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Original article

The initial effects of a sustained glenohumeral postero-lateral glide during elevation on shoulder muscle activity: A repeated measures study on asymptomatic shoulders

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ABSTRACT

Background: Manual therapy enhances pain-free range of motion and reduces pain levels, but its effect on shoulder muscle activity is unclear. This study aimed to assess the effects of a sustained glenohumeral postero-lateral glide during elevation on shoulder muscle activity.
Methods: Thirty asymptomatic individuals participated in a repeated measures study of the electromyographic activity of the supraspinatus, infraspinatus, posterior deltoid, and middle deltoid. Participants performed four sets of 10 repetitions of shoulder scaption and abduction with and without a glide of the glenohumeral joint. Repeated-measures multivariate analysis of variance (MANOVA) was used to assess the effects of movement direction (scaption and abduction), and condition (with and without glide) (within-subject factors) on activity level of each muscle (dependent variables). Significant MANOVAs were followed-up with repeated-measures one-way analysis of variance.
Results: During shoulder scaption with glide, the supraspinatus showed a reduction of 4.1% maximal isometric voluntary contraction (MVIC) (95% CI 2.4, 5.8); and infraspinatus 1.3% MVIC (95% CI 0.5, 2.1). During shoulder abduction with a glide, supraspinatus presented a reduction of 2.5% MVIC (95% CI 1.1, 4.0), infraspinatus 2.1% MVIC (95% CI 1.0, 3.2), middle deltoid 2.2% MVIC (95% CI = 0.4, 4.1), posterior deltoid 2.1% MVIC (95% CI 1.3, 2.8).
Conclusions: In asymptomatic individuals, sustained glide reduced shoulder muscle activity compared to control conditions. This might be useful in enhancing shoulder movement in clinical populations. Reductions in muscle activity might result from altered joint mechanics, including simply helping to lift the arm, and/or through changing afferent sensory input about the shoulder.

1. Introduction

Multimodal physiotherapy on shoulder disorders are considered as complex interventions, due to the difficulty in identifying and understanding the effect of the different physical modalities (e.g., exercise, manual therapy, electrotherapy) on clinical outcomes (MRC, 2008). Currently, the effect of physiotherapy on clinical outcomes in patients with shoulder disorders are unclear, with systematic reviews reporting divergent findings (Michener et al., 2004; Dorrestijn et al., 2009; Ho et al., 2009; van den Dolder et al., 2014). It is challenging to determine effects of physical modalities (e.g., exercise, manual therapy, electrotherapy) on clinical outcomes in multimodal randomized controlled trials (RCTs). To enhance the strength and quality of future RCTs, exploring the mechanisms and effects of each component of complex interventions is recommended (MRC, 2008).

Manual therapy is commonly used for increasing joint mobility and reducing pain (Ho et al., 2009; Vicenzino et al., 2011). Mobilization With Movement (MWM) has been shown to reduce pain levels, increase range of motion (Abbott, 2001; Abbott et al., 2001; Mulligan, 2006; Vicenzino et al., 2011), and function in patients with shoulder pain (Mulligan, 2006; Teys et al., 2008; Vicenzino et al., 2011). Correction of bony positional fault, neurophysiological effects or a combination of both have been proposed as the underlying mechanisms of MWM (Vicenzino et al., 2007).

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Altered muscle recruitment patterns may be associated with shoulder symptoms (Kelly et al., 2005; Rajaratnam et al., 2013; Shinozaki et al., 2014). Individuals with shoulder impingement syndrome were found to have decreased muscle activity in infraspinatus and middle deltoid during scaption compared to controls (Reddy et al., 2000), while patients with symptomatic rotator cuff tear were found to have decreased activity for the deltoid muscle (Shinozaki et al., 2014). One of the goals of physiotherapy is to restore optimal muscle recruitment patterns about the shoulder joint (Sahrmann, 2002).

This study assessed the effects of a sustained glenohumeral postero-lateral glide (technique that resembles MWM used in patients) on shoulder muscle activity during abduction and scaption in a group of asymptomatic individuals. The inclusion of asymptomatic individuals provides the opportunity to define what a normal response to this technique is, before assessing its effect on a group of patients with shoulder disorders. It was hypothesized that sustained glenohumeral postero-lateral glide would lead to increases in muscle activity levels.

2. Methods

2.1. Study design

This was a laboratory-based, repeated measures study with a sample of convenience. As previous published studies in the field, we opted to use surface electrodes to monitor shoulder muscle activity (Fischer et al., 2011; Kisiel-Sajewicz et al., 2011; McDonald et al., 2014). Activity of four shoulder muscles (supraspinatus, infraspinatus, posterior deltoid, and middle deltoid) was monitored using surface electromyography (SEMG). Participants performed four different shoulder movements: shoulder scaption and abduction with and without a sustained postero-lateral glenohumeral glide.

2.2. Participants

Asymptomatic individuals were recruited from the local community. All participants signed an informed consent form prior to taking part in the study. Participants then underwent a screening examination for shoulder, and cervical spine disorders. Screening tests included full cervical active range of motion with overpressure, active shoulder scaption with overpressure, and maximum voluntary isometric internal and external rotation strength testing (Petty, 2011). This study was approved by the University of Otago Human Ethics Committee.

2.3. Equipment

Myoelectric signals were collected using a 16 channel wireless Noraxon TeleMyo 2400T G2 (Noraxon USA Inc., Arizona, USA) at a 1500 Hz sampling frequency with a gain of 500. Raw electromyography (EMG) signals were sent wirelessly from the transmitter to a Noraxon TeleMyo EMG receiver. To record muscle activity, we used disposable, self-adhesive surface Ag/AgCl electrodes (Product SP-00-S/50, Ambu, DK-2750 Ballerup, Denmark). Surface electrodes were placed 2 cm apart in parallel alignment with muscle fibers according to the Surface Electromyography for the Non-Invasive Assessment of Muscles (SENIAM) guidelines (Freriks et al., 1999). The ground electrode was placed over the spinous process of the seventh cervical vertebrae (Freriks et al., 1999).

A detailed description of electrode placement is presented in Table 1. We followed SENIAM guidelines for electrode placement for middle and posterior deltoid muscles (Hermens et al., 2015). SENIAM does not provide electrode placement recommendations for supraspinatus and infraspinatus muscles. Therefore, we followed the electrode placement recommendations and descriptions by Criswell (Criswell, 2010) and Waite et al. (Waite et al., 2010). An illustration of electrodes placement is presented in Fig. 1.

An electrogoniometer (Noraxon USA Inc., Arizona, USA) was used to record to shoulder movement, and identify the start and end of shoulder elevation at the scapular and coronal plane. Data was recorded concomitantly to the EMG, with a frequency sample of 1500 Hz. The electrogoniometer was carefully positioned, with the proximal level over the spine of the scapula and the distal level over the arm. The use of electrogoniometer has been reported to be reliable and valid for measuring angles below 45° of abduction, with a ceiling effect for measuring movement above that range (Yen and Radwin, 2000). Thus, we considered the electrogoniometer suitable for defining the start and end of movement.

2.4. Experimental protocol

Prior to applying the electrodes, the skin was prepared to ensure good conductivity. Firstly, hair was removed with a razor over the area where the surface electrodes were going to be placed. Then, the area was abraded with a coarse towel, and cleaned with alcohol wipes. To reduce EMG baseline noise, this procedure was repeated until skin impedance was verified as <5 kΩ using a standard voltmeter.

The participants' self-reported dominant upper limb was assessed. Participants performed four maximal isometric voluntary contraction (MIVC), one for each muscle, against manual resistance provided by the researcher (Table 1), and sustained for 5 s (Kendall et al., 2005). The MIVC of each muscle was used for normalizing EMG data collected during the trials. Participant's positioning was monitored by the researcher to minimize compensatory movements.

Following isometric testing, participants performed four shoulder movements in a randomized order according to a computer-generated number list (Haahr, 2012), this was implemented by the principal investigator. The shoulder movements included: (1) shoulder scaption (control); (2) shoulder scaption with a sustained glenohumeral postero-lateral glide (experimental); (3) shoulder abduction (control); (4) shoulder abduction with a sustained glenohumeral postero-lateral glide (experimental). Fig. 2 illustrates the postero-lateral glide technique used during the experimental conditions. Shoulder scaption or abduction performed without the sustained glide served as the control conditions, while shoulder scaption and abduction with a sustained postero-lateral glide were considered as the experimental conditions. To standardize the velocity in which participants performed the dynamic tasks, shoulder abduction and scaption (with and without a sustained postero-lateral glide applied at the shoulder) were performed at 30 beats/min.

When performing shoulder scaption, participants were asked to elevate their shoulder while pointing their fingers to a wood stadiometer to ensure participants maintained their arms in the scapular plane (Fig. 3).

For the purpose of this study, shoulder abduction was executed in the frontal plane, while shoulder scaption was performed in the scapular plane. This was performed with and without a postero-lateral glide of the humerus on the scapula, which resembles a glenohumeral MWM in a painful shoulder condition (Mulligan, 2003). The stabilizing hand was placed over the distal aspect of the infraspinal fossa of the scapula and over the inferior angle of the scapula. This allowed the clinician to stabilize the scapula, without restricting its movement (e.g. blocking scapular upward rotation). The gliding hand was placed over the anterior head of the humerus.