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Original Article

Can Kinesio Tape Alter the Cutting Kinematics in Female Athletes with Functional Ankle Instability?

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Abstract

Background: Functional ankle instability (FAI) often occurs after ankle sprains and involves impaired neuromuscular control. Cutting maneuvers, common in many sports, may increase ankle injury risk. Kinesio taping (KT) is used to enhance joint stability and proprioception, but its effect on lower-extremity kinematics during cutting is unclear. This study investigated the effect of KT on cutting kinematics in female athletes with FAI.
Methods: This controlled pre–post intervention study was conducted in April and May 2024 on 28 female athletes, including 14 with functional ankle instability (FAI) and 14 healthy controls, at the laboratory of the Sport Sciences Research Institute in Tehran, Iran. Research tools included the Persian validated Cumberland Ankle Instability Tool (CAIT) for participant classification, anthropometric measurements (height, weight, and body mass index), and a 3-dimensional motion analysis system (Kestrel, 10 cameras) with Cortex software to record lower-extremity kinematic data. Kinematic data for the ankle, knee, and hip joints across all three anatomical planes were extracted specifically at the time frame corresponding to the peak frontal plane knee valgus during the stance phase of the cutting maneuver. The intervention consisted of Kinesio taping applied according to the John Gibbons technique before the post-test phase. Sample size was estimated using G*Power software (v.3.1.9.4). Statistical analysis was performed using the independent t-test and one-way repeated measures ANOVA, with the significance level set at $P < 0.05$.
Results: KT did not significantly affect lower extremity kinematics such as hip flexion (pre: -38.02±12.37, post: -34.56±12.33, P=0.30), knee flexion (pre: 50.28±7.26, post: 49.17±7.07, P=0.430), and ankle flexion (pre: -95.37±4.18, post: -93.50±5.31, P=0.320) angles in both groups. Only the effect of Kinesio tape on the knee abduction angle was statistically significant (pre: 3.74±1.8, post: 4.82±0.13 P=0.008).
Conclusions: It appears that the effect of Kinesio tape during cutting maneuvers is not substantial enough to alter the movement kinematics in individuals with FAI. Therefore, Kinesio tape is not recommended for injury prevention or performance enhancement in athletes with ankle sprains.

Keywords: Kinesio Tape, Ankle Injuries, Athletes, Cutting Kinematics

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1. Introduction

The ankle joint is consistently one of the most commonly injured joints in athletic activities, accounting for approximately 30% of sports-related injuries (1). This type of ankle injury involves both mechanical and functional instability and is associated with a wider range of potential disorders. Mechanical instability refers to joint laxity due to the loss of mechanical restraints such as ligamentous tissue (2). In contrast, functional instability is a self-reported phenomenon manifests with recurrent episodes of instability or the sensation of the ankle joint "giving way or a sense of instability during daily life activities and sports, or by repeated symptomatic ankle sprains (3). Nearly 40% of individuals who suffer from an acute lateral ankle sprain experience functional ankle instability. The lateral ligaments of individuals with functional instability are structurally normal (4). The most common mechanism of lateral ankle sprain is excessive inversion combined with plantarflexion at the ankle joint (5).

Rapid direction changes, such as cutting maneuvers (CM), are a key skill during many team sports competitions and can occur over 100 times in a single game (6). During CM, The athlete's task involves executing a dynamic and multifaceted maneuver to navigate a new path, necessitating the successful maintenance of balance (7). Sudden body redirections in fast sports activities pose a greater risk compared with forward movements and have been a focus of kinematic research in terms of risk and occurrence of injury (8). Additionally, during CM, the body's center of mass moves laterally after stopping (9).

To avert ankle sprains, common strategies involve bracing, enhancing the strength of the evertor muscles, incorporating proprioceptive exercises, and undertaking physiotherapy (10). Another preventive method for ankle injuries is Kinesio tape (KT) (11). KT has gained global popularity as a new intervention and preventive method for musculoskeletal injuries (12). This elastic tape can stretch up to 140% of its original length and can be worn for 3 to 5 days, offering multiple benefits; it reduces pain and discomfort, supports injured muscles and joints, and accelerates the natural healing process (12). Different KT techniques can lead to varying effects, accordingly, different shapes, stretches, and directions can be used as needed (12). It has been shown that KT of the foot reduces the risk of recurrent ankle injuries (11). Although research indicated that Kinesio tape may help control and reduce ankle sprain injuries, the possible mechanisms of this effect remain unclear (13). It has been reported that the effect of KT may be due to the way taping or ankle bracing limits joint range of motion, reduces mechanical instability, or improves confidence during functional tasks (14). It is believed that Kinesio tape should be regarded as an adjunct technique that, by itself, does not resolve physical problems (15). KT is thought to enhance proprioceptive accuracy by increasing stimulation of cutaneous mechanoreceptors (16). However, conflicting results in this area make decision-making difficult. For instance, it was found that ankle KT or bracing had no effect on proprioception, and there is evidence suggesting that when proprioception is measured as the threshold to detect passive movement, proprioception may even worsen in inversion or eversion (17). In another study, results showed that Kinesio tape with tension significantly limited inversion and eversion and increased inversion stiffness (18). This research indicated that Kinesio tape with tension limits frontal-plane motion of the ankle complex without reducing dorsiflexion and plantarflexion range of motion, affecting restriction at the talocrural and subtalar joints (18).

Various methodologies have been proposed to correct altered ankle joint kinematics. While many interventions aim to improve kinetics, kinematics, and overall performance, few studies have specifically investigated the effect of Kinesio tape (KT) on the kinematics of cutting movements in this population based on the literature search (19). Given the critical role of proper lower limb alignment during cutting maneuvers in ankle injury prevention, and the suspected influence of KT in mitigating risk factors (particularly those related to excessive internal rotation during rapid changes of direction) investigating this relationship is essential for optimizing safe return-to-sport protocols. Therefore, the present study primarily aimed to investigate the effect of Kinesio tape application on the cutting movement kinematics in female athletes with functional ankle instability.

2. Methods

2.1. Design

This was a controlled pre-post intervention study conducted on female athletes with and without FAI in April–May 2024 at the Sport Sciences Research Institute in Tehran, Iran.

2.2. Selection and Description of Participants

The participants were female athletes with and without functional ankle instability (FAI) who had regularly participated in sports training during the past three years. The inclusion criteria were: age between 18 and 28 years, regular sports participation for at least the past three years, diagnosis of FAI using the Cumberland test. Athletes who scored below 24 were classified in the group with functional ankle instability, while those who scored above 24 were placed in the healthy group. They were selected by the examiner based on the inclusion and exclusion criteria and their personal consent. Participants had experienced ankle giving way or instability during daily activities and sports at least twice in the last two years. The exclusion criteria were: a history of ankle injuries in the past six months that led to missing or modifying training for at least one week—including surgeries, muscular or ligamentous injuries, no observed pathological signs, joint diseases in the lower limbs or spine, history of fractures or surgeries in the past five years, lower limb pain immediately after testing, no exercise within 24 hours before the test session, a history of balance-impairing diseases or metabolic disorders such as diabetes, use of sedatives or medications potentially affecting neurological function, and the presence of postural abnormalities in the lower limbs such as genu valgum, genu varum, genu recurvatum, flat feet, or high arches.

2.3. Sample Size Determination

To ensure our study had sufficient statistical power, we used G*Power software (version 3.1.9.4), with a two-tailed comparison of the difference between two dependent mean values. Specifically, data from a previous study (20) were used for sample size estimation with α=0.05 and β=0.20. Accordingly, the effect size was calculated based on the ankle inversion angles during the stance phase of walking in individuals with chronic ankle instability (pre-test: 6.90±3.50, and post-test: 10.32±5.34 from the maximum lateral inclination) were used. Based on the results, a total of 18 participants were required to participate in this study. To account for any potential participant dropouts, we recruited 14 participants for each group (FAI and Without functional ankle instability (WFAI)), yielding a total of 28 individuals.

2.4. Data Collection and Measurements

All procedures were conducted in accordance with the ethical principles of the Declaration of Helsinki, and written informed consent was obtained from all participants prior to data collection. The entire testing protocol—including warmup, pretest, and posttest—was conducted in the biomechanics laboratory of the Sport Sciences Research Institute in Tehran, Iran. Environmental conditions such as lighting and room temperature were kept constant throughout the testing sessions. To minimize external influences, only one participant was present during each testing session, and all procedures were explained individually before the experiment began.

Ankle instability severity was assessed using the Cumberland Ankle Instability Tool (CAIT). The CAIT is a validated questionnaire consisting of nine items with a maximum score of 30 and is widely used to determine the severity of ankle instability (21). The test–retest reliability is ICC=0.960 and the internal consistency is α=0.885 which show they are high (22). In the present study, the validated Persian version of the CAIT was used (23). Participants who scored less than 24 were classified as having functional ankle instability (FAI), while those scoring above 24 were categorized in the healthy group. After participant selection and completion of the consent forms, anthropometric measurements including height and weight were obtained using a measuring tape and digital scale, and body mass index (BMI) was calculated accordingly (Table 1).

Threedimensional lowerextremity kinematics were recorded using a 10camera Kestrel motion capture system (Motion Analysis Corp., USA) operating at a sampling frequency of 250 Hz. The motion capture system was calibrated prior to testing following the manufacturer's recommended procedures. Calibration consisted of two phases: static and dynamic calibration. During static calibration, a calibration frame was placed at the center of the capture volume to define the coordinate system and the orientation of the X, Y, and Z axes. The Xaxis was defined by a line connecting three markers, the Yaxis by a line containing two markers, and the Zaxis was defined as perpendicular to the other two axes and directed upward. Dynamic calibration was then performed by moving a Tshaped wand with three reflective markers in a figureeight pattern throughout the capture space.

A total of 58 reflective markers with diameters of 6−8 mm were placed bilaterally on standardized

Table 1: Demographic characteristics of participants in the Functional Ankle Instability (FAI) and healthy groups

Data	Group	Mean±SD	P value
Height (cm)	FAI	166.45±2.81	0.366
	Healthy	167.81±3.81	
Weight (kg)	FAI	62.65±5.35	0.304
	Healthy	60.72±2.64	
Age (years)	FAI	23.32±3.23	0.242
	Healthy	22.22±8.91	
Body Mass Index (BMI) (kg/m²)	FAI	21±93/2	0.752
	Healthy	21±53/2	

FAI: Functional Ankle Instability; SD: Standard Deviation anatomical landmarks of the trunk and lower extremities, including the acromion process, sternum, seventh cervical vertebra, tenth thoracic vertebra, anterior and posterior superior iliac spines, quadriceps muscle belly, distal femur, fibular head, medial femoral condyle, tibial tuberosity, tibia, lateral and medial malleoli, heel, sustentaculum Tali, and multiple locations on the first and fifth metatarsals and toes. In addition, cluster markers were placed on the lateral aspect of the thighs and shanks to improve tracking (24). Following marker placement and system calibration, participants performed a series of 45° cutting maneuvers using their dominant leg. Each participant completed five trials, from which three valid trials were selected for further analysis (25). The cutting task began approximately two meters before the changeofdirection point marked on the floor (Figure 1). Participants were allowed several practice trials to become familiar with the movement and the laboratory environment. During each trial, participants were instructed to perform the maneuver so that the designated foot contacted the marked changeofdirection point at the required 45° angle. A oneminute rest period was provided between trials to minimize fatigue effects. After completion of the pretest trials, Kinesio tape was applied to both the experimental and control groups at least 20 minutes prior to the posttest. The cutting maneuver protocol was then repeated under identical conditions.

Threedimensional optoelectronic motion capture systems have been widely used to evaluate lowerextremity kinematics and have demonstrated high validity and reliability when compared with stereophotogrammetry methods (26). Reliability is generally high in the sagittal plane, particularly for knee flexion–extension parameters, where intraclass correlation coefficients (ICC) often exceed 0.90. However, softtissue artifacts may influence measurements in the frontal and transverse planes, particularly for hip and ankle movements, potentially increasing measurement error (RMSE) up to approximately 5° and reducing interrater reliability in more complex joint motions.

2.5. Procedure

The application of the Kinesio tape was carried

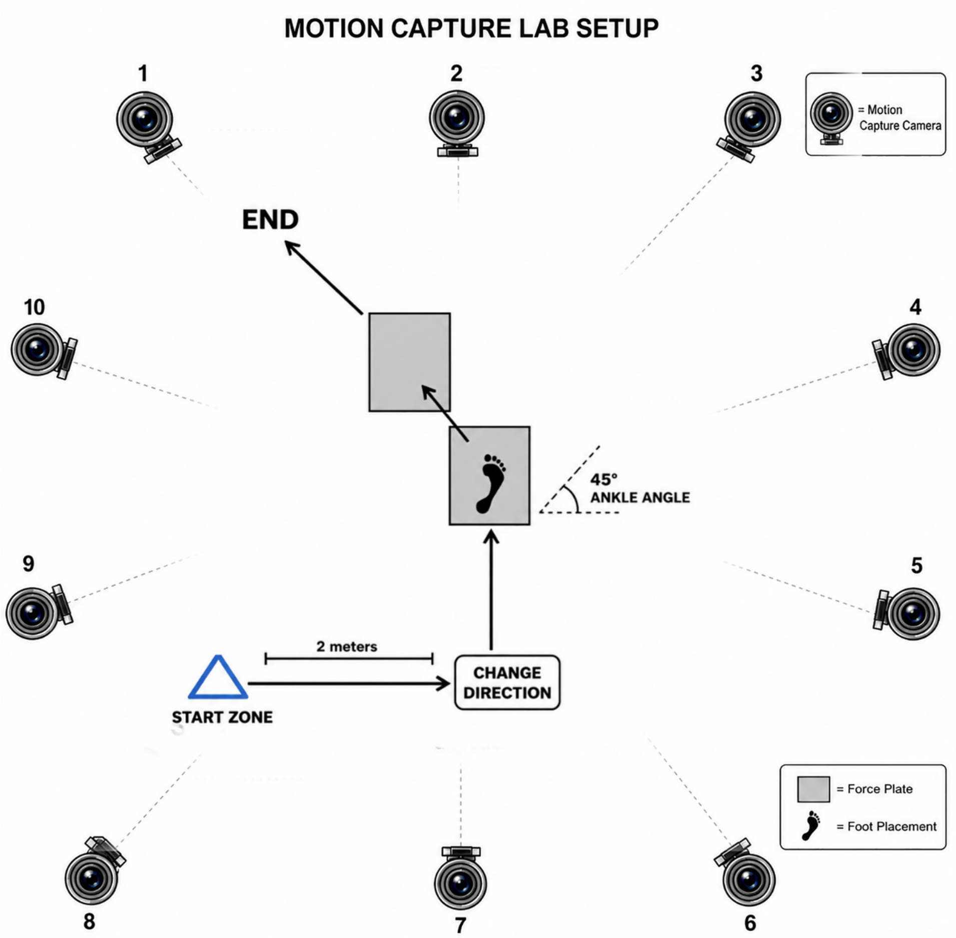

Figure 1: The figure shows the cutting movement.

out by the examiner. The participant was asked to sit with their knees extended and then move their ankle into dorsiflexion and eversion. In this position, the examiner applied an "I"-shaped Kinesio tape strip starting from the medial side of the ankle, just above the medial malleolus, with 100% tension, running under the heel to the lateral malleolus.

Next, another "I"-shaped Kinesio tape strip was applied transversely from the medial side of the calcaneus and directed toward the posterior part of the heel so that the tape covered the plantar surface of the foot. It was then applied with 50% tension over the dorsum of the foot, as shown in the Figure 2. In the final stage, the same technique was applied in the opposite direction, which is known as Technique 8. After applying the Kinesio tape, heat was applied to the taped area using the backing paper to activate the adhesive (27).

Figure 2: The figure shows the Gibbons Kinesio taping model.

2.6. Data Analysis

To record the data, markers were placed on specific points on the participants' bodies. The participants were required to perform a cutting maneuver with their functionally unstable leg (right leg). Data were collected in both static and dynamic conditions. The motion analysis system recorded data at a frequency of 200 Hz. The data analysis focused on the moment of maximum knee valgus.

The experimental data were recorded in C3D format, and after data recording, the labeling and tracking processes were carried out. This included naming several frames before and after the cutting moment and performing gap filling for any missing data sections. Markers were labeled from the shoulder down to the ankle, and the RECTIFY option was selected in the software, creating a logical model for both static and dynamic data.

The raw datasets were acquired using Mokka software and formatted into Excel spreadsheets. Subsequently, kinematic and kinetic data underwent modeling and analysis within the Visual3D environment (C-Motion, Inc., Germantown, MD). Statistical analysis was performed using IBM SPSS version 24. Descriptive statistics, including mean and standard deviation (SD), were used to summarize the data. An independent t-test was employed to compare baseline variables between the groups. Furthermore, a one-way repeated measures ANOVA was conducted to explore the differences between the FAI and healthy groups across two conditions (with and without Kinesio tape), with the significance level set at $P<0.05$. The analysis focused on the angular measures (flexion/extension, abduction/adduction, and internal/external rotation) of the hip, knee, and ankle joints, captured at the instant of peak knee valgus.

3. Results

In the analysis of the hip joint angles in three planes, Kinesio tape did not have a significant effect on any of the angles for both the healthy group and the FAI group. Specifically, no significant effect was observed in flexion-extension ($P=0.47$), abduction-adduction ($P=0.14$), and internal rotation-external rotation ($P=0.82$) angles (Table 2). Additionally, the time×group interaction also showed no significant difference in the flexion-extension ($P=0.30$), abduction-adduction ($P=0.62$), and internal rotation-external rotation ($P=0.87$) angles.

In the analysis of knee joint angles in three planes, Kinesio tape did not have a significant effect on either the healthy or the FAI group in the flexion-extension ($P=0.09$) and internal rotation-external rotation ($P=0.081$) angles. However, a significant effect was observed in the abduction-adduction angle ($P=0.008$) for both groups (Table 2). The time × group interaction showed no significant difference between the groups in the flexion-

Table 2: Mean±SD of kinematic variables in the Functional Ankle Instability (FAI) and healthy groups

Joint	Plane	Group	Mean ±SD (without Kinesio tape)	Mean ±SD (with Kinesio tape)	Time Effect		Effect Size	Test Power
					P value	F		
Hip	Flexion/Extension	Healthy	-35.14±6.82	-35.76±9.52	0.47	0.54	0.05	0.17
		FAI	-38.02±12.37	-34.56±12.33				
		P value	0.512	0.805				
	Abduction/ Adduction	Healthy	-7.81±6.72	-6.41±6.7	0.14	2.40	0.01	0.07
		FAI	-10.2±4.95	-7.48±4.43				
		P value	0.638	0.781				
	Internal Rotation/ External Rotation	Healthy	-11.76±4.038	-11.63±4.77	0.82	0.05	0.00	0.005
		FAI	-5.49±4.513	-4.74±10.33				
		P value	0.060	0.442				
Knee	Flexion/Extension	Healthy	49.25±3.62	50.76±6.64	0.09	0.01	0.03	0.11
		FAI	50.28±7.26	49.17±7.07				
		P value	0.683	0.601				
	Abduction/ Adduction	Healthy	1.83±3.74	2.48±4.75	0.008*	9.45	0.005	0.005
		FAI	2.50±4.75	0.62±5.6				
		P value	0.738	0.844				
	Internal Rotation/ External Rotation	Healthy	-5.18±5.96	-4.92±6.84	0.081	3.27	0.09	0.27
		FAI	-7.75±2.92	-5.51±2.92				
		P value	0.232	0.804				
Ankle	Flexion/Extension	Healthy	-92.83±12.53	1.31-94.20±11.31	0.86	0.02	0.05	0.16
		FAI	-95.37±4.18	-93.50±5.31				
		P value	0.550	0.861				
	Abduction/ Adduction	Healthy	-16.86±16.11	-17.18±16.27	0.47	0.52	0.05	0.15
		FAI	-17.50±4.69	-15.5±7.66				
		P value	0.909	0.640				
	Internal Rotation/ External Rotation	Healthy	-7.60±6.82	--6.40±7.50	0.93	0.008	0.03	0.1
		FAI	-5.37±5.18	-6.14±5.92				
		P value	0.458	0.674				

FAI: Functional Ankle Instability; SD: Standard Deviation; P (time): P value for time effect; Positive (+) values denote flexion, adduction, and internal rotation, while negative (-) values represent extension, abduction, and external rotation for the hip and knee. For the ankle in the sagittal plane, negative values specifically indicate a plantarflexion position.

extension (P=0.43), abduction-adduction (P=0.77), and internal rotation-external rotation (P=0.16) angles. In the analysis of the ankle joint angles in three planes, Kinesio tape did not have a significant effect on any of the angles for both the healthy and the FAI group. Specifically, no significant effect was observed in flexion-extension (P=0.86), abduction-adduction (P=0.47), and internal rotation-external rotation (P=0.93) angles. Furthermore, the time × group interaction showed no significant difference between the groups in the flexion-extension (P=0.32), abduction-adduction (P=0.33), and internal rotation-external rotation (P=0.48) angles.

Table 2 shows the results of comparing hip, knee, and ankle joint angles in three planes of cutting maneuver in each group for each variable of the study.

4. Discussion

The main findings of the present study demonstrated that Kinesio Tape (KT) did not significantly influence hip or ankle joint angles during the 45° cutting maneuver and only significantly affected the knee abduction–adduction angle.

The lack of a significant effect of KT on hip joint angles in the present study is consistent with previous evidence indicating the limited biomechanical effects of KT in musculoskeletal conditions (28). One systematic review concluded that the current evidence does not strongly support the use of KT for musculoskeletal disorders, as its effects are typically minimal or clinically insignificant and comparable to sham interventions or other active treatments (29). It has also been reported that the tensile force generated by KT is relatively negligible compared with the muscle forces and inertial loads involved in dynamic movements such as cutting, and thus may be insufficient to produce meaningful changes in joint kinematics (30). Furthermore, individuals with FAI often demonstrate compensatory movement patterns in proximal joints, including the knee and hip, which may not be readily modifiable by localized interventions such as KT. These compensatory strategies may persist even after the application of external support, resulting in minimal detectable changes in hip joint kinematics (31). Additional evidence demonstrates that KT and MT each exert a significant effect on neuromuscular control following sudden perturbation in individuals with CAI, although their modes of action appear to differ (32).

However, some studies reported findings that contrast with those of the present study (33, 34). Increased gluteus Medius muscle strength accompanied by decreased electromyographic activity has been reported following the direct application of KT to this muscle in athletes with CAI (33). This discrepancy may be attributed to methodological differences, particularly the site of tape application and the type of outcome variables measured. In that study, KT was applied directly to the gluteus Medius muscle, and the variables examined included muscle strength and electromyographic (EMG) activity rather than movement kinematics (33). Moreover, biomechanical analyses of cutting maneuvers in individuals with CAI have demonstrated that extensive taping protocols covering the ankle and tibiofibular region can influence joint kinematics, angular velocities, and joint moments across the sagittal, frontal, and transverse planes, leading to increased hip and knee flexion as well as increased angular velocities (34). Therefore, differences in taping protocols may partly explain the discrepancies between the present study and previous research by Wang and colleagues (34), as full-coverage taping may provide greater sensory stimulation or mechanical input compared with the standard KT protocol used in the present study. Another factor that may influence responsiveness to KT is proximal muscle weakness. It has been reported that the hip abductor muscles on the affected side are weaker than those on the unaffected side in individuals with chronic ankle sprains, which may alter lower extremity biomechanics and potentially affect individual responses to taping interventions (35).

It was also found that KT intervention exerted a significant effect only on the knee abduction–adduction angle. This finding is consistent with previous evidence indicating that external ankle supports can influence the frontal plane mechanics of proximal joints during dynamic activities (36, 37). Improved frontal plane stability at the ankle joint may alter load distribution within the lower extremity kinematic chain, thereby affecting knee valgus–varus alignment during cutting maneuvers (36). It has also been suggested that rigid ankle braces may restrict distal joint motion and result in a stiffer knee landing pattern, which is associated with an increased risk of secondary injuries such as anterior cruciate ligament (ACL) injury (36). However, the present findings differed from the research that has reported increased knee flexion angle and angular velocity following the use of long tape during cutting maneuvers (34). These differences may arise from variations in taping protocols, as greater tape coverage may generate stronger sensory input or mechanical effects capable of influencing sagittal plane knee kinematics. Furthermore, it has been demonstrated that individuals with CAI exhibit impaired feedforward neuromuscular control, which may reduce the effectiveness of KT in modifying movement patterns during high-speed athletic activities (38).

The finding that KT did not significantly affect ankle joint angles during the cutting maneuver contrasts with several previous studies that reported reduced ankle inversion following KT application during dynamic movements (19) Reduced ankle inversion during cutting maneuvers following the application of short tape has been reported in individuals with CAI (34). Similarly, reduced ankle inversion and increased knee flexion during unexpected jump landings have been observed following KT application in healthy collegiate athletes (39).

One important factor contributing to these discrepancies may be differences in participant characteristics. A study on healthy athletes demonstrated that measurable biomechanical changes are more detectable in this group, as their intact neuromuscular control system responds effectively to sensory inputs (40). In contrast, individuals with functional ankle instability (FAI) typically present with proprioceptive deficits, impaired neuromuscular control, and mechanical joint instability (4). Under such conditions, the sensory stimulation provided by KT may be insufficient to compensate for these underlying impairments (35).

Task characteristics may also play a role; unanticipated jump-landings and cutting maneuvers impose different biomechanical and neuromuscular demands on the lower extremity (38). KT may be more effective in tasks requiring rapid reactive stabilization following perturbation, where sensory feedback from the tape can facilitate reflex-like neuromuscular responses (15). Conversely, cutting maneuvers involve substantial multiplanar forces and require strong active muscular stabilization to control rapid directional changes. Evidence indicates that cutting and landing tasks impose different sensorimotor control demands, which may influence the effectiveness of proprioceptive interventions such as KT (16).

In support of this interpretation, it has been reported that individuals with CAI exhibit kinematic alterations at the ankle during unanticipated cutting maneuvers, suggesting that persistent neuromuscular deficits may not be fully corrected by sensory-based interventions such as KT (41, 42). Consequently, the neuromuscular impairments associated with FAI may overshadow any acute effects of KT, resulting in minimal or non-significant changes in ankle joint kinematics during cutting maneuvers (36, 37).

4.1. Limitations

The main limitations of the present study included evaluating only the immediate effects of KT without longterm followup, conducting the tests under controlled laboratory conditions that may not reflect reallife sporting environments, not assessing sensorimotor variables or electromyographic (EMG) activity, and measuring lowerextremity joint angles at only a single time point during the cutting maneuver.

5. Conclusions

Given the limited and selective effects of KT observed in this study, it may not be sufficient as a primary intervention for altering lowerextremity biomechanics in individuals with functional ankle instability (FAI). Instead, KT may be more appropriately used as an adjunctive strategy for proprioceptive enhancement or pain reduction. For optimal rehabilitation outcomes and injury prevention, KT should be integrated with comprehensive neuromuscular and proprioceptive training programs. Future studies investigating the effects of KT are recommended to employ multi-week intervention designs with periodic follow-up assessments and larger sample sizes. Furthermore, combining KT with neuromuscular rehabilitation protocols, including electromyographic (EMG) monitoring and proprioceptive training, should be considered. Evaluating KT under diverse movement conditions (such as varying cutting angles, movement speeds, and fatigue levels) may also provide a more comprehensive understanding of its potential benefits and limitations.

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Authors' Contribution

Atefeh Rahimi Jamal: Substantial contributions to the conception and design of the study; the acquisition, analysis, and interpretation of the data; drafting the work and reviewing it critically for important intellectual content. Rahman Sheikhhoseini: Substantial contributions to the conception and design of the study; the acquisition, analysis, and interpretation of the data; drafting the work and reviewing it critically for important intellectual content. Hashem Piri: Substantial contributions to the conception and design of the study; the acquisition, analysis, and interpretation of the data; drafting the work and reviewing it critically for important intellectual content. Mohammadreza Seyedi: Substantial contributions to the conception and design of the study; the acquisition, analysis, and interpretation of the data; reviewing the work critically for important intellectual content. Mina Forati: Substantial contributions to the conception and design of the study; the acquisition, analysis, and interpretation of the data; reviewing the work critically for important intellectual content. All authors have reviewed and approved the final manuscript and take responsibility for all aspects of the work, including questions regarding the accuracy or integrity of any part.

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Ethical Approval

The Ethics Committee of the Allameh Tabataba'i University, Tehran, Iran approved the present study with the code of IR.ATU.REC.1402.021. Also, written informed consent was obtained from the participants.

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