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Immediate Effects of Ankle Balance Taping with Kinesiology Tape for Amateur Soccer Players with Lateral Ankle Sprain: A Randomized Cross-Over Design

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Study Design A
Data Collection B
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Data Interpretation D
Manuscript Preparation E
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Background: The objective of this study was to investigate the immediate effect on gait function when ankle balance taping is applied to amateur soccer players with lateral ankle sprain.





Material/Methods: A cross-over randomized design was used. Twenty-two soccer players with an ankle sprain underwent 3 interventions in a random order. Subjects were randomly assigned to ankle balance taping, placebo taping, and no taping groups. The assessment was performed using the GAITRite portable walkway system, which records the location and timing of each footfall during ambulation.

Results: Significant differences were found in the velocity, step length, stride length, and H-H base support among the 3 different taping methods ($p < 0.05$). The ankle balance taping group showed significantly greater velocity, step length, and stride length in comparison to the placebo and no taping group. The ankle balance taping group showed a statistically significant decrease ($p < 0.05$) in the H-H base support compared to the placebo and no taping groups, and the placebo group showed significantly greater velocity in comparison to the no taping group ($p < 0.05$).

Conclusions: We conclude that ankle balance taping that uses kinesiology tape instantly increased the walking ability of amateur soccer players with lateral ankle sprain. Therefore, ankle balance taping is a useful alternative to prevent and treat ankle sprain of soccer players.

MeSH Keywords: **Ankle Injuries • Kinesiology, Applied • Soccer**

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Background

Ankle sprain is one of the most frequent musculoskeletal injuries [1] and is strongly associated with sports activities [2].

Sprain is an injury in which the ligament gets stretched or torn due to damage of the soft tissue, but the damage mechanism is not clearly understood [3]. However, a predominant view is that an ankle sprain occurs with excessive movement in the ankle, and damage frequently happens when the foot gets over-inverted or -everted during running or landing after a jump [4].

Most cases of ankle sprain among soccer players are lateral ankle sprains that occurs when the foot gets over-plantar-flexed or inverted during walking, running, or landing after a jump [5]. A less common injury, medial ankle sprain, occasionally occurs during excessive sports activity. Since amateur soccer players have less training and experience, less physical strength, and less developed technical soccer skills than professional soccer players, they may have greater risk of lateral ankle sprain [6].

When lateral ankle sprain occurs, the anterior talofibular ligament (ATFL), calcaneofibular ligament (CFL), and posterior talofibular ligament (PTFL), which provide stability to the outer side of the ankle, are damaged [7]. In reference to lateral ankle sprain, it is worth noting that the ATFL, CFL, and PTFL can be injured independently of each other. When medial ankle sprain occurs, the deltoid ligament, which provides stability to the inner side of the ankle, is damaged [8].

Clinical considerations in diagnosis include type of injury and severity [9]. With severe ankle sprain damage, instability of the foot increases due to damage to the ligament that provides stability to the ankle, and pain appears at the acute stage, accompanying edema [10]. During the first 2 weeks after an acute lateral ankle sprains, there is a rapid decrease in pain, after which it continues to improve more slowly [11]. This obviously leads to functional disability such as balance deficits, strength deficits, decrease of ankle range of motion, and sinus tarsi syndrome [12]. Due to ankle instability on the damaged side, weight movement becomes difficult and a change in walking pattern occurs. Ankle sprains impair ability to perform activities of daily living such as walking [13]. Crosbie et al. [14] showed that ankle sprain results in slower walking speed, shorter step length, and decreased single-leg support time.

Ankle sprain is an injury with high recurrence possibility [14] and may cause functional disability, making it extremely important to receive proper treatment and remedial exercises. Except for serious damage, ankle sprains are generally treated conservatively rather than surgically. At the acute stage, use of the RICE (Rest, Ice, Compression, and Elevation) protocol is recommended to decrease edema, followed by physical

therapies such as electrostimulation, ultrasonic therapy, massage, and manual therapy to decrease pain and speed functional recovery [15].

Later, rehabilitation focuses on increasing the range of motion in the joints, improving muscle strength, recovering balance, and improving walking pattern through balance and muscle exercises [15].

There is growing interest in taping methods for prevention of ankle sprain recurrence and to improve proprioception of the ankle [16]. Taping with elastic bandages is used for neuromuscular diseases as well, and numerous studies have reporting its effect [17].

According to HwangBo et al. [18], taping treatment applied to round-shouldered patients gradually diminishes the round shoulder posture and decreases upper back pain.

Lee et al. [19] reported the effect of ankle taping on the dynamic balance of young soccer players with functionally instable ankles. Kim et al. [20] observed that ankle taping has a therapeutic effect in recovering ankle stability in patients with chronic ankle instability. However, no studies have been conducted to analyze walking movement of amateur soccer players with lateral ankle sprains after the application of taping treatment.

The present study examined the immediate effect on walking ability when ankle balance taping is applied to amateur soccer players with severe lateral ankle sprains.

Material and Methods

Participants

Although 28 subjects were recruited, 6 failed to meet inclusion criteria due to refusal to participate and not meeting inclusion criteria. Twenty-two subjects who met inclusion criteria were diagnosed with severe lateral ankle sprain between August 2016 and October 2016. Ice packs were applied directly to the injury to reduce edema after ankle sprain (within 36 h of injury) [21]. We did not use nonsteroidal anti-inflammatory drugs (NSAIDs) for the treatment of severe ankle sprains and other soft tissue injuries. Subjects were recruited from the soccer team at Hyun-pung High School, after providing informed written consent and study approval from the Research Ethics Committee of Daegu University.

Twenty-two subjects with severe lateral ankle sprain met the study criteria. All subjects were diagnosed with severe ankle sprain confirmed by computed tomography (CT) or magnetic resonance imaging (MRI). The enrollment criteria applied

were: (1) Ankle sprain within 1 month. (2) Cumberland Ankle Instability Tool (CAIT) score <24 (individuals with a score of <24 were designated with chronic ankle instability [22]), (3) Not participating in any ankle treatment program, (4) No muscular-skeletal disorder and other severe lower extremity injury (excluding ankle sprain), (5) No history of ankle fracture or ankle surgery, (6) No ankle edema, (7) No history of neurological disease, vestibular or visual disturbance, or any other pathology, (8) No taping side effects such as skin redness.

Study design

A cross-over randomized design was used. Each subject underwent each intervention in a random order. Subjects were randomly assigned to ankle balance taping, placebo taping, and no taping. For randomization, sealed envelopes were prepared in advance and marked inside with A, B, or C representing ankle balance taping, placebo taping, and no taping, respectively. To eliminate the effect of tearing off the taping, a 10-min break was given between ankle balance taping and placebo taping intervention. This randomization was performed by a third party unaware of the nature of the study. Subject characteristics and all outcome measures obtained before and after treatment were assessed by Physician 1, who was blinded to treatment allocations. Interventions were performed in a closed room by Physician 2, who was not involved in subject assessment. Both physicians were instructed not to communicate with subjects about study goals or treatments.

Intervention

Ankle balance taping

This study used elastic kinesiology tape (Kinematics Tex, SPOL CO., LTD., Seoul, Korea). Patients were seated in a comfortable position on a table high enough to prevent the feet from touching the ground, while the therapist applied the tape stretched with a tension of 30–40% on the damaged ankle.

Ankle balance taping consists of 4 stages [19]. The first stage is posterior talar gliding taping, which is performed to increase the dorsiflexion of the ankle. This taping sets the patient's ankle in a slightly dorsiflexed position and begins from the front part of the talus, passes through both sides of the malleolus, and wraps up the calcaneus. The second stage is inversion taping for the inversion of the ankle. Putting the patient's ankle in a slightly inversed state, taping begins from 5 cm above the internal malleolus, passes through the back side and down the external malleolus, and wraps up the sole from the outside to inside.

The third stage is eversion taping for eversion of the ankle. It sets the patient's ankle in a slightly everted position and begins

from 5 cm above the external malleolus, passes through the back and down the internal malleolus, and wraps up the sole from the inside to outside. This stage applies the kinesiology tape twice, with approximately 50% overlap. Since the patients have a disability in the inversion of the foot due to lateral ankle sprain, taping is done twice to reinforce the ankle inversion through eversion taping.

The fourth stage applies posterior talar gliding taping conducted in the first stage twice. Putting the ankle in a slightly dorsiflexed state, taping begins from the talus, passes through both sides of the malleolus, and wraps up the calcaneus to increase dorsiflexion (Figure 1).

Placebo taping is classified into 2 stages [23]. The first stage begins from the internal malleolus, and is applied up to the inner middle point of the lower limb. The second stage begins from the external malleolus up to the outer middle point of the lower limb (Figure 2).

Outcome measures

The assessment was performed using the GAITRite portable walkway system ('Platinum model, CIR Systems Inc., Clifton, NJ, USA), which records the location and timing of each footfall during ambulation. The GAITRite system is an electronic walkway utilized to measure the temporal and spatial parameters of gait. The subjects walked at their preferred speed. Each subject completed enough passes to allow for at least 18 footfalls to be analyzed (2–4 passes). The measured walking variables are gait velocity (m/s), step length (m), stride length (m) and H-H base support (m).

Step length is the distance between the heel centers of the current and previous footsteps. Stride length is the distance between the heel centers of 2 consecutive footsteps of the same foot. Gait velocity is obtained by dividing the distance traveled by the ambulation time. It is expressed in centimeters per second (cm/s).

H-H base support refers to the vertical distance from the heel of one foot to the proceeding line of the other foot.

Statistical analysis

The sample size for this study was calculated using the G*Power program 3.1.0 (G power program Version 3.1, Heinrich-Heine University, Dusseldorf, Germany).

The necessary sample size was calculated based on preliminary results from 14 subjects, assuming an alpha of 0.05 and a statistical power of 0.90. Based on this calculation, we aimed to recruit 22 subjects for intervention.



Figure 1. Ankle balance taping.

Statistical analysis was performed using SPSS (SPSS Inc. Released 2009. PASW Statistics for Windows, Version 18.0. Chicago: SPSS Inc.). Subject general characteristics were analyzed using descriptive statistics and results are reported as means and standard deviations. One-way repeated ANOVA was used for the group analysis, and the post hoc Tukey test was used to correct for multiple comparisons. Null hypotheses of no difference were rejected if p-values were less than .05.

Results

A CONSORT flow diagram is provided in Figure 3, and a summary of clinical and demographic features of the 22 study subjects is provided in Table 1. The characteristics of the study subjects before and after each intervention are shown in Table 2.



Figure 2. Placebo taping.

Table 1. General subject characteristics (n=22).

Variable	Mean ±SD
Age (year)	17.72±0.76
Height (cm)	175±5.15
Weight (kg)	78.63±9.91
Sex (Male/Female)	22/0
Cumberland Ankle Instability Tool (score)	10.68±3.92
Since onset (day)	8.31±3.21
BMI	25.37±1.97

SD – standard deviation.

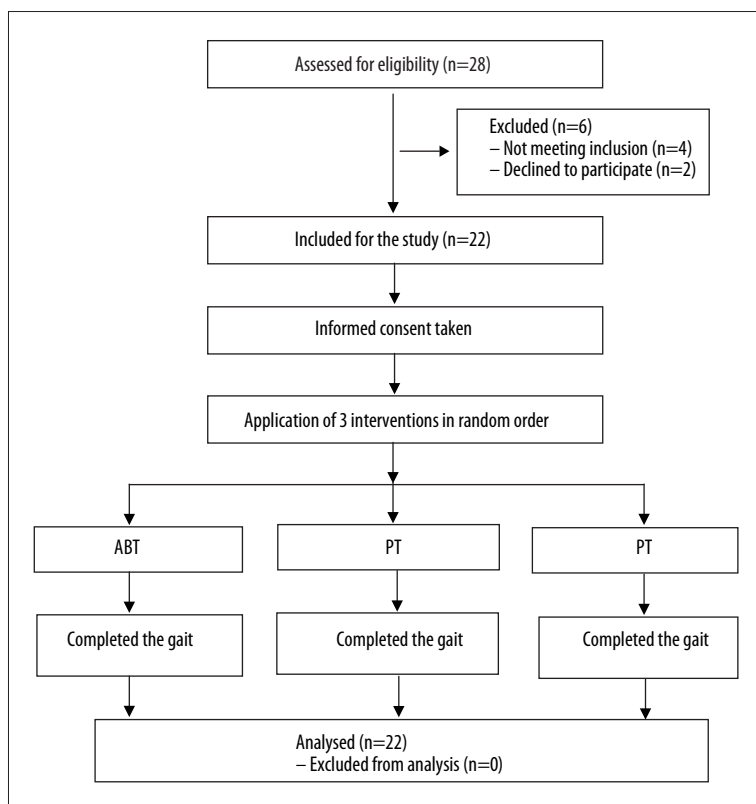


Figure 3. Study flowchart. ABT – ankle balance taping; PT – placebo taping; NT – no taping.

Velocity, step length, and stride length in the ankle balance taping group increased significantly compared to the placebo and no taping groups ($p < 0.05$). H-H base support decreased

significantly in the ankle balance taping group compared to the placebo and no taping groups ($p < 0.05$) (Figure 4).

Table 2. Comparison of the velocity, step length, stride length and H-H base support among the 3 conditions (n=22).

	Mean ±SD			F	p
	NT	PT	ABT		
Velocity (cm/s)	50.62±12.79	56.54±12.12	78.57±15.35	54.596	0.000
Step Length (cm)	30.57±7.43	34.96±6.84	48.20±8.08	83.594	0.000
Stride Length (cm)	61.38±15.03	70.19±13.77	96.65±15.93	86.784	0.000
H-H base support (cm)	19.78±3.53	18.21±3.66	13.34±3.17	70.937	0.000

NT – no taping; PT – placebo taping; ABT – ankle balance taping.

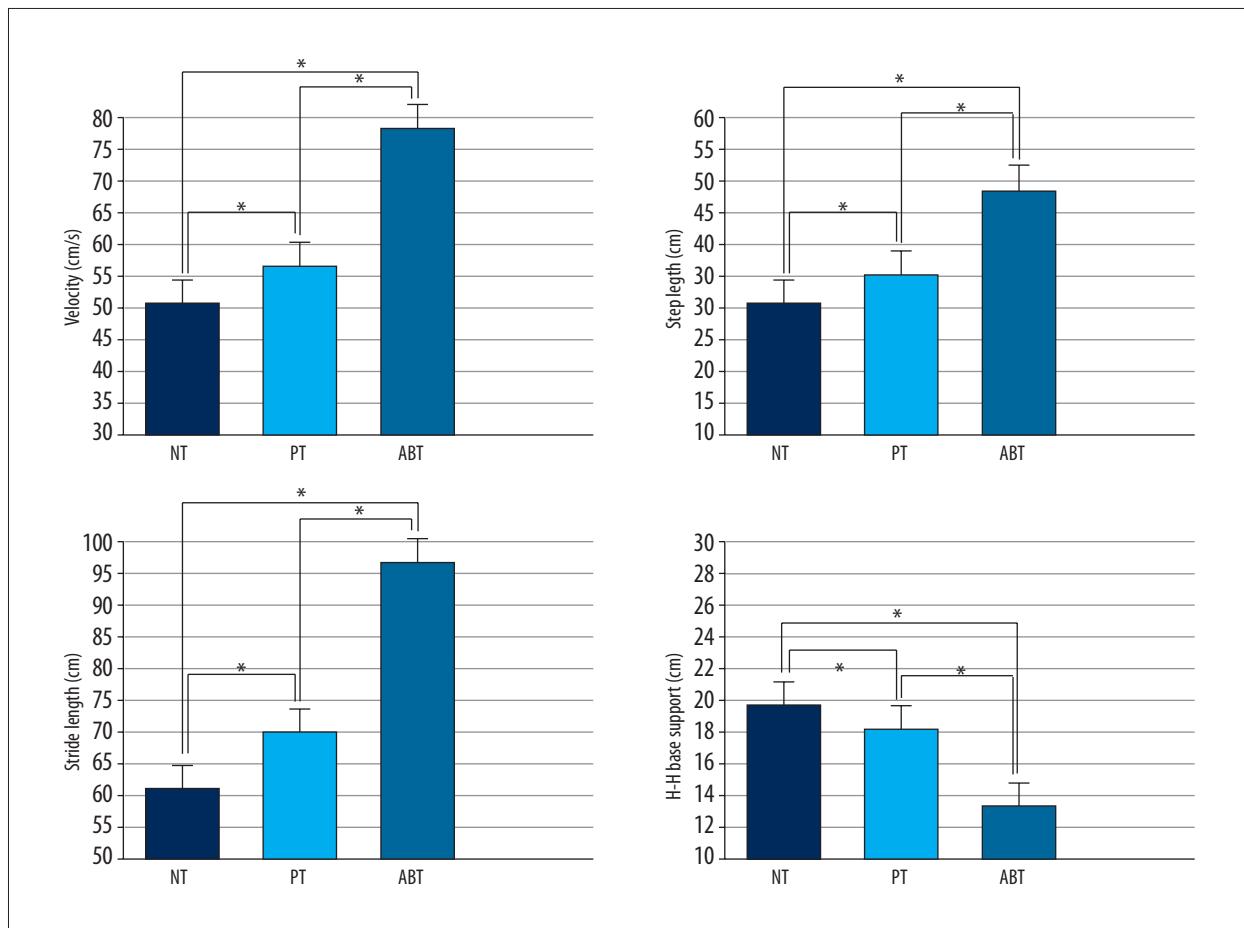


Figure 4. Comparison of the velocity, step length, stride length, and H-H base support among the 3 different taping methods (* p<0.05).

Discussion

After ankle balance taping, significant improvements in gait were observed in the experimental group over the control groups. These results supported the primary hypothesis that ankle balance taping improves gait function of amateur soccer players with severe lateral ankle sprain.

After the application of ankle balance taping, considerable improvements were observed in gait velocity, step length, and stride length compared to the 2 control interventions (placebo taping and no taping). H-H base support decreased significantly in the ankle balance taping group compared to the 2 control interventions (placebo taping and no taping). These are all related to ankle stability.

Several underlying mechanisms have been suggested to explain the effect of ankle balance taping on gait function improvement after ankle sprain.

There are numerous studies confirming the effect of taping in preventing movement. Yazici et al. [24] reported that taping provides somatosensory information and prevents excessive movement, while Kim et al. [25] stated that kinesiology taping may relieve pain and improve the ROM in physical therapists with repetitive strain injuries.

The present study used kinesiology tape with elasticity, instead of the generally used non-elastic tape, to hold the damaged side of a soccer player's ankle. The tape was stretched with a tension of 30–40% to enable free movement within the elasticity range while also preventing excessive movement of the ankle [26].

Usually, pain is caused by excessive plantar flexion and inversion in the case of lateral sprain ankle. Lateral ankle sprain often leads to mechanical instability of the ankle. This mechanical instability can lead to the development of chronic ankle instability. Hence, patients with lateral ankle sprain demonstrate decreased foot clearance and dorsiflexion [27], and altered gait patterns, characterized by increased ankle inversion positioning during walking [28]. This causes a change in the overall gait cycle of slower gait speed, shorter step length, and decreased single support time [13]. Therefore, increased ankle stability will have a positive effect on gait parameters. Kim et al. [29] reported that application of elastic taping to improve stability of the ankle joint had a positive effect on gait speed and balance ability. Applying kinesiology tape on the damaged side of the ankle increased stability of the ankle joint while preventing excessive posture that can cause pain, simultaneously allowing movement within the elastic range, creating a significant difference in the measured walking variable.

Research verifies that kinesiology tape alleviates pain. Application of kinesiology taping stimulates cutaneous mechanoreceptors [30]. According to the counterirritant theory, the stimulation of mechanoreceptive afferents induces the release of enkephalin, inhibiting the transmission of nociceptive signals. Enkephalin inhibits the neurotransmitter involved in the integration of pain (substance P) [31]. Therefore, we assume that kinesiology taping is effective in alleviating ankle sprain pain. The subjects of this study had severe pain, with mean CAIT score of 10.68 ± 3.92 . As the stance phase time of the damaged side shortened due to pain, an abnormal walking pattern with short step length and stride length resulted. By alleviating the pain of the damaged side of the ankle with kinesiology tape, ankle stability increased, producing a statistically significant difference in step length, stride length, H-H base support, and velocity of the patients with ankle balance taping.

Generally, ankle instability increases when the degree of ankle sprain is severe, and the proprioceptive sense is greatly impaired [32]. The patients who participated in this study were amateur soccer players with severe lateral ankle sprain, and their ankle instability increased (CAIT score = 10.68 ± 3.92), causing a great decrease in the proprioceptive sense. Applying kinesiology taping to their ankles increased ankle joint stability, sensory input, proprioceptive sense [30], and sense of position [33]. Due to the increased ankle joint stability and proprioceptive sense, the measured walking variables changed significantly.

Many studies have reported that kinesiology taping increases sensory input and proprioceptive sense. Yazici et al. [24] showed that somatosensory information was improved when kinesiology tape was applied on the ankle and foot of the affected side in patients with stroke, while Konishi [34] reported that the use of tactile stimulation via kinesiology tape improves muscle activity in injured patients.

The present study used the taping method developed by Lee et al. [19], in which taping was applied to soccer players with functional ankle instability to study their dynamic balance ability. This ankle balance taping method consists of 4 stages to increase ankle joint stability. It applied posterior gliding of the talus to increase dorsiflexion of the ankle joint, and applied inversion/external rotation of calcaneus to increase inversion and eversion movement of the ankle joint. By applying kinesiology tape with elasticity, it secured ankle joint stability while simultaneously enabling free movement of the ankle, resulting in a significant difference in the walking variables.

In the present study, a significant difference in walking function was detected between the placebo taping and no taping groups. Chang et al. [35] demonstrated that the kinesio-taping and placebo taping groups using elastic kinesiology tape significantly improved in absolute force sense errors and decreased pain in baseball pitchers suffering from medial epicondylitis. Giancarlo et al. [36] reported that significant eccentric elbow peak torque differences were observed between no taping and placebo taping groups using elastic kinesio tape. Most of the results of the present study are in agreement with results in the literature, and the placebo effect of taping seems to be positive.

The current study has several limitations. First, the small sample size may have influenced certain variables and influenced the results. Therefore, these results cannot be generalized to all subjects who have ankle instability. Second, the current experiment was a cross-over design, which makes it difficult to observe the long-term effect of taping. Third, functional measurements were not performed. Hence, further studies, including a long-term follow-up assessment, are needed to evaluate the long-term benefits of balance taping.

Conclusions

The application of ankle balance taping using kinesiology tape instantly increased the walking ability of amateur soccer players with severe ankle sprains. Therefore, ankle balance taping

is a useful alternative to prevent and treat severe ankle sprain in amateur soccer players.

Conflict of interest

None.

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