

GROUND REACTION FORCES AFTER TAPING DURING SINGLE DROP LANDING IN PERSONS WITH FUNCTIONAL ANKLE INSTABILITY

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ABSTRACT

Objective: Objective of the study was to examine effect of taping on peak ground reaction forces (GRFs) and time to peak GRFs in persons with functional ankle instability (FAI) during post impact single drop landing.

Methods: Ten persons with FAI participated in the study. They were 3 males and 7 females collegiate athletes playing volleyball (n = 4) and basketball (n = 6). Averaged age, weight, and height were 20.6 ± 2.67 years, 61.80 ± 11.99 kg, and 165.50 ± 10.54 cm. Participants were tested single drop landing with the instability foot on forceplate. Three taping conditions were assessed; no tape, Kinesio tape, and non elastic tape.

Results: Minimal reductions of GRFs were demonstrated in taping conditions but no statistical difference ($p > 0.05$) when compared to no taping. Minimal increases in all times to peak GRFs (except for the anterior force) were found in the Kinesio tape condition. Only the time to peak vertical GRF demonstrated significant difference ($p = 0.039$) among three taping conditions.

Conclusion: Minimal beneficial effect of the Kinesio taping was demonstrated in terms of decreased the peak GRFs and prolonged time to peak GRFs during post impact of landing.

KEY WORDS

Functional ankle instability, Drop landing, Ground reaction force.

1. Introduction

From literature review, ankle joint is the most common injured in team sports, such as rugby, soccer, volleyball, handball and basketball [1-3]. In volleyball, 79% of the ankle injury were recurrent and there was relative risk of injury at 3.8 [2]. Repetitive ankle injury and sprain leads to chronic pain and instability at the ankle. Chronic ankle instability may be due to mechanical instability, functional instability, or combination these two phenomena. Mechanical instability may be due to specific insufficiency such as pathologic laxity, arthrokinematic changes, synovial irritation, or degenerative changes. Functional instability is caused by insufficiency in proprioception and neuromuscular control [4]. Ability to control static and dynamic stabilizers by the ankle

structures is important for performing movement especially during the game competition.

Ground reaction forces (GRFs), the stress intensity and duration on the body during foot contact to the ground have been used for indicating injury [5-8]. Altered pattern, higher magnitude of GRFs and impulses, shorter rise time to peak GRFs during post impact presented in persons with ankle instability when compare to the normal [5, 6, 9, 10]. Alteration of GRFs during post impact indicated abnormal load generated during movement which may result from muscle imbalance control around the ankle joint. A reduction of peroneus longus muscle activity and increased ankle displacement during landing were found in subjects with functional ankle instability (FAI) compared to the normal [11, 12]. These learning adaptations from previous repetitive injuries bring into deviated movement pattern. For FAI, objectives of the treatment include managements of pain, muscle strength, performance, proprioception, and stability [4, 13].

To increase stability, taping is usually used for the athletes during practice and game competition. Several kinds of tape and techniques are popular and have been used for improving proprioception and postural control deficit in subjects with FAI such as non elastic tape, elastic tape, and Kinesio tape [13, 14]. However, there is very few evidence regarding the taping effect on the peak GRFs and time to peak GRFs during performing the landing task. Thus, the present study examined the effect of taping conditions on the peak GRFs and time to peak GRFs during single drop landing in persons with FAI.

2. Methods

2.1 Participants

Prior to participate in the study, all participants were explained the aim, advantage, and procedure and signed an informed consent approval by University research review board. Inclusion criteria composed of history of functional instability of the ankle tested by the Cumberland ankle instability (CAIT ≤ 27 scores), history of ankle sprains in 12 months with moderate to severe pain, and instability complaints. Ten collegiate athletes were included in the study who were diagnosed with the

Functional Ankle Instability (FAI) defined by a subjective episodes of giving way at the ankle without ligamentous laxity [4]. Demographic data and clinical measures of the participants are summarized in Table 1. They have played two types of sport (volleyball and basketball) which usually jump and had opportunity of injury at the ankle. The CAIT scores are 20.6 ± 5.64 . Moderate instability perception at the ankle is reported (6.16 ± 2.19). This was rated by the participants how they felt about instability symptoms by marking on the 10-cm visual analogue scale. They were excluded from the study when demonstrated an ankle injury in the last 3 months, and history of fracture or surgery at lower limb.

Table 1. Subject characteristics

Variables	Values
Gender	Male (n = 3), Female (n = 7)
Age (years)	20.6 ± 2.67
Weight (kg)	61.80 ± 11.99
Height (cm)	165.50 ± 10.54
Sport types	Volleyball (n = 4), Basketball (n = 6)
Dominant foot	Right (n = 10), Left (n = 0)
Testing side	Right (n = 6), Left (n = 4)
Practice frequency (times per week)	4.50 ± 1.18 , (range 3-6)
CAIT (scores)	20.6 ± 5.64
VAS level of ankle instability perception (cm)	6.16 ± 2.19

2.2 Drop landing test

Three conditions of taping (no tape, Kinesio tape, and non elastic tape) were randomly assigned to the participants. All participants wore the same model of sport shoe during testing. Participants performed single leg drop landing from 40-cm height wooden chair on the forceplate (AMTI OR6-7-Advanced Mechanical Technology, Inc, Watertown, Massachusetts, USA). They were asked to land on the center of forceplate, hands on the waist, and maintain their balance on one leg standing after landing. Demonstration and practice were provided before testing. Laboratory setting is illustrated in Figure 1.

2.3 Taping protocol

For non elastic and Kinesio taping, participants were taped by the same certified Kinesio taping practitioner (YS). Prior to taping, skin cleaning was applied over the area of taping. A closed basketweave and heel lock techniques were used for non elastic taping [15] (Figure 2 a). These basic techniques were applied for stimulating the tibialis anterior and peroneii muscles to dorsiflex and evert the ankle. Stimulation of the muscle function was

performed by 50 % tension for Kinesio taping [16] (Figure 2 b).

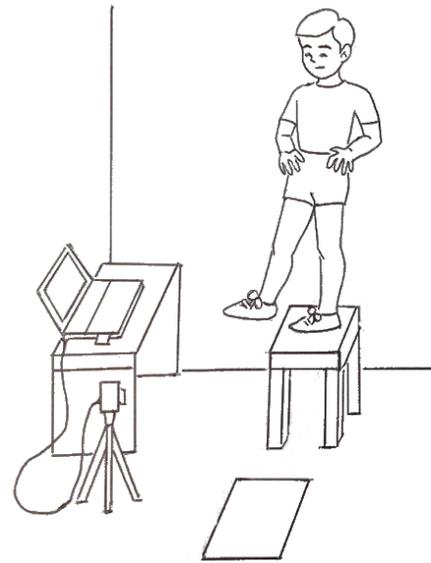


Figure 1: Illustration of laboratory setting.

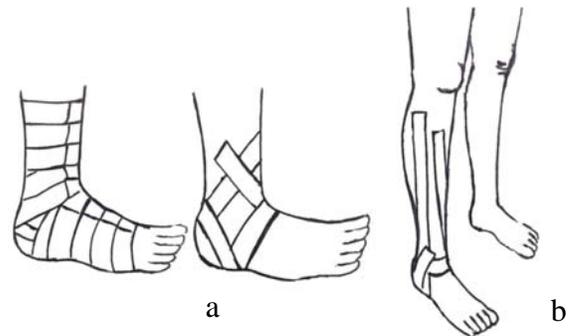


Figure 2: Taping techniques for non elastic tape (a) and Kinesio tape (b).

2.4 Data processing

Averaged two success single drop landing trials were analyzed. GRF data were collected at 1500 Hz and filtered by low pass Butterworth filtering technique at 35 Hz. GRF variables included the vertical, anterior, posterior, medial, and lateral peak forces and time to peak forces at post impact.

2.5 Statistical analysis

Normal distribution of the data was tested by the Kolmogorov Smirnov Goodness of Fit test. Repeated measures ANOVA was used for comparing the peak GRFs and time to peak GRFs data among taping conditions. The Fisher's least significant difference (LSD) post hoc analysis was performed to examine differences

between pair of condition if significant differences were found. Statistical significance was set at the p-value 0.05 level.

3. Results

Table 2 demonstrates the means and standard deviations of peak force and time to peak force among taping conditions during single drop landing. Positive values indicate the forces in the anterior and lateral directions and negative values indicate the forces in the posterior and medial directions. All participants presented the consistent patterns of the antero-posterior, medio-lateral, and vertical forces. Six out of ten participants demonstrated the anterior peak force in posterior direction (negative value). For the remaining, participants demonstrated anterior peak force in positive value.

There was no significant difference ($p > 0.05$) of the peak GRFs in all axes (vertical, antero-posterior, and medio-lateral) among taping conditions. Only the time to vertical GRF showed significant difference ($p = 0.039$) among test conditions. Testing by LSD, there was significant difference of the time to peak vertical GRF between Kinesio and non elastic taping ($p = 0.045$).

Table 2: Peak force and time to peak force during single drop landing (n=10)

Variables	Taping conditions			F	df	p-value#
	No tape	Kinesio tape	Non elastic tape			
Peak force (%BW)						
-Vertical	122.28 ± 27.39	119.59 ± 21.45	120.95 ± 15.69	0.102	2	0.904
-Anterior	-1.62 ± 6.36	-2.01 ± 7.16	-3.37 ± 8.73	0.156	2	0.857
-Posterior	-59.18 ± 11.66	-58.69 ± 9.10	-58.18 ± 7.98	0.067	2	0.936
- Medial	-12.30 ± 9.41	-11.61 ± 9.15	-15.66 ± 14.05	0.663	2	0.537
- Lateral	31.95 ± 19.69	26.16 ± 14.28	31.00 ± 11.79	0.058	2	0.815
Time to peak force (ms)						
- Vertical	70.37 ± 10.13	71.10 ± 8.52	62.63 ± 11.63	3.896	2	0.039*
-Anterior	311.27 ± 89.86	300.50 ± 53.95	290.37 ± 89.12	0.362	2	0.701
- Posterior	100.30 ± 14.15	103.43 ± 19.09	95.57 ± 15.77	1.132	2	0.344
- Medial	51.90 ± 25.65	59.43 ± 22.51	39.17 ± 37.32	2.665	2	0.097
- Lateral	91.17 ± 39.67	101.97 ± 45.12	90.87 ± 36.05	1.614	2	0.227

Repeated Measures for ANOVA, * $p < 0.05$

Positive values indicate forces in the anterior and lateral directions

Negative values indicate forces in the posterior and medial directions

4. Discussion

High GRFs post impact may be a precipitating factor associated with injury. If the musculoskeletal system is unable to disperse the forces, it would increase the potential of injury [5-8]. More injury risks may potentially relate with higher loading rate and speed of force during post impact of landing [17]. Problems of shock absorption and force distribution occurred in the musculoskeletal system during landing, depending on magnitude of loading rate being insufficient [18]. Persons with ankle instability demonstrated a greater vertical GRF than the contralateral unaffected side during cutting movement [10]. Many attempts tried to find out the methods or techniques to reduce force generation during landing such as correct movement techniques and instructions [6, 8]. Taping is one of the techniques that usually used in many types of sport because of the effect on improvement of neuromuscular mechanisms through cutaneous input and stimulate the muscular responses and had shown to prevent ankle sprain in game [19].

The present study demonstrated no statistical difference among taping conditions (no tape, Kinesio tape, and non elastic tape) in peak GRFs. However, there was minimal reduction of vertical GRF when taping with Kinesio and non elastic tape. In addition, vertical and mediolateral GRFs during post impact of single drop landing were the lowest when taping with Kinesio tape. Although there was no statistically significant difference, a reduction of GRFs when taping may indicate the beneficial effect of taping as compared with no taping condition.

From literature review, shorter time to peak GRFs presented in persons with FAI when compare to the normal [9, 10]. Reduction in time to peak GRFs related with the ability to adapt of structure around the ankle. Loss of time to adaptation before landing may result in risk of injury in eventual. In the present study, minimal increases in time to peak GRFs (vertical, posterior, medial, and lateral forces) were found in the Kinesio taping condition. Although no statistical significance was found, this taping might be useful for the muscle in preparation prior to landing. Only the time to peak vertical GRF demonstrated significant difference between non elastic taping and Kinesio taping conditions. Reduced time to peak vertical GRF when taped with non elastic taping was found. This may be the result of no elasticity of tape and technique used that made the ankle difficult to move. With different property and technique used in non elastic taping condition, ankle joint stability was promoted which may interfere the ability of relevant muscle motor response in landing.

5. Conclusion

Minimal beneficial effect of the Kinesio taping was demonstrated in terms of decreased peak GRFs and

prolonged time to peak GRFs during post impact of landing. Further research would be benefit if measuring muscle pre-activation and 3D motion analysis for examining biomechanics of the instability of ankle joint during landing.

Limitation of the study

The study can be limited by a number of samples and generalizability in other types of ankle injury.

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