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Effect of Motion Taping in a Rehabilitation Exercise Program on Quadricep Muscle Activity and WOMAC (Pain, Stiffness, Physical Function) in Elderly People with Knee Osteoarthritis

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| Abstract |

Purpose: This study was conducted to determine the effects of motion taping on muscle activity and the WOMAC in a rehabilitation exercise program for elderly women with knee joint osteoarthritis.

Methods: The subjects were 28 elderly women aged over 65 years with knee joint osteoarthritis. The subjects were divided into two groups: one experimental and one control group. During the study period, a total of 26 patients completed the experiment, with one drop each from the experimental group and control group. The experimental group applied motion taping and conducted a rehabilitation exercise program. The control group experienced a rehabilitation exercise program without motion taping. The rehabilitation exercise program consisted of warm-up exercises, maximum isometric exercises, the range of motion of the joints, and leg stretching exercises. The intervention was conducted three times a week for six weeks. To investigate the effects of the intervention, muscle activity and the WOMAC were measured. The WOMAC is a tool that can be used to evaluate the pain, stiffness, and physical function of osteoarthritis patients; it has 29 items in three areas.

Results: The change in muscle activity according to the intervention showed a statistically significant increase in both the experimental group and control group. The WOMAC also showed statistically significant changes in terms of pain, stiffness, and physical function in both the experimental and control groups. The experimental group showed a greater functional improvement than the control group.

Conclusion: For older women with osteoarthritis of the knee, a rehabilitation exercise program is a good intervention. When motion-taping is applied, it is considered to be an intervention program that can be expected to have a better effect on knee joint osteoarthritis.

Key Words: Elderly women, Muscle activity, Osteoarthritis, WOMAC

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I. Introduction

Knee-related diseases are the second highest among musculoskeletal disorders following low back pain in 2018, based on the Ministry of Health and Welfare in Korea (Ministry of health & welfare, 2018). Osteoarthritis of the knee is the fifth most common disease among the elderly, and it is frequently seen in the elderly because the osteoarthritis is a degenerative disease that can deteriorate the condition of the joints with age. As of 2018, in Korea, the rate of increase in the elderly population is rapidly rising. The percentage of the elderly population in Korea has risen to 14.3%, exceeding the 14% standard for the aged society. The number of patients with osteoarthritis of the knee is increasing accordingly. Patients with knee osteoarthritis are more likely to be older females than older males, as the proportion of the elderly population of females is higher than that of males. Based on the 65-year-old standard, the ratio of women to men is 100:74.6 (Statistics Korea, 2018). Accordingly, it can be said that the number of women with osteoarthritis of the knee is higher than that of men. Osteoarthritis, including the knee osteoarthritis, has a very serious adverse effect on daily life quality in elderly women (Lee, 2011).

Osteoarthritis of the knee is usually a degenerative change with aging, and when osteoarthritis occurs, the muscles around the knee are unbalanced. The imbalance shows symptoms such as a muscle weakness around the knee, a decrease in the range of motion, and an increase in pain (Nguyen, 2011). Because of these symptoms, patients with knee osteoarthritis have difficulty living a normal life. Therefore, an appropriate intervention program for knee osteoarthritis is very important (Jack et al., 2014).

For the elderly, non-surgical methods are recommended first due to the risk of surgery. Non-surgical methods

include physical therapy and exercise. It has been reported that exercise is effective in patients with knee osteoarthritis (McAlindon et al., 2014). Also, taping is a non-surgical method used to improve pain and movement. There are elastic tape and non-elastic tape for taping intervention, and non-elastic tape is used for fixing joints. Elastic tapes are well known as kinesio tapes, and it is reported to improve muscle and movement through pain (Ki et al., 2010). In clinical practice, elastic tapes are widely used for the management of pain patients, and their effects have also been reported.

This study was conducted to know the effect of applying rehabilitation exercise program with the motion taping method. Park and Kim (2017) reported an immediate improvement in balance when joint mobilization and elastic taping were applied to patients with knee arthritis. Park and Park (2010) reported that balance taping has a positive effect on pain and knee joint range of motion in elderly people with lower limb arthritis. In this study, we try to find out the effect of motion taping among various taping methods. Motion taping is a method of diagnosis by examining the range of motion of a joint and attaching tapes to the muscle on the side where joint movement is bad during pair movements such as flexion and extension (Yoo, 2018).

Therefore, this study was conducted to investigate the effect of rehabilitation exercise program with motion taping on muscle activity, pain, and stiffness, physical function of knee osteoarthritis.

II. Method

1. Subject

This study was conducted on 28 women with knee osteoarthritis over 65 years elderly in a orthopedic surgery

clinic located in Daegu. The subjects were recruited and selected by the selection criteria for elderly women over the age of 65 diagnosed with osteoarthritis of the knee by an orthopedic specialist. Subjects with neurological disorders other than knee osteoarthritis were excluded. For the recruited subjects, the purpose of the study was described, and it was agreed to participate in the experiment. The selected subjects were divided into the experimental group and the control group using a random method.

Subjects in the experimental group and the control group performed the same exercise program. The experimental group applied motion taping and the exercise, while the control group applied only the exercise program without taping intervention. Fourteen subjects were assigned to the each experimental and control group. During the study period, a total of 2 patients were discontinued through voluntary abandonment, one each from the experimental group and the control group. Finally, the results of 26 subjects were processed. The experimental group was 67.91 ± 0.83 yrs, 148.45 ± 2.79 cm, 53.83 ± 3.53 kg, and the control group was 67.54 ± 0.87 yrs, 147.41 ± 3.57 cm, and 54.56 ± 3.79 kg (Table 1).

Table 1. General Characteristics of subjects

Variable	Mean \pm SD	
	EG	CG
Age (years)	67.91 ± 0.83	67.54 ± 0.87
Height (cm)	148.45 ± 2.79	147.41 ± 3.57
Weight (kg)	53.83 ± 3.53	54.56 ± 3.79

EG: experimental group, CG: control group

2. Intervention

Both the experimental group and the control group performed the same exercise program. The experimental group implemented an exercise program, by applying

motion taping before performing exercise. After rehabilitation exercise program, taping continued (Ju & Lee, 2006). The tape was removed the evening and reapplied at the next rehabilitation exercise program. The control group applied the exercise program without taping. The rehabilitation exercise program was carried out with some modifications to the method presented for patients with knee osteoarthritis in previous studies.

1) Exercise program

Among the existing rehabilitation exercise methods that have been reported to be effective in patients with knee osteoarthritis, the exercise to increase the muscle strength of the quadriceps muscle was modified and applied (Lim & Jun, 2006; Sled et al., 2010). The method of exercise is as follows.

- (1) 10 minutes of stretching for the quadriceps, hamstring, and calf muscles as a warm-up exercise.
- (2) The maximum isometric exercise of the quadriceps and hamstring muscles to increase muscle strength with this exercise, and the range of motion exercise for flexion and extension of the knee joint (Lim & Jun, 2006).
- (3) In the standing position, a leg spreading exercise (hip abduction) was performed using an elastic band (Seld et al., 2010).

Thera-band (The Hygenic Corporation, USA) was used for the leg spreading exercise.

This exercise was conducted for 40 minutes (Lim & Jun, 2006). The resistance strength of the elastic band was performed by replacing the band with a higher resistance strength if the patient did not feel fatigue during the 20 times (Choi, 2020). The rehabilitation exercise program was conducted three times a week, for a total

of six weeks.

2) How to apply motion taping

The motion taping was applied to patients using an elastic tape. The method of attaching taping to the more restrictive side was applied by evaluating flexion and extension through ROM test. When flexion did not occur well compared to extension, it was applied to quadriceps. And when extension did not occur well compared to flexion, it was applied to hamstring (Yoo, 2018). It was applied using Kinesio tape (3NA. Corporation, Korea).

When attaching the tape, the position of the joint was adjusted to stretch the muscles, and the tape was attached without stretching. When attaching to the hamstring, the tape was attached from the hip flexion position down to the back of the knee. The last part of the back of the knee was split into two branches. When attaching to the quadriceps muscle, it was attached in the supine position. After attaching the tape to the maximal extension position of the hip joint, the tape was attached from the ASIS to the lower front, and then downward. After that, the knee joint was flexion to the maximum, and the tape was split into two branches and attached to the knee below.

3. Measurement

1) Muscle activity

EMG (MP150, Biopac Corporation, USA) was performed to measure muscle activity. The measurement position was performed by attaching an active electrode to the belly of the quadriceps muscle of the dominant side. As muscle activity differed among individuals, %RVC was employed for standardization. The reference position was full extension of the knee joint. Activity movement was maximum full extension isometric

contraction. The subjects performed each movement during 10 seconds. The time of 6 seconds except the first 2 seconds and the last 2 seconds was calculated and used. EMG signals collected at a sampling rate of 1,000Hz. A 60 Hz notch filter was used to remove electrical noise. And, 30~500Hz band pass filtering was conducted (Cho, 2014).

2) WOMAC

The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) is a tool for assessing osteoarthritis and is used in many countries. This tool has shown reliability through several studies. In Korea, It was reported that reliability and validity were high in a study of patients with knee and hip osteoarthritis (Yi et al., 2008). This WOMAC was used in this study. The WOMAC is divided into 3 areas with a total of 24 items, and the higher the score of each item, the more negative it is.

- (1) Pain (5 items): during walking, using stairs, in bed, sitting or lying, and standing upright
- (2) Stiffness (2 items): after first waking and later in the day
- (3) Physical function (17 items): using stairs, rising from sitting, standing, bending, walking, getting in/out of a car, shopping, putting on/taking off socks, rising from bed, lying in bed, getting in/out of bath, sitting, getting on/off toilet, heavy domestic duties, and light domestic duties

4. Analysis method

To investigate the effect of rehabilitation exercise program with motion taping on pain, muscle activity, and WOMAC changes, statistical processing was performed

using the statistical program SPSS 25.0 for windows. As a comparison method, a paired t-test was used to investigate the change according to the intervention. Before the intervention, there was no difference between the two groups, confirming homogeneity. In order to find out the difference according to the intervention, the comparison between groups was conducted by the independent t-test method for the changes pre and post the intervention. The significance level was 0.05.

III. Results

The change in muscle activity according to the intervention showed a statistically significant increase in

both the experimental group and the control group ($p < 0.05$).

The WOMAC showed statistically significant changes in pain, stiffness, and physical function in both the experimental and control groups. In comparison between the groups for the amount of change, there was no difference between the groups in muscle activity, pain, and stiffness, but there was a significant difference between the groups in physical function ($p < 0.05$) (Table 2).

The experimental group showed a greater functional improvement than the control group (Table 3).

Table 2. Comparison of pain and strength between pre and post intervention

Group	Mean±SD		T	p	
	Pre	Post			
Muscle activity (%RVC)	EG	297.61±57.32	333.69±61.93	-4.36	0.00*
	CG	315.42±44.32	340.72±56.51	-2.24	0.04*
WOMAC – pain (scores)	EG	10.92±1.38	7.84±0.68	6.69	0.00*
	CG	10.69±0.94	8.38±0.76	8.78	0.00*
WOMAC – stiffness (scores)	EG	5.07±0.95	3.30±0.63	6.88	0.00*
	CG	5.00±0.81	3.46±0.77	5.28	0.00*
WOMAC – physical function (scores)	EG	43.92±2.06	35.69±1.75	9.53	0.00*
	CG	45.07±2.66	39.46±3.35	7.27	0.00*

* $p < 0.05$

EG: experimental group, CG: control group

Table 3. Comparison of muscle activity, WOMAC between group

value	Group	Mean±SD		T	p
		EG	CG		
Pre – post	Muscle activity (%RVC)	-36.07±29.79	-25.30±40.67	-0.77	0.44
	WOMAC – pain (scores)	3.07±1.65	2.30±0.94	1.45	0.15
	WOMAC – stiffness (scores)	1.76±0.92	1.53±1.05	0.59	0.55
	WOMAC – physical function (scores)	8.23±3.11	5.61±2.78	2.25	0.03*

* $p < 0.05$

EG: experimental group, CG: control group

IV. Discussion

There are a variety of interventions in patients with knee osteoarthritis. Pharmacotherapy is used to improve pain through medicines that have analgesic effects, but sometimes it can be difficult to treat with medication alone because of side effects caused by medicines (Finnerup & Jensen, 2007). As a non-pharmacological method, strengthening the muscles around the joints and the use of guards and canes help improve symptoms, and it has been suggested that weight loss and avoiding excessive activity on the knee are effective methods (Christensen, 2005). There is also an opinion that excessive exercise directly on the knee joint can exacerbate osteoarthritis of the knee joint. Accordingly, appropriate exercise interventions are needed (Esser & Bailey, 2011). Surgical method has been reported as an effective approach to patients with severe dysfunction due to pain or poor quality of life. It can have side effects such as thrombus and risk of anesthesia due to old age, along with high cost (Pendleton Et al., 2000).

Exercise, the method with the least side effects, is recommended. In a meta-analysis study comparing aqua and ground exercises in an interventional method through exercise, it was found that underwater exercise was better for pain in patients with knee osteoarthritis, but there was no difference in other physical functions, including the range of motion. Both aqua and ground exercises have been shown to help knee osteoarthritis patients (Kim et al., 2015).

This study applied an exercise program that proved its effectiveness among the intervention methods of ground exercise that can be easily applied to patients with osteoarthritis of the knee, and was conducted to investigate the effect of motion taping when exercising. The rehabilitation exercise program applied in this study was modified and applied to an existing rehabilitation exercise

program that is effective for knee osteoarthritis. In order to strengthen the muscle strength of the leg, it was applied by isometric exercise, leg spreading exercise, and joint motion range exercise. Leg abduction exercises are effective for knee osteoarthritis by strengthening leg muscle strength, and isometric and range-of-articulation exercises are effective (Lim & Jun, 2006; Sled et al., 2010). Therefore, this study was conducted by modified rehabilitation exercise applied in the two studies. In a previous study, the combination of taping and exercise program was effective on muscle strength and pain in low back pain patients. In this study, it was conducted to find out what effect the combination of taping and exercise program has on knee osteoarthritis (Ju & Lee, 2006).

This study investigated changes in muscle activity unlike previous studies. As a result, when the exercise program was applied, both the experimental group and the control group showed changes in muscle activity and pain, stiffness, and physical function according to the intervention. Previous studies reported an increase in muscle strength through rehabilitation exercise intervention (Choi, 2020), and this study reported an increase in muscle activity, such as improvement in muscle strength.

The three items of WOMAC, Pain, stiffness, and physical function, showed significant reduction in both the experimental group and the control group to which the rehabilitation exercise program was applied, and showed a positive improvement effect. In addition, the comparison between the experimental group and the control group showed a difference between the two groups in the physical function category, which was more effective when motion taping was applied ($p < 0.05$). The WOMAC pain score showed a statistically significant decrease in both groups when the exercise program was applied. In the experimental group to which taping was

applied, a greater reduction in pain was reported, but no statistical difference was observed.

Valgus alignment increased the risk of incident knee osteoarthritis (Sharma et al., 2010). Patients with knee osteoarthritis showed higher knee valgus compared to normal subjects (Miyazaki et al., 2006). It is thought that the exercise program will increase the ROM of the knees as well as the hip muscle strength of the hip joint, thereby showing the balance of the knee joints, resulting in pain, stiffness and physical function improvement.

In the group-to-group comparison of the amount of change according to the intervention, the physical function showed a larger amount of change with statistical significance in the experimental group to which motion taping was applied. When taping was applied to a rehabilitation exercise program, it showed a greater effect in the functional part. These results are similar to the results of previous studies in which muscle fatigue was reduced along with improvement in lower extremity muscle strength when kinesio taping was applied (Sin et al., 2011). It is thought that the improvement of muscle strength and the reduction of muscle fatigue can indicate a higher functional improvement, so it is considered that it showed a marked improvement in the function.

When taping is applied, it is thought that stimuli such as proprioceptive sensory organs, and these proprioceptive sensory organs affect physical functions. That is reducing the onset time of muscles by improving the sensory feedback mechanism (Karlsson & Andreasson, 1992). Motion taping has been reported to have an effect on pain and muscle function even in middle-aged women with shoulder impingement syndrome.

When applied to middle-aged women with shoulder impingement syndrome, pain was reduced, muscle stiffness and muscle tone decreased, and it was reported that it had an effect on muscles (Lee & Lee, 2019). In clinical trials, taping has been widely applied for

treatment/prevention. As a result of this study, it was verified that the combined rehabilitation exercise program of knee isometric, muscle strength, and range of motion can be applied as a good intervention method for patients with knee osteoarthritis. In particular, applying the motion taping method among the tapings that are frequently used in clinical practice can be said to be more effective in improving the function when the knee osteoarthritis patient performs rehabilitation exercises.

Motion taping may be a good intervention method for elderly women with osteoarthritis of the knee when patients performed rehabilitation exercise program. This intervention program is expected to be positively applied to many patients.

V. Conclusion

This study was conducted to investigate changes in muscle activity, pain, stiffness, and physical function when taping is applied to the isometric exercise, leg stretching muscle strength exercise, and range of motion range exercise program for patients aged over 65 years old with knee osteoarthritis. The subjects were elderly women with knee osteoarthritis.

As a result of the study, the exercise program according to the intervention had a positive effect on muscle activity, pain, stiffness, and physical function, and it showed a more positive effect on muscle activity and physical function when taping was applied additionally.

For older women with osteoarthritis of the knee, a rehabilitation exercise program is a good intervention. When motion-taping is applied, it is considered to be applied as an intervention program that can expect a better effect on knee joint osteoarthritis.

References

- Cho YH. Effects of tai chi on pain and muscle activity in young males with acute low back pain. *Journal of Physical Therapy Science*. 2014;26(5):679-681.
- Choi JH. Effect of taping on a home program of hip abductor exercise on pain and quadriceps muscle strength in elderly women with knee osteoarthritis. *Korean Society of Physical Medicine*. 2017;13(3):61-66.
- Christensen R, Astrup A, Bliddal H. Weight loss: the treatment of choice for knee osteoarthritis? A randomized trial. *Osteoarthritis and Cartilage*. 2005;13(1):20-27.
- Esser S, Bailey A. Effects of exercise and physical activity on knee osteoarthritis. *Current Pain and Headache Reports*. 2011;15(6):423-430.
- Finnerup NB, Jensen TS. Clinical use of pregabalin in the management of central neuropathic pain. *Neuropsychiatric Disease and Treatment*. 2007;3(6):885-891.
- Jack Farr II, Miller LE, Block JE. Quality of life in patients with knee osteoarthritis: a commentary on nonsurgical and surgical treatments. *The Open Orthopaedics Journal*. 2013;7:619-623.
- Ju SB, Lee WJ. The effects of kinesio taping and exercise therapy program on lumbar extension muscle strength, visual analogue scale in operation patients of lumbar disk herniation. *The Korean Journal of Physical Education*. 2006;45(3):537-546.
- Karlsson J, Andreasson GO. The effect of external ankle support in chronic lateral ankle joint instability: an electromyographic study. *American Journal of Sports Medicine*. 1992;20(3):257-261.
- Ki HS, Kwon OY, Yi CH, et al. Effects of the scapular taping on the muscle activity of the scapula rotators and pain in subjects with upper trapezius pain. *Physical Therapy Korea*. 2010;17(1):77-85.
- Kim YI, Choi HS, Han JH, et al. Aquatic exercise for the treatment of knee osteoarthritis: a systematic review & meta analysis. *Journal of the Korea Academia-Industrial Cooperation Society*. 2015; 16(9):6099-6111.
- Lee YH, Lee JB. Effects of motion taping on muscle tone, muscle stiffness, and pain in middle-aged women with shoulder impingement syndrome. *PNF and Movement*. 2019;17(3): 431-439.
- Lee YJ. A study on the effects of pain, sleep pattern, life satisfaction on depression in elderly women with osteoarthritis. *Journal of the Korean Gerontological Society*. 2011;31(2):211-222.
- Lim CG, Jun MK. The effects of rehabilitation exercise program on muscle strength and pain in elderly with the knee osteoarthritis. *Journal of Korean Physical Therapy*. 2006;18(6):59-65.
- Mahendira L, Jones C, Papachristos A, et al. Comparative clinical and cost analysis between surgical and non-surgical intervention for knee osteoarthritis. *International Orthopaedics*. 2020;44(1):77-83.
- McAlindon TE, Bannuru R, Sullivan MC. OARSI guidelines for the non-surgical management of knee osteoarthritis. *Osteoarthritis and Cartilage*. 2014; 22(3):363-388.
- Ministry of health and welfare. The national health plan 2020. Ministry of health and welfare. 2018.
- Miyazaki T, Wada M, Kawahara H, et al. Dynamic load at baseline can predict radiographic disease progression in medial compartment knee osteoarthritis. *Annals of the Rheumatic Diseases*. 2006;61(7):617-622.
- Nguyen USD, Zhang Y, Zhu Y, et al. Increasing prevalence of knee pain and symptomatic knee osteoarthritis: survey and cohort data. *Annals of Internal Medicine*. 2011;155(11):725-732.
- Park SJ, Kim DD. The impact of joint mobilization with an elastic taping on immediate standing balance in

- patients with knee osteoarthritis. *Journal of the Korean Convergence Society*. 2017;8(7):295-304.
- Park KY, Park KS. Effects of a balance taping on pain and ROM of the knee joint in the elderly with lower limbs arthritis. *Korean Journal of Adult Nursing*. 2010;22(3):312-321.
- Pendleton A, Arden N, Dougados M, et al. EULAR recommendations for the management of knee osteoarthritis: report of a task force of the standing committee for international clinical studies including therapeutic trials (ESCISIT). *Annals of the Rheumatic Diseases*. 2000;59(12):936-44.
- Sharma L, Song J, Dunlop D, et al. Varus and valgus alignment and incident and progressive knee osteoarthritis. *Annals of the Rheumatic Diseases*. 2010; 69(11): 1940-1945.
- Sin JG, Kim CK, Jeon YK, et al. Influence of high school football players related kinesio taping application isokinetic strength and skill performance ability. *Korean Society for Wellness*. 2011;6(2):379-388.
- Sled EA, Khoja L, Deluzio KJ, et al. Effect of a home program of hip abductor exercises on knee joint loading, strength, function, and pain in people with knee osteoarthritis: a clinical trial. *Physical Therapy*. 2010;90(6):895-904.
- Statistics Korea. Korean statistical information service. 2018.
- Yi SJ, Lee HJ, Woo YK. Validity and reliability of the Western Ontario and McMaster universities osteoarthritis index (WOMAC)-VA3.0 in hip and knee osteoarthritis patients. *Physical Therapy Korea*. 2008;15(2):20-29.
- Yoo HJ. Motion taping. Seoul. Daekyung books. 2018.