LEG PRESS EXERCISE IN PATELLOFEMORAL PAIN- A ONE-YEAR FOLLOW-UP STUDY

Chen-Yi Song[1] and Mei-Hwa Jan[1,2]

School and Graduate Institute of Physical Therapy, College of Medicine, National Taiwan University, Taipei, Taiwan[1]
Physical Therapy Center, National Taiwan University Hospital, Taipei, Taiwan [2]

The purpose of this study was to investigate the short- and long-term effect of leg-press exercises in dealing with patellofemoral pain. Sixty subjects with patellofemoral pain participated. They were randomly assigned into leg-press exercise or control (no exercise) group. Training consisted of three weekly sessions for eight weeks. Measurements of pain (VAS), Lysholm scale score, morphology of vastus medialis obliquus (including cross-sectional area and volume by ultrasonography) were obtained before and after 8-wk treatment. Long-term follow-ups were carried out (on leg-press group only) at 6-month and 12-month later. Significant improvements in pain, functional score, and muscle hypertrophy were observed after leg-press intervention, but not in the control group. The good subjective and functional outcomes achieved immediately after exercise intervention were maintained at long-term follow-up. Since the short- and long-term prognoses of subjects who underwent leg-press exercise were relatively good, simple and convenient leg-press exercise was recommended in rehabilitation of patellofemoral pain.

KEY WORDS: knee, leg press, morphology.

INTRODUCTION: Patellofemoral pain is a common musculoskeletal problem of the knee that frequently affects both young and sporty populations. It was thought to occur with lateral malalignment of the patella where hypotrophy or atrophy of vastus medialis obliquus (VMO) muscle was one of possible cause that commonly seen in patients with patellofemoral pain. Since the VMO plays an important role in medial stabilization of patella, numerous rehabilitation protocols regarding quadriceps strengthening were described for dealing with this problem. Among them, the leg-press exercise was a common approach. However, the clinical evidence regarding the efficacy of this approach, especially on VMO morphology, was lacking. It is unclear if the improvement of subjective outcome, i.e. decrease of pain and increase of functional ability, is interrelated with VMO hypertrophy. The purpose of this study was to investigate the short-term (2-month) and long-term (6- and 12-month) effects of leg-press exercise. The morphology of VMO along with the pain and functional ability were measured.

METHODS: Data Collection: A total of 60 participants diagnosed with unilateral or bilateral patellofremoral pain were enrolled in this study. They were randomly allocated into leg-press exercise (LP) or control (no exercise) group. Three-weekly exercise interventions were carried out by one physical therapist. Four assessment sessions, at time of initial evaluation (pre-training), 2-month post-training, and 6-month, 12-month later, were performed by another physical therapist who was blinded to each patient's grouping. At long-term follow-up (6- and 12-month), only leg-press exercise group was evaluated.

Leg-press exercises training was performed unilaterally starting from 45° of knee flexion to full extension using leg-press machine (Enraf-Nonius B.V., Rotterdam, The Netherlands) since the patellofemoral joint stress was less in the functional range of knee motion. Prior to the beginning of exercise training, unilateral one-repetition-maximum (1RM) strength of the lower extremity was determined with repetition-to-fatigue testing. Patients were unilaterally trained at 60% of 1 RM for 5 sets of 10 repetitions. For the advancement of training resistance, the 1RM was re-measured every 2 weeks and the exercise intensity adjusted accordingly. A metronome was used to control the exercise pace at 2 second concentric and eccentric contractions from 45° of knee flexion to full extension. There was a 2 second break between each repetition and a 2 minute break between each set. Left and right limbs were alternatively trained between each exercise set. A hot pack was applied to quadriceps for 15 minutes before exercise. After exercise, participants were taught to stretch their quadriceps, hamstrings, iliotibial bands and calf muscle groups, and had a cold pack applied to their knee joints for 10 minutes. Self-stretches were maintained for 30 seconds and were repeated 3 times for each muscle group. Control group participants did not receive any exercise intervention, but were provided with health educational material regarding patellofemoral pain. During the intervention period, all participants were advised not to perform or receive any other exercise program or intervention. Neither tape nor brace was used. After that, 8-wk exercise program (the same with that of leg-press group) was then given to control group. The exercise intervention participants then received health education. In addition, simple home exercise programs (including general quadriceps strengthening exercise and lower-extremity stretching exercise) were taught, but they were not requested to keep up the program during follow-up period.

The outcome measures in this study included VAS pain assessment, and the worst pain experienced in the previous week was measured using the 100-mm VAS line. The functional ability was measured by Lysholm scale (0-100 point scale) where 100 point indicating maximal functions. Additionally, VMO morphology, including VMO cross-sectional area (CSA) on the patella-base level and VMO volume under the patella-base level, were assessed by ultrasonography (HDI 5000, Advanced Technology Laboratories, Bothell, WA) with a 5 to 12 MHz broadband linear-array transducer (38 mm). All ultrasonographic measurements were obtained while participants were lying on a bed, with both legs relaxed (feet were positioned in a frame to prevent leg rotation) and a thick padded towel placed underneath the knee to maintain resting position. The longitudinal length of the patella in mm was determined from the upper to the lower border with calipers. The VMO volume under the patella-base was approximated from a series of VMO CSAs using the trapezoidal rule (Lin et al., 2008). To obtain a valid calculation of VMO volume from the sonographic image, a custom-made holder was used to fix the probe (Lin et al., 2008). The holder was calibrated to quantify movement of the transducer by synchronizing with a scaled hub, which was turned in a full circle to mobilize the transducer by 1 mm from the proximal patellar-base toward the distal patellar-apex along a line perpendicular to the horizontal representing the upper border of the patella. The first VMO CSA was taken from the line passing through the patella-base level. Serial VMO CSAs were obtained every 2 mm, until the VMO image on the visual display faded (Lin et al., 2008).

Data Analysis: Data obtained from the most symptomatic knee were analyzed using SPSS 11.0 (SPSS, Inc., Chicago, IL). Data were subjected to an intention-to-treat analysis and included all drop-outs. The data of control group gathered at post-training evaluation was then used in long-term follow-ups for comparison with exercise group. Descriptive statistics (mean ± standard deviation, SD) were used to determine participant characteristics. Prior to statistical analysis, the Kolmogorov-Smirnov test was performed to assess the normality of continuous data. Normally distributed baseline demographic variables were compared independent t-test. Non-normally distributed variables were compared by Mann-Whitney test with an alpha 0.05. Gender and numbers of afflicted sides (bilateral vs. unilateral) were compared by Chi-square test with an alpha 0.05. For each outcome variable measured, a 4 (assessment time) × 2 (treatment groups) two-way mixed ANOVA was performed. When a significant two-way interaction was detected, post-hoc analysis was performed using Bonferroni adjustment.

RESULTS: The demographic data for both LP and control group participants was presented in Table 1. There were no significant between group differences, except symptom duration (P= 0.025), for the demographic variables.

Table 1 Demographic Data for Study Participants

	LP (n= 30)	Control (n= 30)	*P* value
Sex (Male：Female)	8：22	4：26	.197
Age (y/o)	40.2±9.9	43.9±9.8	.155
Height (cm)	161.3±8.4	159.7±5.2	.390
Weight (kg)	60.1±11.2	57.4±6.9	.259
BMI (kg/m^2)	23.0±3.0	22.5±2.1	.423
Involved side (Bilateral：Unilateral)	18：12	18：12	-
Duration of symptoms (month)	38.3±34.2	27.7±41.0	.025 *

During 8-wk intervention period, 8 participants dropped out of the study due to personal factors (not knee pain) or work commitment. Fifty-two participants completed the trial (27 in the LP exercise group and 25 in the control group). The follow-up rate was 0.90 in LP and 0.83 in control group at post-intervention evaluation. At 6- and 12-month, the follow-up rate was 0.83 for LP exercise group.

The main results of this study were summarized in Figure 1-4, with 4 assessment time in horizontal axis, where 0-month denoted pre-intervention, 2-month denote post-intervention, and 6-month and 12-month represent the follow-ups. There were no significant between-group differences in all outcome measures at baseline (pre-intervention). Significant decreases in pain, increases in functional score and VMO muscle hypertrophy were observed after LP intervention (all *P*< 0.05), but not in the control group. Only the good subjective and functional outcomes (VAS and Lysholm scale score) achieved immediately after exercise intervention were maintained at long-term follow-up (all *P*< 0.05 as compared to pre-intervention).

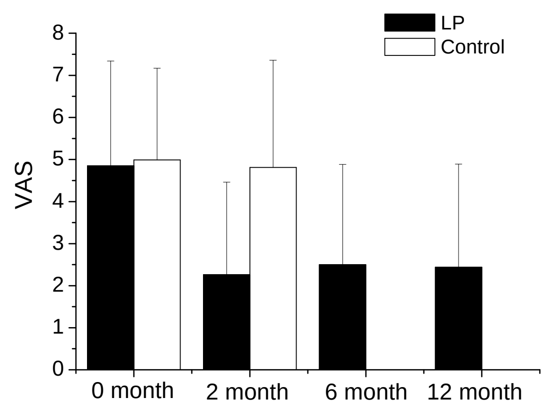

Figure 1: Comparison between Assessment Time Changes of VAS among Groups

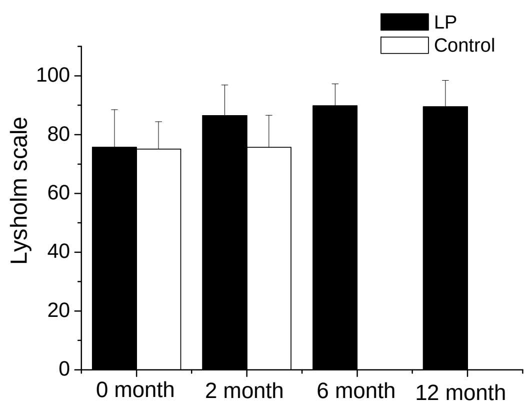

Figure 2: Comparison between Assessment Time Changes of Lysholm score among Groups

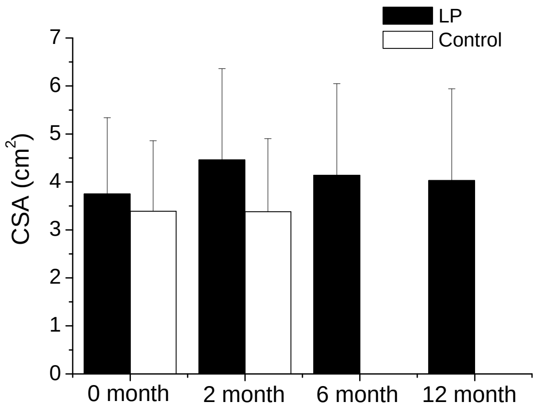

Figure 3: Comparison between Assessment Time Changes of VMO CSA among Groups

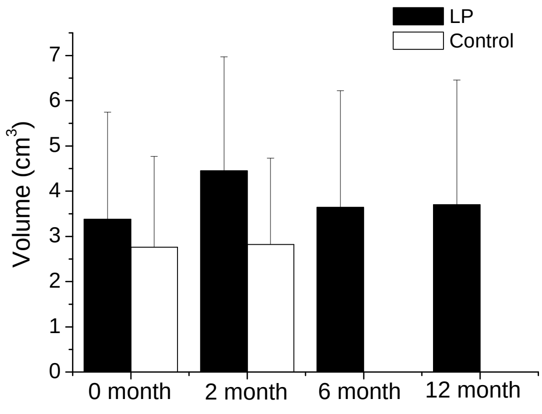

Figure 4: Comparison between Assessment Time Changes of VMO Volume among Groups

DISCUSSION: The results of present study showed decreased pain and increased function at both short-and long-term (1-yr, at least) follow-up which was consistent with previous study (Herrington, et al., 2007, Witvrouw, et al., 2000,2004). To our knowledge, we were the first to use ultrasonography to examine the therapeutic effect on VMO muscle morphology. The better result of VMO hypertrophy was found after 8-wk leg-press training, however, it was lost after 6 to 12-month follow-up time while patients remained less pain and better function compared to pre-training status. Restoration of quadriceps strength, flexibility and adjusted physical activity (life style) taught by health education may contribute to improvement in symptom and function. According to homeostasis theory proposed by Dye (Dye, 2005), patients could become pain-free once they function within the envelope of function. Further research regarding to what extent the VMO hypotrophy or atrophy may response for symptomatic patellofemoral pain will be of great interest.

CONCLUSION: The short- and long-term prognoses of subjects who underwent leg-press exercise were relatively good. Simple leg-press alone was recommended in clinical practice for dealing with patellofemoral pain.

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