

Effect of Isometric Exercises (Quadriceps Strengthening) in Patients with Osteoarthritis Knee

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ABSTRACT

Introduction: Osteoarthritis (OA) is the most common musculoskeletal disorder among the elderly population. Quadriceps muscle weakness is one of the biological factors that may contribute to knee pain. There was only limited evidence that higher quadriceps strength may improve knee pain. This study investigates whether quadriceps strengthening improves pain, joint stability, and quality of life (QOL) in OA patients.

Materials and methodology: Prospective study was done among the outpatients visiting the orthopedic department, Velammal Medical College Hospital & Research Institute, Madurai, Tamil Nadu, India. The study period is between 1st October 2020 and 1st January 2021. We had 340 OA knee patients in the age-group <65 years who met the inclusion criteria as the study participants. Patients were randomly assigned to two groups A and B by card method. Group A is the case group, and group B is the control group. The patients allocated in the case group underwent isometric exercise (isometric hip adduction, isometric quadriceps exercise, and straight leg raise exercise) along with pharmacotherapy and lifestyle modification advices. The control group only had pharmacotherapy and lifestyle modification advices. The Knee Injury and Osteoarthritis Outcome Scale (KOOS) scale was used to measure the outcome.

Results: Unpaired t-test was used to compare between two groups, reduction in pain intensity (0.001**), improvement in QOL (0.001**), and improvement in joint stability (0.001**) in the isometric exercise group at the end of the 8th week were significantly greater than those of the control group ($p < 0.05$).

Conclusion: The 8-week isometric quadriceps exercise program showed beneficial effects on pain, QOL, and joint stability in patients with OA of the knee.

Keywords: Isometric quadriceps exercise, Knee Injury and Osteoarthritis Outcome Scale, Knee pain, Osteoarthritis, Quadriceps.

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INTRODUCTION

Osteoarthritis is the most common musculoskeletal disorder in the elderly population all over the world. A new study in India reported a prevalence of 32.6% in the provincial and 60.3% in the metropolitan population.¹ It is documented as the 10th leading cause of nonfatal burden in a study conducted in 2009. The most commonly diagnosed OA in the outpatient department is primary OA, where there is no underlying factor as compared to secondary OA. The most common problem faced in this era is "the sedentary lifestyle," which is the driving factor for OA in the near future. It is evident from various studies that lower extremity strength is one of the important factors in knee shock absorbing capacity during day-to-day activities. A study conducted in India in 2016 documented that people leading a sedentary lifestyle were affected by around 36.8%, while people with physically active were affected by only around 26%.² It has been documented that the normal hamstring: quadriceps ratio of >0.6 is protective in individuals from developing OA by sharing the total load given to the joint.^{3,4} So, it is essential to include quadriceps-strengthening exercises along with pharmacological methods. The Osteoarthritis Research Society International recommends non-pharmacological methods and exercise programs for the treatment of knee OA.⁵ As there are various forms of exercise, we have chosen the isometric exercise because of its nature to cause less inflammation, pressure, and bone destruction, and it can be easily learned by the patient and executed at home without supervision. This study investigates whether quadriceps strengthening improves pain, joint stability, and QOL in OA patients.

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MATERIALS AND METHODOLOGY

It is a prospective study done among the outpatients visiting the orthopedic department, Velammal Medical College Hospital & Research Institute, Madurai, Tamil Nadu, India. The study period is between 1st October 2020 and 1st January 2021. The study population is patients who present to the department with nontraumatic knee pain. The study proceeded after obtaining approval from our Institutional Ethical Committee. Also, all the participants involved in the study signed written consent.

Screening of all the patients is done by the principal investigator (senior consultant in orthopedics), and diagnosis is made after a thorough clinical and radiological examination. Patients included in this study were suffering from grade I and grade II OA, according to

the American College of Rheumatology and grade III or less on the Kellgren–Lawrence scale. The follow-up period is 2 months. Patients excluded from the study are patients with inflammatory arthritis, posttraumatic arthritis, patients with deformity, and patients with a meniscal tear. We had 340 OA knee patients in the age-group <65 years who met the inclusion criteria as the study participants. Patients were randomly assigned to two groups A and B by card method. Group A is the case group, and group B is the control group.

Patients in the case group received isometric exercise along with pharmacotherapy and lifestyle advices. All exercises, including isometric hip adduction, isometric quadriceps exercise, and straight leg raising exercise, were performed in sets of 10 repetitions: one set of all exercises was performed twice a day for the 1st week, which will be progressed weekly until three sets twice a day by the end of 5th week.

Isometric quadriceps exercise (Fig. 1): patients were asked to lay in a recumbent position. A moved-up towel was put underneath the knee. They were asked to contract their thigh muscles as much as they could to fix their knee and hold the contraction for 5 seconds. Straight leg raising exercise (Fig. 2): patients were made to lay in a supine position. They were instructed not to bend the knee prior to the lifting phase of the exercise. Then they were instructed to lift the leg up to 10 cm above the plinth and hold the contraction during the lifting phase for 10 seconds. Isometric hip adduction exercise (Fig. 3): patients lay in a supine position. A small pillow was put between the knees. They were instructed to perform this exercise by pressing the pillow between the knees and to maintain the adduction with contraction for 5 seconds.

The control group only received pharmacotherapy and lifestyle advices without any intervention. The patients from the control group were asked to come for follow-up at baseline, weeks 2, 4, 6, and 8 (end of the trial) to measure the dependent variables (pain intensity, joint stability, and QOL) using the KOOS.

The KOOS assesses patient pain (nine items), other symptoms (seven items), function in daily living (17 items), function in sport and recreation (five items), and knee-related QOL (four items). A score of 0 indicates very bad symptoms, while a score of 100 indicates no knee symptoms. The KOOS is a patient-detailed joint-explicit score, which might be helpful for evaluating changes in knee pathology over the long run, with or without treatment.⁶ Statistical analysis was carried out using Statistical Package for the Social Sciences (SPSS) 23.0 version and MS Excel. Unpaired *t*-test was used to compare case and control groups with respect to numerical scores. About 5% level of significance was considered statistically significant.

RESULTS

A total of 340 patients were assessed. Twelve patients lost the follow-up, and we had 328 patients for analysis, with 164 subjects in each group.

DISCUSSION

Quadriceps muscle weakness is one of the biological factors that may contribute to knee pain. There was only limited evidence that higher quadriceps strength may improve knee pain. The objective of this study was to evaluate whether isometric quadriceps exercise has a beneficial effect on patients with knee OA. Table 1 implies that group A presenting with a pain score (13.80 + 0.901) after incorporating quadriceps-strengthening exercise, started to see



Fig. 1: Isometric quadriceps exercise



Fig. 2: Straight leg raising exercise



Fig. 3: Isometric hip adduction exercise

greater improvement in their pain by the end of the 6th week (80.40 + 1.290) and 8th week (85.43 + 1.237). From Table 2, as the pain scale improved, the case group improved symptomatically. The activities of daily living (ADL), as per Table 3 cases, did show an improvement in carrying out their daily activity without any limitation at the end of the 6th and by the 8th week when compared to the control.

Table 1: Comparing pain on both case and control groups

Sl. no.	Study variables pain	KOOS scale		p-value
		Case	Control	
1	0 weeks	13.80 + 0.901	14.00 + 0.0	0.005
2	2 weeks	46.91 + 0.289	19.00 + 0.0	0.001**
3	4 weeks	66.19 + 2.005	33.00 + 0.0	0.001**
4	6 weeks	80.40 + 1.290	50.00 + 0.0	0.001**
5	8 weeks	85.43 + 1.237	56.00 + 0.00	0.001**

**Denotes that p-value <0.001 is statistically significant

Table 2: Comparing symptoms on both case and control groups

Sl. no.	Study variables symptoms	KOOS scale		p-value
		Case	Control	
1	0 weeks	10.64 + 0.767	11.00 + 0.0	0.001**
2	2 weeks	45.65 + 0.765	11.00 + 0.0	0.001**
3	4 weeks	53.54 + 1.145	21.00 + 0.00	0.001**
4	6 weeks	63.73 + 0.857	21.00 + 0.00	0.001**
5	8 weeks	67.62 + 0.880	43.00 + 0.00	0.001**

**Denotes that p-value <0.001 is statistically significant

Table 3: Comparing ADL on both case and control groups

Sl. no.	Study variables ADL	KOOS scale		p-value
		Case	Control	
1	0 weeks	21.65 + 0.862	21.00 + 0.00	0.001**
2	2 weeks	48.73 + 0.608	22.00 + 0.00	0.001**
3	4 weeks	48.72 + 0.614	40.00 + 0.00	0.001**
4	6 weeks	56.82 + 0.572	40.00 + 0.00	0.001**
5	8 weeks	80.63 + 0.879	49.00 + 0.00	0.001**

**Denotes that p-value <0.001 is statistically significant

Table 4: Comparing QOL on both case and control groups

Sl. no.	Study variables QOL	KOOS scale		p-value
		Case	Control	
1	0 weeks	0.00 + 0.00	0.00 + 0.00	
2	2 weeks	50.00 + 0.00	0.00 + 0.00	0.001**
3	4 weeks	50.00 + 0.00	25.00 + 0.00	0.001**
4	6 weeks	56.00 + 0.00	25.00 + 0.00	0.001**
5	8 weeks	68.47 + 0.00	50.00 + 0.00	0.001**

**Denotes that p-value <0.001 is statistically significant

Quality of life was found to be improving in group A as the pain decreased and with improved knee stability when compared to group B as per Table 4. Case and control group patients' pain, symptoms, ADL, and QOL scores are statistically different at various time periods. As we interpret from the above data observed from the patients with knee OA, initially, patients came with severe pain with limitation of their daily activities, but when we introduced our intervention (pharmacotherapy and exercise) to patients, we saw improvement in their 2nd week with their pain, but at this time they were not so confident about carrying out their daily activities with confidence, but as of weeks 6 and 8, when patients came for review, they were symptomatically better with negligible pain and

had confidence in carrying out their daily activities as they had better knee stability when compared to week 0. The results of this study demonstrated that isometric quadriceps exercise brought significant improvements in all the parameters after the 8-week training program.

The results of the present study showed that the 8 weeks period of intervention brought about a significant reduction in knee pain (0.001**) and improvement in function in the case group at the 8th week. The significant reduction in pain and improvement in function in the case group may be attributed to improved quadriceps strength and therefore increased stability of the knee joint. The study conducted by Messier et al. concluded

that there was no correlation between quadriceps strengthening and improvement in pain and joint stability.⁷ Whereas the findings are consistent with the findings of previous investigators who have reported that exercise can reduce pain and increase the functional abilities of OA patients. The Fitness Arthritis and Seniors Trial⁸ reported a modest 8–10% improvement in pain and function scores as a result of 18 months of aerobic or resistance exercise among their sample of knee OA patients. Further, Deyle et al.,⁹ Falconer et al.,¹⁰ and Fisher et al.¹¹ found the same positive effects of exercise programs on pain and function. In the present study, the reduction in pain and disability in the case group may be attributed to increased quadriceps muscle strength and, thereby, improved stability, which leads to a reduction of pain and stability and QOL.

Limitations of the Study

Close monitoring of the cases and control was not possible in our study, which may change the outcome. Other factors like squatting, sitting cross legs, and climbing stairs up and down which are not taken into account in this study. The study population consists mostly of urban patients, which can have an impact on the result.

Strength of Study

Single-center study and all the study participants were screened by a single primary investigator.

Future

We also suggest a further, more advanced study to pinpoint the exact time at which these changes happen exactly and what is the minimal amount of exercise required to elicit this response which will be easy for us to motivate patients to do their exercise consistently.

CONCLUSION

From the study conducted, we are able to conclude that quadriceps strengthening is tied up with a better prognosis in patients with moderate OA knee.

ETHICAL APPROVAL

Approved.

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