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Kinesiology tape does not facilitate muscle performance: A deceptive controlled trial

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ABSTRACT

Kinesiology tape (KinTape) is a therapeutic tape without much understanding of its mechanism. KinTape claims to increase cutaneous stimulation, which facilitates motor unit firing, and consequently improves functional performance; however these, benefits could be due to placebo effects. This study investigated the true effects of KinTape by a deceptive, randomized, and controlled trial. Thirty healthy participants performed isokinetic testing of three taping conditions: true facilitative KinTape, sham KinTape, and no KinTape. The participants were blindfolded during the evaluation. Under the pretense of applying adhesive muscle sensors, KinTape was applied to their quadriceps in the first two conditions. Normalized peak torque, normalized total work, and time to peak torque were measured at two angular speeds (60°/s and 180°/s) and analyzed with one-way repeated measures ANOVA. Participants were successfully deceived and they were ignorant about KinTape. No significant differences were found between normalized peak torque, normalized total work, and time to peak torque at 60°/s or 180°/s ($p = 0.31 - 0.99$) between three taping conditions. The results showed that KinTape did not facilitate muscle performance in generating higher peak torque, yielding a greater total work, or inducing an earlier onset of peak torque. These findings suggest that previously reported muscle facilitatory effects using KinTape may be attributed to placebo effects.

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1. Introduction

Kinesiology tape (KinTape) is a well-recognized adhesive therapeutic tape which has been widely used for injury prevention, rehabilitation, and even performance enhancement. It appears to be clinically effective in controlling pain (Thelen et al., 2008; González-Iglesias et al., 2009; García-Muro et al., 2010; Kalichman et al., 2010; Saavedra-Hernández et al., 2012), promoting range of movement (Jaraczewska and Long, 2006; Yoshida and Kahanov, 2007; Kalichman et al., 2010; Williams et al., 2012), increasing muscle activity (Thelen et al., 2008; Briem et al., 2011; Wong et al., 2012), inducing an earlier occurrence of muscle peak torque (Wong et al., 2012; Fratocchi et al., 2013), and functional performance enhancement (Jaraczewska and Long, 2006; Yasukawa et al., 2006; Chang et al., 2010). However, the positive results can be due to the absence of adequate blinding and placebo controls. More importantly, the working mechanism of KinTape

remains unclear. It has been speculated that the muscle facilitatory effects of KinTape may be due to the interplay between cutaneous afferent stimulation and motor unit firing in both central and peripheral nervous systems. An increase of peripheral nerve stimulation was shown to promote excitability of the motor cortex (Ridding et al., 2000). Reduction of motor neuron threshold may be induced by cutaneous stimulation, resulting in easier recruitment of the motor units (Maratou and Theophilidis, 2000), and in turn, leading to an improved functional performance.

Such speculation can only be proved or refuted by an experiment with a true placebo group. Previous clinical controlled trials and randomized controlled trials used KinTape without any additional tension, or KinTape application on irrelevant position as their sham condition (Thelen et al., 2008; González-Iglesias et al., 2009; Hsu et al., 2009; Saavedra-Hernández et al., 2012; Fratocchi et al., 2013; de Almeida Lins et al., 2013). However, it is arguable that sham KinTape may still provide therapeutic effect as additional cutaneous sensory input may still be present in both sham conditions. It is also noteworthy that the participants in other studies were aware of the KinTape application, meaning the observed effects could be attributed to placebo effects (Beedie and Foad, 2009).

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Hence, it is necessary to interpret the results of previous studies with caution.

Since it is not feasible to effectively induce a temporary block to tactile sensation that the tape stimulates, a possible method to eliminate placebo effects is deception. A deception experimental design previously has been considered impractical by healthcare professionals. However, a recent large scale study which recruited more than 6000 laypeople suggests that deceptive placebo use appears to be more pragmatic than what was previously thought (Köteles and Ferentzi, 2012). Deception in healthcare research is considered acceptable if the study fulfills the following criteria (Wendler, 1996): 1) any other effective non-deceptive alternatives are not feasible; 2) participants are not deceived about research risk, discomfort, or unpleasant emotional experience; 3) the deception must be explained to participants as early as is feasible; and 4) debriefing is offered immediately after the study. Thus, deception can be used to evaluate the true effects of KinTape by deceiving a group of laypeople who are ignorant about KinTape.

Isokinetic test of muscle strength is a reliable and safe method to quantify muscle performance at selected contraction speeds (Osternig, 1986; Montgomery et al., 1989). It is also a common test in previous randomized controlled trials which examined effects of KinTape. Therefore, this study examined the muscle performance of the quadriceps with and without KinTape application in participants who did not realize the potential treatment effects of the adhesive therapeutic tape using isokinetic muscle strength measurement. We hypothesized that there would be no difference in the muscle performance when the participants were taped with true facilitative KinTape, sham KinTape, and received no KinTape.

2. Methods

2.1. Participants

A total of 46 healthy participants were recruited. The institutional review board reviewed and approved the research protocol and all of the participants provided their written informed consent before being tested. All participants were issued a screening survey prior to participation in order to ensure that they were: 1) free of known musculoskeletal, cardiopulmonary, and any other chronic medical conditions requiring pharmaceutical management; 2) free of any active joint pain or other related symptoms in the recent 12 months; and 3) ignorant about KinTape, meaning participants had no exposure to KinTape and failed to name “kinesiology tape”, “KT”, “tape”, “adhesive plaster”, “adhesive ribbon”, or anything equivalent as prophylactic equipment for sports. Participants' ignorance towards KinTape was re-assessed after the experiment with a second brief survey. Ten participants were screened out before the experiment and six of them dropped out due to scheduling conflicts (Fig. 1). Remaining 30 participants (18 females) had a mean \pm SD age of 21.8 ± 3.05 and a body mass of 59.72 ± 15.5 kg.

2.2. Testing procedures

All participants attended three isokinetic knee testing sessions (Fig. 1), each of which was separated by around seven days to avoid any carryover effect (Fu et al., 2008). An isokinetic dynamometer (Cybex Norm, Humac, CA, USA) was calibrated before each data collection session. The measurements for each testing session were taken at two angular speeds ($60^\circ/s$ and $180^\circ/s$) for five repetitions (Carregaro et al., 2011). The order of the testing speed was randomly assigned using an online program (<http://www.random.org>).

Participants' dominant knee, defined by the leg preferred to kick a ball (Ghena et al., 1991), were tested in a seated position at 100°

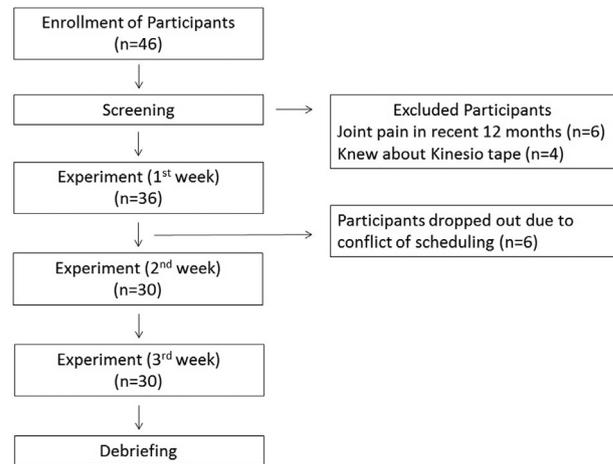


Fig. 1. Flow diagram of the study and dropout of participants.

hip flexion. The pad of the lower leg attachment was positioned 5 cm above the lateral malleolus. The trunk was stabilized with a torso seat belt and the thigh with a Velcro strap. The range of motion was set at maximal concentric knee extension to 100° knee flexion (Wong et al., 2012).

Participants were blindfolded once they were seated on the apparatus. They were informed that we were testing different adhesive sensors to examine muscle activity and they may or may not feel the sensor application. Under the pretense of applying a series of adhesive sensors, participants underwent one of three conditions pre-assigned in a randomized order: the true KinTape condition, the sham KinTape condition, and the tapeless condition. In true KinTape condition, KT was applied onto the skin overlying the rectus femoris and vastus medialis muscle of the dominant leg from origin to insertion with 35% of its maximal length tension, which has been proposed to provide muscle facilitatory effect (Fig. 2) (Kase et al., 2003). The tension of KinTape was confirmed by the anthropometric measurement of the tape i.e. measuring the change in length of tape before and after being stretched. In sham KinTape condition, the procedure was identical with true KinTape condition except that there was no additional tension put onto the tape. In tapeless condition, no tape was applied but we still touched on participants' thigh to mimic the tape application.

The participants were allowed to have 90-s rest periods between each set (Blazquez et al., 2013). Five trials of sub-maximal effort were performed before each set of measurement to ensure familiarity of the evaluation. Standardized and consistent verbal encouragement was provided for all participants.

Peak torque (NPT) was functionally defined as the mean of maximum force output in the five repetitions and total work (NTW) was the amount of energy generated by the muscle for the entire set of testing. Time to peak torque (TPT) was defined as the mean time from the onset of movement to the point of the peak torque in all trials. NPT and NTW were normalized with participants' body mass. These three parameters were used to determine the muscle performance. All of the participants were explained with the true purpose of the experiment during debriefing after the end of the third isokinetic knee testing session.

2.3. Statistical analysis

One-way repeated measures ANOVA was used to test the effects of KinTape on the muscle performance at the selected angular speeds. Least Significant Difference test was used for pair-wise



Fig. 2. Application of Kinesiology tape onto the rectus femoris and vastus medialis muscle.

comparison, if applicable. The global alpha level was set at 0.05. All data were analyzed using SPSS version 17 (SPSS Software, Chicago, IL, USA).

3. Results

All the participants were confirmed to be ignorant about KinTape at the debriefing after the experiment. None of them used KinTape prior to the study and they had never heard of the application of KinTape in any circumstances. NPT, NTW, and TPT in different conditions were shown in Table 1. There was no significant difference in NPT between all three taping conditions at 60° ($F(2,87) = 0.05$, $p = 0.96$) and 180°/s ($F(2,87) = 0.41$, $p = 0.66$). Similar results were found in NTW ($F(2,87) = 0.27$, $p = 0.76$; $F(2,87) = 0.53$, $p = 0.59$) and TPT ($F(2,87) = 0.03$, $p = 0.98$;

Table 1

Mean normalized peak torque, normalized total work, and time to peak torque of knee extension with true kinesiology tape, sham kinesiology tape, and no tape onto the skin overlying rectus femoris and vastus medialis.

Measures	Speed (degree/sec)	Experimental ^a	Sham ^a	Tapeless ^a
NPT (Nm/kg)	60	1.75 (0.63)	1.79 (0.64)	1.80 (0.58)
	180	1.15 (0.48)	1.22 (0.52)	1.27 (0.45)
NTW (J/kg)	60	10.69 (3.64)	11.29 (3.82)	11.30 (3.51)
	180	7.90 (3.24)	8.43 (3.37)	8.74 (2.97)
TPT (sec)	60	0.79 (0.23)	0.78 (0.16)	0.79 (0.15)
	180	0.40 (0.09)	0.40 (0.08)	0.41 (0.07)

NPT = Normalized peak torque; NTW = Normalized total work; TPT = Time to peak torque.

^a Standard deviation value indicated in bracket.

$F(2,87) = 0.32$, $p = 0.73$) at slow and fast contraction speed respectively.

4. Discussions

The present study, at our best knowledge, is the first study which examines the true effects of KinTape by successful elimination of placebo effects. Our findings were in accord with our hypotheses that KinTape did not significantly improve NPT, NTW, or TPT in healthy young adults who were deceived and ignorant about KinTape.

Since we excluded any participants who were able to name KinTape or equivalents, people who were physically active and athletes were likely to be screened. We originally expected lower NPT and NTW would be found in our cohort compared with previous studies which recruited sportsmen (Fu et al., 2008; Kim and Lee, 2013). However, our findings were very comparable to the previous findings. Instead, we noticed greater standard deviations in our outcomes, which may be due to the fact that our sample comprised a wider scope of participants. Fortunately, we adopted a within-subject comparisons design which would not affect large variations between subjects.

Without any regard of the psychological factors, KinTape in previous studies were shown to be effective in increasing muscle activity (Thelen et al., 2008; Briem et al., 2011; Wong et al., 2012), inducing an earlier occurrence of muscle peak torque (Wong et al., 2012; Fratocchi et al., 2013), and enhancing functional performance (Jaraczewska and Long, 2006; Yasukawa et al., 2006; Chang et al., 2010). With the present findings, we believed these previously reported effects could be attributed to placebo effect. Placebo effect is a psychological phenomenon which attributes to alter the condition and performance because the expectations of the individual changes their beliefs and behavior leading to a more positive or negative outcome (Beedie, 2007; Beedie and Foad, 2009). Previous research has suggested that placebo may provide analgesic effects via opioid or non-opioid mechanisms acting on different parts of the body, such as respiratory centers and adrenal glands, leading to reduction of pain (Qiu et al., 2009). Beneficial results were also found in patients with Parkinson disease while they were told to receive an anti-parkinsonism drug which would improve their motor function and results showed that expectations of the patients led to neural changes rapidly (Benedetti et al., 2005). Similar results have been reported among athletes, using placebo effects to enhance sports performance. A survey suggested that a majority of the athletes believed that placebo effects could influence sports and admitted to having experienced placebo effects themselves (Beedie, 2007; Beedie and Foad, 2009). Although there is limited knowledge about placebo mechanisms, results suggest that there is a strong relationship between belief and performance which could affect the accuracy of experimental research (Beedie, 2007).

In order to understand whether the non-significant results were due to a lack of statistical power, a post-hoc power analysis was conducted using a statistical package (G-Power version 3.1.9, Autenzell, Germany). With alpha level at 0.05 and the present data, the power was 0.95, which indicated 95% chance of finding significant results in the sample if they exist in the population. The sample size required to detect a statistical significant differences in the selected variable ranged from 17,670 to 5,639,076.

There were several limitations of the study. Firstly, only young healthy adults were recruited in this study. It may limit the generalization of our findings to other populations. In addition, because of the deception design, elite athletes were likely to be screened out. Secondly, there was controversy about the amount of facilitatory tape tension; while one suggested that KinTape applied from origin to insertion with 35% tension improved muscle

strength, another stated that 50–75% may serve the same purpose (Kinesio Taping Association International, 2011a, 2011b). Future study should examine the effect of KinTape tension on the muscle facilitation. Thirdly, testing over three different days may introduce measurement error, as we did not strictly control the daily activity between testing sessions. Fourthly, this experiment only investigated the relationship between KinTape and muscle performance. The clinical efficacy of other applications, such as pain control by KinTape, remains unknown. Finally, the current study only investigated the immediate effects of KinTape while other studies showed that there may be observable KinTape effects one to two days later after application (Stupik et al., 2007; Thelen et al., 2008). KinTape application has become very popular with professional and amateur athletes. Future clinical study should examine the efficacy of KinTape in other applications by eliminating the placebo effects and deception may be a preferred design of research study. A test directed to see the placebo effects of the tape is warranted. Introducing electromyography would further aid in understanding the potential effects of KinTape on muscle activity.

5. Conclusions

The present study demonstrated that the KinTape application did not generate higher peak torque, yield greater total work, or shorten time to peak torque in healthy young adults. Positive results in the previous studies of KinTape may be attributed to the placebo effects.

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