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Original Research

The effectiveness of a novel Kinesio Taping technique on the ground reaction force components during bilateral drop landing in athletes with concurrent pronated foot and patella-femoral pain syndrome

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ABSTRACT

In different sport activities, taping is widely used as a treatment in the prevention and treatment of lower or upper extremity disorders. The aim of this study was to determine the immediate effect of Kinesio Taping (KT) on the ground reaction force (GRF) components during bilateral drop landing task in athletes with concurrent pronated foot and patella-femoral pain syndrome (PFPS). Twelve male athletes (mean age = 20.1 ± 1.4 years; mean height = 169.4 ± 4.8 cm; mean weight = 66.9 ±10.4 kg) with concurrent PFPS and pronated foot were volunteered to participate in this study. Subjects were instructed to perform three bilateral drop landing attempts, before and after Kinesio Taping. To perform the bilateral drop landing tests, the subjects were instructed to execute a double-leg landing task by stepping off a platform (height=30 cm) and landing barefoot with both feet on a Kistler force platform at a frequency of 1000 Hz. Meanwhile, they were asked to employ their natural landing style. Paired sample t test was chosen to measure differences between both with and without taping conditions. The statistical significant level was set at $P < 0.05$.

Results: Peak vertical GRF amplitude (Fz_{max}) was similar between both conditions ($P>0.05$). However, taping condition displayed a lower peak posterior GRF amplitude (by 44%) than that without taping condition ($P=0.002$). Furthermore, peak medio-lateral GRF amplitudes (Fy_{max} and Fy_{min}) did not show any significant diferences between both conditions ($P>0.05$). KT could decrease the possibility of injury by improving both amplitude and time to peak of GRF during bilateral drop landing task in athletes with concurrent pronated foot type and PFPS.

Keywords: Kinesio Taping, Ground Reaction Force, Pronation, Landing, PFPS.

Introduction

Excessive foot pronation is highly associated with a number of lower extremity injuries, including ankle sprains, tibial stress fracture, knee ligament sprains, meniscus tears and patella-femoral pain syndrome (PFPS) [1-3]. Moreover, it is demonstrated that static pronated foot posture has been associated with lower back injuries [26, 27]. Therefore, finding treatment methods is necessary for these patients.

Previous studies showed that long distance runners have greater peak pressure in the medial forefoot during running [28]. The vast majority of weight-bearing tasks, such as walking, standing from a chair, and climbing stairs, involve the closed chain coupling of the foot, shank, and thigh. The elevated ground reaction force (GRF) components result in higher compressive load to the proximal joints of lower extremity and lumbar [6-9]. Therefore, a change in the foot posture could lead to a change in the motion of the proximal joints.

In different sport activities, taping is widely used as a treatment in the prevention and treatment of lower or upper extremity disorders. Evidence suggests that low-dye or traditional taping can be an effective treatment by controlling excessive pronation [29]. However, there is growing popularity in the use of Kinesio Taping (KT) instead of traditional taping. Hip abductor weakness, and excessive mid foot mobility and rear foot eversion are one of the most popular mentioned causes of PFPS [11-15]. Hence, KT of these muscles may be effective in treatment of PFPS. In addition, it was demonstrated that attenuating GRF values during performing closed kinetics chain tasks can help individuals in accelerating the healing process [30].Unfortunately, there is a dearth of information regarding the effects of KT of lower extremity muscles on the forces and loads which were applied on the body during performing closed kinetics chain tasks, and subsequently in the treatment process of patients with PFPS.

KT plays the role of skin structure; it is thin like epidermis and can be stretched between 30% and 40% of its resting length [31]. More recently, the positive effects of KT on the plantar fascia clinical outcomes was demonstrated [32]. Furthermore, it is shown that KT does not correct foot pronation as compared with sham KT in people with pronated feet [33]. Another study of hindfoot KT suggested that there was no acute or lasting effect on the pronated foot posture [33]. To the best of our knowledge, no study has examined the effect of KT (KT of tibialis anterior and the hip abductor muscles) on the GRF components during the bilateral drop landing task. Therefore, further biomechanical and clinical studies are needed.

The aim of this study was to address the lack of biomechanical studies and determine the immediate effects of KT on the GRF components when drop landing task is done by athletes with concurrent pronated foot type and PFPS. In the present study, it is hypothesized that KT of tibialis anterior and hip abductor muscles will be reduced the three dimensional GRF amplitudes of athletes with concurrent pronated foot type and PFPS during bilateral drop landing.

Material and Methods

Twelve male athletes (6 basketball and 6 handball players with at least 3 years of regular participation in amateur contests) with concurrent PFPS and pronated foot were volunteered to participate in this study. The inclusion criteria was: a pronated foot type as defined by the Foot Posture Index (FPI) [34] (FPI score of 6 to 12 was confirmed on the both limbs). Moreover, the participants had to have regular participation in sport activities (continuous training >30 minutes, at least three times per week, age between 18 and 40 years and also they should not have pain provoked by at least two of the following activities: running, walking, hopping, squatting, stair negotiation, or kneeling; and pain elicited by patellar palpation or resisted isometric quadriceps contraction [35]. Exclusion criteria were: lower limb surgery, obvious leg length discrepancy, edema on foot-ankle articulation that may make difficult or mask any necessary details for collecting the FPI. All procedures were done in accordance with the Declaration of Helsinki. Demographic characteristics of participants were: age = 20.1 ± 1.4 years; height = 169.4 ± 4.8 cm, weight = 66.9 ±10.4 kg, visual analog pain scale (VAS) score at rest and during pre-taping condition = 4.1 ± 1.7, and foot posture index [FPI] = 7.5 ± 1.2).

In the taping procedures, tibialis anterior and hip abductor KT was applied by a specialized physiotherapist with more than 9 years of experience. KT was applied according to procedures recommended by Kase et al. [31, 36, 37]. For gluteus medius taping, the participants lied laterally with the adducted hip and the flexed knee position. The strip was anchored with slight tension (approximately 20% of resting length, owing to the adduction of the hip), to the lateral lip of the iliac crest. The tape was placed at proximal anchor point and was placed distal to the greater trochanter. For tibialis anterior taping, each participant sat with the plantar flexed ankle and the everted foot position. The tape was applied from the proximal lateral portion of the tibia to the first metatarsal and medial cuneiform, and was laid along with the tibialis anterior fibers (Figure 1). Standard 5 cm KT was applied bilaterally for both dominant and non-dominant lower limbs.

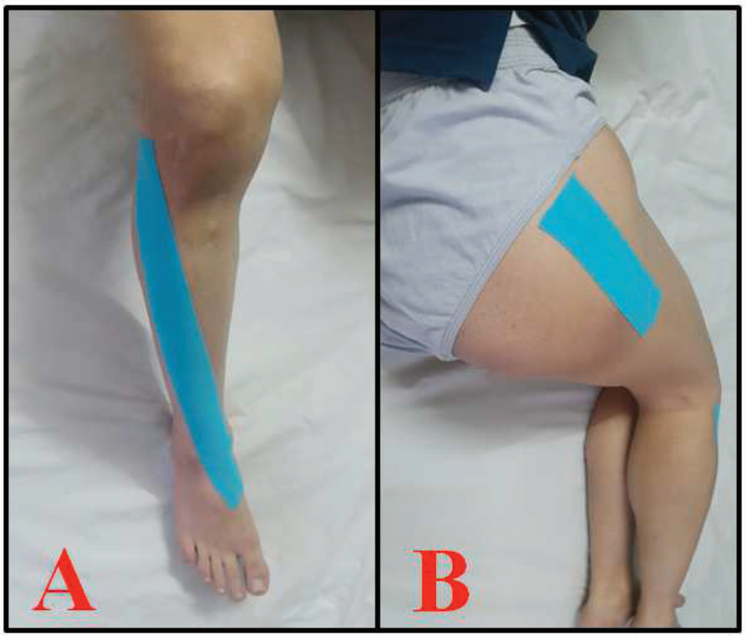


Figure 1. Kinesio taping of (A) tibialis anterior and (B) gluteus medius muscles.

First, participants were allowed to perform up to five landing trials to become familiar with landing task. Then, before and after of KT, a researcher instructed the subject to do three bilateral drop landing trials. The subjects were instructed to execute six double-leg landing attempts by stepping off a platform (height=30 cm) and landing barefoot with both feet on a force plate, while they had to employ their natural landing style. Eventually, for each subject three output signals, which were obtained from Nexus-1.7.5 data capture software, with the highest resolution were selected for further analysis.

The GRFs was measured by two Kistler Force Platforms (Type 9281, Kistler Instrument AG, Winterthur, Switzerland) at a frequency of 1000 Hz. The GRF data were then filtered using a fourth-order low-pass Butterworth filter with a 50 Hz cutoff frequency. The GRF values were recorded along vertical (z), medio-lateral (y) and anterior-posterior (x) directions (Figure 2). The vertical GRF curve in normal landing contains one peak (Fz_{MAX}). From the medio-lateral curve also, two values were recorded corresponding to the positive peak (Fy_{MAX}), and negative peaks (Fy_{MIN}) of the landing cycle. Moreover, on the anterior-posterior curve, two peaks were recorded as the braking reaction force (Fx_{MIN}) and propulsion (Fx_{MAX}) forces (Figure 2). These parameters and their time to peak (TTP) (Figure 2) were computed for further analysis.

SPSS Software v. 22 was used to perform the statistical analysis using descriptive and inferential statistical tests. The GRF data was tested for normality by using the Shapiro-Wilk test. All variable in the GRF data were normally distributed therefore Paired sample t test was chosen to measure differences between both with and without taping conditions. The significant level was set at $P < 0.05$.

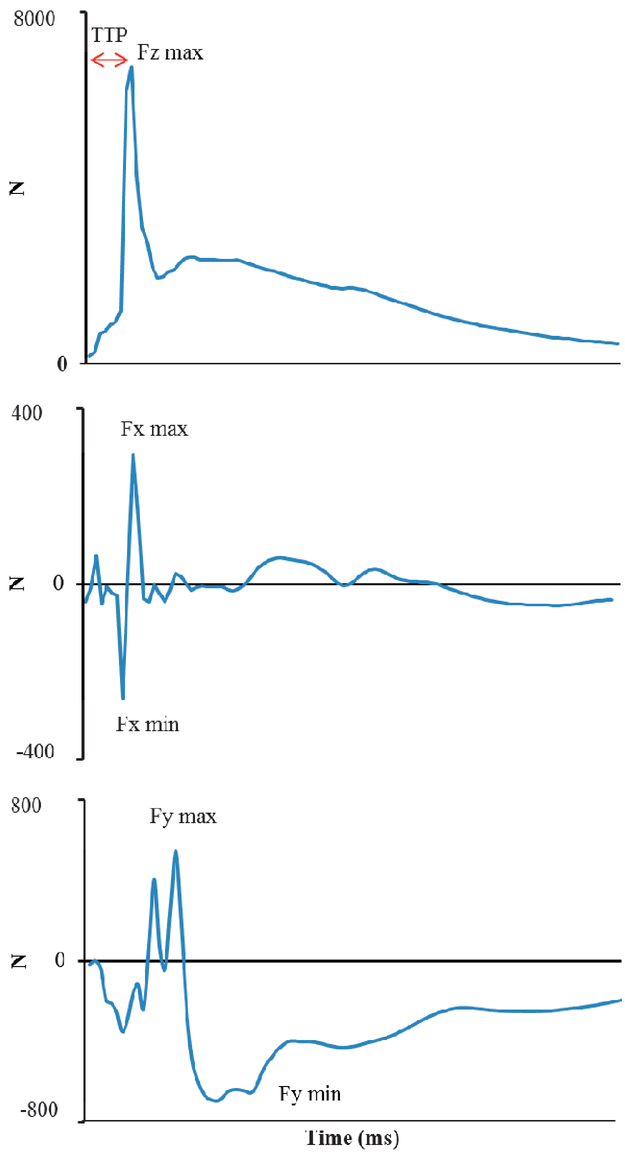


Figure 2. Three dimensional GRF data in a bilateral drop landing of one trial.

Results

Peak vertical GRF variable for both with and without taping conditions are presented in Figure 3. Peak vertical GRF amplitude (Fz_{max}) was similar between both conditions (P>0.05).

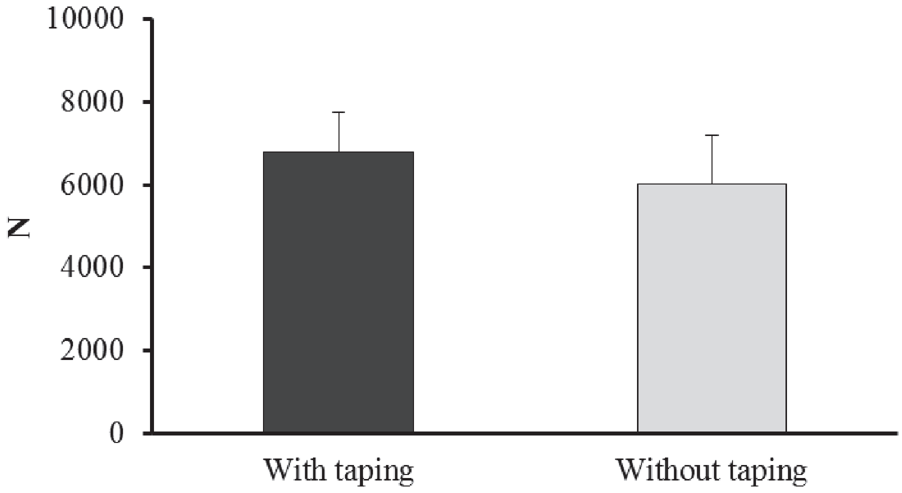
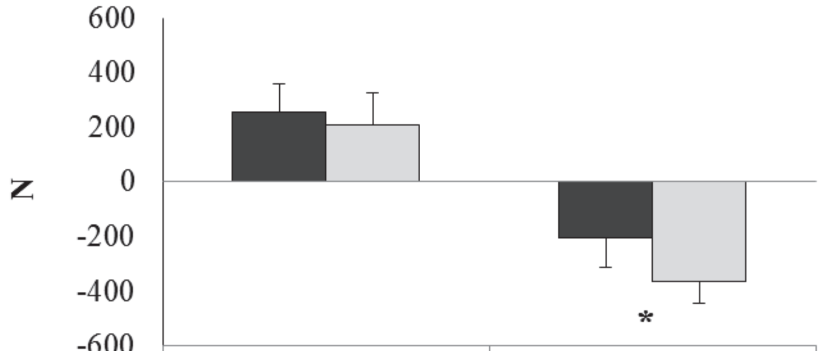


Figure 3. Mean ± standard deviation of peak GRF amplitude of Z axis (Fz_{max}) for both conditions.

Peak posterior-anterior GRF variables for both with and without taping conditions are presented in Figure 4. Peak anterior GRF amplitude (Fx_{max}) was similar between both conditions (P>0.05). However, taping condition displayed a lower peak posterior GRF amplitude (by 44%) than that in without taping condition (P=0.002).



	Fx max	Fx min
■ With taping	254.7	-204.7
□ Without taping	208.4	-365

Figure 4. Mean ± standard deviation of peak positive (Fx_{max}) and negative (Fx_{min}) GRF amplitudes in anterior-posterior directions in each condition.

Peak medio-lateral GRF variables for both with and without taping conditions are presented in Figure 5. Peak medio-lateral GRF amplitudes (Fy_{max} and Fy_{min}) did not show any significant differences between both conditions (P>0.05).

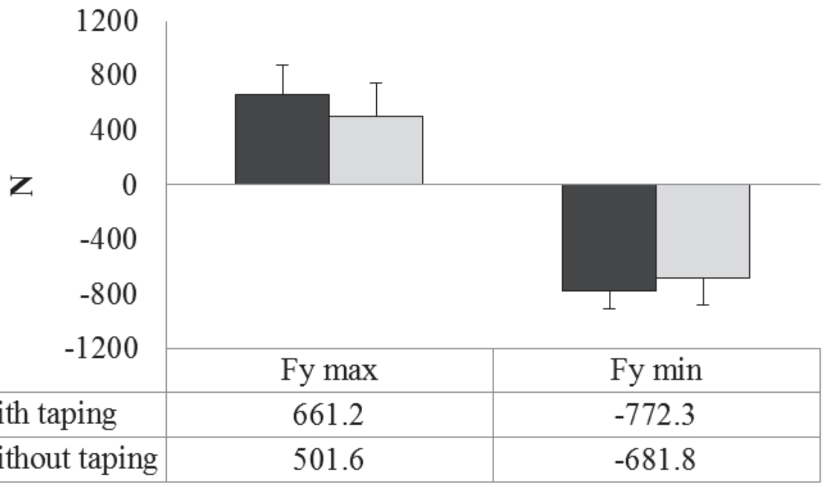


Figure 5. Mean ± standard deviation of peak positive (Fy_{max}) and negative (Fy_{min}) GRF amplitudes in medio-lateral direction for both conditions.

Table 1 illustrates the TTP in both conditions. TTP for Fx_{max}, Fx_{min}, and Fy_{max} during taping condition was significantly higher than that in without taping condition by 22 ms (P=0.001), 30 ms (P=0.001), and 12 ms (p=0.023), respectively. Other TTP variables between with and without taping conditions were not statistically different (p>0.05).

Table 1. The time to peak of GRF components are presented for both with and without taping conditions.

Time to peak	With taping	Without taping	Sig.
Fz max	37.00±8.02	29.83±16.99	0.196
Fx max	44.91±16.58	22.16±12.79	0.001*
Fx min	37.83±12.13	7.75±1.54	0.001*
Fy max	40.58±8.21	28.00±15.43	0.023*
Fy min	45.66±23.13	34.66±21.15	0.196

* $P < 0.05$

Discussion

The aim of this study was to address the immediate effect of KT on the ground reaction force components during bilateral drop landing task in athletes with concurrent pronated foot type and PFPS.

In the present study, the peak vertical GRF amplitude (Fz_{max}) and peak anterior GRF amplitude (Fx_{max}) were similar between both conditions. However, taping condition demonstrated lower peak posterior GRF amplitude than without taping condition. The mechanism of action of KT has been speculated, however, only a limited number of studies have investigated the effect of KT on pain and joint motion [38]. In the foot and ankle for instance, a study to assess the effect of KT on ankle proprioception no enhancement of joint proprioception was shown; on the other hand, the study was limited by a small sample size and without control group [39]. Based on our results, tibialis anterior and hip abductor KT possibly could decrease the posterior GRF amplitude. This result may be owing to a better control of pronation immediately after application of KT [40] and therefore could possibly reduce the rate of shear force induced injuries in the proximal joints of lower extremities.

In this study, peak medio-lateral GRF amplitudes (Fy_{max} and Fy_{min}) did not show any significant differences between both conditions. A pronated foot type is highly associated with excessive foot pronation [41], where hindfoot and midfoot joints show movement that is greater than those in the comparative normal groups [41]. Previous studies have been demonstrated that pronated or flat foot type is associated with a greater medial forces and pressures during walking or running tasks [42, 43]. Nevertheless, our results did not show any significant effect of KT on medio-lateral GRF amplitudes.

TTP for Fx_{max}, Fx_{min}, and Fy_{max} during taping condition was significantly higher than that in without taping condition. Long TTP during the taping condition in frontal and horizontal planes could reduce the rate of injury by delaying the occurrence of the peak GRF amplitude. Other TTP variables between with and without taping conditions were not statistically different. It was found that the temporal aspects of the force platform data were more consistent than the magnitude of the forces [44]. Timing consistency reflects motor programs for movement control in which a stored sequence of motor commands can be individualized to meet specific task demands [44, 45]. In consequences, KT possibly could change motor programs, especially in frontal and horizontal planes. However, further studies were warranted to investigate the effects of KT on other aspects of motor programs, posture and movement control.

A main limitation of our study is that the present study was conducted without sham taping condition for any of the measured variables. In addition, although this study allows reasonable comparison of GRF and their TTP between both with and without taping conditions, the results may not completely reflect the physiological landing maneuver during sports activities which contain jumping and landing such as volleyball and basketball.

Conclusion

In comparison with no taping condition, taping can create lower peak posterior GRF values. Furthermore, TTP for Fx_{max}, Fx_{min}, and Fy_{max} during taping condition were significantly higher than that in without taping condition. Therefore, KT could decrease the possibility of injury by improving both amplitude and TTP of GRF during bilateral drop landing.

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References

1. Lun, V., et al., *Relation between running injury and static lower limb alignment in recreational runners*. British journal of sports medicine, 2004; **38**(5):576-580.
2. Kothari, A., et al., *Are flexible flat feet associated with proximal joint problems in children?* Gait & posture, 2016; **45**:204-210.
3. Escamilla-Martínez, E., et al., *The effect of moderate running on foot posture index and plantar pressure distribution in male recreational runners*. Journal of the American Podiatric Medical Association, 2013; **103**(2):121-125.
4. O'Sullivan, K., et al., *The effect of low-dye taping on rearfoot motion and plantar pressure during the stance phase of gait*. BMC musculoskeletal disorders, 2008; **9**(111):1-9.
5. Gruber, A.H., et al., *Impact shock frequency components and attenuation in rearfoot and forefoot running*. Journal of sport and health science, 2014; **3**(2):113-121.
6. Kase, K., J. Wallis, and T. Kase, *Clinical Therapeutic Applications of the Kinesio Taping Method: Universal Printing & Publishing Inc.* Alberquerque New Mexico, 2003.
7. Tsai, C.-T., W.-D. Chang, and J.-P. Lee, *Effects of short-term treatment with kinesiotaping for plantar fasciitis*. Journal of Musculoskeletal Pain, 2010; **18**(1):71-80.
8. Luque-Suarez, A., et al., *Effects of kinesiotaping on foot posture in participants with pronated foot: A quasi-randomised, double-blind study*. Physiotherapy, 2014; **100**(1):36-40.
9. Redmond, A.C., Y.Z. Crane, and H.B. Menz, *Normative values for the foot posture index*. Journal of Foot and Ankle research, 2008; **1**(1):1.
10. Barton, C.J., et al., *The relationship between rearfoot, tibial and hip kinematics in individuals with patellofemoral pain syndrome*. Clinical biomechanics, 2012; **27**(7):702-705.
11. Pijnappel, H., *Medical taping concept*. Aneid (UK) Ltd, 2009.

12. BPhty, S.B., *Plantar foot pressures after the augmented low dye taping technique*. Journal of Athletic Training, 2007; **42**(3):374-380.
13. Morris, D., et al., *The clinical effects of Kinesio® Tex taping: A systematic review*. Physiotherapy theory and practice, 2013; **29**(4):259-270.
14. Halseth, T., et al., *The effects of kinesio taping on proprioception at the ankle*. J Sports Sci Med, 2004; **3**(1):1-7.
15. Vicenzino, B., et al., *An investigation of the anti-pronation effect of two taping methods after application and exercise*. Gait & posture, 1997; **5**(1):1-5.
16. Scranton, P.E., L.R. Pedegana, and J.P. Whitesel, *Gait analysis alterations in support phase forces using supportive devices*. The American journal of sports medicine, 1982; **10**(1):6-11.
17. García-Pérez, J.A., et al., *Effect of overground vs treadmill running on plantar pressure: Influence of fatigue*. Gait & posture, 2013; **38**(4):929-933.
18. Farahpour, N., et al., *Gait ground reaction force characteristics of low back pain patients with pronated foot and able-bodied individuals with and without foot pronation*. Journal of Biomechanics, 2016; **49**(9):1705-1710.
19. Begg, R., W. Sparrow, and N. Lythgo, *Time-domain analysis of foot–ground reaction forces in negotiating obstacles*. Gait & posture, 1998; **7**(2):99-109.
20. Shapiro, D.C., et al., *Evidence for generalized motor programs using gait pattern analysis*. Journal of motor behavior, 1981; **13**(1):33-47.

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