

RUNNING HEAD: KINESIO®TAPE DIRECTION OF APPLICATION EFFECT

DOES THE DIRECTION OF APPLICATION OF KINESIO®TAPE HAVE AN
EFFECT ON TIME TO PEAK MUSCLE TORQUE OF THE CONCENTRIC
CONTRACTION OF THE QUADRICEPS MUSCLE IN HEALTHY YOUNG
ADULTS?

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KINESIO®TAPE DIRECTION OF APPLICATION EFFECT	1
TABLE OF CONTENTS	
Abstract	2
Background	4
Effect on Muscle Performance	4
Inhibitory vs. Facilitory Effects	7
Reliability of Isokinetic Measurements	8
Summary	10
Methods	11
Participants	11
Procedure	11
Data Collection	13
Data Analysis	13
Results	14
Discussion	18
Conclusion	20
References	21

ABSTRACT

Objective: The current study was designed to determine if the direction of application of Kinesio® tape has an effect on the time to peak muscle torque of the concentric quadriceps contraction in the healthy young adult population.

Background: There are many proposed effects of Kinesio®Tape, but the available research on these effects is limited and of poor quality. Previous studies have shown that when the tape is applied from muscle origin to insertion with 25-50% tension on the tape, the time to peak muscle torque is decreased. There have been very few studies investigating the inhibitory effect that Kinesio® tape claims to have by applying the tape from muscle insertion to origin. Further research is necessary to explore the true effects that the directionality of application of the tape has on healthy muscle function.

Methods: This study was a randomized clinical trial consisting of 21 participants who performed 10 repetitions of maximum effort concentric quadriceps at 60 degrees/second, 120 degrees/second, and 180 degrees/second in a randomly assigned order of three taping conditions over three testing days. Each participant performed 10 repetitions of maximum effort concentric quadriceps contractions with one of the three taping conditions and without tape on each of the three testing days. The order of taping versus no taping was randomly assigned in addition to the order of the three taping conditions: facilitory Kinesio®Tape application, inhibitory Kinesio®Tape application, and no tension “placebo” Kinesio®Tape application. The Biodex system 4 Pro Isokinetic dynamometer was used to measure the force production of concentric knee extension.

Results: The 21 participants (mean \pm SD age, 25.0 \pm 3.63) completed all three testing days of the study. Data analysis displayed no statistically significant differences in

maximum peak torque across all 4 taping conditions (facilitory, inhibitory, no tension placebo, and no tape) at all 3 velocities (60 deg/sec, 120 deg/sec, 180 deg/sec) with p values of 0.506, 0.441, and 0.306 respectively. Analysis of the time to peak muscle torque across all four taping conditions at the three velocities tested revealed no statistically significant differences with p values of 0.056, 0.835, and 0.264 respectively. The time to peak muscle torque at 60 deg/second was further analyzed due to the fact that the p value was close to 0.05. A pairwise comparison among the taping conditions revealed that facilitory taping (from muscle origin to insertion) had the most impact on the decrease in time to peak torque (decrease of 49.52 milliseconds). Analysis of the torque per body weight across all four taping conditions of the three velocities revealed no statistically significant differences with p values of 0.577, 0.894, and 0.691 respectively.

Conclusions: Neither facilitory nor inhibitory effects were observed between various directions of application of Kinesio® tape in the healthy young adult population when analyzing peak muscle torque. However, the present study suggests that the facilitory application of Kinesio®Tape decreases the time required to generate peak torque at the velocity of 60 deg/second during a concentric quadriceps contraction. This finding can have important implications for athletes that utilize Kinesio®Tape to improve their sports performance.

BACKGROUND

Kinesio® Tape is a well-known adhesive tape among many healthcare professionals and athletes around the world. Kinesio® tape is commonly used for injury prevention, rehabilitation, and performance enhancement. There are many proposed effects of Kinesio® Tape, but the available research on these effects is limited and of poor quality. Dr. Kenzo Kase, developed Kinesio® tape in Japan more than 25 years ago. His vision was to create a therapeutic tape and technique that would support the joints and muscles, without restricting normal movement. He claims that the Kinesio® taping technique can improve the localized effect of fluid circulation, decrease pain, provide anatomical support, enhance muscle and joint range of motion, and assist proprioception.⁴ Due to the increased familiarity and popularity of this taping method, it is important to understand the true effects it has on normal healthy muscle function. Previous studies^{1,2,3} have shown that when the tape is applied from muscle origin to insertion with 25-50% tension on the tape, the time to peak muscle torque is decreased. There have been very few studies investigating the inhibitory effect that Kinesio® tape claims to have by applying the tape from muscle insertion to origin. Further research is necessary to explore the true effects that the directionality of application of the tape has on healthy muscle function. Therefore, our research question is “Does the direction of application of Kinesio® tape have an effect on time to peak muscle torque of the concentric contraction of the quadriceps muscle, in healthy young adults?”

Effect on Muscle Performance

Numerous studies have looked at the effect Kinesio® taping has on muscle strength and performance on healthy subjects with mixed results. However, current

research is starting to show a common trend in results, that Kinesio® taping from muscle origin to insertion does not increase the peak torque in an individual's concentric contraction, but it does reduce the time it takes to reach it. This finding is significant in that, a shorter time to peak torque has been associated with increased strength during ballistic activities.⁵

In a study by Fu et al.,⁶ 14 healthy athletes were assessed via isokinetic dynamometer under three conditions: without taping, immediately after taping, and 12 hours after taping. With the order of taping conditions randomized the subjects performed concentric quadriceps contractions at 60°/s, eccentric quadriceps contractions at 60°/s, concentric quadriceps contractions at 180°/s, and eccentric quadriceps contractions at 180°/s on a Cybex NORM. Results of the study showed no significant difference in peak torque among the three testing conditions at the various velocities being tested. This study did not analyze the time it took the athletes to reach their maximum peak torque unlike various other studies.^{1,2,3,7} In one study with 30 healthy participants the design was similar in which the participants performed concentric contractions of the quadriceps on an isokinetic dynamometer.¹ The measurements were taken at three angular velocities, 60°/s, 120°/s, and 180°/s, for ten repetitions. The participants were tested with and without Kinesio® tape on two different testing days with seven days in between. The seven days in between was to avoid any potential carryover effect, and the order of the testing condition was randomized by a coin toss. Results of this study were similar to that of the previous study in which there was no difference in peak torque between the two conditions (with and without tape). However, this study also analyzed the time it took to reach peak torque and found that it was significantly decreased with Kinesio® tape

application at all three angular velocities. The time to reach peak torque remained unchanged without the application of Kinesio® tape.¹

Another study that included young healthy adults, observed the effect Kinesio® tape had on knee extensor peak torque before and after exhaustive isometric knee extension.² Participants were either taped from muscle origin to insertion with Kinesio® tape (13 subjects) or placed in the control group (13 subjects) receiving sham taping with a non-stretchable tape. The participants were tested before taping, immediately after taping, and 5 and 10 minutes after an isometric fatigue protocol. Results showed no differences between the two groups on peak torque performance. Results did show significantly higher rates of peak torque (the time from onset of movement to the point of peak torque) in the intervention group over all tests, suggesting Kinesio® tape decreases the time to reach peak torque.² This study also accounted for the placebo effect by using a sham tape that was non-stretchable in the same region. Some researchers believe the placebo effect is the reason for enhancement of muscle performance with application of Kinesio® tape.

A similarly designed study found that there was no increase in peak torque or decrease in the time to reach peak torque among testing conditions.⁷ This study had 30 healthy participants tested at two angular velocities, 60°/s and 180°/s for five repetitions. Participants were tested three different sessions with seven days in between each session with various taping conditions. Participants were blindfolded after being placed on the isokinetic dynamometer and were either taped with true Kinesio® tape, sham Kinesio® tape in which no tension was applied to the tape, or were not taped. In the tapeless condition, the participant's thigh was touched in order to mimic the application of tape

being applied. The results concluded that there were no differences in the peak torque or time to peak torque among all taping conditions. Because the participants were confirmed to be ignorant about Kinesio® tape through a screening survey prior to participation and at the debriefing after the study was concluded, the placebo effect was successfully eliminated. This study concluded that positive results in previous studies using Kinesio® tape may be due to the placebo effects of using the tape.⁷

An unpublished study from Florida Gulf Coast University tested the effects Kinesio® tape application had on concentric force production of the quadriceps in non-injured individuals. They had 51 participants tested with tape and without tape on a Biodex System 4 Pro isokinetic dynamometer at two angular velocities (60°/s and 240°/s). Results were similar to the previous studies as there was no effect on the peak torque, but there was a decrease in time to peak torque at the 60°/s angular velocity. There was not a decreased time to peak torque at 240°/s.³

Inhibitory vs. Facilitory Effects

Kinesio®Tape claims to have both a muscle facilitative effect and a muscle inhibitory effect depending on the method of application. Damaged muscle can benefit from the inhibitory effect by applying the tape with light (15-25%) tension, from the insertion to origin of the muscle. The proposed mechanism as to why this works is that the recoil from the tape induces motor neuron inhibition by stretching the Golgi tendon organs located at the distal end of the muscle. In muscles where support and full range of motion is desired, the tape is applied with moderate tension (25-50%), from the origin to insertion of the muscle.⁴ This proposed mechanism works by facilitating the muscle spindle reflex contraction.² While these statements are thought of as accurate, research

has been inconclusive in demonstrating a true alteration in muscle function between the two taping directions.

In a study by Cai, Au, An, & Cheung,⁸ 33 participants performed maximal grip assessment in a randomly assigned order of three taping conditions. The participants were blindfolded in order to eliminate the placebo effect and were taped with facilitatory Kinesio® tape, inhibitory Kinesio® tape, and no tape. The participants were tested using a Jamar dynamometer and EMG activity. Results showed no significant differences in maximum grip strength, EMG activity, or self-perceived performance in the various taping conditions. Their findings concluded, that with the placebo effect of Kinesio®Tape eliminated, Kinesio®Tape did not facilitate or inhibit muscle activity and change the functional performance in healthy adults.⁸ While this study showed similar results with previous research that the facilitatory effect did not enhance muscular performance, it did not examine the effect the Kinesio® taping method had on the time it took to reach peak muscle performance. There is currently no research published that has investigated the time it took to reach peak torque in both facilitatory and inhibitory Kinesio® taping methods.

Reliability of Isokinetic Measurements

It is necessary to understand the test reliability and validity of an isokinetic dynamometer during a concentric quadriceps contraction for increased consistency between testing conditions and to ensure that the proper measuring instrument is utilized. An isokinetic dynamometer measures torque and work during eccentric and concentric isokinetic loading. The dynamometer provides resistance with a rotating lever arm at various velocities of movement.

A study⁹ looking at the mechanical reliability and validity of the Biodex System 3, found that it was a “mechanically reliable instrument for the valid measurement of angular position, isometric torque, and slow to moderately high velocities (<300°/s)”. The same study found that when testing isometric torque, the dynamometer produced valid measurements. Although greater discrepancy in torque was seen at higher torques, the discrepancy was still negligible. Additionally, concentric velocity measurements were found to be valid up to 300°/s.

Two studies looked at the reliability of the Biodex System 4. One found that it was reliable and valid for measuring abdominal muscle function.¹⁰ The other looked at test-retest reliability of the Biodex System 4 in measuring knee strength in pediatric populations.¹¹ It too, found the isokinetic dynamometer to be reliable, although a learning effect was determined to have occurred when analyzing isometric torque.

A study¹² looking at intra-machine and inter-machine reliability of the Biodex for knee flexion and extension found that it is clinically reliable for peak torque and angular work. Although it was found reliable for both conditions, the researchers found that the Biodex was more reliable at 20-minute intervals when compared to 1-week intervals. Additionally, they also found that the Biodex was more reliable for knee extension at a slower speed of 60°/s than at the higher speed of 180°/s. However, the Biodex was found to be reliable at both speeds and reliability increased when measurements were taken in a window in the middle of the range of motion (ROM). This led the researchers to believe that the decreased reliability at higher speeds might have been due to an increased variability of ROM at the higher speed.

A study with 14 healthy young male participants (23-32 years old) examined the test-retest reliability of both concentric and eccentric contractions of the quadriceps on a KIN/COM® isokinetic dynamometer.¹³ The subjects had three testing sessions, with the first session designed to practice the movements and control for potential learning effects. Each session took place on the same day of the week and the same time of the day in order to ensure consistent activity levels. The sessions included a five-repetition warm-up of eccentric and concentric loading at the three angular velocities tested: 60°/s, 120°/s, and 180°/s. Results showed that the reliability of the concentric peak torque and work measurements was excellent at 60°/s and 120°/s and was good at 180°/s. There was low reliability reported with eccentric contraction at 60°/s but was good at 120°/s and 180°/s.¹³ Other research has reported that with concentric quadriceps testing over a 6-week period, with sessions two weeks apart there was no change in peak torque values. They also reported that when testing inexperienced subjects in one session only, at least one maximal trial should be given before scores are recorded.¹⁴

Summary

A trend toward decreased time to reach peak torque with the application of Kinesio® tape is seen in the current literature. Research is very limited in testing the impact of the direction of application of Kinesio® tape on muscle performance. Studies using an isokinetic dynamometer at the angular velocities 60°/s, 120°/s, and 180°/s have had excellent test retest reliability when measuring concentric quadriceps contractions.¹³ Future research on the effects of the direction of taping on a concentric quadriceps contraction is necessary to determine if there truly is a muscle inhibitory or facilitatory effect.

METHODS

The study constitutes a single group, repeated measures, experimental design.

Participants

21 individuals including 9 males and 12 females (mean \pm SD age, 25 ± 3.63 , 57.1% female) willing to participate in this pilot study were recruited by convenience sampling from the Marieb College of Health & Human Services at Florida Gulf Coast University. The individuals were only included if they had no history of cardiac illness, no musculoskeletal issues pertaining to the right knee within the last 6 months, and no neurologic conditions. Participants were excluded if they had chronic knee injury or knee surgery in the past 6 months, had rehabilitation for the right lower extremity in the last 6 months, if they had participated in the active use of Kinesio® Tape for muscle facilitation around the knee within the last month, or if they weren't medically cleared to participate in exercise via PAR-Q and Health History Questionnaire. The data collection for the study took place in the Sports Medicine Lab located in Marieb Hall at Florida Gulf Coast University. All participants were required to sign an informed consent prior to participation in the study. The study was approved by the Institutional Review Board for the protection of Human Subjects in Research and Research Related Activities at Florida Gulf Coast University prior to participant recruitment.

Procedure

Participants were scheduled for four days to participate in the study. The first day was a practice day and was scheduled prior to the first data collection day in order to minimize the potential learning effect of using the Biodex. All participants received thorough instructions on how to perform the exercise on the Biodex and were motivated

throughout the exercise. Random allocation of testing sequence was established by having participants roll a standard die on the learning day. If the participant rolled a 1 or 2, they received the facilitatory taping technique on the first day, if they rolled a 3 or 4, they received inhibitory taping technique on the first day, and if they rolled a 5 or a 6, they received the placebo no tension taping technique on the first day. They then rolled the die for their second treatment day group. They continued to roll the die until they got a new treatment group for the second data collection day. They were then assigned the third treatment group for the third data collection day. Next, they rolled the die 3 times to determine whether they would perform the exercise on the Biodex without the tape first, or if they would perform the exercise with the tape first on each data collection day. If the participant rolled an even number he/she performed the exercise on the Biodex without the tape first, if he/she rolled an odd number they performed the exercise with their randomized taping technique first. Due to the nature of the study, neither the investigators nor participants were blinded to the study. The application of the Kinesio® Tape was applied by Dr. Venglar, who is a Certified Kinesio® Tape Practitioner. The tape was applied in the direction of muscle origin to insertion for the facilitatory condition, from muscle insertion to origin for the inhibitory condition, and from muscle origin to insertion with no tension for the placebo condition. Participants had to wait 30 minutes after the tape has been applied to allow time for it to activate.⁴

The Biodex system 4 Pro Isokinetic dynamometer was used to measure the force production for concentric knee extension. This system was chosen due to its availability and high test, re-test reliability.¹⁵ Data collectors were educated in the use of this equipment by the Program Director of the Athletic Training Program and demonstrated

baseline competency in using it. Each participant had a trial day to practice on the equipment and had a practice trial on the day of data collection to re-familiarize themselves to the machine. The participants performed 10 repetitions of maximum effort at 60 degrees/second, 10 repetitions at 120 degrees/second, and 10 repetitions of maximum effort at 180 degrees/second. The participants were allowed a 3-minute rest period between each set. This procedure mimics that in the study by Wong et. al¹ which found a significant difference in the time it took to reach peak torque among all angular velocities for 10 repetitions when taping from muscle origin to insertion.

Data Collection

The Biodex System 4 Pro software measured peak muscle torque and time to peak torque for each individual repetition. Peak torque can be defined as the highest torque out of the ten repetitions. The time to peak torque can be defined as the time it takes from the beginning of the movement to the time it takes to reach peak torque.

Data Analysis

Due to the fact that this is a pilot study, only 21 participants were recruited. Variables examined were peak torque and time to peak torque. Results from the Biodex system 4 Pro Isokinetic dynamometer were assessed using a multivariate analysis of variance, or MANOVA and based on results, a post-hoc paired-t test for dependent variables with a Bonferroni correction to minimize the risk of a Type I error. An alpha level of .05 was set. Analysis was conducted using IBM SPSS version 17 software.

RESULTS

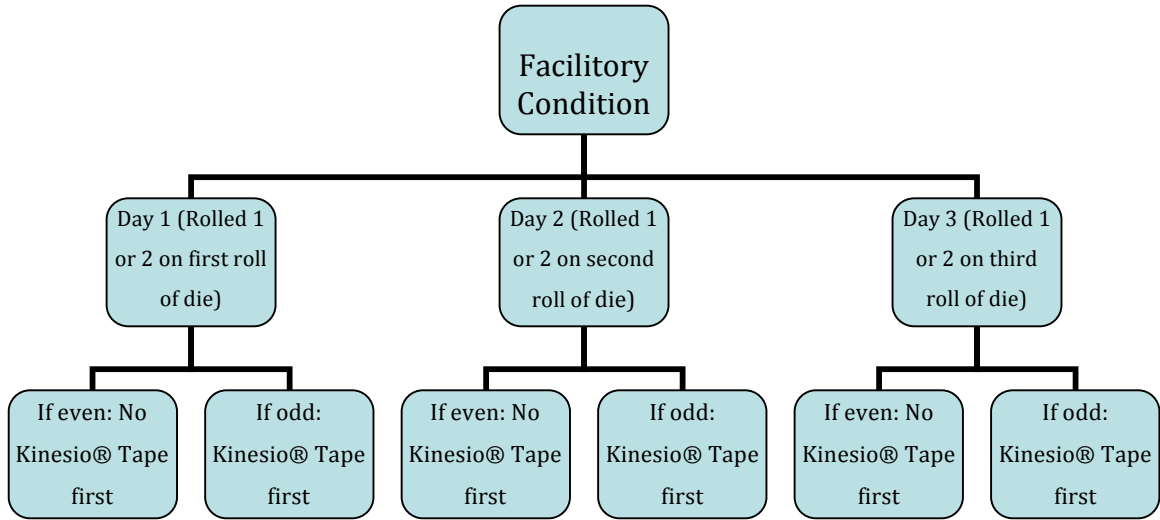


Figure 1.1. Participant decision flow for Facilitory Condition

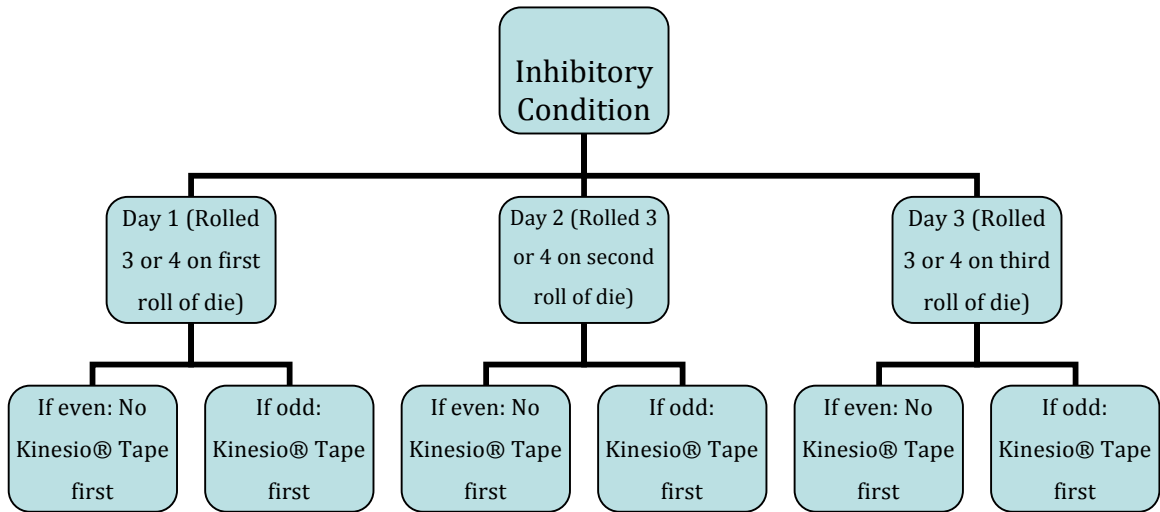


Figure 1.2. Participant decision flow for Inhibitory Condition

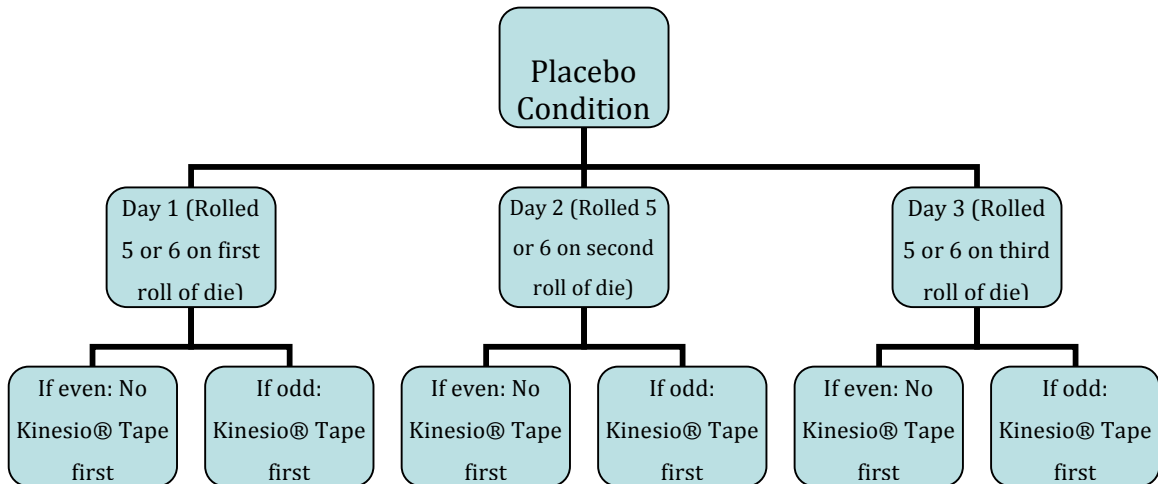


Figure 1.3. Participant decision flow for Placebo Condition

Recruitment of participants occurred from August to October 2016. No follow-up of participants was required and the study was discontinued due to reaching the goal sample size of 20. There was no statistically significant difference in peak torque and time to peak torque for the no tape condition among all three testing days. Therefore, when analyzing data across conditions, the information from the facilitory taping day was used. No statistically significant differences were noted across the four conditions (no tape on the facilitory day, placebo taping, facilitory taping, and inhibitory taping) for peak torque or time to peak torque at any of the three speeds (60 deg/sec, 120 deg/sec, and 180 deg/sec). However, the p-value for the time to peak torque across all four conditions at 60 deg/sec came close to being statistically significant at $p=0.56$ (Table 1). Therefore, it was decided to analyze three pairwise comparisons to determine the relationship between the four taping conditions to better understand which taping condition had the greatest impact on reducing the time to peak muscle torque.

Only the paired-t test comparing average time to peak torque at 60 deg/sec with no tape on the facilitory taping day and average time to peak torque at 60 deg/sec with

facilitory taping was found to be statistically significant with a p-value of 0.015 (Table 2). This was found to be statistically significant even with a Bonferroni correction to minimize the risk of a Type I error. There was an average decrease in time to peak torque of 49.52 msec.

Table 1. MANOVA statistics of time to peak torque across all four conditions (no tape on the facilitory day, placebo taping, facilitory taping, and inhibitory taping) at 60 deg/sec

Within-Subjects Factors

Measure: MEASURE_1

CONDITION	Dependent Variable
1	TTPT60_PL
2	TTPT60_INH
3	TTPT60_F
4	TTPT60_NTF

Multivariate Tests^a

Effect		Value	F	Hypothesis df	Error df	Sig.
CONDITION	Pillai's Trace	.336	3.040 ^b	3.000	18.000	.056
	Wilks' Lambda	.664	3.040 ^b	3.000	18.000	.056
	Hotelling's Trace	.507	3.040 ^b	3.000	18.000	.056
	Roy's Largest Root	.507	3.040 ^b	3.000	18.000	.056

Table 2. Three pairwise comparison statistics of time to peak torque between conditions at 60 deg/sec

Paired Samples Test

	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of Diff.		t	df	Sig. (2-tailed)
				Lower	Upper			
Pair 1: Avg. time to peak torque at 60°/sec NT facilitory – (minus) avg. time to peak torque at 60°/sec facilitory tape	-.04952	.08500	.01855	-.08821	-.01083	-2.670	20	.015
Pair 2: Avg. time to peak torque at 60°/sec NT facilitory day – (minus) avg. time to peak torque at 60°/sec inhibitory tape	-.01952	.13332	.02909	-.08021	.04116	-.671	20	.510
Pair 3: Avg. time to peak torque at 60°/sec NT facilitory day – (minus) avg. time to peak torque at 60°/sec placebo (no stretch) tape	.02524	.12258	.02675	-.03056	.08104	.943	20	.357

The average maximum effort repetition across all variables and all days was found to be 3.43 reps (Figure 2) suggesting that a 10 repetition set might not be necessary to achieve maximal voluntary contraction measurements. No adverse effects were seen with any participants throughout the study.

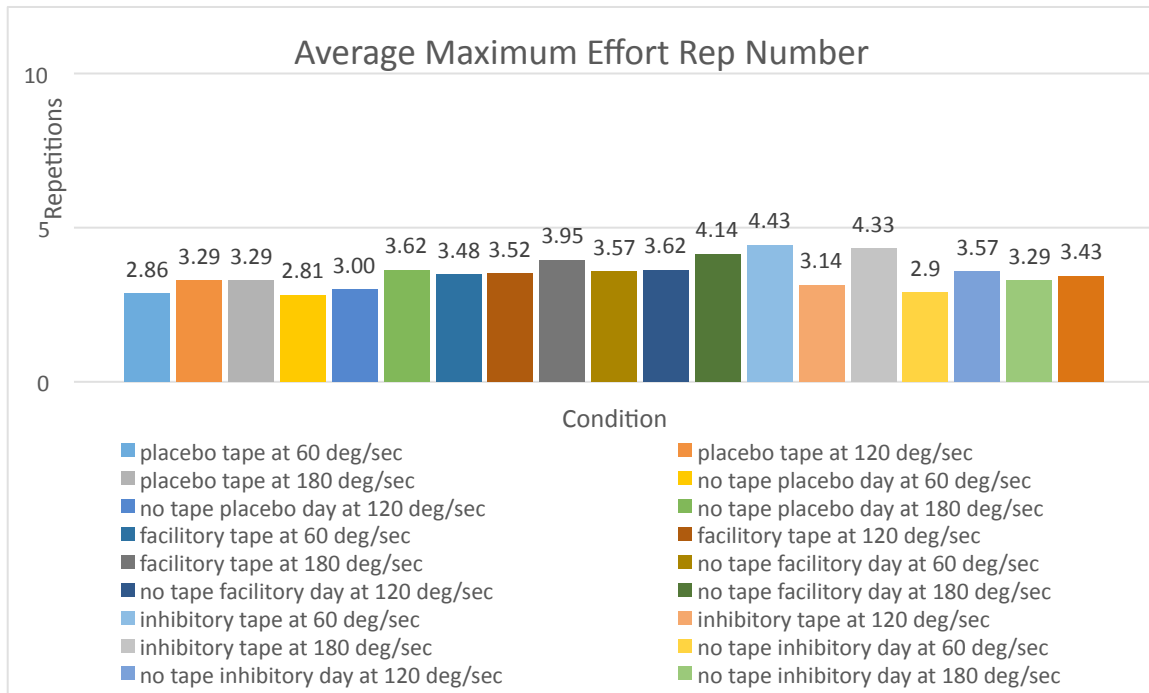


Figure 2. Average maximum effort repetition number for all conditions across all days. Average across all days and conditions was 3.43 repetitions.

DISCUSSION

The current study examined the true effects of facilitory and inhibitory application of Kinesio® Tape on the force production and time to maximal force production of the right quadriceps during repeated concentric contractions. Our findings were consistent with the few other studies that have examined the effects of facilitory application on force production. Our results indicate that at three different angular velocities (60°/sec, 120°/sec, and 180°/sec), there is no significant difference in force production with facilitory tape, no tape, no tension “placebo” tape, or inhibitory tape. Our study is also

consistent with recent other findings in that the time to peak muscle torque can be decreased with a facilitory application of tape at 60°/sec. When analyzing the time to peak muscle torque across all four taping conditions, the p value was close to being statistically significant ($p= 0.056$) at 60 deg/second, leading to further analysis to determine which taping condition had the greatest impact on reducing the time to peak muscle torque. Three pairwise comparisons among the taping conditions revealed that facilitory taping (from muscle origin to insertion) had the greatest impact on the decrease in time to peak torque during maximal contractions performed at 60°/sec.

The results of the study indicate that there is no significant impact of the direction of taping application or the use of tape at all on peak muscle force production at the three tested angular velocities. However, when performing maximum voluntary contractions at 60°/sec with Kinesio® Tape facilitory application, the time it takes to reach peak muscle torque can be reduced by 49.52 milliseconds. In the present study the reduction in time to peak muscle torque has only been decreased with facilitory application at the angular velocity 60°/sec and there was no impact on the time to peak muscle torque at velocities 120°/sec and 180°/sec.

The present study had numerous confounding variables potentially impacting the results of the study. Participants had visual feedback from the Biodex software system and some participants would try and beat their highest force production from their previous testing day affecting their motivation levels. Some participants did not appear to be performing at their maximal level of effort despite verbal encouragement from the researchers and visual feedback from the computer screen. One of the major limitations of the study is that there were not a set number of days in between each testing session to

allow adequate recovery and the same exact testing protocol for each participant. A participant may have had testing sessions over two consecutive days allowing only 24 hours for recovery, potentially impacting the results of their performance secondary to fatigue. Participants of the study were healthy young adults with the majority of them reporting to exercise frequently. Some of the participants would report that they had worked out their legs a day or so prior to participating in the study and that they were sore, potentially impacting their ability to perform at maximal effort.

Future research studies trying to determine the effects of Kinesio® Tape should incorporate a larger sample size to better reflect the mean population versus a small group of healthy young adults. Future research designs should also ensure that each participant has the same number of days in between each testing session to allow for standardization and decreased fatigue impacting results.

CONCLUSION

This study demonstrated that direction of application of Kinesio®Tape did not have a significant positive or negative impact on maximal force production in concentric quadriceps contractions in healthy, un-injured adults. However, the time it took to reach peak muscle torque displayed a statistically significant decrease when Kinesio®Tape was applied in a facilitory pattern from muscle origin to insertion for the 60 deg/sec condition when compared to the no tape condition. The time it took to reach peak muscle torque was reduced by 49.52 milliseconds with facilitory Kinesio® Tape application. The average maximum effort repetition across all variables and testing days was 3.43 reps suggesting that Kinesio® Tape application can be most beneficial in functional activities that require muscle power versus muscle endurance.

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