The Effect of Kinesio Tape on Factors for Neuromuscular Control of the Lower-Extremity: A Critically Appraised Topic

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Clinical Scenario: Joint instability is a common condition that often stems from inadequate muscle activation and results in precarious movement patterns. When clinicians attempt to mechanically treat the unstable joint rather than attending to the underlying cause of the instability, patient outcomes may suffer. The use of kinesiology tape (KT) on an unstable joint has been proposed to aid in improving lower-extremity neuromuscular control. **Clinical Question:** Does KT improve factors of neuromuscular control in an athletic population when compared with no-tape or nonelastic taping techniques? **Summary of Key Findings:** The current literature was searched, and 5 randomized controlled studies were selected comparing the effects of KT with no-tape or nonelastic taping techniques on lower-extremity neuromuscular control in an athletic population. Primary findings suggest KT is not more effective than no-tape or nonelastic tape conditions at improving lower-extremity neuromuscular control in a healthy population. **Clinical Bottom Line:** The current evidence suggests that KT is ineffective for improving neuromuscular control at the ankle compared with nonelastic tape or no-tape conditions. KT was also found to be ineffective at improving hip and knee kinematics in healthy runners and cyclists. However, preliminary research has demonstrated improved neuromuscular control in a population displaying excessive knee valgus during a drop jump landing, after the application of KT. Clinicians should be cautious of these conflicting results and apply the best available evidence to their evaluation of the patient's status. **Strength of Recommendation:** There is grade B evidence that the use of KT on an athletic population does not improve biomechanical measures of ankle stability. There is inconclusive, grade B evidence that KT improves neuromuscular control at the knee in symptomatic populations.

Keywords: kinesiology tape, nonelastic tape, motor control, movement patterns

Clinical Scenario

Interventions used in sports medicine are often focused on addressing a symptom rather than the cause of the deficit or pathology.¹ For example, the use of nonelastic athletic tape to reduce joint mobility and prevent injury is a typical symptom-focused intervention used in sport therapy. Instead of attempting to mechanically influence a perceived mechanical deficiency at the joint, it has been suggested that clinicians should identify why the joint is unstable, to determine if the cause is a local pathological condition or stems from regionally interdependent deficits.² During movement, dynamic joint stability is achieved through both passive ligament restraints and muscle forces acting on the joint.¹ Therefore, factors of neuromuscular control, such as muscle activation and strength, as well as the resulting kinetic and kinematic measures, should be considered when prescribing or assessing the effectiveness of an intervention.

A common cause of injury or increased joint mobility is insufficient neuromuscular control, which has been found to increase the risk of various lower-extremity injuries in an athletic population.¹ Multiple investigations have demonstrated that increased knee abduction (knee valgus) is correlated with a greater risk of anterior cruciate ligament injuries in female athletes.^{1,3} The mechanism behind this relationship is thought to arise from the inability of neuromuscular control to dissipate forces at the knee during high load movements.¹ Dynamic knee valgus (DKV) is a practical example of an at-risk movement pattern, thought to arise

from insufficient neuromuscular control of the hip girdle.³ Though there are many factors for noncontact anterior cruciate ligament injury, an intervention focused on improving precarious movement patterns through improved neuromuscular control may be the most effective method for decreasing the risk of injury.^{1,3}

Elastic tape applications, commonly referred to as kinesiology tape (KT), have become popular interventions among rehabilitation professionals in recent years. An increased prevalence may be attributed to KT brands claiming the tape can be used for neuromuscular reeducation.⁴ Given the increased popularity of KT in clinical settings, there is a need to determine if a KT application has a positive or negative effect on neuromuscular control. Exploring the use of KT applications compared with other nonelastic tape applications or no-tape applications is necessary to better understand whether KT applications improve neuromuscular control and have a place in clinical practice.

Focused Clinical Question

Does KT improve factors of neuromuscular control in an athletic population when compared with no-tape or nonelastic taping techniques?

Summary of Search, "Best Evidence" Appraised, and Key Findings

- The literature was searched to identify peer-reviewed articles that investigated the comparison of KT with no-tape or nonelastic tape conditions in athletes.

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- Of the 21 identified articles, 4 were randomized crossover studies and 1 article was a randomized controlled trial.
- Seven articles were excluded for using participants with current injuries or pain, 6 articles were published before 2010, 3 articles included glenohumeral motion, and 1 article included a secondary school population.
- An application of KT reduced knee valgus in males and females, and the improved movement patterns were maintained in the female group 3 days following application.²
- No significant differences in ankle joint proprioception were found between KT and no-tape conditions.^{2,5}
- Electromyography measures of rectus femoris to biceps femoris muscle ratio were demonstrated to significantly decrease in professional cyclists, following a KT application.

Clinical Bottom Line

There is minimal evidence to support the use of KT for improved lower-extremity motor control in a healthy athletic population when compared with no intervention. Current evidence is inconclusive across multiple populations and taping applications, rendering it difficult for clinicians to determine an appropriate use for KT. However, when a KT application was administered to a population with precarious movement patterns, short-term benefits were observed. Consideration for the use of KT in patient care must include diagnostic expertise, a patient's needs, and the clinical context. Clinicians should also be mindful of the potential for taping applications to alter biomechanical behavior away from the site of application, as demonstrated by 2 studies reviewed in this article. Further research is needed to determine the biomechanical effects of KT tape applications directed at improving the movement patterns of populations that are thought to be at risk for injury.

Strength of Recommendation

The strength of these recommendations is supported using the Strength of Recommendation Taxonomy.⁶ Grade A evidence indicates that the recommendation is based on consistent, good-quality evidence.⁶ Grade B evidence indicates that the recommendation is based on inconsistent or limited-quality evidence.⁶ Grade C evidence indicates that the recommendation is based on consensus, usual practice, or expert opinion.⁶ There is Grade B evidence that the use of KT is ineffective for improving lower-extremity neuromuscular control at the ankle. At the knee, there is grade B evidence to support the use of KT compared with no tape (NT) or Mulligan Concept taping (MCT). There is grade B evidence to support the use of MCT for reducing kinetic forces at the hip and knee. There is grade B evidence that traditional nonelastic ankle taping is more effective than KT and NT at improving neuromuscular control of the ankle.

Search Strategy

Terms Used to Guide Search Strategy

- **Patient/Client Group:** athletic population
- **Intervention/Assessment:** KT and kinesio tape
- **Comparison:** no tape and nonelastic tape
- **Outcomes:** lower-extremity neuromuscular control, electromyography, kinematics, and kinetics

Sources of Evidence Searched

- MEDLINE
- LILI
- ScienceDirect
- Additional references obtained via reference list review and hand search

Inclusion Criteria

- Adult, athletic population
- At least one outcome measuring factors of neuromuscular control
- Articles published after 2010
- Studies classified as level 2 evidence or higher on the Oxford Center for Evidence-Based Medicine (CEBM) Scale⁸

Exclusion Criteria

- Participants with orthopedic injuries
- Studies of upper-extremity neuromuscular control
- Studies examining the effect of KT on pain
- KT not included as a treatment condition
- Articles not published in English

Results of Search

For this study, 21 articles were identified, with 5 articles meeting the inclusion criteria (Table 1). The level of evidence was assessed using the Template for Intervention Description and Replication (TIDieR) checklist and the Oxford CEBM.⁸ In addition, each article was scored using the PEDro scale to assess the validity of the studies following standard scoring procedures.

Best Evidence

As described in Table 2, the studies selected for inclusion in this critically appraised topic were identified as the best evidence. The authors of these level 1 and level 2 studies considered the use of KT for targeting joint kinematics, kinetics, muscle activation, and center of pressure (COP) in comparison with nonelastic tape or no-tape conditions.

Implications for Practice, Education, and Future Research

Traditionally, sports therapists have utilized a nonelastic tape intended to mechanically restrict excessive range of motion (eg, sudden ankle perturbation) through braces and nonelastic tape applications.² However, investigators have begun to examine the hypothesized effects of elastic tape on the stimulation of mechanoreceptors through skin stretch to facilitate proprioception; thus, improving neuromuscular control and ultimately, an athlete's movement patterns.² To examine KT as a potential intervention for athletes at risk for ankle trauma, investigators analyzed the COP of professional soccer players when comparing a KT application with a no-tape condition.⁴ Though there is no gold standard for measuring ankle proprioception, the investigators utilized a moving target program from the balance module of a Kin-Com[®] 125AP isokinetic dynamometer (East Ridge, TN). The participants controlled their

Table 1 Levels of Evidence Selected Using the Oxford CEBM Guidelines⁷

Level of evidence	Study design/methodology of article retrieved	Number located	Study
Level 1b	Double-blinded, randomized controlled study	1	Rajasekar et al ³
Level 1b	Single-blind randomized crossover study	3	Bailey and Firth ⁴ Howe et al ⁹ Briem et al ²
Level 2b	Randomized crossover study	1	Hebert-Losier et al ⁵

COP to track an on-screen visual stimulus to simulate the ankle instability that might occur in a soccer match.⁴ Researchers observed that an application of KT had no significant effect on the COP of professional soccer players.⁴ Although no positive effect was observed following the application of KT, consideration should be given to the population in question, as this finding may not translate to amateur athletes or the general population.

Although the previous study examined the potential of KT to increase ankle stability through improved proprioception, KT has also been proposed to improve muscle activation.² Therefore, investigators examined whether KT was effective as a preventative measure for ankle trauma by using surface electromyography to assess the effectiveness of KT at facilitating the muscle activation of fibularis longus.² The participants stabilized on a balance board with the tested limb as the board was subjected to perturbation from a 10-kg weight.² Muscle activity was assessed at 3 time points for mean, peak, and time to peak electromyography data.² When compared with a nonelastic tape and no-tape condition, KT was not found to be effective for improving fibularis muscle activation (thought to be impaired in those with functional ankle instability) during sudden ankle perturbation.² Furthermore, Briem et al² demonstrated a greater increase in fibularis longus activation from the nonelastic tape group, suggesting that a tape that creates more pull on the skin (ie, nonelastic tape) may better increase mechanoreceptor stimulation.² However, clinicians should be cautious of laboratory experiments utilizing a nonelastic white tape because it has been demonstrated to decrease in its tensile strength during exercise, potentially reducing the ability of the tape to cue muscle activity throughout the course of athletic competitions of longer duration.²

The use of KT has also been proposed as an intervention option to manage and prevent knee injuries associated with biomechanical deficiencies.^{8,9} Traditional bracing of the knee to prevent injury during athletic movements is cumbersome and may not address all potential drivers of inefficient biomechanics.⁸ Elastic tapes, as well as other tape applications, have been hypothesized as an alternative to improve joint kinematics and reduce the risk factors for knee trauma.⁸ For example, researchers hypothesized that an application of KT utilized to facilitate the activation of the gluteus medius could improve DKV, which has been demonstrated as a risk factor for anterior cruciate ligament ruptures.³ When tested acutely, DKV, as well as the muscle strength of the gluteus medius (as measured by the Donetelli Leg Drop Test), was reported to have improved after the application of KT.³ The participants in this study presented without injury, but were required to demonstrate impaired motor control through the presence of DKV ($>8^\circ$ for men and $>13^\circ$ for women) during a drop jump.³ Unlike the other 4 studies presented, Rajasekar et al³ studied the effects of KT on participants with known impairments in lower-extremity movement patterns and found significant improvements following the application of KT. Though results from this study are promising for clinicians

looking to improve at-risk movement patterns, 3D motion capture analysis might have provided more insight into the kinematics of the hip, knee, and ankle in all planes of motion.

Recently, researchers compared a KT application with an MCT application and no application of tape to assess the potential biomechanical changes from different tape applications targeted at improving patella femoral pain syndrome. KT was applied in a manner to facilitate a medial glide of the patella and potentially improved activation of the vastus medialis oblique.⁹ The MCT application is postulated to improve patella tracking through a mechanical internal rotation of the tibia.⁹ Participants performed 10-m “run throughs” while being analyzed by 3D motion capture cameras and force plates.⁹ When compared with the no-tape condition, healthy runners with an application of KT and MCT demonstrated no significant differences from their baseline data for hip and knee angles. However, when MCT was applied, healthy runners were found to have decreased knee and hip extensor moments when compared with KT.⁹ The results of this study do not demonstrate that a KT application intended for patients with patella femoral pain syndrome will alter the biomechanics of a healthy population. However, clinicians should be attentive to the potential for tape to alter biomechanics at segments of the kinetic chain away from the sight of application, as demonstrated by the MC application.

Hebert-Losier et al⁵ investigated the effect of KT compared with a no-tape application on knee kinematics in professional cyclists. The investigators hypothesized that an increase in muscle activation would result in changes to knee kinematic values during cycling.⁵ Participants completed 4 minutes of cycling at 100 and 200 W, while 3D motion capture cameras and surface electromyography captured data values under KT and no-tape conditions.⁵ When compared with the no-tape condition, cyclists with KT demonstrated no difference in lower-extremity kinematic values.⁵ The investigators did find a significant increase in vastus medialis activity, as well as a decrease in the ratio of rectus femoris to biceps femoris activation following a simple application of KT across the patella.⁵ The demonstrated improvements in the coactivation of biceps femoris and rectus femoris may benefit individuals with quad-dominant movement strategies.⁵ However, further investigation into the effect of this specific taping application on a population with movement strategies considered to be quad-dominant (ie, DKV) would provide more applicable evidence for the guidance of clinical practice.

In conclusion, a consensus on the effectiveness of KT could not be reached from the 5 studies examined in this critically appraised topic. Although the evidence to support the use of KT to improve factors regarding neuromuscular control is insufficient, the strength of these recommendations is limited due to a lack of consistency between study methods, as well as transferability to practice. Not only did applications of KT vary, but motor patterns performed by participants varied as well. For these reasons, clinical implications must be extrapolated on a study-by-study basis at this time, until a stronger, more homogenous knowledge base has been established to

Table 2 Characteristics of Included Studies

Study	Bailey and Firth⁴	Howe et al⁹	Rajasekar et al³	Briem et al²	Hebert-Losier et al⁵
Study design	Randomized crossover study	Randomized crossover study	Randomized control study	Randomized crossover study	Randomized crossover study
Participants	Twenty professional male soccer players over the age of 18 y with no current injuries or deemed unfit to play by the club's medical department.	Twenty-nine female recreational runners who ran a minimum of 3 km, a minimum of 3 times per week, and between the ages of 18 and 35 y. Participants were excluded if they had any lower-limb musculoskeletal injury within the 6 wk prior to the data collection.	Forty male and female college level athletes between the ages of 18 and 28 y who demonstrated DKV (>8° for men and >13° for women) during a drop jump landing. Participants were excluded for a history of lower back pain or any injury to the lower-extremities within 1 y prior to the data collection.	Fifty-one male premier league athletes from soccer, basketball, and team handball clubs. Participants were excluded for any lower-extremity injury within the 6 wk prior to data collection. Participants performed a Star Excursion Balance Test and were then allocated to stable and unstable groups based on their scores.	Twelve male cyclists from a national cycling team who were in good health and had no musculoskeletal injuries within 1 mo of data collection were included.
Intervention investigated	The participants were randomized to either the KT or no tape condition prior to performing the initial balance and fine movement control task. Following a washout period, the task was then performed with the alternate condition.	Participants were randomized in the order of the 3 conditions (KT, Mulligan tape [MT], and NT). Tape applications were applied unilaterally to a randomized knee and according to the protocol of each tape application. Under each condition, participants performed a series of "run throughs" along a 10-m runway.	Participants were randomly allocated to either the KT or sham tape (ST) group. KT was applied to the gluteus medius in both groups; however, the ST group was not taped in a position with 90° hip flexion, adduction, and internal rotation. The KT group application was intended to improve activation of the gluteus medius.	A KT application hypothesized to improve fibularis longus activation was compared with a common ankle taping technique using white tape (WT) and a no-tape condition during sudden ankle perturbation. Each participant was subjected to the 3 conditions.	All participants performed a submaximal cycling effort at 100 and 200 W conditions as measured by an ergometer. Each of the 2 cycling conditions was performed with and without a patella KT application that had previously been reported to induce changes in cycling biomechanics.
Outcome measure	Participants were scored for percentage of accuracy on the moving target program through an isokinetic dynamometer with load cell-based force plates, which measured load around 2 axis: anteroposterior and mediolateral.	3D motion analysis and force plate data were used to analyze hip and knee kinematics and kinetics. Kinematics were analyzed for peak angles and peak angular velocity, while kinetics were analyzed for peak forces and moments at the hip and knee.	DKV was measured at the initial contact phase during a drop jump with a video camera located 10 m from the drop platform. Video was analyzed with computer software. Gluteus medius strength was assessed by measuring leg drop during an isometric hip abduction in the side-laying position. Measures for both tests were recorded immediately following tape application and at a 3-d follow-up.	Fibularis longus muscle activity was measured using wireless EMG. Muscle activity was analyzed for mean and peak magnitude, as well as time to peak magnitude following perturbation. Data were analyzed during four phases: 500 ms before perturbation, and at three 500 ms blocks following perturbation.	Kinematic data were recorded through 3D motion analysis for lower-extremity and pelvis movements. Peak and mean EMG data were recorded bilaterally at the vastus medialis, vastus lateralis, rectus femoris, and BF. Data for both motion analysis and EMG were normalized based on maximal knee flexion events.

(continued)

Table 2 (continued)

Study	Bailey and Firth ⁴	Howe et al ⁹	Rajasekar et al ³	Briem et al ²	Hebert-Losier et al ⁵
Main finding	The application of KT did not significantly improve the participants' ability to perform the balance and fine movement control task ($P = .28$).	For hip and knee kinematics, there were no differences in peak hip and knee angles between conditions. However, the MT condition significantly decreased knee flexion velocity ($P < .01$). Hip kinetics were demonstrated to change significantly during hip flexion ($P < .01$) and extension ($P < .01$) moments for the MCT condition.	Immediately following the application of tape, male participants had decreased peak knee abduction angles ($P < .01$), but not at follow-up ($P = .31$). Females were demonstrated to have reduced knee valgus angles at both time points ($P < .01$).	Ankles taped with WT were demonstrated to have significantly greater mean muscle activity ($P = .03$) when compared with KT and no tape. KT had no significant effect on muscle peak or mean muscle activity ($P = .86$) when compared with no tape for both stable and unstable conditions.	There were no effects on lower-extremity kinematics at both 100- and 200-W conditions. At 100 W, there was a significant effect on nondominant leg VM peak ($P = .04$) and RF to BF ratio peak ($P = .02$). However, at 200 W, there was not a significant increase in VM peak ($P = .12$).
Level of evidence	1b	1b	1b	1b	2b
Validity score	PEDro 8/10	PEDro 8/10	PEDro 10/10	PEDro 8/10	PEDro 8/10
Conclusion	The main finding does not support the use of KT in professional soccer players for the improvement of proprioception as assessed by the ability to accurately track a moving target through control of COP.	An application of KT intended to provide a medial glide of the patella had no significant effects on the running biomechanics of recreational female runners.	An application of KT intended to facilitate gluteus medius activation acutely improved knee abduction angles during a drop jump landing task. For females, the reduction of knee motion was still present after 3 d.	The use of KT is not warranted for increasing muscle activity of the fibularis longus and potentially preventing excessive ankle inversion during sudden perturbation.	The demonstrated increase of BF activation in relation to rectus femoris activation implies that there is potential for KT to alter neuromuscular recruitment patterns in elite cyclists.

Abbreviations: BF, biceps femoris; COP, center of pressure; DKV, dynamic knee valgus; EMG, electromyography; KT, kinesiology tape; RF, rectus femoris; VM, vastus medialis.

evaluate KT in comparison with other taping materials and methods. To better solidify current knowledge, future research should address the existing evidence with more consistent study designs and further address the potential for KT applications to improve the neuromuscular control and movement patterns of populations displaying excessive joint movement. This critically appraised topic should be reassessed in 2 years to determine if additional evidence supports KT as an intervention to improve lower-extremity motor control and prevent injury in an athletic population.

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