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Original article

Effects of dry needling to the symptomatic versus control shoulder in patients with unilateral subacromial pain syndrome☆

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ABSTRACT

Background: Initial reports suggest that treating myofascial trigger points in the infraspinatus with dry needling may be effective in treating patients with shoulder pain. However, to date, high quality clinical trials and thorough knowledge of the physiologic mechanisms involved is lacking.
Objectives: To examine the effect of dry needling to the infraspinatus muscle on muscle function, nociceptive sensitivity, and shoulder range of motion (ROM) in the symptomatic and asymptomatic shoulders of individuals with unilateral subacromial pain syndrome.
Design: Within-subjects controlled trial.
Methods: Fifty-seven volunteers with unilateral subacromial pain syndrome underwent one session of dry needling to bilateral infraspinatus muscles. Outcome assessments, including ultrasonic measures of infraspinatus muscle thickness, pressure algometry, shoulder internal rotation and horizontal adduction ROM, and questionnaires regarding pain and related disability were taken at baseline, immediately after dry needling, and 3–4 days later.
Results: Participants experienced statistically significant and clinically relevant changes in all self-report measures. Pressure pain threshold and ROM significantly increased 3–4 days, but not immediately after dry needling only in the symptomatic shoulder [Pressure pain threshold: 5.1 (2.2, 8.0) N/cm^2, internal rotation ROM: 9.6 (5.0, 14.1) degrees, horizontal adduction ROM: 5.9 (2.5, 9.4) degrees]. No significant changes occurred in resting or contracted infraspinatus muscle thickness in either shoulder.
Conclusions: This study found changes in shoulder ROM and pain sensitivity, but not in muscle function, after dry needling to the infraspinatus muscle in participants with unilateral subacromial pain syndrome. These changes generally occurred 3–4 days after dry needling and only in the symptomatic shoulders.
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Shoulder pain is a frequent complaint (Feleus et al., 2008) that commonly involves a spectrum of subacromial space pathologies, including partial thickness rotator cuff tears, rotator cuff tendinosis, calcific tendinitis, and subacromial bursitis, collectively referred as subacromial pain syndrome (Diercks et al., 2014; Escamilla et al., 2014). Although the pathophysiology of subacromial pain syndrome is multifactorial, it likely includes at least a subgroup of patients who present with impairments in rotator cuff muscle function (Escamilla et al., 2014). Decreased force generation of the rotator cuff muscles, in particular the infraspinatus muscle, has been shown to increase superior translation of the humeral head leading to narrowing of the subacromial space and impingement (Ebaugh et al., 2006; Royer et al., 2009). Muscle impairments associated with subacromial pain syndrome are most often treated with rotator cuff strengthening exercises, which have been found to be effective at reducing pain and dysfunction in some, but not all studies (Michener et al., 2004; Kuhn, 2009).

Myofascial trigger points are sensitive spots within palpable taut bands of muscles which commonly refer pain with mechanical stimulation (Simons, 1998). Previous studies have found that trigger points in the infraspinatus muscle can reproduce the pain

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complaints in individuals with shoulder pain (Ge et al., 2008; Hidalgo-Lozano et al., 2010) and have been associated with impaired shoulder muscle function (Lucas et al., 2010; Ibarra et al., 2011; Ge et al., 2014). Dry needling involves the insertion of thin filiform needles directly into muscles identified as having trigger points in an attempt to reduce pain and normalize muscle function (Kalichman and Vulfsons, 2010; Dommerholt, 2011). Initial reports suggest that treating myofascial trigger points in the infraspinatus with dry needling may be effective in treating patients with shoulder pain (Osborne and Gatt, 2010; Calvo-Lobo et al., 2015) However, supporting evidence from high quality clinical trials and an understanding of the physical mechanisms involved is lacking (Tough et al., 2009; Kietrys et al., 2013; Boyles et al., 2015; Liu et al., 2015).

Multiple studies have investigated the effect of dry needling on pain sensitivity (pressure algometry) in patients with shoulder pain and found it to decrease immediately after (Hsieh et al., 2007; Srbely et al., 2010; Tsai et al., 2010; Calvo-Lobo et al., 2015) and one week after (Hsieh et al., 2007) treatment. One of these studies also reported concurrent immediate changes in shoulder range of motion (ROM) (internal rotation) after dry needling (Hsieh et al., 2007), but none included any assessment of muscle function. The sole study to our knowledge to investigate changes in muscle function following dry needling found altered timing of scapular muscles (primarily the infraspinatus) in the presence of trigger points that was "normalized" immediately following treatment (Lucas et al., 2004). Although this study used surface electromyography (EMG) and asymptomatic participants with latent myofascial trigger points (i.e. only painful upon palpation), the results preliminarily suggest that the mechanism of effect of dry needling in patients with shoulder problems could include a "resetting" of normal scapulo-humeral muscle function.

No study to date has investigated potential changes in infraspinatus muscle function after dry needling in patients with subacromial pain syndrome. Therefore, the purpose of this study was to examine the effect of dry needling to the infraspinatus muscle on muscle function, nociceptive sensitivity, and shoulder ROM in the symptomatic and asymptomatic shoulders of individuals with unilateral subacromial pain syndrome. We hypothesized that changes would occur in both shoulders after dry needling, however, that they would be larger in the symptomatic shoulders. Additionally, we aimed to assess the clinical relevance of these changes by examining their correlation with self-reported clinical improvement.

1. Methods

1.1. Study design

The study was a within-subjects design in which participants were used as their own control. Each participant underwent identical procedures, which included baseline measurements of outcome measures, dry needling treatment to the infraspinatus muscles, and reassessment of outcome measures both immediately after and three to four days after treatment.

1.2. Participants

Participants were all Department of Defense beneficiaries who responded to recruiting advertisements from Joint Base San Antonio, Texas. Participant selection criteria are listed in Table 1 and were aimed at including individuals who would seek healthcare for unilateral subacromial pain syndrome without any contraindications to dry needling. The study protocol was approved by the Institutional Review Board of Brooke Army Medical Center. All participants provided consent prior to study enrollment and the rights of the participants were protected.

A priori power analysis was performed using G*Power 3 (Faul et al., 2007). The amount of change in infraspinatus muscle thickness that would be considered clinically important is currently unknown. Therefore, we powered this study to have at least 80% power to detect an effect size of 0.40 for pre-to-post change and between shoulder differences in muscle thickness and other outcomes, assuming alpha of 0.05 and 10% attrition at follow up. Enrolling 57 subjects was planned which would additionally give adequate precision to correlational estimates.

1.3. Dry needling intervention

After collection of baseline outcome measures, participants received dry needling by an experienced physical therapist trained in dry needling. The treating therapist performed palpation, but was otherwise blinded to the clinical exam, baseline outcome measurements, and which shoulder was symptomatic unless ascertained via palpation. The dry needling technique used disposable 0.25 × 40 mm stainless steel Seirin J-type needles (Seirin Corp., Shizuoka, Japan). "Clean technique" was used throughout the treatment procedure which included hand washing, clean latex-free exam gloves, and cleaning the participants skin with an alcohol swab prior to treatment (Baima and Isaac, 2007). Treatment location was standardized for each participant. Needles were inserted into 3 general locations (superior, medial, inferior) in each infraspinatus muscle based on prior research (Ge et al., 2008) and depictions of common locations of myofascial trigger points (Simons, 1998; Fig. 1). Prior to needle insertion, manual palpation of the infraspinatus muscle was performed to localize treatment to the most painful area at each of the three locations. Each needle insertion lasted approximately 5–10 s using a "sparrow pecking" (in and out motion) technique in an attempt to elicit as many local twitch responses as possible (Itoh et al., 2006).

1.4. Outcome measures

1.4.1. Infraspinatus muscle function

Function of the infraspinatus muscle was quantified using ultrasound imaging and taking muscle thickness measurements during a contraction and comparing them to muscle thickness at rest. In addition to being less invasive than electromyography, these procedures allowed us to quantity muscle function with an alternative tool to the treatment being studied (inserting a needle) (Koppenhaver et al., 2009a).

Images of the infraspinatus muscle were acquired at rest and during submaximal contraction using a SonoSite Titan and M-Turbo with a 38 mm linear array transducer. Participants were positioned prone on an examination table with the imaged shoulder in 90° abduction and neutral glenohumeral joint rotation. The elbow was at 90° with the wrist secured to a pressure cuff attached to a fixed pole underneath the examination table. The pressure cuff was used as a biofeedback device so that the participants could monitor their force during contraction. For all images, the ultrasound transducer was placed immediately inferior to the spine of the scapula and oriented longitudinally so that the suprascapular notch was positioned at the far right image border and the medial border of the scapula was lined up on the left image border (Fig. 2). Ultrasound images were then taken in two muscle conditions, relaxed and a submaximal isometric contraction into external rotation at 20 mmHg of pressure. Each muscle condition was imaged three times to reduce measurement error (Koppenhaver et al., 2009b). Infraspinatus muscle thickness was measured in