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Effect of exercise using a Reformer on Balance and Gait after Total Hip Replacement-Preliminary study

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[Abstract]

The purpose of this study was to determine whether exercise using a reformer has a positive effect on balance and walking ability in patients undergoing total hip arthroplasty due to aging. In this study, 30 patients were randomly assigned to the experimental group and 15 patients to the control group using random tables. As an intervention method, the experimental group exercised with a reformer for 6 weeks and the control group did slide exercise. As measuring tools, the stand-up and walk test was used to measure balance ability, and the 10-meter walk test was used measure walking ability. Independent sample tests were conducted for each group analysis, and corresponding sample tests were conducted for in-group analysis. As a result of this study, there was a notable change in the balance in the group comparison of the experimental group($p<0.05$). There were notable changes in gait in the experimental group and the control group($p<0.05$). There was a statistically notable change in the balance and gait after intervention in the experimental group($p<0.05$). These results suggest that the group applying the reformer has a positive effect on the balance and gait ability of patients undergoing total hip replacement.

▸ **Key words**: Balance, Gait, Total hip replacement, Reformer exercise, Slide exercise

[요 약]

본 연구의 목적은 노화로 인한 고관절 전치환술 받은 환자를 대상으로 리포머를 이용한 운동이 균형과 보행 능력에 긍정적인 영향을 주는지 알아보고자 한다. 본 연구는 병원에 입원 중인 환자를 30명을 난수표를 이용하여 무작위로 실험군 15명, 대조군 15명을 배정하였다. 중재 방법으로 실험군은 6주간 리포머를 이용한 운동을, 대조군은 슬라이드 운동을 하였다. 측정 도구는 균형은 일어나서 걸어가기 검사, 보행은 10미터 보행 검사를 하였다. 각 군 간 분석은 독립 표본 검정, 그룹 내 분석은 대응 표본 검정을 하였다. 본 연구 결과, 실험군의 군 내 비교에서 균형에서 긍정적인 변화가 나타났다($p<0.05$). 보행은 실험군과 대조군에서 군 내 긍정적인 변화가 나타났다($p<0.05$). 군 간에서는 중재 후 균형과 보행에서 실험군에서 긍정적인 변화가 나타났다($p<0.05$). 이러한 결과는 리포머를 적용한 고관절 전치환술 받은 환자의 균형과 보행 능력에 유의미한 변화가 생긴 것으로 긍정적인 영향을 미친 것으로 판단한다.

▸ **주제어**: 할당량, 작업량, 이송, 부하균형, 시뮬레이션

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I. Introduction

The elderly population in South Korea has entered an aging society, accounting for 16.5% in 2021, up from 13.8% in 2017. Statistics Korea reported that the elderly population will gradually increase until 2050, and that the relative of the population aged 70 or older will be approximately 44% in 2060[1]. In this aging society, there are problems related to various geriatric diseases, the most common of which is osteoarthritis caused by degeneration of articular cartilage, and in cases where hip joint articular cartilage necrosis or destruction of articular cartilage occurs in diseases such as avascular necrosis of the osteophyte head, rheumatoid arthritis, and ankylosing spondylitis, hip joint artificial joint replacement is performed[2]. Additionally, when a fracture of the proximal femur occurs in the elderly due to a fall, total hip replacement (THR) is performed to help them return to their daily lives[3]. Approximately 20% of patients who practice a hip fracture will die within one year from factors directly related to the fracture[4]. In general, patients with THR have weakness and shortening of the quadriceps tendon, which limits flexion of the hip joint as well as the knee joint, and even changes the movement of the knee joint during walking[5]. These changes affect gait, resulting in inefficient walking with shorter strides and slower speeds.[6]. Postoperative rehabilitation should focus on increasing the range of motion of the joint, reducing pain around the joint, increasing muscle strength, and improving normal walking and balance[7]. Among them, recovery of the quadriceps femoris muscle is a necessary element involved in weight-bearing, stability, and functional movements of the hip and knee joints[8]. Additionally, massage, ROM exercises, and exercises using various devices are being performed clinically to increase pain and limited joint range of motion in patients who have undergone total hip replacement[9]. The squat exercise is one of the representative closed chain exercises, and has the characteristics of having a lower risk of injury and improving physical function compared to other exercises[10].

For this reason, squat exercises can be used in the early stages of surgery to prevent complications, prevent damage to the hip, knee, and ankle joints, and restore joint range of motion[11].

A recent study showed that weight-bearing training using a reformer was effective in improving postural control, functional mobility, self-efficacy, and range of motion, and had a positive effect on the return to daily life in surgical patients[12]. Therefore, the aim of this study was to research the effect of exercise using a reformer on the balance and walking ability of patients undergoing total hip replacement for early rehabilitation.

II. Research Method

1. Subjects

This study randomly assigned 30 patients receiving inpatient treatment after hip replacement to an experimental group and a control group. The subjects of the study were hospitalized patients who underwent total hip replacement. For 6 weeks, the experimental group performed exercises using a reformer and general physical therapy, while the control group performed slide exercises on the ground and general physical therapy. All research participants understood the purpose of the study and participated voluntarily. The general characteristics of the research participants are as follows<Table 1>.

Table 1. General characteristics of the research subjects

Variable	Experimental group (n=15)	Control group (n=15)
Male/Female	7/8	6/9
Age (Years)	75.40±13.97	72.70±14.48
Weight (Kg)	55.25±12.50	54.00±7.73
Height	161.40±8.20	158.10±6.45

2. Intervention

2.1 Experimental group

The reformer (Woong's Pilates, Korea) used in this study used springs to adjust the strength while lying down correctly, and the exercise was performed using two springs with weaker strength out of five springs[16]. The subjects performed the exercises within a pain-free range. The exercise program is as follows<Table 2><Figure 1>.

Main exercise :

1. After fixing both feet on a flat ground, bend and straighten the knees
2. Support training by lifting the legs alternately
3. Put foot on the ground and lift the heel

2.2 Control group

The sliding trainer (Man&Tel, Korea) used in the control group enables body weight support training through various exercises using ground reaction force. You can also create a standing inclination angle from 0 to 60 degrees, and the exercise program is as follows[16].

Main exercise :

1. After fixing both feet on a flat ground, bend and straighten the knees
2. Support training by lifting the legs alternately
3. Put foot on the ground and lift the heel

Table 2. Exercise program

Process	Exercise	Minutes
Warming Up	Hip joint ROM exercise	5min
Main Exercise	exercise program	30min
Cooling Down	Hip joint ROM exercise	5min

Fig. 1. Refomer Exercise

3. Measurement

3. 1 Timed up & go test (TUG)

To determine the subjects' balance ability, a stand-up and walk test was conducted. This test measured the time it took for a patient to stand up from a chair, turn 3 meters, and sit down on the chair. A total of two computations were taken and the average value was calculated[13].

3. 3 10-Meter walk test (10MWT)

The + to exclude acceleration and deceleration, the subject should walk from 3 m before the first mark to 3 m after the last mark, which are the boundaries of 10m[14].

4. Statistical analysis

The data analysis method of this study was showed using the statistical program SPSS for WINDOW, version 22.0. To verify the homogeneity of general characteristics between groups, independent sample test and chi-square test were executed. Independent sample tests were conducted for each group analysis, and corresponding sample tests were conducted for in-group analysis. The within-group effect size in this study was calculated using the R program. The statistical probability was set at α=0.05.

III. Research results

1. Comparison of balance ability

In a comparison within the group, there was a important difference in balance between before and after the experiment, from 35.50±4.21 before the intervention in the experimental group to 27.66±3.11 after the intervention.($p < 0.05$). In a contrast between groups, there was a statistically notable difference in balance ability between groups even after the intervention($p < 0.05$). The effect size of the experimental group was 0.54, a medium effect size, and the control group was 0.13, a small effect size<Table 3>.

Table 3. Comparison of balance ability between each groups

Group	Pre	Post	p	Effect size
EG	35,50±4.21	27.66±3.11	0.01*	0.54
CG	36.08±4.21	29.08±3.94	0.31	0.13
t	-0.77	2.24		
p	0.54	0.05*		

EG; Experiment group, CG; Control group, *p<.05

2. Comparison of gait ability

In a comparison within the group, the change in walking ability before and after the experiment showed a significant difference from 35.50±4.21 before the intervention to 21.66±3.11 after the intervention in the experimental group($p < 0.05$), In a comparison between groups, walking ability showed a statistically significant difference in change between groups after the intervention($p < 0.05$). The effect size of the experimental group was 0.69, a medium effect size, and the control group was 0.12, a small effect size<Table 4>.

Table 4. Comparison of gait ability between each group

Group	Pre	Post	p	Effect size
EG	35,50±4.21	21.66±3.11	0.05*	0.69
CG	32.08±4.21	23.08±3.94	0.31	0.12
t	-0.77	2.24		
p	0.54	0.05*		

EG; Experiment group, CG; Control group, *p<.05

IV. Discuss

This study was conducted to investigate the effects of weight-bearing training using a reformer on balance and gait in 30 patients undergoing hip replacement.

Most patients avoid bearing their weight properly after surgery due to fear of movement[15]. Education about taboo positions and fear of re-dislocation increase dependence on caregivers[16]. For patients in the early postoperative period who have a fear of such movements, training with the instrument can provide a sense of stability[17]. A previous study reported that in the early treatment of patients undergoing hip joint replacement surgery, the group that performed exercise using equipment had greater postural control and increased muscle strength than the group that only received simple physical therapy[18]. Additionally, exercises on the reformer performed on patients after hip replacement surgery helped improve their balance and walking ability by helping them perform safe weight-bearing training[17]. In this study, statistically significant differences were observed in balanc ability in the experimental group using the reformer. A comparison between groups also showed significant differences in balance ability in the experimental group after the intervention. It is thought that the eccentric contraction movement that occurs when the spring is pushed out of the reformer, the knee and hip joints are extended, and then the hip joint is slowly bent during the squat process, improving balance and walking ability. Squats require more joint movement than non-weight-bearing exercises[19]. Additionally, squat exercises are widely used not only in elderly subjects but also in surgical patients[20]. This is because squat exercise is a closed chain exercise that has been recommended since the early stages of surgery[21].

Patients undergoing hip replacement surgery are subject to contraindications to certain positions after surgery, depending on the surgical direction. When performing posterior/lateral surgery, flexion, adduction, and internal rotation of more than 90 degrees are contraindicated, and when performing anterior surgery, extension, abduction, and external rotation are contraindicated[22]. It is believed that exercise using the reformer created various movements of the hip joint.

Asymmetry is observed in the range of motion, tilt, and rotation of the hip joint after total hip arthroplasty[23]. And after surgery, there is a decrease in walking speed, stride length, and hip joint range of motion[24]. Additionally, the decrease in abduction moment after surgery may affect

walking speed and stride length[25]. In this study, there was a significant difference within the reformer group in walking, and a notable difference was also found in the reformer group compared to the control group in the between-group comparison. This is because the squat exercise using the reformer had a positive effect on the range of joint motion and muscle strength in hip joint extension and abduction, and the resulting stability of support would have been helpful in walking. In particular, previous studies have reported that exercise using a reformer is effective in improving balance as well as developing lower body muscles[25]. Therefore, it is thought that exercise using the reformer helped improve balance and contributed to improving walking ability.

A limitation of this study is that it only targeted patients hospitalized in a rehabilitation hospital, making it difficult to generalize the results. We could not control for individual activity times of the participants and could not control for other variables after surgery. Additionally, there were no restrictions on the intensity or exercise method of the sliding exercise applied to the control group.

V. Conclusion

This study reached the following conclusions regarding the effects of exercise using a reformer on balance and gait in patients undergoing hip arthroplasty.

In a comparison before and after the intervention within the group, there was a notable difference in balance and gait in the group using the reformer.($p < 0.05$). In the pre- and post-intervention comparison between groups, a notable difference was found in the group using the reformer in balance and gait after the intervention.($p < 0.05$). It was confirmed that exercise using the reformer had a positive effect on improving balance and walking ability in patients undergoing total hip arthroplasty.

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