J Orthop Sci (2013) 18:932–939
DOI 10.1007/s00776-013-0443-9

ORIGINAL ARTICLE

Analysis of effectiveness of therapeutic exercise for knee osteoarthritis and possible factors affecting outcome

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Received: 4 April 2012 / Accepted: 9 July 2013 / Published online: 2 October 2013

Abstract
Background There are numerous reports and evidences to suggest that exercise therapy is effective for knee osteoarthritis (knee OA). However, there is a lack of sufficient research concerning the factors influencing its application and effectiveness. The purposes of this study were to evaluate effects of the mode of treatment delivery on the improvement of symptoms in knee OA, and to analyze potential risk factors affecting improvement after exercise therapies.
Methods The 209 women applicants diagnosed with knee OA were randomly allocated into either a group performing group exercise in a class or a group performing home exercise. The 90 min exercise program was performed under the guidance of physiotherapists as a group exercise therapy. The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) of the subjects of both groups before and after intervention was compared to examine the effect of exercise therapy. In addition, body mass index, knee range of motion (ROM), the femorotibial angle from radiographs, OA severity from Kellgren–Lawrence grade, and meniscus abnormality and subchondral bone marrow lesions from MRI findings were statistically analyzed as factors that may affect exercise therapy.
Results A significantly greater improvement in WOMAC was observed in the subjects of group exercise (81 subjects) as compared with the subjects of home exercise (122 subjects). There was a significantly high proportion of subjects with knee flexion contracture among the subjects participating in group exercise that showed only minor symptom improvement ($p < 0.05$). In addition, exercise therapy proved to be highly effective for subjects with limited quadriceps muscle strength ($p < 0.05$).
Conclusions When prescribing exercise therapy for knee OA, evaluation of a subject's ROM and muscle strength is important in deciding whether to commence exercise therapy and what type of exercise therapy to apply; it is also important in predicting the effect of exercise therapy.

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Introduction

Knee osteoarthritis (knee OA) is a condition often seen in the elderly; thus, the number of affected individuals has consequently been increasing along with the aging of society. It is imperative to systematize the treatment of this condition, and it is clear that conservative treatment is particularly important from a medical-economic perspective. Four items are listed as intervention strategies for knee OA in the "National Strategy for OA 2010" published by the US Centers for Disease Control and Prevention (CDC) and Arthritis Foundation [1]: (1) self-management education, (2) exercise therapy, (3) injury prevention, and (4) weight management. In particular, exercise therapy is viewed as being important in the treatment of knee OA. In addition, randomized prospective studies and the

Osteoarthritis Research Society International (OARSI) guidelines regard exercise therapy as a non-drug therapy backed by a significant amount of evidence [2–4].

However, few reports have examined the factors influencing the application and effectiveness of exercise therapy in detail. Age, gender, obesity, leg alignment, leg strength, joint distension, and a history of injury are cited as risk factors for knee OA and are believed to be involved in its onset and progression. Moreover, these factors may influence the effect of exercise therapy on knee OA.

Exercise therapy for knee OA can be divided into muscle isolation strength training, range of motion (ROM) exercises, and weight training. In addition, although muscle isolation strength training is given as a single category, many variations of muscle isolation strength training exist. Its content can range from straight leg raises and other bodyweight exercises to training using specialized equipment. Furthermore, the muscles trained can either be limited to the quadriceps only or expanded to include muscles around the hip as well as the trunk. Moreover, the form of exercise intervention can be divided into exercise therapy performed under the direct guidance of a physiotherapist (either in a class or individually) and exercise performed by the patient at home. Questions regarding the differences in the effects of exercise therapy as a consequence of the intervention format still persist.

The main focus of this study was to analyze potential factors affecting improvement after exercise therapy for patients with knee OA. This study tested the following hypotheses: (1) exercise therapy is an effective treatment for knee OA, and group-guided therapy has a greater effect than home therapy, and (2) factors influencing the effectiveness of exercise therapy exist, and they vary according to the method of exercise therapy employed.

Materials and methods

Trial participants were invited with local newspapers to participate in classes to test the effectiveness of exercise therapy on knee OA. The conditions required for the participants were females with knee pain aged between 55 and 75 years. In total, 495 females responded during the 2006–2008 invitation period. These 495 applicants were examined by orthopedic specialists and underwent imaging before a decision was made to include them in the trial. The exclusion criteria for participation in the trial included the following: applicants with a Japanese Orthopaedic Association score [5] of <65 points or a score of 100 points, or a the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) score [6] of more than or equal to 96 points, applicants who had difficulty in walking, cases where the applicant's pain worsened acutely, applicants with motion-limiting conditions other than knee OA, and applicants adjudged as Kellgren–Lawrence grade (KL grade) 0 [7] from simple knee X-ray imaging of an anterior–posterior view with full extension in weight-bearing. Ultimately, 209 applicants were included in this study. The participants were informed that data from the case would be submitted for publication and gave their consent, and this study was given approval by the institutional review board (IRB) of our facility.

Subjects were randomly allocated into either a group performing group exercise therapy conducted in a class (group exercise) or a group performing home exercise therapy (home exercise) by drawing lots. The number of participants in the group exercise was limited to 81, because there was a limit of a room and equipment for exercise. The group that waited for 3 months before commencing home exercise was designated the "control group" (control). There were 81 subjects in the group exercise group, with an average age of 63.8 years, average height of 152.6 cm, average weight of 55.1 kg, and average body mass index (BMI) of 23.8; there were 128 subjects in the control group, with an average age of 65.6 years, average height of 152.4 cm, average weight of 55.3 kg, and average BMI of 23.8. This control group subsequently performed home exercise therapy, with 122 subjects ultimately completing the program (the home exercise group). There were no statistically significant differences in age, height, weight, or BMI between the group exercise and control/home exercise groups (Table 1).

The test items included simple front upright radiographs and MRIs of the subjects' knees in addition to their height, weight, ROM, and muscle strength. In addition, the WOMAC score were used as an index of clinical symptoms.

Table 1 Characteristics of participants at baseline

	Group exercise ($n = 81$)	Control ($n = 128$)
Age, years	63.8 ± 5.9	65.6 ± 5.8
Height, cm	152.6 ± 4.9	152.4 ± 5.1
Body weight, kg	55.1 ± 7.3	55.3 ± 7.3
BMI, kg/m^2	23.8 ± 2.9	23.8 ± 3.0
KL grade, no. (%)		
Grade 1	24 (29.6)	31 (24.2)
Grade 2	26 (32.1)	49 (38.3)
Grade 3	27 (33.3)	42 (32.8)
Grade 4	4 (4.9)	6 (4.7)
Mink grade, no. (%)		
Grade 0	8 (9.9)	29 (22.7)
Grade 1	22 (27.2)	33 (25.8)
Grade 2	24 (29.6)	34 (26.6)
Grade 3	27 (33.3)	32 (25.0)

Values are the mean ± standard deviation unless otherwise indicated