

The Immediate Effects of Kinesio Taping on Lumbar Range of Motions

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ABSTRACT

This study aims at determining the initial effects of kinesio taping (KT) applied to erector spinae muscle on lumbar flexion, extension and lateral flexion range of motions (ROM). Pre-post parallel controlled trial study was conducted on twenty healthy subjects divided equally into two groups (KT and placebo). Lumbar spine flexibility was evaluated using tape measure method for all lumbar tested motions. KT group showed significantly improve lumbar flexion ROM, yielded an increment of 9.9 cm compared with placebo group (9.9 cm, $t(9) = -4.265$, $p = 0.002$). However, no significant differences were discovered for lumbar extension (-0.9 cm, $t(9) = 1.132$, $p = 0.287$), right lumbar lateral flexion (1.2 cm, $t(9) = -1.964$, $p = 0.081$) and left lumbar lateral flexion ROM (0.8 cm, $t(9) = -1.633$, $p = 0.137$). The ANCOVA adjusted change scores revealed that the KT group demonstrated a very large effect size in lumbar flexion ROM. Meanwhile, trivial and moderate effect sizes were identified in lumbar extension and lateral flexion ROM respectively. Hence, the KT positively influences erector spinae muscle, allowing improvements in the active lumbar flexion ROM immediately after the application of KT.

Keywords: *kinesio taping, low back pain, lumbar flexibility, lumbar range of motions – erector spinae muscle.*

Introduction

Low back pain (LBP) is an extremely prevalent musculoskeletal disorders, associated with major health and socioeconomic costs resulting from job loss, mobility restriction, activity limitation, work absenteeism, substantial work disability and quality of life impairment (Anderson, 1999 & Ryan et al, 2009). Therefore, more effective interventions such as kinesio taping (KT) are crucial in order to prevent further worsening of the conditions over time as it has revealed some clinical and cost effectiveness (NICE, 2009).

KT, unlike conventional white athletic tape, is a relatively novel therapeutic technique invented by Dr Kenzo Kase, which such technique is purported to: reposition articular malalignment by normalizing muscle tension, support muscle function by strengthening muscles weakness, eliminate congestion by assisting blood and lymphatic flow and relieve pain by

activating the endogenous analgesic system (Kase et al, 1996, 2003). When applied to the skin, the tension imposed along the tape provides a shear force to the skin, lifting the skin away from the tissue beneath by the formation of micro convolutions in the tape occur after the application (Kahanov, L. 20017). This subsequently facilitates a release of pressure in the mechanoreceptors on tender tissues underneath, thereby decreasing nociceptive stimuli as well as creates additional space aiding circulation of blood, lymph fluids and tissue fluids in the space, thus producing a lesser mechanical restraint than standard rigid athletic tape (Kase et al, 1996, 2003). Furthermore, it has been proposed that the convolutions alter the recruitment of muscles through inhibition and excitatory neuromuscular mechanisms, depending on the direction of the tape application (Kase et al, 1996, 2003). However, scientific evidence on its therapeutic effectiveness has proven to be limited and remains to be elucidated regarding the mechanisms underlying the beneficial effects of KT (Drouin et al, 2013).

To date, there is only one current literature available KT and lumbar flexibility in all directions on healthy normal adults (Yoshida A & Kahanov L, 2007). Although significant improvement was demonstrated in lumbar flexion ROM only, the study presents several methodological shortcomings. Firstly, the study lack of placebo group to address the placebo effect of taping, and therefore it is not possible to know whether the intervention itself has any effects. Secondly, biased was introduced as the same researchers assessed the outcome of the intervention without being blinded to the evaluating group (Yoshida A & Kahanov L, 2007). The current study found in the literature differs from the present work with regard to the research design as well as the method of KT application. KT has been proposed to positively affect a wide-ranging of physiological conditions, including the ROM, and it is therefore plausible to hypothesize that the application of KT on erector spinae muscle of normal adults interferes with muscle function, thereby influencing the lumbar spine flexibility (Murray, H 2001 & Halseth et al, 2004). Accordingly, in this study, the intent is to compare the immediate effects of KT application on the erector spinae muscle for lumbar ROM in asymptomatic adults. Furthermore, it is also intended to provide a basis evidence of KT as a viable prophylactic option as the outcomes may have implications for the prevention of sporting injuries (Williams, S. et al, 2012).

Materials and Methods

This study is a pre-post parallel controlled trial design. There are two independent variables: the KT and sham taping (ST). The dependent variable is the lumbar ROM. Subjects were assigned to the treatment group of KT and ST, and then the outcome measures were recorded before and immediately after the intervention.

Twenty healthy subjects were voluntarily recruited in the study. All subjects were given informed, written consent prior to their participation. Following the signing of the informed consent forms, background information and anthropometric measurements were taken. Using a card with even and odd numbers, placed in sealed opaque envelopes, the subjects were randomly allocated and equally assigned with the treatment according to the group assignment. Standard 5 cm blue Kinesio Tex Gold Tape was used for both conditions and neither the subjects nor the investigator who performed the measurements knew what the procedure performed.

Initially, subjects were screened via a careful medical history and physical examination in order to confirm eligibility. Allergy test was performed on all subjects by applying a small patch of kinesio tape over the skin for 24 hours on small area of abdominal region. Those with positive allergic reaction to the patch test were not allowed to proceed with the study.

The criteria for inclusion in the clinical trial were as follow:

- Asymptomatic healthy subjects of either gender, ability to understand and to follow instruction.
- Age between 20-30 years old

Subjects were excluded if any of the following was found:

- Recent LBP or previous history of LBP within the past 12 months,
- Generalized neuromusculoskeletal disease,
- Congenital spinal disorder,
- Dislocation, fracture or surgery of the lumbar spine.

The standard tape with a width of 5cm and a thickness of 0.5mm was administered for both groups. The blue tape with I-strip (a straight cut, perpendicular to the length of the tape) was placed bilaterally over the erector spinae muscles, which is applied parallel to the ipsilateral spinous process of the lumbar vertebrae, starting near the posterior superior iliac spine (PSIS) to the lateral transverse process of T8 vertebrae (Kase K, Wallis J, Kase ,T. 2003). Length of the tape was measured in standing position while the lumbar spine was flexed to the maximum. Throughout application, both knees were maintained in full extension with the feet held together. The subjects were examined with swimming trunks without wearing a shirt and barefoot. The area to be treated was cleaned with alcohol-based hand sanitizer to remove oils from the skin.

Subjects in the experimental group received a standard therapeutic KT and had convolutions in neutral position (Kase K, Wallis J, Kase ,T. 2003). Initially, in a neutral upright spine position, each of the distal base of I-strip were first anchored approximately 2 inches (5cm) below the PSIS without tension (0% tension). Subsequently, subjects were asked to move into unforced maximum lumbar flexion to position the erector spinae muscle in a stretched position before each I-strip with 10 - 15% of tension (paper-off tension) were taped over the targeted area. To complete the procedure, the final 5cm of each I-strip was laid down approximately 2 inches (5cm) above the T8 vertebrae level without tension. The tape was rubbed by hand several times to initiate adhesive glue activation prior to any further movement.

The ST group received a ST with the same taping procedure but without tension and applied in neutral non-stretched position over the lumbar region. In this technique, the researcher completely removed the protective backing paper of the tape in order to remove the tension from the tape, thus creating no convolutions in the skin after the application.

Subjects were instructed to perform a static stretching exercise consisting of five repetitions of each of the tested motions. Lumbar ROM were measured by using tape measurement procedure as evidenced (Frost et al, 1982) to have an excellent measures of test -

retest reliability coefficient (r) for lumbar flexion ($r = 0.98$), lumbar extension ($r = 0.96$) and lumbar lateral flexion ROM ($r = 0.98$).

Based on the general procedure described by Yoshida et al. 2017 several protocol modification were made in order to obtain an accurate measurement of lumbar ROM:

- 1) For lumbar flexion ROM, subjects were instructed to stand on the step stool (height 20 cm) in erect upright position with knees straight, heels held together, and arms in a neutral position. Then, measurement of the vertical distance between the distal end of middle finger and the ground was recorded as the subjects performed maximal bending forward with fingers in a straight position.
- 2) For lumbar extension ROM, subjects were instructed to stand on the ground in erect upright position as previously mentioned. Then, measurement of the distance between the spinous process of C7 and midpoint of imaginary line of two PSIS was recorded as the subjects performed maximal bending backward with arms hanging freely toward the ground.
- 3) For right lumbar lateral (RLL) flexion ROM, subjects were instructed to stand on the ground in erect position as previously mentioned. Then, measurement of the vertical distance between the distal end of the middle finger and the ground was recorded as the subject performed maximal right side bending with right upper limb in a straight position hanging perpendicular to the ground. Later, with the same measurement procedure, subjects were tested to perform maximal left side bending in order to measure left lumbar lateral (LLL) flexion ROM.
- 4) Subjects were asked to perform three times ROM in all directions prior to and after the application of KT and ST, then the result achieved a greater motion will be recorded on the data collection sheet.

Data Analysis

The data were entered in Microsoft Excel 2013 and the statistical analysis was performed using IBM SPSS version 21 for Windows. Results were expressed as mean \pm standard deviation. To verify statistical difference, student's t-tests (paired design) were used to analyze within-group changes prior to and after the application of tape in each group. Normality assumption was checked with the Shapiro-Wilk test prior to parametric statistical procedures. Between-groups comparison was performed using analysis of covariance (ANCOVA) method on sample data, with the pre-test value as a covariate to control for chance imbalance in our measures between the control and intervention groups at baseline that may occur with small sample sizes (Vickers A.J. & Altman D.G 2001., Dimitrov D.N & Rumrill, Jr 2003). The value of 0.2 between-subject standard deviations was defined as a threshold value for clinical benefit according to Hopkins et al. (Hopkins W et al, 2009). The effect size (Cohen's d [95% confidence interval]) of the difference between groups were measured using custom-made spreadsheet in order to evaluate

meaningfulness of differences and are classified as trivial (<0.1), small ($0.1 - 0.2$), moderate ($0.2 - 0.5$), large ($0.5 - 0.8$) and very large (>0.8) [17, 18]. By using another custom-made spreadsheet, the probability of the population effect is practically beneficial, trivial or harmful (<0.2 SDs) were computed in accordance with magnitude-based inference approach using the following criteria: 25 - 75%, possibly; 75 - 95%, likely; 95 - 99.5%, very likely; $>99.5\%$, most likely [16, 19]. The significance probability was set at $p < 0.05$.

Results

General Characteristics of the Subjects

Table 1: Anthropometrical characteristics of ST and KT groups (mean \pm SD)

Variables	Group	
	ST (n=10)	KT (n=10)
Age (years)	22.8 \pm 1.14	22.7 \pm 0.95
Height (cm)	173.63 \pm 5.22	173.11 \pm 5.94
Weight (kg)	73.75 \pm 6.79	73.21 \pm 7.75
BMI (kg/m ²)	24.3 \pm 0.95	24.35 \pm 0.99

A total of twenty healthy subjects were enrolled in this study in which both KT group and ST group had 10 male subjects each. The mean age, height, weight and BMI for KT group was 22.7 \pm 0.95 years, 173.11 \pm 5.94 cm, 73.21 \pm 7.75 kg, 24.35 \pm 0.99 kg/m², respectively, while for ST group, it was 22.8 \pm 1.14 years, 173.63 \pm 5.22 cm, 73.75 \pm 6.79 kg, 24.3 \pm 0.95 kg/m², respectively. The baseline characteristics of the subjects are presented in Table 1.

Changes of lumbar ROM in KT and ST groups

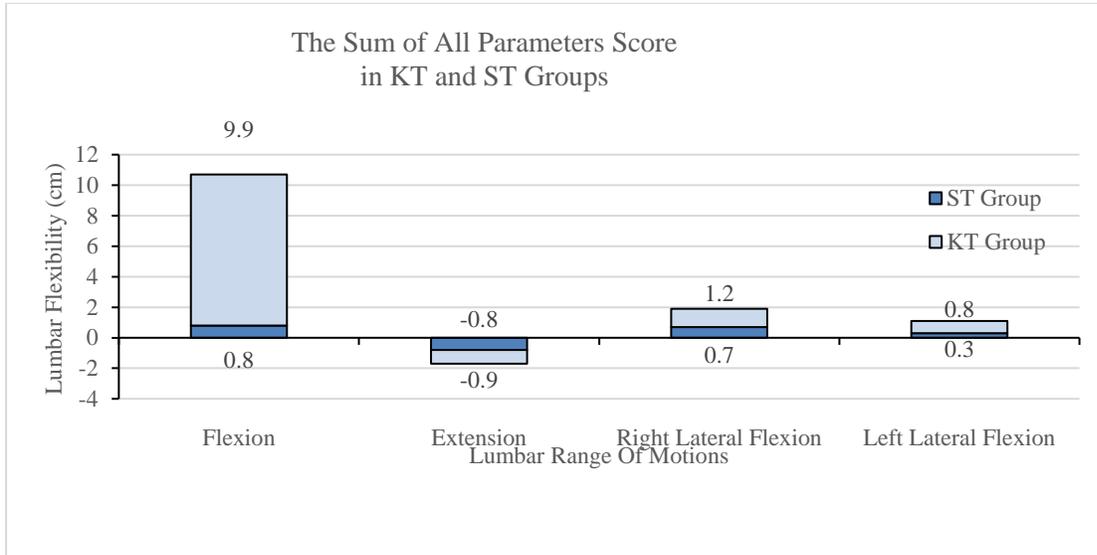


Figure 1: The sum of all parameter scores in KT and ST groups

Table 2: Pre and Post Significant Difference on the Lumbar ROM within Group [mean (SD)]

Parameters	KT group				ST group			
	Pre	Post	p-value	t-value	Pre	Post	p-value	t-value
Lumbar flexion	32.32 (7.06)	31.33 (6.62) *	0.002	-4.265	32.98 (6.67)	32.9 (6.53)	0.443	- 0.80 2
Lumbar extension	46.01 (2.29)	46.10 (2.27)	0.287	1.132	46.73 (1.76)	46.81 (1.64)	0.290	1.12 4
RLL flexion	47.62 (3.29)	47.5 (3.34)	0.081	-1.964	47.16 (1.96)	47.09 (1.94)	0.271	- 1.17 2
LLL flexion	47.33 (2.49)	47.25 (2.56)	0.137	-1.633	46.54 (2.10)	46.51 (2.08)	0.496	- 0.70 9

*Significant difference within KT and ST groups (*p<0.05)*

Pre and post intervention lumbar ROM in KT and ST groups are shown in Figure 1 and Table 2. According to the analysis of changes in lumbar ROM after the application of the tape, for KT group, there is an evidence of significant difference in lumbar flexion ROM, yielded an increment of 9.9 cm compared with ST group (9.9 cm, $t(9) = -4.265$, $p = 0.002$). However, no significant differences were discovered for lumbar extension (-0.9 cm, $t(9) = 1.132$, $p = 0.287$), RLL flexion (1.2 cm, $t(9) = -1.964$, $p = 0.081$) and LLL flexion ROM (0.8 cm, $t(9) = -1.633$, $p = 0.137$). For ST group, results of verifying significance in these values showed no statistical significance between pre and post intervention in all parameters.

Adjusted Change Scores between KT and ST groups

Table 3: Adjusted change scores (with the pre-test value as a covariate) for all measurements, including effect sizes and clinical inferences with reference to the smallest worthwhile effect (0.2 SD of the pre-test score).

Parameters	Adjusted change scores				Likelihood (%) of the intervention being beneficial/trivial/harmful (clinical inference)
	KT mean (SD)	ST mean (SD)	Mean Difference (95% CI)	Effect Size, d (95% CI)	
Lumbar flexion	0.99 (0.734)*	0.08 (0.316)	0.94 (0.48 to 1.40)	1.61 (0.54 to 2.54)	99.8/0.2/0.0 (Most likely positive)
Lumbar extension	-0.09 (0.251)	-0.08 (0.225)	0.017 (-0.21 to 0.24)	-0.04 (-0.80 to 0.73)	4.9/92.4/2.7 (Likely trivial)
RLL flexion	0.12 (0.193)	0.07 (0.189)	0.053 (-0.13 to 0.24)	0.26 (-0.63 to 1.13)	5.7/93.8/0.5 (Likely trivial)
LLL flexion	0.08 (0.155)	0.03 (0.134)	0.058 (-0.08 to 0.20)	0.35 (-0.55 to 1.21)	2.4/97.5/0.1 (Very likely trivial)

* Significant difference between KT and ST groups (*p<0.05)
SD: Standard Deviation; CI: Confidence Interval

Adjusted change score analyses were illustrated in Table 3, revealing that there was a significant effect of KT on lumbar flexion ROM only after controlling the effect of pre-test, $F(1,17) = 18.583$, $p = 0.000474$. The ANCOVA adjusted change scores exhibited that when compared to the ST group, the KT group recorded a mean increase in lumbar flexion flexibility of 0.94 cm (95% confidence interval 0.48 to 1.40 cm), which demonstrated a very large effect size (1.61 [0.54 to 2.54]). The probability (% chances) that the true population effect is practically beneficial/trivial/harmful is 99.8/ 0.2/ 0.0; the KT intervention is most likely to be beneficial to improve lumbar flexion flexibility.

For lumbar extension ROM, the KT group recorded a mean increase in lumbar extension flexibility of 0.017 cm (95% confidence interval -0.21 to 0.24 cm), which demonstrated a trivial effect size (-0.04 [-0.80 to 0.73]). The probability (% chances) that the true population effect is practically beneficial/trivial/harmful is 4.9/92.4/2.7; the KT intervention is likely to be trivial to improve lumbar extension flexibility.

For RLL flexion ROM, the KT group recorded a mean increase in RLL flexion flexibility of 0.053 cm (95% confidence interval -0.13 to 0.24 cm), which demonstrated a moderate effect size (0.26 [-0.63 to 1.13]). The probability (% chances) that the true population effect is practically beneficial/trivial/harmful is 5.7/93.8/0.5; the KT intervention is likely to be trivial to improve RLL flexion flexibility.

For LLL flexion ROM, the KT group recorded a mean increase in LLL flexion flexibility of 0.058 cm (95% confidence interval -0.08 to 0.20 cm), which demonstrated a moderate effect size (0.35 [-0.55 to 1.21]). The probability (% chances) that the true population effect is practically beneficial/trivial/harmful is 2.4/97.5/0.1; the KT intervention is very likely trivial to improve LLL flexion flexibility.

Discussion

This research was conducted to investigate the immediate effects of KT on lumbar ROM when a stretched and non-stretched kinesio tape was applied over the erector spinae muscle in normal healthy subjects. The results of our study exhibited a significant improvement in lumbar flexion ROM immediately following KT application while no statistically significant changes were observed for other measurements. Although the effects of KT remain controversial, the outcomes of previous studies suggest that KT may support muscular functioning activity (Yoshida A & Kahanov L, 2007., Salvat I & Alonso Slvat A 2010., Lemos Herp G et al, 2014). It is therefore plausible to deduce that KT influences some of the mechanisms associated with lumbar flexibility and could therefore have a possible role in preventing sport injuries and management of LBP.

Results of the present study corroborate those obtained from previous studies in which Yoshida et al. 2017 had applied KT on the erector spinae muscle of 30 healthy subjects to understand the immediate effects of KT on lumbar ROM. The authors reported a significant change in lumbar flexion flexibility by around 17 cm greater than in untapped condition in the sum of all scores, but no significant differences were detected for extension and lateral flexion ROM despite a tiny improvement observed in relation to the baseline. However, our study is not ideal to compare with the current study that have a mixed samples since there are differences in flexibility between men and women (Van Herp G, Rowe, Salter P & Paul J.P., 2000).

Lemos et al. 2014 assessed the lumbar flexion ROM only upon 39 healthy subjects divided into three groups (control, ST and KT). The authors reported that both KT and ST groups revealed significantly improved lumbar flexion flexibility with an average increase of 8.49 cm in ST group and 5.31 cm in KT group. In the studies, although KT group shows significant improvement, we observed that ST group presented better than the KT group which contradicts to our findings. Such results can be attributed to the wrong technique of tape application by the authors. In the ST group, the authors described more convolutions, as opposed to KT groups, were formed following application of kinesio tape with 0% tension. This violates the principles of KT application explained by Kenzo Kase (2003).

Furthermore, the results of the present study appears to contradict those obtained by Salvat et al. 2010, who concluded that there was no statistically significant increase in lumbar flexion ROM (analysis of variance, $p = 0.67$) in healthy subjects immediately following application of KT although the mean increase of KT group (2.04 ± 1.71 cm) is higher than ST group (1.39 ± 1.65 cm). This could be attributed to the younger population, unlike in our study, who enrolled in the study (mean age is 16.67 ± 3.05 years). According to Kendall et al 2000, the high leg to trunk length ratio in early adolescent growth phase development could lead to erroneous conclusions about lumbar spine flexibility following sit-and-reach test. Therefore, the fact of having theoretical “inflexibility” participants between 10 to 14 years in the study, it is not ideal to compare with our studies that have an adults samples since there were differences in lumbar spine flexibility between adults and adolescents population (Kendall’s F.P, Kendall E & Geise. P, 2000).

Recent studies have postulated that both circulatory and neurological mechanisms by which KT induced these changes could explain the greater ROM in our subjects (Kase et al, 1996, 2003). The underpinning theory of the mechanisms are based on the elastic properties of kinesio tape which is purported to strengthen weaken muscle and normalize muscle function that may affect the ROM (Murray H & Husk. L 2001., Murray H , 2000). Stimulation of the autonomic nervous system causes vasodilatation in the treated area, hence improved blood circulation, increased the rate of gas exchange intramuscularly, and therefore improves the muscular functions (Kase et al, 1996, 2003, Halseth T et al, 2004). Neurological activation, on the other hand, improves the excitability of the muscles beneath the targeted area by causing local depolarization when the tactile stimulation of KT creates deformation of cutaneous mechanoreceptor (Halseth T et al, 2004., Murray H, 2000). Adequate stimulus by the mechanical loads of KT enables the nerve impulse to reach the threshold of activation in recruiting motor units of those muscles, and would therefore propagate the signals via the afferent fiber into the central nervous system (Halseth T et al, 2004., Murray H, 2000).

However, none of these two theories explains why the specific I-strip technique used in this study may be beneficial only in improving lumbar flexion ROM. We speculate that the effect of KT on lumbar spine in this study is determined by the position of subjects prior the KT application. Therefore, an additional I-strip technique may be worth considering when the subjects performing lumbar backward bending or lumbar side bending to confirm whether the application of KT has an immediate effect for those motions (Yoshida A & Kahanov L, 2007).

Limitation

There are several limitations in this present study that impact the clinical importance which deserve thorough investigation in future clinical trials. The size of sample was small, and therefore it is unclear whether the result, including those in experimental group analysis, is accurate. Thus, more trials with large sample size are necessary to validate the outcome of the study. Since the sample was only comprised of young male subjects, this limit the applicability of our findings to older and younger population than those subjects we studied. Moreover, it is not ideal to compare with other studies that have mixed samples since there are differences in

flexibility between men and women (Van Herp G, Rowe, Salter P & Paul J.P., 2000). Additionally, we recruited asymptomatic adults with normal BMI values and no lumbar issue such characteristics, therefore direct application of our findings to individual with pathology is not appropriate. In terms of measurement method, unlike tape measure method, we recommend using infrared thermography and electromyography to detect any possible physiological changes following KT application since determining the mechanism of actions by which KT works is admittedly beyond the scope of our study.

Conclusion

In conclusion, normal healthy individuals experienced statistically significant improvements in the active lumbar flexion ROM immediately after the application of KT over the erector spinae muscle. Despite the lack of evidence to show a clinical benefit following the KT application, KT has shown a promise viable prophylactic option for the prevention of sporting injuries; it is a safe modality, non-invasive technique and the risks of its use seem minimal. However, advance research is indeed warranted in order to verify and evaluate the effectiveness of KT both in clinical and neurophysiological fields for a better understanding in KT mechanism of actions.

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