Effect of a Complex Exercise Program for the Lower Extremities on Quadriceps Activity and Pain of Elderly Patients with Knee Osteoarthritis: a Pilot Study

Chae Gil Lim, PT, MM1), Sun-Ju Lee, PT, MPH2), Eunhye Ko, PT, PhD3), Kang Sung Lee, CPO, PT, PhD4)

1) Department of Physical Therapy, Gachon University
2) Department of Physical Therapy, Graduate School of Public Health and Social Welfare, Medicine and Science of Gachon University
3) Professional Physical Therapy P.C.: 143-70 Sanford Ave., Flushing, NY 11355, USA. TEL: +1 718-886-2078, FAX: +1 718-886-2109, E-mail: kone03@hotmail.com
4) Department of Prosthetics and Orthotics, Hanseo University

Abstract. [Purpose] This study was done to determine the effect of a complex exercise on quadriceps activity and pain of elderly patients with knee osteoarthritis (OA) in a clinical setting. [Subjects] Twelve subjects over the age of 65, who were diagnosed with knee OA and hospitalized at a rehabilitation facility in the Republic of Korea, participated in this study. [Methods] All participants were supervised by an expert. They performed a program which consisted of stretch and strength exercises with traditional therapy for 10 weeks. The main outcome measures were assessed a pain scale and EMG data (%MVIC) of the rectus femoris (RF), vastus lateralis (VL), and vastus medialis (VM) at baseline, after 5 weeks of exercise, and after 10 weeks of exercise. [Results] There was no significant difference between the male and female groups in pain or quadriceps activity. After the 10-week intervention, all participants showed improvement of RF, VL and VM activities and had decreased knee pain. [Conclusions] Older patients with OA showed a reduction in knee pain and improvement quadriceps activity after performing a complex exercise program that might help to stabilize the knee.

Key words: Knee OA, Complex exercise program, Quadriceps activity

INTRODUCTION

As the proportion of the population aged over 50 years old increases, the number of chronic degenerative diseases is likely to rise, and age-related changes in physical strength, coordination, and functional abilities may compromise independent living3). Osteoarthritis (OA) is the most common joint disorder of the musculoskeletal system, especially in the knee joint and is the major cause of lower limb disability2–5). However, no specific therapies exist that can prevent the progression of joint damage, even though knee OA is an increasingly important public health problem. Degenerative changes in the joints may lead to inactive muscles3, 6). In particular, quadriceps weakness, which is a clinical feature of knee OA, has been implicated in the development of knee OA. The quadriceps muscle provides an eccentric contraction force for shock absorption at the knee7). Therefore, muscle weakness can cause an inappropriate impulsive loading response, an increase in abnormal mechanical joint stress, and alteration of the movement of the knees during functional activities7–10). Many previous reviews of knee pain and OA treatment have introduced non-pharmacologic treatments including resistance training exercises and a self-management program11), aquatic exercise12–14), strengthening exercise2, 14, 15), aerobic fitness training as general exercise, yoga, and Tai Chi, to minimize the level of limitations experienced and improve subjects’ functional abilities. Strength exercises and muscle rehabilitation programs may improve the load bearing capacities of the lower extremities and distribute excessive load to prevent tissue damage16). Because the positive effect of exercise has been noted by virtually all experts, we provided a complex exercise program based on flexibility, strengthen, and mobility exercises to decrease muscle stiffness, pain, and mechanical stress on the knee17). The aim of the present study was to investigate the short-term beneficial effects of the complex exercise program on quadriceps muscle activation of elderly patients with OA of the knee in a clinical setting, and to determine if there were differences between men and women in the benefits provided by this program.

SUBJECTS AND METHODS

The participants were 12 subjects (6 males and 6
To measure patient-rated pain, we used a visual analog scale (VAS). Surface EMG (BTS FREEEMG, MI, Italy) was used to measure maximal voluntary isometric contraction (MVIC) and activation of each muscle. Disposable bipolar surface electrodes (Ag/AgCl) were placed over the rectus femoris (RF), vastus lateralis (VL) and vastus medialis (VM) after shaving and wiping the skin with an alcohol pad. A single reference electrode was placed over the tibial tuberosity of the affected limb. Before recording EMG, each subject was instructed to practice each of the MVIC tests, which were performed in the manual muscle testing position. After resting for five minutes, the subject performed maximum-effort knee extension at 45° of knee flexion, which was measured with a goniometer against the resistance of an instructor for five seconds. All subjects received verbal encouragement to exert maximum contraction in all trials. The exercise was repeated three times with rests of five minutes between each trial. We calculated the mean MVIC of three trials of each muscle to obtain one value for normalization of EMG amplitude data.

Raw EMG signals were collected at a rate of 1,000 Hz. EMG signals were band-pass filtered between 20–50 Hz. Data processing was performed with an EMG analyzer (BTS FREEEMG, MI, Italy). The middle 3 seconds of each trial, where the EMG amplitude was the greatest, was determined and smoothed using the root mean square (RMS) value for amplitude analysis. The normalized mean EMG amplitude data (%MVIC) was analyzed using SPSS Version 19.0 (SPSS, Chicago, IL, USA). Statistical significance was accepted for values of p<0.05. Data was obtained for all participants in the first session, during a supervised session after five weeks, and at a supervised session after ten weeks was assessed by using one-way ANOVA. Because of the limited sample size and uncertainty associated with normality assumptions, we used the Mann-Whitney test to assess differences between the male and female groups.

RESULTS

Two participants failed to return for the follow-up and two participants were not included in the analysis because of data corruption. At the beginning of exercise, there was a significant difference in VM activity between the male and female groups. However, there was no statistical significant effect of gender on pain or quadriceps muscle activity after completion of the program (p>0.05). After the 10 weeks exercise, RF, VL, and VM activities of all participants had significant increased and pain the knee had significantly decreased overall in the program (Table 2). However, there was no difference in pain (p=0.69) or muscle activity (RF; p=1.00, VL; p=1.00, VM; p=1.00) after 5 weeks of exercise.

DISCUSSION

In a clinical setting, we suggest an appropriate exercise program...
to suit patients’ goals and overall health condition, because individuals adapt their muscle activity patterns as age-related muscle weakness develops. Patients with knee joint disease, however, might not compensate for the muscle strength decline associated with age the diminished force-generating capacity[10, 22]. Women patients were shown to have greater muscle weakness than men[23, 24]. Thus, previous reports have concluded that exercises for the quadriceps, hamstring, and triceps surae are especially necessary for patients with knee OA[25]. In this study, performance of a complex exercise program for the lower extremity was shown to effectively decrease pain and improve the quadriceps activity of elderly patients with knee OA after 10 weeks. Although, we administered conservation therapy and the number of subjects was too small to generalize, the result was similar that of a previous study in which regular exercise of the quadriceps muscles reduced pain and improved muscle strength as well as physical function[26]. Therefore, older people can process in which improve their strength and flexibility with appropriate exercise, even if they suffer from fibrosis, the fibrous connective tissue replaces degenerating muscle fibers due to inactivity or a tendency to use less of the available range of motion[27]. The present study’s design had considerable limitations because we did not account for subjects’ levels of physical functional ability and demographic factors such as the severity of knee OA between the male and female groups. In the comparison of the baseline values of muscle strength, there was a sex-related difference in VM activity. Our findings, however, showed that the 10-week complex exercise program significantly improved the quadriceps muscle activity, including VM, despite gender differences. Because professionals with experience can prescribe the intensity of exercise and allow patients a conditioning period through a properly adapted training protocol, women can increase their strength to the point that their relative strength is about the same as men, or perhaps even greater can increase their strength to the point that their relative strength is about the same as men, or perhaps even greater can increase their strength to the point that their relative strength is about the same as men, or perhaps even greater can increase their strength to the point that their relative strength is about the same as men, or perhaps even greater can increase their strength to the point that their relative

REFERENCES