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Original article

The effects of Kinesio taping on muscle tone in healthy subjects: A double-blind, placebo-controlled crossover trial

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ABSTRACT

Kinesio taping (KT) has been proposed to modulate muscle tone. However no studies have systematically studied the efficacy of KT on this primary outcome measure. The objective of this study was to determine the effect of Kinesio taping (KT) applied over the gastrocnemius muscles on muscle tone, extensibility, electromyography (EMG) and strength. Nineteen healthy subjects were enrolled in a double-blind, placebo-controlled crossover trial. KT and sham-tape were applied onto the gastrocnemius muscles of all subjects in two randomized sessions. Measurements before, at 10 min and 24 h after the intervention were taken. Outcome measurements included passive resistive torque to ankle dorsiflexion, dorsiflexion passive range of motion (PROM), surface Gastrocnemius Medialis (GM) EMG and maximal isometric voluntary force (MIVF). No significant differences were found between the sham-tape and KT groups for passive resistive torque, PROM nor maximal plantarflexion isometric voluntary force. A short-term increase of GM EMG activity was found in the KT group during the PROM mobilization, which was not maintained at 24 h following treatment. A short-term decrease in dorsiflexion force was produced 10 min after KT with respect to sham-tape application. These results demonstrate that the application of KT in the gastrocnemius muscles has no effect on healthy muscle tone, extensibility nor strength. However a short-term increase of GM EMG activity after KT treatment suggests the activation of central nervous system mechanisms, although without a therapeutic implication. Further studies with more appropriate designs are needed to clarify the physiological and therapeutic effects of this taping technique.

1. Introduction

Kinesio taping (KT), developed by Kase (Kase et al., 1996), is a new application of adhesive taping. It is a thin elastic tape which can be stretched up to 130–140% of its original length and is applied over or around muscles to provide functional support (Kase et al., 1996; Kase, 1997). In the last few years the use of KT has extended among professionals, athletes and patients. However the specific effects and mechanisms of action of this kind of taping are still unknown. Although several studies have addressed the effects of KT on muscle strength, no effects have been identified in healthy subjects (Fu et al., 2008; Lins et al., 2012; Vercelli et al., 2012). Increase in electromyographic (EMG) activity has also been reported with KT (Slupik et al., 2007; Hsu et al., 2009) although this effect is not always clear (Huang et al., 2011; Lins et al., 2012). Range of motion increases statistically following KT treatment in subjects with several types of pain, without reaching clinical relevance (Thelen et al., 2008; Gonzalez-Iglesias et al., 2009; Castro-Sanchez et al., 2012). Taken together the equivocal results obtained measuring both EMG and range of motion suggests a need fully characterize the effect of KT on muscle tone in the context of muscle strength, muscle extensibility and evoked EMG activity.

The two main theories proposed to explain the reported functional effects of KT are increased blood and lymphatic fluid circulation in the taped area due to a lifting effect, which creates a wider space between the skin and the muscle and interstitial space (Halseth et al., 2004; Yoshida and Kahanov, 2007; Akbas et al., 2011). An additional theory is that KT may apply pressure or continual stretching of the skin within the taped area, and this

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external activation of cutaneous mechanoreceptors would activate modulatory mechanisms within the central nervous system demonstrated as an increase in muscle excitability (Yoshida and Kahanov, 2007; Akbas et al., 2011). Further studies are required to establish the role of these physiological mechanisms during KT on skeletal muscle tone.

Muscle tone is defined as "the state of activity or tension of a muscle beyond that related to its physical properties" (Stedman, 1982). Clinically muscle tone is accepted as the resistance felt to externally imposed movements during a state of voluntary relaxation (Lance, 1980). Therefore in a completely relaxed subject, a joint will resist movement as a result of three physical processes: (1) the inertia of the limb, (2) the viscoelastic properties of the muscle and joint opposing the movement and (3) evoked reflex activity (Pisano et al., 1996). According to these mechanisms skeletal muscle tone reflects intrinsic viscoelastic muscle properties (also called "passive tone", "mechanical", "non-reflex" or "EMG-silent") and neurogenic factors that are activated by stimuli, represented mainly as the stretch reflex and also called "active tone", "reflex tone" or "neurogenic tone" (Mirbagheri et al., 2001; Masi and Hannon, 2008). Both the viscoelastic and neurogenic components of muscle tone can be quantified separately by employing specific measurement techniques (Pisano et al., 1996; Lorentzen et al., 2010).

Several physical therapy techniques have been demonstrated to decrease muscle tone in healthy subjects, such as stretching and repetitive peripheral magnetic stimulation (McNair et al., 2001; Struppler et al., 2004). The main goal of this study was to assess whether KT would modulate muscle tone or other associated measures such as muscle extensibility, strength and evoked EMG activity. To achieve this goal a double-blind, crossover trial was designed including a masking technique so that subject and evaluator were blinded to the application of either sham or active KT. Furthermore a battery of quantitative measures were used to demonstrate the potential effect of KT treatment on gastrocnemius muscle function.

2. Methods

2.1. Subjects

The study was approved by the Toledo Hospital Clinical Research Ethics Committee. Nineteen healthy volunteers (8 males and 11 females) with a mean age of 23.8 ± 3.9 years (accepted range 18–40), height of 168 ± 9 cm, weight of 65.8 ± 11.3 Kg and Body Mass Index of 23.2 ± 2.5 were recruited into the study following informed consent. Sample size was previously calculated based on McNair et al. (2001), which measured passive resistive torque to ankle dorsiflexion in healthy subjects using a Kin-Com dynamometer (McNair et al., 2001). The minimal number of subjects required to attain a power of 0.9 and an alpha level of 0.05 was calculated to be 11. Participants were recruited among students of the local University and Hospital staff, by non-probabilistic convenience sampling. The exclusion criteria included any history of ipsilateral lower limb severe injury or intervention (e.g. fracture, surgical intervention…), pain or musculoskeletal injury in the previous month to the intervention, peripheral or central nervous system neurological disease, altered sensation within the taping area and changes in physical activity which would have affected muscle tone during the study.

2.2. Procedures

Initially, all volunteers were seated with the hip placed at a 90° position, with the knee straight and the ankle in a neutral position strapped to a footplate connected to a Kin-Com dynamometer (Chattanooga Group Inc.). Bipolar silver chloride coated surface electrodes (Delsys Inc. Signal Conditioning Electrodes v2.3, USA) were placed over the Tibialis Anterior and Gastrocnemius Medialis (GM) muscles by the non-blinded researcher according to the SENIAM protocol (www.seniam.org). A 2 cm^2 stainless steel ground electrode was placed over the patella.

At baseline (T0) the assessment consisted of a warm-up period, a passive resistive torque test at both slow (10°/s) and fast (180°/s) velocities, a passive range of motion (PROM) test and a maximal voluntary isometric force (MVIF) test (see below) for all subjects evaluated by the blinded evaluator. Concealed random allocation was performed to assign participants into the Sham-tape or KT arm during the first session. Tapes were applied to the subject in a prone position with the lower leg protruding from the bed by a physiotherapist with more than 20 years of KT application. Following application of the sham or active KT, the calf was covered by a non-compressive opaque fabric material. Subjects were instructed not to remove the cover during the study. This masking protocol effectively blinded both the evaluators and the subjects to the applied taping. Ten minutes after taping a second assessment was made (T1). To ensure the double-blind design, the non-blinded evaluator removed the cover material, placed the EMG electrodes and then re-covered the active or sham tapes before the T1 assessment. Finally a third assessment was made in the same way 24 h after initial taping (T2). The crossover study design was achieved by applying the sham or active KT treatment arm one week later.

2.3. Tape application

2.3.1. Kinesiotape

The Gastrocnemius muscle of the right leg was taped by an experienced physiotherapist (see above) according to Kenzo Kase's Kinesiotaping Manual (Kase et al., 1996; Kase, 1997) (Fig. 1A). The skin was cleaned and shaved and the Triceps Surae was stretched with the subject in the prone position with the lower leg protruding off the bed. In this position, the length of the tape strip of 5 cm width (CureTape®, Fysiotape; Enschede, Netherlands) was measured from the proximal gastrocnemius muscle insertion to the calcaneus bone, including an additional 4 cm to enable the tape fixes properly to the heel. This strip was then cut longitudinally from the proximal extreme of the tape to the Triceps Surae myotendinous junction and was positioned directly on the skin without undue tension (100% of its maximum tape length) according to three phases: 1) the tape was anchored at the heel with the ankle joint in a neutral position, 2) Triceps Surae was stretched and 3) the divided proximal end of the tape was attached onto the medial and lateral heads of the gastrocnemius muscles.

2.3.2. Sham-tape

The sham-taping protocol consisted of placing three short strips of the same kind of material only onto the extremes of the KT application (heel, 12 cm) and medial/lateral heads of gastrocnemius muscles (5 cm), Fig. 1B). In this way, the sham-taping was made on the ineffective parts of the triceps surae muscle without continuity, which is assumed not to have any effect (Karadag-Saygi et al., 2010). Furthermore both types of taping had a similar appearance due to the cover of the non-compressive opaque material over the calf (Fig. 1C).

2.4. Assessment

2.4.1. Measurement of passive resistive torque

The measurement of the resistance to passive stretch using isokinetic dynamometric techniques is considered a valid method to measure muscle tone in non-injured subjects (Pisano et al.,