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EFFECTS OF SIT TO STAND TRAINING WITH VISUAL FEEDBACK ON THE WALKING ABILITY IN SUBJECT WITH TOTAL KNEE REPLACEMENT PATIENTS

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ABSTRACT

Purpose

The purpose of this study was to verify the effectiveness of sit to stand training with visual feedback to improve walking ability of total knee replacement patients.

Methods

In this study, 15 patients with total knee replacement patients were recruited from a rehabilitation hospital. They were divided into two groups: a feedback group (n=8) and a control group (n=7). They all received 30 minutes of continuous passive motion (CPM) and sit to stand training for 15 minutes five times a week for two weeks. Spatio-temporal gait parameters were measured. Spatio-temporal gait parameters were measured by Biodex gait trainer2.

Results

After the training periods, the feedback group showed a significant improvement in walking speed, step length of the operated side and non-operated side than control group ($p<0.05$).

Conclusion

The results of this study showed that sit to stand training with visual feedback was more

effective in improving walking ability than the sit to stand training without visual feedback.

INTRODUCTION

The knee joint provides stability and mobility at the same time, and is an important joint in daily life because it distributes weight and stress from the ground [1]. The knee joint are the most frequent areas of degenerative arthritis as aging progresses, and exhibits forms such as pain and weakness in leg muscle strength, changes in joint shape, and a decrease in balance ability due to decline in proprioceptive function [2]. Anti-inflammatory drugs and physical therapy are used to control degenerative knee arthritis, but in severe patients, total knee replacement (TKR) is performed. Total knee replacement is an effective method for improving pain, but even after surgery, it shows a decrease in balance and walking ability due to weakness of leg muscle strength, and functional ability such as sit to stand and stairs up [3].

In order to improve these points, the improvement of knee joint extensor muscle strength is important in restoring stability, movement and function of the knee joint and improving walking ability [4]. Suh et al. [5] reported that in patients with total knee replacement, improvement of knee joint extensor muscle strength affects walking speed and cadence. In a study by Park et al. [6], it was reported that performing knee joint extensor muscle strength training in patients with total knee replacement improves leg strength and walking endurance. Particularly, in the case of total knee replacement, since it has an asymmetrical weight distribution, it is necessary to exercise the strength of the leg during the rehabilitation process [7].

Sit to stand is a movement that occurs frequently in daily life, and movement is performed based on the moment at the hip, knee and ankle joints [8]. It is an effective method to improve balance and walking ability as it requires the ability to move the center of pressure on a narrow support surface in order to perform the sit to stand [9]. A review of previous studies that verified the effectiveness of the sit to stand training, it has been verified that standing training is an effective method to induce a symmetrical posture for subjects who show asymmetric posture [10, 11]. In particular, it has been verified that the sit to stand training with visual feedback is an effective method to perform movement in a symmetrical posture according to visual information [12].

Based on these previous studies, it can be seen that the sit to stand training with visual feedback is an effective method for improving the gait ability by inducing a symmetrical posture. There are few studies that have verified. Therefore, in this study, we tried to verify the effect of sit to stand training with visual feedback to patients with total knee replacement on walking ability, and to provide clinical information based on this.

METHODS

Subjects

The study was conducted on a total of 15 patients who were admitted to the rehabilitation hospital January 2020 to May 2020, who understood the purpose of the study and made informed consent to participate in the study based on the declaration of Helsinki. The inclusion criteria for the participants in the study were those who received total knee replacement due to osteoarthritis on one leg, those who understand and follow the therapist's instructions, those who can sit to stand independently, and those who can walk without aids. In addition, patients with other surgery or disease of the leg and patients with total knee replacement due to external damage other than osteoarthritis were excluded. Table 1 shows the general characteristics of the subjects (Table 1).

Table 1 General characteristics of subjects (n= 15)

Characteristics	Feedback group[a](n_1=8)	Control group[b](n_2=7)	p
Age (years)	66.00±6.14[d]	66.43±5.97	0.89
Gender (M/F)	4/4	3/4	0.80
Height (㎝)	162.25±7.99	167.57±8.56	0.24
Weight (㎏)	65.86±9.46	66.29±9.60	0.94
Operation side (Rt/Lt)	5/3	4/3	0.80
VAS[c] (score)	4.13±1.45	3.86±1.68	0.75
[a]Sit to stand training with visual feedback, [b]Sit to stand training without visual feedback, [c]Visual analogue scale, [d]Mean±standard deviation			

Procedure

Prior to the study, subjects were randomly assigned to each group. Information on the subject's diagnosis, age, sex, height, and weight was investigated through interviews and medical records. There were 8 feedback group who were trained to sit to stand with visual feedback, and 7 were the control group who trained sit to stand without visual feedback. In both groups, a continuous passive motion (Artromot K-3 CPM, Ormed, Germany) was applied for 30 minutes before training, followed by sit to stand training for 15 minutes, 5 times a week, for a total of 2 weeks. The amount of change was analyzed by measuring spatio-temporal gait parameters before and after training.

For the sit to stand training, the subjects were to sit on a height-adjustable bed (Bobath table, Kwang-won meditec, Korea) according to the knee joint height of the subjects, and then put both hands crossed in front of the chest. The subjects were seated by adjusting their position so that only half of the femurs touched the bed, and gradually performed from 105° to 75° according to the knee joint flexion angle [13]. In order to minimize the subject's fatigue, they

were allowed to rest for 30 seconds after 10 times, and stopped when they complained of pain or fatigue. In addition, language was emphasized so that one therapist could perform stand-up training in a symmetrical position by being located at close distance for the safety of the subject (Fig. 1).

The feedback group provided visual feedback using a balance ability measuring device (Balancia software, Mintosys, Korea). During the sit to stand training, a Wii Balance Board (Wii Balance Board, Nintendo, Japan) was placed under the subject's feet to check the subject's center of pressure (COP) information through a connected monitor to achieve symmetry.

In the control group, the balance ability measurement equipment was placed under the subject's feet and the sit to stand training was performed without visual feedback.

Fig.1 Sit to stand training with visual feedback.

Assessment

Biodex gait trainer 2 (Biodex Medical System, Shirley, USA) was used to measure the change in walking ability of the subjects. Prior to the measurement, the subjects' general information was entered, and they were allowed to walk at a comfortable pace for 3 minutes in a walking ability measuring device to adapt to the device. After that, the researcher started with a speed of 0.3km/h and increased by 0.1km/h, walking at a comfortable speed for 5 minutes, and statistically processing the measured data. The spatiotemporal gait parameters used in the study were walking speed, step cycle, step length of the operated side and non-operated side, and time on each foot of the operated side.

Statistical analysis

All statistical analyzes of this study were conducted using the Korean version of SPSS 22.0 (SPSS Inc., Chicago, IL, USA), and a normality test was performed by Kolmogorov-Smirnov test. To examine the differences in general characteristics between the two groups, the independent t-test were

used. The paired t-test was conducted to examine the changes before and after the walking ability of each group. In order to investigate the difference in the amount of change in walking ability between groups, the pre-intervention value was set as a covariate and analysis of covariance was performed. The significance level was 0.05.

RESULTS

The results of a comparison before and after the training showed that feedback group's walking speed, step length of the operated side and non-operated side, time on each foot of the operated side significantly increased ($p<0.05$). In the control group's walking speed, step length of the non-operated side significantly increased ($p<0.05$). After the training, the results of a comparison between the two groups showed that the feedback group's walking speed, step length of the operated side and non-operated side statistically significantly difference compared to the control group ($p<0.05$) (Table 2).

Table 2. Comparison of pre and post training outcome measures of walking ability within and between groups (n= 15)

		Feedback group[a] (n_1=8)	Control group[b] (n_2=7)	p
Speed (㎧)	Pre Post p	0.30±0.17[c] 0.37±0.20 0.00[*]	0.31±0.12 0.33±0.11 0.00[*]	0.01[†]
Cycle (steps/min)	Pre Post p	0.60±0.11 0.63±0.14 0.08	0.61±0.11 0.63±0.14 0.41	0.64
Step length (㎝)				
operated	Pre Post p	28.75±13.34 32.75±12.76 0.00[*]	31.21±13.57 31.71±13.98 0.23	0.00[†]
non-operated	Pre Post p	24.00±12.07 30.13±11.64 0.00[*]	24.86±12.60 27.14±11.39 0.01[*]	0.00[†]
Time on each foot(%)				
operated	Pre Post p	45.66±3.34 48.25±2.19 0.00[*]	45.14±2.19 46.71±1.70 0.13	0.12

[a]Sit to stand training with visual feedback, [b]Sit to stand training without visual feedback, [c]Mean±standard deviation, significant difference between pre and post intervention within the group ([*]$p<0.05$), significant difference between the change values among the groups ([†]$p<0.05$)

DISCUSSION

This study was conducted to verify the effect of the provision of visual feedback on the walking ability during sit to stand training in total knee replacement patients, and to provide clinical information based on this.

Results on the spatio-temporal gait parameters in the feedback group, walking speed, step length of the operated and non-operated side, and time on each foot of the operated side were improved, and walking speed and step length of the non-operated side were improved in the control group. The improvement of knee joint extensor muscle strength has an effect on the stance phase during walking and is related to the improvement of walking ability. It was reported that sit to stand training led to an improvement in muscle strength of the knee joint extensor muscles and improved walking ability [14]. In a study by Suh et al. [15], it was reported that the exercise method that combines eccentric contraction and concentric contraction of the knee joint extensor muscle was effective in improving walking speed in patients with total knee replacement. This results in improved results when the improvement of the knee joint extensor muscle strength is performed by combining the eccentric contraction and concentric contraction. In particular, it was said that the eccentric contraction is a method that can generate a large force with less energy consumption compared to the concentric contraction. In this study, the repetition of the sit to stand motions performed in both groups was a combined method of eccentric contraction and concentric contraction to improve the muscle strength of the extensor muscles of the knee joint. It is thought that the improved results of the gait parameters were observed by affecting the stance phase during walking.

In comparison between groups, the feedback group showed improved walking speed, step length of the operated side and non-operated side compared to the control group. Abujaber et al. [12] reported that providing a visual feedback of the weight distribution during sit to stand training to patients with total hip arthroplasty was an effective method for improving the symmetry of both legs, thereby improving walking ability. A study by Foo et al. [16] also verified that providing weight distribution as a visual feedback during sit to stand training to subjects with asymmetric postures is an effective method to induce a symmetric posture and improve walking ability. It is said that the movement of the hip joint, knee joint, and ankle joint should occur to perform the sit to stand, and the result of improved symmetry was achieved by facilitating the movement of the leg on the operated side through visual feedback. In this study, the symmetry was improved as the weight distribution of the operated side increased in the feedback group. The result of improved symmetry in this study is that the COP movement path is confirmed through visual feedback, and by performing sit to stand training, the motor control that induces the movement of the leg on the operated side.

In this study, sit to stand training was performed to improve the walking ability of patients with total knee replacement. The therapist observed and instructed the subjects to perform in a symmetrical posture while performing sit to stand training, but it was difficult to confirm whether the correct posture was maintained continuously. The sit to stand is affected by the hip joint, ankle joint, and spine at the same time as the role of the knee joint extensor, and there is a limitation in verifying the correlation with the changed walking ability because the related strengths were not evaluated. In a future study, it is

necessary to verify the correlation with walking ability through the evaluation of muscle strength at various joints according to sit to stand training in total knee replacement patient.

Total knee arthroplasty patient has an asymmetrical weight distribution and abnormal gait pattern due to weakening of the knee joint extensor muscles. Therefore, in this study, sit to stand training with visual feedback to total knee replacement patients improved walking speed, step length of the operated side and non-operated side, and time on each foot of the operated side compared to when no visual feedback was provided. This is the result of inducing a symmetrical posture in accordance with the visual feedback provided during sit to stand training and effectively improving the movement of the extensor muscles of the knee joint on the operated side. Therefore, in clinical practice, it is recommended to provide visual feedback during sit to stand training in order to elicit an improvement in the walking ability of patients with total knee replacement.

Conflicts of interest: The authors declare no conflicts of interest.

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