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**Original Research**

# The Effect of Ankle Kinesio Taping on Ground Reaction Force Components in Individual with Ankle Sprain during Walking

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**ABSTRACT**

Ankle sprain is one of the most common injuries in different population. One way to treat ankle sprain is to use a Kinsio tape. Given the importance of the ground reaction forces, no research has been done on the effect of the kinesio tape on the components of the ground reaction force. Therefore, in this study, we intend to investigate the effect of Kinsio Tape on the components of ground reaction force. 10 females with ankle sprain participated in this study. Using a force plate (1000 Hz), the components of the ground reaction force were measured while walking in two conditions with and without tape. Then, the peak variables of the ground reaction forces, impulse, and loading rate were extracted. The repeated measure test with a significance level ($P \leq 0.05$) was used for statistical analysis. The results showed that the use of kinesio tape significantly reduced the components of ground reaction force in the direction of Fz1($p = 0.01$), Fx1 ($p = 0.027$) and Fy1 ($p = 0.001$), but in the other components there was no difference between the two conditions. According to the results of the present study, it seems that Kinesio Tape cannot provide sufficient mechanical support to improve the condition of the ankle, so the use of Kinesio Tape for treatment is ambiguous.

**Keywords:** kinesio tape, walking, ground reaction force, ankle sprain

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## Introduction

Ankle sprain is one of the most common injuries in different people (1). According to research reports, 10 to 30 percent of people with ankle sprains develop ankle instability (2). This problem leads to a feeling of instability, frequent emptying of the ankle and recurrent sprain of the ankle (3). Ankle sprains impose a high cost of treatment on the community due to increased medical care and absenteeism. Mechanical instability and functional instability play a role in the development of chronic ankle instability (3). Therefore, providing appropriate solutions for the prevention of sprain and treatment for sprain has always been considered by researchers. Three treatments have been suggested for the treatment of ankle sprain (4,5). The first is surgical treatment, the second is braces, and the third is tape treatment (4,5). Bandage is used by the kinesio tape band as an alternative to more advanced techniques and braces to prevent and treat ankle sprain (6). Kinsiotape is the

latest form of elastic band used by Dr. Kenzo Kase in the 1970s (7,8). kinesio tape is used to increase joint stability without restricting the range of motion of the body (7,8). The tape used for the kinsiotape is different from the traditional sports tape (8,9). It has a one-sided elasticity and can be stretched up to 140% of its original length before applying it to the skin, so that a constant tensile force can be applied to the skin (8,9). In addition, the tape used for the kinesio tape type is air-permeable and water-resistant and can be worn for several days without removal (10). kinesio tape may help people with ankle sprains by reduce pain, change muscle function, improve blood circulation, enhancing proprioception, and repositioning subluxed joints (10,11). In other words, using a kinesio tape not only control the movement of the ankle, but also cause enhancing proprioception the ankle joint (8-10,11). Limited studies have been performed on the effect of kinesio tape on individuals (12,13).
Ground reaction force is great clinical importance (14,15) so that increasing the components of the ground reaction forces are associated with injuries from overuse and expose the individual to injuries such as stress fracture, patellar pain, and the complication of plantar fasciitis (16-19). So researchers are looking for a way to reduce ground reaction force. The use of kinesio tape is recommended for the treatment of ankle sprains. However, given the importance of the issue, no research has been conducted on the effect of kinesio tape on reaction forces. Since the three-dimensional distribution of the ground reaction forces is of clinical importance and will help therapists in determining the appropriate treatment strategies, in this study we intend to examine the effect of kinesio tape on the ground reaction forces and also, the related components to gain an understanding of the forces applied to the body in these people. Our hypothesis in the present study is that the use of kinesio tape reduces the components of the grounf reaction force in people with ankle sprain.

## Material and Methods

### Participants

The present study is of quasi-experimental and experimental type. 10 women with ankle instability were participant in this study. The mean and standard deviation of the age, height and mass of the subjects were equal to (30.87 ± 5.05 year), (166 ± 7 cm), and (71.6 + 15.2 kg), respectively. The criteria for subjects to enter the study were: obtaining a score above 26 from the ankle performance evaluation questionnaire, a history of severe external ankle sprains, a history of ankle instability in the last 6 months. Also, the exclusion criteria from the study were the difference of more than 3 mm between the length of the two lower extremities, the history of surgery, and skeletal abnormalities. All subjects were right-handed and right-footed, which was measured by hand throwing test and foot kick. Subjects were advised not to engage in strenuous physical activity for 48 hours prior to the test. Prior to the test, the objectives and the study method were described to the subjects. Subjects signed a written consent to participate in the study.

### Instruments and Procedure

In the present study, South Korean kinesio tape was used (Fig 1).


**Fig 1. Kinesio tape**

Using two force plates of Kistler (Kistler AG, Winterthur, Switzerland) of dimensions 600 mm *400 mm, the ground reaction forces (GRF) in the vertical (Fz), anterior-posterior (Fy) and mediolateral directions (Fx) were measured while walking. The sampling frequency was set to Hz1000 (20). The two force plates were placed along each other, apart 1 cm from each other in the middle of a 20-meter path, so that the subject would take at least 5 steps before reaching the force plate. The force plate was calibrated before the test was performed.

During walking, the GRF of both legs was recorded and the results of the dominant leg were used for analysis. Before the test, each subject would walk in the lab for about 5 minutes to adjust to the test conditions. Then, each subject walked 6 times with "shoes" and 6 times with "shoes + tapping" and their kinetic information was recorded. In the present study, the type of shoes (ASICS design) was the same for all subjects and selected according to their foot size.

## Data Processing

The gathered force plate signals were fitted using fourth-order low-pass Butterworth filter with a 10 Hz cut of frequency (20). Peak variables of ground reaction forces, impulse and loading rate were measured. For the GRF variables, three vertical components, five mediolateral components and two anterior-posterior components were extracted. For ground reaction forces, the 3-point vertical line includes the value of the initial contact (FzI.C), the mid-stance phase (FzM.S), and the push off (FzP.O), in the anterior-posterior direction of the two peak points (FyP.O) and brake (FyI.C), and in the mediolateral direction of the 5 peaks (FxI.C, FxF.F FxM.S, FxH.O and FxP.O) were calculated. All GRF forces were normalized according to individual weight.

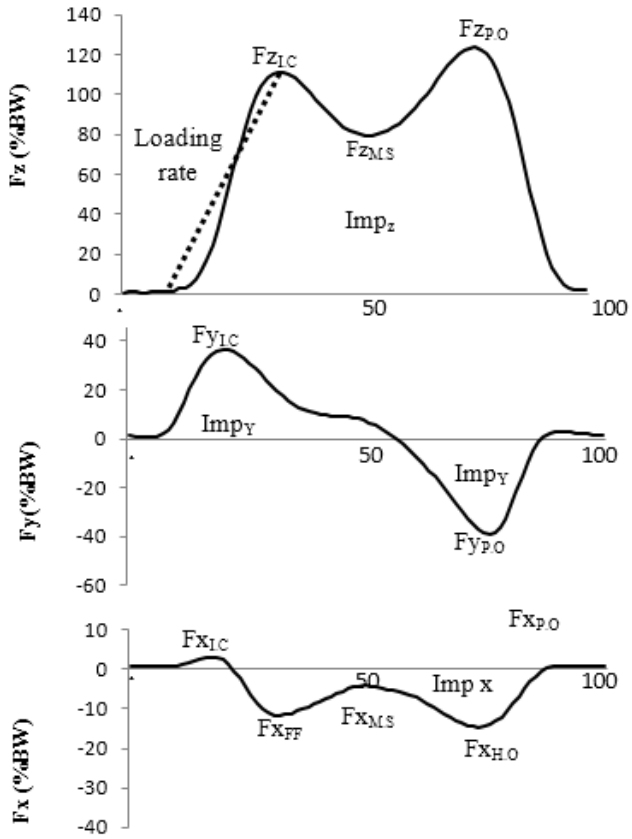


**Fig 2: Three dimensional GRF data during walking (20)**

Impulse was also measured in three directions: x (Impx), y (Impy), and z (Impz). To calculate the impulse amount, the method Trapezoidal integration was used (21).

$$\text{impulse} = \Delta t\left(\left(\frac{F1 + Fn}{2}\right) + \sum_{i=2}^{n-1} Fi\right)$$

Vertical loading rate is defined as the initial section slope between heel contact moment to the first peak of vertical ground reaction force (17).

$$\text{Loading rate} = \left[\left[\frac{FZ_1(\text{N})/\text{body weight(N)}}{\text{time to peak } FZ_1}\right]\right]$$

## Statistical Analyses

Shapiro Wilk test was used to check the normality of the data. Due to the normal distribution of the data, the repeated measure ANOVA test was used to make the intragroup comparison at the significance level of $p < 0.05$.

## Results

The values for the maximum ground reaction force in the vertical, anterior-posterior, and medio-lateral directions are summarized in Table 1. As can be seen, taping increases ground reaction force values in the Fz1, Fx1, and Fy1 directions ($p>0.05$).

**Table 1.** Mean and standard deviation of the normalized ground reaction force during walking

| BW% | | Without tapping | With tapping | P value |
|---|---|---|---|---|
| Fz | $Fz_1$ | 1.52±0.26 | 1.61±0.27 | 0.011* |
| | $Fz_2$ | 1.08±0.192 | 1.12±0.19 | 0.67 |
| | $Fz_3$ | 1.56±0.25 | 1.56±0.2 | 0.95 |
| Fx | $Fx_1$ | 0.036±0.017 | 0.051±0.015 | 0.027* |
| | $Fx_2$ | -0.062±0.011 | -0.073±0.017 | 0.059 |
| | $Fx_3$ | -0.0305±0.01 | -0.026±0.019 | 0.289 |
| | $Fx_4$ | -0.052±0.016 | -0.052±0.023 | 0.94 |
| | $Fx_5$ | 0.008±0.006 | 0.0113±0.007 | 0.112 |
| Fy | $Fy_1$ | -0.22±0.048 | -0.28±0.057 | 0.001* |
| | $Fy_2$ | 0.29±0.051 | 0.29±0.047 | 0.763 |

Figure 3 shows the impulse values in three directions. Examining the results, it was found that taping had no significant effect on impulse results ($p<0.05$).

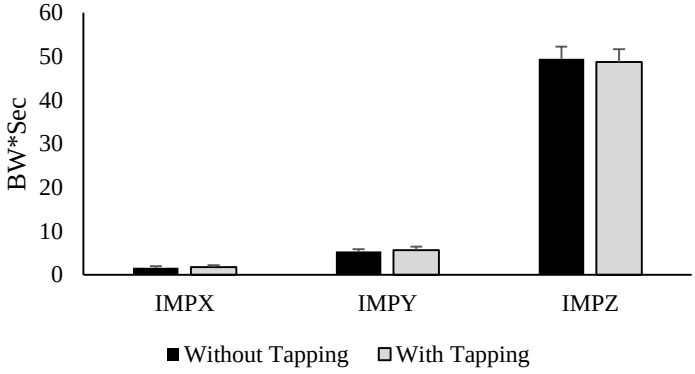


**Fig 3. Impulse value in stance phase of gait for tow condition (with and without tapping)**

Figure 4 shows the vertical force loading rate in two conditions of with and without tapping during walking. As seen, the kinesio tape did not reduce the loading rate ($p > 0.05$).

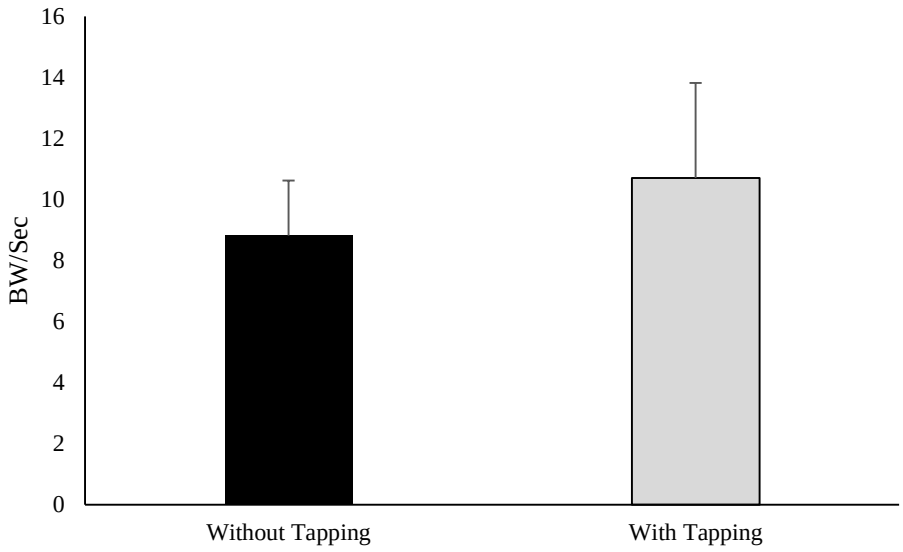


**Fig 4. Loading rate in stance phase of gait for tow condition (with and without tapping)**

## Discussion

The aim of the present study was to investigate the effect of immediate use of kinesio tape on the maximum ground reaction forces, loading rate and impulse in people with ankle sprain during walking.

At the moment of heel contact with the ground, various factors such as surface material, type of shoe, muscle activity, range of motion of the joints affect the amount of force acting on the ground (22). Since in this study both the surface on which the walking was performed and the type of shoes were considered the same for both groups, the cause of the difference in the components of the ground reaction force can be considered as a result of using kinesio tape (23). It is clinically important to examine the ground reaction forces in all three dimensions. In the present study, it was observed that when using kinesio tape, the horizontal ground reaction (Fx1) force is significantly increased. Research has shown that changes in the horizontal ground reaction force are related to those in the center of gravity, so an increase in the internal and external force of the horizontal ground reaction force indicates more changes in the center of gravity and therefore more instability in individuals (24).

These findings are consistent with the findings of Caulfield et al., 2004 (25). They suggested that changes in the lateral and anterior cranial forces observed may lead to recurrent injuries due to a significant increase in stress in the structure of the ankle joints, because peak forces occur especially in individuals with functional ankle instability (25).

The results of the present study showed that the kinesio tape increases the posterior ground reaction force. In various studies, the posterior reaction force is referred to as the braking force. The increase in the posterior reaction force is related to the anterior shear force in the knee, so increasing this force is one of the risk factors for knee injuries (26). On the other hand, increasing posterior force is one of the compensatory strategies to maintain balance and prevent slipping. People with ankle sprains appear to use a conservative walking strategy which increases the ground reaction force at the posterior surface. These findings are consistent with the findings of McKayet al., 2001 (27). The higher braking forces are explained by the need to decelerate in

preparation to cut toward the new plane of progression. These greater braking forces have been associated with a relative increase in quadriceps activation during the early stance of running (27,12). The results of the present study showed that the use of kinesio tape increases the vertical ground reaction force at the moment of heel contact with the ground. Various studies have shown that the increase in the vertical ground reaction force is related to the application of compressive force on the musculoskeletal structure of the body. One of the limitations of this study was that the man subjects were not included in the study, and due to differences in anthropometric characteristics, the generalization of the results of this study to the whole population would bear problems.

## Conclusion

The results of the present research have shown that the kinesio tapping of ankle increases the horizontal ground reaction force, anterior-posterior ground reaction force and vertical ground reaction force. According to the results of the present study, it seems that kinesio tape cannot provide sufficient mechanical support to improve the condition of the ankle, so the use of kinesio tape for treatment is ambiguous. However, further study on other treatment methods (e.g rehabilitation, shoes, foot orthoses, and etc (28-35)) simultaneous with kinsio taping was recommended.

## Acknowledgement

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## References

1. Ho Y, Lin C, Chang C, & Wu H. Effect of ankle kinesio taping on vertical jump with run-up and countermovement jump in athletes with ankle functional instability. Journal of physical therapy science. 2015; 27(7), 2087-2090.
2. Hale S, Hertel J. Reliability and sensitivity of the Foot and Ankle Disability Index in subjects with chronic ankle instability. Journal of athletic training. 2005; 40(1), 35.
3. Monaghan K, Delahunt E, Caulfield B. Ankle function during gait in patients with chronic ankle instability compared to controls. Clinical Biomechanics. 2006; 21(2), 168-174.
4. Kim J, Cho M, Park J, Shin J, Cho H, Park G, & Nam D. The effects of Kinesiotape on acute lateral ankle sprain: study protocol for a randomized controlled trial. Trials. 2018;19(1), 125.
5. van Den Bekerom M, van Kimmenade R, Sierevelt I, Eggink K, Kerkhoffs G. ,van Dijk C, Raven E. Randomized comparison of tape versus semi-rigid and versus lace-up ankle support in the treatment of acute lateral ankle ligament injury. Knee surgery, sports traumatology, arthroscopy. 2016; 24(4), 978-984.
6. Wilkerson, G. B. Biomechanical and neuromuscular effects of ankle taping and bracing. Journal of Athletic training. 2002; 37(4), 436.

7. Williams S, Whatman C, Hume P, Sheerin K. Kinesio taping in treatment and prevention of sports injuries. Sports medicine. 2012; 42(2), 153-164.

8. Nakajima M, Baldridge C. The effect of kinesio® tape on vertical jump and dynamic postural control. International journal of sports physical therapy. 2013; 8(4), 393.

9. Bicici S, Karatas N, Baltaci G. Effect of athletic taping and kinesiotaping® on measurements of functional performance in basketball players with chronic inversion ankle sprains. International Journal of Sports Physical Therapy.2012; 7(2), 154.

10. Kase, K. Clinical therapeutic applications of the Kinesio taping method. Albuquerque.2003.

11. Kim J H, Cho M, Park J H, Shin J C, Cho J, Park G, & Nam D. The effects of Kinesiotape on acute lateral ankle sprain: study protocol for a randomized controlled trial. Trials. 2018; 19(1), 125.

12. Sacco I D, Takahasi, H, Suda E, Battistella L, Kavamoto C, Lopes J, Vasconcelos J. Ground reaction force in basketball cutting maneuvers with and without ankle bracing and taping. Sao Paulo Medical Journal. 2006; 124(5), 245-252.

13. Jafarnezhadgero A, Shad M, Majlesi M, Zago M. Effect of kinesio taping on lower limb joint powers in individuals with genu varum. Journal of bodywork and movement therapies. 2018; 22(2), 511-518.

14. Farahpour N, Jafarnezhad A, Damavandi M, Bakhtiari A, Allard P. 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.

15. Jafarnezhadgero A A, Majlesi M, Azadian E. Gait ground reaction force characteristics in deaf and hearing children. Gait & posture. 2017; 53, 236-240.

16. Zadpoor, A. A., & Nikooyan, A. A. The relationship between lower-extremity stress fractures and the ground reaction force: a systematic review. Clinical Biomechanics. 2011; 26(1): 23-28.

17. Crowell, H. P., & Davis, I. S. Gait retraining to reduce lower extremity loading in runners. Clinical biomechanics. 2011; 26(1): 78-83.

18. McClay Davis, I. S., Bowser, B. J., & Hamill, J. D.Vertical impact loading in runners with a history of patellofemoral pain syndrome. Medicine & Science in Sports & Exercise. 2010; 42(5): 682.

19. Pohl, M. B., Hamill, J., & Davis, I. S. Biomechanical and anatomic factors associated with a history of plantar fasciitis in female runners. Clinical Journal of Sport Medicine. 2009; 19(5): 372-376.

20. Yazdani, S., Farahpour, N. Kinetic Gait analysis in Patients with Adolescent Idiopathic Scoliosis and Normal Control Subjects. Journal of Paramedical Sciences & Rehabilitation. 2017; 6(2): 48-59.

21. Robertson, G. E., Caldwell, G. E., Hamill, J., Kamen, G., & Whittlesey, S Research methods in biomechanics, 2E. Human Kinetics. 2013.

22. Frederick, E. C., & Hagy, J. L. Factors affecting peak vertical ground reaction forces in running. International journal of sport biomechanics.1986; 2(1): 41-49.

23. Brown, C., Padua, D., Marshall, S. W., & Guskiewicz, K. Individuals with mechanical ankle instability exhibit different motion patterns than those with functional ankle instability and ankle sprain copers. Clinical biomechanics. 2008; 23(6): 822-831.

24. John, C. T., Seth, A., Schwartz, M. H., & Delp, S. L. Contributions of muscles to mediolateral ground reaction force over a range of walking speeds. Journal of biomechanics. 2012; 45(14): 2438-2443.

25. Caulfield, B., & Garrett, M. Changes in ground reaction force during jump landing in subjects with functional instability of the ankle joint. Clinical biomechanics. 2004; 19(6), 617-621.

26. Feagin, J. A., & Steadman, J. R. The crucial principles in care of the knee. Lippincott Williams & Wilkins, 2008.

27. Mckay, G. D., Goldie, P. A., Payne, W. R., & Oakes, B. W. Ankle injuries in basketball: injury rate and risk factors. British journal of sports medicine. 2001; 35(2) 103-108.

28. Jafarnezhadgero, A.A., Majlesi, M., Etemadi, H. and Robertson, D.G.E. Rehabilitation improves walking kinematics in children with a knee varus: Randomized controlled trial. Annals of physical and rehabilitation medicine. 2018; 61(3): 125-134.

29. Mohammadi, V., Letafatkar, A., Sadeghi, H., Jafarnezhadgero, A. and Hilfiker, R. The effect of motor control training on kinetics variables of patients with non-specific low back pain and movement control impairment: Prospective observational study. Journal of bodywork and movement therapies. 2017; 21(4): 1009-1016.

30. Alavi-Mehr, S.M., Jafarnezhadgero, A., Salari-Esker, F. and Zago, M. Acute effect of foot orthoses on frequency domain of ground reaction forces in male children with flexible flatfeet during walking. The Foot. 2018; 37: 77-84.

31. Jafarnezhadgero, A., Madadi-Shad, M., Alavi-Mehr, S.M. and Granacher, U. The long-term use of foot orthoses affects walking kinematics and kinetics of children with flexible flat feet: A randomized controlled trial. PloS one. 2018; *3*(10): e0205187.

32. Jafarnezhadgero, A., Alavi-Mehr, S.M. and Granacher, U. Effects of anti-pronation shoes on lower limb kinematics and kinetics in female runners with pronated feet: The role of physical fatigue. PloS one. 2019; 14(5): e0216818.

33. Jafarnezhadgero, A., Fatollahi, A., Amirzadeh, N., Siahkouhian, M. and Granacher, U. Ground reaction forces and muscle activity while walking on sand versus stable ground in individuals with pronated feet compared with healthy controls. PloS one. 2019; 14(9): e0223219.

34. Madadi-Shad, M., Jafarnezhadgero, A.A., Sheikhalizade, H. and Dionisio, V.C.. Effect of a corrective exercise program on gait kinetics and muscle activities in older adults with both low back pain and pronated feet: A double-blind, randomized controlled trial. Gait & Posture. 2020; 76; 339-345.
35. Jafarnezhadgero, A., Mousavi, S.H., Madadi-Shad, M. and Hijmans, J.M. Quantifying lower limb inter-joint coordination and coordination variability after four-month wearing arch support foot orthoses in children with flexible flat feet. Human Movement Science. 2020; 70: 102593.

**چکیده فارسی**

# تاثیر کینزیوتیپ بر متغییرهای نیروی عکس العمل زمین در افرادی با عارضه اسپرین مچ پا

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اسپرین مچ پا یکی از آسیب‌های رایج در افراد مختلف است. یکی از روش‌های درمان این آسیب استفاده از کینسیو تیپ است. با توجه به اهمیت نیروهای عکس العمل زمین، تاکنون تحقیقی در رابطه با تاثیر کینسیو تیپ بر نیروهای عکس العمل زمین صورت نگرفته است. لذا در این تحقیق قصد داریم به بررسی اثر کینسیوتیپ بر مولفه های نیروی عکس العمل زمین بپردازیم. ۱۰ زن با عارضه اسپرین مچ پا در این مطالعه شرکت نمودند. با استفاده از یک صفحه نیرو (۱۰۰۰ هرتز) مولفه‌های نیروی عکس‌العمل زمین هنگام راه رفتن در دو شرایط با و بدون باند اندازه‌گیری شد. سپس متغیرهای اوج نیروهای عکس‌العمل زمین، ایمپالس، ونرخ بارگذاری استخراج شدند. آزمون آماریRepeatedmesure با سطح معناداری (P<۰/۰۵) جهت تحلیل آماری مورد استفاده قرار گرفت. نتایج نشان داد در نیروی عکس‌العمل همسان‌سازی‌شده درجهتFz1، Fx1 و Fy2 بین دو شرایط اختلاف معناداری وجود دارد (P=۰/۰۴)، اما در سایر مولفه‌ها اختلافی بین دو شرایط مشاهده نشد. با توجه به نتایج تحقیق حاضر به نظر می‌رسد کینسیو تیپ نمی تواند حمایت مکانیکی کافی برای بهبود شرایط مچ پا ایجاد کند لذا استفاده از کینسیو تیپ برای درمان با ابهام مواجه است.

**واژه های کلیدی:** کینزیوتیپ، راه رفتن، نیروی عکس العمل زمین، اسپرین مچ پا