

Effects of Squat Exercise according to Weight Support on Balance and Gait in Patients after Total Hip Replacement: a Pilot Study

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Purpose: The purpose of this pilot study is to identify the problems and stability of a study to investigate "Effects of Squat Exercise according to Weight Support on Balance and Gait in Patients after Total Hip Replacement." before proceeding with the study.

Methods: Twenty-two rehabilitation patients after THR surgery who met the selection criteria participated. The study subjects were randomly assigned to a squat group using a slider or a squat group using a reformer. The interventions were applied for two weeks. The patients were assessed using Berg balance scale (BBS), Timed up and go test (TUG), and 10-meter walking test (10MW).

Results: Although twenty-two study subjects participated in this study, eight study subjects participated dropouts occurred during the study period. There was a significant difference within the group in BBS and TUG in two groups ($p < 0.05$). The difference between the two groups was not significant in all outcome measures ($p > 0.05$). The largest effect size was 1.21 and the smallest effect size was 0.39, all from the BBS.

Conclusion: This pilot study suggest that it is feasible with minor adjustment to conduct a larger scale, powered RCT to examine the efficacy of squat exercise according to weight support with patients after THR.

Keywords: Total hip replacement, Rehabilitation, Squat, Pilot study

INTRODUCTION

The incidence of hip fractures continues to increase.^{1,2} This is because fractures occur frequently in the elderly. After age 50, 1/2 of women and 1/5 of men and half of osteoporotic patients experience a fracture.³⁻⁵ Since fractures are associated with mortality in the elderly, appropriate treatment and management are required.^{6,7}

After hip fracture, surgery is the most common.⁶ After surgery rehabilitation is important because it affects recovery depending on the timing of it.⁸ Early rehabilitation after surgery shortens the length of hospital stay and reduces pain.⁹ In addition, delayed after-surgery rehabilitation is associated with the onset of delirium and pneumonia and increases in the length of hospital stay.¹⁰ Therefore, after surgery rehabilitation is necessary.

After surgery rehabilitation exercises include many exercises such as early walking,¹¹ progressive muscle strengthening exercise,¹² weight-bearing exercise,¹³ and balance exercise.¹⁴ Among them, After surgery weight-

bearing exercise is presented as an important exercise. Physical therapists also prefer weight-bearing exercises to progressive resistance exercises.¹⁵ Therefore, It is important to exercise after surgery weight-bearing.

However, previous studies on weight-bearing exercise and squats have limitations. Previous weight-bearing studies have shown that early rehabilitation using crutches after surgery involves a risk of falls,¹⁶ and weight-bearing exercises were carried out several months after surgery.¹⁷ Therefore, previous studies have a risk of falls and missed the early rehabilitation period.

There are also limitations on squats. Patients can squat up to 80 degrees of hip joint after surgery.¹⁸ However, there is a limitation that patients do not squat due to anxiety about dislocation, despite their ability to squat increases after surgery.¹⁹

Therefore, the purpose of this pilot study is to identify the problems and stability of a main study to examine "the effects of squat exercise according to weight support on balance and gait in patients after total hip re-

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placement (THR)” before proceeding with the main study.

METHODS

This pilot study was prepared in compliance with the reporting recommendations of the CONSORT statement.^{20,21} This study was conducted with the approval of G Hospital. Consent was obtained from all participants before the study.

1. Subjects

This study was conducted from October to December 2021 with twenty-two patients who were hospitalized and being treated at G Rehabilitation Hospital in Gwangju to which they were transferred after THR surgery. Study subjects were recruited through a notice for recruitment of study participants on a bulletin board in the hospital. The selection criteria were 1) those who received their medical attendant’s finding that they could support their weight, 2) those who could walk at least 10 m using a walking aid or independently, and 3) those who voluntarily agreed to the study. Exclusion criteria were 1) those who had pathological problems at the surgical site, 2) those who were diagnosed with a neurological problem, and 3) those who had visual or hearing impairments. The number of subjects in this pilot study was calculated to be 22 in total by adding 10% to the minimum sample size of a pilot study, which is 10 per group.^{22,23} Twenty-two participants in this study were randomly assigned to one of two treatment groups. The ratio of allocation was 1:1. An assessor prepared randomly shuffled sticks (A stick: Reformer; and B stick: Sliding) and sealed each stick in an opaque envelope. The participants were assigned to the groups for the sticks they selected.

2. Experimental method

The subjects of this study were commonly intervened with general physi-

cal therapy and occupational therapy. Thereafter, they were intervened with the intervention methods assigned to each group. The intensity and frequency of interventions were applied according to the individual condition of the patient. Interventions were conducted daily for 2 weeks.

1) Reformer

The reformer used in this study (REFORMER, Korea) enables gradual muscle strengthening exercise as the strength can be adjusted in the supine position through the degree of compression of the spring connected to the device. The exercise program is as follows (Table 1, Figure 1A).

2) Slide

The sliding trainer used in this study (Man&Tel, Korea) can make a standing inclination angles from 0 to 60 degrees and enables weight bearing training through various exercises using ground reaction forces. The exercise program is as follows (Table 1, Figure 1B).

3. Measurements

1) Side effect

The subjects of this study were asked whether any side effect occurred at each treatment session, and the results were recorded in a standardized form.

Table 1. Exercise program

Exercise program	Detailed items	Duration
Warm-up	Mobility exercise for the hip joint	5 min
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 Place both soles of the feet on the ground and lift the heels ④ Put one foot on the ground and lift the heel	20 min
Cooling down	Mobility exercise for the hip joint	5 min



Figure 1. Exercise by group. (A) Reformer group, (B) Sliding group.

2) Primary outcome

The Berg balance scale (BBS) was used to assess balance ability. The scale consisted of 14 activities of the subjects related to balance ranging from sitting to standing including standing on one leg. The subjects are scored from 0 to 4 points according to the level of performance of each item so that the full score is a total of 56 points and higher scores indicate better balance ability.

The timed up and go test (TUG) was used to assess balance ability. The subject is prepared by sitting in an upright posture on a chair with a back-rest. The time taken for the subject to safely return to the chair after going to the turning point at a distance of 3 m following a starting signal and turning around the turning point using a walking aid or by walking independently depending on the functional state of the subject. When turning around the turning point, the subjects were instructed to turn around the unaffected side so that no rotational force would be applied to the fracture site.

3) Secondary outcome

The 10-meter walking test (10MW) was used to determine walking ability. The subjects can walk independently or use assistive tools and are instructed to walk in their usual gait. In order to exclude acceleration and deceleration, the subject should walk from 2 m before the first mark to 2 m after the last mark, which are the boundaries of 10 m. The test begins when the subject passes over the first mark line and ends when the subject passes over the last mark line.

4. Statistical analysis

The purpose of this pilot study is not to test a hypothesis, but to confirm the validity of the main study.^{24,25} In this study, descriptive statistics were performed using a statistical program (SPSS for Windows, version 21.0, IBM, Chicago, IL USA) for recruitment data, baseline characteristics, and outcome measures. The Mann-Whitney U test was used to see the difference between groups and the Wilcoxon signed-rank test was used to see

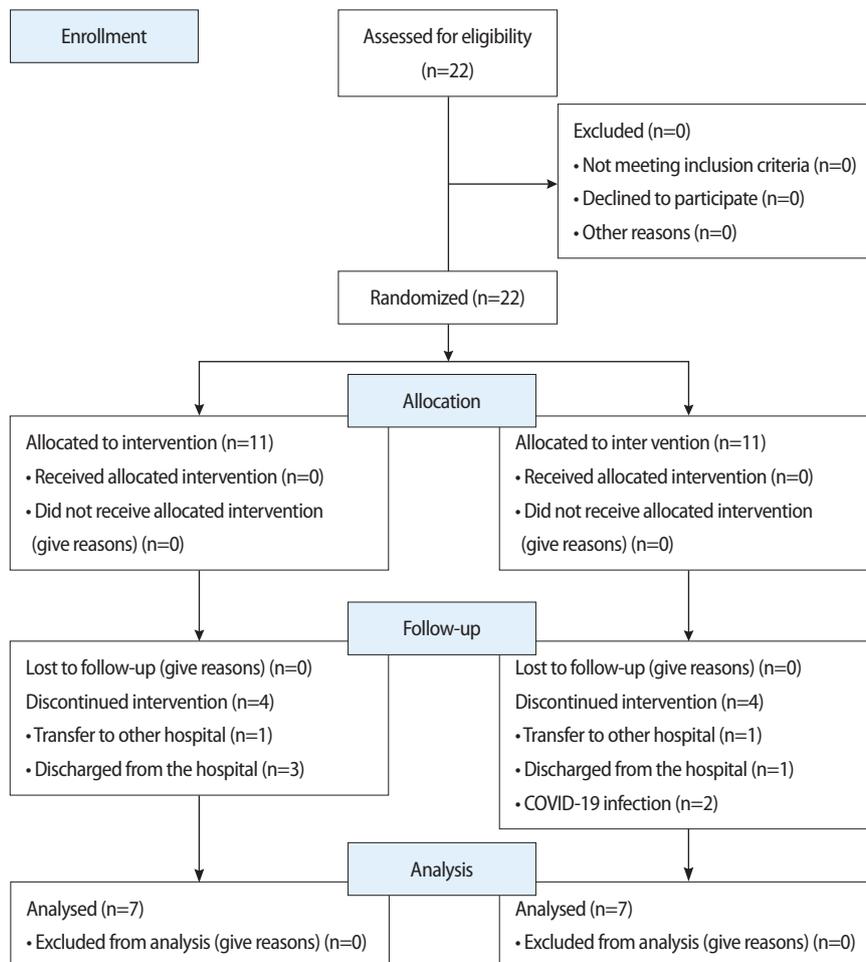


Figure 2. CONSORT flow diagram of the experimental design.

the difference within the group. Effect sizes were calculated using Cohen's D method for each group.

RESULTS

1. Study subjects

Twenty two study subjects participated in this pilot study. Among them, 14 completed the 2-week study participation. A total of eight subjects did not complete the study participation in this pilot study. Out of the eight subjects in total, two were transferred to other hospitals, four were abruptly discharged, and two were unable to complete the participation in the study due to COVID-19. Two patients who were transferred to other hospitals suffered injuries due to carelessness in the ward that was not related to the study intervention. The reasons for the transfers were fractures in the knee joint and injuries at the surgical site. The flow of study subjects' participation in the study is as shown in Figure 2. No side effects were observed in 14 subjects who completed the participation in this study. Table 2 shows the general characteristics of those study subjects who completed their participation in the study.

Table 2. Characteristics of subjects

Characteristic	Reformer	Sliding	All patients
Patients (n)	7	7	14
Male patients (n)	2	1	3
Female patients (n)	5	6	11
Age (yr)	72.7±16.7	75.4±7.5	74.1±12.5
Height (cm)	159.6±9.9	155.3±6.9	157.4±8.5
Weight (kg)	55.5±8.7	56.4±11.5	56.0±9.8
Surgery side (L)	4	3	7
Surgery side (R)	2	4	6
Surgery side (B)	1	0	1

Mean±SD, L: Left, R: Right, B: Both.

Table 3. Comparison of reformer and sliding

Variable	Intervention	Pre	Post	Change	Effect size
BBS (score)	Reformer	24.71±14.31	40.29±11.32*	15.57±15.13	1.21
	Sliding	34.86±13.75	40.29±13.74*	5.43±3.51	0.39
TUG (sec)	Reformer	35.97±29.87	26.12±17.59*	-9.84±14.03	0.4
	Sliding	36.66±22.36	21.13±11.40*	-15.53±14.86	0.88
10MW (sec)	Reformer	36.53±29.58	21.74±7.07	-14.79±24.97	0.69
	Sliding	29.06±20.10	20.75±16.76	-8.32±17.78	0.45

Mean±SD, BBS: Berg balance scale, TUG: The timed up and go test, 10MW: 10-meter walking test.

*Significant differences within groups.

2. Outcome measures

The results of assessment of the 14 subjects who completed their participation in this study are shown in Table 3. The difference between the two groups was not significant in all outcome measures ($p > 0.05$). There was a significant difference within the group in BBS and TUG in two groups ($p < 0.05$). The effect sizes in the results of assessment varied from a small effect size to a large effect size. The largest effect size was 1.21 and the smallest effect size was 0.39, all from the BBS.

DISCUSSION

Although the weight-bearing intervention method after THR surgery is a preferred intervention method in rehabilitation, there are limitations in the diversity and stability of the weight-bearing method based on previous studies to date. Therefore, the purpose of this pilot study is to confirm the feasibility of the weight-bearing method through the squat in the rehabilitation of patients after THR surgery. As a result of this study, there was a significant difference in BBS and TUG within group in both groups. However, 10MW was no significant difference within the group in both groups. And there was no difference between the two groups in all variables.

A squat that repeatedly flexion and extension the ankle, knee, and hip joints were performed as an intervention method In this study. Squat and sit-to-stand are basic movements frequently performed daily,^{26,27} but studies on the squat applied to patients lack the evidence. In a previous study on THR surgery patients, the effect of the squat could not be confirmed because the squat was included in the complex exercise program.²⁸ This study differs from this previous study in that balance was not evaluated in the previous study in which strength training was performed in a form similar to that of the squat.²⁹ In this study, it is thought that the balance was improved because repeated contractions affected proprioception. Therefore, additional studies involving a lot of subjects are needed to de-

termine the effect of squat on balance in THR patients.

Weight support is an important factor for patients after THR. The weight-bearing group can be discharged from the hospital earlier than the weight-bearing restriction group,³⁰ and it is effective in improving functional performance.³¹ However, when patients are instructed to bear their self-own weight, they do not perform adequate weight-bearing.³² Therefore, weight-bearing exercise under the supervision of a physical therapist is necessary for a quick return to daily life after surgery.

Some limitations need to be supplemented in future studies. First, pilot studies like this provide opportunities to review all aspects of the main studies thereby helping researchers, study participants, and study resources not to be wasted.²¹ As a result of this study, the balance was restored, so the intervention method is valid. However, there is no control group in this study design, so it is difficult to confirm the effect. Therefore, it is necessary to proceed with the RCT study with the addition of a control group during the main study. Second, THR patients are more common in winter.³³ However, there is a limitation in planning the study period as one season and one year. There is a possibility that the sample size required for the main study may not be fully recruited during the previously planned study period. Therefore, it is necessary to consider modifying the study period to a multi-year study period or a multi-center study. Third, Eight subjects were dropped out In this pilot study. In the main study, attention should be paid to simple changes of mind and COVID-19 infection for the study subject's participation. Currently, the world is at risk of infectious diseases due to the COVID-19 pandemic.³⁴ Methods to lower the risk of contracting COVID-19 in study subjects during the study period should be considered. Therefore, when calculating the size of the main study sample, a method of calculating the dropout rate from 10% to 20% should be considered.

In conclusion, this pilot study suggest that it is feasible with minor adjustment to conduct a larger scale, powered RCT to examine the efficacy of squat exercise according to weight support with patients after THR.

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