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Rigid and Elastic taping changes scapular kinematics and pain in subjects with shoulder impingement syndrome; an experimental study

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ABSTRACT

Rigid and Elastic scapular taping is used in physical rehabilitation of shoulder impingement syndrome (SIS). It is believed to reduce pain and normalise scapular movement patterns. However, there is insufficient evidence to support its use.

The aim of the study was to investigate the effect of Rigid and Elastic taping techniques on the scapular kinematics and pain in patients with SIS.

Eleven patients with SIS participated in the study. They performed elevation and lowering of the arm in the scapular and sagittal planes under three conditions: Baseline, Rigid taping and Elastic taping. The movements of the thorax, humerus and scapula were tracked. Scapular displacements and scapulothoracic joint rotations were calculated. Subjects used a visual analogue scale to rate the intensity of pain at rest and during movements in both planes.

Both taping techniques externally rotated the scapula in sagittal plane movements ($p < 0.05$) and resulted in reduced pain. In the scapular plane, Elastic taping increased the scapular retraction ($p < 0.05$) and posterior displacement ($p < 0.01$), but neither of the taping techniques had an effect on pain in this plane.

In conclusion, both taping techniques had an effect on scapular kinematics and pain in movements occurring in the sagittal plane. Elastic taping also affected scapular kinematics in scapular plane movements, but without the concomitant decrease in pain.

1. Introduction

Shoulder impingement syndrome (SIS) accounts for the majority of reported shoulder complaints (van der Windt et al., 1996; Vecchio et al., 1995). The condition is associated with a reduced clearance of the soft tissues occupying the subacromial space as the arm is elevated (Neer, 1972). Despite its high prevalence (Lo et al., 1990; Michener et al., 2003), the underlying aetiology of the condition is still debated (Budoff et al., 1998; Fu et al., 1991; Jobe et al., 2000). Poor posture and abnormal scapular kinematics have been suggested as possible primary factors in developing SIS (Fu et al., 1991; Jobe et al., 2000) and also as secondary observed phenomena of SIS (Kamkar et al., 1993). These patterns are also believed to exacerbate the condition by further narrowing of the subacromial space (Kaya et al., 2011; Ludewig and Cook, 2000; Lukasiewicz et al., 1999).

Most of the physiotherapeutic rehabilitation programmes for SIS are designed to correct posture (Lewis et al., 2005b; Ludewig and Reynolds, 2009) and minimise the deviation of shoulder kinematics from normality (Host, 1995; Kaya et al., 2011; Ludewig and Reynolds, 2009). To this end, the application of tape is extensively used. Two types of tape of different elastic properties have been used in shoulder rehabilitation; Rigid (Ackermann et al., 2002; Alexander et al., 2003; Cools et al., 2002; Host, 1995, Kalter et al., 2011; Lewis et al., 2005b, McConnell et al., 2011; Selkowitz et al., 2007; Smith et al., 2009) and Elastic taping techniques (Bradley et al., 2009; Garcia-Muro et al., 2010; Hsu et al., 2009; Kase and Kase, 2003; Kaya et al., 2011; Lin et al., 2011; Thelen et al., 2008).

The underlying mechanism of taping is also poorly understood. A number of hypotheses have been put forward to explain the effects of taping; it has been suggested that taping alters muscle force (Host, 1995; Morrissey, 2000), neuromuscular control

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(Alexander et al., 2008; Lin et al., 2011; Lohrer et al., 1999) and proprioception (Lin et al., 2011; Morrissey, 2000). One of the other proposed theories suggests that taping achieves its effects via a biomechanical realignment of the joints (Bennell et al., 2000; Host, 1995; Lewis et al., 2005a) and restrictions to the joint range of motion (Bradley et al., 2009; McConnell et al., 2011). This poor understanding contributes to the variations in the taping techniques used by different clinicians. For example many application techniques have been presented in the literature for the management of SIS alone (Host, 1995; Hsu et al., 2009; Kalter et al., 2011; Kaya et al., 2011; Lewis et al., 2005b; Selkowitz et al., 2007; Smith et al., 2009; Thelen et al., 2008).

The popularity of using taping with the shoulder is not supported by sufficient scientific evidence. It is generally believed that taping helps in reducing pain and normalising scapular kinematics, however, these claims are often based on anecdotal observations. Recent systematic reviews that investigated the effect of Elastic taping on musculoskeletal conditions highlight the shortage of supporting evidence (Mostafavifar et al., 2012; Williams et al., 2012). The reviews included small numbers (10 and 6 respectively) of studies covering a wide range of musculoskeletal joints and many outcome measures including pain, range of motion, proprioception and muscle strength. As a result, it is still not possible to prove or discount any beneficial effects of taping (Mostafavifar et al., 2012; Williams et al., 2012).

In addition, few studies have investigated the effects of taping on kinematics despite the association of altered scapular resting position (Borstad, 2006) and kinematics (Ludewig and Reynolds, 2009) with shoulder pathology. This is in part because of the difficulties involved in obtaining in-vivo measurements of the scapular movement (Hill et al., 2007; Kontaxis et al., 2009). Recently, a number of studies have developed methods to obtain scapular kinematics in-vivo with relatively high accuracies (Brochard et al., 2011; Prinold et al., 2011; Shaheen et al., 2011a,b; Warner et al., 2012).

One of these methods (Karduna et al., 2001) was utilised by Hsu et al. (2009) who investigated the effects of an Elastic tape applied to envelope the lower trapezius muscle on shoulder kinematics and muscle activity in a group of baseball players with SIS. The study found that taping increased posterior tilt (approximately 1°) in low humeral elevations in scapular plane movements.

Shaheen et al. (2013) also utilised a scapular tracking method (Shaheen et al., 2011b) to measure subtle changes in scapular kinematics caused by Rigid taping. In the aforementioned study, taping was applied bilaterally in a non-symptomatic subject group according to the method described by Lewis et al. (2005b). The study showed that taping increased scapular external rotation, upward rotation and posterior tilt compared to baseline measurements (Shaheen et al., 2013). The magnitudes of these alterations (3–6°) were significantly higher than those reported by Hsu et al. (2009).

The results of previous studies point towards a positive effect of taping on scapular kinematics; the reported alterations are believed to reverse the effects of SIS on scapular kinematics and can contribute to an increase in the subacromial space (Lewis et al., 2005a; Ludewig and Cook, 2000) thus possibly resulting in pain relief. However, both studies have obtained measurements in either pain-free subjects or a pain-free state (Hsu et al., 2009), hence it is not possible to make any conclusions regarding the association of these alterations with pain relief.

In addition, the magnitudes as well as some of these alterations (scapular external and upward rotations) are different in the two studies. This may be caused by differences in the subject groups, the measurement method or the different application techniques. To date, no studies have attempted to investigate the effects of Elastic and Rigid tape applications designed to treat the same symptoms on a single subject group.

The aim of this study was to investigate the effects of taping on scapular kinematics and pain in patients with SIS when two different taping techniques designed for the management of SIS are used; a Rigid tape application and an Elastic tape application.

2. Method

2.1. Participants

Subjects were included in the study if they experienced pain in elevation of the shoulder and if they tested positive to at least 4 of the following tests: (1) Neer impingement sign (2) Hawkins sign (3) pain during supraspinatis empty can test (4) painful arc between 60° and 120° and (5) tenderness when palpating the greater tuberosity of the humerus. Subjects were excluded if they experienced pain with cervical spinal tests, had a history of spinal or upper-limb fractures or had systemic illnesses. Subjects who fit these criteria and consented to participating in the study signed a consent sheet approved by Central London REC 4.

2.2. Intervention

2.2.1. Taping techniques

Two taping techniques commonly used for SIS were applied. The first technique uses Rigid tape and is applied bilaterally (Lewis et al., 2005b). In the Rigid tape application, a combination pack of zinc oxide tape and protective tape[a] was used. The protective tape was applied first with no tension. To apply the Rigid tape, subjects placed their thoracic spine in a neutral position, the Rigid tape was applied bilaterally from the first to the twelfth thoracic vertebra (Fig. 1). Subjects were then asked to retract and depress the scapula; this was demonstrated by the investigator. Rigid tape was applied diagonally from the middle of the scapular spine to the twelfth thoracic vertebra; this was also applied bilaterally.

The second taping technique used Elastic tape[b] and was applied on the symptomatic side only (Kase and Kase, 2003). Placing the arm in various positions before application of each strip, firstly, a Y-strip was applied from the insertion to the origin of the supraspinatus with no additional stretch, another Y-strip was applied from the insertion to the origin of the deltoid with no additional stretch and a final I-strip was applied from the coracoid process to the posterior deltoid with approximately 75% stretch and a downward pressure (Fig. 1).

2.3. Outcome measures

2.3.1. Experimental setup

A 10-camera motion capture system[c] was used to track the trajectories of reflective markers attached to the thorax, humerus and the scapula locator (Shaheen et al., 2011b).

Subjects were asked to attend one laboratory session, the sessions lasted between 60 and 90 min. Subjects were seated on a backless stool with the feet at a comfortable width apart. Subjects performed three bilateral elevations and lowerings in the scapular and the sagittal planes at a comfortable pace; the order of planes was randomised. During this session, movements were repeated for three conditions: Baseline, Rigid taping and Elastic taping. Subjects were allowed short breaks between conditions, the durations of which were determined by the subjects. The markers were not removed during these breaks.

Baseline measurements were always obtained at the start. The order of the Rigid and Elastic taping was randomised. Visual Analogue Scales (VAS) were used to assess the intensity of pain at rest and during movements in the scapular and sagittal planes for the three conditions. The scales were horizontal lines of 10 cm in