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The Effect of Trigger Point Dry Needling to the Multifidus Muscle on Resting and Contracted Thickness of Transversus Abdominis in Healthy Subjects

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THE EFFECT OF TRIGGER POINT DRY NEEDLING TO THE MULTIFIDUS MUSCLE ON RESTNG AND CONTRACTED THICKNESS OF TRANSVERSUS ABDOMINIS IN HEALTHY SUBJECTS

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A doctoral project submitted in partial fulfillment

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Abstract

Study Design: Randomized, blinded, controlled cross-over trial with each subject receiving both interventions within a seven-day span.

Objective: To determine if differences occurred in resting- or contraction-thickness of the transversus abdominis (TrA) muscle following application of trigger point dry needling (TPN) of the lumbar multifidus (MF) muscle in asymptomatic subjects.

Background: Recent studies have shown TPN decreases pain in areas throughout the body. The effect of dry needling the MF on low back pain (LBP), and its effect on core stabilization have not been investigated.

Methods: Forty-three healthy individuals who had not experienced LBP in the previous six months were randomly assigned to receive TPN to the MF or a sham intervention at their initial treatment session. All individuals were instructed on how to perform a concentric contraction of the TrA. Resting and contraction thicknesses of the TrA were obtained through real-time ultrasound (US) measurements before and immediately following intervention. As part of this crossover trial, subjects returned 2-7 days after the initial treatment to receive the alternate intervention, and the US measurements were repeated.

Results: Two-way ANOVA revealed a significant interaction for contraction and treatment ($p=.002$). Simple main effects using paired-samples t-tests and a Bonferroni post-hoc revealed difference in contracted states for needling versus sham ($p=.009$) and between contracted and resting states for needling ($p=.001$). There was no significant difference between resting states for needling versus sham.

Conclusion: Our results indicate that TPN to the MF causes a decreased thickness of the TrA at rest and an increased thickness of TrA in contracted state. These findings suggest that TPN could allow for a more efficient contraction of the TrA to help increase core stability.

Introduction:

Low back pain (LBP) affects a large percentage of people in the world each year, consuming healthcare resources and contributing significantly to healthcare costs. In the United States, LBP has a direct cost of up to $90.6 billion per year.[1] It is the most frequently reported musculoskeletal complaint in the United States, with 26.4% of the population reporting pain for at least one day within the last three months and 41% of adults aged 28-44 years reporting LBP within the last six months, which has limited people from performing work and participating in leisurely activities.[2,3] Low back complaints are responsible for 31% of healthcare visits for people between the ages of 18 and 44.[2]

Despite LBP being a prevalent condition, only low levels of evidence exist supporting the effectiveness of many interventions currently used by physical therapists. These interventions include exercise therapy, back school, transcutaneous electrical nerve stimulation (TENS), low level laser therapy, manipulation, education, massage, behavioral treatment, traction, multidisciplinary treatment, lumbar supports, and heat/cold therapy.[4] Alternative interventions should be evaluated in order to find a more efficient way to help these individuals.

A considerable precipitating factor in the manifestation of LBP is the presence of myofascial trigger points (TrPs) within the lower back musculature itself, as well as in adjacent muscle groups. A TrP is defined as "a highly localized, hyperirritable spot in a palpable, taut band of skeletal muscle fibers".[5] TrPs are believed to be due to an excessive release of acetylcholine from dysfunctional motor nerve terminals, resulting in spontaneous electrical activity and stimulating muscle contraction, leading to muscle shortening.[6-8] These TrPs present as hyperirritable spots that are painful upon compression and palpation, leading to increased pain levels, referred tenderness, motor dysfunction, and autonomic sensations.[7] TrPs have been organized into two separate classifications, referred to as active trigger points (ATrPs) and latent trigger points (LTrPs). ATrPs result in pain with compression, movement, and even at rest; they can cause local pain, muscle weakness, loss of coordination, decreased work tolerance, autonomic phenomena, and refer pain or paresthesias to distal sites.[6-8] Conversely, LTrPs result in pain only under localized compression and often permit pain-free movement. LTrPs are often found in healthy muscles and are considered to be a precursor to ATrPs, as they can alter muscle activation patterns and contribute to limited range of motion.[6-8]

One technique that may be utilized to address the presence of TrPs is a manual therapy technique referred to as trigger point dry needing (TPN). TPN involves the insertion of a solid monofilament needle into a palpated TrP to deactivate the TrP, leading to decreased pain levels and increased range of motion. TPN is applied based on a strict physical exam and assessment of the neuromuscular system. It is based on pain patterns, muscular dysfunction, and ultimately the clinical signs and symptoms specific for each individual patient.[9] TPN is not to be confused with acupuncture, which is based on eastern Chinese medicine with a medical diagnosis which dictates treatment of specific acupuncture points along specific meridians.[9] Despite the differences in these approaches, acupuncture and TPN are found to share about 70% of the same insertion points.[8] However, the important difference is how these insertion points are located. The location to be dry needled is determined via careful palpation to ensure specific treatment to the muscle of interest, whereas acupuncture is applied to a preset generic map of locations.[9]

The overall goals of TPN are to decrease spontaneous electrical activity, release shortened muscles to restore range of motion, promote healing via a local inflammatory response, and obtain a local twitch response (LTR).[6,10] A LTR is a spinal cord reflex that results in a muscular twitch contraction when a TrP is stimulated via the insertion of a needle that is typically visually observable.[6] This LTR is considered the most reliable measure of a TrP being released.[6]

Several studies have researched the benefits of TPN in various parts of the body, which include reduction of pain levels and improvements in range of motion (ROM).[5,11,12,13] Local TrPs can cause generalized pain, such as LBP or headache.[11] TPN of these points can increase an individual's pain threshold, resulting in a reduction in pain levels.[11] Research involving TPN of the infraspinatus muscle resulted in increased active range of motion (AROM), passive range of motion (PROM), and pressure pain threshold, as well as decreased pain intensity on the treated side compared to the untreated side.[12] TPN of additional TrPs throughout the body has been shown to decrease pain immediately after treatment, at two weeks and at eight weeks following treatment.[13] Theoretically, the taut band restricts the muscle's ability to relax fully by maintaining a level of contraction, causing the muscle be thicker at rest. Potentially, this could also prevent the muscle from contracting to its maximum potential due to muscular fatigue caused by the taut band itself. This concept suggests that TPN could release the taut band, leading to a thinner muscle at rest and a thicker muscle when actively contracted, and thus enhancing the overall contractile ability of the muscle.

The MF and TrA have been shown to play an important role in LBP. [14,15,16] These muscles are linked together via the thoracolumbar fascia, enabling them to work together for core stabilization. Individuals with LBP have shown decreased shear strain in their thoracolumbar fascia compared to their healthy counterparts.[15] Patients with a strong MF contraction are 4.5 times more likely to have a strong TrA contraction.[14] Similarly, the inability to contract the MF was correlated with an inability to contract the TrA.[14] TPN of TrPs has been shown to affect the agonist-antagonist relationship within muscle groups, such as the shoulders.[12] It has been shown, that LTrPs decrease reciprocal inhibition, making agonist contractions less effective. One study looked at the effects of dry needling the posterior deltoid when measuring shoulder flexion. During shoulder flexion, there was more activity in the posterior deltoid, the antagonist, when trigger points were present, therefore decreasing the overall effectiveness of the agonist muscles.[17] If this concept can be spread to the agonist actions of the MF and TrA, it is likely that TPN of TrPs in the MF muscles may result in an increase in the contraction thickness of the TrA.

The thickness of the MF muscle is associated with LBP, with prolonged LBP correlating with a thinner MF muscle than individuals experiencing shorter-duration LBP.[14] Additionally, individuals with LBP had a decreased ability to contract the MF.[14] Also, subjects performing MF and TrA strengthening exercises have shown significant improvements in the Joint Play Grading Scale and decreased pressure pain compared to subjects who were only placed in prone lying and received no other treatment.[16] These studies suggest decreased strength in the core muscles could be associated with LBP.

This study will examine the effect that TPN of the MF has on the resting and contraction thickness of the TrA. The ability of TPN of the MF to facilitate a change in the thickness of the TrA would result via the biomechanical mechanism involving the thoracolumbar fascia. Since very few studies have examined TPN of the MF, this study was performed on asymptomatic individuals to examine the biomechanical effect. This means that LTrPs were targeted. It is believed that TPN of the MF may decrease the resting thickness of the TrA and increase the contraction thickness of the TrA. An increase in the contraction thickness of the TrA may demonstrate an increased ability to contract this muscle, thereby increasing the contraction of the core stabilizers. This potential increase could aid in the recovery of patients with LBP in future treatments. Current evidence is lacking on this subject and is greatly needed in order to effectively treat this extensive patient population.

Methods

Subjects

Data from this study were obtained from a sample of convenience resulting in 43 asymptomatic subjects (18 male, 25 female) that were recruited by word of mouth and flyers at University of Nevada Las Vegas. According to Koppenhaver et al,[18] a moderate to large effect size would be obtained from this number of subjects (Cohen's d = .30-.40), making it a sufficient sample size for our study. Specifically, using a degree of freedom of 1 for the 2-way interaction, $\alpha = .05$ and power = .80, 26 to 45 individuals were needed for an adequate sample size.

Inclusion criteria for this study were that subjects had to be: a) between the ages of 18 and 60, b) report that they had not had LBP for at least six months, c) were comfortable being needled, and d) were able to perform a deep corset contraction (DCC). As this study was limited to healthy individuals, exclusion criteria consisted of seeking medical treatment for LBP in the last six months, fear of needles, history of abdominal or spinal surgery, significant scoliosis, rheumatoid arthritis, osteoporosis, osteopenia, or active ankylosing spondylitis. Subjects were also excluded if they were pregnant; as dry needling can induce uterine contractions.[10] Written informed consent was given at the treatment facility prior to the first treatment being administered. This study was approved by the UNLV Biomedical Institutional Review Board.[*]

Procedures

Randomization and DCC training

The order in which the two interventions, TPN or sham needling, were administered for each participant was determined through random assignment. A card reading one of two interventions was drawn from a sealed envelope at the beginning of each participant's first session. The alternative intervention was administered at the follow-up visit two to seven days later. This process is detailed in a flow chart in Figure 1.

At each subject's initial visit, they were taught how to perform a DCC. This involves the drawing in of the abdominal wall, eliciting a maximal concentric contraction of the TrA. Re-educating the TrA muscle function using this draw-in maneuver allows for a more efficient and measurable contraction.[19] Initially, participants were manually assisted in finding the neutral spine position in the quadruped position. Then they were instructed to perform the DCC by drawing the umbilicus towards their spine. This

[*] Protocol #1202-4059: The effect of trigger point dry needling to the multifidus muscle on resting and contracted thickness of transversus abdominis in healthy subjects

contraction was performed five times in quadruped, holding each contraction for the duration of two normal breaths. This was followed by performing the same contraction five times in prone, five times in right hook-lying, and five times in supine.

Next, a researcher used a real-time ultrasound unit on the subject's right TrA and showed the image to the subject while they performed two contractions of the TrA. This visual feedback was provided to facilitate a maximal contraction of the TrA. The subjects were given a rest period of approximately 5 minutes to prevent fatigue, then the screen was turned away from the subject for images to be taken for measurement. Six total measurements were taken, three with the subject relaxed and three with the subject performing a DCC. The subject was placed in prone to receive either the TPN intervention or the sham intervention based on their random assignment as described above. Prior to each treatment, a sanitization wipe was used on the subject's lower back and the researcher put on protective gloves to ensure sterile conditions.

The TPN intervention consisted of the subject lying prone and receiving two needles into their MF muscle, one on each side. Needles were placed bilaterally approximately one-inch lateral to the spinous process of the L4 vertebrae. This location was found by palpation of the posterior superior iliac spine and moving up one spinous process from that level, at which time the general vicinity was palpated for LTrPs to be needled. Each needle was threaded until a TrP was hit, eliciting a local twitch response (Images 1 and 2). After each use, all needles were disposed of in a sharps container.

The sham intervention consisted of taking the needle out of the tube and placing it in a sharps container without the subject's knowledge of that occurrence. The same palpation method was used to locate the treatment site. The empty tube was repeatedly tapped approximately ten times on the subject's back at the same locations in which the dry needle would have been inserted (Image 3). Immediately following treatment, the subject was placed in supine for an additional six ultrasound measurements of the right TrA, three with the subject relaxed and three with the subject performing a DCC.

Subjects then returned two to seven days later to receive the alternate intervention, following the same procedure. Measurements of the ultrasound images were performed at a later time after all data had been collected.

Ultrasound Instrumentation and Measurement Technique

The contraction thickness of the TrA was measured using real-time ultrasound imaging. This technique has been shown to be reliable for measuring cross-sectional area of MF and TrA when compared to measurements using MRIs.[20] Standardization of the images was achieved by placing the transducer one inch above the right iliac crest with the best attempt at maintaining a steady position throughout the imaging. Studies have found measuring the TrA during a DCC provides a reliable measurement of a concentric contraction.[19]

Researchers performing ultrasound imaging were not present in the room when treatments were being administered to ensure blinding. Patients were instructed not to discuss which treatment they thought they had received with the other researchers. Measurement of the ultrasound images was done by a sonographer blinded to the treatments. The sonographer had more than 10 years of experience in musculoskeletal imaging and was a member of the Society of Diagnostic Medical Sonography (SDMS).

Intra-rater and inter-rater reliability in using ultrasound measurements in the cross-sectional area of the TrA are high.[20] It has been shown that individuals trained on

US machines have much higher inter-rater and intra-rater reliability than untrained individuals. The ability of the sonographer to consistently measure TrA thickness directly from the images was confirmed by having her measure muscle thickness on the same images from 10 consecutive subjects on different days. These included 3 separate images of the muscle taken at rest and another 3 images taken during contraction prior to the intervention phase of the study. Intrarater reliability was excellent with intraclass correlation coefficients ICC (3,3) = 0.99 (SEM = 0.0113).

In a crossover acupuncture study evaluating the use of a sham needle and a blunted acupuncture needle that did not penetrate the skin, it was found that subjects could not tell the difference between the blunted needle and the penetrating acupuncture needle.[21] This validates the use of an empty tube pressed on the MF bilaterally in our study, representing the sham treatment.

Data Management and Analysis

All ultrasound imaging images were coded, stored on the ultrasound unit's hard drive, and later downloaded to ImageJ software for measurement.[23] Muscle thickness (to the nearest 0.01 mm) was measured from the inside edges of the fascial bands of the TrA muscle. To consistently measure the same point along the muscle belly, measurements were taken perpendicular to a line through the middle of the muscle belly, 2.5 cm lateral to the rectus sheath muscle-fascia junction.[20]

To assess the relationship of dry needling of MF on TrA muscle thickness, a 2 (contraction: resting and contracted) X 2 (treatment: needling and sham) factorial ANOVA was conducted. We calculated resting thickness for each treatment condition by subtracting the post-intervention thickness from the pre-intervention thickness. We then repeated this for contracted thickness for each treatment condition. If an interaction was found, we conducted post-hoc paired t-tests with Bonferonni correction.

All statistical analyses were performed using SPSS statistical software (v. 21.0, International Business Machines Corp., Armonk, NY, USA) and the significance level was set as 0.05.

Results

Descriptive statistics from the study are provided in Table 1. We conducted a 2 (contraction: resting and contracted) X 2 (treatment: needling and sham) factorial ANOVA for each contraction state. Resting thickness was calculated by subtracting post-intervention thickness from pre-intervention thickness. This calculation was also done for contraction thickness.

There was a significant interaction observed for contraction and treatment $F(1,42) = 11.489$, $P=0.002$ (observed power = 0.912). Simple main effects using 4 paired-samples t-tests and a Bonferroni corrected alpha of 0.0125 were conducted. There were statistically significant differences in contracted states for needling versus sham ($P=0.009$) (Figure 2, Table 3) and between contracted and resting states for the needling ($P=0.001$)(Figure 3, Table 3). After dry needling, the mean change of TrA thickness at rest was a .03cm decrease and during contraction was a .05cm increase. This is well beyond the measurement error of the ImageJ software of .01 mm. Means for each pre-treatment and post- treatment measure, and the mean change for each treatment may be found in Table 2.

There was no significant difference in resting states for needling versus sham (P=0.107) and between contracted and resting states for sham needling (P=0.874) (Table 3).

Discussion

Despite several treatment approaches to LBP, only low levels of evidence suggest any of them as effective. TPN is a treatment technique that has been proven to decrease pain and improve function in various parts of the body. We hypothesized that TPN the MF would result in a decreased thickness in the TrA at rest and an increased thickness of the TrA when contracted, resulting in an overall increased excursion of the muscle. This hypothesis held true. Our results indicate that TPN of the MF creates an increased contraction thickness of the TrA and a decreased resting thickness of the TrA. Therefore, the TrA has a greater overall extensibility and is presumably capable of a larger contraction following dry needling of MF. This effect is likely due to the connection of the TrA to the MF via the thoracolumbar fascia. TPN of the MF allows for further relaxation at rest, which decreases the strain through the thoracolumbar fascia, therefore allowing the TrA to further relax. Additionally, it is possible that TPN released the LTrPs in the MF, allowing a more efficient contraction. A more efficient contraction of the MF would then allow the TrA to also elicit a stronger contraction, increasing the stability of the abdominal brace and overall core control.

Participants receiving the sham treatment did not have a significant change in thickness of the TrA at rest or when contracted, showing that our findings were not a result of increased ability to properly perform the contraction. Our results also show that after needling, contraction thickness of the TrA was significantly larger than that of participants receiving sham treatment. As studies have shown that LBP is directly correlated to the strength of the MF and TrA, this is a clinically relevant treatment for LBP that could help improve core strength and stability. If the TrA is enabled to elicit a more efficient contraction, LBP should theoretically decrease. Additionally, LBP is directly related to the thickness of the MF. Therefore, given that the MF had an increased contraction thickness following TPN, this may also contribute to a potential decrease in LBP.

Strengths and Limitations

Our study utilized an ultrasound imaging protocol similar to those used in other studies that were found to be reliable. Instructions for performing the DCC were similar for each patient, but no standardized script was used, leaving room for variability. Also, it was not possible to determine if each participant was consistently performing the DCC to the best of their abilities.

Although ultrasound measurements were obtained in less than 2 minutes following treatment given, a short lag time did take place, which may have allowed for neurophysiological changes to occur which may not have been captured by ultrasound imaging.

We did not investigate the effects of dry needling the MF on the MF directly. This choice was made due to the lack of reliability of measuring thickness of MF with ultrasound imaging. This should be considered in future research.

Our study was performed on healthy individuals to investigate the biomechanical effects of dry needling the MF on LTrPs. It must be considered that patients with LBP may have different neurophysiological responses to this treatment on ATrPs than patients with no recent history of LBP.

Future studies should examine the effects of dry needling the MF on both the TrA and the MF. Research should also investigate the effects of dry needling the MF on the pain level in patients with LBP.

Conclusion

Our results suggest that dry needling of the MF in healthy individuals results in a decreased thickness of the TrA at rest and an increased thickness of the TrA in a contracted state, indicating an increased overall excursion of this muscle. These results suggest that dry needling may be an effective alternative to treatment of LBP by increasing core control and stability.

Figure 1: Study flow chart

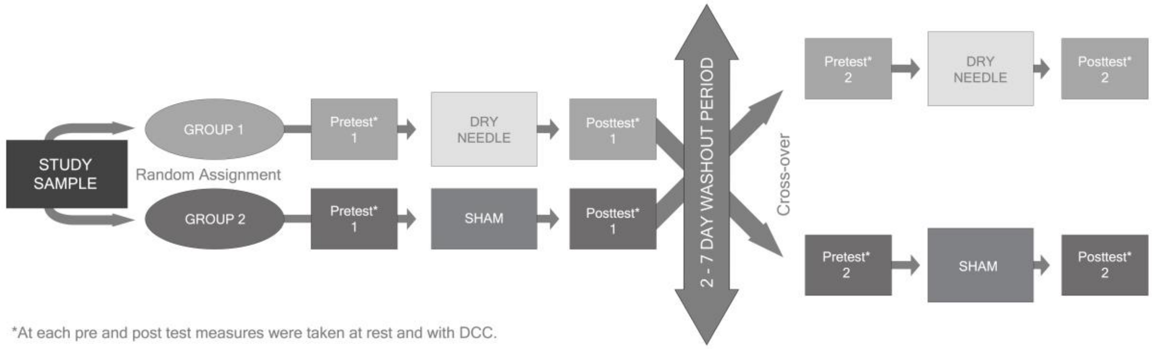


Image 1: Dry needle inserted into MF

Image 2: Threading with the dry needle in the MF to elicit a twitch response

Image 3: Sham needle placed on the MF and threaded to elicit a twitch response

Table 1: Descriptive statistics

Descriptive Statistics			
Gender	Male	18	42%
	Female	25	58%
BMI	< 18.5	1	2%
	18.5-24.9	35	82%
	>25	7	16%
Activity Level **(time spent exercising in 1 week)**	0-60 minutes	0	0%
	1-3 hours	10	23%
	4-6 hours	21	49%
	7-9 hours	5	12%
	> 9 hours	7	16%
Age Ranges **Mean age-25.23**	20-25	33	77%
	26-30	6	15%
	31-35	1	2%
	36-40	1	2%
	41-45	2	4%

Table 2: Mean resting and contraction measures and mean change (pre-treatment – post-treatment values) following treatment

Contraction	Treatment	Time	Mean (cm)	Standard deviation	Confidence Intervals		Mean change (pre-post)	Standard deviation of change	Confidence Interval of change	
					Lower Bound	Upper Bound			Lower Bound	Upper Bound
Analysis 1: Rest	TPN	Pre	.366	.115	.331	.401	.031	.072	.009	.053
		Post	.335	.120	.298	.372				
	Sham	Pre	.353	.116	.317	.389	.010	.046	-.004	.024
		Post	.343	.113	.308	.378				
Analysis 2: Contracted	TPN	Pre	.755	.224	.686	.824	-.050	.136	-.092	-.008
		Post	.805	.252	.727	.882				
	Sham	Pre	.702	.240	.628	.776	.012	.096	-.017	.042
		Post	.689	.223	.621	.758				

Table 3: Results of paired t-tests for change in TrA resting and contraction thickness following sham or TPN interventions

Results of paired t-tests for change in TrA resting and contraction thickness following sham or TPN interventions		
TPN Vs Sham	Contraction thickness	P = 0.009*
	Resting thickness	P = 0.107
Contraction Thickness Vs Resting Thickness	TPN	P = 0.001*
	Sham	P = 0.874

* Statistically significant values

Figure 2: Mean change of TrA thickness in contraction state following TPN vs. sham intervention

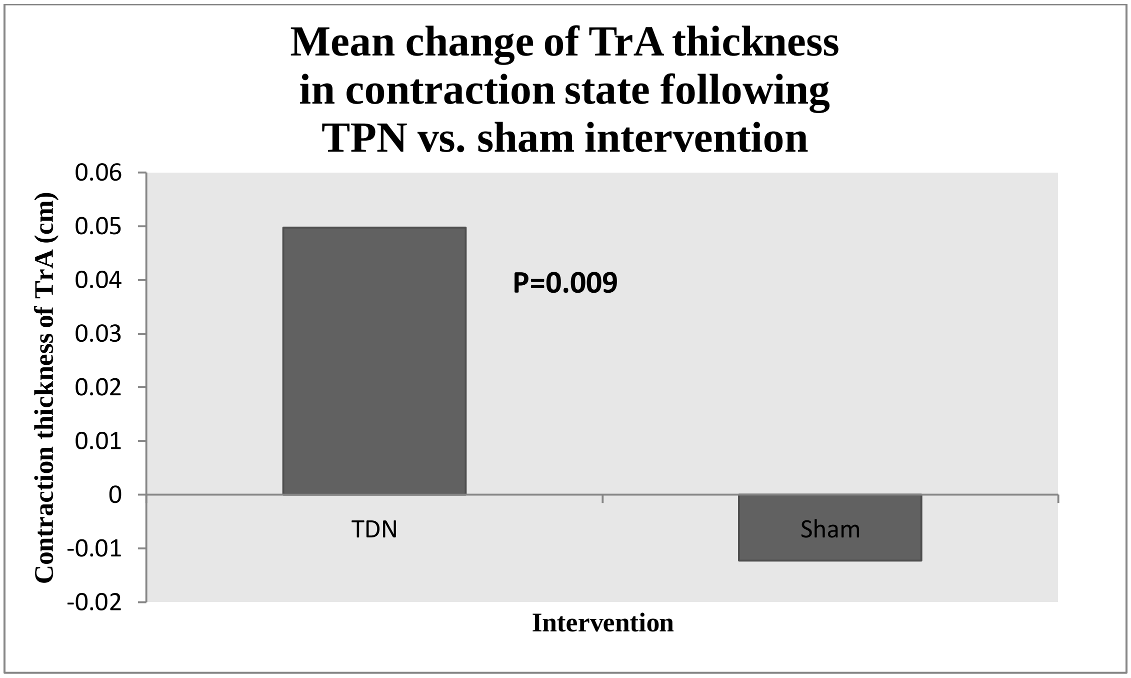
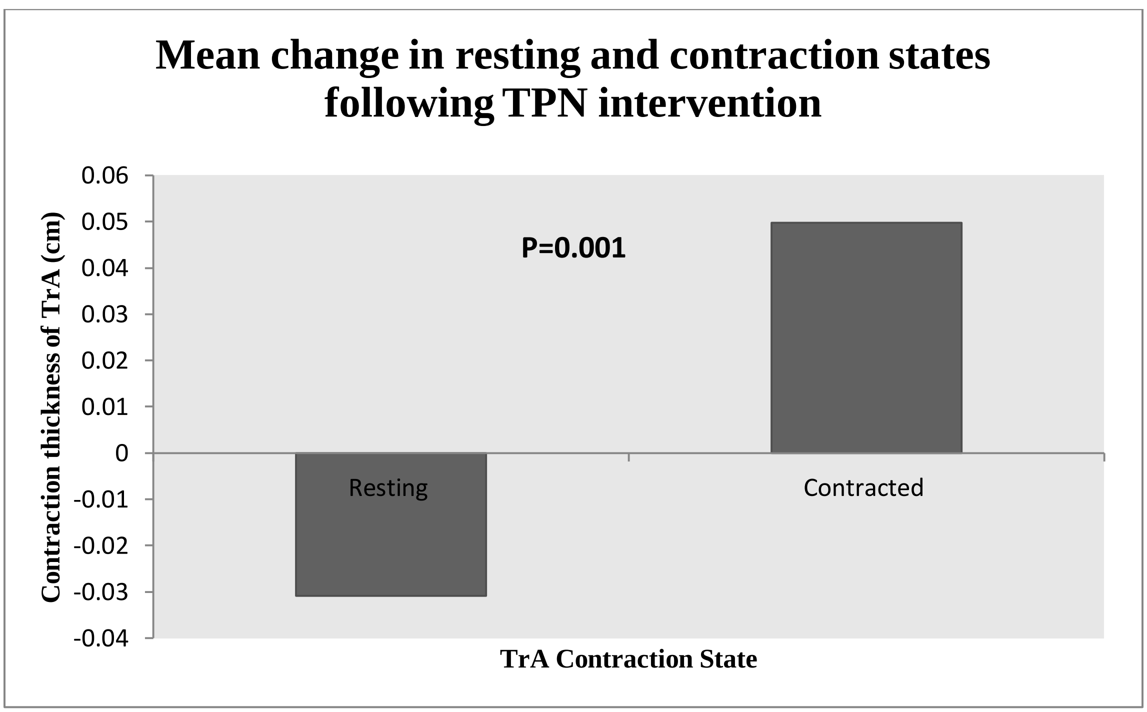


Figure 3: Mean change in resting and contraction states following TPN intervention



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Curriculum Vitae

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Education

University of Nevada, Las Vegas
Doctorate of Physical Therapy, expected graduation May 2014

University of Nevada Las Vegas
B.S of Kinesiological Science May 2011
Graduated Cum Laude

Clinical Experience

Henderson Physical Therapy
Henderson NV 89015
Orthopedic Outpatient Intern
06/25/2012 – 08/03/2012

Summerlin Hospital Medical Center
Las Vegas NV 89144
Inpatient Rehab Intern
07/15/2013 – 09/27/2013

Children's Medical Center at Legacy
Plano, TX 75024
Pediatric Outpatient Intern
10/07/2013- 12/18/2013

Texas Health Presbyterian Hospital Plano
Plano, TX 75093
Pediatric Outpatient/ Outpatient Rehabilitation Intern
01/06/2014 – 03/31/20

Research

Puentedura L, Buckingham S, Montoya C, Morton D. The Effect of Trigger Point Dry Needling to the Multifidus Muscle on Resting and Contracted Thickness of Transversus Abdominis in Healthy Subjects.