



Original Article

## The effects of taping, stretching, and joint exercise on hip joint flexibility and range of motion

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**Abstract.** [Purpose] This study aimed to examine the effects of joint exercise, taping, and stretching on hip joint flexion, flexibility, and range of motion. [Subjects and Methods] Forty-five college students in their 20s were randomly assigned and equally divided into three groups, as follows: a stretching group, a taping and exercise group, and an exercise group. Changes in trunk range of motion and hip joint flexibility of the three groups were measured before and after the intervention. [Results] Comparison between flexibility before and after the intervention revealed statistically significant changes in all three groups. Moreover, the evaluation of joint range of motion after the intervention showed that there were statistically significant changes in all three groups. [Conclusion] Taping, stretching, and joint exercise are considered effective for the increase in flexibility and joint range of motion.

**Key words:** Range of motion, Stretching, Taping

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### INTRODUCTION

Recently, among diverse aids employed in the sports field, taping has been identified as a method to improve the muscular and joint functions and physiological stability of a certain area, by attaching a tape with elasticity similar to muscle and skin elasticity. In addition to elite and professional athletes, this method is also used by laypersons<sup>1-4)</sup>.

Kinesio taping provides positional sense through the skin; aligns fascial tissues; lifts the fascial and soft tissues of the inflamed areas, thereby generating space; provides skin stimulation aimed at aiding or restricting movement; and moves interstitial fluid into the lymphatic vessels, helping to remove edema<sup>5)</sup>. In addition, tape applied to the joints and musculoskeletal system enhances proprioception and muscle activity while reducing pain<sup>1, 6)</sup>. Contraction and tone of the muscles are controlled by the nerves; by attaching Kinesio tape, the scattered nerves regulating the muscles may be better controlled, thereby recovering their original functions and protecting the muscles<sup>1, 7)</sup>. By attaching a tape, a space is created between the skin and fasciae or muscles underneath. In particular, muscular movement drains the blood or tissue fluid stagnating in the space. As a result, edema or internal hemorrhage is reduced, which lowers the increased tissue pressure and relieves pressure and pain<sup>7)</sup>.

Stretching enhances joint range of motion. When movement becomes smooth, excessive burden is not applied to the muscles or the body, and the pressure on each muscle is reduced, thereby decreasing the risk of injuries<sup>8)</sup>. Therefore, stretch-

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ing is effective in preventing damage, and conducting stretching as a cool-down measure before and after exercise is effective in preventing muscle pain and overuse syndrome, which appears as a result of excessive use<sup>9</sup>).

There are different kinds of warm-up exercises, generally divided into static stretching and dynamic stretching exercises. Static stretching is recommended as a method to improve performance ability and prevent injuries by statically maintaining maximal joint range of motion for 10 to 15 seconds manually; most students perform this as a warm-up exercise<sup>10, 11</sup>). There has been research done on static and dynamic stretching methods for flexibility improvement and muscular extension, but little research involved taping in addition to stretching<sup>12, 13</sup>). Accordingly, this study intends to examine the effects of taping, stretching, and joint exercise on flexibility and hip joint range of motion.

## **SUBJECTS AND METHODS**

Forty-five college students in their 20s were randomly assigned and equally divided into three groups, as follows: a stretching group (SG), a taping and exercise group (TEG), and an exercise group (EG). The subjects were able to understand the purpose of this study and presented no orthopedic or neurological abnormalities. All participants were told about the potential risks and about the design of the study, and they provided informed consent for participation, with the knowledge that they could withdraw at any time. The Ethics Committee of Namseoul University in Korea also approved the study. The IRB approval number is Research-NSU-1041479-201511-HR-010. The general characteristics of the study subjects are presented in Table 1.

To examine the subjects' range of motion of the lower limb joints, a flexometer (Helmas, Korea) and an electronic goniometer (Patterson Medical, Canada) were used. To ensure that stretching was applied equivalently, three subjects conducted stretching three times and the average value was retained. They carried out stretching exercises for 10 times in total. To note the changes in the subjects, the number of times per minute when muscular changes increased most effectively were chosen from the set points of 15, 30, and 45 times per minute.

While adopting a sitting posture, the subject extended both arms and hands forward, flexed the body, and then pushed the measurement tube of the flexometer to the maximum extent possible. The length of the measured plate pushed by the hands was measured twice and recorded. First, the subject took off his/her shoes, sat, and placed the soles flat in the opposite position to the flexometer. The innermost edges of the soles were situated within 2 cm of the measurement value. Then, the subject extended both hands as slowly as possible and maintained the position for two seconds. Both hands needed to be in a parallel position so that neither hand was extended further than the other. Regardless of whether the ends of the hands were overlapped, they came into contact with the graduated ruler or the measuring parts. The score was measured when the tips of the hands reached as far as possible. The better of the scores for two attempts was recorded. For a better record, the head was lowered between the arms and the subject exhaled when he reached the arrival point.

The examiner checked whether the subject's knees had been extended, but the participants' knees were not pushed. The examinee was asked to breathe normally, without holding his/her breath during the test. The goniometer could differ in size according to the measured areas. Therefore, the researcher needed to be trained in advance on how to use it, and an appropriate goniometer, suitable for each measured area, needed to be used. During measurement, sufficient explanation was given to the examinee first, and the examinee was asked to assume a comfortable position, afterwards. After the measured joint of the subject was sufficiently exposed, the starting position was determined and recorded. Based on the anatomical posture, the location of zero degrees was precisely observed, and then the measurement was taken. All points that could be observed accompanied by measurement were recorded. Before measurement, the subject rested for 20 minutes, and in a spinal posture, a fixed ruler was placed in parallel with the trunk and the movable ruler was placed at the center of the femur. The axis was fixed at the greater trochanter.

The stretching group concurrently conducted passive stretching of the hamstring muscles and ankle joint dorsiflexion. The subjects assumed a supine position and the examiner had the subject conduct ankle joint dorsiflexion and passively stretch the hamstring muscles, as much as possible and without causing pain. The subject returned to the original position after the maximal stretch and maintained the posture for 30 seconds; he/she then rested for 10 seconds. The subject repeated this motion six times and measurements were taken immediately<sup>14</sup>). The taping and exercise group carried out taping and exercise as follows: taping was applied to the vastus lateralis, biceps femoris, gastrocnemius muscle, and medial malleolus using an elastic tape (width, 5 cm). The subject lay in a prone position on a bed and the examiner attached the tape diagonally to the medial malleolus, starting from the vastus lateralis of both limbs<sup>15</sup>). After attaching the elastic band, the subject conducted the exercise immediately. The subject sat straight on the mat and alternately conducted flexion and extension of both limbs in a knee curl position. After conducting the motion 60 times for 2 minutes, measurement was immediately taken.

The exercise group sat straight on the mat and alternately conducted flexion and extension of both limbs in a knee curl position. After conducting the motion 60 times for 2 minutes, measurement was immediately taken. For analysis of data in this study, the statistical analysis program SPSS 18.0 for Windows was used. Normality of the data was verified through the Kolmogorov–Smirnov test, and then a paired t-test was conducted for the three groups, in order to examine differences in flexibility and angles before and after the exercise. In order to compare differences in flexibility and range of motion changes between the two groups, according to the type of exercise, multivariate analysis of variance was used. Statistical significance was set at  $\alpha=0.05$ .

**Table 1.** General characteristics of the study subjects

	SG	TEG	TG
	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD
Age (yrs)	21.2 $\pm$ 1.3	21.0 $\pm$ 1.3	21.9 $\pm$ 2.1
Height (cm)	166.9 $\pm$ 13.4	165.9 $\pm$ 6.6	169.3 $\pm$ 9.6
Weight (kg)	60.7 $\pm$ 13.7	60.4 $\pm$ 8.4	62.9 $\pm$ 13.1

SG: stretching group, TEG: taping and exercise group, TG: taping group

**Table 2.** Comparison of flexibility and range of motion according to taping, stretching, and joint exercise

	Flexibility (cm)		Hip Joint Flexion Range of Motion (angle)	
	Pre	Post	Pre	Post
SG	-5.7 $\pm$ 11.1	-9.6 $\pm$ 10.8 <sup>†</sup>	82.1 $\pm$ 12.4	92.3 $\pm$ 15.7 <sup>†</sup>
TEG	-7.4 $\pm$ 9.0	-11.6 $\pm$ 7.8 <sup>†</sup>	72.9 $\pm$ 9.2	80.5 $\pm$ 11.5 <sup>†</sup>
EG	-2.0 $\pm$ 10.2	-6.2 $\pm$ 11.3 <sup>†</sup>	70.4 $\pm$ 15.8	80.8 $\pm$ 16.2 <sup>†</sup>

Values are shown as the mean  $\pm$  SD, <sup>†</sup>p<0.05. <sup>†</sup>Significant difference between before and after intervention. SG: stretching group, TEG: taping and exercise group, EG: exercise group

## RESULTS

A before and after comparison of flexibility according to taping, stretching, and joint exercise revealed that all three groups showed statistically significant changes (p<0.05). The comparison of joint range of motion according to taping, stretching, and joint exercise, revealed that all three groups showed statistically significant changes (p<0.05) (Table 2).

## DISCUSSION

Flexibility is the ability to move the joints through the complete range of motion. This is very important for motor performance and physical activities in everyday life<sup>9</sup>. Maintaining flexibility in all joints is an important element for smooth graded movements, due to which an easy carried out movement of the body structures is possible. When there are problems in areas like flexibility, injuries might occur<sup>11</sup>. For maintenance and improvement of flexibility, different methods, such as diverse stretching and self-exercise, are in use. This study aimed to examine the effects of taping and stretching on flexibility and range of motion at the level of the hip joints. Comparison of flexibility and range of motion according to the interventions revealed that all three groups experienced statistically significant changes.

Behm and Chaouachi reported that static stretching improved flexibility without the accompanying pain and was effective for preventing and alleviating impairments<sup>16</sup>. Moreover, Etnyre and Abraham noted that static stretching stimulated proprioceptors distributed in the human body, thereby promoting or increasing neuromuscular system response; this had the effects of improving muscular relaxation and range of motion, while increasing the length of connective tissues at rest, and decreasing muscular pain<sup>17</sup>. For improvement in range of motion, and the index for flexibility, different exercise methods including stretching are in use. Stretching is recommended as an exercise therapy for increasing joint range of motion<sup>18</sup>. The main effects of static stretching on flexibility are related with the viscoelasticity of the tendon and the relaxation of the actin-myosin complex, resulting in a temporary lengthening of muscles and tendons<sup>19</sup>. In this study, increase in hip joint flexibility and range of motion was the result of muscular relaxation, viscosity of the tendons, and elasticity changes resulting from static stretching.

Flexibility is the range of motion of a single joint or different joints in combination, and it greatly affects the efficiency of body movements<sup>20</sup>. The elements that affect flexibility include the following: 1) the structures or shapes of joints, flexibility of tendons or ligaments, or the conditions of the muscles and joints that attach to these joints; and 2) age, gender, and physical activity. Finally, a lack of exercise has negative effects on flexibility<sup>20, 21</sup>. When a muscle contracts, the distance between the origin and insertion of the muscle is shortened; the cross-sectional area of the muscle belly is increased; and when it becomes close to the direction of tendon or the skin, it swells; At this time, when tape is attached to put light pressure on the muscles, tendons, or skin, fine pressure stimulation on the skin acts on the muscle spindle, Golgi tendon organ, and cutaneous nerve, relieving muscle tone and reducing pain<sup>7, 16</sup>. Accordingly, the increase in flexibility and joint range of motion in the TEG and EG was triggered by the increase in elasticity of the fascia through exercise. Physiological effects on the muscle spindle, tendon organs, and skin nerves generated by the application of tape improved flexibility and joint range of motions, as well.

The limitations of this study are that the day-to-day life of the subjects was not controlled for the study goals and the study sample was limited to college students in their 20s. More research needs to be conducted in order to address these limitations.

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