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Original research

Effects of scapular taping on the activity onset of scapular muscles and the scapular kinematics in volleyball players with rotator cuff tendinopathy

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ABSTRACT

Objectives: To examine the effect of scapular taping on the activity onset of scapular muscles and the scapular kinematics during arm elevation in volleyball players with rotator cuff (RC) tendinopathy.
Design: Randomized placebo-controlled repeated measures
Methods: Twenty-six male volleyball players with RC tendinopathy (mean age = 23.6 ± 3.3 years) participated in the study. Electromyography (EMG) activity onset of upper trapezius (UT), middle trapezius (MT), lower trapezius (LT) and serratus anterior (SA) and the three-dimensional scapular kinematics quantified by using an acromial marker cluster method were compared with three scapular taping protocols, namely, no taping, therapeutic taping, and placebo taping.
Results: The MT, LT and SA activated significantly earlier in both therapeutic taping (all $p < 0.005$) and placebo taping conditions than no taping conditions (all $p < 0.002$). There was a small increase in the scapular upward rotation when therapeutic taping and no taping conditions were compared ($p = 0.007$).
Conclusions: Scapular taping may enhance the neuromotor control of the scapular muscles. Whether it provides adequate support for normal scapular kinematics during arm movement in athletes with RC tendinopathy await for further studies.

1. Introduction

Chronic shoulder pain is the most common musculoskeletal complaints in volleyball players. Approximately 60% of volleyball players reported a history of shoulder problems.[1] Rotator cuff (RC) tendinopathy is one of the most frequently reported overuse injury in volleyball players that is characterised by pain, weakness, and disability during arm elevation,[2,3] and result in long periods of absence from training and competition.[4]

Scapular muscles are important for stabilizing and controlling the scapula for proper position and normal kinematics during arm elevation. Synchronized activity onset of the scapular muscles is important for a smooth scapular motion during arm abduction.[5] Delayed electromyographic (EMG) activation of the upper (UT), middle (MT), and lower trapezius (LT), as well as the serratus anterior (SA) were demonstrated in non-athletes with RC tendinopathy during arm elevation[6]; and delayed activation of the MT and LT was reported in athletes of upper limb sports with RC tendinopathy during a sudden drop arm test.[5] Alteration in the activity onset of scapular muscles during arm elevation may affect the normal kinematics of the scapula and affect the function of the rotator cuff muscles and render the athletes to RC pathology.[7,8] Maintenance of the activity onset of the scapular muscles and normal scapular motion is essential for the prevention and rehabilitation of RC tendinopathy in athletes with overhead sports, and one of the strategies for maintaining normal scapular motion is using therapeutic taping.[9,10]

Therapeutic taping is widely used for the prevention and management of shoulder injuries in professional athletes.[10,11] Scapular taping is believed to help reduce pain and discomfort of the shoulder.[9,11] One of the proposed mechanisms of taping is that it stimulates the neuromuscular pathways via increased proprioceptive feedback from cutaneous receptors and muscle afferents.[10,12,13] Previous studies have investigated the effects of scapular taping on the amplitude of activation of the scapular muscles[14–16]; however, the effects of scapular taping on the activity onset of scapular muscles has not been investigated. Information on changes in the activity onset of scapular muscles with application of tape would provide a better understanding of the mechanism of taping on neuromotor control in athletes with RC tendinopathy.

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Another proposed mechanism of taping is the mechanical effects in correcting the scapular position leading to an increase in subacromial space.[10,17] Although previous studies have demonstrated a mean increase in scapular upward and external rotation and posterior tilt during arm elevation in asymptomatic individuals[18] and a mean increase in external rotation in people with RC tendinopathy after therapeutic taping,[17] both studies did not standardize the tension of the tape which may affect the mechanical effects on the scapula.[17,18] Also, whether the observed effects are related to a placebo effect is unclear.

To better understand the mechanism of tape applied on the scapula, this study examined the effect of scapular taping on the activity onset timing of scapular muscles and scapular kinematics during dynamic shoulder abduction in volleyball players with RC tendinopathy. We hypothesized that scapular taping can induce earlier activity onset of scapular muscles and can effectively increase scapular upward rotation, posterior tilt and external rotation during arm elevation in players with RC tendinopathy.

2. Method

Twenty-six male volleyball players between 18 and 35 years participated in this study. They were recruited from local sports clubs and universities. They had training experience of more than 3 years with at least three training sessions per week. Players with a history of shoulder fractures, instability or dislocation, shoulder surgery or clinical treatment for a shoulder injury, frozen shoulders (more than 50% restriction in external rotation, abduction and flexion during both active and passive movements in comparison to the uninvolved shoulder) and a positive general laxity test (>5/9 Beighton Score) were excluded.[19]

Demographic information such as age, gender, height, weight, body mass index (BMI), arm dominance (the side on which they throw a ball), number of years of involvement in volleyball training and training hours per week were recorded. The intensity of pain during training was recorded using a visual analogue scale (VAS) from 0 to 10, with 0 indicating no pain, and 10 indicating the worst pain during training. Clinical tests were conducted by an experienced physiotherapist to confirm the presence of RC tendinopathy. In the present study, RC tendinopathy was defined as (1) presence of shoulder pain during training for more than 3 months,[19] (2) three out of five positive results for the following: painful arc, pain or weakness with resisted external rotation, Neer test, Kennedy–Hawkins test and Jobe test.[20] The intensity of pain being provoked should be ≥3/10 on the VAS score,[19] and (4) ultrasound image showed the presence of non-homogeneity or partial tear in the supraspinatus tendon.[19] The study was approved by the Human Subjects Ethics Sub-committee of the Departmental Research Committee, The Hong Kong Polytechnic University (Reference number: HSEARS20141201002), and all participants gave their written informed consent before the study. All procedures adhered to the Declaration of Helsinki.

Three taping protocols were tested in random order: (1) no taping, (2) placebo taping (taping without tension), and (3) therapeutic taping with full tension.[14–16] A piece of 3.8 cm I-shaped rigid Leukotape adhesive tape was used for conditions (2) and (3). Tape was applied with the participants seated upright on a stool with their head in the neutral position. Each participant was asked to fully extend their thoracic spine, with the scapula positioned in the full retraction and depression position.[17,18] Tape was applied starting from the inferior margin of the medial 1/3 of the clavicle, then firmly on the UT muscle with full stretching of the tape to the thoracic spine at T12 (Fig. 1).[14] In order to standardize the tension, the other end of the tape was connected to a strain gauge transducer (Ronso Electronic, Hong Kong) with a digital force display unit. The examiner pulled on the strain gauge transducer until a force of 1.5–2 kg was displayed while the tape was applied to the skin.[21] The placebo tape was applied in the same way but without any tension applied. The same researcher, who is experienced in the procedure, performed all the taping procedures.

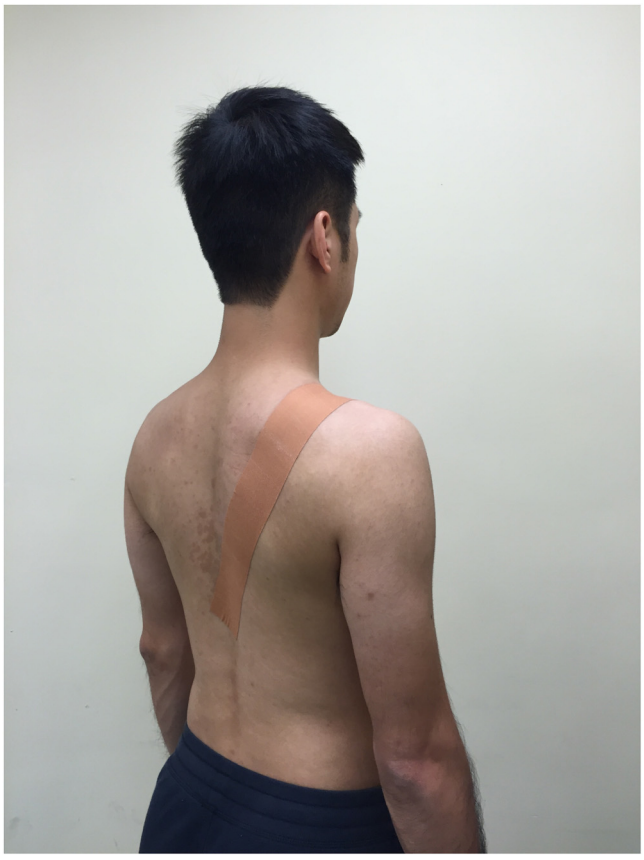

Fig. 1. Scapular taping. A 3.8 cm I-shaped rigid Leukotape tape was used. Tape was applied starting from the inferior margin of the medial 1/3 of the clavicle to thoracic spine at T12.

A Vicon v-370 3-D motion analysis system (Vicon Motion Systems, Oxford, UK) with six cameras was used to capture the upper extremity, trunk and scapular motion during arm movement. After standard calibration procedures, the motion was filmed at 100 Hz. Reflective markers were placed over anatomical landmarks as per the recommendations of the International Society of Biomechanics: suprasternal notch, C7 vertebra, xiphoid process and T8 vertebra to determine the trunk positions.[22] A three-marker acromion cluster was adhered to the postero-lateral part of acromion to track its movement.[23] The acromial marker cluster method has been validated for measuring scapular movement with humeral elevation up to 100°.[23] The humeral four-marker cluster was also fastened to the participant's upper arm to determine the amount of shoulder abduction. The thoracic markers, acromial marker cluster, and humeral marker cluster were attached by the same investigator and remained in situ during the testing protocol.

Surface electromyography with Ag/AgCl electrodes (SX230, Biometrics Limited, Newport, UK) was used to measure the recruitment patterns and latencies of the upper (UT), middle (MT) and lower trapezius (LT), and serratus anterior (SA). The EMG signal was sampled at 1000 Hz. The participants were asked to sit upright on a stool with arms relaxed on both sides. Skin of the tested shoulder was lightly abraded with sandpaper and cleaned with alcohol to reduce impedance. Conductive gel was applied to the electrodes and then the active electrodes were positioned longitudinally along