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Immediate and Short-Term Effects of Kinesio® Taping on Lower Trunk Range of Motion in Division I Athletes

Hoshito Mizutani
Portland State University

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Immediate and Short-Term Effects of Kinesio® Taping on Lower Trunk Range of
Motion in Division I Athletes

by

Hoshito Mizutani

A thesis submitted in partial fulfillment of the
requirements for the degree of

Master of Science
in
Health Studies

Thesis Committee:
Gary Brodowicz, Chair
Jim Wallis
Randy Logan

Portland State University
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Abstract

Low back pain (LBP) is a common health problem that contributes to the high cost of health care. Improvement in trunk range of motion has been considered to be an important factor in ameliorating the symptoms of LBP. Kinesio[®] taping is a prominent therapeutic modality commonly used in the variety of populations for treating musculoskeletal conditions. However, previous research on the efficacy of Kinesio[®] taping for LBP is limited. The purpose of this study was to investigate the immediate and short-term effects of Kinesio[®] taping with the muscle inhibition technique on active trunk flexion range of motion. Twenty-five subjects with no history of LBP in the past 6 months or LBP lasting over six weeks at any point in past were recruited from a Division I athlete population. Each subject underwent two Kinesio[®] taping trials in a cross-over design with a 7-10 day washout period (placebo application and inhibition technique application), during which several trunk flexion range of motion measurements were made. Subjects wore the tape for 48 hours, and active trunk flexion range of motion was measured at baseline, immediate post-tape application, and 48 hours post-tape application. A significant trial by time interaction was found ($F = 9.629$; $p = 0.002$), and follow-up analysis of the inhibition technique trial revealed a significant increase in active trunk range of motion between baseline and 48-hours post-tape. No significant differences were noted in the placebo trial. The findings suggest that the inhibition Kinesio[®] taping technique may eventually prove to be a beneficial therapeutic modality for improving active trunk flexion range of motion in patients with LBP.

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Chapter 1

Introduction

Statement of the Problem

Low back pain (LBP) is a common health problem which contributes to one of the most expensive health care costs in recent Western societies (Heijink, Koopmanschap, & Polder, 2006). It is estimated that LBP affects up to 90% of the adult population, and athletes are no exception. Sports that require repeated flexion and hyperextension increase risk of LBP in those athletes (Searle, Spink & Chuter, 2015; Papanicolaou, Wilkinson, Emans, Treves, & Micheli, 1985). The prevalence of LBP in athletes has been reported to be up to 30%, and cases of LBP account for one in ten of all athletic injuries (Micheli & Wood, 1995).

People who suffer from LBP tend to reduce trunk range of motion to assuage the pain in the lumbar area that would also cause weakness in paraspinal muscles (Danneels Vanderstraeten, Cambier, Witvrouw, & De Cuyper, 2000). In addition, patients with LBP are prone to exhibit errors in motion and motor control due to impaired proprioception, which is the unconscious perception of motion, position, and equilibrium of the human body (Lee, Cholewicki, Reeves, Zazulak, & Mysliwiec, 2010). These functional impairments cause poor postural control and delayed muscle activation (Hodges, van den Hoorn, Dawson, & Cholewicki, 2009). Consequently, enhancement of trunk range of motion is one of the elements thought to improve the symptoms of LBP and prevent trunk muscle weakening and postural control impairment. There are many approaches to treating LBP such as physical therapy, massage therapy, stretching, anti-

inflammatory medications, and ointments. However, these treatments have provided varying outcomes (Pai & Sundaram, 2004).

Kinesio[®] taping is a relatively new therapeutic modality widely used in both athletic and non-athletic populations for treating musculoskeletal conditions. The Kinesio[®] taping method was developed by a Japanese chiropractor, Dr. Kenzo Kase, and interest in this modality has not only been increasing in the United States but also in many other countries. Kinesio[®] tape is an elastic tape which is designed to stretch up to 60% of available tension and is relatively the same thickness as the epidermis. The material of Kinesio[®] tape is 100% cotton fibers which are latex-free and allows for evaporation and quick drying. In addition, Kinesio[®] tape is water-resistant, so it is wearable in a shower or pool. These features allow Kinesio[®] tape to be worn for extended periods, usually 3 to 5 days. Kinesio[®] taping is also appropriate for various stages of treatment: acute, sub-acute, rehabilitative, and chronic. The tape mimics the flexibility and thickness of the skin and is thought to improve the function of many different tissues and physiologic systems (Kase, Wallis, & Kase, 2013). The following benefits of Kinesio[®] taping have been suggested, depending on the direction and the amount of tension applied to the tape during application: 1) increasing subcutaneous space by lifting fascia and soft tissue above area of pain/inflammation, 2) aligning fascial tissues, 3) providing a positional stimulus through the skin, 4) assisting in the reduction of edema by directing exudates towards a lymph duct, and 5) providing sensory stimulation to assist or limit motion (Kase et al., 2013).

There are several methods of applying Kinesio[®] tape. One method is called the muscle inhibition/facilitation technique, which involves the appropriate combination of

direction and tension of tape. For the muscle inhibition application, the Kinesio[®] tape is applied “as it comes off of the paper backing (paper-off tension)”, with 15-25% of available tension, from the insertion to the origin directly over the targeted muscle, parallel to the muscle fibers. This application method will provide a tape recoil effect and is purported to inhibit and elongate the targeted muscle. For the muscle facilitation application, the Kinesio[®] tape is applied with 15-35% of tension from the origin to the insertion. This is purported to provide a more dynamic recoil effect and facilitate the targeted muscle (Kase et al., 2013). Based on these concepts, the muscle inhibition application is considered to increase the range of motion in the joint over which the targeted muscle crosses. A study conducted by Yoshida and Kahanov (2007) showed that applying KT on lower trunk is immediately effective for increasing active lower trunk flexion range of motion. However, the taping method used was the muscle facilitation application. The Y-shaped tape was applied with paper-off tension from the origin toward the insertion of the sacrospinalis (Yoshida & Kahanov, 2007). To date, no studies have compared the inhibition and facilitation applications. In addition, the short-term and long-term effects were not studied in the Yoshida and Kahanov (2007) study.

Purpose

The purpose of this study is to investigate the immediate and short-term effects of Kinesio[®] taping with muscle inhibition technique on active trunk flexion range of motion.

Hypothesis

Previous research has shown that Kinesio[®] taping can result in a variety of outcomes, such as improving lymphatic drainage, decreasing pain, and increasing the range of motion. A meta-analysis conducted by Kalron and Bar-Sela (2013) reported the

following: effectiveness of pain reduction in shoulder disorder at the one-week follow-up; the efficacy of lymphatic fluid elimination 10 consecutive days; and better hamstring flexibility at the end of the three-week and six-week intervention program. These results show the short-term effectiveness of Kinesio[®] taping in multiple conditions, and a similar outcome is expected in this study. Thus, it is hypothesized that Kinesio[®] taping muscle inhibition technique on lower back will immediately increase lower trunk flexion range of motion and continue to increase or maintain increased the range of motion for at least 48 hours.

Significance of the Study

The features of Kinesio[®] tape allow the application to any muscle or joint in the body for consecutive days. However, there is limited evidence that supports the use of this type of tape in assisting the range of motion (Kalron & Bar-Sela, 2013). Although a previous study conducted by Yoshida and Kahanov (2007) reported the immediate effects of Kinesio[®] taping on trunk range of motion, short- and long-term effects have not been studied. Suggested Kinesio[®] taping wear time for one application is 3 to 5 days, and continued therapeutic effects are expected (Kase et al., 2013). This study will investigate the short-term effects of the inhibition technique on active lower trunk flexion range of motion using a single-blind crossover study design. This research is significant because Kinesio[®] taping-assisted range of motion improvements in patients who experience LBP would not only reduce the risk of functional impairment and further injury but also may expedite the recovery process. This will also provide an evidence-based treatment option for physical therapists, certified athletic trainers, occupational therapists, doctors of

chiropractic, medical doctors, acupuncturists and massage therapists who treat patients with LBP.

Limitations

This study will use volunteer subjects recruiting from Division I athletes attending Portland State University (PSU). Therefore, findings may not be applicable to other populations such as non-athletes, children, elderly, etc. Ideally, subjects should be recruited from people who have LBP to investigate the true clinical effects, but this study is delimited to healthy PSU athletes. Since the dependent variable is active trunk flexion range of motion, the effects of Kinesio[®] taping on other variables (perceived pain, muscle strength, etc.) will not be measured in the study. Moreover, we originally plan to compare the effectiveness of inhibition and facilitation techniques, but it was not compared in this study due to the limited amount of subjects and time.

Definition of Terms

- I. Active trunk flexion range of motion: the range of conjunct motion which a participant can actively (without assistance) bend forward the lumbar spine using the adjacent muscles (Blaber & Harris, 2011).
- II. Kinesio[®] tape: Kinesio[®] Tex Tape is an elastic tape which is latex-free and made of 100% cotton fibers (Kase, Wallis, & Kase, 2013).
- III. Kinesio[®] taping: Method utilizes the unique qualities of the Kinesio[®] tape (Kase, Wallis, & Kase, 2013).
- IV. I-strip: strip of Kinesio[®] tape that may be cut to length and width of the target tissue (Kase et al., 2013).

V. Y-strip: the portion of Kinesio[®] tape strip following the split in the Y-cut (Kase et al., 2013).

Assumptions

It is assumed that all subjects will follow all instructions during the course of the study. For example, use of medications and other aids that may affect trunk range of motion will not be allowed. Habitual stretching exercises will not be restricted, but additional stretching exercise that may influence trunk range of motion will be prohibited. In addition, participants will be instructed not to participate in any unaccustomed exercise in order to avoid any delayed-onset muscle soreness, which may affect the range of motion. Also, it is assumed that the investigator will accurately and consistently apply Kinesio[®] taping on participants and accurately and reliably measure the trunk range of motion with a modified-modified Schober test.

Chapter 2

Review of Literature

Kinesio® Taping & Range of Motion

The Portland State University Library online database system and published research on the Kinesio® Taping Association International official website were used to conduct this literature review. The keywords Kinesio tape, Kinesio taping, Kinesiology tape, Kinesiology taping, range of motion, range of movement, extensibility, and flexibility were used to help locate relevant published research.

There are few published research studies that have investigated the effect of Kinesio tape on the range of motion. Gonzalez-Iglesia et al. (2009) performed a randomized clinical trial to investigate short-term effects of cervical Kinesio taping on pain and cervical range of motion. Forty-one subjects with acute whiplash were randomly assigned to Kinesio tape group or placebo group. For the Kinesio tape group, Y-strip Kinesio Tex Tape was placed on the posterior cervical extensors in accordance with the inhibition application developed by Dr. Kase, from insertion to origin with paper-off tension. In addition, “a space-tape” was attached perpendicular to the first tape over the middle cervical area. Instead of using a different tape, the placebo group received the exact same tape, Kinesio Tex Tape, in a non-therapeutic manner. It consisted with two I-strips and looked very similar, but the tapes were attached with the original length of the tape while subject’s neck was placed in a neutral position. The cervical range of motion was measured at baseline, immediately after the tape application, and 24 hours after application. The results of this study showed statistically significant improvement in all

cervical ranges of motion: flexion, extension, lateral flexions, and rotations in the Kinesio tape group immediately following the taping application and 24 hours post treatment.

Thelen, Dauber, and Stoneman (2008) assessed the short-term therapeutic efficacy of Kinesio Tape on college-aged subjects clinically diagnosed with shoulder pain related to rotator cuff impingement/tendonitis. The participants were randomly selected to a therapeutic Kinesio Taping group or sham taping group. The therapeutic Kinesio Taping group received 3 strips of Kinesio Tex tape. Two Y-Strips were applied on the supraspinatus and the deltoid using the inhibition application. The third strip was I strip that was attached from anterior aspect of the coracoid process to the posterior deltoid with approximately 50-75% stretch. Similar to the Gonzalez-Iglesia et al. (2009) study, Thelen et al. (2008) applied Kinesio Tex tape on the sham tape subjects in a non-therapeutic way. One I-strip was attached on over the acromioclavicular joint and another I-strip was on the distal deltoid without the stretch of the tape. A pain-free active range of motion in flexion, abduction, and scapular plane elevation was measured at baseline, immediately after taping, 3 days and 6 days post tape application. The therapeutic Kinesio Taping group showed immediate positive improvement in all motions, and abduction was significantly increased. However, significant differences were not found at the day 3 and day 6 follow-ups for either group regarding the pain-free range of motion and pain scores.

A study conducted by Merino-Marban et al. (2014) reported a significant difference in the ankle dorsiflexion range of motion between prior and immediate post application of Kinesio tape in duathletes. Twenty-eight subjects were recruited from the athletes in a duathlon competition, and the Kinesio tape was applied in a randomized

order on only one of the legs for each subject. They defined the Kinesio tape leg as experimental leg and the contralateral leg as control leg. The Kinesio taping inhibition application was applied with one I-strip from distal to proximal to the calf muscle with a 10% stretch of the tape. The range of motion measurement was obtained at baseline, immediately after the taping, and 10 to 15 minutes after completing the duathlon race. Even though there was no statistically significant difference found between the experimental and control legs, significant improvement was found in dorsiflexion range of motion only in the Kinesio Taped leg.

Ujino et al. (2013) investigated the effects of Kinesio tape and stretching on shoulder range of motion. Seventy-one healthy subjects were randomly assigned to three groups: Kinesio Tape application only; stretch only; and both Kinesio tape and stretch. The Kinesio Tape treatment groups received two strips of Kinesio tape application. One I-strip was applied on the anterior aspect of the glenoid rim through the inferior border of the lower trapezius, with a 50% stretch of its elasticity, the mechanical collection technique (Kase et al., 2013). A Y-strip was attached from the middle medial region of the scapula to the anterior region of the glenoid rim with a 50% stretch of the tape. The stretch treatment consisted of 3 stretches: “Sleeper stretch”; “Doorway stretch”; and “Cross body stretch”. The participants assigned to the stretch treatment performed 3 repetitions of a 30-second stretch. A digital inclinometer was used to measure the shoulder range of motion, and post-treatment measurement occurred on day 1 and day 4. The data showed the greatest improvement in the shoulder internal and external rotations in the Kinesio tape only group. However, the Stretch only and Kinesio tape+Stretch groups did not exhibit the similar effect.

One of the other Kinesio® taping techniques—the functional correction technique—was used to improve active wrist range of motion in 15 children with cerebral palsy. Demirel and Bayrakci (2014) applied Kinesio tape on the wrist extensor muscles from the dorsum of the hand to the lateral epicondyle with a 50% stretch of the tape while extending the wrist (Kase et al., 2013). They measured active wrist range of motion in extension, radial and ulnar deviations, and functional wrist extension while holding a light plastic ball at 90-degree shoulder flexed position prior to and 45 minutes post Kinesio tape application. The researchers reported that the Kinesio taping significantly increased the active wrist extension and radial deviation range of motion and functional wrist extension range of motion while grasping a ball 45 minutes after the treatment in children with cerebral palsy.

A case report conducted by Gak and Jung-Hoon (2011) showed the effect of Kinesio Taping on pain and trunk range of motion in a patient with acute occupational LBP. Kinesio taping was applied on erector spinae, latissimus dorsi, internal oblique, and rectus abdominis muscles for 3 days (average of 10 hours per day). The patient was able to relieve the pain completely and recover full trunk range of motion 3 days after the Kinesio taping application. However, the Kinesio® taping techniques used in the study were not specified.

As studies above suggest, Kinesio® tape appears to be effective in improving range of motion. However, the effects of Kinesio® taping on the range of motion are still unclear due to a limited number of studies on a variety taping techniques and joints. Moreover, no study has compared the inhibition and facilitation application Kinesio® taping techniques. These techniques emphasize the importance of both the direction and

the tension of Kinesio® tape application. Therefore, further studies are needed to investigate the effect of Kinesio® taping on the range of motion.

Chapter 3

Methods

Subjects

Twenty-five subjects (mean \pm SD age, 21 \pm 1.2 years; 12 male, 13 female) were recruited from Division I student-athletes attending Portland State University (PSU). Athletes were invited to participate in this study via e-mail and informal verbal contact. When an athlete agreed to participate in the study, days and times were scheduled for the student-athlete to meet individually with the investigator for data collection. Eligibility criteria included being healthy and at least 18 years of age. Exclusion criteria included a history of LBP in the past 6 months or LBP lasting over six weeks at any point in past. Subjects were asked to describe their previous experience with Kinesio® tape (i.e., adverse skin reactions, etc.). There were no ethnic or cultural restrictions. Approval was obtained from the institutional human subjects research review committee, and all subjects were required to read and sign a written informed consent form prior to any data collection.

Procedures and Materials

Initially, each subject was randomly assigned to one of two Kinesio® taping trials: a placebo application and an inhibition technique application. Baseline measurements were made following the randomization. The baseline/outcome measure for this study was active trunk flexion range of motion assessed with a modified-modified Schober test (MMST) (Norkin & White, 2009). For injury prevention purposes, the participant performed static stretching before administration of the MMST. After the baseline measurement, each subject received the assigned Kinesio® taping application (inhibition

technique or placebo) on the iliocostalis lumborum muscles (low back muscle). Immediately after the tape was applied, another MMST was administered. Participants were also scheduled for follow-up measurement of trunk flexion range of motion at 48 hours post-Kinesio[®] taping application. After a 7-10 day washout period, subjects revisited the test facility and followed the same procedures, with the other taping application. Thus, all subject experienced both taping applications (inhibition and placebo) with a single-blind, cross-over study design. For each application, there were 3 measurement periods for active trunk range of motion: baseline, immediate post-tape application, and 48 hours post-tape application. The trunk flexion measurements and taping applications took place in the team physician room in the Peter W. Stott Center at PSU. Participants were instructed to refrain from any physical activity one hour prior to each measurement, as the physical activity could increase muscle temperature and tissue elasticity that may influence the measurement (Petrofsky, Laymon, & Lee, 2013).

Modified-Modified Schober Test (Active Trunk Flexion Range of Motion)

The modified-modified Schober was performed using procedures outlined by Norkin and White (2009). Prior to the test, participants performed a short warm-up consisting of one 30-s stretch (hurdler's stretch) for each leg. The participant then stood upright, and 2 marks were made on the participant's lower back with a washable-ink marker. The first mark was placed over the sacral spine on a horizontal line connecting the left and right posterior superior iliac spines (approximately over the spinous process of S2), and a second mark was placed over the spine 15 cm superior to the first mark (Figure 1).

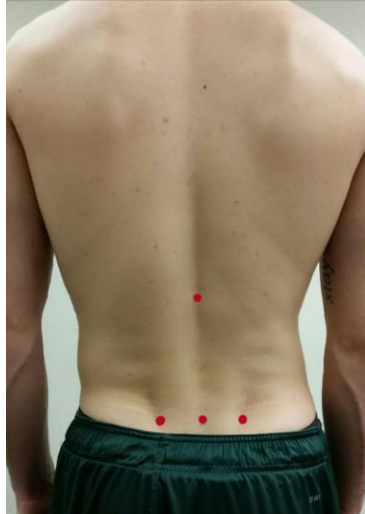


Figure 1. MMST measurement site location

The examiner aligned an anthropometric tape between the 2 marks (Figure 2). The participant then bent forward as far as possible without bending the knees, and the examiner kept the tape against the participant during flexion. While the participant held the position at the end of flexion range of motion, the examiner measured the distance between the two marks (Figure 3).



Figure 2. MMST procedure (step 1)



Figure 3. MMST procedure (step 2)

The lumbar flexion range of motion score was the difference between the final measurement distance between the 2 points (end of flexion range of motion) and the initial measurement (15 cm). At least two trials were performed, with the best trial recorded and used for subsequent analysis.

Taping Application

All Kinesio[®] tape applications were performed by the principal investigator, who is certified by the Kinesio[®] Taping Association as a Kinesio[®] taping practitioner. The inhibition technique application or a placebo tape application immediately followed the baseline trunk range of motion measurement.

For the inhibition application, the subject stood upright, and the origin of the Kinesio[®] tape I-strip was attached just above the 5th rib along with the iliocostalis lumborum. Then, the subject was directed to bend forward as much as possible to place the target muscle (iliocostalis lumborum) in a position of stretch. The I-strip was applied directly over and parallel to the target tissue with 15-35% of available tension. The end of the I-strip was attached without tension. The same procedure was repeated on the contralateral side (Figure 4).

The placebo tape application consisted of two Kinesio[®] tape I-strips applied in a manner similar to the inhibition technique application, but I-strips were attached on bilateral iliocostalis lumborum without stretching the tape. Throughout the placebo taping application, the participant maintained an upright position instead of bending forward. The appearance of the placebo tape application was very similar to the inhibition technique application, but the placebo tape application maintained the original length of the tape (Figure 5).



Figure 4. Inhibition technique

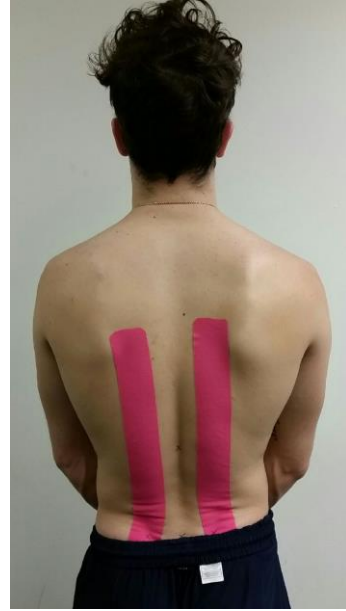


Figure 5. Placebo application

Data Analysis

Data were analyzed using a 2 x 3 repeated measures analysis of variance (RMANOVA) with IBM SPSS Statistics. The two-way RMANOVA was used to evaluate the effects of the Kinesio® taping on active trunk flexion range of motion, with the taping application (inhibition technique application or placebo application) as the between-subject variable and time (baseline, immediate post-taping, and 48-hours post-taping) as the within-subject variable. The primary interest was the technique-by-time interaction. Statistical significance was determined with a priori alpha level of $p < 0.05$. Mauchly's test of sphericity was used to evaluate the sphericity assumption, and the Greenhouse-Geisser adjustment was used when the assumption was not met. If a significant interaction was revealed, tests of simple main effects were performed for each

tape application condition with a one-way RMANOVA. This was followed by a Tukey's Honestly Significant Difference test to locate significantly different means, if appropriate.

Chapter 4

Results

Twenty-five subjects (mean \pm SD age, 21 ± 1.2 years; 12 male, 13 female) satisfied the eligibility criteria and participated in this study. Each subject was initially randomly assigned to one of two tape applications: placebo tape application and inhibition technique application. After a wash-out period of at least one week, the subjects repeated the testing protocol under the other tape application. Mean MMST scores for active trunk flexion range of motion at baseline, immediate post-taping, and 48-hours post-taping are shown in Table 1.

Table 1. MMST score (Active Trunk Flexion ROM) at baseline, immediate post-taping, 48-hours post-taping

	Baseline	Immediate post-taping	48-hours post-taping
MMST (cm)			
Inhibition (n = 25)	6.4 ± 1.6	6.7 ± 1.5	7.0 ± 1.3
Placebo (n = 25)	6.8 ± 1.3	6.6 ± 1.1	6.6 ± 1.0

Mean \pm SD

Results of the two-way RMANOVA revealed no significant main effect for technique ($F = 0.226$; $p = 0.639$) and no main effect for time ($F = 1.767$; $p = 0.191$). As shown in Figure 6, however, there was a significant interaction ($F = 9.629$; $p = 0.002$).

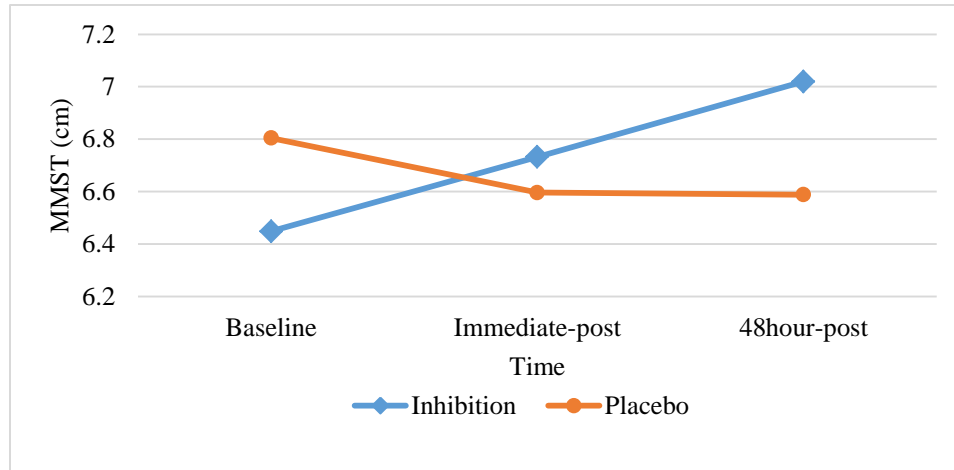


Figure 6. Mean MMST scores (active trunk flexion range of motion) for the inhibition and placebo applications at each measurement period

The significant interaction was followed-up with tests of simple main effects. Although, the one-way RMANOVA for placebo taping did not reveal a statistically significant difference in MMST scores over time (Figure 7).

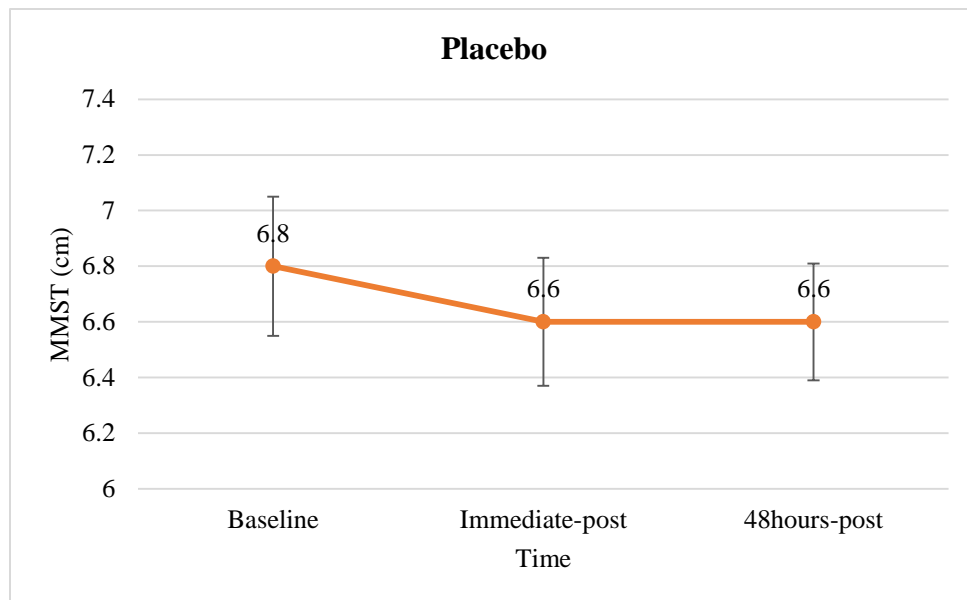


Figure 7. Mean MMST scores (\pm SEM) for the placebo application at each measurement period

A significant increase ($F = 7.367$; $p = 0.005$) was identified in the inhibition technique application (Figure 8). A Tukey's Honestly Significant Difference Post Hoc Test was used to determine which MMST scores were significantly different at each time period. The results reveal no statistically significant difference in MMST scores from baseline to immediate post-taping and from immediate post-taping to 48-hours post-taping, but the 48-hours post-taping MMST score was significantly greater than the score at baseline.

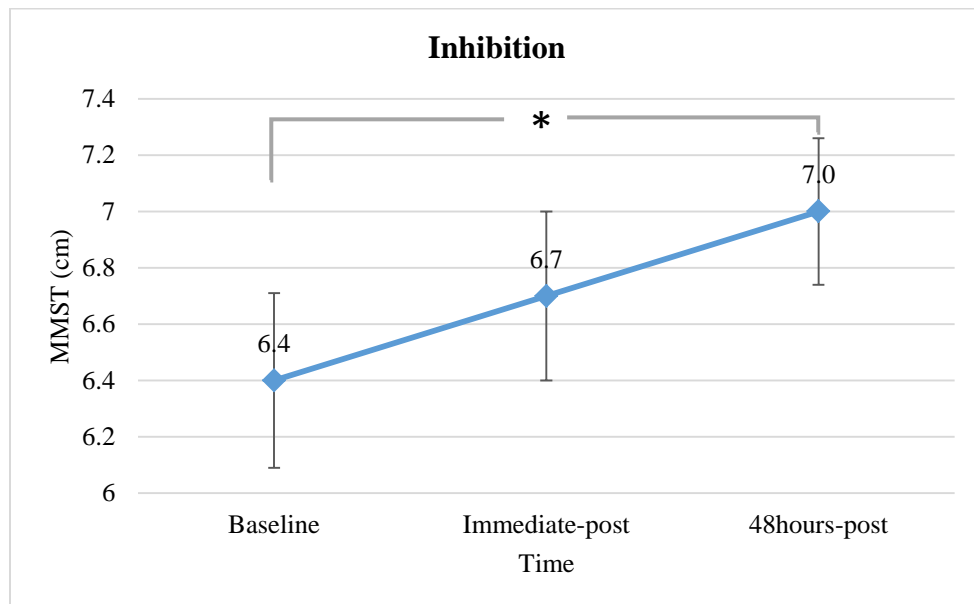


Figure 8. Mean MMST scores (\pm SEM) for the inhibition technique at each measurement period. * $p < 0.05$

Chapter 5

Discussion & Conclusion

The purpose of this study was to examine the immediate and short-term effects of Kinesio® taping with the muscle inhibition technique on active trunk flexion range of motion. Other ranges of motion were not measured in the study because previous research reported that there was no effect on extension and lateral flexion with a Kinesio® tape Y flexion pattern on the iliocostalis lumborum (Yoshida & Kahanov, 2007). The results of the current study indicated that healthy subjects who received the Kinesio® taping inhibition technique on the iliocostalis lumborum muscles showed statistically significant increase in active trunk flexion range of motion at 48-hours post-taping. Although statistically significant differences were not found from baseline to immediate post-taping and from immediate post-taping to 48-hours post-taping, the mean MMST scores for the inhibition technique appeared to increase in both periods. To evaluate the immediate effects of the Kinesio® taping in the current study, the MMST was conducted within 5 minutes after each subject received the tape application. This may be an explanation for the finding of no significant improvement in active trunk flexion ROM immediate post-taping. In their study of children with cerebral palsy, Demirel and Bayrakci (2014) waited 45 minutes to ensure a maximum effect of the Kinesio® taping, and found a significant increase in active wrist extension, radial deviation range of motion, and functional wrist extension range of motion. Aktas and Baltaci (2011) also conducted vertical jump and one leg hop tests 45 minutes after Kinesio® tape application and found significant improvements. Thus, the subjects in the current study might have

obtained a significant increase in MMST at 45 minutes after the inhibition tape application, which would presumably be maintained or improved at 48-hours post-taping.

The subjects were told before their participation that investigators were comparing two different Kinesio® taping techniques; thus, they did not know there was a placebo application until the completion of the study. Despite the single blind crossover design, however, 16 out of 25 subjects correctly guessed the trial in which they received the placebo application. Several subjects reported that they felt they were able to flex at the trunk much further with the inhibition technique application. Other subjects explained the inhibition technique felt more supportive and comfortable to wear, whereas the placebo taping was irritating and tight. Interestingly, one subject made the comment that his back felt warm when the tape had been applied with the inhibition technique and that it also helped him out with his workouts. He felt better when completing weight lifting and also felt better throughout the day with being more flexible. Although, there were perceptual differences among individuals, the majority of subjects who correctly guessed which order they received the Kinesio® tape applications actually improved their active trunk flexion immediately or at 48-hours post-inhibition application.

The physiological mechanism(s) underlying the positive effect of Kinesio® taping with the inhibition technique on active lower trunk flexion were not determined in the current study. However, there are several hypotheses about Kinesio® taping's presumed effect on the active trunk flexion range of motion in this study. Proponents of Kinesio® tape believe that proper stretching of Kinesio® tape is one of the most important elements for therapeutic effects, as changes in neural responses depend on the

stretch of Kinesio® tape (Kase et al., 2013; Yoshida & Kahanov, 2007). The major difference between the inhibition technique application and placebo application was the existence of stretch on the tape. No stretch (resting length of the Kinesio® tape) was applied in the placebo application. In contrast, in the inhibition technique application, the tape was applied with paper-off tension (15-25% tension). It is considered that the tape stretch present in the inhibition technique application might stimulate sensory receptors found in the dermis and epidermis, altering neural responses in the subjects. Afferent neurons are activated and transmit messages to the central nervous system when sensory receptors detect mechanical stimuli such as pressure, touch, vibration, and stretch. The tape stretch in the inhibition technique application can be thought of as a mechanical stimulus that might activate sensory receptors and reduce mechanical irritation of the soft tissues at the taped area. This might be related to gate control theory, which proposes that non-nociceptive input indirectly inhibits the function of nociceptors and suppresses pain. Since sensory receptors are larger diameter nerve fibers than nociceptive nerve fibers, more afferent stimulus to sensory receptors is able to restrain the stimulus received by nociceptors (Yoshida & Kahanov, 2007; Thelen et al., 2008; Gonzalez-Iglesia et al., 2009). Even though the subjects in the current study did not have lower back pain, most people feel pain or discomfort when they stretch as far as possible. Therefore, it is plausible that afferent stimuli provided by the tape stretch using the inhibition technique application might increase the pain threshold, thereby allowing the subjects to improve active trunk flexion range of motion.

Another possible hypothesis is that there may have been an increase in blood flow in the taped area. Kinesio® tape creates convolutions in the taped area (as seen in Figure 4) that is more evident inferiorly. The convolutions are usually apparent when proper inhibition/facilitation taping techniques are used in which the target muscle is in a position of stretch and the tape stretch is appropriate (approximately 15-35% tension). The developers of the Kinesio® taping technique believe the convolutions created by the tape may increase subcutaneous space that promotes circulation of blood and lymphatic fluid (Kase, 2003). This alteration in blood and lymphatic fluid circulation presumably cause an alteration in soft tissue extensibility and lead an increased active range of motion.

The original plan for the current study included a comparison of the inhibition and facilitation Kinesio® taping techniques. However, the facilitation technique was eliminated for several reasons. First, the relatively small sample size of the current study limited statistical power. Also, a previous study has already reported significant improvement in trunk flexion range of motion with the facilitation technique (Yoshida & Kahanov, 2007). The current study demonstrated significant improvement in the range of motion with the inhibition technique application. However, the inhibition technique application would be more appropriate to assist the range of motion based on the concept purported by Kase et al. (2013) that the inhibition method of application is considered to be appropriate for elongating the targeted muscle. Although we were not able to compare the techniques, both inhibition and facilitation techniques are recommend for use in assisting trunk mobility.

There are several limitations to this study that should be recognized. One of the limitations of the current study is that the sample included only 25 subjects. The small sample size limited statistical power. In addition, all subjects were recruited from healthy Division I student-athletes. A different population such as, older, younger, or inactive individuals may show a different reaction to Kinesio® taping. Furthermore, athletes who have been experiencing a lower back pathology ideally should be recruited to examine the clinical significance of Kinesio® taping as used in this study, but such athletes were eliminated from the study because they would be unable to receive their regular therapeutic treatment while participating in the study. Another limitation is that MMST measurements were made only immediate post-taping and at 48-hours post-taping; therefore, it was not possible to examine the long-term effects of the treatment.

Although it has been 30 years since the invention of the Kinesio® taping technique, there has been a limited amount of published research to support its clinical efficacy. Future studies should include a larger sample size with lower back pathology, and longer examination periods to more accurately investigate the clinical effectiveness of Kinesio® taping. Moreover, future studies should use appropriate tools to gain a better understanding of the physiological mechanism(s) of Kinesio® taping.

Conclusion

Healthy Division I athletes receiving the inhibition Kinesio® taping technique on iliocostalis lumborum muscles demonstrated statistically significant improvement in active trunk flexion range of motion at a 48-hours post-taping in healthy individuals. Therefore, the inhibition Kinesio® taping technique may eventually prove to be a useful

therapeutic modality for health care professionals in assisting the recovery process in patients with LBP. An improved trunk range of motion using the inhibition Kinesio® taping application may prevent functional impairments such as weakness in paraspinal muscles, errors in motion, and delayed muscle activation. Future studies should examine long-term effects and clinical significance of the inhibition/facilitation Kinesio® taping techniques for subjects suffering from chronic low back pathologies. Further, appropriate tools should be employed to explain the physiological mechanism(s) of Kinesio® taping.

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Appendix A: Consent Form

Portland State University Consent to Participate in Research

Title: *Immediate and Short-Term Effects of Kinesio® Taping on Lower Trunk Range of Motion in Division I Athletes*

You are invited to participate in a research study being conducted by Hoshito Mizutani, from the Department of Community Health, at Portland State University (PSU) in Portland, Oregon. The researcher is studying the therapeutic effects of two Kinesio® taping techniques on lower trunk range of motion. Dr. Gary Brodowicz, Professor of Community Health, will supervise this study. You are being asked to participate in this study because you have been identified as a PSU student-athlete in 2015-2016.

This form will explain the research study, and will also explain the possible risks as well as the possible benefits to you. We encourage you to talk with your family and friends before you decide to take part in this research study. If you have any questions, please ask the study investigator.

If you decide to participate, you will be asked to report to the PSU Team Physician Room, located in the Peter W. Stott Center, on 4 days for approximately 30-40 minutes on day one, and 5-15 minutes on other 3 days. On the first day of the study, you will complete a demographic survey following the informed consent procedure. Then, your active trunk flexion range of motion will be measured. Following the initial measurements, one of the Kinesio® taping techniques will be applied to your iliocostalis lumborum muscles (low back muscle). During the taping application procedure, you will be asked to expose your back. Immediately after the Kinesio® tape application, another measurement of your trunk range of motion will take place. You may be asked for a permission to take few pictures of the taping application on your back. The pictures be taken from your back, using a Galaxy S5 camera application. Your images will be password protected so the investigator will be the only one with access to the images until personal identifiers are removed. At the completion of the first day, you will be asked to make follow-up appointment times for 48 hours post Kinesio® taping application. The same measurements that were made on day one will be made on follow-up appointment day. After the measurement is made at your follow-up, the Kinesio® tape will be removed, and you will be asked to make another appointment after at least one week washout period for the another Kinesio® taping technique and the measurements. Again, you will be asked to make another follow-up appointment times 48 hours post Kinesio® taping application for the same measurement. After the measurement is made at another follow-up, the Kinesio® tape will be removed, and you will be excused from the study. During the study, you are not likely to experience any discomfort, with the possible exception of minor skin irritation from the application of Kinesio® tape. A possible benefit from taking part in this study is that you may improve your trunk flexibility. This study will benefit you and others by investigating the effects of Kinesio® tape on trunk flexibility. This may help therapists provide better treatments for low

back related health problems. All data collected will be password protected or sealed and kept for four years, and then destroyed after July, 2020.

There are risks of stress, emotional distress, inconvenience and possible loss of privacy and confidentiality associated with participating in a research study. Participation and the results of the study will not affect your University enrollment or academic status. It will also not affect your position on the team nor your scholarship status. Individual results will remain confidential and unavailable to the general public. If photographs of the taping application are eventually submitted for publication in a scholarly journal or presentation, it will have your face obscured with a black bar if the picture shows your face. Any information that is obtained in association with this study will be kept strictly confidential. We will take measures to protect the security of all your personal information, but we cannot guarantee confidentiality of all study data. Each subject will be provided with a subject identification number. The subject identification number linked to participant names will be secured in a locked file cabinet in a sealed envelope. Your name will not be used in any published reports about this study. The student investigator making all measurements is a NATA-certified graduate student athletic trainer. All measurements will be made in a private location.

Information contained in your study records is used by study staff. The Portland State University Institutional Review Board (IRB) that oversees human subject research and/or other entities may be permitted to access your records, and there may be times when we are required by law to share your information. It is the investigator's legal obligation to report child abuse, child neglect, elder abuse, harm to self or others or any life-threatening situation to the appropriate authorities, and; therefore, your confidentiality will not be maintained.

Your participation in this study is voluntary. You are not obligated to take part in this study, and it will not affect your status at Portland State University. You may withdraw from this study at any time without penalty or consequence.

If you have any questions, concerns or complaints at any time about the research study, Gary Brodowicz, or his associates will be glad to answer them at (503)725-5119.

If you need to contact someone after business hours or on weekends, please call (541)908-2936 and ask for Hoshito Mizutani.

If you have questions regarding your rights as a research participant, you may call the PSU Office for Research Integrity at (503) 725-2227 or 1(877) 480-4400. The ORI is the office that supports the PSU Institutional Review Board (IRB). The IRB is a group of people from PSU and the community who provide independent oversight of safety and ethical issues related to research involving human participants. For more information, you may also access the IRB website at <https://sites.google.com/a/pdx.edu/research/integrity>.

You are making a decision whether to participate in this study. Your signature below indicates that you have read the information provided (or the information was read to you). By signing this consent form, you are not waiving any of your legal rights as a research participant.

You have had an opportunity to ask questions and all questions have been answered to your satisfaction. By signing this consent form, you agree to participate in this study. A copy of this consent form will be provided to you.

Name of Adult Subject (print)

Signature of Adult Subject

Date

This research study has been explained to the participant and all of his/her questions have been answered. The participant understands the information described in this consent form and freely consents to participate.

Name of Investigator (print)

Signature of Investigator

Date

Appendix B: Demographic and Data Collection Form

Subject # _____

Demographic Information

Please answer each question honestly and to the best of your ability. If you have any questions ask the investigator.

Age: _____ yrs

Gender (Circle one): Male / Female

Year of Eligibility in Sport (Circle one): Freshman / Sophomore / Junior / Senior

Primary Sport (Circle one): Football / Basketball / Tennis / Cross Country and Track & Field/

Softball / Volleyball / Golf / Soccer

Measurements

1. Baseline modified-modified Schober test (MMST) score: _____ cm

1.1. Immediate outcome MMST score: _____ cm

1.2. 48 hour-post outcome MMST score: _____ cm

*After 7-10days washout period

2. Baseline modified-modified Schober test (MMST) score: _____ cm

2.1. Immediate outcome MMST score: _____ cm

2.2. 48 hour-post outcome MMST score: _____ cm

Appendix C: Raw Data

Subject #	Inhibition			Placebo		
	Baseline	Post	48 post	Baseline	Post	48post
1	8.3	8.3	8.2	9.0	8.0	5.9
2	7.6	7.8	7.6	7.2	7.0	7.2
3	6.0	6.1	6.3	6.2	5.8	5.7
4	7.2	7.3	7.3	7.5	6.7	6.4
5	6.1	6.2	7.7	7.0	6.8	6.2
6	7.0	7.2	8.0	7.2	6.4	6.7
7	7.9	7.8	8.3	7.8	7.4	7.8
8	9.5	9.7	9.0	8.1	7.8	8.0
9	9.6	10.1	9.6	9.7	9.6	9.0
10	8.8	8.8	8.4	8.0	7.6	7.8
11	7.3	7.4	8.5	8.0	7.6	7.9
12	5.8	6.1	7.5	6.3	6.3	6.0
13	5.4	5.4	6.2	6.2	7.0	7.1
14	6.8	7.0	6.8	7.9	7.6	8.0
15	6.0	6.4	4.8	5.9	5.5	6.0
16	4.6	4.8	5.6	5.2	5.2	5.3
17	3.6	3.8	5.1	5.8	5.7	6.0
18	5.7	6.1	6.5	5.9	5.9	6.2
19	6.3	6.6	7.2	7.2	7.2	6.2
20	4.7	7.2	5.1	4.2	4.1	4.4
21	6.3	6.5	7.1	6.0	6.0	6.4
22	4.8	5.3	7.0	5.3	5.7	6.0
23	5.1	5.4	5.2	5.5	5.4	5.5
24	6.1	6.2	7.2	6.6	6.7	6.6
25	4.7	4.8	5.4	6.4	5.9	6.4

Appendix D: IRB Approval

Date: February 19, 2016

To: Gary Brodowicz / Hoshito Mizutani

From: Karen Cellarius, HSRRC Chair

Re: HSRRC approval for your project titled, "Immediate and Short-Term Effects of Kinesio® Taping on Lower Trunk Range of Motion in Division I Athletes"

HSRRC Proposal # 163706

Approval-Expiration: February 19, 2016 – February 18, 2017

Review Type: Expedited, Categories 4, 6, 7

In accordance with your request, the PSU Human Subjects Research Review Committee has reviewed your request for approval of the project referenced above for compliance with PSU and DHHS policies and regulations covering the protection of human subjects. The Committee is satisfied that your provisions for protecting the rights and welfare of all subjects participating in the research are adequate, and your project is approved. Please note the following requirements:

Approval: You are approved to conduct this research study only during the period of approval cited above; and the research must be conducted according to the plans and protocol submitted (approved copy enclosed).

Consent: Signed consent is required from all participants in this study.

Changes to Protocol: Any changes in the proposed study, whether to procedures, survey instruments, consent forms or cover letters, must be outlined and submitted to the Committee immediately. The proposed changes cannot be implemented before they have been reviewed and approved by the Committee.

Continuing Review: This approval will expire on 02/18/2017. It is the investigator's responsibility to ensure that a Continuing Review Report on the status of the project is submitted to the HSRRC two months before the expiration date, and that approval of the study is kept current. The IRB offices does not send out notifications of expiration dates. The Continuing Review Report is available at www.rsp.pdx.edu/compliance_human.php and in the Office of Research and Strategic Partnerships (RSP).

Adverse Reactions and/or Unanticipated Problems: If any adverse reactions or unanticipated problems occur as a result of this study, you are required to notify the Committee immediately. If the issue is serious, approval may be withdrawn pending an investigation by the Committee.

Completion of Study: Please notify the Committee as soon as your research has been completed. Study records, including protocols and signed consent forms for each participant, must be kept by the investigator in a secure location for three years following completion of the study (or per any requirements specified by the project's funding agency).

If you have questions or concerns, please contact the Office of Research Integrity in the PSU RSP at 503-725-2227