

## The Effects of Resistance Exercise and Balance Exercise on Proprioception and WOMAC Index of Patients with Degenerative Knee Osteoarthritis

The purpose of this study was to analyze and compare the effect of resistance exercise and balance exercise on proprioception and WOMAC index of patients with degenerative knee osteoarthritis. A total of 40 subjects participated in this study. The subjects were diagnosed with degenerative knee osteoarthritis and all were more than 60 years old. They were divided into three groups. Group I (n=8) was trained with resistance exercise, Group II (n=6) was trained with balance exercise and Group III (n=6) was trained with range of motion as a control. The results of this study were as follows. It was significantly indicated that the resistance exercise group and balance exercise group elicited error-reduction on proprioception goal-angle ( $p < .05$ ). There was a statistically significant difference on proprioception between resistance exercise group and control (range of motion) group. There was a statistically significant reduction on WOMAC index between resistance exercise group and balance exercise group ( $p < .05$ ) and on the WOMAC index between resistance exercise group and range of motion group ( $p < .05$ ). In conclusion, resistance exercise and balance exercise are effective on degenerative knee osteoarthritis and resistance exercise is the most effective for improving proprioception and WOMAC index. More research on the intervention according to the degree of degenerative knee osteoarthritis is needed.

Key words: *Degenerative Osteoarthritis; Proprioception; WOMAC Index; Resistance Exercise; Balance Exercise*

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Received : 29 June 2010  
Accepted : 21 September 2010

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## INTRODUCTION

Degenerative knee osteoarthritis is a painful disease and 33% people of the age of 63 to 94 years old have it(1). The disease limits functional performance such as standing up from a chair, standing comfortably, walking, and going up and down stairs(2). 5–15% people of the age of 35 to 74 years old, and 20% people of more than 65 years have degenerative knee osteoarthritis on radiology. It has been reported that knee joints get degenerative osteoarthritis more easily than other joints because of support weight and the increase of attack rate as one gets older(3).

Degenerative osteoarthritis is caused by damage of joint cartilages and it happens for two reasons. First, joint tissues are damaged by excessive loads. Second,

in the case of weak of joint cartilage or bone, degenerative osteoarthritis happens easily(4).

Degenerative osteoarthritis patients go through great pain and the decrease of extremity especially in quadriceps, mobility, stiffness of joint, limited movement, and proprioception(5). In addition, they have a lot of functional limitation when sitting and standing or going up and down stairs. Weakness of muscles or asymmetric muscle activity leads to unstable joints and aggravates muscle by lesser use. And decrease of balance and walking ability is a factor for causing falls in elderly(6).

Once degenerative knee osteoarthritis appears, it affects posture and gait negatively. Primarily, it decreases muscle power and aerobic capacity. Next, it causes the onset of obesity, coronary cardiac problem,

and pulmonary diseases. When degenerative knee osteoarthritis occurs, getting rest is a vital matter. However, longer rest may also result in decrease of physical strength and muscle loss. Therefore, light activity is recommended(7).

Exercise to ease pain and maintain normal range of motion is needed to improve the function of osteoarthritis patients(8). In addition, search for exercise that contributes to improve muscle power, flexibility, motor ability, positive effect of daily living and decrease pain are also needed(7). Therapeutic exercise on osteoarthritis is a 3 step program: a) release muscle spasm due to pain, active ROM exercise which maintains normal ROM, b) isometric exercise which protects atrophy of muscles and increases muscles strength, c) progressive resistance exercise according to the patient's condition(9).

In many previous studies, knee extensor weakness was reported as a sufficient strength to control the lower limb when walking owing to the decrease of flexor and extensor strength of knee osteoarthritis patients compared to healthy people(10, 11, 12). It is said that the strength of knee osteoarthritis patients was depressed, however there was no difference in muscle volumes compared to the control group. This loss of muscle strength is not caused by atrophy, but by weakness of quadriceps according to pain and disability(11). And decreased facilitation of quadriceps, proprioception and postural control, injuries of mechanoreceptor of cartilage demonstrate the defect of motor control and joint position sense(12).

According to anticipatory studies on the effects of exercise for osteoarthritis, Roddy et al. indicated that aerobic walking and quadriceps strengthening exercise helped patients decrease pain and hypofunction(13). Fisher et al. found that with aerobic walking, muscle rehabilitation program, light stretching and muscle strengthening exercise, pain and medicine use declined and muscle power and endurance increased(8). Moreover, Maurer et al. study with adults between 50 and 80 years of age who had knee osteoarthritis found that the quadriceps strengthening exercise group felt lesser pain than the group that just got education of exercise(14).

Because joint strengthening exercised induce great shearing force, less dangerous exercise manners are groped(15). Resistance exercise using an elastic band on knee muscles is a suitable way to put less load on joints during various positions(16).

Patients who have knee osteoarthritis have difficulty in walking and going up and down stairs. These daily activities are related to balance(17). Understanding balance for knee osteoarthritis can explain the

mechanism of dinger. Balance training is more effective way for knee osteoarthritis(17).

Balance exercise is effective for the decline of knee stability. Improving stability and exercise techniques with conversion of direction, beginning and end of unexpected exercise by using balance board or inclination board helps protect knee joints from noxious loads. Performing balance exercise can help the stability of knee joints, as well as performance of harder movement in daily activity(18).

Konradson and Ravn reported that balance exercise on rehabilitation of knee or ankle is essential to restore muscles power and ligament and damaged tissues around the joint(19). Thompson reported that lower extremity coordination movement through balance exercise improved proprioception sense(20).

There are various studies on treatment of pain and functional disorder in knee osteoarthritis(8, 9, 13, 14), but those related to proprioception and disorder index are rare. There is not enough study on how balance exercise is more effective than muscle strengthening exercise.

The goal of this study is to identify effective therapeutic exercises according to proprioception and WOMAC index by applying balance exercise and resistance exercise on knee osteoarthritis.

## MATERIALS AND METHODS

### Subjects

24 subjects were selected. All were confirmed to have knee osteoarthritis and were 60 years old or older at K hospital in Yong-in. When selecting subjects, this study excluded neurologic diseases such as stroke, parkinsonism, dementia, metabolic diseases such as diabetic mellitus, orthopedic diseases such as lateral collateral ligament, anterior and posterior cruciate ligament within 5 years ago. Persons who had regular exercise life within 5 years were excluded.

In order to minimize selection bias, classification of group were done randomly. Each group did not meet each other during each exercise according to arranged dates and time.

### Procedure

24 subjects were separated into 3 groups by RE group (resistance exercise group, n=8), BE group(balance exercise group, n=8), RM group(range of motion group, n=8). Exercise was performed three times a week for 4 weeks.

The RE group exercise was extension of knee by using an elastic band(yellow band) 10 times a 1 set for 1 min 30 sec(6 seconds a time) in sitting position on chair with 90 degree flexed hip and knee joint. Resting time was 1 min between each set.

The BE group was placed on a balance board (Tumble Form2, Patterson medical, USA) in front of a chest high table. Then, subjects were asked to move the cup from left to right, from right to left between 30cm on table for 4 sets, 5 min a 1 set and 1 min rest between each set.

The RM group held a maximal flexion of the knee and then extension, holding it for 3 sec at each end range for a total of 10 sets(each knee 5 sets) for 1 min 30 sec. Resting time was 1 min between each set.

After exercise, 2 patients out of the BE group and RM group dropped out due to pain and deficiency of motivation. Finally, the RE group 8, BE group 6, RM group 6 participated in this study.

#### Proprioception measure

Proprioception of knee was measured by joint position sense(21). Joint position sense was practiced on a high chair with flexed hip and knee joint not to reach with status of 90 degree(22).

Subjects closed their eyes and extended passively to a 40 degree flexion.

This was maintained for 5 sec on a flexed status to accustom sense of the position then back to the starting position. And then, subjects actively extended their knee to achieve a target-angle by using electrogoniometer(SJO-061, guymon gonio meter, USA) measure between making angle actively and a target-angle. Resting time was 15 sec and we used average of proprioception measuring 3 times for both knees.

#### WOMAC index

WOMAC index(Western Ontario and McMaster Universities Osteoarthritis Index) was used to assess pain, rigidity, functional status with patients(Cronbach's alpha .81).

This index is a self-reported tool and consist of 5 items for pain, 2 items for rigidity and 17 items for function.

Subjects marked each of the items and higher scores indicated more severe pain. Scores were between 4 and 0 for each item, which resulted in a maximum 20 for pain items, 8 for rigidity and 68 for physical function items.

#### Data Analysis

SPSS(v.12) was used to analyze the data. Shapiro-Wilk test of normality and paired sample t-test were used to compare with before and after treatment. ANOVA was used to analyze the differences between the three groups. Post-hoc analyses were performed using Scheffe test. Statistical significance level was .05.

## RESULTS

#### Characteristics of Subjects

RE group, BE group, RM group indicated same quality.

With general characteristics, the average age of RE group, BE group, RM group were 65.63, 66.17, 67.17 and average height were 164.03cm, 161.71cm, 158.68cm and also average weight was 63.16kg, 54.20kg, 54.00kg (Table 1).

Table 1. General characteristics of subjects

	RE group(n=8)	BE group(n=6)	RM group(n=6)	p
Age	65.63±3.46	66.17±2.23	67.17±3.25	.528
Height(cm)	164.03±9.13	161.71±8.62	158.68±8.01	.419
Weight(kg)	63.16±.46	54.20±12.31	54.00±1.81	.269

Value are Mean±SD

#### Comparison of Proprioception

Following is proprioception changes for each of groups after and before exercise(Table 2).

For each group, RE group, BE group, RM group errors decreased by 2.25 degree, 2.17 degree and 0.5

degree on target degree. Resulting from difference of before and after exercise is present significant reduction for RE group and BE group( $p < .05$ ), not significant for RM group( $p > .05$ ).

Resulting from comparison between groups of proprioception is significant difference( $p < .05$ )(Table 3),

Post-hoc test result is indicated significant difference between RE group and RM group( $p < .05$ )(Fig. 1).

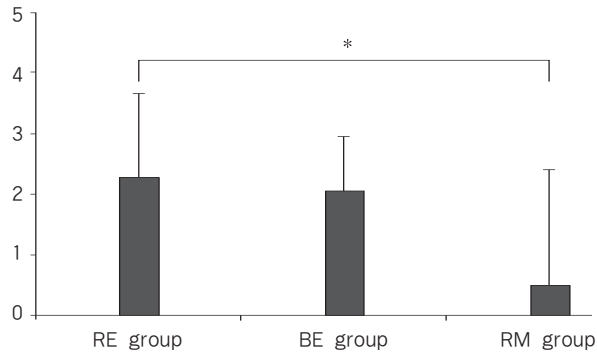
**Table 2.** Proprioception changes in group

	Proprioception		t	p
	RE group(n=8)	BE group(n=6)		
RE group	5.00±1.51	2.75± .71	4.583	.003
BE group	5.67±1.37	3.50±1.39	7.050	.001
RM group	4.83±2.23	4.33±1.03	.655	.542

Value are Mean±SD

**Table 3.** Comparison between groups of proprioception

	Sum of squares	df	Mean squares	F	p	
Proprioception after exercise	Between groups	8.617	2	4.308	3.995	.038
	Within groups	18.333	17	1.078		
	Total	26.950	19			



**Fig. 1.** Post-hoc test before and after exercise of proprioception

**Comparison of WOMAC Index**

Following is the WOMAC index changes for each group with before and after exercise(Table 4).

RE group, BE group, RM group improved in WOMAC index to 4.75, 3.50, 1.34 score. Resulting from difference of before and after exercise is present significant reduction for RE group and BE group( $p < .05$ ), not significant for RM group( $p > .05$ ).

Resulting from comparison between groups of WOMAC index is significant difference( $p < .05$ )(Table 5), Post-hoc test result is indicated significant difference between RE group and RM group( $p < .05$ )(Fig. 2).

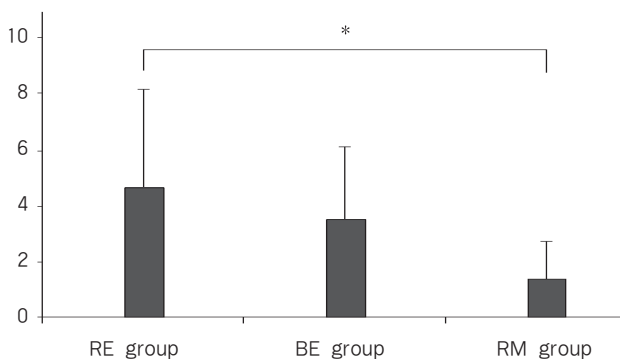
**Table 4.** WOMAC index changes in group

(score)

	WOMAC index		t	p
	Before exercise	After exercise		
RE group	30.25±3.28	25.50±1.41	3.973	.006
BE group	27.50±2.25	24.00±1.67	3.312	.021
RM group	29.17±4.88	27.83±3.76	2.390	.062

**Table 5.** Comparison between groups of WOMAC index

		Sum of squares	df	Mean squares	F	p
WOMAC index after exercise	Between groups	44.917	2	22.458	3.863	.041
	Within groups	98.833	17	5.814		
	Total	143.750	19			



**Fig. 2.** Post-hoc test before and after exercise of WOMAC index

## DISCUSSION

Knee osteoarthritis is an inflammation disease that causes abrasion of joint cartilage. This affects the weight-bearing joint to engender regression change of joint cartilage, excessive bone formation, pain and the deformity of joints that bring about limitation and discomfort in daily activity(23).

Recently, comparing trials on effects of knee osteoarthritis were reported through various intervention methods(24, 25, 26). However, studies on exercise effect for decreased proprioception are rare with these patients. Hence, this study analyzes and compares differences of proprioception and WOMAC index as performing resistance exercise and balance training.

McAlindon et al. reported that as a result of implemented resistance exercise subject to arthritis patients, the difference of proprioception was reduced to .47 degree and showed a 12.9% improvement(27). Hurley and Scott reported that exercise program group had improved proprioception com-

pared to performance of exercise program composed of isometric exercise, bicycle ergometer, isotonic exercise and functional activity during 5 weeks by 2 times a week with a control group(10).

Konradsen and Ravn reported that balance exercise was essential to recover proprioception of damaged tissue around the joint, ligament and motor power in rehabilitation of knee and ankle(19). Thompson et al. also reported that coordination movement through balance exercise improved proprioception in women(20).

In these study, stimulation caused by mechanical receptors through resistance exercise and balance training improved proprioception. In this study, results from applying resistance exercise and balance exercise improved proprioception, and there were differences between groups of resistance exercise and control group.

However, Bearne et al. reported that results from parallel resistance exercise and balance exercise were not different on proprioception of rheumatoid knee arthritis compared to the control group(28). Beard et al. reported exercise through balance board improved proprioception and muscle strengthening patients with damaged cruciate ligament(29). Like this, difference in proprioception improvement is presented differently according to disease and exercise method.

It is said that proprioception, through the balance exercise, shall be an important element determining the generation, progress and disability of knee osteoarthritis, and it is seen that knee joint proprioception among knee osteoarthritis patients has a less than 1,5 degree difference compared with normal groups(10). These small differences of knee joint when walking results in laying an inaccurate position of foot in heel strike. On the contrary, the small improvement of knee joint proprioception helps correct the position of foot and minimize the impact of power delivered from walking(10). Injury of proprioception may impact the daily activities, although it

showed little difference in the angle. It can also be seen that the recovery is needed for smooth and efficient movement.

Physical disorder is appear in knee osteoarthritis and described damage of joint generally and range of motion, flexibility, edema and pain are main factors of disorder(27). If patients have limitation of range of motion, disorder index is increasing. Thus, this reason caused mobility damage of joint, which create disorder on knee osteoarthritis(31).

Once it is possible to control sudden joint motion through balance exercise, muscle activity can control load of knee and improvement of proprioception, and physical activity can influence WOMAC index(12). According to this study, improvement of proprioception and WOMAC index were indicated in resistance exercise and balance exercise group. Loss of proprioception that can be showed from knee osteoarthritis patients was reported as a cause of diseases and as a factor of progress and it will be effective to reduce progress and disability of knee osteoarthritis if the proprioception is improved.

In conclusion, patients who have knee osteoarthritis need to improve muscle power, proprioception and disorder. We think that designing appropriate exercise programs create effective result.

## CONCLUSION

This study is performed to identify how resistance exercise and balance exercise influences proprioception and WOMAC index on patients with knee osteoarthritis, over the age of 60. Following are the results of the study.

1. RE group and BE group showed statistically significant error reduction in target degree on proprioception measure( $p < .05$ ).
2. There is a statistically significant difference between RE group and RM group are on proprioception comparison with each group( $p < .05$ ).
3. RE group and BE group showed statistically significant decrease on WOMAC index measure( $p < .05$ ).
4. RE group and RM group showed statistically different WOMAC index comparisons( $p < .05$ ).

In conclusion, resistance exercise and balance exercise are effective exercise method to improve

proprioception and decrease WOMAC index. However, resistance exercise is more effective than balance exercise.

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