The Effect of Kinesio Tape® on Lower Extremity Functional Movement Screen™ Scores

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ABSTRACT

International Journal of Exercise Science 5(3) : 196-204, 2012. The purpose was to determine if application of Kinesio Tape (KT®) improves lower extremity scores on the Functional Movement Screen (FMS™). Individual FMS™ score assessments of 32 college students were obtained. The subjects were then randomized into treatment and control groups. The treatment group had a second FMS™ score after application of KT® to the lower extremity while the control group had a second FMS™ score with no intervention. 16 varsity women's basketball players and 16 non-varsity female students (Tegner Scale: 6.84 ±1.25, Age: 19±1.2, Height: 165.1±15.1cm, Weight: 68.1±10.9kg) at a NCAA Division II institution participated. FMS™ scores were collected and recorded by the principal investigator. Data was analyzed through two way analysis of variance (ANOVA). Post hoc analysis indicated the treatment group significantly improved in comparison to the control group (Left: $P<.001$, 95% CI: .283 - .467; Right $P<.001$, 95% CI: .327 - .523) for both sides of the Hurdle Step. There were no interactions with Deep Squat ($P=0.667$) or either side of In-Line Lunge (Left: $P=0.291$, and Right: $P=0.530$). There were no interactions with either group in Deep Squat and In-Line Lunge of FMS™. However, there was a significant interaction with both groups in the Hurdle Step of FMS™. Findings from this research suggest that KT® may improve movement that incorporates a non-weight-bearing segment.

KEY WORDS: Performance screening, injury prevention, injury risk, sport performance

INTRODUCTION

Kinesio Tape (KT®) is a well-known taping technique for pain control and muscle facilitation (16). During the 2008 Beijing Olympic Games, many athletes used KT® during competition. Despite the growing widespread use, minimal research has been published on how KT® relates to performance enhancement (17). However, some articles are available concerning the effectiveness of KT® in pain control (16), fast recovery of muscle hematoma (1), and muscle facilitation (2).

The Functional Movement Screen (FMS™) is a valid and reliable method to assess symmetry of motion and risk of injury (11, 14). The FMS™ comprises a battery of seven movements that demand both stability and mobility. The basic motions are designed to allow measurement of the symmetry of motion. These tests utilize end ranges of motion to identify weakness and imbalance in the subject (3, 4). Additional research has addressed the reliability concerns of the FMS scoring and has found the screen to be good to excellent: kappa 0.6 or above (6, 11, 14).

We chose to focus on the lower extremity for this initial project. We concentrated on the three movements of the FMS™ most involved with the lower extremity (Hurdle Step, In-Line Lunge and Deep Squat) to minimize confounding variables in this preliminary design. Minick et al., Onate et al. and Schneiders et al. each showed acceptable reliability in the individual items of the FMS™ (11, 13, 14). Minick et al. compared experts and novices, finding that each group had acceptable reliability (kappa 0.53-0.8) with the individual tests of the FMS™. Schneiders et al. (14) compared two experts (kappa 0.86-1.00) and Onate et al. (13) compared an expert to a novice evaluator (0.16-0.69). We also designed a modification to the scoring system for improved description of the movement restrictions identified by the FMS™. A similar modification has been utilized with the correlation between the traditional and modified scoring system being 0.85 for the pre-test and 0.86 for post-test evaluations (7).

Many high level athletes have difficulty performing these simple movements (5, 9, 10). Compensatory patterns are substituted during physical activity, allowing inefficient recruitment patterns to develop. If substitutions persist, poor muscle recruitment patterns are reinforced. The resulting abnormal biomechanics increase injury risk (3, 4). Kiesel et al. reported that professional American football players with a lower composite score (<14) on the FMS™ had a greater chance of suffering a serious injury over the course of one season (10).

An interaction between the KT® and FMS™ score has not been previously reported. The purpose of this project is to determine if application of Kinesio Tape (KT®) improves lower extremity scores on the Functional Movement Screen (FMS™).

METHODS

Participants

Approval for this project was obtained through the Institutional Review Board. FMS™ scores were collected and recorded by the principal investigator (HMA), who has been formally trained in both FMS™ and KT®. KT® was applied by the second investigator (CM) trained by the principal investigator. 16 NCAA Division II varsity women's basketball players and 16 non-varsity female college student volunteers from athletic training and human movement science classes participated in this study. Age (19±1.2 yrs), height (165.1±15.1 cm), weight (68.1±10.9 kg) and activity level data (6.84 ±1.25 Tegner Scale) were obtained for each subject.

Protocol

All participants were tested in the three main movements of the FMS™ (Deep Squat, Hurdle Step-both sides, In-Line Lunge-both sides) that evaluate motion of the lower extremity. See figure 1.

The principal investigator modified the scoring system in an attempt to elicit more descriptive scores for the subjects. The traditional FMS™ uses a 0-3 scale. See table

1. In the Deep Squat, participants unable to complete the motion appropriately have a board placed under the heels and the motion is repeated for a scoring assessment. We followed normal testing protocols but added some scoring options to better delineate observed motion restrictions.

Figure 1. Left: Deep Squat, Middle: Hurdle Step, Right: In-Line Lunge.

Table 1. Functional Movement Screen™ Scoring

0	Pain with movement
1	Unable to complete movement
2	Completes movement with compensation
3	Completes movement properly

The modified FMS™ score added 0.2 for each of the checklist criteria that were properly accomplished during the assessed motions in an effort to further delineate the restrictions present. Identification of specific restrictions has import for subsequent rehabilitation and performance enhancement measures. These extra points were added to any scores designated as 1 or 2. See table 2. A similar modification has been utilized with the correlation between the traditional and modified scoring system being 0.85 for the pre-test and 0.86 for the post-test evaluations (7).

The principal investigator randomly assigned the participants into two groups: treatment (n= 16, Tegner Scale: 6.9 ± 1.18; Ht: 174.53 ± 8.65 cm; Wt: 72.08 ± 8.55 kg) and control group (n=16, Tegner Scale: 6.75 ± 1.34; Ht: 166.79 ± 6.58 cm; Wt: 65.05 ± 11.8 kg). All 32 subjects were re-assessed by the primary investigator (HMA) with the second FMS™ 2-4 days later.

Table 2. Functional Movement Screening Test Description.

Test	Criteria	Left	Right	Final
Deep Squat	Heels stay down			
	Feet do not slide or rotate			
	Hips are below knees			
	Knees are aligned over feet			
	Upper extremities stay straight			
In-line Lunge	Minimal to no upper body movement			
	Feet remain on the tape			
	Back knee touches tape			
	Dowel touches head, thoracic spine, sacrum			
	Balance is maintained			
Hurdle Step	Dowel does not dip right or left			
	Hips do not dip right or left			
	Knees stay aligned over feet			
	Ankles stay under knees			
	Balance is maintained			

The treatment group had KT® applied (Sartorius, Rectus Femoris, Hamstrings, Patella, Tibialis Anterior, Peroneous Brevis) by the second investigator (CM) immediately before the second test on the FMS™. See figure 2. The 16 members of the treatment group were reassessed in the

FMS tests by the primary investigator (HMA) immediately after application of KT®. The three movements chosen for investigation are performed in the sagittal plane to encompass flexion, extension, and plantar flexion. The KT® applications were chosen as Sartorius to assist hip flexion; Rectus femoris for knee extension; Hamstrings for knee flexion; Tibialis anterior for dorsiflexion; and Fibularis brevis (Peroneus brevis) for plantar flexion.

Figure 2. Left: tape application, Middle: anterior view, Right: posterior view.

KT was applied to each participant in the treatment group for the sartorius, rectus femoris, hamstrings, tibialis anterior, fibularis brevis, and the patella bilaterally using strips of the standard 2 inch Kinesio Tex Tape. The first and last inch of each strip was applied without tension. The length of the strip was applied with a 20%-25% stretch and downward pressure to the insertion. Each of the sartorius, rectus femoris, hamstrings, tibialis anterior, and fibularis brevis tapings used an I-strip. A Y-strip was utilized for the patellar taping.

In taping the sartorius, the participant was positioned side lying with the knee in flexion, the hip in extension and medially rotated, and the contralateral leg slightly bent for stability. The upwardly facing arm was bent and anteriorly stabilizing the body while the participant's head rested on the opposite abducted arm. KT was applied from the ASIS to the medial edge of the patella. See figure 3.

Figure 3. Sartorius taping (blue strip).

Rectus femoris taping had the participant side lying with the knee in flexion, the hip in extension, and the contralateral leg slightly bent for stability. The upwardly facing arm was bent and anteriorly stabilizing the body while the participant's head was resting on the opposite abducted arm. Tape was applied from the AIIS to the superior edge of the patella. See figure 4.

Figure 4. Rectus femoris taping (black strip).

Hamstring taping included an I-strip for the semimembranosus and semitendinosus, and a separate I-strip for the biceps femoris. Semimembranosus/semitendinosus taping involved the subject positioned side lying with the knee in extension, the hip in flexion, the hip laterally rotated, the contralateral leg slightly bent for stability, and the same arm positioning as previously stated. Tape was applied from the ischial tuberosity to the posterior surface of the medial tibial condyle. See figure 5.

Figure 5. Semimembranosus/semitendinosus taping (blue strip).

For biceps femoris taping, the subject was positioned side lying with the knee in extension, the hip in flexion, the hip medially rotated, and the contralateral leg slightly bent for stability. The upwardly facing arm was bent and anteriorly stabilizing the body while the participant's head was resting on the opposite abducted arm. KT was applied from the ischial tuberosity to the posterior region of the fibular head. See figure 6.

Figure 6. Biceps femoris taping (black strip).

The patellar KT application utilized two Y-strips cut about 2/3 of the length of the strip down the middle to create 2 tails. The participant was supine with the knee in flexion. The uncut portion of the Y-strip was applied above the superior portion of the patella. One tail was winged medially with the other winged laterally around the patella to the surface of the medial and lateral femoral condyles, respectively. The uncut portion of the other Y-strip was applied to the tibial tuberosity. One tail was winged medially with the other winged laterally around the patella to the surface of the medial and lateral femoral condyles, respectively. See figure 7.

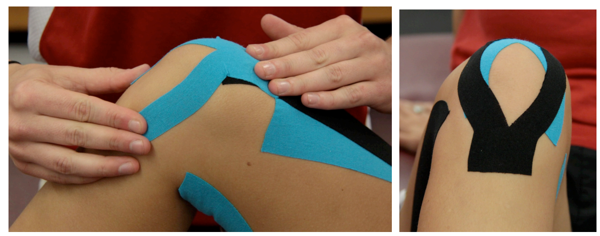

Figure 7. Left: Patellar taping (first Y strip in blue), Right: Patellar taping (second Y strip in black).

Taping for the tibialis anterior had the subject sitting with the ankle in plantar flexion and the foot in eversion. KT was applied from the proximal lateral portion of the tibia to the first metatarsal and medial cuneiform. See figure 8.

Figure 8. Anterior tibilalis taping (blue strip).

Taping of the fibularis brevis had the participant positioned sitting with the ankle in dorsiflexion and the foot in inversion. Tape was applied from the proximal fibular head to the base of the fifth metatarsal. See figure 9.

Figure 9. Fibularis brevis taping (black strip).

Statistical Analysis
Two way analysis of variance (ANOVA) was performed to study the application of KT® (tape vs. no tape) to FMS™ scores (dependent variable) utilizing SPSS (v. 18; SPSS, Inc. Chicago, IL, USA). The alpha level for significance was set at $P \leq 0.05$.

RESULTS

Table 3 shows the average FMS™ scores of the treatment and control groups. There were no differences in the Deep Squat (P=0.667) or either side of the In-Line Lunge (Left: P= 0.291 and Right: P=0.530) with a two-way ANOVA. However, there were significant interactions with both sides of the Hurdle Step (Left: $F(1, 30) = 28.26$, $P<0.001$, r = 1.34; Right: $F(1, 30) = 34.91$, $P<0.001$, r = 1.48). A post hoc analysis suggests the treatment group significantly improved in comparison to the control (Left: $P<.001$, 95% CI: .283 - .467; Right: $P<.001$, 95% CI: .327 - .523) with both sides of Hurdle Step.

DISCUSSION

This project begins an investigation of the relationship between KT® and FMS™. We hypothesized the application of KT® would improve lower extremity FMS™ scores. There was an increase in performance on both sides for the treatment group when performing the Hurdle Step. This raises a question as to whether the prophylactic application of KT® to areas with less desirable FMS™ scores (< 14) may decrease injury rates while a corrective exercise program is instituted.

The undersurface of the Kinesio Tape is designed with digitations or ridges to face and adhere to the skin of the subject. The elemental theory purports that tissue is lifted more by the adhesive ridges, creating spaces below the tape. This lift opens the lymphatic system to increase fluid flow while decompressing pain receptors in the

Table 3. FMS scores of trial 1 and trial 2 for the control and treatment groups.

FMS Screening	Control		Treatment	
	Trial 1 (FMS ± SD)	Trial 2	Trial 1	Trial 2
Deep Squat	2.05 ± .52	2.04 ± .51	2.06 ± .43	2.08 ± .39
In-Lunge Right	2.55 ± .17	2.66 ± .19	2.59 ± .24	2.73 ± .16
In-Lunge Left	2.63 ± .19	2.68 ± .18	2.64 ± .19	2.74 ± .17
Hurdle Step Right	2.36 ± .28	2.39 ± .26	2.18 ± .32	2.60 ± .24
Hurdle Step Left	2.34 ± .27	2.38 ± .28	2.19 ± .33	2.56 ± .26

area (8). The lifting and recoil of the tape is also thought to influence the underlying muscle. How this occurs is not currently clear but a neural influence is presumed to accompany a release on the intertwining connective tissue of the muscle (12). The goal of Kinesio Tape is to change the underlying tissue for long term effect.

The FMS™ measures seven basic movements that reflect appropriate function of the kinetic chain with a balance of stability and mobility. The kinetic chain is a combination of successively arranged joints that constitute a complex motor unit. The chain is generally considered as a proximal to distal sequencing of movement. An open kinetic chain movement traditionally has a freely moving terminal joint (e.g., a hand waving or throwing) while a closed kinetic chain movement has a terminal joint that is fixed (e.g., a foot during the squat).

Asymmetry and limitation of motion on the FMS™ has been associated with an increased injury risk (10). Inability to perform these functional movements properly results in compensated inefficient movements. These compensations heighten injury risk, even when performed at high skill levels.

Three FMS™ tests were deemed appropriate for this study since the three involved the lower extremity and had large ranges of motion to allow consistent identification and scoring of limitations or compensations. Two of these motions (Deep Squat and In-Line Lunge) have both feet fixed and weight-bearing while the third (Hurdle Step) involves one fixed weight-bearing extremity with the other non-weight-bearing and freely moving.

Minick et al., Onate et al. and Schneiders et al. each showed acceptable reliability in the individual items of the FMS™ (11, 13, 14). Minick et al. compared experts and novices, finding that each group had acceptable reliability with the individual tests of the FMS™. Onate et al. compared an expert to a novice evaluator (13) while Schneiders et al. compared two experts (14). See table 4. We utilized a modification of the FMS™ in an attempt to better describe the observed motion restrictions identified during scoring. A similar modification has been used with the correlation between the traditional and modified scoring system being 0.85 for the pre-test and 0.86 for the post-test evaluations (7). A limitation of our project is the lack of formal reliability data comparing our modification with either the traditional or modified scoring system.

Table 4. Reliability of designated FMS tests (κ).

FMS test	Minick et al. (11)		Onate et al. (13)	Schneiders et al. (14)
	Novice	Expert		
Deep Squat	0.80	0.64	0.69	1.00
Hurdle Step	0.65	0.65	0.16	0.80
In-Line Lunge	0.74	0.53	0.69	0.86

Excellent, High 0.8-1.00; Substantial, good 0.6-0.79; Moderate 0.40-0.59; Fair 0.21-0.39; poor ≤ 0.20 (11, 13, 14)

We found the Hurdle Step, the only movement that involves a non-weight-bearing and freely moving component of the three tests chosen, had a significant interaction (*P*<.001) in ANOVA and Post Hoc test. The full weight-bearing motions (Deep Squat and In-Line Lunge) utilized body weight in a single repetition at end range of motion. The freely moving component of the Hurdle Step also involves a weight shift of the single stance limb during one repetition. We believe Kinesio Tape may alter motion sufficiently in the non-weight-bearing component of the movement to document a change during a single repetition. This may have been due to influences on the musculature or through proprioceptive effects of the Kinesio Tape. Our study design does not yet differentiate between effects on the mobilizing (open kinetic) extremity or the stabilizing (closed kinetic) leg. Kinesio Tape may well affect closed chain motion over multiple repetitions or at various loads, but our study design does not address that question.

This suggests the application of KT® may have the greatest benefit at those joints that have a non-weight-bearing component in sport the movements. Further research is needed to investigate the effects of KT® and its ability to positively affect the FMS™ scoring system. Clinical correlation will be necessary to document a change in injury rates due to the preventative application of KT®.

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(http://www.kinesiotaping.com/kta/research.html)

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