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Original Research Article

Effects of open chain exercises on muscle strength and function in elderly patients with knee osteoarthritis

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Abstract

Objective: The purpose of this research was to verify the effectiveness of an eight week quadriceps strengthening program on pain, function and quality of life of patients with knee osteoarthritis. **Material and methods:** A hundred patients were randomized into two groups. **Experimental Group - A** performed open chain exercises in form of isometric quadriceps and straight leg exercises 5 days a week for 5 days whereas **Control Group - B** did not perform any exercise. The outcome measures or dependent variables selected for this study were pain intensity, isometric quadriceps strength, and knee function. All the measurements were taken at baseline (week 0) and at the end of the trial at week 5.

Results: In between group comparisons, the maximum isometric quadriceps strength, reduction in pain intensity, and improvement in function in the isometric exercise Group - A at the end of the 5^{th} week were significantly greater than those of the control Group - B ($p<0.05$).

Conclusion: The 5 week isometric quadriceps exercise program showed beneficial effects on quadriceps muscle strength, pain, and functional disability.

Key words

Open chain exercises, Visual analogue scale (VAS), WOMAC, Functional disability.

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Introduction

Osteoarthritis (OA) is the most common musculoskeletal condition affecting the quality of life of older adults [1, 2]. A recent survey in India reported that the prevalence of OA in older adults more than 65 years of age was 32.6% in the rural population and 60.3% in the urban population [3]. Knee OA is likely to become the eighth most important cause of disability in men and the fourth most important cause of disability in women according to the World Health Organization report on global burden of disease [4]. Three major physical impairments, such as knee pain, stiffness, and decreased quadriceps strength, are highly associated with a knee OA and are believed to contribute to physical disability and progression of the disease [5, 6, 7]. As the quadriceps muscle plays the role of shock absorber, a weakness of this muscle decreases the joint protection resulting in greater stress and overload on the knee [4]. Quadriceps strengthening exercises performed over eight weeks proved just as effective in function improvement as the use of non-hormonal anti-inflammatory drugs in patients with OA of the knee [5]. Moreover, moderate-intensity exercises showed themselves to be a good form of treatment not only for the improvement of symptoms, but also in the increase of the glycosaminoglycan content [6]. The authors verified that these have a beneficial effect on pain and function. Strength of the quadriceps musculature is one of the intrinsic factors that have been shown to affect the knee joint functions. Reduction of pain and disability is the main aim of any treatment approach in the management of knee OA [8, 9, 10]. The Osteoarthritis Research Society International (OARSI) recommended non-pharmacological methods including patient education programs, weight reduction, coping strategies, and exercise programs for treatment of knee OA [11]. Isometric exercise is the most appropriate and easy to understand by the patients and can be easily and safely performed at home because it requires no or minimal apparatus [9]. Norden, Leventhal, and Schumacher reported that “isometric exercises” are simple and inexpensive to perform and that they rapidly improve strength [12, 13]. Hence, the purpose of this study was to investigate whether open chain exercises has a beneficial effect in patients with knee osteoarthritis

Material and methods

The criteria for inclusion were as follows. Prediagnosed case of knee OA as per the American College of Rheumatology (ACR) and radiological evidence of primary osteoarthritis of grade 3 or less on the Kellgren Lawrence scale [14]; Age between 65-85 years; Unilateral involvement and pain in and around the knee. The study was approved by our Institutional Ethical Committee (IEC), and written consent was obtained from all the participants. Patients who met the inclusion criteria were randomly assigned to one of two groups. **(Figure - 1)**

Inclusion criteria

Age ≥65 years and ≤85 years, Having no morning stiffness or morning stiffness less than 30 minutes; Having primary osteoarthritis of the knee joints, Having no evidence of malignancy and having no evidence of infection on the skin over knee joints.

Recording and assessment

Before admission into the trial, the nature of the study was discussed with the patients and written consent of the patients was taken. The findings were recorded at first attendance and follow up was done weekly for five weeks.

The parameters used for comparing the treatment are visual analogue scale, Western Ontario and McMaster Osteoarthritis Index

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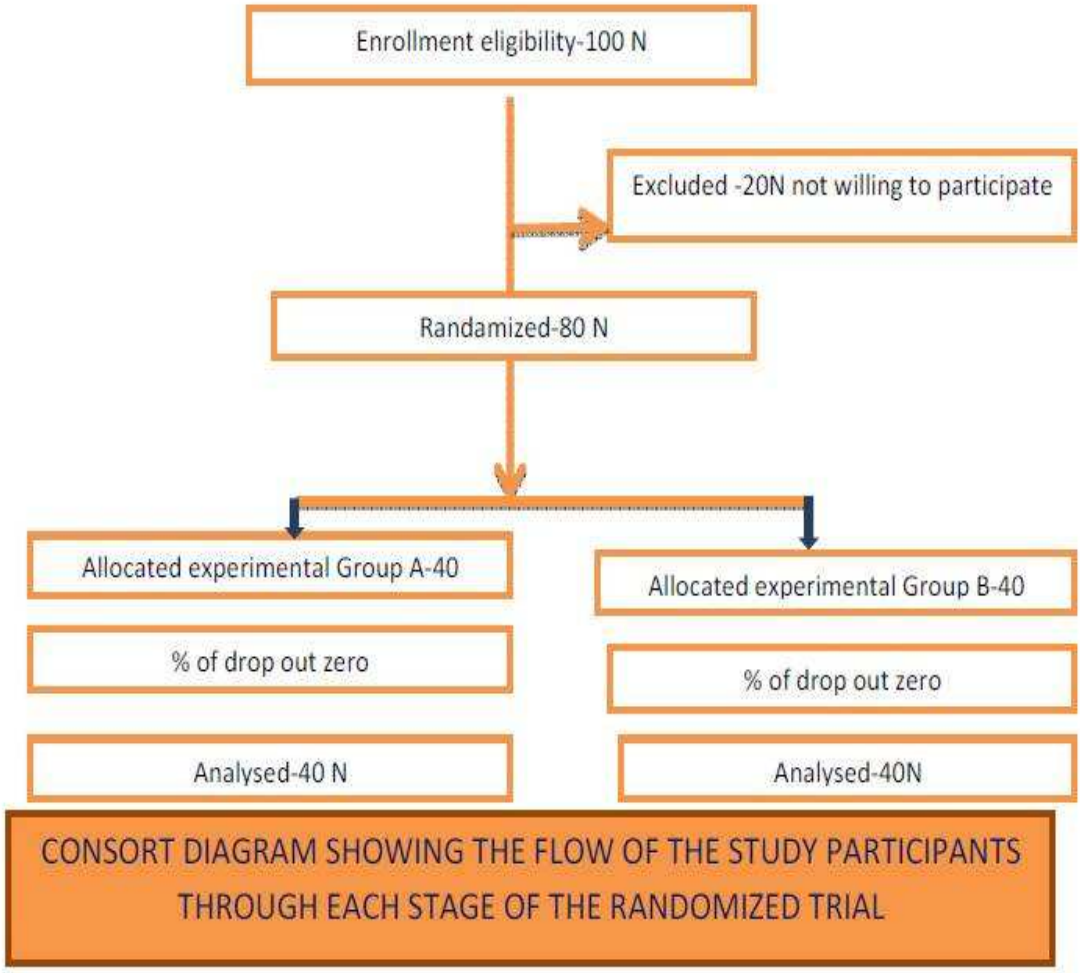
(WOMAC) and range of motion (ROM) of the knee.

Figure – 1: Flow of the study participants through each stage of the randomized trial.



Statistical methods

The numerical data were analyzed statistically. The results were expressed as mean ± SD and the level of significant was expressed by p-value unless otherwise stated. Statistical analysis was done by using SPSS package for Windows. Student's 't' tests was done to see the level of significance.

The subjects in the experimental group performed the following sets of exercise for 5 weeks (5 days/week). All exercises were performed in sets of 10 repetitions; 1 set of all exercises was performed twice a day for the 1st week, and this progressed to 2 sets twice a day until the 3rd week and then 3 sets twice a day until the 5th week. Isometric quadriceps exercise and Straight leg raising (SLR) exercise was given in supine position [15]. The control group was not advised exercise but received non-steroidal anti-inflammatory drugs (NSAIDs).

Results

Subject characteristics and demographic details including age, weight, height, and body mass index (BMI) were as per **Table – 1**.

There was significant improvement after treatment in both the groups. (p = 0.001) In comparison between two groups, it was found

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that there was no significant difference in pre-treatment, in zero week assessment scores between the two groups i.e. there was any difference in improvement. More improvement was found in exercise group than non-exercise group at 5th week (95% CI was -10.33 to -1.52). Then it was found difference in the improvement. (95% CI was -13.29 to -5.2; **Table - 2**).

Regarding range of motion, in comparison between two groups, there was no significance difference in improvement of ROM between two group after treatment at 5th week (p = 0.45).

For both the groups, the baseline WOMAC score was statistically insignificant (p=0.889). On comparing the WOMAC scores between baseline and at the end of the 5th week, a significant improvement was noted in the experimental group (p<0.001).

At the end of the 5th week, the between-group difference in WOMAC score was found to be significant (p<0.001). During the 5 week treatment period, the mean (SD) improvements in WOMAC score in the experimental group and control group were found to be 16.66 (1.09) and 6.47 (0.13), respectively.

For both groups, the baseline VAS was statistically insignificant (p=0.958). On comparing the VAS between baseline and at 5th week, a significant improvement was noted in the experimental group (p<0.001) as per **Table – 2**.

Table – 1: Subject characteristics and comparison of isometric quadriceps strength, pain intensity, and functional disability.

Characteristic	Experimental group n-40 means (SD)	Control group n-40 means (SD)
Age (years)	69 (9.9)	66.0 (7.8)
Weight (kg)	67.0 (7.0)	75.6 (5.5)
Height (cm)	2.3 (0.40)	2.55 (0.34)
BMI (kg/m^2)	29 (2.1)	28 (2.2)

Table – 2: Comparative improvement between experimental group and control group at variables (muscle strength, pain intensity by VAS functional performance by WOMAC).

Groups	Baseline means (SD)	5th week means (SD)	Difference means (SD)	Variables
Experimental group	9.63 (1.28)	11.93 (1.86)	3.00 (0.18)†	**Strength**
Control group	10.28 (1.71)	9.32 (1.72)	0.04 (0.01)	
Experimental group	6.05 (0.86)	1.24 (0.76)*	4.81 (0.10)†	**Visual analogue Scale (VAS)**
Control group	5.95 (1.11)	4.24 (0.88)	1.71 (0.23)	
Experimental group	24.71 (3.42	8.05 (2.33)*	16.66 (1.09)†	**WOMAC**
Control group	24.52 (4.43)	18.05 (4.30)	6.47 (0.13)	

†Significant at p < 0.05 (Mann-Whitney U test).
*Significant at p < 0.05 (Wilcoxon signed-rank test).

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Discussion

A total of 100 subjects were assessed for eligibility. Twenty subjects refused to participate. Forty subjects were enrolled in the study, with 40 subjects divided in each group. Their demographic details including age, weight, height, and body mass index (BMI) were recorded. These variables showed no significant difference between the two groups ($p>0.05$).

The results of the present study showed that the 5 week period of intervention brought about a significant reduction in knee pain and improvement in function in the experimental group at the 5^{th} week. The significant reduction in pain and improvement in function in the experimental group may be attributed to improved quadriceps strength and therefore increase stability of the knee joint.

In this study, we used only isometric quadriceps muscle strengthening exercise and found significant improvement. Brandit, et al. found that an exercise program may be as effective in decreasing joint pain, this may be due to increased muscle strength of quadriceps and thereby joint become stronger and reduced the symptoms [16].

Further study done by Boon Whatt LIM, et al. concluded that quadriceps strengthening has beneficial effect on pain and function in patients with OA knee [17]. The study done by Shreyasee Amin, et al. reported that subjects having stronger quadriceps strength had less knee pain and better physical function as compared with those with the least strength [12].

Conclusion

In conclusion, open chain exercises are found to have better effect than to NSAIDs in osteoarthritis knee joint. Exercise may decrease the need of NSAIDs and thereby side effects of NSAIDs can be avoided.

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