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Effect of Muscle Taping and Joint Taping on Static and Dynamic Balance in Normal Adults with Chronic Ankle Instability

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Abstract

Purpose : This study was conducted to investigate the effect of muscle taping and joint taping on static and dynamic balance in normal adults with chronic ankle instability.

Methods : The subjects of this study were 32 people who met the inclusion criteria. This cross-sectional study was conducted using the Kinesio tape, an elastic tape, was used. Subjects were randomized to exclude the effect of sequence, and no taping, joint taping, and muscle taping were applied as taping interventions. One-leg standing test and a Functional reach test were conducted to measure static balance, and Y-balance test was conducted to measure dynamic balance. One way repeated ANOVA was performed to investigate the difference in balance ability according to the taping intervention. If there was a significant difference, a post-hoc was performed using the Bonferroni method.

Results : In the case of static balance, joint taping showed more significant results than did no taping and muscle taping ($p<.05$), and muscle taping showed more significant results than did no taping ($p<.05$). In the case of dynamic balance, muscle taping showed significantly larger results than did no taping and joint taping ($p<.05$) and joint taping showed significantly larger results than did no taping ($p<.05$).

Conclusion : This study found that mechanical stimulation of muscles and joint compression by elastic taping increased ankle stability and improved static and dynamic balance. In particular, for static balance, joint taping was more effective than muscle taping, and for dynamic balance, muscle taping was more effective than joint taping. Applying the appropriate taping method to individual subjects has the advantage of maximizing the therapeutic effect for the recovery of balance ability. Similarly, the application of various tapings to subjects with ankle instability will have a positive effect on functional improvement.

Key Words : balance, chronic ankle instability, joint taping, muscle taping

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Ⅰ. Introduction

Ankle sprain is the most common musculoskeletal injury to the lower extremities of physically active people (Ortega-Avila et al., 2020). It mainly occurs when plantar flexion and inversion of the ankle joint exceed the normal range of motion (Fox et al., 2008). 20.00~40.00 % of these ankle sprains progress to chronic ankle instability (CAI) with chronic pain symptoms (Park et al., 2020). CAI causes damage such as deformation of joints and cartilage and changes in synovial membrane due to excessive movement of the joint. In particular, damage to nerve tissues, including mechanical receptors around ankle joints, leads to a lack of afferent information related to joint movement or position, which reduces the neuromuscular control and balance ability of the lower limb muscles (Gilbreath et al., 2014; Gribble et al., 2004).

Balance is the process of continuously maintaining postural stability, and it is one of the essential elements for human beings to accomplish daily tasks or perform purposeful activities (Fitzgerald et al., 2010). Balance is divided into static balance and dynamic balance. Static balance is the ability to maintain balance when maintaining a posture, and the ability to maintain a posture so that the body does not move with the center of gravity within the base of support. Dynamic balance is the ability of the body to maintain its desired posture by placing the center of gravity within the base of support while the body moves (Lugade et al., 2011). The decrease in balance ability due to CAI not only increases the functional instability of the ankle joint and causes diseases related to re-injury, but also increases the activity of the rectus femoris and hamstring muscles, which are the muscles of the hip joint by a compensatory strategy (Terada et al., 2014).

To date, multiple studies have been conducted on the effects of CAI interventions such as muscle strengthening exercise (Park & Kim, 2019), ankle orthosis (Gribble et al., 2010), manual therapy (Beazell et al., 2012), and elastic taping (Kuni et al., 2016). Elastic taping is a thin adhesive tape made of cotton that stretches from 120.00 % to 140.00 % of its original length (Lee & Cho, 2018). As an intervention method, the tape can be wrapped around muscles and joints, and it has the advantage of being easy to handle, having an immediate effect, and having few side effects or risks (Raymond et al., 2012).

Although the mechanism of the taping effect has not been clarified yet, there are three representative concepts. In the case of the first promoting lymphatic circulation, if the muscles in the painful area are stretched as much as possible and the tape is applied in a stretched state, when the skin and muscles return to their normal position, wrinkles are formed at the place where the tape was applied. This space is enlarged and the circulation of blood, lymph, and tissue fluid is improved (Arikawa, 1997). In the case of the second gate control theory, mechanical stimulation of the skin such as pressure and touch by taping is transmitted by group II sensory fibers to the sensory areas of the cerebral cortex at a faster transmission rate than that by group IV sensory fibers, blocking pain as a result (Artioli & Bertolini, 2014). In the case of the third muscle tension control, involves taping the Ia sensory fiber and the type II sensory fiber, which are involved in the stretch reflex from the muscle spindle, as well as the Ib sensory fiber, which is involved in the stretch reflex in the tendon. In response, the muscle tension of the muscle is regulated (Artioli & Bertolini, 2014).

There have been many prior studies on the topic of taping interventions, including an examination of the effects of placebo (Domingo et al., 2015), a comparative study of the effects of orthosis and ankle taping (Raymond et al., 2012), a study on the kinematic analysis of movement after taping (Chinn et al., 2014). In addition, previous studies confirmed that joint taping and muscle taping had a positive effect on dynamic balance and gait in stroke patients (Joo et al., 2019), but studies on the effect of chronic ankle instability on normal adults are insufficient.

Therefore, the purpose of this study is to investigate the effects of muscle taping on the tibialis anterior and peroneal muscles and joint taping on the ankle on static and dynamic balance when CAI is applied, and to investigate the appropriate taping application for optimal recovery of balance after a CAI-related loss.

Ⅱ. Methods

1. Subjects

This study was conducted with normal adults who met the inclusion criteria among those who agreed to participate after being explained about the purpose and method of the study. The inclusion criteria are as follows. Cumberland ankle instability tool (CAIT) score of 24 points or less (Powden et al., 2019), no pain or severe nervous or musculoskeletal disease, no history of ankle surgery, complete weight support on one leg, taping attachment Those who did not have an allergic reaction afterward were inclusion as subjects. Sample sizes with a significance level of 0.05, a power of 0.95, and an effect size of 0.7 were analyzed using G-Power (G-Power 3.1.9.7 for Windows, Heinrich-Heine-Universität Düsseldorf, Germany) version 3.1. As a result of the calculation, the minimum sample size of the subjects was determined to be 30, and based on this, 32 people were recruited.

2. Procedures

In this cross-sectional study, CAIT was used to evaluate ankle instability. CAIT (ICC=.96) is a widely used assessment tool for the identification of patients with chronic ankle instability (Donahue et al., 2011). The taping interventions, which were conducted using elastic Kinesio tape (Kinesio Co. Ltd, Tokyo, Japan), were no taping, muscle taping and joint taping. The taping intervention sequence was randomly determined by random sampling to exclude any unforeseen effects of the sequence. A five-minute break was taken between taping interventions to return to normal skin sensation, and the next taping intervention was performed (Kim, 2011). The taping method is as follows.

1) Muscle taping

In the case of muscle taping, in the state where the tibialis anterior is stretched first, it starts under the lateral epicondyle of the tibia and attaches to the based of the first metatarsal and the distal side of the medial cuneiform, which is the point where the tape does not stretch without stretching. Second, starting from the lateral side of the fibula, divide it into two above the lateral malleolus, attach one side to the based of the first metatarsal, which is the point where the peroneus longus muscle, and the other side, attach the tape to the based of the fifth metatarsal, which is the point where the peroneus brevis muscle, without stretching the tape (Joo et al., 2019)(Fig 1).

2) Joint taping

In the case of joint taping, the supine subject’s ankle is positioned at maximum dorsiflexion. Then extends the tape 120.00 % from the top of the foot to 1/2 point of the calf. The second is attached by extending the ankle by 120.00 % from the medial malleolus to the 1/2 point of the calf, starting from the medial malleolus and passing through the sole and lateral malleolus. Lastly, attach it to the lateral malleolus, wrap the front and back of the ankle, and attach it to the lateral malleolus again (Joo et al., 2019)(Fig 2).

Fig 1. Muscle taping

Fig 2. Joint taping

3. Outcome measures

1) Static balance

The static balance evaluation used the One-leg standing test and the Functional reach test. One-leg standing test (ICC=.97) measures how long a participant can balance on one foot. The time is measured from the moment one foot is released, and the measurement ends when the support foot moves or the opposite foot touches the ground (Jorrakate et al., 2015). Functional reach test (ICC=.92), standing with both feet shoulder-width apart, raising arm to the height of the peak was asked to extend the arm parallel to a measuring tape marked on the wall. The hand should remain lightly clenched, as the reference point is measured as the distance between the first and last points of the distal end of the third metacarpal bone that protrudes the most in the state of clenching the fist. The measurement distance was measured with the starting point at the point where the arm was stretched in a comfortable standing position and the point at which the arm was extended as far as possible at the same time as the signal as the stopping point. Both feet should remain flat on the ground throughout the test (Duncan et al., 1990).

2) Dynamic balance

The dynamic balance evaluation used the Y-balance test (ICC=.85~.91), which judges balance ability and stability of movement according to the measurement distance. Subjects stand with their heels on a set line and stretch their feet as far as possible from the line where the feet do not fall, and the measurer measures the point through a tape measure when the farthest foot is maintained for more than 3 seconds (Herrington et al., 2009).

4. Statistical analysis

For the general characteristics of the subjects, the average value and standard deviation were calculated through descriptive statistics. For normality test, Shapiro-Wilk test was performed to confirm normality. To analyze the difference in balance ability according to the taping intervention, one-way repeated measure ANOVA was performed, and if there was a significant difference, a post-hoc was performed using the Bonferroni method.

The statistical significance level was set to .05, and SPSS (SPSS 22.0 for Window, IBM Corp., USA) was used for statistical analysis.

Ⅲ. Results

1. General characteristic of subjects

The general characteristics of the study subjects are as follows. 32 adults (18 males, 14 females) with ankle instability, with an average age of 21.13±1.57 years, an average weight of 64.12±11.41 kg, an average height of 170.21±6.74 cm, and an average leg length of 100.71±1.44 cm, The average CAIT score is 26.21±1.62 (Table 1).

Table 1. General characteristic of subjects (n=32)

Variables	Values
Sex (men/women)	18/14
Age (years)	21.13±1.57[a]
Weight (kg)	64.12±11.41
Height (cm)	170.21±6.74
Leg length (cm)	100.71±1.44
CAIT (score)	26.21±1.62

[a]Mean±SD; mean±standard deviation, CAIT; cumberland ankle instability tool

2. Comparison of static balance ability

One-leg standing test and Functional reach test showed statistically significant differences between no taping, muscle taping, and joint taping (p<.05). As the post-hoc results made clear, the joint taping showed significantly larger results compared to no taping and muscle taping (p<.05), and the muscle taping showed significantly larger results compared to no taping (p<.05)(Table 2).

Table 2. Comparison of static balance ability according to the various taping methods (n=32)

	No taping	Muscle taping	Joint taping	F	*p*
OLST (sec)	12.35±7.95[a]	16.83±8.60†	22.40±10.43†,‡	43.212	.000
FRT (cm)	36.59±2.10	39.11±1.94†	41.55±1.56†,‡	77.712	.000

[a]Mean±SD; mean±standard deviation, †Significantly different compared to no taping, ‡Significantly different compared to muscle taping, OLST; one-leg standing test, FRT; functional reach test

3. Comparison of dynamic balance ability

Y-balance test showed statistically significant differences between no taping, muscle taping, and joint taping (p<.05). As the post-hoc results made clear, the muscle taping showed significantly larger results compared to no taping and joint taping (p<.05), and the joint taping showed significantly larger results compared to no taping (p<.05)(Table 3).

Table 3. Comparison of dynamic balance ability according to the various taping methods (n=32)

		No taping	*Muscle taping*	*Joint taping*	*F*	*p*
YBT (cm)	anterior	84.22±19.52[a]	98.00±18.80†	91.64±11.82†,‡	32.019	.000
	left	83.25±19.37	99.58±16.91†	92.35±17.08†,‡	36.200	.000
	right	81.80±12.31	102.01±18.31†	98.13±12.31†,‡	30.552	.000

[a]Mean±SD; mean±standard deviation, †Significantly different compared to no taping, ‡Significantly different compared to muscle taping, YBT; y-balance test

Ⅳ. Discussion

Various factors such as muscle strength and joints affect balance and postural stability, in particular, the ankle joint plays an important function in the human body by centering movement and ensuring stability (Shumway-Cook & Woollacott, 2001). Therefore, proper functioning of the ankle is very important for normal balance ability. Although many studies have been performed on the effect of taping on CAI through several previous studies, there is a lack of comparative research that examines the effect of directly taping the ankle joint or of taping the muscles on ankle joint stability. Therefore, this study compared and analyzed the effects on static and dynamic balance when muscle taping and joint taping were applied to CAI.

In the case of static balance, the taping application showed a significant difference compared to the no taping application, and in particular, the joint taping showed a significant difference compared to the muscle taping. When taping is applied to the joint for the purpose of fixation, it is used to intentionally limit the movement of the joint and assist the movement of the joint with mechanical support or to prevent injury (Ricard et al., 2000). According to a previous study, it was reported that the application of ankle fixation taping had a significant difference in the One-leg standing test and joint range of motion (Kim, 2010) and was effective in limiting ankle displacement and inclination in patients with ankle instability (Yoon et al., 2013). It was reported that the recruitment timing of the dynamic ankle stabilization muscles was shortened and the balance ability was improved by stimulating proprioceptors in the muscles surrounding the joint and improving the proprioceptive feedback mechanism (Raymond et al., 2012). Combining with the static balance ability results of this study, it seems clear that the application of joint taping of CAI contributed to the stability of the ankle during the One-leg standing test and the Functional reach test, thereby having a positive effect on the low mobility and stability of the ankle joint.

In the case of dynamic balance, the taping application showed a significant difference compared to the no taping application, and in particular, the muscle taping showed a significant difference compared to the joint taping. When taping is applied to the muscle, the contact between the tape and the skin increases the activation of motor neurons as well as sensory neurons entering the spinal cord from receptors on the epidermis, resulting in rapid excitatory firing of muscle spindles through epidermal stimulation (Burke et al., 1991). In addition, stimulation caused by the adhesion of the tape to the skin induces a sustained response of the muscle and generates information about muscle contraction, both of which lead to the improvement of stable balance ability (Chao et al., 2016). According to a previous study, it was reported that the application of muscle taping had a significant difference in the dynamic balance of chronic stroke patients (Joo et al., 2019) and showed a significant effect on the YBT results (Kim & Roh, 2018). Combining with the results of the dynamic balance testing in this study, it can be concluded that the application of taping to the tibialis anterior and calf muscles, which contribute to ankle stability, led to close to normal muscle activation, and as a result, it is thought to have a significant effect on dynamic balance compared to joint taping.

This study found that mechanical stimulation of muscles and joint compression by elastic taping increased ankle stability and improved static and dynamic balance. In particular, for static balance, joint taping was more effective than muscle taping, and for dynamic balance, muscle taping was more effective than joint taping. Therefore, based on the results of this study, if elastic taping is applied to CAI subjects, it is thought that the recovery of balance ability and secondary damage will be prevented by improving ankle stability.

The limitations of this study are as follows. First, it is difficult to generalize due to the small number of subjects, so it is necessary to expand the study. Second, although the degree of disability of ankle instability of CAI subjects who participated in the experiment was classified using CAIT, it is difficult to generalize the results to all CAI subjects because it is a subjective measurement. Third, in this study, taping could not be applied to several joints, such as the hip and knee joints, which may have problems due to ankle instability. The three-dimensional direction change of CAI subjects will have a difference in the functional reduction of lower extremity and compensatory action in other joints (Powers, 2003). Therefore, in future research, it is considered that various studies are needed through the selection of a wide range of subjects and evaluation tools, as well as the application of taping to the lower extremity joints including the ankle.

Ⅴ. Conclusion

The purpose of this study was to investigate the effects of muscle taping and joint taping on the static and dynamic balance of adults with ankle instability. For the restoration of balance ability, it is thought that applying the appropriate taping method required for each subject will have the advantage of maximizing the therapeutic effect. Based on the results of this study, it is expected that the application of various tapings will have a positive effect on functional improvement in subjects with ankle instability and will lead to many more studies in the future.

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