

Kinesio Taping Applied to Lumbar Muscles in Static Lumbar Flexion

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ABSTRACT

Purpose: In approaching full trunk flexion (75%-80% of full flexion), myoelectric activity of lumbar erector spinae muscles is reduced or silenced; this response is known as flexion-relaxation phenomenon (FRP). FRP is a shift in load sharing and spinal stabilization from active structures (erector spinae muscles) to passive ligamentous and articular structures. Static lumbar flexion under constant displacement or load, within the physiological range, elicits creep in lumbar viscoelastic tissues. During a short static lumbar flexion, significant changes are elicited in the muscular activity pattern of the FRP. Laxity in the passive tissues of the spine during prolonged spinal flexion disturbs the spinal stability. This study investigated the effects of Kinesio taping (KT) before and after periods of the static lumbar flexion on the timing of FRP for the erector spinae muscles.

Methods: The research was conducted on 22 healthy female college students. The surface electromyographic silence and onset of the erector spinae muscle activities were measured in two states; before the static lumbar flexion and 10 minutes after the static lumbar flexion in two conditions (with and without KT).

Results: The results indicate that KT causes erector spinae muscles relaxation earlier in the flexion and later reactivated in the extension. In other words, KT increased flexion relaxation time in erector spinae muscles ($P < 0.05$). The results also indicate that 10 minutes static lumbar flexion will produce relaxation of the erector spinae muscles later during the forward bending activity and earlier reactivation during the extension ($P < 0.05$). Application of KT cannot compensate the effects of 10 minutes static flexion at the onset and the silence of flexion relaxation and over again creep causes FRP occurs later.

Conclusion: According to the effects of KT before the creep in reducing the duration of the muscles activity, kinesio tape may be used in reducing muscle spasms and duration of erector spinae muscles activity. It may also improve FRP in the back and the people who are predisposed to the back pain and FRP has not seen in them. Therefore, the need for research on these subjects and other factors, such as the electrical activity of muscles is essential. Although the application of KT cannot substitute the effects of 10 minutes static flexion on the onset and the silence of flexion relaxation, it could be used for protection and reduction of using strained viscoelastic structures.

Keywords:

Muscle relaxation,
Atheletic tape,
Lumbar vertebrae,
Electromyography

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1. Introduction

The human spine is a complex structure; Its principal function is to protect the spinal cord and transfer loads from the head and trunk to the pelvis. In the spinal axis, different anatomic components contribute to the spinal stability, including intervertebral disks, joints, ligaments, and muscles. The muscles in the lumbar spine have a major contribution for protecting the joints against excessive shear forces [1].

The trunk flexion is controlled by the eccentric contraction of the lumbar erector spinae (ES) muscles combined with the eccentric contraction of the hip extensors and hamstrings to control the pelvic movement [2]. Passive stretching of posterior ligaments and capsules also contribute to the control of the trunk flexion. In approaching the full trunk flexion (75%-80% of full flexion), in the healthy individuals, the myoelectric activity of the lumbar ES muscles is reduced or silenced. First described by Floyd and Silver [3], this response is called the Flexion-Relaxation Phenomenon (FRP). Different mechanisms have been proposed to explain FRP. A shift in the load sharing and the spinal stabilization from the active structures (ES muscles) to the passive ligamentous and articular structures (supraspinous, interspinous and other ligaments, intervertebral disks, and thoracolumbar fascia) have been postulated by several authors [3, 4, 5, 6].

The lumbar FRP has been found to be present in the healthy individuals; its absence is a myoelectric measure that characterizes the patients with CLBP (Chronic Low Back Pain) [6, 7]. Persistent activation of the lumbar ES muscles in subjects with LBP (Low Back Pain) may consist of a protective “splinting” response to increase the lumbar stabilization, elevating the myoelectric activity in response to pain, or an altered motor control strategy [7, 8]. The optimal lumbar stability is obtained by contributions of the passive and active stabilizing elements, which can be modified by pain, angular trunk velocity, [5] and loading [2]. Other authors [9, 10] have shown that muscular fatigue could increase the myoelectric silence period of the ES during flexion-extension task and subsequent creep and laxity in the passive articular tissues would have significant impact on the muscular responses [10, 11]. They associated the prolonged “FRP” with the reduction of the lumbar spinal stability and an increased risk of the lumbar injuries.

Up to now, we have found that the static lumbar flexion under the constant displacement or load, within the physiological range, would elicit creep in the lumbar

viscoelastic tissues. The creep response and recovery behaviour of ES is an interesting model to study the modulation of the lumbar stability. Solomonow et al. (2003) showed that the creep, developed during the short static lumbar flexion, would elicit a significant decrease in the FRP duration [12].

An interesting and relatively new method of treating musculoskeletal conditions is the application of the Kinesio taping (KT) [13]. KT has become a very popular treatment for several health conditions over the last decade. KT is an elastic tape, which is extremely thin and much more elastic than conventional bandages. This tape can be stretched up to 140% of its original length, producing less mechanical retention and restriction to movement [13].

The creators of KT also state that the tape is able to improve blood and lymphatic circulation, reduces pain, realign joints, and reduces the muscle tension. Additionally, the use of KT is likely to change the pattern of recruitment of the muscle fibres, which involves greater activation of the paravertebral musculature in response to pain; It is expected that the use of bandages (such as KT) would inhibit this excessive activation, increase range of motion, improve the functionality, and reduce the pain intensity [14]. Although physical therapists use KT in clinical practice, scientific evidence about its effects is limited [15].

Paoloni conducted a study on KT applied to the lumbar muscles and its effects on the clinical and the electromyographic characteristics in patients with chronic low back pain. The study concluded that KT leads to both immediate and short-term pain relief and return of the lumbar muscle function [15]. Castro-Sanchez (2012) conducted a study on KT use and showed that it reduces the disability and pain in the chronic non-specific low back pain (a randomized trial). Sixty adults with chronic nonspecific low back pain were included in the study. The outcome measures included Oswestry disability index, Ronald-Morris low back pain, disability questionnaire, visual analogue scale, Tampa Kinesio phobia scale, trunk flexion range of motion, and MCQuade test of trunk muscle endurance.

The study indicated that KT reduced disability and the pain in people with the chronic nonspecific low back pain [16]. Ayako Yoshida (2005) conducted a study to determine the effects of KT on trunk flexion, extension, and lateral flexion on healthy subjects with no history of lower trunk or back problems. Subjects performed two experimental measurements of range of motion (with

and without the application of KT) in trunk flexion, extension, and right lateral flexion. Based on the findings, they concluded that KT applied over the lower trunk may increase the active lower trunk flexion range of motion. Further investigation on the effects of KT is warranted [15].

However, no studies have yet evaluated the effects of KT on the relaxation of the ES muscles during forward bending and their reactivation during the extension in the prolonging flexion in the healthy subjects. The purpose of the study was to find out the effects of KT on FRP in the healthy subjects after the static flexion for 10 minutes.

2. Materials & Methods

Participants

Twenty-two female people were selected by nonprobability convenient sampling method. The participants were 18-30 years old and recruited from the University of Social Welfare and Rehabilitation Sciences and Health Services. The exclusion criteria were history of the lower trunk or the back issues, spondylolisthesis, axial skeletal inflammation or osteoarthritis, collagenosis, osteoporosis, spinal surgery, neuromuscular disease, lower limb musculoskeletal injuries, malignant tumor, hypertension, infection or any other nonmechanical condition, radiculopathy, progressive neurological deficit, myelopathy, and herniated lumbar disk.

Previous studies have shown that the creep-related changes are different in males and females with more obvious changes in women [12]. Thus to neutralize the effect of gender and its confounding factors (also they were more accessible), only the females were recruited for this study. All participants gave their informed, written consent according to a protocol approved by the examiner. The mean (SD) age, height, and weight of the 22 participants were 27 (2.71) y, 1.6 (6.9) m, and 53.9 (7.1) kg, respectively.

Experimental protocol

Instruments

Surface EMG data were collected using an 8-channel electromyography device (CT8MIE Medica 5 Research Ltd. UK). The EMG signals were detected by pre-gelled Ag/AgCl electrode pairs applied at the L3-4 level over the left ES musculature (about 4 cm lateral to midline). Center-to-center electrode spacing was 2.5 cm. The electrodes were longitudinally oriented along the fibres of the ES muscles [12]. A reference electrode was placed

on the right side on the table. To identify the L3 level, we first found the sacrum and followed the spinous processes of the lumbar vertebrae up to L3, which is located at the center of the lumbar curve and due to its long transverse processes, provides mechanical advantage for the muscles. So the investigation of the muscular activity at this level is preferred [17] and makes it more comparable to other research reports [12].

The EMG signals were amplified by 1000 with a frequency band pass of 20e500 Hz, Gain 100 mV/div., 80 dB signals to noise ratio and CMRR of 90 dB. Maximum acceptable skin impedance level was set at 5 kU. Sampling rate of recording was 1000 Hz and the data were digitized and stored in a 12-bit A/D board. Skin impedance was reduced by shaving excess body hair, if necessary, and wiping it with alcohol swabs.

Protocol

The study participants were tested in one session of approximately 30 minutes in the laboratory. Before the experimental task, they were examined by the examiner. The participants were then asked to perform the trunk flexion-extension task. Verbal instructions, followed by a demonstration and practice trials, were provided before the experiment. The subjects stood just behind a horizontally drawn line on the ground barefoot with their feet pelvis width apart, from an upright standing position with arms crossed over their chest. Then the participants were instructed to bend forward as far as possible during a 3 seconds movement period (flexion phase).

Next, they were required to hold the fully flexed position for 3 seconds period and then return to the initial upright position. The extension phase lasted 3 seconds. The speed and the duration of all movement phases were standardized with a metronome. Three flexion-extension cycles were completed by each participant, and then static standing to the end of recording. Finally, one of the trials was chosen depending on signal quality of data analysis [18].

After recording EMG, the subjects sat on the floor with their trunk in the full lumbar flexion. A hemi-cylindrical foam bolster was placed under the thighs to tilt the pelvis posteriorly, and reduce hamstring stretch [12] (Figure 1). The subjects were remained in this static flexion position for 10 consecutive minutes, immediately after which they stood up and performed another set of the flexion-extension tasks similar to the one performed prior to the static flexion period.

Application of kinesio tape

Three 20×5cm strips thin, cotton, porous, adhesive and latex free elastic KT tape with a longitudinal elasticity of 40% were applied over the lumbar region between the spinous processes of T12 and L5 vertebrae. One strip was placed along the line corresponding to the spinous processes of T12 and L5 vertebrae. Two strips were placed on the right and the left erector spinae muscles, 4 cm from the first strip (Figure 2) [16]. Subjects were asked to bend forward till their hands could reach to the knees during the taping procedure [15]. Immediately after the KT, the subjects performed the above steps of the trunk flexion-extension tasks before and after 10 minutes static flexion.

Data analysis

The recorded EMG signals were full-wave rectified and smoothed with the time constant of 50 ms to yield linear envelopes. A threshold level of 10% of the peak EMG magnitude during the extension phase was used to determine the onset and the end of the flexion relaxation period [12]. The onset of the FRP (EMG-Off) was defined as the point at which the magnitude of EMG signal got less than

the threshold level and the end point of the phenomenon (EMG-On) during the extension phase was defined as the point at which EMG signals amplitude exceeded the threshold level (Figure 2) [18].

The dependent variables included the onset of the FRP (time of EMG-Off) and end point of the FRP (time of EMG-On), in two times of before and immediately after 10 minutes static flexion with and without KT.

Statistical analysis

Analysis of variance with repeated measures (before vs. after 10 minutes of deep flexion, and with vs. without KT) was used to evaluate the effect of the static flexion and KT on the timing of EMG activity pattern of ES muscles. The α level was set at 0.05.

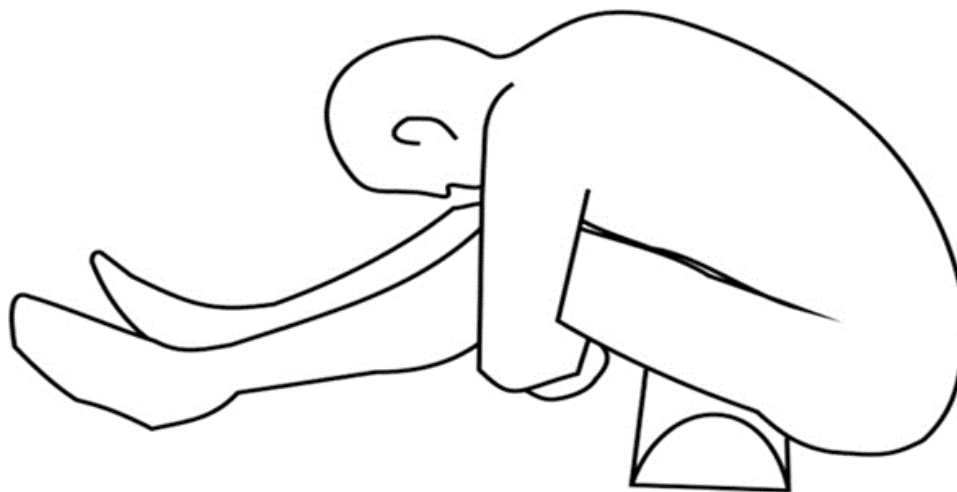
3. Results

All 22 subjects exhibited FRP in their ES muscles before the creep. The data from all subjects who also showed FRP after the static lumbar flexion were subjected to the statistical analysis.

Table 1. The effect of kinesio taping and creep on EMG-Off and EMG-On before and immediately after creep phenomenon with and without kinesio taping.

Parameter	With kinesio tape Mean (SD)		With kinesio tape Mean (SD)		P-Value			
	Before creep Condition (I)	After creep Condition (II)	Before creep Condition (III)	After creep Condition (IV)	Condition I, II	Condition III, IV	Condition I, III	Condition I, IV
EMG off, s	4.64 (0.61)	5.12 (0.87)	4.34 (0.64)	4.79 (0.75)	0.039	0.011	0.047	0.189
EMG on, s	9.26 (1.04)	8.88 (0.099)	9.97 (0.77)	9.33 (0.80)	0.046	0.000	0.001	0.288

PHYSICAL TREATMENTS



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Figure 1. Schematic representation of a subject during the 10 min of static lumbar flexion.

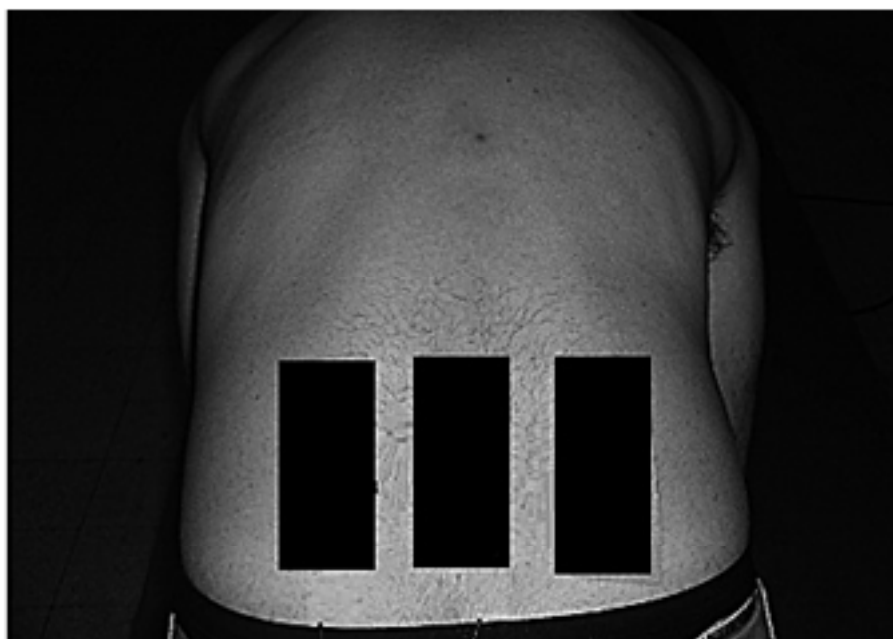


Figure 2. Application of KT during forward bending.

PHYSICAL TREATMENTS

Table 1 presents the test results of EMG-On and EMG-Off in two conditions with and without KT before and immediately after the creep. Ten minutes of the static lumbar flexion increased the time of EMG-Off point for 0.48 seconds (from 4.64 to 5.12 s) and decreased time of EMG-ON point for 0.38 seconds (from 9.26 to 8.88 s) ($P < 0.05$). After the creep, ES muscles remained active longer in the flexion and the reactive earlier during the extension. In other words, 10 minutes of static lumbar flexion reduced the FRP time in the ES muscles.

KT decrease the time of EMG-Off point for 0.3 seconds (from 4.64 to 4.34 s) and increased the time of EMG-ON point for 0.71 seconds (from 9.26 to 9.97 s) before the creep ($P < 0.05$). In other words, KT causes ES muscles be relaxed earlier in the flexion and later reactivated in the extension. Using KT before the creep increased the FRP time in ES muscles.

The time points of EMG-Off and EMG-On after the creep were compared in two conditions of with and without KT and yielded no significant difference. In other words, according to the timing of EMG activity, ES muscles were relaxed and reactivated at the same time in two conditions of with and without KT after the creep. KT was unable to compensate for the negative effects of 10 minutes static lumbar flexion for the relaxation and the reactivation time of ES muscles.

4. Discussion

The major results of this study point out that KT elicits significant changes in the response of FRP. Kinesio taping caused the ES muscles to relax earlier during anterior flexion and to become active later during the extension phase. Although the mechanism underlying the effect of KT is beyond the scope of this study, some hypotheses may be made in an attempt to understand how KT acts on FRP.

Paoloni and colleagues find that KT application led to the reappearance of the flexion relaxation in 43.6% of the patients [14]. They did not find any correlation between FRP reappearance and the pain reduction, which is in agreement with previous studies that failed to find a relationship between the pain state and EMG in persons with chronic low back pain [19, 20]. They stated that that normalized FRP may result from correct sensory feedback in the patients who receive KT, in whom fear of movement is consequently reduced and the lumbar muscle function is improved [15].

The FRP was explained as the muscular representation of a synergistic load sharing between the ES muscles and the viscoelastic elements (posterior ligaments, lumbar fascia, disks, and capsules) of the lumbar spine [21, 22]. As an individual initiates the anterior flexion, the erector spinae muscles gradually increase their contraction in order to offset the gradually increasing effect of gravity on the mass of the upper trunk and the head. At some point the passive forces generated by the

increasingly strained viscoelastic structures are sufficient to completely offset the effect of the gravity on the upper body and the head mass, and the muscular forces are no longer required and therefore diminish completely. Additional increase in the flexion requires the contraction of abdominal muscles to overcome the forces generated by the posterior viscoelastic tissue [12].

In this regard, the use of 3 KT stripes in our protocol may lead to an increased involvement of cutaneous receptors. Sensory stimulation provided by KT may also represent a dynamic stabilization system of the lumbar joints in a flexion position, which may help to reflexogenically inhibit the muscle activity [12, 15, 22].

Ten minutes of deep static lumbar flexion elicits significant changes in the response of FRP. The moderate creep developed in the viscoelastic structures of the spine caused ES muscles to remain active longer during the anterior flexion and become active earlier during the extension phase.

The musculature, however, compensates for the decreased capacity of the viscoelastic tissues to generate passive forces by initiating and or maintaining an active force in the necessary periods. This process further supports the neurological synergy between the ligaments and the muscles to control movements and preserve skeletal stability. The creep of viscoelastic tissues seems to be associated with microdamage to the collagen structure, with larger loads or duration of the static flexion, even more pronounced changes in the flexion relaxation response could be expected [12].

According to the effects of the kinesio tape before the creep in reducing the duration of the muscles activity, perhaps kinesio tape can be used in reducing the muscle spasms and the duration of erector spinae muscles activity in the back and the people who are predisposed to the back pain that FRP has not seen in them. In any case, the need for the research on these subjects and other factors such as the electrical activity of the muscles is essential. Although application of the KT cannot compensate for or neutralize the effects of 10 minutes static flexion on the onset and the silence of flexion relaxation, it may be used for protection and reduction of the strained viscoelastic structures.

Ethical clearance

As this study involves human subjects, the ethical clearance has been obtained from the research and the Ethics Committee of the Institution. Also a written consent was taken from each subject who participated in the study.

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