



Original Article

The effects of proprioception exercise with and without visual feedback on the pain and balance in patients after total knee arthroplasty

HYUNG-TAEK OH, PT, MS¹⁾, GAK HWANGBO, PT, PhD^{1)*}

¹⁾ Department of Physical Therapy, College of Rehabilitation Sciences, Daegu University: Jillyang, Gyeongsan, Gyeongbuk 712-714, Republic of Korea

Abstract. [Purpose] The aim of this study was to determine the effects of proprioception exercise to decrease pain and increase the ability to balance by implementing visual feedback during early rehabilitation after total knee arthroplasty. [Subjects and Methods] In this study, 24 patients who receive a total knee arthroplasty were randomly and equally assigned to a visual feedback training group (VFT group) and a visual disuse group (Control group). They performed visual feedback training using the My Fitness Trainer (MFT, Austria) for 20 minutes, three times per week for eight weeks. The patients' balance ability and pain was measured before and after the exercises. Pain was measured by the visual analogue scale (VAS). To assess balance ability, the anteroposterior and mediolateral directions on unstable ground was measured by using the MFT measurement system. [Results] The VFT group showed a significant decrease in VAS and an increase in balance ability within the group, as well as a significant increase in balance ability between groups when compared with the control group. [Conclusion] Visual feedback training during the rehabilitation of patients who received a total knee arthroplasty will be useful in reducing pain and improving balance.

Key words: Total knee arthroplasty, Visual feedback, Balance

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INTRODUCTION

Total knee arthroplasty (TKA) is a procedure that ameliorates pain in the knee joint and restores its function¹⁾. The balance index of patients who receive a TKA is affected by whether they receive balance training²⁾. Considerable research on the ability to balance after TKA has been conducted; maintaining balance, proprioception, visual feedback, a parallel sense system, and stabilizing the contraction of lower limb muscles are closely related³⁾. Proprioception plays an important role in the rehabilitation that aims at recovering balance control. It has been established that the efficacy of exercise is higher in an exercise regimen that combines visual information with proprioception, rather than depending solely on proprioception⁴⁾.

Visual feedback contributes to posture control when it is combined with afferent information that comes from the vestibular system and the somatic senses. Since visual feedback helps decrease posture sway, it can improve the ability to control posture⁵⁾. Hatzitaki et al.⁶⁾ reported that the subjects' posture control ability improved when the visual feedback mechanism was used. In addition, they stated that an intervention including the balance exercise through visual feedback, when administered to degenerative knee arthritis patients along with a surgical intervention, was helpful for the patients' joint ability and balance⁷⁾. Although numerous studies have examined the general rehabilitation for patients who receive a TKA, few studies have investigated the visual feedback and proprioceptive training implemented during the early stages after surgery.

This study attempts to discover how visual feedback applied to proprioceptive exercise during the early rehabilitation process after TKA affects the patient's pain and balancing ability and provides fundamental data concerning early rehabilitation.

*Corresponding author. Gak Hwangbo (E-mail: hbgak@daegu.ac.kr)

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Table 1. The general characteristics of the subjects

	VFT group (n=12) (Mean ± SD)	Control group (n=12) (Mean ± SD)
Gender (male/female)	5/7	4/8
Age (yrs)	69.5 ± 2.9	70.3 ± 2.5
Height (cm)	161.6 ± 6.7	159.1 ± 10.2
Weight (kg)	62.7 ± 6.8	59.1 ± 7.5

VFT group: visual feedback training group; Control group: visual feedback disuse group.

Table 2. Comparison of within and between two groups

	VFT group			Control group		
	pre-test	post-test	change	pre-test	post-test	change
VAS	5.33 ± 1.37	2.66 ± 1.07*	2.66 ± 1.07	5.58 ± 1.50	2.75 ± 0.96*	2.83 ± 0.93
A-P balance (scores)	3.44 ± 0.21	3.06 ± 0.16*	-0.37 ± 0.18†	3.48 ± 0.23	3.26 ± 0.21*	-0.21 ± 0.09
M-L balance (scores)	3.31 ± 0.19	2.97 ± 0.23*	-0.34 ± 0.15†	3.35 ± 0.27	3.17 ± 0.24*	-0.17 ± 0.08

(Mean ± SD) *p<0.05, †Significant difference between groups (p<0.05).

VFT group: visual feedback training group; Control group: visual feedback disuse group;

A-P balance: anteroposterior balance; M-L balance: mediolateral balance, score: 0–5 point.

SUBJECTS AND METHODS

Among the patients who received rehabilitation exercise after TKA, 24 patients who were aware of the intent of this study and agreed to participate were chosen as subjects. Written informed consent according to the ethical standards of the Declaration of Helsinki was provided by all subjects prior to participation, and all agree to participate in this study. The subjects, who were capable of standing and weight loading on the affected side after TKA, were randomly divided into an experimental group (n=12) and a control group (n=12). The two groups received training three times a week for a total of eight weeks.

The My Fitness Trainer (MFT, Austria) balance board, which is manufactured in Austria, was used for the experimental group and the control group. The equipment is comprised of a circular foothold that moves freely in the anteroposterior and mediolateral directions on stable ground, a monitor that displays the movement of the foothold, and a computer that processes the movements. The patients moved their trunks, which were marked with a cross at the center of the target displayed on the monitor, while in a standing position with slightly bent knees, maintaining the center position as long as possible. The members of the experimental group, known as the visual feedback training (VFT) group, received training on the MFT while using visual feedback by watching the monitor. To ensure identical conditions, the control group trained on the same MFT used by the VFT group but did not receive any visual feedback. Both the VFT group and the control group exercised for 20 minutes.

Pain was measured by the visual analogue scale (VAS) twice during the eight-week research period for the members of the VFT group and the control group—before the study began and at the end of the eight weeks. The anteroposterior and mediolateral directions on unstable ground was measured for 30 seconds by using the MFT measurement system. The time it took an individual to balance his/her weight was marked on a target divided into five sections, from the highest score of 0 to the lowest score of 5; the results were calculated as a ratio of the delay time to the total measured time, which was given as a percentage. In both the VFT group and the control group, balancing ability was measured before and after the experiment. For the latter measurement, balance was determined after a 30-minute rest following the end of the exercise to minimize fatigue.

This study used SPSS 18.0 for Windows to conduct the data analysis. A paired t-test was used to test the within-group level of pain and balancing ability before and after the experiment. A covariance analysis (ANCOVA) on the post-measured value was conducted by setting the pre-value as the covariance to test the significance of the difference between groups. The significance level α was set at 0.05 for all statistical analyses.

RESULTS

No significant difference was observed between the two groups in terms of the general characteristics of the research subjects ($p>0.05$) (Table 1). When comparing the VAS after the experiment, both the VFT group and the control group showed a significant decrease within-group difference ($p<0.01$). However, there was no significant between-group difference ($p>0.05$). In a comparison of MFT balancing ability scores after the experiment, both the VFT group and the control group showed a significant decrease within-group difference in both, the anteroposterior and mediolateral directions ($p<0.01$). In addition, in the intergroup comparison, the VFT group showed more significant decrease compared to the control group ($p<0.05$) (Table 2).

DISCUSSION

This study attempted to determine the effects of proprioception exercise to decrease pain and increase the ability to balance by implementing visual feedback during early rehabilitation after TKA. The study showed that the VFT group exhibited a significant difference in the level of pain and balancing ability.

Although the VFT group and control group showed significant decrease within-group differences in the VAS after the eight-week training, there was no significant between-group difference. Visual feedback training is reported to be very useful for reducing overall pain and increasing the active range of motion⁸⁾. In our study, there was a significant within-group difference of pain after TKA, although no significant difference was observed between the VFT group and the control group when comparing them at the end of the experiment. We can say that pain decreased as time passed, although not because of the eight-week training. This is consistent with previous studies that report that almost all patients complain about pain in the early phase after TKA; the pain ameliorates or disappears with time⁹⁾.

This study measured the balance ability of a VFT group and a control group using MFT equipment. Both groups' balance ability in the anteroposterior direction and the mediolateral direction significantly increased. Moreover, the VFT group showed a significant increase compared to the control group in a between-group comparison after the treatment. Consistent with this study result, Yu et al.²⁾ noted that the balance exercise, when applied to TKA patients, was effective in increasing their balance indices; this is also consistent with the results of a previous paper that studied the effects of visual feedback on knee joint diseases^{10, 11)}. Among the factors required for maintaining balance, proprioception of the lower limb is 58%, visual information is 22%, and the vestibular system is 20%¹²⁾. As such, proprioception is extremely important and it is necessary to engage in training that emphasizes the visual and vestibular systems. The effects of visual feedback occur when neurological change occurs as spinal cord and cerebral cortex areas are stimulated following the coordination of the nerve root and the voluntary muscle contraction. The current study also assumed that visual information was effective in improving the proprioceptive senses, which decreased after TKA surgery, through postoperative rehabilitation.

Limitations of this study were that compensation actions of the upper extremities and trunk were not prevented during the balance training, and the surgical sites of the subjects were not consistent. Therefore, future research that improves these limitations is considered necessary.

Based on the results of this study, we believe that proprioceptive training that uses visual feedback during the rehabilitation of patients who received a TKA will be useful in reducing pain and improving balance.

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