EFFECT OF TWO KINESIO TAPE TECHNIQUES ON KNEE KINEMATICS DURING A DROP JUMP TEST

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This study investigated the effects of Kinesio® Tape on knee kinematics during a drop jump (DJ) test in 20 young women that had or were currently participating in competitive basketball or volleyball. Three taping conditions were randomly applied to the dominant leg of each participant: no tape (NT), gluteus medius (GM) facilitation, and spiral technique (ST). Multiple 3 x 2 RMANOVAs assessed the differences in peak knee flexion and abduction, and time to peak (TTP) angles, between taping conditions. No significant differences were found for peak knee angles or TTP, suggesting that GM and ST Kinesio® Tape applications did not alter measured knee kinematics during a DJ test. Any mitigation strategy should not depend on Kinesio® Tape alone and take a comprehensive approach that includes strength and neuromuscular training.

KEYWORDS: knee abduction, hip abductor, motion analysis, ACL injury.

INTRODUCTION: Dynamic knee valgus is a complex multiplanar movement that presents as a medial knee collapse during sport related movements (Ford et al., 2015; Rajasekar et al., 2018). This position can cause excess strain on the knee and result in injury to the anterior cruciate ligament (ACL) (Gerber et al., 2019). Additionally, female athletes are at a greater risk for ACL injury than males, with most injuries noncontact in nature (Gerber et al., 2019). The gluteus medius (GM) is the prime hip abductor and plays a critical role in stabilizing the hip and knee and preventing dynamic knee valgus (Rajasekar et al., 2018). Inadequate neuromuscular control and weakness of GM could contribute to knee instability and excessive dynamic knee valgus (Gerber et al., 2019; Rajasekar et al., 2018).

Double leg landings are frequent causes of ACL injuries, and therefore commonly used to evaluate neuromuscular control and knee valgus (Ishida et al., 2018). The drop jump (DJ) is such a test used to mimic a sport related deceleration (Ciccodicola et al., 2021; Rajasekar et al., 2018). The initial landing phase of the DJ test is well researched because rapid onset of knee valgus during the early moments following initial ground contact contributes to ACL injuries (Ciccodicola et al., 2021; Koga et al., 2010). Despite the complexity of dynamic knee valgus, frontal plane knee motion is a predictor of future ACL injury risk, and ACL re-injury following rehabilitation and return to sport (Ford et al., 2015).

Kinesio® Tape is an elastic, cotton tape with an acrylic adhesive backing that can stretch up to 140% of its original length, and after application can stimulate mechanoreceptors, and by reflex increase muscle tone and proprioception (Csapo & Alegre, 2015; Mostert-Wentzel et al., 2012). While some interventions have tried to reduce dynamic knee valgus with hip-focused strength programs and orthotics (Ford et al., 2015; Nguyen & Shultz, 2009), Kinesio® Tape is another method used in recent literature (Rajasekar et al., 2018; Tsai et al., 2020). Taping on the GM muscle has shown to reduce dynamic knee valgus in male and female collegiate athletes during a DJ test (Rajasekar et al., 2018). However, the study measured valgus with two-dimensional (2D) video analysis which may not be as accurate as three-dimensional (3D) motion analysis. Additionally, a spiral technique (ST) has been utilized to limit hip internal rotation and adduction during dynamic lower body movements (Tsai et al., 2020). Facilitating the action of the hip abductors with Kinesio® Tape may limit femoral internal rotation and help prevent dynamic knee valgus. Therefore, the purpose of this study was to compare the acute effects of two Kinesio tape applications on 3D knee kinematics in the DJ test.

METHODS: This study included 20 women (age = 21.2 ± 2.5, height = 1.8 ± 0.2 m, body mass = 66.8 ± 6.1 kg) between the ages of 18 and 40, that had or were currently participating in competitive basketball or volleyball. Exclusion criteria was any pain with jumping or landing,

lower body surgery within the last 12 months, or any contraindications to Kinesio® Tape. Participants all signed an informed consent, and this study was approved by the university Institutional Review Board.

The participants reported to the lab for one visit. After a five-minute general warm-up on a cycle ergometer, participants were allowed three practice trials of the DJ test. Participants stepped off a 30 cm box and performed a bilateral landing followed by a countermovement vertical jump with arm swing and a subsequent landing. The first landing of the DJ test was analyzed for this study. Three taping conditions included no tape (NT) as a control, GM, and ST, applied to the dominant leg in a randomized order. The facilitative GM snowflake technique was applied from origin to insertion of the muscle on participants positioned side-lying, knee and hip flexed to 90 degrees. A strip of Kinesio® Performance Plus Tape was anchored at the gluteal surface of the ilium with no tension, applied towards the greater trochanter with 10-20% tension and was adhered again with no tension. Before activating the adhesive, pre-cut lengthwise slits were spread out with minimal tension. The ST taping condition was applied with Kinesio® Classic Tape on participants standing with feet approximately hip width apart. A strip of tape was measured and applied with no tension on the medial aspect of the distal tibia. The tape was pulled with 75-100% tension and applied towards the lateral aspect of the knee. Then, with no tension, the tape was adhered to the posterior aspect of the knee, from lateral to medial. Next, 75-100% tension was applied from the medial femoral condyle and secured to the lateral thigh with no tension. Tape conditions were applied by the same Certified Kinesio® Tape Practitioner.

Following the tape application, participants rested for 10 minutes during which 40 reflective markers were placed on the lower body. This included five clusters of four markers place on the sacrum, thighs, and shanks, and 20 individual markers placed on lower body landmarks. Three DJ trials were performed for each tape condition, and one minute of rest allowed between trials. An eight-camera motion analysis system (Vicon Motion Systems Ltd., Oxford, England) recorded marker positions at 200 Hz. The local coordinate system for the lower body segments was made in accordance with the International Society of Biomechanics (Wu et al., 2002). A lower body model measured lower body kinematics during the initial landing phase of the DJ test with Vicon Nexus 2.12 and Vicon ProCalc 1.5. Static and functional trials were recorded for normalization and to calculate hip joint centers, respectively (Taylor et al., 2010). Knee joint centers were defined as the midpoint between epicondyles. Euler angles were calculated (y, x, z) with the distal segment in reference to the proximal. Positive knee angles reflect flexion and adduction, while negative values reflect extension and abduction. Initial contact (IC) was defined as zero vertical velocity of both feet. Landing phase was defined as IC to peak knee flexion for both legs, and peak knee abduction determined during the landing phase. Time to peak (TTP) knee flexion and knee abduction were also calculated, and the three trials for each condition were averaged for statistical analysis.

Data normality was assessed with QQ plots and histograms. Multiple 3 x 2 repeated measures ANOVAs assessed the differences in peak knee flexion, TTP knee flexion, peak knee abduction, and TTP knee abduction between dominant and non-dominant legs and between taping conditions. Significance of pairwise comparisons were based on the Bonferroni adjustment for multiple comparisons. Statistical analysis was performed with SPSS (ver. 28, IBM Corp., Armonk, NY) and alpha level for significance set at 0.05.

RESULTS: Results (mean ± SD (95% CI)) from the repeated measures ANOVAs are listed in Table 1. None of the ANOVAs showed significance for peak knee angles or TTP variables.

Table 1: Peak knee angles and time to peak (mean ± SD (95% CI)) during the DJ test.

		Dominant	Non-Dominant
NT	Knee Flexion (°)	98.13 ± 11.55 (92.72, 103.54)	97.19 ± 11.56 (91.79, 102.60)
	TTP Knee Flexion (s)	0.26 ± 0.08 (0.23, 0.30)	0.26 ± 0.07 (0.23, 0.30)
	Knee Abduction (°)	-3.57 ± 5.96 (-6.36, -0.78)	-3.97 ± 7.73 (-7.59, -0.35)
	TTP Knee Abduction (s)	0.10 ± 0.07 (0.06, 0.13)	0.10 ± 0.06 (0.07, 0.13)
GM	Knee Flexion (°)	97.18 ± 9.55 (92.71, 101.65)	96.42 ± 9.68 (91.89, 100.95)
	TTP Knee Flexion (s)	0.26 ± 0.07 (0.23, 0.29)	0.26 ± 0.06 (0.23, 0.29)

	Knee Abduction (°)	-2.52 ± 5.45 (-5.06, 0.03)	-4.05 ± 7.28 (-7.46, -0.64)
	TTP Knee Abduction (s)	0.08 ± 0.06 (0.05, 0.11)	0.10 ± 0.05 (0.08, 0.13)
ST	Knee Flexion (°)	98.83 ± 9.70 (94.29, 103.37)	96.24 ± 11.52 (90.84, 101.63)
	TTP Knee Flexion (s)	0.26 ± 0.07 (0.23, 0.30)	0.26 ± 0.07 (0.23, 0.30)
	Knee Abduction (°)	-1.96 ± 6.65 (-5.08, 1.15)	-3.45 ± 7.78 (-7.09, 0.19)
	TTP Knee Abduction (s)	0.09 ± 0.06 (0.06, 0.12)	0.12 ± 0.05 (0.09, 0.14)

NT = no tape; GM = gluteus medius; ST = spiral tape; TTP = time to peak

DISCUSSION: This aim of this study was to assess whether different Kinesio® Tape applications could affect frontal and sagittal plan knee kinematics in a DJ test. The tape conditions were applied to the dominant leg and comparisons made between legs, and between the GM facilitation, ST condition, and NT condition serving as the control. No significant differences between condition or leg were observed. These findings suggest the application of Kinesio® Tape does not significantly alter peak angle or TTP for knee flexion and abduction during a DJ test.

Decreased knee flexion and reduced ability to absorb shock during dynamic lower body tasks is associated with increased risk of ACL injury (Ciccodicola et al., 2021). The present study showed peak knee flexion did not significantly change between conditions or legs. Knee flexion findings from this study (96.24 – 98.83°) are similar to prior research that reported no significant difference between of knee flexion between a taped and placebo condition (90.93 – 96.22°) (Limroongreungrat & Boonkerd, 2019). Female noncontact ACL injuries observed on video have commonalities of high knee abduction, lateral trunk motion, and low knee flexion (Hewett & Myer, 2011). The participants in this study had no history of dynamic knee valgus, and thus may exhibit a landing strategy with increased knee flexion and less valgus loading of the knee. Rajasekar and colleagues conducted a randomized control trial to investigate whether GM Kinesio taping affected dynamic knee valgus in 28 male and 12 female collegiate level athletes. They used 2D recordings to assess valgus during a DJ test and reported a significant reduction in dynamic knee valgus in both males and females with the GM facilitation (Rajasekar et al., 2018). This contradicts the results from the present study, as we did not find a significant difference in frontal and sagittal plane kinematics between conditions. The results from 2D analysis represent knee the multiplanar movements of the hip, knee, and ankle as knee valgus. This contrasts with 3D motion analysis, where each movement plane from a joint is isolated and reported separately. This may explain some of the differences between studies; as the 2D analysis reported 10.7 degrees of dynamic knee valgus (post application for women), and our study showed 2.5 degrees of knee abduction in the taped leg (Rajasekar et al., 2018). Lastly, differences may be because the collegiate athletes all had a history of dynamic knee valgus, and the participants from this study did not. Successful intervention has also been reported using the ST taping condition in effecting 3D lower body kinematics in collegiate basketball players. It should be noted that between the tape and no tape conditions, only hip adduction and internal rotation was significantly different. Knee abduction and flexion were in agreement with the present study, and not significantly different (Tsai et al., 2020).

While the present study showed no significant differences between TTP variables, the TTP knee abduction was 100ms (0.10 s) on average, which somewhat aligns with prior literature. Gokeler et al. reported TTP knee valgus angles (0.14 – 0.32 s) in a single leg hop, with the shortest time in the previously injured (ACL reconstruction) limb (Gokeler et al., 2015). Other studies have shown that ACL injuries can occur just 40 to 50 ms following IC (Kiapour et al., 2014; Koga et al., 2010). While TTP knee abduction is not the same as time to peak strain on the ACL itself, the two have shown to occur about the same time (Kiapour et al., 2014).

There are some limitations of this study worth noting. This study was conducted with healthy young women with no history of dynamic knee valgus. Examining the distribution of the data showed that some of the participants landed with valgus, and some were neutral or even in a varus (knee adduction) position. Future research could aim for a larger sample size to increase statistical power and compare the effects of Kinesio® Tape on the valgus landers and non valgus landers. Lastly, this study only included some 3D knee kinematics, and combining hip and knee kinematics might be better for analysis.

CONCLUSION: Neither the GM or ST taping conditions had a significant effect on the frontal and sagittal plane kinematics in the DJ landing phase. While Kinesio® Tape use remains a popular option, there is limited evidence on whether it can positively affect dynamic knee valgus. Any mitigation strategy should not depend on Kinesio® Tape alone and take a comprehensive approach that includes strength and neuromuscular training.

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