Kinesio Taping on Short-Term Changes in Shoulder Strength in Healthy Adults: A Randomized Clinical Trial

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KINESIO TAPING ON SHORT-TERM CHANGES IN SHOULDER STRENGTH IN HEALTHY ADULTS: A RANDOMIZED CLINICAL TRIAL

By

Dario A. Callegari, Cristobal E. Cordova, Julia R. Dunievitz

A doctoral project submitted in partial fulfillment of the requirements for the

Doctorate of Physical Therapy

Department of Physical Therapy

School of Allied Health Sciences

The Graduate College

University of Nevada, Las Vegas

May 2012
THE GRADUATE COLLEGE

We recommend the doctoral project prepared under our supervision by

Dario A. Callegari, Cristobal E. Cordova, and Julia R. Dunievitz

entitled

Kinesio Taping on Short-Term Changes in Shoulder Strength in Healthy Adults: A Randomized Clinical Trial

be accepted in partial fulfillment of the requirements for the degree of

Doctor of Physical Therapy
Department of Physical Therapy

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Merrill Landers, Ph.D., Chair, Department of Physical Therapy
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May 2012
Abstract

Study Type: A Randomized Clinical Trial

Introduction
Kinesio tape is an elastic tape used in various settings and it is purported to assist in strengthening weakened muscles. The mechanism behind this claim is neuromuscular facilitation. The purpose of this study was to determine if the claims of Kinesio tape would be supported in its role in strength enhancing properties.

Methods
Twenty-nine healthy, untrained male and female college-aged individuals participated in this study. Two baseline measurements assessing shoulder external rotation (ER) strength were collected using isokinetic dynamometry. Subjects were then randomized into two groups, Kinesio tape with ER strengthening (KT-Ex) and ER strengthening only (Ex). Both groups followed a training program for 3 weeks with measurements obtained at the end of each week.

Results
Shoulder external rotator concentric and eccentric peak torque values were assessed using factorial ANOVAs. No significant interaction was found for concentric strength changes over time, (p=0.862). Likewise, no significant interaction was found for eccentric strength over time, (p=0.183).

Discussion
The training program used in this study was insufficient to drive strength changes
in shoulder external rotation strength in either group. The effect that Kinesio
tape, in conjunction with a training program, could not be determined from this
study. Future studies should employ a design with more power.
Introduction

Kinesio tape was first introduced by Kenzo Kase in 1979. Since its conception and development usage and popularity have increased. Kinesio tape has been used in hospital settings, professional sports teams, universities and various medical settings. Recently, Kinesio tape has been the subject of various research articles investigating the multitude of applications in a sport or medical settings. Despite a lack of direct evidence, Kinesio tape is purported to: 1) strengthen weakened muscles, 2) realign fascial tissue function by normalizing abnormal muscle tension 3) decrease pain through neurological suppression, 4) increase proprioception by providing cutaneous afferent stimulation through the skin, and 5) create more space by eliminating extra fluid, blood and edema under the skin for improved circulation of blood and lymph flow.\textsuperscript{1-3} Of the available research into the above claims, Garcia-Muro et al., showed that a patient's myofascial shoulder pain was resolved with the application of Kinesio tape.\textsuperscript{4} Kaya et al. showed that the application of Kinesio tape on patients with shoulder impingement had better outcomes than patients given other standard physical therapy modalities.\textsuperscript{5}

Kinesio tape and its strength enhancing properties have been the focus of recent research based on the neuromuscular facilitatory theory. There has been, however, inconclusive evidence to either support or refute this theory. Vithoulka et al. demonstrated that the application of Kinesio tape could increase eccentric isokinetic peak torque in healthy normal females upon application of tape.\textsuperscript{6} Likewise, Lee et al. showed a significant increase in grip strength following the
application of Kinesio tape. Conversely, in a study conducted by Fu et al. in which the effects of Kinesio tape on trained individuals were analyzed, they found no increase in quadriceps muscle strength with the application of Kinesio tape.

To this point, no study has examined the use of Kinesio tape used simultaneously with any other strengthening intervention to ascertain its influence on strength. Therefore, the purpose of this study was to determine if the claims of Kinesio tape would be supported in its role in strength enhancing properties. To provide this opportunity, the addition of Kinesio tape was implemented to augment any strength gains associated with a strength training program. We hypothesized that the application of Kinesio tape on muscle combined with a strength training program in untrained individuals would produce greater strength gains compared to a strength training program alone. The clinical significance of this study would be that Kinesio tape could be used to strengthen weakened muscles following a pathological condition (e.g., rotator cuff weakness), which is a common goal of most therapeutic interventions in the clinic.

**Methods and Materials**

*Overall study design*

This study was a single blinded randomized controlled trial (N=29) in which subjects were randomly assigned into two groups (exercise only and exercise and Kinesio tape). Following two baseline measurements, subjects followed a three week exercise protocol with strength measurements taken at the end of every week (Figure 1).
Participants

A convenience sample of 29 healthy individuals, 9 males and 20 females, were recruited from the student population at UNLV using email. Subjects were included in this study if they were healthy, untrained individuals between the ages of 18 and 36 years (mean age: 25.2 ± 2.7 years; mean height: 172.1 ± 9.6 cm; mean weight: 154.5 ± 34.1 lbs.). Due to the neuromuscular strength changes that occur in the early phases of strength training, selecting an untrained population was deemed optimal for the purpose of this study.\textsuperscript{9,10} Theoretically, Kinesio tape should have more of an effect during this beginning phase because of its action at the neurological level as opposed to the later phases of strength gains that are due to muscular hypertrophy.\textsuperscript{9} Subjects were excluded from this study if they had trained their shoulder external rotators in the previous 2 months, had pain or pathology in their shoulder as determined by the Shortened Disabilities of the Arm, Shoulder and Hand Questionnaire (QuickDASH) that would interfere with exercise or allergies to Kinesio tape. The QuickDASH has been found to have good test-retest reliability (0.90) and responsive in people with shoulder pain.\textsuperscript{11}

The shoulder external rotators of the non-dominant arm were selected because the authors hypothesize that this muscle group may allow for strength change in this healthy untrained population. All participants signed an informed consent form, under institutional review board approval, prior to the commencement of the study. Using a random number generator,\textsuperscript{12} subjects were
randomly assigned to two groups: Treatment Group 1 - Kinesio tape with ER strengthening (KT-Ex) (n=15) and ER strengthening only (Ex) (n=14).

**Taping method**

In order to ensure consistent placement of the tape, it was applied to every subject in Group 1 (KT-Ex) to the posterior shoulder of the non-dominant hand every training session by the same researcher. The tape was applied with the subject sitting; elbow bent to 90° and the forearm across the abdomen to ensure shoulder was in internal rotation to elongate the infraspinatus and teres minor. The Kinesio tape was applied from origin to insertion to facilitate movement (Figure 2). Five centimeter beige Kinesio® Tex Gold™ tape was used for every tape application to standardize the taping protocol. Before application, the skin was cleaned with Isopropyl alcohol and the lengths of tape to be used were determined by measuring from 2 cm lateral of the medial border of the scapula just inferior to the scapular spine for the infraspinatus origin to its insertion on the greater tubercle of the humerus for the first piece of tape, and 2 cm superior of the inferior angle of the scapula for the teres minor origin to its insertion on the greater tubercle for the second piece of tape. Rounding the corners of the tape strip before application, 2 cm of the length was applied directly over the origin of the infraspinatus with no stretch to act like an anchor, and rubbed gently to activate the glue.

Fifty percent tension was applied to the tape as it was stretched out over the muscle. To attain this, the tape was stretched out to its maximal tension then

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*Kinesio USA 3901 Georgia Street NE, Building F, Albuquerque, NM 87110*
subjectively backed off half way as it was put along the course of the muscle and over the insertion on the greater tubercle. No stretch was applied to anchor the tape. The tape was rubbed briefly to adhere to the skin. The same tape application technique was then used to facilitate the teres minor, and it was allowed to overlap onto half the width of the tape over the infraspinatus for the distal half of the tape course, terminating over the greater tubercle of the humerus (Figure 2). Tape was only worn during training sessions (approximately $\frac{1}{2}$ hour) and was removed immediately after. Tape was not worn during strength testing sessions with the isokinetic dynamometer.

**Test protocol**

The protocol for this study lasted for a total of 5 weeks; the first 2 weeks were used to obtain baseline measurements followed by a 3-week strength training program. A 3-week training period was selected because during this time, most muscular strength gains are neurological in origin.\textsuperscript{9} To obtain baseline measurements, all subjects met in the lab once per week for the first 2 weeks to measure concentric/eccentric shoulder external rotation strength using a Biodex\textsuperscript{**} isokinetic dynamometer (see setup for dynamometer in outcome measures below). Following 2 weeks of baseline strength measurements, all study participants followed a 3-week strength training program, supervised by two researchers to ensure proper exercise technique. Both groups met together twice a week and performed 2 exercises that targeted shoulder external rotators, one in a seated position and the other in side lying:

\textsuperscript{**} Biodex Medical Systems, 20 Ramsey Road, Shirley, New York, 11967-4704
The first exercise was performed with the subject lying on their side with the training shoulder toward the ceiling (Figure 3). Participants kept a pillow or towel roll between their body and elbow to maintain neutral shoulder position. The exercise motion was the forearm externally rotating away from the body with the elbow bent to 90° using a elastic resistance band fixed to the floor with a controlled return to the starting position and repeated this motion until the participant reached fatigue measured by a 17 out of 20 on the Rate of Perceived Exertion (RPE) scale.

The second exercise was done in a seated position and had the same motion as the first exercise except the elastic resistance band was now attached to an immovable object to attain a solid pull across the body keeping the forearm parallel with the floor (Figure 4).

Both exercises were performed with enough repetitions to reach fatigue for 4 sets. All subjects met 48 hours after their second exercise session of the week to obtain strength measurements using the isokinetic dynamometer.

**Outcome measures**

The outcome measures for this study consisted of strength, both concentric and eccentric, as measured by a Biodex isokinetic dynamometer. A blinded tester used the isokinetic dynamometer to assess any change in peak torque values in shoulder external rotation musculature over the course of the testing protocol. Subjects’ shoulder external rotation strength was assessed using the Biodex isokinetic dynamometer with an angular velocity of 60°/sec. With the subject seated, the chair was rotated to 90° with the leg of the T-frame and the
back of the chair was nearly vertical. Additionally, the powerhead was positioned parallel to the chair, and was rotated 20° from neutral in the horizontal plane and tilted 50° in the vertical plane. The axis of the dynamometer was placed in the longitudinal axis of the humerus through the olecranon. The subject was strapped with two criss-crossing shoulder straps and one lap strap to minimize accessory motion. Seat and arm rest adjustments were customized to the individual so that the shoulders were level, the dynamometer’s axis of rotation was aligned approximately with the olecranon process of the test arm and the subject was able to move through 90° of external rotation (Figure 5). Subjects were not able to watch the computer screen but were verbally encouraged to give their maximum effort for 3 trials in which the highest peak torque in ft·lbers was recorded. Subjects were allowed a practice trial before each measurement at 50% of their maximal effort.

Statistical Analysis

In order to determine the effects of Kinesio tape on short-term outcomes related to concentric and eccentric shoulder strength, separate 2 (group: Kinesio tape and exercise, no tape and exercise) x 5 (time: pre1, pre2, post1, post2, post3) mixed factor ANOVAs were conducted. The independent variable was the training program with two levels, tape or no tape. There were two dependent variables: shoulder external rotation peak torque and time. Analysis of the data was conducted using Statistical Package for the Social Sciences.*** Statistical significance was set at α<0.05.

*** SPSS Version 18.0;SPSS Inc, Chicago, IL
Results

The ANOVA utilized to test the effect of taping on concentric shoulder strength violated the assumption of sphericity (p=0.033) and the Huynh-Feldt adjustment was used. Because no interaction was observed (F(4,108)=0.298, p=0.862), main effects were analyzed (see Figure 6 for means and standard deviations). No statistical difference between groups (F(1,27)=0.412, p=0.526) or time (F(4,108)=1.951, p=0.115) was found.

The ANOVA used to assess the effect of taping on eccentric strength changes also violated assumption of sphericity (p=0.030), and the analysis was conducted utilizing the Greenhouse-Geisser adjustment. Because no interaction was observed (F(4,108)=1.661, p=0.183), main effects were analyzed for between and within groups (see Figure 7). No statistical significance between groups (F(1,27)=0.608, p=.442) were found. However, the main effect for time was statistically significant, (F(4,108)=3.364, p=0.024). Differences existed from baseline 1 to baseline 2 (p=.027), from baseline 1 to week 1 (p=.024), and baseline 1 to week 2 (p=.013), all otherwise pairwise comparisons were not significant (See Table 1 for values).

Discussion

The purpose of this study was to evaluate the clinical usefulness of Kinesio tape when combined with a strengthening program on short-term related concentric and eccentric shoulder peak torque values. The main findings of this study were that there were no differences over time in concentric shoulder external rotator strength between and within the two groups. Looking at eccentric
strength changes, strength increases existed from baseline 1 to baseline 2, from baseline 1 to week 1, and baseline 1 to week 2.

These results are consistent with a study by Fu et al, who found that after the application of Kinesio tape there was no change in concentric peak torque compared to baseline when using a Biodex isokinetic dynamometer. Likewise, Vithoulka et al, discovered no concentric strength changes upon application of Kinesio tape in un-trained individuals. However, they did find eccentric strength improvements that were significant following the application of Kinesio tape. The inherent flaws in our exercise program could explain possible reasons behind the current results. The exercise program may not have been challenging enough to drive strength gains. Furthermore, the present research was carried out on subjects with no shoulder pathology. Kinesio tape researchers such as Kaya et al, recommend the use of Kinesio tape in conjunction with a training program in the pathologically weakened shoulder. It is possible a ceiling effect was present within the group of healthy un-trained individuals used in this study but that still does not explain the lack of any appreciable strength gain from the exercise program. It is also possible that the effect size from Kinesio tape in a healthy, un-trained population is so small that the power needs to be greatly increased to detect any measurable change. These inconclusive results are further supported by the lack of concrete evidence found in the literature. The fashion in which the exercises were guided may have influenced the results, as they were performed in a large group setting making it difficult to ensure proper challenge or technique for everybody and every repetition.
Furthermore, this study cannot confidently suggest that Kinesio tape produced the observed eccentric strength changes as strength increases were observed from baseline 1 and baseline 2. This suggests that a learning effect may have been responsible for the notable increases in strength, as a change was noticed between baseline 1 and baseline 2, and no tape had yet been applied.

It is not possible to say that Kinesio tape was effective or ineffective in producing strength changes greater than no application of the tape based on the results from this study, as neither group showed a change in strength over time. It is speculated that the exercise program utilized in this study was insufficient in developing muscle strength in healthy college-aged individuals. Therefore, either a more individualized or a more challenging protocol should be implemented to properly influence strength changes within this muscle group and population and/or the methods used to measure change.

Limitations to this study included difficulty for research subjects to perform the eccentric mode on the Biodex isokinetic dynamometer. Even with practice trials at each measurement, the motion was hard to consistently perform among most of the research subjects. An additional limitation to this current study was that the exercise protocol was not sufficient enough to drive strength changes in a healthy and young population. Exercises that were performed are commonly found in a clinical setting; however, the method in which they were conducted was not common in a clinical setting where in exercises are usually more one-on-one.
Future research should focus on a more individualized and/or a more challenging approach to strength training, and a larger group format may not be recommended for clinical research. Additionally, research that is implemented to examine these effects should perform specific strength training using the Biodex isokinetic dynamometer instead of elastic resistance band or another mode of resistance training.

In conclusion, the training program we selected was insufficient to drive strength changes in shoulder external rotation strength. The effect that Kinesio tape, in conjunction with a training program, could not be determined from this study.
Sample Of Convenience UNLV PT Population (N=30)

Exclusion 1: Pre-existing shoulder pathology

Study Population (N=29)

Randomization Random Number Generator

Exercise Only Group (n=14)
- Baseline 1 (3 trials used) Eccentric & Concentric Peak Torque Measured
- Baseline 2 (3 trials used) Eccentric & Concentric Peak Torque Measured
- Measure 1 (2 trials used) Eccentric & Concentric Peak Torque Measured
- Measure 2 (2 trials used) Eccentric & Concentric Peak Torque Measured
- Measure 3 (2 trials used) Eccentric & Concentric Peak Torque Measured

Kinesio Tape + Exercise Group (n=15)
- Baseline 1 (3 trials used) Eccentric & Concentric Peak Torque Measured
- Baseline 2 (3 trials used) Eccentric & Concentric Peak Torque Measured
- Measure 1 (2 trials used) Eccentric & Concentric Peak Torque Measured
- Measure 2 (2 trials used) Eccentric & Concentric Peak Torque Measured
- Measure 3 (2 trials used) Eccentric & Concentric Peak Torque Measured

Data Analyzed SPSS 18 2 x 5 Mixed Factorial ANOVA

**Figure 1** Overall Study Design
Figure 2  Kinesio-taping technique
Figure 3  Shoulders External Rotation Exercise with subject lying on side
Figure 4  Shoulder External Rotation Seated
Figure 5  Testing position for shoulder external rotation using Biodex isokinetic dynamometer
Figure 6  Descriptive Statistic for measurement of concentric strength
Figure 7  Descriptive Statistic for measurement of eccentric strength
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References


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EDUCATION

• University of Nevada, Reno - Reno, Nevada
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  o Clinical internship in inpatient acute care setting
• Carson Tahoe Regional Medical Center - Carson City, NV - October 3 - December 14 2011 (10.5 weeks)
  o Clinical internship in an acute rehabilitation setting
• Physical Therapy Partners Nevada - Fernley, NV - July 11- September 23 2011 (11 weeks)
  o Clinical internship in a rural orthopedic outpatient setting

RESEARCH

• Thesis: Kinesio taping on short-term changes in shoulder strength in healthy adults: a randomized clinical trial
  o Advisor: Harvey Wallmann, PT, DSc, SCS, LAT, ATC, CSCS

PROFFESIONAL MEMBERSHIP

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  o Clinical internship in inpatient acute and CCU
• Renown Rehabilitation, Reno NV - July 11- September 23 2011 (11 weeks)
  o Clinical internship in inpatient acute rehabilitation setting
• Sports Therapy and Rehabilitation, Carson City NV - June 21-July 30 2010 (6 weeks)
  o Clinical internship in orthopedic outpatient setting

RESEARCH

• Thesis: Kinesio taping on short-term changes in shoulder strength in healthy adults: a randomized clinical
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• Renown Rehabilitation Hospital - Reno, NV - October 3 - December 14 2011 (10.5 weeks)
  o Clinical internship in an acute rehabilitation setting
• Concentra Medical Centers - Sparks, NV - July 11- September 23 2011 (11 weeks)
  o Clinical internship in an outpatient setting
• Physical Therapy Partners Nevada - Fernley, NV - June 21-July 30 2010 (6 weeks)
  o Clinical internship in a rural orthopedic outpatient setting

RESEARCH

• Thesis: Kinesio taping on short-term changes in shoulder strength in healthy adults: a randomized clinical trial
  o Advisor: Harvey Wallmann, PT, DSc, SCS, LAT, ATC, CSCS

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• Member Research Section of the American Physical Therapy Association (2009-present)

PROFESSIONAL ACTIVITIES

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