4085/1062-6050-48.3.17

[5] Brewster, B.D., Snyder Valier, A.R. and Falsone, S. (2022) A Systematic Dry-Needling Treatment to Support Recovery Posttraining for Division I Ice Hockey Athletes: An Exploration Case Series. *Journal of Athletic Training*, **57**, 788-794. https://doi.org/10.4085/1062-6050-0096.21

[6] Bynum, R., Garcia, O., Herbst, E., Kossa, M., Liou, K., Cowan, A., *et al.* (2021) Effects of Dry Needling on Spasticity and Range of Motion: A Systematic Review. *The American Journal of Occupational Therapy*, **75**, 7501205030p1-7501205030p13. https://doi.org/10.5014/ajot.2021.041798

[7] Dommerholt, J., Mayoral del Moral, O. and Gröbli, C. (2006) Trigger Point Dry Needling. *Journal of Manual & Manipulative Therapy*, **14**, 70E-87E. https://doi.org/10.1179/jmt.2006.14.4.70e

[8] Dommerholt, J., Grieve, R., Layton, M. and Hooks, T. (2015) An Evidence-Informed Review of the Current Myofascial Pain Literature. *Journal of Bodywork and Movement Therapies*, **19**, 126-137. https://doi.org/10.1016/j.jbmt.2014.11.006

[9] Gattie, E., Cleland, J.A. and Snodgrass, S. (2017) The Effectiveness of Trigger Point Dry Needling for Musculoskeletal Conditions by Physical Therapists: A Systematic Review and Meta-Analysis. *Journal of Orthopaedic & Sports Physical Therapy*, **47**, 133-149. https://doi.org/10.2519/jospt.2017.7096

[10] Dunning, J., Butts, R., Mourad, F., Young, I., Flannagan, S. and Perreault, T. (2014) Dry Needling: A Literature Review with Implications for Clinical Practice Guidelines. *Physical Therapy Reviews*, **19**, 252-265. https://doi.org/10.1179/108331913x13844245102034

[11] Vickers, A. and Zollman, C. (1999) ABC of Complementary Medicine: Acupuncture. *British Medical Journal*, **319**, 973-976. https://doi.org/10.1136/bmj.319.7215.973

[12] Lucas, N., Macaskill, P., Irwig, L., Moran, R. and Bogduk, N. (2009) Reliability of Physical Examination for Diagnosis of Myofascial Trigger Points. *The Clinical Journal of Pain*, **25**, 80-89. https://doi.org/10.1097/ajp.0b013e31817e13b6

[13] Unverzagt, C., Berglund, K. and Thomas, J.J. (2015) Dry Needling for Myofascial Trigger Point Pain: A Clinical Commentary. *International Journal of Sports Physical Therapy*, **10**, 402-418. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4458928/

[14] Simons, D.G. (2004) Review of Enigmatic MTrPs as a Common Cause of Enigmatic Musculoskeletal Pain and Dysfunction. *Journal of Electromyography and Kinesiology*, **14**, 95-107. https://doi.org/10.1016/j.jelekin.2003.09.018

[15] Rudolf, R., Khan, M.M. and Witzemann, V. (2019) Motor Endplate—Anatomical, Functional, and Molecular Concepts in the Historical Perspective. *Cells*, **8**, Article 387. https://doi.org/10.3390/cells8050387

[16] Hocking, M.J.L. (2010) Trigger Points and Central Modulation—A New Hypothesis. *Journal of Musculoskeletal Pain*, **18**, 186-203. https://doi.org/10.3109/10582452.2010.483964

[17] Partanen, J.V., Ojala, T.A. and Arokoski, J.P.A. (2010) Myofascial Syndrome and Pain: A Neurophysiological Approach. *Pathophysiology*, **17**, 19-28. https://doi.org/10.1016/j.pathophys.2009.05.001

[18] Dommerholt, J. (2011) Dry Needling—Peripheral and Central Considerations. *Journal of Manual & Manipulative Therapy*, **19**, 223-227. https://doi.org/10.1179/106698111x13129729552065

[19] Mansfield, C.J., Vanetten, L., Willy, R., di Stasi, S., Magnussen, R. and Briggs, M. (2019) The Effects of Needling Therapies on Muscle Force Production: A Systematic Review and Meta-Analysis. *Journal of Orthopaedic & Sports Physical Therapy*, **49**, 154-170. https://doi.org/10.2519/jospt.2019.8270

[20] Ceballos-Laita, L., Jiménez-del-Barrio, S., Marín-Zurdo, J., Moreno-Calvo, A., Marín-Boné, J., Albarova-Corral, M.I., *et al*. (2021) Effectiveness of Dry Needling Therapy on Pain, Hip Muscle Strength, and Physical Function in Patients with Hip Osteoarthritis: A Randomized Controlled Trial. *Archives of Physical Medicine and Rehabilitation*, **102**, 959-966. https://doi.org/10.1016/j.apmr.2021.01.077

[21] Schneider, E., Moore, E.S., Stanborough, R. and Slaven, E. (2022) Effects of Trigger

Point Dry Needling on Strength Measurements and Activation Levels of the Gluteus Medius: A Quasi-Experimental Randomized Control Study. *International Journal of Sports Physical Therapy*, **17**, 1404-1416. https://doi.org/10.26603/001c.55536

[22] Kietrys, D.M., Palombaro, K.M., Azzaretto, E., Hubler, R., Schaller, B., Schlussel, J.M., *et al.* (2013) Effectiveness of Dry Needling for Upper-Quarter Myofascial Pain: A Systematic Review and Meta-Analysis. *Journal of Orthopaedic & Sports Physical Therapy*, **43**, 620-634. https://doi.org/10.2519/jospt.2013.4668

[23] Noguchi, T., Demura, S., Takahashi, K., Demura, G. and Mori, Y. (2014) Differences in Muscle Power between the Dominant and Nondominant Upper Limbs of Baseball Players. *Journal of Strength and Conditioning Research*, **28**, 82-86. https://doi.org/10.1519/jsc.0b013e3182909112

[24] Kendall, F.P., McCreary, E.K., Provance, P.G., *et al.* (2005) Muscles: Testing and Testing and Function with Posture and Pain. 5th Edition, Lippincott Williams and Wilkins.

[25] Chen, B., Liu, L., Bin Chen, L., Cao, X., Han, P., Wang, C., *et al.* (2021) Concurrent Validity and Reliability of a Handheld Dynamometer in Measuring Isometric Shoulder Rotational Strength. *Journal of Sport Rehabilitation*, **30**, 965-968. https://doi.org/10.1123/jsr.2020-0021

[26] Cohen, J. (1988) Statistical Power Analysis for the Behavioural Sciences. 2nd Edition, Lawrence Erlbaum Associates.

[27] Zakzanis, K.K. (2001) Statistics to Tell the Truth, the Whole Truth, and Nothing but the Truth Formulae, Illustrative Numerical Examples, and Heuristic Interpretation of Effect Size Analyses for Neuropsychological Researchers. *Archives of Clinical Neuropsychology*, **16**, 653-667. https://doi.org/10.1016/s0887-6177(00)00076-7

[28] Cross, K.M. and McMurray, M. (2017) Dry Needling Increases Muscle Thickness in a Subject with Persistent Muscle Dysfunction: A Case Report. *International Journal of Sports Physical Therapy*, **12**, 468-475. https://ijspt.scholasticahq.com/issues

[29] Sánchez-Infante, J., Bravo-Sánchez, A., Jiménez, F. and Abián-Vicén, J. (2021) Effects of Dry Needling on Muscle Stiffness in Latent Myofascial Trigger Points: A Randomized Controlled Trial. *The Journal of Pain*, **22**, 817-825. https://doi.org/10.1016/j.jpain.2021.02.004

[30] Cao, W., Yin, L., Sun, H., Ge, H., Guo, R. and Lyu, X. (2025) Ultrasound Features of Myofascial Trigger Points: A Multimodal Study Integrating Preliminary Histological Findings from the Upper Trapezius. *Scientific Reports*, **15**, Article No. 20510. https://doi.org/10.1038/s41598-025-05869-2

[31] Koppenhaver, S., Harris, D., Harris, A., O'Connor, E., *et al.* (2015) The Reliability of Rehabilitative Ultrasound Imaging in the Measurement of Infraspinatus Muscle Function in the Symptomatic and Asymptomatic Shoulders of Patients with Unilateral Shoulder Impingement Syndrome. *International Journal of Sports Physical Therapy*, **10**, 128-135.

[32] Chys, M., De Meulemeester, K., De Greef, I., Murillo, C., Kindt, W., Kouzouz, Y., *et al.* (2023) Clinical Effectiveness of Dry Needling in Patients with Musculoskeletal Pain—An Umbrella Review. *Journal of Clinical Medicine*, **12**, Article 1205. https://doi.org/10.3390/jcm12031205

[33] Pérez-Palomares, S., Oliván-Blázquez, B., Pérez-Palomares, A., Gaspar-Calvo, E., Pérez-Benito, M., López-Lapeña, E., *et al.* (2017) Contribution of Dry Needling to Individualized Physical Therapy Treatment of Shoulder Pain: A Randomized Clinical Trial. *Journal of Orthopaedic & Sports Physical Therapy*, **47**, 11-20. https://doi.org/10.2519/jospt.2017.6698

[34] Constant, C.R. and G. Murley, A.H. (1987) A Clinical Method of Functional Assessment of the Shoulder. *Clinical Orthopaedics and Related Research*, **214**, 160-164. https://doi.org/10.1097/00003086-198701000-00023

[35] Calvo-Lobo, C., Pacheco-da-Costa, S., Martínez-Martínez, J., Rodríguez-Sanz, D., Cuesta-Álvaro, P. and López-López, D. (2018) Dry Needling on the Infraspinatus Latent and Active Myofascial Trigger Points in Older Adults with Nonspecific Shoulder Pain: A Randomized Clinical Trial. *Journal of Geriatric Physical Therapy*, **41**, 1-13. https://doi.org/10.1519/jpt.0000000000000079

[36] Haser, C., Stöggl, T., Kriner, M., Mikoleit, J., Wolfahrt, B., Scherr, J., *et al.* (2017) Effect of Dry Needling on Thigh Muscle Strength and Hip Flexion in Elite Soccer Players. *Medicine & Science in Sports & Exercise*, **49**, 378-383. https://doi.org/10.1249/mss.0000000000001111

[37] McDevitt, A.W., Snodgrass, S.J., Cleland, J.A., Leibold, M.B.R., Krause, L.A. and Mintken, P.E. (2020) Treatment of Individuals with Chronic Bicipital Tendinopathy Using Dry Needling, Eccentric-Concentric Exercise and Stretching; A Case Series. *Physiotherapy Theory and Practice*, **36**, 397-407. https://doi.org/10.1080/09593985.2018.1488023

[38] Moosaei Saein, A., Safavi-Farokhi, Z., Aminianfar, A. and Mortezanejad, M. (2022) The Effect of Dry Needling on Pain, Range of Motion of Ankle Joint, and Ultrasonographic Changes of Plantar Fascia in Patients with Plantar Fasciitis. *Journal of Sport Rehabilitation*, **31**, 299-304. https://doi.org/10.1123/jsr.2021-0156

[39] Biel, A. (2014) Muscles. In: *Trail Guide to Movement: Building the Body in Motion*, Books of Discovery, 105-119.

[40] Haizlip, K.M., Harrison, B.C. and Leinwand, L.A. (2015) Sex-based Differences in Skeletal Muscle Kinetics and Fiber-Type Composition. *Physiology*, **30**, 30-39. https://doi.org/10.1152/physiol.00024.2014

[41] Zhou, S. (2000) Chronic Neural Adaptations to Unilateral Exercise: Mechanisms of Cross Education. *Exercise and Sport Sciences Reviews*, **28**, 177-184.

[42] Hortobágyi, T., Richardson, S.P., Lomarev, M., Shamim, E., Meunier, S., Russman, H., *et al.* (2011) Interhemispheric Plasticity in Humans. *Medicine & Science in Sports & Exercise*, **43**, 1188-1199. https://doi.org/10.1249/mss.0b013e31820a94b8

[43] Manca, A., Hortobágyi, T., Carroll, T.J., Enoka, R.M., Farthing, J.P., Gandevia, S.C., *et al.* (2021) Contralateral Effects of Unilateral Strength and Skill Training: Modified Delphi Consensus to Establish Key Aspects of Cross-Education. *Sports Medicine*, **51**, 11-20. https://doi.org/10.1007/s40279-020-01377-7