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The Effect of Elasticity of Taping on Ankle Muscles' Activity and Endurance after Plyometric Training

The purpose of this study is to observe the effect of elasticity of taping on ankle muscles' activity and endurance after plyometric training that easily causes ankle injury, and provide baseline data for physical therapy intervention methods. The study subjects are 24 male students in their 20s who attend N University in Choongnam. They were divided into three groups; 8 subjects in the elastic taping group, 8 in the non-elastic taping group, and 8 in the non-taping group(control group). They had plyometric training for 6 weeks. After the training, this study measured their maximum voluntary isometric contraction(MVIC) and muscle endurance of the muscles around ankle joint. The experiment result is as follows. After the training, all three groups showed improvement in muscle strength and endurance. The elastic taping group showed insignificant improvement in muscle strength but significant increase in muscle endurance in plantarflexion. In dorsiflexion, both muscle strength and endurance increased significantly. The non-elastic taping group showed insignificant improvement in muscle strength but significant increase in muscle endurance in plantarflexion. Taping during plyometric training had a little or insignificant effect on muscle endurance and strength compared to the non-taping group.

Key words: *Taping; Ankle Muscle's Activeity; Ankle Muscle's Endurance; Plyometric*

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INTRODUCTION

Plyometric training is an exercise that can improve body balance, cooperativeness, quickness, and power. Not only athletes but also general adults are paying attention to this training to improve their functional ability as well as physical strength and technical improvement in sports fields(1). In addition, the training does not require any special equipment and easily strengthens muscles by varying intensity of exercise such as number of repetition, length, or height of jump. Moreover, it is effective in improving muscle coordination capability as it includes repetitive directional changes(2).

Kim et al.(2000) report that jump activity in plyometric training mostly focuses on lower limb activity, and the training is helpful for ankle joint exercise as well as jumping capability(3). Kim(2012) reports that the training is not only helpful for improving motor performance but also positively effective for ankle joint movements(4). However, too much contractile force during plyometric training results in activation of Golgi tendon organ which decreases muscular irritation(5). Moreover, if the amount or intensity of the training is not properly managed and simply depended on the trainer's personal experiences, it can cause injuries(6).

Among various supplementary equipment that are recently used in sports fields, taping has been renowned for improving specific muscle and joint functions as well as psychological stabilization by attaching a tape which has similar elasticity to muscle and skin on the body. As a result, many elite players, professionals, and general public widely use this taping method(7). Tobin(2000) reports that non-elastic taping can stimulate or suppress muscles depending on muscular fiber and the direction of taping. Moreover, it is an effective method that prevents recurrence of damage on lateral ankle ligament as well as ankle sprain by limiting joint's range of

motion intentionally and maintain skeletal structure by fixing joints before one gets back to sports activity early or before making dangerous movements(9). However, previous studies on non-elastic taping report that taping become loose as one performs various movements and it results in decreased effectiveness(10). Kim et al.(2008) report that applying elastic taping during vertical jump improves muscle strength and reduces muscle fatigue and helpful for improving vertical jump record(11). It also blocks abnormal stimulation from muscles so that it controls muscle stretch and improves pain and insufficiency of skeletomuscular system(12).

Ankle taping is used for many different purposes. It is used to support chronically unstable ankle, to instantly support right after injury, and to suppress edema. It is also used to prevent recurrence of injury on lateral ankle ligaments, for early return to sports activity, or for prevention purposes for uninjured ankle(13). In addition to the effect of injury prevention during exercising, it also improves muscle strength of patients with osteoarthritis or knee joint pain(14).

Most of the previous studies that dealt with taping only mentioned injured patients or specific muscles of elite athletes and rarely dealt with the cases where general public use it as prevention method. This study observes the effect of elasticity of taping on ankle muscles' activity and endurance after plyometric training that easily causes ankle injury, and provides baseline data for physical therapy intervention methods.

METHODS

Subject

This study chose 24 male students in their 20s who were studying at N University, Choongnam. They were divided into three groups; 8 in the elastic taping group(ETG), 8 in the non-elastic taping group (NTG), and 8 in the control group(CG). They did not have any particular lesion or history on the lower limb at the time of examination. This study chose the ones who haven' t participated in regular exercising program over a year in the past. They were fully described with the significance and procedures of the study and voluntarily participated after signing an agreement form for experiment participation.

Table 1. Characteristics of the Subjects

	ETG	NTG	CG
Age(y)	20.62±1.92	20.12±1.45	20.50±2.20
Height(cm)	177.28±7.89	173.03±9.25	174.76±4.45
Weight(kg)	76.51±12.64	75.56±19.5	71.23±5.57

ETG : Elastic taping group
NTG : Non-elastic taping group
CG : Control group

Procedure and Measurement

This study compared the changes of maximum voluntary isometric contraction(MVIC) after plyometric training of the three groups to see which group received the biggest effect from taping on ankle joints' muscle activity and endurance. The tapes that this study used were sponge tape with 70mm width, C-tape which is non-elastic tape with 32.75kg/cm^2 of tensile strength with 38mm width, and which is produced by S company with the size of 5x5cm^2. All subjects were taped on the both ankles by the same examiner. The experiment used Primus RS (BTE/U.S.) for measuring. The subjects sat comfortably on Primus RS chair with stretched knees and put their feet on the foothold with their shoes on. Their ankle motor axis was aligned with the motor axis of the dynamometer.

Thighs were fixed with Velcro to prevent any movement. Starting from 90 degrees position of ankle joint, this study measured muscle activity and endurance in plantarflexion and dorsiflexion of non-dominant leg. This study conducted isometric contraction of ankle joint by plantarflexion and dorsiflexion for 3 seconds for 3 times to measure MVIC. To eliminate the effect of fatigue, the subjects took 2minute break after every 3 second contraction. After repeating it for 3 times without any abnormality, the mean value was chosen as MVIC. When an abnormality is observed, the abnormal value was eliminated and used the mean of the remaining two values as MVIC.

To measure the muscle endurance of ankle joints, this study applied resistance which was 50% of MVIC and made the subjects perform continuous isotonic exercise of plantarflexion and dorsiflexion. Isotonic exercise was stopped when the computer monitor gives a measurement which was less than 70% of the original target over 3 times or when it was less than 50% at least once.

Taping Methods

Non-elastic taping

It used closed basket weave technique which is the most effective and generally used method(15).

Elastic taping

Ankle taping followed the guideline suggested by the International Balance Taping Federation. Using elastic tape with 5cm width and 30cm length, the middle part of the tape was put at the center of metatarsal arch and to the ankle bone. At plantar flexion state, the middle of 5cm-width and 15cm-length tape was put on Achilles and it met in the front part of ankle joint(16).

Plyometric training procedures

The subjects warmed up for 10 minutes before plyometric training. After pre-measurement, the three groups had plyometric training for 40 minutes a time, 3 times a week for 6 weeks. After the training, this study observed changes through post-measurement. There are 3 to 5 training programs. It has been reported that 4 to 10 times of repetition consists 1 set and 3 to 10 sets is appropriate. Although it may vary according to intensity of training, it has been reported that total repetition of 100 to 200 times and 300 if possible generates maximum effect. Based on the report, this study referred to Lee(2007) training program and modified it for this experiment(Table 2)(17).

Table 2. Plyometric Training Procedures

Weeks / Items	1-2 weeks	3-4 weeks	5~6 weeks
Items	• Squat jump • Split squat jump • Double leg tuck jump • Depth jump • Double leg lateral hop jump	• Squat jump • Split squat jump • Double leg tuck jump • Depth jump • Double leg lateral hop jump	• Squat jump • Split squat jump • Double leg tuck jump • Depth jump • Double leg lateral hop jump
set	3 sets	4 sets	5 sets
Break between sets	2 minutes	2 minutes	2 minutes
Break between items	2 minutes	2 minutes	2 minutes
Number of repeatition	10 times	12 times	12 times

Data Analysis

The collected data were analyzed using SPSS Ver. 18.0. To compare the muscle strength and endurance of ankle joints before and after using elastic tape within each group, this study conducted Wilcoxson Signed-Rank Test. To compare the difference in the muscle endurance and strength of ankle joints between the groups before and after using elastic tape with plyometric training, this study conducted Kruskal-Wallis H test. The significance level was α =.05 in all tests.

RESULTS

Changes in PF(plantar flexion) and DF(dorsiflexion) according to the use of elastic tape

When the difference in PF was compared within each group after the intervention, the control group showed significant difference. However, difference in PF between the groups was not statistically significant(Table 3)($p<.05$).

When the difference in DF was compared within each group after the intervention, the elastic taping group and the control group showed significant difference. However, difference in DF between the groups was not statistically significant(Table 3)($p<.05$).

Changes in PFE (plantar flexion endurance) and DFE (dorsiflexion endurance) according to the use of elastic tape

When the difference in PFE was compared within each group after the intervention, the elastic taping group, the non-elastic taping group, and the control group all showed significant difference. However, difference in PFE between the groups was not statistically significant(Table 4)($p<.05$).

When the difference in DFE was compared within each group after the intervention, the elastic taping group and the control group showed significant difference. However, difference in PFE between the groups was not statistically significant(Table 4) ($p<.05$).

Table 3. Changes in muscle strength depending on the taping method

(Mean±SD)

	ETG		NTG		CG		Chi-Square	p
	pre	post	pre	post	pre	post		
PF	391.13±106.08	417.60±97.01	317.71±39.76	356.03±69.49	324.63±51.80	386.30±78.18	3.240	.198
Z	−1.782[a]		−1.153[a]		−2.201[a]			
p	.075		.249		.028*			
DF	277.55±62.42	315.70±55.10	246.43±49.64	272.78±70.14	279.48±31.20	307.38±55.38	.152	.927
Z	−2.201[a]		−1.572[a]		−2.201[a]			
p	.028*		.116		.028*			

*p<.05
PF : Plantarflexion, DF : Dorsiflexion
ETG : Elastic taping group
NTG : Non-elastic taping group
CG : Control group

Table 4. Changes in muscle endurance depending on the taping intervention

(Mean±SD)

	ETG		NTG		CG		Chi-Square	p
	pre	post	pre	post	pre	post		
PF	927.33±270.75	1827.83±711.20	717.33±182.47	1515.67±459.96	1102.50±614.78	1618.83±791.44	2.947	.229
Z	−2.201[a]		−2.201[a]		−2.201[a]			
p	.028*		.028*		.028*			
DF	297.00±72.57	372.33±70.74	293.50±61.11	304.67±86.02	374.33±153.00	447.67±160.03	4.877	087
Z	−2.201[a]		−.314[a]		−2.201[a]			
p	.028*		.753		.028*			

*p<.05
PF : Plantarflexion, DF : Dorsiflexion
ETG : Elastic taping group
NTG : Non-elastic taping group
CG : Control group

DISCUSSION

This study applied plyometric training to the elastic taping group, non-elastic taping group, and the control group for 6 weeks and analyzed the muscle endurance and strength of ankle joints to see how each tape is effective when plyometric training was applied.

Plyometric training trains major muscles of lower limb including tibial muscle, soleus muscle, gastrocnemius, vastus, rectus femoris, biceps femoris, hamstring, iliopsoas, and gluteus maximus. Among these muscles, rectus femoris is affected the most during vertical jump followed by vastus, gastrocnemius, and soleus muscle. These muscles are responsible for stretching of hip joints, knee joints, and ankle joints (18). Ankle sprain is the most common sports related damage, and 85% of ankle sprain is known to be inversion sprain. Repetitive damages of ankle weaken muscle strength and lowers proprioceptive sensibility of tibialis anterior and peroneus longus. These symptoms cause ankle instability and repetitive ankle damage (19). Recently, taping us widely used to prevent ankle injury.

Lee(2008) reports that application of kinesio tape on ankle joint results in changes of maximum muscle strength of ankle joint for dorsiflexion, although not significant, while the change is significant for plantarflexion(20). The result of this study that showed numeric changes in the elastic taping group and non-elastic taping group was the same as Lee's report. However, there was no significant difference in the non-elastic taping group and the elastic taping group for plantarflexion, and in the non-elastic taping group for dorsiflexion. This result is the same as Han(2007) research that indicates muscle strength and power of plantarflexion significantly decreases as time passes after the training when ankle joint is taped with non-elastic tape. It means that non-elastic taping does not significantly affect muscle strength(21).

Elastic taping did not give significant change in maximum muscle strength of plantarflexion in this study. Considering the taping method, it is because fixation effect was bigger for plantarflexion on the bonding surface that wraps metatarsal in the center of sole compared to dorsiflexion like the non-elastic taping. Muscle endurance is an ability to produce maximum amount of power during long hours of repetition. It mostly depends on muscle strength and partially depends on cardiovascular endurance (22). Park(1998) conducted isokinetic training for 12 weeks to observe the effect of the training on ankle's maximum muscle strength, explosive muscular strength, and muscle endurance. The result was the same as this study showing that muscle endurance increases as maximum muscle strength increases(23). Taping treatment has been a treatment method that minimizes exhaustion of physical strength and maximizes athletic performance while it helps stretching and contraction and helps smooth body movement(24). However, there was no significant difference in muscle endurance when compared to the non-taping group indicating taping does not have any effect.

Cordova et.al(2000) report that exercising with taping lowers the ability to limit joints to 45.9% than before exercising(25). Verbrugee(1996) reports that taping does not have any effect on agility run test, 50m run, and standing high jump which are to measure agility of lower limb. Verbrugee also suggests additional researches using more extensive and various methods are necessary(26). According to the result of this study, there is no significant difference between the groups after plyometric training. Since taping does not have any significant effect on muscle strength and endurance, it is difficult to expect the effect of taping in plyometric training. There have been a lot of disputes on the effect of taping. Although this study could not suggest positive effect of taping, it tried to prove the effect of taping using various methods.

Since this study only conducted the training for a short period of time and did not have many subjects, it is hard to apply the result to general public in their 20s. In addition, this study could not find any effect on female as it only had male subjects. Also, taping during exercising might have affected both legs. However, this study only measured dominant leg which is why it could not compared the result with non-dominant leg. Therefore, the future studies should conduct additional studies with more variety of age groups, gender, and more number of subjects. Considering the current trend that variety of taping methods is introduced, there should be many studies on the effect of taping during plyometric training. It is necessary to consider more variables that affect maximum muscle strength and muscle endurance with taping.

CONCLUSIONS

1. After plyometric training, all three groups showed improvement in muscle strength and muscle endurance.

2. In the elastic taping group, muscle strength did not show significant difference in PF while muscle endurance significantly increased. In DF, both muscle strength and muscle endurance increased significantly.

3. In the non-elastic taping group, muscle strength did not show significant difference in PF while muscle endurance significantly increased. In DF, neither of them was significant,

4. In the non-taping group (control group), muscle strength and muscle endurance both showed significant difference in PF and significantly increased in DF.

Therefore, taping during plyometric training had a little effect or no special difference in muscle endurance and muscle strength compared to non-taping group.

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