

Original Article

Effect of ankle kinesio taping on vertical jump with run-up and countermovement jump in athletes with ankle functional instability

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Abstract. [Purpose] Limited research has been performed in spite of biomechanical evaluation of jump landing with kinesio taping. Therefore, the main objective of this study was to evaluate the effect of kinesio taping applied to athletes. In this study, the authors wished to investigate the effect of kinesio taping during a vertical jump with run-up and countermovement jump on ankle functional instability. [Subjects and Methods] Ten male athletes with ankle functional instability (FI) were recruited in this study from a college volleyball team. Each participant was requested to perform two tasks, the countermovement jump and vertical jump with run-up. Infrared high-speed cameras and force plates were used to assess the effect of ankle taping. [Results] The results showed that the peak ground reaction force in the sagittal plane during a vertical jump with run-up slowed down after kinesio taping and that the peak ankle plantar flexion moment in both types of jump also decreased. [Conclusion] In conclusion, this study proved the effect of kinesio taping on ankle functional instability, which was evaluated by measuring the vertical ground reaction force and peak plantar flexion moment. Its finding may allow us to provide some recommendations for athletes and trainers.

Key words: Kinesio taping, Ankle functional instability

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INTRODUCTION

Ankle sprain is a common injury for athletes who perform cutting maneuvers, landings, or frequent jumps or make contact with other players¹⁾. Approximately 40–75% of individuals develop residual symptoms or chronic ankle dysfunction due to lateral ankle sprain²⁾. In addition, functional ankle instability may affect the postural control and whole body balance. Ross et al. quantified the time required for stabilization during single-leg jump landing. They concluded that their functional ankle instability group took significantly longer to stabilize in the sagittal and frontal planes of motion³⁾. Based on the findings of the abovementioned studies, individuals with functional ankle instability have a greater risk of injury because of their poor postural control, balance, and proprioception.

Ankle taping has been proved to reduce impact force and to balance the ankle power⁴⁾. Peak dorsiflexion and average eversion moments were significantly reduced in sidestepping

tasks after taping⁵⁾. Proper ankle taping decreases inversion and plantar flexion, which may be related to the most common injury mechanisms⁶⁾. Some scholars also reported that kinesio tape may improve static restraint without altering dynamic postural control or peak motion⁷⁾. To summarize the above reports, taping and bracing have been widely practiced as both preventative and rehabilitative interventions for ankle sprains by providing mechanical support and enhancing proprioception⁸⁾.

So far, limited research has been performed in spite of biomechanical evaluation of jump landing with kinesio taping. Further investigation of the effectiveness about kinesio taping is still needed. Therefore, evaluating the effect on athletes during landing is an important issue. The aim of this study was to investigate the effect of the kinesio taping on the ankle functional instability (FI) of athletes during the landing phase in three-dimensional (3D) biomechanics analysis. From the hypothesized biomechanical view, kinesio taping had a positive effect on peak ankle plantar flexion moment and peak vertical ground reaction forces in the FI group.

SUBJECTS AND METHODS

Ten male athletes with ankle functional instability (FI) were recruited in this study from a college volleyball team. (age, 23±1.58 years; height, 172.3±6.27 cm; weight, 70.2±9.11 kg). The inclusion criteria of the FI group were

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as follows: (1) no structural instability or other anatomy structure disorder, (2) a feeling of giving way in the ankle joint during exercise or daily activities, and (3) history of ankle sprain, but not in the past six months⁹. Subjects were excluded if painful gait or painful range of motion was observed during the data collection procedure.

Each subject's age, height, weight, and previous injury history were recorded. A physical therapist applied the anterior drawer test and talar tilt test to exclude subjects with ankle mechanical instability.

Each participant was requested to perform two tasks, the countermovement jump and vertical jump with run-up. Each subject rested more than seven days between two conditions (with and without kinesio tape), and performed the countermovement jump and vertical jump with run-up randomly. In the vertical jump with run-up movement, the subjects take a stride with their dominant leg and then jump as high as possible. In the countermovement jump, the subjects start from an upright standing position and then flex the knees and hips to make a preliminary downward movement. The subjects then immediately extend their knees and hips to jump vertically. The subjects were asked to jump as high as possible in both jump movements.

Kinesio tape was applied to each participant's ankle by a professional athletic trainer. The taping methods used included application of tape in the basketweave pattern with application of horseshoe and reinforcing strips¹⁰. The tape applied was a 5-cm kinesio tape (Kinesio TEX Products, NKT-050, Japan). The procedure for ankle taping was as follows: the tibialis anterior was taped with elasticity of 60–70% (Fig. 1a), the Achilles tendon was taped (Fig. 1b), and then the area from the medial malleolus to the lateral malleolus was taped (Fig. 1c). Finally we applied tape with a basketweave pattern, which was followed by application of heel locks with elasticity of 40–50% (Fig. 1d).

Twenty-one reflective markers were placed on anatomic landmarks of the bilateral lower limbs for each subject. The

selected anatomic landmarks were the sacrum, bilateral anterior superior iliac spine, medial and lateral epicondyles of the femur, lateral thigh, lateral shank, calcaneus, medial and lateral malleolus, and base of the second metatarsal bone¹¹. A VICON612 motion analysis system (Oxford Metrics Group, Oxford, UK) with six cameras was used to collect the trajectories of the markers at 250 Hz. Two AMTI force plates (Advanced Mechanical Technology Inc., Watertown, MA, USA) was used to record the ground reaction forces and moments at 1,000 Hz sampling rates. These two devices were initiated with a trigger, and the synchronization was recorded. The study protocols were approved by the Ethics Committee of National Taiwan College of Physical Education (No. 98002). All participants signed an informed consent form and agreed to participate in the test.

NF1 and NF2 were defined as the first and second peak vertical ground reaction forces normalized by each subject's body weight. T1 and T2 were defined as the times to the first and second peak vertical ground reaction forces after landing¹¹.

For smoothing the trajectories of the markers, a generalized cross-validation spline smoothing routine at a cutoff frequency of 6 Hz was used in this study¹². Programs custom made with the MATLAB computer language (The MathWorks, Inc, Natick, MA, USA) were used to calculate the joint moments of the lower limbs using the inverse dynamic method and the parameters of ground reaction forces.

The paired t-test was used to evaluate the effects of ankle taping. The independent t test was used to compare the differences between the countermovement jump and vertical jump with run-up. Ninety-five percent confidence intervals (95% CI) were calculated for the difference between groups and conditions. The a priori level of significance was set at 0.05.

RESULTS

A statistical significant difference was observed only in the vertical jump with run-up group ($p=0.02$, Table 1). To further investigate the effect of kinesio taping on the vertical ground reaction force, the first (NF1) and second (NF2) peak vertical ground reaction forces were computed (Table 1). We found that the NF2 in the vertical jump with run-up decreased significantly after application of kinesio tape. However, there was no significant difference in NF1 after application of kinesio tape. We then compared the types of jump, and the results showed that larger values were observed for the vertical jump with run-up than the countermovement jump.

Regarding the peak ankle inversion moment, the moment



Fig. 1. Kinesio Taping Procedures

Table 1. The first (NF1) and second (NF2) peak vertical ground reaction forces normalized by each subject's body weight

Unit = N/Kg	Countermovement Jump		Vertical jump with run-up	
	NF1	NF2	NF1	NF2
Non-taped	1.56±0.23	4.03±0.76	1.72±0.51	5.31±1.00
Taped	1.37±0.18	3.64±0.68	1.75±0.49	4.55±0.72
Significance				#

#Significant difference with and without taping ($p<0.05$)

decreased after taping, but no statistical difference was revealed. In addition, there was no significant difference between the two types of jump. Furthermore, a larger plantar flexion moment was measured in the vertical jump with run-up than the countermovement jump during landing (Table 2).

The times to the first (T1) and second (T2) peak vertical ground reaction forces after landing are shown in Table 3. No significant difference was observed for the effect of taping on the times to the first (T1) and second (T2) peak vertical ground reaction forces.

DISCUSSION

A positive effect was observed on the peak vertical ground reaction forces and peak ankle plantar flexion moment in the vertical jump with kinesio taping with run-up. These experimental results provide useful information for attenuating the risk of both jump movements in athletes with ankle functional instability.

Ankle sprains that occur during landing may result from uncertain factors, such as uneven stance and exertion of excessive force. Large ground reaction forces at landing have been reported, and the same results were obtained in this study¹³.

In the vertical jump with run-up, there was a significant difference in NF2 after taping. It seems that taping has an important effect on the vertical jump with run-up. The findings for the instability group may due to distinct recruitment of muscle fibers of the skeletal muscle during the jump exercise. In the study of Simon et al., it was speculated that an "injured" population with an actual proprioceptive deficit would respond differently¹⁴. Ankle functional instability is a proprioceptive deficit. Thus, it is likely more effective for sensory input of the skin to modulate muscle performance. In our study, the knee angle was not controlled in the subject, and this could be a reason why no significant differences occurred during the countermovement jump.

McNitt-Gray reported an NF2 of 4.16 ± 1.3 N/kg (jumping height 0.32 m). The results of the present study were

in agreement with those of the study of McNitt-Gray¹³. However, Riemann's study revealed that NF1 and NF2 were significantly higher in a non-taped group than a taped group during a jumping motion¹⁵. The difference in NF1 might have been due to the various heights that the subjects jumped. The subjects landed after jumping to a height of 0.59 m in Riemann's study, while the subjects landed after jumping to a height of only 0.40 m in this study. A greater jumping height might cause a significant difference in ground reaction. Thus, the difference between the studies may be due to use of different subjects. However, we hypothesize that NF1 and NF2 would decrease after taping.

The ankle plantar flexion moment decreased significantly both in the countermovement jump and vertical jump with run-up after kinesio taping. However, the inversion moment did not decrease when tape was applied. These results were consistent with those of the study of Heit et al¹⁶. They concluded that taping decreased joint position errors in plantar flexion but not inversion. In our results for plantar flexion moment, it appears that application of kinesio tape may restrict the range of motion of the ankle (Table 2). Postural amendment, decreased inflammation and pain, feelings of comfort, and normalization of joint range of motion after application of elastic taping have been pointed out by many scholars⁹.

From a biomechanical perspective, using elastic taping would affect the joint reposition sense and proprioception. Application of kinesio tape may support the muscles and ligaments and reduce sudden force concentration during the landing phase, and it may especially decrease the plantar flexion moment. On the other hand, kinesio taping did not improve the ankle sensory sense in the healthy subjects in the study of Halseth et al¹⁷. The mechanism for instability group whether same for healthy group need to be further discussed.

McNitt-Gray's study reported a mean value of T2 of about 61 ms for a jump with a height of 0.32 m. In our study, the average jumping height was 0.40 m, and the mean T2 value was 63.73 ms¹³. We believe that these results are very similar.

Nigg mentioned that the duration between muscle contraction for energy absorption and landing was about 50–70 ms. Larger ground reaction forces in this period (50 ms) would increase the risk of injury¹⁸. In our study, the time of the second (T2) peak vertical ground reaction force was often greater than 50 ms, and this may be a reason for recurrence of ankle sprains in countermovement jumping and vertical jumping.

Hubbard et al. concluded that mechanical laxity significantly decreased in ankle instability subjects after tape application¹⁹. But in the study of Delahunt et al., the authors

Table 2. The peak moment of ankle plantar flexion

Unit = Nm/kg	Counter-movement jump	Vertical jump with run-up	Significance
Non-taped	0.09±0.04	0.17±0.06	*
Taped	0.06±0.02	0.12±0.05	
Significance	#	#	

#Significant difference with and without taping ($p < 0.05$).

*Significant difference between tasks ($p < 0.05$)

Table 3. The times to the first (T1) and second (T2) peak vertical ground reaction forces after landing

Unit = ms	Countermovement jump		Vertical jump with run-up	
	T1	T2	T1	T2
Non-taped	11.36±2.91	62.77±8.34	10.41±3.89	53.01±15.75
Taped	13.29±3.60	66.82±6.97	10.63±3.59	53.05±13.8

observed no significant change in dynamic postural stability after taping²⁰). In retrospect, there is a clear need for further clinical and science research of taping. The results would help the athletes with ankle functional instability to select appropriate management.

Although we made an effort to investigate the effect of kinesiio taping, there are many limitations of this study. Only ten subjects were recruited in this study. This is because very few subjects met the criteria of ankle functional instability. Also, potential subjects were worried about the risk of reinjury and rejected our invitation. Future studies with more subjects are required. The purpose of this study was to understand the impact of ankle taping. We investigated the characteristics of the vertical jump with run-up and counter-movement jump in subjects with functional ankle instability. This study proved the beneficial effect of kinesiio taping on the ground reaction force in the sagittal plane and peak ankle plantar flexion moment. Fortunately, ankle kinesiio taping plays an important role in reducing the moment of the ankle joint. These findings may provide some suggestions for avoiding lateral ankle sprain. In terms of clinical application, kinesiio taping may be applied to individuals with ankle instability and may be considered as alternative intervention in the sports rehabilitation field.

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