The effect of gluteus medius strengthening on the knee joint function score and pain in meniscal surgery patients

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Abstract. [Purpose] The purpose of this study was to analyze the effect of gluteus medius activity strengthening due to squat with isometric hip adduction and hip abduction in side-lying exercise on knee joint function index and pain in meniscal surgery patients. [Subjects and Methods] This study selected sample of 26 patients who had meniscal surgery more than 4 weeks ago. The patients were divided into squat with isometric hip adduction exercise group I (n=8), hip abduction in side-lying exercise group II (n=9), and combined exercise group III. The lysholm score was used to evaluate knee joint function and visual analog scale was used to evaluate pain index of knee joint. [Results] Two-way repeated measures ANOVA was used to analyze the lysholm score and visual analog scale and showed significant interaction between the groups and durations. [Conclusion] Strengthening vastus medialis oblique and gluteus medius improved functional recovery and pain reduction of knee joint in meniscal injury surgery patients. Gluteus medius strengthening exercise is essential to meniscal injury surgery patients and should be included in rehabilitation program in early stages to be conducted systematically.

Key words: Meniscus injury, Gluteus medius, Muscle strength

INTRODUCTION

Meniscus used to be considered as nonfunctional structure. However, in fact, it increases efficient contact surface between femur and tibia and minimizes loads per unit area to decrease contact pressure to articular cartilage1). Meniscal injury causes knee extension block in daily life as a characteristic finding, pain, limping gait, crepitus and giving way during stair or gravel gait1, 2). In addition, knee joint stiffness because of locking leads to limitation of motion.

Therefore, remarkable atrophy in vastus medialis oblique (VMO) among quadriceps femoris occurs without exception2). Muscular imbalance of VMO with vastus lateralis (VL) and delayed muscle onset time during knee extension generate excessive lateral movement of patella3). Change in pathway of patella during movement causes excessive loads on subchondral bone4, 5). This will result in lower extremity malalignment.

Instability of knee joint can change neuromuscular control system of lower limbs followed by abnormal changes in core muscles that control hip joint such as gluteus maximus (Gmax) and gluteus medius (GMed)6). Gmed malfunction and decreased muscle activity cause adduction and internal rotation in hip joint during weight bearing while walking7, 8). Like in the case of VMO weakness, this increases Q-angle, causes genu valgum and moves patella to lateral side to increase valgus vector9).

Therefore, importance of VMO strengthening and selective strengthening of GMed should be emphasized to consistently improve symptoms of knee joint meniscal injury8, 9). However, recent studies relating to knee joint rehabilitation after meniscal surgery only analyzed comparison of muscle activity ratio between VMO and VL or muscle activity of GMed.

Therefore, this study analyzed the effect of improvement in muscle strengths of both VMO and GMed after meniscal surgery on knee joint function index and pain to provide effective and useful information for the physical therapeutic treatment.
SUBJECTS AND METHODS

This study selected sample of 26 patients who were aged from 20 to 40, diagnosed with meniscal tears and had meniscal surgery. The patients were hospitalized in or visiting S hospital in Gwangju. The test was conducted from Nov. 2015 to Jan. 2016. The patients were understood the purpose and procedure of this study, exercise period etc. and provided written informed consent prior to participation according to the ethical standards of the Declaration of Helsinki.

Table 1 shows general characteristics of the participants. The selection criteria for the participants were as follows; (1) meniscal surgery more than 4 weeks ago, (2) no knee joint rehabilitation experience, (3) the lysholm score of less than 64 points and (4) GMed weakness with lower than grade 4 (good) at manual muscle testing (grade 0 to grade 4) according to muscle strength grade standard by Kendall et al\(^{[11]}\).

The participants were randomly divided into group I; VMO strengthening exercise through squat with isometric hip adduction (SIHA), group II; GMed strengthening exercise through hip abduction in side-lying (ABD), and combined exercise group III.

For the intervention method of group I, the participant’s knee joint flexion was set to 45 degrees using a goniometer. The participant stood with his back to the wall. For femur and tibia to maintain neutral position, the patient was controlled to avoid hip joint adduction keeping the center of patella in line with the second toe. A pillow was placed in the middle of both patella and the knees were flexed to 45 degrees (squatting position) and then the participant came back to standing position\(^{[2]}\). On the basis of 10RM (repetition maximum), ability to repeat the squatting 10 times, the participant had 10-second break between the 20-minute exercise. For the ABD starting position of group II, the hip and knees were fixed to be flexed to 45 degrees and 90 degrees retrospectively in a side lying position and the back and foot-floor were fixed on the wall. The participant abducted the hip to 40 degrees with the ther-a-band looped around the knees and came back to the original position\(^{[12]}\). On the basis of 10RM (repetition maximum), ability to repeat the movement 10 times, the participant had 10-second break between the 20-minute exercise. Group III conducted SIHA for 10 minutes and ABD for 10 minutes and had 10-second break between the exercises. All groups conducted the exercises with a load of 70% 1RM three times a week for 5 weeks.

The lysholm score was used to analyze knee joint function. The scale items include limp, support (using stick or crutches), stair-climbing, squatting, instability (walking, running, and jumping), pain, swelling, and thigh atrophy to evaluate instability of knee joint. Maximum score is 100. Visual analog scale (VAS, Gyma, Belgium) was used to evaluate the pain level of knee joint numerically. It was a 10 cm line that evaluated pain subjectively. The participant indicated a position along the line between two end points.

PASW Statistics ver. 18.0 was used to analyze the data and the mean value and standard deviation were calculated. Two-way repeated measures ANOVA was used to investigate the interaction effect between the group and period. The statistical significance level used was α=0.05.

RESULTS

Two-way repeated measures ANOVA about the lysholm score revealed that there was a significant interaction between the group and period (p<0.05) (Table 2). VAS for knee joint pain evaluation showed that there was a significant interaction between the group and period (p<0.05) (Table 2).

DISCUSSION

This study conducted SIHA and ABD exercise and combined exercises of the two with the patients who had meniscal surgery 4 weeks ago in terms of VMO strengthening and selective strengthening of GMed and analyzed the lysholm score and VAS.

Squat is a closed kinetic chain exercise that uses various joints and muscles in one action. It is an effective and safe intervention method because co-contraction of surrounding muscles of knee increases and tension on anterior cruciate ligament is minimized\(^{[15]}\). In the squat intervention, a pillow was placed between the knees to maintain neutral position and semi-squat to 45 degrees flexion was conducted to selectively strengthen VMO and induce isometric hip joint adduction\(^{[9]}\). Consequently, the lysholm score of the squat group increased. This result occurred because femur and tibia maintained neutral position and SIHA exercise was performed with knee joints flexed to 45 degrees in this study. Thus, VMO activity was strengthened rather than VL and iliotibial tract and lateral knee vector quantity was controlled so that patella could move through normal pathway. Nyland et al.\(^{[2]}\) showed that the squat exercise with isometric hip joint adduction would increase GMed activity because it is related to pelvic stability and controls femur internal rotation.

GMed weakness causes overactivity and shortness of tensor fasciae latae and Iliotibial tract and gonarthrosis because of lack of lateral knee joint stability\(^{[15]}\). This means that patients with meniscal surgery need selective strengthening of GMed. This study conducted ABD exercise with SIHA for GMed strengthening. As SIHA exercise group, ABD group showed that the lysholm score increased and VAS decreased. The combined exercise group (SIHA with ABD) showed more improvement than SIHA and ABD group: knee functional index increased and pain decreased. This result is consistent with a previous study in that hip joint adduction and internal rotation due to failure of hip abductor and hip external rotator to handle increased stress on knee joint caused excessive knee valgus due to weakness and atrophy of VMO and this produced lateral...
movement of patella. Hip joint abduction exercise in a side lying position is commonly used open kinetic chain exercises. A study about strengthening hip muscles by Distefano et al. revealed that GMed had the greatest muscle activity in a side lying position after 12 exercise programs. Therefore, clinical use of GMed strengthening exercise with hip joint abduction in a side lying position should be conducted carefully.

A limitation of this study was that surgical method the patient received before the test, whether it was meniscectomy or meniscus repair, was not specified. In addition, whether the patient had medial or lateral meniscal injury was also not specified.

Therefore, GMed strengthening for the patients with meniscal surgery improved knee joint function recovery and pain in this study and systematic rehabilitation program should be actively suggested to patients and conducted in early stage.

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