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CASE REPORT

DRY NEEDLING INCREASES MUSCLE THICKNESS IN A SUBJECT WITH PERSISTENT MUSCLE DYSFUNCTION: A CASE REPORT

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ABSTRACT

Background and purpose: Muscle dysfunction is very common following musculoskeletal injury. There is very little evidence to suggest that muscle function may be positively impacted by soft tissue interventions, such as dry needling. The purpose of this case report is to describe the immediate effect of dry needling on muscle thickness in a subject after shoulder surgery.

Case Description: A 22 year-old competitive gymnast presented seven months post shoulder surgery with significant impairments and functional limitations. Previous physical therapy focused on restoration of range of motion and strength using general exercise interventions, but the subject had persistent tightness and weakness of musculature of the shoulder complex. A subject-specific physical therapy program including manual physical therapy resulted in significant initial improvement, but lack of flexibility and weakness of the rotator cuff limited progress. Dry needling was used to address persistent myofascial trigger points.

Outcomes: Immediately after dry needling the infraspinatus, the muscle's thickness was significantly improved as measured by rehabilitative ultrasound imaging. There was a corresponding increase in force production of external rotation at 90 degrees of abduction.

Discussion: Minimal research exists that validates the potential of dry needling on muscle function, as assessed by muscle thickness measured using rehabilitative ultrasound imaging. The results of this case report suggest that dry needling contributed to improvement in muscle thickness and strength in a subject with muscle dysfunction following an injury.

Level of Evidence: 4

Key words: Dry needling, muscle thickness, trigger points

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BACKGROUND AND PURPOSE

Muscle dysfunction is commonly identified among subjects with persistent pain syndromes and musculoskeletal injuries.[1,2] Myofascial trigger points (MTrPs) develop within muscles associated with musculoskeletal pathology and may create a variety of symptoms and impairments including local and referred pain, decreased range of motion, muscle stiffness, and altered muscle function.[3-12] MTrPs are hypothesized to occur as a consequence of muscle overload either from prolonged low-level exertion (occupational posturing), repetitive eccentric and concentric contractions (throwing a ball), or direct traumatic overload (whiplash).[13]

Specifically, muscle inhibition following a musculoskeletal injury is a limiting factor to impairment resolution and functional progression. The exact mechanism of muscle inhibition has not been definitively identified, but appears to be due to deactivation of the muscle by the central nervous system in response to an injury, pain, or both.[14] This response occurs as a protective means to prevent further injury to the damaged structure. [14-16] However, even after the body has repaired the injured tissue, persistent muscle weakness and fatigue results when the muscle inhibition is left unaddressed, and ultimately, the muscle atrophies.[16] The sequelae of not treating muscle inhibition may include poor functional outcome and poor subject satisfaction.

A relatively novel mode of measuring muscle function in the clinic is with rehabilitation ultrasound imaging (RUSI). Measurement of the muscle thickness during contraction, relative to its resting thickness, provides an indirect measure of the muscle's function.[17] Muscle function is implied to be greater if there is an increase in muscle thickness during the contracted state as compared to the resting state. While the clinimetrics of RUSI are still developing, it appears to be a very promising tool for indirect measurement of muscle function in the trunk[17] and shoulder region.[18,19]

Most interventions that target muscle inhibition following a joint injury have focused on influencing the joint's mechanoreceptors, the peripheral nervous system, or the central nervous system.[15] A comprehensive systematic review[15] of interventions that combat muscle inhibition of the quadriceps revealed that TENS application had the strongest and most consistent benefit for improving muscle contractibility. Manual therapy had weak immediate effects, however, as only one study was identified that directly manipulated the soft tissue.[20] Specifically, the performance of active release technique for subjects with anterior knee pain did not reduce muscle inhibition or increase muscle strength immediately or within 20 minutes after the intervention.[20] Variable findings are reported when considering soft tissue mobilization on a more general measure of muscle function such as force production.[8,21-24] Direct intervention of the MTrP may be required to improve the function of the pathological muscle.

Dry Needling (DN) has become a recognized and accepted form of treatment of MTrPs among many different medical professionals.[3,25] DN has been defined by the American Physical Therapy Association as "a skilled intervention that uses a thin filiform needle to penetrate the skin and stimulate underlying myofascial trigger points, muscular and connective tissues for the management of neuromusculoskeletal pain and movement impairments".[26] While this intervention has received increasing attention as a modality for treatment of musculoskeletal disorders, quality research is limited with regard to its influence on MTrP symptoms, especially motor function.[10] The purpose of this case report is to describe the immediate effect of dry needling on muscle thickness in a subject after shoulder surgery.

CASE DESCRIPTION: SUBJECT HISTORY AND SYSTEM REVIEW

A 22-year-old female former collegiate gymnast presented to the physical therapy clinic seven months post surgical repair of a posterior labral tear of the right shoulder. She injured her shoulder during gymnastics practice five months prior to the surgery. However, because the competitive season had already started, she elected conservative management and participated in gymnastics with activity modifications. Immediately after the competitive season, the subject had surgery to repair the posterior labrum. She initially participated in physical therapy for six months, and the focus of therapy was self-directed restoration of range of motion (ROM) and standard strengthening exercises. She was frustrated with her continued limitation in shoulder mobility and strength which disrupted routine daily activities that required her to reach overhead. Therefore, the subject sought treatment at the authors' facility. The subject had no other significant medical conditions.

CLINICAL IMPRESSION #1

After taking a thorough history, the exact cause of the subject's limited range of motion (ROM) and strength could not be specified. Given that the surgical procedure was a posterior Bankart repair without involvement of other static or dynamic structures, there was no suspicion of iatrogenic involvement such as excessive tightening of the capsule or rotator cuff contracture. Also, given that the subject was young and had excellent health without any comorbidities, it seemed unlikely that she had developed any capsular adhesions from pathologies such as metabolic disorders. The authors' experience suggests that patients who have joint instability frequently develop muscle dysfunction in response to extreme muscle guarding of the shoulder musculature as they attempt to improve dynamic stability. Her description of the post-operative rehabilitation program also implied a non-specific exercise regimen that did not address specific limitations of muscle and capsular restrictions, such as inferior capsular restrictions, which limit shoulder elevation.

Examination

Posture: The subject had an endomorphic body type. Her BMI was 19.39 kg/m^2, and she had good general muscle definition and tone. She had a minimal forward head and anteriorly tilted scapulae, but the right scapula presented with a predominant Type 3 dysfunction as defined by Kibler et al.[27]

Cervical Screen: The cervical spine had full ROM without restriction or pain. There was no reproduction of symptoms with assessment.

Range Of Motion (ROM): Examination revealed significant limitations in active (AROM) and passive (PROM) ROM of the left shoulder. The limitations were especially remarkable with shoulder elevation (Table 1) as there was observable scapular elevation as a compensation strategy during AROM, and PROM required manual scapular stabilization. All end ranges of ROM were painful with stiff capsular endfeels.

Joint Mobility: Glenohumeral and scapulothoracic articulations were significantly restricted and stiff in all planes. Joint restrictions varied between Grade 1 and Grade 2 hypomobility.

Strength: Left shoulder complex musculature demonstrated strength deficits per manual muscle testing (Table 1). [28]

Palpation: Palpation revealed a generalized decrease in soft tissue mobility in all muscles adjacent to

Table 1. *Clinical measurements taken at initial evaluation, three weeks, and six weeks after the initial evaluation*

Shoulder ROM	Initial Evaluation	3 Weeks Post IE	6 Weeks Post IE
Flexion	AROM = 145 PROM = 160	AROM = 170 PROM = 180	AROM = 170 PROM = 180
Abduction	AROM = 130 PROM = 145	AROM = 150 PROM = 170	AROM = 160 PROM = 180
ER at 0	AROM = 35 PROM = 50	AROM = 50 PROM = 70	AROM = 60 PROM = 80
ER at 90	Immediate Scapular Compensation	AROM = 70 PROM = 90	AROM = 85 PROM = 110
IR at 90	PROM = 35	PROM = 45	PROM = 55
Strength	MMT: Flexion =4/5 Abduction = 4-/5 ER @ 0 abd =4/5 IR @ 0 abd = 5-/5	MMT: Flexion =4+/5 Abduction = 4/5 ER @ 0 abd =4+/5 IR @ 0 abd = 5/5	HHD (% opposite): Flexion = 78% Abduction = 72% ER @ 0 abd = 86% ER @ 90 abd = 64% IR @ 0 abd = 85%

IE=Initial evaluation; AROM= Active range of Motion; PROM= Passive range of motion; ER= External rotation the scapulothoracic and glenohumeral articulations. Highly irritable active and latent MTrPs were present throughout the region, specifically in the rotator cuff muscles. The most significant MTrPs were noted in the muscle belly of the infraspinatus. They were identified by point tenderness that replicated the subject's pain and were associated with a taut band within the muscle. Several of the MTrPs responded to palpation with a local twitch as described by Simons, Travell and Simons. [29] Neurological: Sensory was intact to light touch throughout the upper extremity. Reflexes and myotomes were unremarkable.

Pain Score: The visual analog scale was used to assess pain with 0 representing no pain and 10 representing the worst pain imaginable.[30] The patient's average Numeric Pain Rating Scale was 3/10 with her current pain = 2/10, worst pain = 5/10, and her least pain = 2/10.

Functional Outcome: The QuickDASH was used to assess the patient's function.[31] There are three sections to the questionnaire: the Disability/Symptom section, the Work section, and the Sports section. Each section is scored 0-100 with 0 representing no disability and 100 representing complete disability. The subject's score on the Disability/Symptom section was 47%, the Work section was 0% and the Sports/Performing Arts module was 100%.

CLINICAL IMPRESSION #2

Given the longevity of the post-surgical impairments, one hypothesis was that the surgical procedure had failed and the patient still had joint pathology. However, due to the lack of trauma or reinjury to the shoulder, joint derangement as a cause of ROM and strength limitations was low on the list of differential diagnoses. Neurologically, there were no indications of sensory or reflex deficits. Shoulder complex musculature was diminished in all planes and was associated with shoulder discomfort. Moreover, resistance testing of the distal extremity did not indicate nerve root or peripheral nerve involvement.

Palpation of the shoulder musculature revealed multiple active and latent MTrPs, most notably within the infraspinatus muscle belly, which replicated glenohumeral joint pain that was reported during ROM and resistance testing. ROM was restricted in all planes with stiff with capsular endfeels. (Table 1) The presence of palpation findings with concordant ROM restrictions and strength deficits verified the presence of MTrPs as described by Simons, Travell and Simons.[29] Assessment of joint mobility within the midrange of ROM confirmed stiffness of the joint capsule. Specifically, inferior glide, anterior glide and posterior glide demonstrated Grade I hypomobility. Based on the results of the examination, the subject appeared to have generalized soft tissue restrictions in the glenohumeral joint, scapulothoracic articulation and the surrounding musculature as well as extensive MTrP activation which influenced muscle function.

INTERVENTION #1

Physical therapy focused on an individualized program to improve shoulder mobility, strength and scapular stabilization. ROM limitations were specifically addressed with various manual therapies including joint mobilization, instrumented soft tissue mobilization, MTrP release, and manual stretching. Within three weeks, there were dramatic improvements in ROM and strength (Table 1).

CLINICAL IMPRESSION #3

After the initial gains from the individualized program, impairment and functional progress plateaued. Although ROM improved immediately following a treatment, the subject continued to complain of weakness at the endranges of motion and consequently, the stiffness and immobility returned quickly after each session. Given the perpetuation of highly irritable trigger points in the scapulohumeral muscles, DN was incorporated into her treatment plan for a more direct, targeted, and time-efficient intervention for the MTrPs . Due to the complexity of dysfunction in the shoulder complex muscles, the infraspinatus was chosen to evaluate the influence of DN on muscle thickness given its influence on shoulder stability and function.[32]

INTERVENTION #2

A physical therapist certified in dry needling performed the additional interventions. In the state of Virginia a dry needling certified physical therapist must have completed at least 54 hours of post professional training including providing evidence of meeting expected competencies that include demonstration of cognitive and psychomotor knowledge and skills.[33] Prior to the intervention the subject was educated on dry needling and signed a consent form. For the treatment, a clean needle technique was utilized, as per facility policy and procedures, and universal precautions were used by the treating PT. Seirin No. 8 (0.30) x 60mm needles were used (Seirin Corporation, Shizuoka, Japan). The subject was placed in a prone position with her arm slightly abducted, and the therapist identified active and latent MTrPs in the infraspinatus. The therapist performed a pistoning technique in the active and latent MTrPs. Fast repetitive needle movements in a cone pattern were performed to elicit local twitch responses. Once a twitch response was elicited the needle was removed. If no twitch response was elicited at a certain MTrP after multiple attempts the needle was removed. This procedure was repeated once at three distinct MTrPs in the infraspinatus. The patient received DN as part of her physical therapy treatment for three successive visits.

OUTCOME MEASURES

Before the first DN, the subject's external rotation isometric force (as a measure of strength) was assessed using a hand held dynamometer (HHD) (MicroFet2, Hoggan Health Industries, Salt Lake City Utah) with the subject placed in prone with the shoulder passively placed at 90 degrees of abduction and neutral external rotation.[18] In the same position, the infraspinatus thickness was also assessed in both shoulders using rehabilitative ultrasound imaging (RUSI).[18] The RUSI device used to take images was the Interson SR 7.5 MHz (Interson Corporation, Pleasanton, California) with a linear array transducer. Images were taken at the superior-medial margin of the infraspinatus[18] and the inferior aspect of the infraspinatus. Because the subject had prominent latent MTrPs in the inferior aspect of the infraspinatus, which was to be a focus of DN, we chose to also measure the thickness of this part of the muscle. The superior border of the RUSI soundhead was placed 5 cm distal from the intersection of the spine of the scapula and the medial border of the scapula. The medial border of the soundhead was parallel and immediately adjacent to the medial border of the scapula. A marker was used to outline the sound head on the patient's skin to improve the accuracy of measuring the same area of the muscle when subsequent measurements were performed. Three images were taken of each shoulder at rest and at a 50% MVIC of external rotation, as measured by a HHD. On the right shoulder, 50% MVIC images were also taken after the DN.

OUTCOMES

Immediately prior to DN, the thickness of the right inferior infraspinatus was at an approximate 20% deficit compared to the left with a consequent strength deficit of 35% as measured with HHD. There was no difference in muscle thickness of the superior infraspinatus between the left and right shoulders. Immediately following the DN, external rotation strength increased by approximately 30%, and the RUSI measurement of the inferior infraspinatus thickness increased by 25%. (Figure 1) This

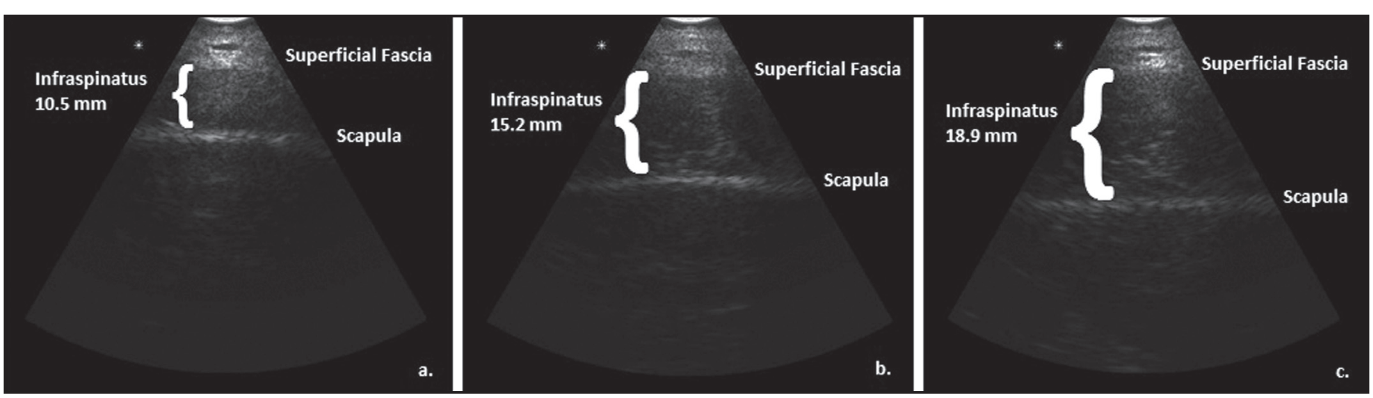

Figure 1. *a. Right inferior infraspinatus image at rest. b. Right inferior infraspinatus image at 50% MVIC before dry needling. c. Right inferior infraspinatus image at 50% MVIC after dry needling*

Table 2. *Infraspinatus thickness (mm) at rest and at 50% MVIC before and after dry needling*

	Rest	Pre-Treatment 50% MVIC	Post-Treatment 50% MVIC
Right Inferior Infraspinatus	10.5	15.2	18.9
Left Inferior Infraspinatus	10.4	19.1	-
Right Superior Infraspinatus	9.8	17.8	18.2
Left Superior Infraspinatus	10.6	18.6	-

value was comparable to the thickness of the left infraspinatus. (Table 2) There was no immediate change in the pain scale, but the patient did report increased muscle "soreness" in the treatment location with active motion. She reported the "soreness" as different from the typical pain.

DISCUSSION

Muscle dysfunction is a common component of musculoskeletal injuries. MTrPs have been proposed as a primary contributor to muscle dysfunction and are associated with a variety of signs and symptoms.[3] DN is an emerging intervention used to address the motor dysfunction caused by MTrPs. Unfortunately, there is limited evidence assessing the efficacy of DN, specifically on motor function.[4-7,34] This case report provides an addition to the evidence that demonstrated a change in muscle thickness, (a surrogate measure of motor function) following DN in a patient with long-term post-operative shoulder complex dysfunction.

Lucas et al [4,5] evaluated the effect of latent MTrPs on muscle function as indirectly measured by the timing of muscle activation. Shoulder muscle activation during active scaption was compared between pain-free subjects with and without identifiable latent MTrPs in scapular stabilizing muscles. The infraspinatus of subjects with latent MTrPs activated much earlier, and the upper trapezius significantly later. Additionally, compared to the control group, all shoulder muscles of the subjects with latent MTrPs were not activated within a consistent timeframe. The increased variability of muscle activation in conjunction with delayed upper trap activation and prolonged duration of infraspinatus activation may be responsible for inconsistent shoulder complex mechanics that results in glenohumeral joint pathology. [5]

Given the effect of latent MTrPs on activation patterns, Lucas et al [5] assessed the effects of DN and passive stretching of the latent MTrPs on activation patterns during scaption. Following the treatment, the activation of the infraspinatus and the upper trapezius significantly changed to resemble the timing of the control group. The timing of activation also became more consistent for all of the shoulder complex muscles. The authors suggest that the MTrPs are part of a neurological loop that when successfully diminished allow for normalization of muscle function as assessed by activation patterns and thus proficiency of movement.[5]

Koppenhaver et al[34] evaluated the effect of DN on infraspinatus function among subjects diagnosed with subacromial pain syndrome. No significant changes in muscle function were identified immediately after DN to three general locations of common MTrPs. Similar to the current report, the authors measured the thickness of the infraspinatus by RUSI, but only the superior-medial aspect of the infraspinatus was measured. Their findings confirm that DN of the inferior aspect of the muscle did not result in a change of thickness in the superior-medial infraspinatus. As Koppenhaver et al[34] stated, this may have been an important limitation of their study because the measurement occurred at a section of the muscle that was distant from the treatment site. Although the boundaries of the sound head were marked over the inferior infraspinatus in the current study in attempt to accurately relocate its position before and after DN, definitive anatomical boundaries must be identified to provide reliable RUSI measurements of this region between subjects and treatment dates.

With regard to the subject, the portion of the infraspinatus adjacent to the focal region of DN demonstrated a large increase in thickness equal to the infraspinatus of the asymptomatic shoulder. Similar results following DN have been previously described in the lumbar multifidus.[35] However, the changes in multifidus muscle function did not occur uniformly across all subjects, and increased function was only observed at one week post-treatment, unlike the findings of the current case report. The factors underlying the differences in a pathological muscle's response to DN are unknown, but certainly differences in DN technique and treatment of associated MTrPs in the region may impact the treatment success.

The presence of MTrPs also appears to influence the intensity of muscle function. Celik and Yeldan[7] reported that subjects who had MTrPs in selected shoulder and scapular stabilizing muscles had approximately 20% strength deficits in flexion and 15% strength deficits in scaption. In a case series, Osborne and Gatt [6] report similar qualitative findings of decreased external rotation strength at 90 degrees of abduction among elite volleyball players with shoulder pain and MTrPs. Following DN to MTrPs in the infraspinatus and teres minor, strength of external rotation at 90 degrees of abduction was significantly increased as measured by manual muscle testing. This finding occurred in conjunction with a decrease in perceived pain and increased abduction ROM with no pain in the impingement zone.

As with all case reports, limitations exist which restrict the applicability of the conclusions. The subject was seven months after a labral repair. The prolonged period of her impairments after surgery is not typical for most patients. Therefore, these findings may not be generalized to all patients with shoulder complex dysfunctions or those in the immediate post-operative timeframe. The results indicate a simultaneous increase in infraspinatus muscle thickness and external rotation strength immediately following DN. However, these findings may have been the result of a placebo effect or other physiological responses. Although infraspinatus muscle thickness increased immediately following DN, the lack of long term follow up is another limitation because the duration of this change in muscle morphology is unknown. Additional larger studies are required to investigate the relationship between changes in activation, morphology, and strength following DN.

CONCLUSION

The results of this case report highlight the potential benefit of DN on muscle function as measured by RUSI (muscle thickness) and force production (hand-held dynamometry). After a prolonged period of nonspecific rehabilitation, the subject demonstrated significant muscle dysfunction associated with MTrPs. DN of the MTrPs in the infraspinatus resulted in an immediate increase in muscle thickness and a concurrent increase in strength. Healthcare practitioners should consider DN as an adjunctive intervention to promote improvements in muscle function when muscle dysfunction is present.

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