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Kinesio taping of the deltoid does not reduce fatigue induced deficits in shoulder joint position sense

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ABSTRACT

Background: Muscle fatigue is known to decrease shoulder proprioceptive acuity, potentially contributing to injuries. It has been suggested that Kinesio taping can improve proprioception. Therefore, the aim of this study was to investigate the effects of Kinesio taping on shoulder joint position sense after muscle fatigue.

Methods: Twenty-four healthy subjects were evaluated in a randomized, crossover, single-blind study design. Shoulder joint position sense was assessed during active repositioning tests at the target angles of 50°, 70° and 90° of arm elevation in scapular plane, in three sessions: control (no taping), Kinesio taping (Kinesio taping applied over the deltoid muscle with tension) and sham (Kinesio taping applied over deltoid without tension). Joint position sense was assessed three times: before taping; following taping application or rest, in the control session; and following a fatigue protocol. The constant error (repositioned angle–target angle) was considered for statistical analysis, using a 3-way repeated-measure ANOVA (within subject factors: taping, time and target angle).

Findings: There was no interaction or main effect involving taping. An interaction between time and angle was found and the simple effect showed that the constant error increased following fatigue at 70° and 90°, but not at 50°.

Interpretation: The results of this study does not support the use of Kinesio taping applied over the deltoid muscle for compensating or preventing shoulder joint position sense deficits caused by muscle fatigue of shoulder abductors.

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1. Introduction

The shoulder complex relies heavily on sensorimotor control for maintaining functional joint stability, due to its poor osseous and capsuloligamentous restraints (Myers et al., 2006). Proprioceptive signals arise from afferent neural input originating at the level of the mechanoreceptors (Riemann and Lephart, 2002), and has generally been described as having three submodalities: joint position sense (JPS), the appreciation and interpretation of information concerning joint position and orientation; kinesthesia, the ability to identify joint movement; and force sense, the ability to appreciate and interpret forces applied to or generated within a joint (Myers and Lephart, 2000).

Several studies have shown that shoulder JPS and kinesthesia are impaired by muscle fatigue (Carpenter et al., 1998; Iida et al., 2014; Lee et al., 2003; Myers et al., 1999; Voight et al., 1996). These deficits could predispose subjects who perform repetitive arm movement during work or sports activities to shoulder injuries. Therefore, interventions aimed at reducing these proprioceptive deficits may help to prevent shoulder injury.

Skin stretch has been shown to cause illusory movement, demonstrating that cutaneous afferents play a role in proprioception (Collins et al., 2005). Kinesio taping (KT) is a technique that consists of applying an elastic adhesive tape over a target muscle, providing continual skin traction (Kase et al., 2003). Kinesio taping has been widely and increasingly used in clinical and sports practice, although its effects are still not clear (Morris et al., 2013; Williams et al., 2012). Similar to conventional taping, proprioception improvement due to cutaneous mechanoreceptors stimulation is one of the effects attributed to KT (Kase et al., 2003). Few studies have evaluated the effects of KT on proprioception (Chang et al., 2010; Chang et al., 2012; Chang et al., 2013; Halseth et al., 2004; Lin et al., 2011) and an improvement in grip force sense accuracy (Chang et al., 2010) and shoulder JPS (Lin et al., 2011) have been found after the application of KT in healthy subjects.

Given the potential of KT to directly affect proprioception, it could serve as a possible modality for mitigating the negative consequences of fatigue at the shoulder. Consequently, the purpose of this study was to investigate the effects of KT applied on the deltoid muscle on shoulder JPS after muscle fatigue. It was hypothesized that the application

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of KT would partially compensate for the proprioceptive deficits caused by muscle fatigue. The confirmation of this hypothesis would support the use of KT to reduce the effect of proprioceptive deficits caused by muscle fatigue and potentially contribute to shoulder injury prevention in populations that perform repetitive arm movement, such as overhead athletes and workers.

2. Methods

2.1. Subjects

Twenty-four healthy subjects (12 males and 12 females), with a mean age of 21.5 years (SD 2.7), mean height of 158 cm (SD 10) and mean body mass of 70.5 kg (SD 13.1) participated in this study. Prior to participation, all subjects signed an informed consent form approved by the Institutional Review Board of the University of Oregon. Subjects were included if they were healthy, between the ages of 18 and 50 years and had no history of shoulder injuries that required rehabilitation or surgery. Exclusion criteria were current participation in overhead sports training, history of shoulder dislocation and generalized ligamentous laxity, assessed using the Beighton and Horan Joint Mobility Index (Boyle et al., 2003). This study was registered prospectively with ClinicalTrials.gov (NCT02104570).

Power calculations were performed using G*Power (version 3.1.9.2) (Faul et al., 2007). Data were from a previous study using the same JPS protocol on 79 healthy subjects (Gillespie et al., 2013). Given an overall standard deviation of 3.2° and a correlation among repeated measures of 0.5, 24 subjects would result in a power of 0.8 to detect an effect size as small as 0.27 (or approximately 0.9° in this case).

2.2. Experimental design

A crossover, randomized, sham-controlled, single-blind (subject) design was used in this investigation. The dominant shoulder of the participants was evaluated in three sessions: control (no intervention), KT application and sham application, in a randomized order. Subjects performed the three sessions on the same day of the week and time of the day. Additionally, there was a one-week interval between sessions in order to avoid accumulation of taping effects (Hsu et al., 2009) or muscle fatigue (Myers et al., 1999). Participants were instructed not to perform upper-body exercises for the 24 h prior to each session. The experimental protocol was the same for all sessions, except for the taping application (Fig. 1).

2.3. Procedures

For all sessions, participants were seated on an ergonomically designed kneeling chair (Better Posture Kneeling Chairs, Jobri, Konawa, OK, USA). Initially, a maximal isometric voluntary contraction (MVIC) of shoulder abduction was performed, with the arm at 90° of elevation in the scapular plane. Subjects performed three MVIC trials, 5 s each, with 1 min of rest between them. Data were collected at 12 Hz with a hand held dynamometer (MicroFET 2, Hoggan Health Industries, Draper, UT, USA) attached to a rigid support. The mean force generated between the second and third seconds was calculated and then averaged over the 3 MVIC trials.

Following MVIC testing, shoulder JPS was assessed with an active joint repositioning task, using an app developed for Apple's 4th generation iPod Touch (Gillespie et al., 2013). This app uses the internal sensors of the device (accelerometers and gyroscopes) to record the orientation of a segment with respect to gravity, and enables an evaluation protocol similar to that performed using an electromagnetic tracking device (Suprak et al., 2006; Suprak et al., 2007). Instead of visual cues, the app provides auditory commands to the subject thought Bluetooth noise canceling headphones, while subjects keep their eyes closed.

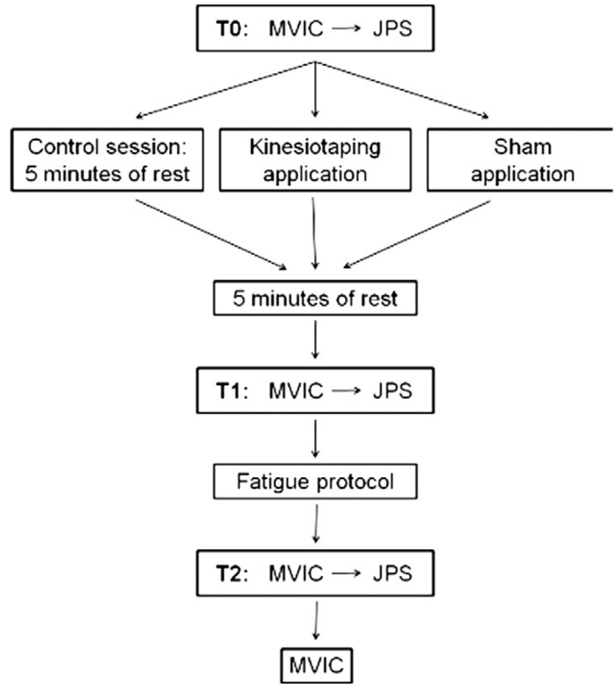

Fig. 1. Schematic representation of the procedures during the experiments. MVIC: Maximal voluntary isometric contractions; JPS: Joint position sense.

The iPod was attached to the distal arm of the subjects, between the deltoid insertion and lateral epicondyle, to minimize artifacts from muscle contraction. The initial position of each trial was with the arm vertical at the side of the body. Subjects were instructed to elevate the arm in the scapular plane (Fig. 2). There were two audible cues to help guide the subjects to the correct target angle. A low frequency

Fig. 2. Subject positioning during the joint position sense assessment.

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