5-1-2016

The Effect of Dry Needling to the Multifidus Muscle on Resting and Contracted Thickness of Transversus Abdominis in Subjects with Low Back Pain

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THE EFFECT OF DRY NEEDLING TO THE MULTIFIDUS MUSCLE ON RESTING AND CONTRACTED THICKNESS OF TRANSVERSUS ABDOMINIS IN SUBJECTS WITH LOW BACK PAIN

By

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Abbay Dow
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A doctoral project submitted in partial fulfillment of the requirements for the

Doctor of Physical Therapy

Department of Physical Therapy
School of Allied Health Sciences
Division of Health Sciences
The Graduate College

University of Nevada, Las Vegas
May 2016
This doctoral project prepared by

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entitled

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is approved in partial fulfillment of the requirements for the degree of

Doctor of Physical Therapy
Department of Physical Therapy

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Graduate College Interim Dean
Abstract

**Study Design:** Randomized, double-blinded, controlled clinical trial.

**Objective:** To measure the effects of dry needling to the lumbar multifidus (MF) muscle for any change in resting and contracted thickness of the transversus abdominis (TrA) muscle as well as symptoms and disability in individuals with low back pain (LBP).

**Background:** Recent studies have demonstrated that individuals with LBP have diminished co-activation of the lumbar MF and TrA muscles, which when working appropriately in healthy individuals, contributes to spinal stability and function. A significant change in the resting and contracted thickness of TrA has been found with dry needling to the lumbar MF in healthy subjects, but this has yet to be studied in individuals with low back pain.

**Methods:** Thirty adults with LBP were randomly assigned to receive dry needling intervention or a sham needling intervention to the lumbar MF. The participants received instruction on the deep corset contraction (DCC) for purposes of measuring TrA muscle relaxation and contracted thickness with real time ultrasound (US) imaging pre- and post-intervention. Along with the US measurements, the Oswestry Disability Index (ODI), the Global Rating of Change Scale (GROC) and the Numeric Pain Rating Scale (NPRS) were used to measure outcomes at baseline, immediately post-, 2-days post, and 7-days post intervention.

**Results:** Five, 2-way repeated measures ANOVAs were conducted. The results showed no significant main effects for group assignment in TrA resting thickness ($p=0.607$), TrA contracted thickness ($p=0.432$), NPRS scores ($p=0.657$), ODI ($p=0.527$), and GROC
scores ($p=0.499$). The results showed no main effect for time for TrA resting thickness ($p=0.862$), or GROC scores ($p=0.895$). However it did indicate a main effect for time for TrA contracted thickness ($p = 0.004$), NRPS scores ($p<0.001$), and ODI scores ($p<0.001$). Post-hoc analyses found contracted thickness increased ($p=0.004$), pain decreased ($p<0.001$), and ODI decreased ($p<0.001$) in both groups. No significant interactions were found between intervention type and time in terms of contracted thickness of TrA ($p=0.697$) or resting thickness of TrA ($p=0.149$). Similarly, no significant interactions were found between intervention type and time in terms of NPRS scores ($p=0.188$); ODI scores ($p=0.421$); and GROC scores ($p=0.350$).

**Conclusion:** Our results indicate that dry needling did not have a significant effect on resting or contracted thickness of TrA compared to the control group, suggesting that individuals with LBP may not experience a physiological change in resting and contracted thickness of TrA following dry needling. A significant increase in contracted thickness of TrA was found for both groups due to a possible learning effect of the DCC. Finally, a significant decrease in pain and ODI scores were found for both groups, suggesting a possible placebo effect.
ACKNOWLEDGEMENTS

We would like to acknowledge the faculty and staff of the University of Nevada, Las Vegas Department of Physical Therapy for challenging our minds and inspiring us to work hard for this project, and supporting our efforts along the way. A special thanks goes out to our primary investigator, Dr. Louie Puentedura, and research coordinator Dr. Kai-Yu Ho, assisting us with completing this project. Lastly, we would like to thank our research subjects for being so gracious during their participation in this study.
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INTRODUCTION

Currently, the cost of treating low back pain (LBP) in the United States is estimated at around $20-50 billion annually.\(^1\) Over 54 million Americans are estimated to have experienced back pain within the last three months, with many claiming even greater prevalence.\(^5\) LBP can have more than just physiological effects, including psychological and social disability.\(^1\) With the current impact of back pain on the United States and world as a whole, the increasing need for effective treatments becomes apparent.

Various treatment modalities exist to treat LBP, from stabilization exercises to spinal manipulation. Dry needling, for example, has been found to be effective in treating LBP.\(^7\) It has been suggested that trigger points form as taut bands of hyperirritable muscle resulting from abnormal end plate potential from excessive acetylcholine release.\(^8\) This formation of trigger points in the muscle can lead to pain, tenderness, and dysfunction.\(^9\) Some studies show that the effectiveness of dry needling in trigger points exists due to the increase in discharges, causing a local twitch response (LTR) and a subsequent reduction in acetylcholine availability, thus causing localized muscle relaxation.\(^10\) Theoretically, this relaxation of the taut muscle band is believed to be responsible for a reduction in pain.

Patients with chronic LBP have been found to have increased atrophy of the transversus abdominis (TrA), leading to a decreased cross sectional thickness before and during contraction and an overall decrease in contractility of the muscle.\(^11\) These findings
can be effectively visualized through real-time ultrasound (US) imaging, which in recent studies has proven to be a reliable method for assessing changes in thickness of the TrA.\textsuperscript{12,24,25,26} Studies show that the TrA plays an important role in spinal stability, from activation in advance of limb movement to account for expected perturbations\textsuperscript{13} to feedback-mediated contraction during unexpected perturbations to posture.\textsuperscript{14} This is due to the anatomical connection of the TrA to the lumbar spine via the lateral raphe.\textsuperscript{15} The lateral raphe is formed by the combination of the tendon of the TrA and the retinacular sheath (thoracolumbar fascia) surrounding the paraspinal muscles.\textsuperscript{15} As the lumbar MF accounts for most of these paraspinal muscles in the low back, TrA contraction combined with simultaneous lumbar MF contraction has been found in numerous studies to provide a role in spinal control.\textsuperscript{16} The deep corset contraction (DCC) aims at facilitating TrA muscle action and improving lumbar spine control and stability, thus helping to alleviate LBP. In patients with LBP, research has shown there to be a delay in the anticipatory and reactive responses of the TrA, presumably leading to a decrease in stabilization.\textsuperscript{17}

Due to this anatomical connection of the lumbar MF and the TrA via the thoracolumbar fascia, we can postulate that the efficiency of TrA contraction is reliant on the extensibility of the connecting fascia and the contraction of MF muscle. This suggests the potential for dry needling to the lumbar MF to cause a change in thickness and contractility of TrA, which would theoretically lead to an increase in stability and a decrease in LBP.

Research currently in review has shown that dry needling of the lumbar MF in healthy individuals results in a significant change in the resting and contracted thickness of the TrA. This effect has yet to be investigated in individuals experiencing LBP.\textsuperscript{18} The
purpose of this study is to investigate the effects of dry needling to the lumbar MF muscle on resting and contracted thickness of TrA, as well as pain and disability in people with LBP. Our hypothesis is that dry needling to the MF muscle in individuals with LBP will result in a significant change in pain and disability rating as well as resting and contracted thickness and therefore, a change in the overall distance the TrA can shorten.

METHODS

Participants

Subjects with a current episode of LBP were recruited for the study using word of mouth, social media, clinicaltrials.gov, and by using flyers posted around the community and on the campus of University of Nevada, Las Vegas. Research has shown a moderate to large effect size has been associated with data obtained from 30 patients (Cohen’s $d = .30-.40$), making it a sufficient sample size for our study. Specifically, using a degree of freedom of one for the two-way interaction, $\alpha = .05$ and power = .80, the article suggests 26 to 45 individuals were needed for an adequate sample size.\(^{11}\) Power analysis was performed using power analysis G software.\(^{19}\)

Interested subjects were pre-screened via phone and email, prior to scheduling their participation, in order to ensure suitability. Inclusion criteria required that the subject: a) be between the ages of 18 and 75 years old; b) be currently experiencing mechanical LBP with a pain level of at least 2 out of 10 on the numeric pain rating scale (NPRS); c) demonstrate no current contraindication to dry needling (e.g. hemophilia, or currently taking anticoagulant medication); d) have no fear of being needled; and e) be
able to appropriately demonstrate deep corset contraction DCC. Mechanical LBP is defined in the literature as pain that is different from pain due to pathological causes, such as neoplasia, fracture, or systemic inflammatory disease, or pain referring from anatomical structures outside the spine.\textsuperscript{20} It refers to any type of pain in the lower spine caused by excessive use and abnormal stress, resulting in muscle or connective tissue strain\textsuperscript{21} and pain that is affected or altered by movement, activity and posture (i.e. it behaves mechanically).

Subjects were excluded from the study if they: a) had a prior medical history including abdominal or spinal surgery; b) presented with any conditions that could conflict with the administration of the intervention or results such as pregnancy, cancer, hemophilia, osteoporosis, osteopenia, anti-coagulant therapy; c) had medical conditions affecting the spine (e.g. active ankylosing spondylitis, significant scoliosis, and rheumatoid arthritis); d) were currently involved in legal proceedings regarding their LBP; or e) were current DPT students at UNLV. Subjects currently receiving physical therapy treatment were able to participate provided that they received written permission from their therapist. This study was approved by the UNLV Biomedical Institutional Review Board* and registered at ClinicalTrials.gov [NCT02284724].

\footnotesize*Protocol #1409-4946: The Effect of Trigger Point Dry Needling to the Multifidus Muscle on Resting and Contracted Thickness of Transversus Abdominis in Subjects with Mechanical Low Back Pain
Methodology

Prior to participation, written informed consent was attained at the facility of intervention. Following consent, all subjects completed a series of questionnaires to establish their baseline disability and pain. These questionnaires included a Pre-Participation Questionnaire, the Numeric Pain Rating Scale (NPRS), the Oswestry Disability Index (ODI), and the Fear Avoidance Belief Questionnaire (FABQ).

All subjects were then educated in performing the DCC and completed training in four-point kneeling and supine hook lying position. The goal of this training was to help the subjects detect and perform a maximal concentric contraction of the TrA for consistency of US measurement. In the four-point kneeling position, subjects were instructed to “bring their umbilicus towards the spine as if it were being pulled up with a string”, and five contractions were performed holding for five seconds each time. A neutral spine was maintained in this position through verbal and tactile cues. In the supine hook lying position, subjects were instructed to “bring the umbilicus down towards the table”. The subjects were allowed to use their fingertips to feel the contraction of the TrA at a point superior to each iliac crest. This time, four contractions were held for five seconds each. The fifth and final contraction was performed while the subjects viewed the US image for the purpose of biofeedback.

Following the DCC training, the subjects remained in supine hook lying position and were blinded to the US screen as images were taken of their TrA muscle in both the relaxed and contracted state. In order to standardize the position of the US transducer to view the TrA, researchers aligned the head perpendicular to the right anterolateral
abdominal muscles, midway between the umbilicus and anterior superior iliac spine of the pelvis. An image was taken when the fascial insertion of all three layers of abdominal musculature (TrA, internal oblique, external oblique) was in view and easily distinguished on the screen. All images were then saved to the US hard drive for later recall and measurement.

**Group Assignment**

Following the baseline measurements of the TrA thickness, the subjects were randomly assigned to either the dry needling group or the sham needling group using a randomization table. The two researchers performing the DCC training and US imaging were blinded to the subjects’ group assignment.

**Needling Group**

Subjects assigned to the dry needling group (n=15), received the dry needling intervention to both the right and left lumbar MF muscle. Subjects were placed in the prone position with a pillow under the abdomen, for the duration of the intervention. Dry needling and sham needling was performed by a researcher with over 30 years of clinical experience and certification in dry needling and acupuncture. The monofilament needles were inserted one inch from the spinous process of the L4 vertebrae and angled medially toward the spinous process. In order to standardize the intervention procedure, dry needling or sham needling was performed first to the right MF muscle, then the left. In order to identify the location for insertion of the needle, bilateral iliac crests were palpated and the corresponding spinous process, L4, was identified. The needle was then
pistoned until a local twitch response was elicited. The twitch response was measured by palpable and visual indications based on the clinical experience of the researcher.

*Sham Needling Group*

The subjects assigned to the sham needling (n=15), group underwent the identical setup procedure. The subjects then received an intervention consisting of localized pressure to first the right and then left lumbar MF area at the level of the L4 vertebrae. The pressure was applied using the empty plastic needle casing without penetration of the skin. In order to attempt to standardize the sham procedure, the researcher pistoned the empty casing for roughly the same amount of time as was used for the dry needling group.

Immediately following the administration of either the dry needling or sham needling intervention, subjects assumed the supine hook lying position and US imaging was obtained following the protocol as mentioned above. After the subjects left the facility, measurements were taken from the US images and recorded into subject’s charts. Follow-up interviews were then conducted over the phone, or in person, at 2 days and 7 days following the intervention. These interviews included the questionnaires listed above as well as a Global Rating of Change Scale (GROC) to assess the overall change in subjects’ perceived outcomes.

*Outcome Measures*

The primary outcome measures were resting and contracted thickness of the TrA as measured using real time ultrasound. Secondary outcome measures were the NPRS, ODI and GROC scale. Resting and contracted thickness of the TrA was measured using
real time, diagnostic ultrasound (Biosound Esaote MyLab25 Gold unit) with variable 2.5- to 6.6 MHz frequency and 60 mm curvilinear array (model CA631) in brightness mode (b-mode). Rehabilitative ultrasound imaging (RUSI) abdominal settings were applied with a frequency of 6.6 MHz and a power of 75% with a maximum depth of 9 cm. In order to maximize the visualization of the TrA, the focal length was manually adjusted for each image. US has been found to be a valid and reliable method for measuring the thickness of abdominal musculature.\(^{12, 24, 25, 26}\)

In order to establish intra-rater reliability, the researcher involved in data collection measured the TrA thickness of 10 volunteers’ using the US images. The measurements were compared on two different days using the same volunteers. These volunteers for the reliability portion of this study did not participate as subjects in the primary study. Excellent intra-rater reliability was found for the researcher, with an intra-class correlation coefficient ICC (3,3) of 0.99 (SEM = 0.0113).

An 11-point numeric pain rating scale (NPRS) was utilized to measure pain level.\(^{27, 28, 29}\) The NPRS is anchored on the left with a score of 0 and the phrase “no pain”, and on the right with a score of 10 and the phrase “worst imaginable pain.” Subjects were asked to rate their current level of pain, and their least and worst amount of pain in the last 24 hours. The subjects’ current level of pain was used for analysis. The minimal detectable change (MDC) and the minimal clinically important difference (MCID) for the NPRS have been reported as 2.1 and 1.3 points, respectively.\(^{30}\)

Perceived disability due to LBP was measured using the Oswestry Disability Index (ODI), which has been shown to demonstrate good reliability and validity as a measure of limitations in function.\(^{31}\) The ODI consists of 10 questions, each scored from
0 to 5, with higher scores indicating higher perceived disability. The MCID for the modified OD has been reported as 6 points in a sample of patients with acute LBP being seen for physical therapy treatment.31

The Fear-Avoidance Beliefs Questionnaire (FABQ) is a 16-item questionnaire developed to determine fear and avoidance beliefs in patients with LBP.32,33 The FABQ has 2 subscales: a 4-item scale to quantify fear-avoidance beliefs about physical activity (FABQPA) and a 7-item, scale to quantify fear-avoidance beliefs about work (FABQW). Each item is scored from 0 to 6, with higher scores representing increased fear-avoidance beliefs. Currently, there is little evidence reporting estimates for the MDC and MCID for the FABQ. Grotle et al.34 reported an MDC of 12 points for the physical activity subscale (FABQ-PA) and 9 points for the work subscale (FABQ-W) in the Norwegian version.

Finally, beginning immediately after the intervention and at each follow-up, subjects completed the Global Rating of Change (GROC) described by Jaeschke et al.35 The 15-point rating scale ranges from -7 (“a very great deal worse”) to 0 (“about the same”) to +7 (“a very great deal better”). Jaeschke et al. reported that scores of +4 and +5 are indicative of moderate changes in patient-perceived status and that scores of +6 and +7 indicate large changes in perceived status.35 The MCID for the GROC has been reported as a 3-point change from baseline.35

Data collection

All images taken in the study were stored on the hard drive of the US unit and were available to be recalled for measurement. The US unit’s built-in measurement tool was used to measure pre- and post-intervention thickness of TrA by two designated researchers. The thickness of the TrA was measured inside fascial layers of the TrA. To
standardize measurements both between and within subjects, measurements were taken perpendicular to a line bisecting the TrA, 2.0 cm lateral to the medial fascial insertion of TrA. Measured thickness was rounded to the nearest 0.01 cm. The two researchers performed each of the measurements together and reached consensus on the measurement by agreement while the data was recorded by a third in order to standardize the measurements and maintain blinding. Three images were collected in each condition; pre-intervention resting, and contracted and post-intervention resting and contracted for a total of 12 measurements for each subject and recorded at the end of each intervention session.

Statistical Analysis

In order to assess the effect of each intervention, five, two-way ANOVA with repeated measures were conducted with time as the within-subject factor and intervention as the between-subject factor. The dependent variables of interest were resting thickness pre- and post-intervention; contraction thickness pre- and post-intervention; NPRS scores at baseline, immediately post-, 2-day post-, and 7-day post-intervention; ODI scores at baseline, 2-days post-, and 7-days post-intervention; GROC scores immediately post-, 2-days post-, and 7-days post-intervention. If a significant time-by-intervention group interaction or a significant main effect was found, post-hoc (paired t-tests with a Bonferroni correction) was utilized to compare the differences between the groups. Statistical analysis was done using SPSS statistical software (v. 22.0, International Business Machines Corp, Armonk NY. USA) using a significance level of 0.05.
RESULTS

Data from this study was obtained from 30 subjects, 11 males and 19 females, currently experiencing symptoms of LBP. The subject demographics can be found in table 1. One subject was excluded due to the absence of the required pain level as described in the inclusion criteria (figure 1). The results of five separate two-way repeated measures ANOVAs showed that intervention type (dry needling and sham needling) did not have a main effect for time on TrA resting thickness ($p=0.862$) (figure 3) or GROC scores ($p=0.895$). The 2-way ANOVAs revealed no intervention*time interactions for TrA resting thickness ($p=0.149$), TrA contracted thickness ($p=0.697$), NPRS scores ($p=0.188$), ODI ($p=0.421$), and GROC ($p=0.350$). We also did not observe main effects for group assignment for TrA resting thickness ($p=0.607$), TrA contracted thickness ($p=0.432$), NPRS scores ($p=0.657$), ODI ($p=0.527$), and GROC ($p=0.499$).

The two-way repeated measures ANOVAs did, however, indicate a main effect for time for TrA contracted thickness ($p = 0.004$), NPRS scores ($p<0.001$), and ODI scores ($p<0.001$). A post-hoc analysis revealed a significant increase in TrA contracted thickness (figure 4) between pre- and post-intervention in both groups ($p=0.004$) as well as a significant decrease in NPRS scores (figure 5) between baseline, immediately post- and 2-days post-, and 7 days post- ($p<0.001$) in addition compared to immediately post-intervention pain scores, pain at 2-days post- was also significantly improved however no difference between scores at 2-days post- and 7-days post-intervention. Post-hoc analysis also showed a significant decrease in ODI scores (figure 6) between baseline and 2-days post-intervention ($p<0.001$), and between baseline and 7-days post-intervention.
(p<0.001), but there was no significance found between ODI scores at 2-days post- and 7-days post-intervention. (p=1.00).

DISCUSSION

Studies have shown that dry needling may have a positive effect on LBP. The intent of this study was to investigate whether dry needling would cause a change in resting and contracted thickness of the TrA, pain, and disability in subjects with LBP when compared to a sham needling group. It was hypothesized that due to the connection of the TrA to the lumbar MF via the lateral raphe, the relaxation of the MF would relieve tension on the TrA and enhance its ability to rest and contract, allowing the muscle to provide better spinal stabilization and improve pain and perceived disability. It was also hypothesized that these changes would not be seen in the sham needling group.

Our data did not support these hypotheses. There was no significant interaction between intervention (sham needling vs. dry needling) and time in regards to resting thickness or contracted thickness of the TrA pre- and post-intervention. Though there may be many potential reasons for this, we speculate that the lack of significant difference in contracted thickness between groups may be due to the subjects’ inability to control activation of TrA. Studies have shown that people experiencing LBP also have a decreased motor planning ability of TrA in preparation for a perturbation\textsuperscript{36}, and that they have a diminished ability to contract TrA independently of the other abdominal muscles.\textsuperscript{37} Even if the dry needling of lumbar MF did have an effect on the ability of the TrA to contract, that difference may not have been seen immediately in our subjects with LBP. As for the lack of significant difference in resting thickness of the TrA between the
two groups, the reason remains unanswered. The study may have been underpowered due to the low number of subjects, which may warrant further investigation. There was, however, a main effect for time for both groups in regards to contracted thickness. This may have been due to a learning effect in which both groups, with repetition and practice of the DCC, were better able to contract the TrA, regardless of the intervention given.

A significant pain reduction from baseline, immediately post-, and 2-days post intervention was seen, but it was seen equally for both the sham needling and dry needling groups, suggesting any decrease in pain may be a result of placebo effect (positive expectation) rather than any physiological effect. A study investigating the mechanism of pain reduction using dry needling to the jaw muscles similarly saw significant pain intensity and unpleasantness score decreases for both the dry needling and sham needling groups.38 Additionally, a study of subjects with myofascial trigger points in the upper trapezius muscle also saw no difference in pain found directly after the intervention between the dry needling and placebo groups.39 Other studies, however, have found dry needling superior to sham needling or placebo in terms of pain reduction for various regions of the body.40,41,42 Further studies need to be conducted to examine the effect of dry needling on pain reduction in the lower back.

A similar reduction in ODI scores was also seen for both groups regardless of intervention type. A study by Gerber et al. looking at dry needling to myofascial trigger points in the upper trapezius also found a reduction in ODI scores,43 while another study by Koppenhaver et al. found that only some of the participants that received dry needling to the lumbar MF had a reduction in ODI scores while others did not.44 Further analysis within that study revealed that the greatest predictor of ODI reduction one-week post dry
needling to the lumbar MF was the presence of pain during the multifidus lift test. This test assesses the isolated activation of the lumbar MF during a contralateral arm lift while prone. Pain during this test which isolates lumbar MF suggests a true active or latent trigger point within the muscle, and dry needling has been shown to have a local hypoalgesic effect for these types of muscles. While our results found that not all people experiencing LBP had greater improvements in disability with dry needling than a control group, it may be that certain classifications of LBP, such as true active or latent trigger point, will respond better than others.

Study Limitations

We recognize that our study is not without limitations. One limitation of our study may be due to the small sample size for both groups. With only 15 subjects in each group, any outliers in data might have shifted the results of the study to a greater degree than if there were more subjects recruited. The results of our study may not represent, as a whole, the population of people with LBP that are using dry needling as a treatment intervention.

A second possible limitation of the study may be related to a lack in understanding of the standardized instruction in performing the DCC. Each subject was given the same instructions using key words, but some participants required additional reinforcement cues, which may have introduced variability in training. Furthermore, verbal and tactile cues were given as needed based on the ability of the subject to contract their TrA, and may also have attributed to some variability.
A third possible limitation may have been variability in the maximum contraction and relaxation of the TrA performed during the DCC by the participant. It was not possible to detect whether the subject was fully relaxing or contracting their TrA. Discretion was given to the researchers obtaining the US images as to whether the participants were performing their maximum contraction or relaxation. Researchers were able to decide to accept an image as their maximum contraction or relaxation, or to perform another repetition with verbal cuing to maximally relax or perform the DCC. Similarly, people with LBP display poor control of the TrA, and an inability to contract the TrA separate from other spine stabilizing muscles. This impairment may cause additional difficulty for our subjects to perform their maximum DCC.

Though each intervention, sham needling and dry needling, required some time to be provided, there may have been a learning effect seen between the pre- and post-intervention DCC and US imaging. With each repetition of DCC, there may have an added neuromuscular control of the TrA. Furthermore, many subjects were not familiar with the isolated contraction of the TrA and the novelty of the DCC may have contributed to their learning.

Finally, another possible limitation in our study is the inclusion of subjects undergoing medical treatment for their LBP. Because we did not exclude participants currently receiving other treatments such as physical therapy, or chiropractic services, any improvements in pain or disability seen in our subjects may have been due to those treatments and not the intervention.
CONCLUSION

Although dry needling may be an effective treatment for relieving LBP, the mechanism behind how this may occur is still not known. Our results showed that dry needling to the lumbar MF did not change resting and contracted thickness of the TrA in comparison to a sham needling intervention, suggesting that the effect of dry needling on LBP may not be through increased contraction efficiency of the TrA. Pain and ODI scores significantly decreased for both the dry needling and sham needling groups, suggesting a possible placebo effect.
Figure 1: Flow Chart of Subject Recruiting and Retention

31 Participants with mechanical low back pain screened for eligibility criteria

Not eligible
(n=1)

Pain level <2/10

Eligible
(n=30)

Declined to participate
(n=0)

Agreed to participate, signed informed consent
(n=30)

Randomization into intervention groups

Dry needling group
(n=15)

Sham needling group
(n=15)

Drop outs
(n=0)

Follow-up 48 hours later
(n=15)

Follow-up 48 hours later
(n=15)

Drop outs
(n=0)

Follow-up 7 days later
(n=15)

Follow-up 7 days later
(n=15)

Drop outs
(n=0)

Total participants who completed study
(n=30)
Figure 2. Flowchart of overall study

Table 1. Comparison of descriptive statistics between intervention groups

<table>
<thead>
<tr>
<th></th>
<th>Dry needling group (N=15)</th>
<th>Sham needling group (N=15)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>6 (40%)</td>
<td>5 (33.33%)</td>
<td>0.716</td>
</tr>
<tr>
<td>Female</td>
<td>9 (60%)</td>
<td>10 (66.67%)</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>27.07 (±6.065)</td>
<td>33.29 (±14.231)</td>
<td>0.072</td>
</tr>
<tr>
<td>Activity level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mostly sedentary sedentary, walking</td>
<td>1 (6.67%)</td>
<td>3 (20%)</td>
<td></td>
</tr>
<tr>
<td>moderately active demanding activity</td>
<td>2 (13.33%)</td>
<td>3 (20%)</td>
<td></td>
</tr>
<tr>
<td>demanding activity</td>
<td>7 (46.67%)</td>
<td>6 (40%)</td>
<td></td>
</tr>
<tr>
<td>5 (33.33%)</td>
<td></td>
<td>3 (20%)</td>
<td></td>
</tr>
<tr>
<td>Days of back pain</td>
<td>1370.00 (±1767.966)</td>
<td>2397.43 (±3140.953)</td>
<td>0.283</td>
</tr>
<tr>
<td>ODI</td>
<td>13.40 (±6.010)</td>
<td>15.73 (±8.128)</td>
<td>0.379</td>
</tr>
<tr>
<td>FABQ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work</td>
<td>12.60 (±7.586)</td>
<td>17.07 (±12.826)</td>
<td>0.255</td>
</tr>
<tr>
<td>Physical</td>
<td>10.80 (±5.906)</td>
<td>14.27 (±7.459)</td>
<td>0.169</td>
</tr>
</tbody>
</table>
Image 1: Subject positioning for ultrasound imaging

Image 2. Set up of filament needle for dry needling intervention

Image 3. Set up of empty needle casing for sham needling intervention
### Table 2. Comparison of TrA thickness, pain, and disability between intervention groups

<table>
<thead>
<tr>
<th></th>
<th>Time</th>
<th>Dry needling group (N=15)</th>
<th>Confidence Interval</th>
<th>Sham needling group (N=15)</th>
<th>Confidence Interval</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Resting thickness (cm)</strong></td>
<td>Pre</td>
<td>0.338 (± 0.094)</td>
<td>0.286-0.391</td>
<td>0.373 (+/- 0.125)</td>
<td>0.304-0.442</td>
<td>0.395</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>0.352 (± 0.099)</td>
<td>0.297-0.407</td>
<td>0.356 (+/- 0.109)</td>
<td>0.296-0.417</td>
<td>0.907</td>
</tr>
<tr>
<td><strong>Contraction thickness (cm)</strong></td>
<td>Pre</td>
<td>0.612 (± 0.085)</td>
<td>0.565-0.659</td>
<td>0.665 (+/- 0.215)</td>
<td>0.546-0.784</td>
<td>0.382</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>0.661 (± 0.121)</td>
<td>0.594-0.728</td>
<td>0.703 (+/- 0.211)</td>
<td>0.586-0.820</td>
<td>0.509</td>
</tr>
<tr>
<td><strong>Pain</strong></td>
<td>Pre</td>
<td>3.60 (± 2.028)</td>
<td>2.48-4.72</td>
<td>3.87 (+/- 1.767)</td>
<td>2.89-4.85</td>
<td>0.704</td>
</tr>
<tr>
<td></td>
<td>Post 2 days</td>
<td>2.80 (± 1.656)</td>
<td>1.88-3.72</td>
<td>2.27 (+/- 1.486)</td>
<td>1.44-3.090</td>
<td>0.361</td>
</tr>
<tr>
<td></td>
<td>Post 7 days</td>
<td>1.33 (± 1.496)</td>
<td>0.50-2.16</td>
<td>2.07 (+/- 1.792)</td>
<td>1.07-3.06</td>
<td>0.234</td>
</tr>
<tr>
<td></td>
<td>Post 1.5 days</td>
<td>1.73 (± 2.120)</td>
<td>0.56-2.91</td>
<td>2.27 (+/- 2.251)</td>
<td>1.02-3.51</td>
<td>0.51</td>
</tr>
<tr>
<td><strong>ODI</strong></td>
<td>Pre 2 days</td>
<td>13.40 (± 6.010)</td>
<td>10.07-16.73</td>
<td>15.73 (+/- 8.128)</td>
<td>11.23-20.23</td>
<td>0.379</td>
</tr>
<tr>
<td></td>
<td>Post 7 days</td>
<td>10.20 (± 6.868)</td>
<td>6.40-14.00</td>
<td>10.47 (+/- 8.070)</td>
<td>6.00-14.94</td>
<td>0.923</td>
</tr>
<tr>
<td></td>
<td>Post 14 days</td>
<td>9.13 (± 5.693)</td>
<td>5.98-12.29</td>
<td>11.33 (+/- 8.910)</td>
<td>6.40-16.27</td>
<td>0.427</td>
</tr>
<tr>
<td><strong>GROC</strong></td>
<td>Post 2 days</td>
<td>2.07 (±2.939)</td>
<td>0.44-3.69</td>
<td>3.67 (+/- 1.799)</td>
<td>2.67-4.66</td>
<td>0.083</td>
</tr>
<tr>
<td></td>
<td>Post 7 days</td>
<td>2.67 (± 2.526)</td>
<td>1.27-4.07</td>
<td>2.53 (+/- 3.159)</td>
<td>0.78-4.28</td>
<td>0.899</td>
</tr>
<tr>
<td></td>
<td>Post 14 days</td>
<td>2.67 (± 2.690)</td>
<td>1.18-4.16</td>
<td>2.47 (+/- 3.292)</td>
<td>0.64-4.29</td>
<td>0.857</td>
</tr>
</tbody>
</table>
Figure 3. Change in resting thickness

No interaction between intervention and time on TrA resting thickness ($p>0.05$) and no main effect of time on TrA resting thickness ($p>0.05$).

Figure 4. Change in contraction thickness

No interaction between intervention and time on TrA contraction thickness ($p>0.05$) but significant main effect for time with significant increase ($p=0.004$) in contraction thickness over time for both groups.
**Figure 5. Change in pain**

No interaction between intervention and time on NPRS scores ($p>0.05$) but * indicates significant decrease in NPRS scores from pre-intervention and ‡ indicates significant decrease from post-intervention.

**Figure 6. Change in disability**

No interaction between intervention and time on ODI scores ($p>0.05$) but * indicates significant decrease in ODI scores from baseline.
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