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Original Research

The Immediate Effects of Kinesio Tape Intervention On Plantar Pressure Parameters in Individuals with Functional Ankle Instability

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ABSTRACT

Given the importance of recognizing athletes with chronic ankle instability for rehabilitation clinics, foot pressure variables are essential parameters in the biomechanical analysis of the gait. This study aimed to determine the effect of kinesio tape application on plantar pressure variables in individuals with functional ankle instability. This quasi-experimental study included 29 men (24.5±2.27 years) with functional ankle instability selected using convenience sampling. A 15-meter path was provided for the subjects to walk. A foot scanner was installed 10 meters from the beginning of the route. Subjects were asked to walk 15 meters along this route. The kinesio tape was applied to the tibialis anterior, gastrocnemius, and peroneus muscles. After 20 minutes, Re-gait test was performed. Foot pressure data were recorded during walking. Plantar pressure variables, including peak plantar pressure distribution, the center of pressure, rearfoot inversion/eversion, forefoot supination, and pronation were measured before and after kinesio tape. No significant differences were found between the ten regions. The highest pressure was monitored in region 5 (third metatarsal) equal to 19.45 kPa, the lowest pressure was observed in the middle metatarsal region (second to the fifth toe) equal to 4.85 kPa. The use of kinesio tape affects on the fifth and middle metatarsus. The use of kinesio tape in people with ankle sprains can prevent the ankle from being too exposed to the pronation and keep the foot in supination, which is essential. Stimulation of mechanical receptors in the arch of the foot and around the ankle by kinesio tape can effectively increase the dynamic stability of the ankle.

Keywords: Ankle sprain, Foot pressure, Kinesio tape, Foot scan

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INTRODUCTION

Lateral ankle sprains are among the most prevalent sports-related injuries, which account for 10 to 30% of all sports injuries. The most common mechanism of injury in ankle sprains is a combination of plantar flexion, inversion, and supination. Although many of these injuries are mild and treatable, about 30% of athletes who suffer from ankle sprains end up suffering from functional ankle instability, which is still known to cause ankle sprains (1). In many sports, such as mountaineering, handball, volleyball, soccer, rhythmic movements in women, and gymnastics, injury prevalence is higher. The recurrence rate of ankle sprains is 19 to 70 percent (2). Previous studies have reported pathological laxity, postural control defects, lower limb reflex defects, lower limb strength defects, arthrokinematics defects, or position sense defects in functional ankle instability (3). Ankle sprains involve most (85%) of the anterior talofibular ligaments, posterior and calcaniofibular ligaments, the deltoid, and in most cases cause joint instability and pain (4). The ligaments and muscles around the ankle play an essential role in absorbing the energy resulting from the foot hitting the ground in various activities such as walking or landing, and jumping. The ankle sprain can cause a change in the amount of contact force in the ankle and lead to long-term chronic problems with the ankle, such as repeated injury (5). Among the methods of gait analysis, measuring the plantar pressure such as plantar surface pressure/force distributions and the contact sensation with the ground is one of the most common and new methods that investigate the function of the foot in static and dynamic conditions (6,7).

Measuring the pressure distribution of the sole of the foot plays a vital role in the evaluation and treatment of foot disorders and gait disorders in general.The distribution of "foot pressure" is considered a biofeedback rehabilitation method for gait and posture control in injured people (8,9). Data on "sole pressure distribution" is used to diagnose foot problems, insole design, performance analysis and improve control, exercise balance, and injury prevention. Any change in the pressure pattern on the sole increases the likelihood of tissue damage and pain. In general, foot pressure analysis has provided a new perspective on pain behavior and complaints of lower limb discomfort, for example, to find abnormal biomechanics and body alignment (10,11).

In the past, it was believed that the gait in healthy persons was automatic and there was no need for attention (12). Therefore, doing an extra task while walking changes gait (e.g., stability, speed) or in performing a second task or both (13). To prove this hypothesis, researchers have evaluated the degree of dependence on attention in controlling the way people walk (13,14) and use to perform simultaneous cognitive tasks while walking, ; the studies have shown that gait in healthy people is not entirelyely automatic and, to some extent, requires "conscious processing" of information (5).

The therapeutic tape, known as the kinesio tape, is a fabric tape with acrylic adhesive that is commonly used to treat a variety of athlete's injuries and various physical disorders (15,16). kinesio tape is also used to improve muscle function, strengthen proprioception, reposition subluxated joints, increase lymphatic and blood circulation by reducing tissue fluid or subcutaneous bleeding, reduce pain, and help to improve joint deviations (17,18). Today, it is almost well established that functional ankle instability is associated with deficiencies in neuromuscular control, proprioception, and postural control. In functional ankle instability, the inability to position sense of the changes the coordination of movement and movement patterns such as delay in the onset of contraction and reduces the range of activity of the muscles around the joint (19). Therefore, most researchers believe that the dysfunction of these receptors in ankle sprains minimizes the ability of joint position sense. To strengthen the ankle ligaments, the use of ankle bandages such as kinesio tape and sports bands as a way to prevent ankle sprains has become widespread. Many athletes and coaches believe that using an ankle kinesio tape is essential in the acute and chronic stages of ankle injuries, They think that ankle support has positive effects on improving their performance. (20).

Nowadays, foot pressure variables are essential parameters in the biomechanical analysis of the gait. This study aimed to investigate the effect of kinesio tape on plantar pressure variables in patients with functional ankle instability.

MATERIAL AND METHODS

This was a quasi-experimental study with a pretest–posttest that 29 men with functional ankle instability were participated by convenience sampling in a university setting. The Sample size was selected using G*power software with an effect size of 0.7 and a power of 0.95. Inclusion criteria; a) at least two sprains in 12 months before the test, b) score of 90% or less in the foot and ankle ability measure questionnaire, c) ankle sprains six weeks before the test, d) no rehabilitation treatment in the last six months, e) no vestibular system disorders, Eye problems will upset the balance. Foot and ankle ability measure questionnaire with a validity of 0.95 and reliability of 0.84 Persian version was collected by Hossein Neghaban et al., and made available to the subjects (21).

Data processing

The data of this test include the contact surface of different areas of the foot, the maximum pressure applied to the foot, the maximum force, the impulse applied to the ten regions of the foot, the ratio of internal to the external force of the foot, and the percentage of time spent under different phases of the foot machine. For plantar pressure data collection, we used a Footscan® system (RSscan International, Olen, Belgium, 1068 mm × 418 mm × 12 mm, 8192 sensors) (22). This device is used to measure the variables related to foot pressure and loading the ten foot regions. The magnitude of the pressure distribution shows by a series of specific colors. Black is the absence of any pressure. Blue indicates the lowest amount of pressure applied, and red indicates the most pressure on different foot parts. The foot scanner also has the ability to display the image in two and three dimensions (23).

Subjects will be asked to walk 15 meters and pass a foot scanner. This test was recorded for five successful repetitions of one leg (injured leg). The kinesio tape was then applied to the anterior tibialis muscle in plantar flexion of the ankle and the subtalar eversion from the middle of the dorsal surface to below the tibial tuberosity (L-shaped) for peroneal muscles in dorsiflexion and inversion of the ankle from the outer surface of the ankle to the submandibular joint (Y-type), for gastrocnemius and soleus muscles in the dorsiflexion of the ankle from the back of the ankle to the knee joint (Figure 1) (19).

Figure 1. Kinesio tape application

A straight path of 10 meters was chosen, and the foot scanner was placed longitudinally in the middle of the route. The subject should start walking barefoot from the beginning of the path and pass through the device so that the right and left feet (not necessarily in order) contact the device and walk the entire path to the end. Before the primary test, subjects were asked to practice on the machine for 3 to 5 minutes at their chosen pace. The walking pace is not controlled, although a set speed may lead to a better comparison of the walking pattern of people, it can prevent the production of a regular walking pattern, and in addition, the use of a timer may lead to abnormal gait (23). Three correct and acceptable trials were collected from each subject. An attempt

was canceled if: the duration of inactivity measured by the device is more than 5% of the average inertia of the subject during usual walking, foot contact with the screen of the device will not be complete.
The variables measured by this device were: peak plantar pressure distribution, impulse, contact area, loading rate, (back, middle and front), in walking, changes in the center of pressure. The footscan® 7 gait 2nd generation software automatically moves the foot into ten anatomical areas , including the inside of the heel (HM), the outside of the heel (HL), the middle of the foot (MF), and metatarsals one to five (M1-5), divides the thumb (T1) and the little finger (T2-5) (24)(Figure 2). Maximum pressure, impulse, and maximum force were calculated as a percentage of body weight applied to the ten points of the foot. For each recorded test, five specific moments of the roll-over process include: first foot contact, first metatarsal contact, forefoot flat, heel off, and last foot contact was determined (25). Between these five points, four keys phases include the initial contact between the initial foot contact and the first metatarsal contact (front foot contact phase), between the first metatarsal contact to the front foot flattening (foot flattening step), between the front foot, flattening, the crown of the heel and the forefoot phase of the foot were identified between the flatfoot of the foot and the end contact of the foot. For each of these steps, the percentage of time elapsed was calculated (24).

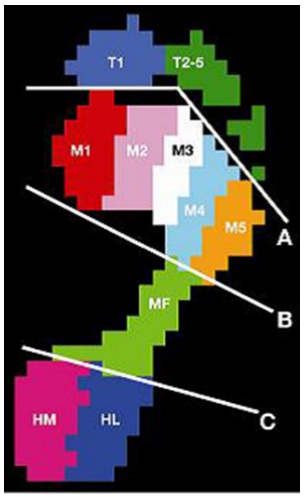

Figure 2. 10 anatomical regions of the foot

Statistical analysis
Shapiro-Wilk test was used to evaluate the normality of data distribution. Paired t-test was used to compare the mean foot pressure data before and after ankle taping with a significance level of 95%. This analysis was performed using SPSS v.18.

RESULTS
Table (1) shows the participant's demographic characteristics.

Table 1: Participant's demographic characteristics

Variable	BMI(kg/m$^{2)}$	Age(year)	Height(cm)	Weight(kg)
Mean±SD	23.9±1.15	24.5±2.27	178.6±6.46	75.8±4.61

Figure 3 shows the peak pressure of the sole in the ten regions of the foot before and after the kinesio tape. As you can see in figure 3, a significant level is seen in m5 and mid (fifth and middle metatarsal). In general, no significant difference was observed between the different ten regions. The highest pressure

was observed in region 5 (third metatarsal) equal to 19.45 kPa , and the lowest pressure was observed in the middle metatarsal region (second to fifth fingers) equal to 4.85 kPa.

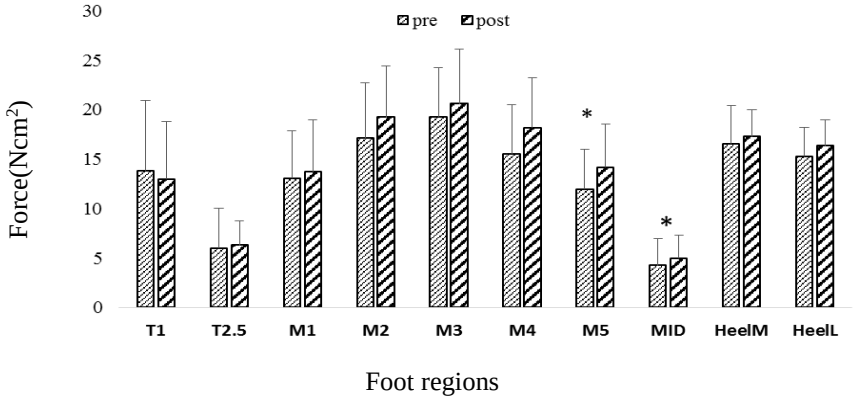

Figure 3. Peak foot pressure

Figure 4 shows the loading rate before and after using the kinesio tape. As can be seen in the picture, only a significant difference was observed at 7 (P = 0.002) , and 8 points (P=0.03), and no significant difference was observed at other points. That is, the difference in foot pressure before and after the kinesio tape was seen only in the fifth metatarsal region and the outer heel.

Figure 5 compares the center of pressure instance phases before and after kinesio tape. After kinesio tape in the propulsion phase, the foot is corrected and moved to the supination. It is crucial in the advanced Phase of foot supination because it strengthens the joints of the sole and prepares it in the form of a lever to transmit force. Therefore, the effect of kinesio tape is helpful for people with functional ankle instability during the propulsion phase.There was no significant difference in the initial contact of the foot with the ground before and after the kinesio tape ($p>0.05$). However, there was a significant difference before and after the kinesio tape in the propulsion phase, also in theis phase, which, or the same phase of progress after the kinesio tape, had a lower pressure center .

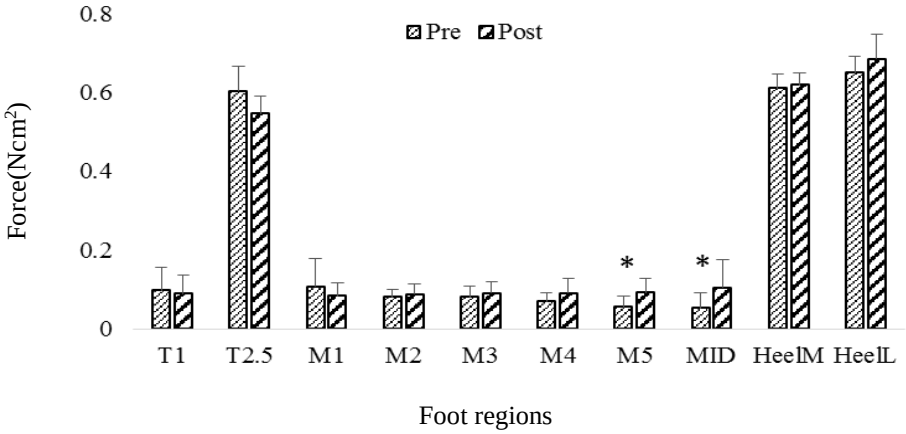

Figure 4. Loading rate

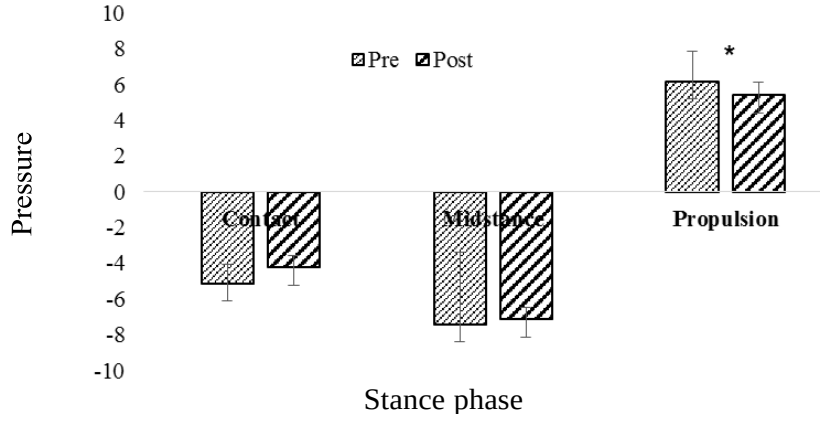

Figure 5. Center of pressure in stance phase

As shown in Figure 5, there was no significant difference in the initial contact phase of the foot before and after using the kinesio tape ($p>0.05$). However, in the propulsion phases, a significant difference was seen before and after the the kinesio tape, also in this phase, which or the same stage of progress after using the kinesio tape, the center of pressure had less fluctuation.
Figure 6 shows the mean impulse before and after kinesio tape. After the kinesio tape, the impulse of the fifth metatarsal region has increased and is another evidence of the increase in the range of motion of the ankle towards supination . The mean in the fifth metatarsal is 1.60206.

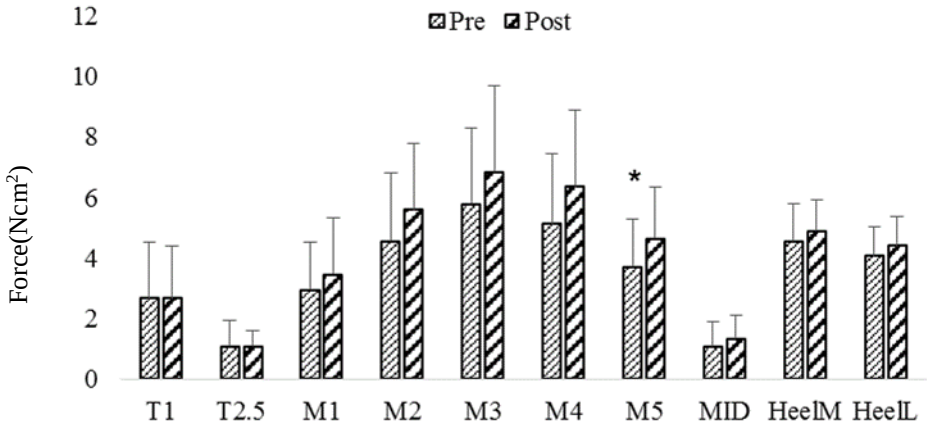

Figure 6: the mean impulse before and after kinesio tape

Figure 7 shows the stance phase schedule. As you can see, only a significant difference was observed at fp point ($p=0.01$) and front foot push-up, and no significant difference was observed at other points ($p> 0.05$).

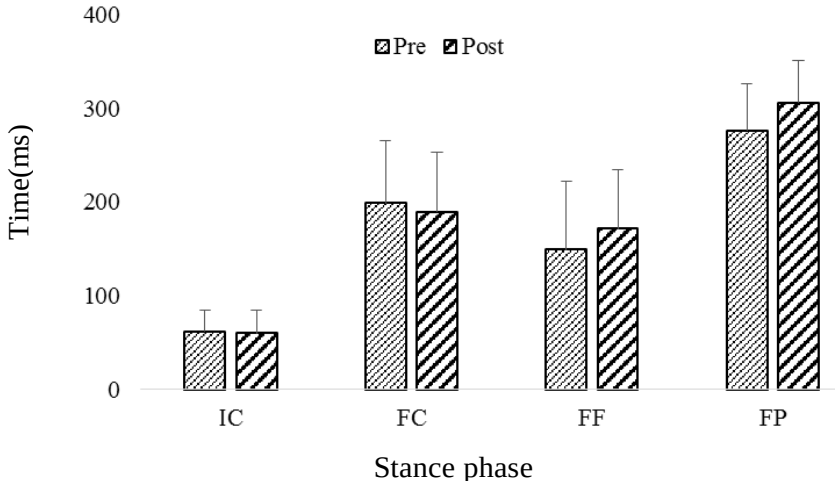

Figure 7. Step timing in stance phase

DISCUSSION

The results revealed that the loading rate increased in the middle area of the sole and the fifth metatarsal after using the kinesio tape. Also after the kinesio tape, the time of the push-off stage in front of the foot has increased. This change may be due to the use of kinesio tape and discomfort of the subject during walking or change in the mechanics of the subjects and the need for further study of Spatio-temporal gait variables of the joints of the foot after kinesio tape seems necessary. The maximum plantar pressure in the big toe and the first, second, third, and fourth metatarsal areas were the same before and after using the kinesio tape and there was no significant difference, but a significant difference was observed in the fifth metatarsus. According to the results, the highest pressure before and after kinesio tape was observed in the heel area and the lowest pressure was observed in the fourth metatarsus.

One of the objectives of the present study was to determine the effect of kinesio tape on plantar pressure in people with ankle instability. The results showed that the peak of plantar pressure in the ten points of plantar in subjects with an ankle sprain before and after using the kinesio tape had an effect only on midpoints and was ineffective in other cases. The pressure increases in the middle area of the sole of the foot as well as in the fifth metatarsus after using the kinesio tape. This increase may be due to correction of ankle movement and prevention of excessive pronation in people with functional ankle instability, which in these areas of the foot has increased during correction by stepping towards the supination. Also, in the data of the pressure center, there is a decrease in the movement of the foot in the propulsion phase towards the pronation, which confirms the previous statement. There are many studies that have introduced different kinesio tape techniques as a quick way to increase an athlete's awareness of the ankle condition. Finally, as a way to improve their performance, Kwiatkowska et al. Stated that kinesio tape increases functional ability and improves balance in people with an acute ankle injury (26) , The reason for this can be expressed to improve the position sense and faster return of painless movements with the use of kinesio tape. In the study of Haji Mir Rahimi et al.(2014), the effects of three types of kinesio taping on the performance of male athletes with chronic ankle instability, they concluded that these two methods significantly improve the balance of subjects (27). It is somewhat consistent with the results of the present study. Any change in gait also affects the distribution of pressure, as previous studies have shown that people with any deformity or injury to the lower limb can affect the variables of plantar pressure, which are consistent with the results of the present study. Any change in gait also affects the distribution of pressure, as previous studies have shown that individuals with any deformity or injury to the lower limb can affect foot pressure variables. In the study of Dehcheshmeh et al. (2016), Effect of kinesio tape on function of lower extremity and pain severity in athletes with and without medial tibial stress syndrome was investigated. They concluded that kinesio tape could immediately increase athletes' performance and reduce their pain intensity (28). Although they did not find significant changes in these factors in the long run, their results are consistent with the present study.

Also, the results of the present study discuss the rate of loading in people with ankle sprains. Also, the results of the present study discuss the rate of loading in people with ankle sprains. According to previous

research, less foot adaptation observed in people with ankle sprains usually occurs due to excessive supination of the foot, which can lead to higher loading rates, and ultimately increases the risk of damage to the upper joints (29). Patients on the verge of osteoarthritis also showed higher vertical loading rates than controls (30). The use of an ankle brace reduces the range of motion of the ankle and knee joints, increases the loading speed, and increases the risk of injury (31). Previous research has shown that people with ankle sprains use a compensatory strategy to protect their injured ankle, called a dry strategy. This strategy may be one of the reasons for the increase in the loading rate. To be more sure of this issue in future studies, it is better to pay special attention to determining the movement strategy of these people. In one study, researchers recommended that exercise and proper shoe design could minimize damage from high loading rates. Various results have shown that increasing the load is associated with a variety of lower limb injuries and reducing the load in various studies has been considered as a way to reduce lower limb injuries (32). Therefore, according to the results of this study and previous studies, it can be concluded that the dynamic adaptation and stability of the natural foot in the sagittal plane and in the posterior direction is better than the pronated foot, but in other directions of movement, are not significant. Also, the use of kinesio tape by stimulating mechanical receptors on the skin of the ankle and sole of the foot can increase the dynamic stability of the ankle in both normal and pronated groups. Considering the health of ligaments in all subjects, it seems that this affects the role of ankle and soleus muscles, and a significant difference is more evident in and near the sagittal plane. In fact, the results of the present study are consistent with previous studies, but since this article is related to a treatment method to correct ankle sprains and also to evaluate the pressure of the sole of the foot before and after using the kinesio tape, it can be said that the position It gives us a wealth of information on injured ankles compared to previous research. It is different from the kinesio tape and therefore has a great effect on walking using kinesio tape due to the position of the foot. Dynamic ankle stability is related to the ability to adapt to different positions and directions of movement, and the role of the muscles that support the arch of the foot is important in this regard. Any stimulation of mechanical receptors in this arch and the area around the ankle, especially mechanical skin receptors using kinesio tape can be effective in increasing the dynamic stability of the ankle. Therefore, athletes, especially those with pronated feet, can use this simple method in sports activities to increase dynamic stability and improve their performance. It can also be said that the use of kinesio tape in people with ankle sprains can prevent the ankle from moving too much towards the pronation and keep moving in the direction of supination, which is important.

CONCLUSION

Using a kinesio tape in people with ankle sprains can prevent the ankle from being overexposed to the pronation and keep the foot in supination, which is important. Stimulation of mechanical receptors in the arch of the foot and around the ankle by kinesio tape can be effective in increasing the dynamic stability of the ankle.

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چکیده فارسی

اثرات فوری مداخله نوار کینزیوتیپ بر پارامترهای فشار کف پا در افراد مبتلا به بی ثباتی عملکردی مچ پا

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با توجه به اهمیت شناخت ورزشکاران مبتلا به بی ثباتی مزمن مچ پا برای کلینیک های توانبخشی، متغیرهای فشار پا پارامترهای مهمی در آنالیز بیومکانیکی راه رفتن هستند. این مطالعه با هدف بررسی اثر کینزیوتیپ بر متغیرهای فشار کف پا در افراد مبتلا به بی ثباتی عملکردی مچ پا انجام شد. این مطالعه نیمه تجربی شامل ۲۹ مرد (۲/۲۷±۲٤/۵ سال) با ناپایداری عملکردی مچ پا بود که به روش نمونه‌گیری در دسترس انتخاب شدند. مسیری ۱۵ متری برای پیاده روی آزمودنی ها در نظر گرفته شد. یک دستگاه اسکنر پا در ۱۰ متری ابتدای مسیر نصب شد. از آزمودنی ها خواسته شد تا ۱۵ متر در این مسیر پیاده روی کنند. کینزیوتیپ بر روی عضلات تیبیالیس قدامی، گاستروکنمیوس و عضلات پرونئوس اعمال شد. پس از ۲۰ دقیقه، تست راه رفتن مجدد انجام شد. داده های فشار کف پا در طول راه رفتن ثبت شد. متغیرهای فشار کف پا شامل اوج توزیع فشار کف پا، مرکز فشار، اینورشن/ایورژن، سوپینشن جلوی پا، و پرونیشن قبل و بعد از کینزیوتیپ اندازه‌گیری شد. هیچ تفاوت معنی داری بین ده منطقه یافت نشد. بیشترین فشار در ناحیه ۵ (متاتارس سوم) برابر با ۱۹,٤۵ کیلو پاسکال، کمترین فشار در ناحیه متاتارس میانی (انگشت دوم تا پنجم) برابر با ٤,۸۵ کیلو پاسکال مشاهده شد. استفاده از کینزیوتیپ روی متاتارس پنجم و میانی تاثیر دارد. استفاده از کینزیوتیپ در افراد مبتلا به پیچ خوردگی مچ پا می‌تواند از قرار گرفتن بیش از حد مچ پا در معرض پرونیشن جلوگیری کند و پا را در حالت خوابیدن نگه دارد که این مهم است. تحریک گیرنده های مکانیکی در قوس پا و اطراف مچ پا توسط کینزیوتیپ می تواند در افزایش پایداری دینامیکی مچ پا موثر باشد.

واژه های کلیدی: اسپرین مچ پا، فشارکف پایی، کینزیوتیپ، فوت اسکن