
Effects of Quadriceps Dynamic Strengthening and Isometrics Exercise in Non-obese and Obese Osteoarthritis of Knee Joint Patients

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Abstract: Introduction: Knee Osteoarthritis (KOA) is a major cause of pain and functional impairment among elders. Currently, there are neither feasible preventive intervention strategies nor effective medical remedies for the management of KOA. Of course, knee osteoarthritis is only one of many adverse consequences of obesity. Physical rehabilitation usually quadriceps exercises for the maintenance of joint range of motion and muscle strength is effective for the treatment of KOA. The aim of the study was to find out whether obesity has an adverse effects on the treatment of knee osteoarthritic patients when quadriceps dynamic strengthening and isometrics exercise were implemented to them. **Materials & Methods:** Sixty osteoarthritic knee patients with thirty patients each in two groups were randomly selected from Kailash Hospital and Obesity Clinics in Delhi. Patients were randomly divided into two groups A and B according to their BMI. In group A, non-obese KOA patients were assigned and in group B obese KOA patients were included. The quadriceps dynamic strengthening and isometrics exercise treatment protocol were introduced in both the groups and were given for fifteen days. Pre and post-treatment knee pain, range of motion of knee joint and quadriceps muscle strength were measured. Student's t-test was applied to find out the statistical level of significance. **Results:** Pain was decreased with the intervention exercise which was highly significant ($p < 0.05$) in both the groups. The ranges of motion for knee joint were increased which was found highly significant in both the cases of flexion and extension ($p < 0.001$, < 0.05 respectively) in group A but in group B, it was found significant for flexion ($p < 0.001$) but in case of extension ROM, it was insignificant ($p > 0.05$). The mean difference of pre-test and post-test muscle strength for flexor and extensors were significant ($p < 0.01$, < 0.001) in group A but in group B for flexors, it was insignificant and for extensor group, it was significant ($p < 0.01$). **Discussion & Conclusion:** It was found that the exercises given to group A (non obese) were more effective than group B (obese). Pain, ROM and MMT were improved significantly in group A but in group B, pain had reduced but MMT and ROM had no significant improvements. We concluded that because of more BMI in group B (obese group), effects of exercise for treatment of OA knee was not as significant as in case of group A subjects (non obese group).

Key Words: Quadriceps dynamic strengthening exercise, Knee Osteoarthritis, Body mass index

INTRODUCTION

Osteoarthritis (OA) is the most common joint disorder with symptoms in the hands, knees, hips, back and neck. It is unclear exactly how

excess weight influences OA. Overweight increases the load placed on the joints such as the knee, which increases stress and could possibly hasten the breakdown of cartilage (1). It is estimated that a force of nearly three to six times one's body weight is exerted across the knee while walking and overweight

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increases the force by this amount (2). However, overweight has also been associated with higher rates of hand OA in some studies (3, 4) suggesting the involvement of a circulating systemic factor as well (5). Being overweight is a clear risk factor for developing OA. Population-based studies have consistently shown a link between overweight or obesity and knee OA. Estimating prevalence across populations is difficult since definitions for obesity and knee OA vary among investigators. Data from the first National Health and Nutrition Examination Survey (HANES I) indicated that obese women had nearly 4 times the risk of knee OA as compared with non-obese women; for obese men, the risk was nearly 5 times greater (6). Felson DT et al observed that overweight individuals in their thirties who did not have knee OA were at greater risk of later developing the disease (7). Some investigators have found that overweight significantly increases the risk of developing knee OA which were confirmed from their repeated x-rays studies over the time (8, 9). It is estimated that persons in the highest quintile of body weight have up to 10 times the risk of knee OA than those in the lowest quintile (5). Even small amounts of weight loss reduce the risk of developing knee OA. Preliminary studies suggested weight loss decreases pain substantially in those with knee OA (10). Successful strategies for weight loss include calorie reduction, increased physical activity and behavior therapy designed to improve eating and physical activity habits (11).

Petrella RJ *et al.* stated that the risk of knee osteoarthritis (OA) attributable to obesity and the interactions between obesity and other established causes of the disorder. These findings gave strong support to public health at reducing the burden of knee OA by controlling obesity (12). Obesity is one of the most important risk factors for OA in knee(s).

However, the relationship between obesity and OA in hand(s) and hip(s) remains controversial and needs further investigation. A high BMI was significantly associated with knee OA and hand OA but not with hip OA (13). It was examined whether obesity increases the risk of progression of knee OA. The author's stated that obesity was not associated with OA progression in knees with valgus alignment; however, it did increase the risk of progression in knees with neutral or valgus alignment. Therefore, weight loss may not be effective in preventing progression of structural damage in OA knees with valgus alignment (14). Felson DT et al stated that as obesity increases overall loading of the knee and limb malalignment concentrates that loading on a focal area, to the level at which cartilage damage may occur. This study evaluated whether the effect of body weight on progression of knee OA differs depending on the degree of limb malalignment.

Although elevated BMI increases the risk of knee OA progression, the effect of BMI is limited to knees in which moderate malalignment exists, presumably because of the combined focus of load from malalignment and the excess load from increased weight. This has implications for clinical recommendations and for trials testing weight loss in those with knee OA (15). Obesity seems to be a mechanical rather than a systemic risk factor for OA with the knee joint being especially susceptible (16). It was stated that women aged 45-64 from the Chingford general population were surveyed cross sectionally to find out the effect of quantity and distribution of body fat on the prevalence of radiologically confirmed osteoarthritis (OA) in the knee, carpometacarpal (CMC), distal interphalangeal (DIP), and proximal interphalangeal (PIP) joints. Obesity was classified as the upper tertile of body mass index (BMI kg/m²) and the boundaries of the

middle tertile were 23.4 and 26.4 kg/m² which confirmed that excess body weight is a powerful predictor of OA of the knee in middle aged women (17).

The role of physical activity, obesity, and history of significant knee injury on the development of severe OA of the knee were evaluated. Obesity, significant knee injury, and long-term heavy physical activity are important risk factors for the development of OA of the knee (18). It is well established that overweight is related to OA of the knees. A moderate increase in BMI, within the normal weight range, was significantly related to knee osteoarthritis among men. Overweight at any time was related to knee osteoarthritis (19). Obesity is a risk factor for OA of the knee; a study was undertaken to determine whether progressively higher BMI among obese women is associated with progressive increases in joint space narrowing (JSN). Joint loading was not evaluated, but it is possible that marked obesity limited the functional capacity of some subjects with OA, protecting their knees from loading (20). Considering all these predisposing factors responsible for the development of OA knee, the aims of the present study was to compare whether BMI affects the effectiveness of quadriceps dynamic strengthening exercise protocols in the improvement of osteoarthritic knee.

MATERIALS & METHODS

Subjects: Sixty osteoarthritis knee patients of both genders at age group of 45-65 years were randomly assigned in the study. They were randomly divided into two groups. Group A consisted of thirty non-obese osteoarthritis knee patients (Mean BMI =24. 02±1.41 kg/m²) and B had obese osteoarthritis knee patients (Mean BMI =35. 14±0.21 kg/m²). In each group patients were selected on the basis of their BMI and inclusion criteria. The details of the examination protocols were explained to each subject and their written consent were

taken. Pain was measured by VAS and knee range of motion (ROM) by goniometre. Research design was experimental model.

BMI was calculated by dividing the subject's weight by the square of his / her height, expressed in metric units: Metric: BMI = kg / m², where *kg* is the subject's weight in kilograms and *m* is the subject's height in meters. Basic anthropometric parameters such as body weight, body height, BMI were measured.

Inclusion criteria

- Primary OA patients were included.
- Patient should be ready to participate.
- Pain: rating on VAS scale more than 5.
- Range of motion: knee flexion 90 degree.
- Muscle strength: rating on MMT 3.
- Male & female both were included.

Exclusion Criteria

- People who had been immobilized for more than 3 weeks.
- Traumatic OA.
- Severe peripheral & autonomic neuropathy.
- Hypertension.

Material Required

- Goniometry
- VAS scale

Settings

- Kailash Hospital, Noida
- Obesity clinics, Delhi

Design: Experimental model

Variables

Dependent: Visual Analogue Scale, knee ROM and MMT

Independent: quadriceps dynamic strengthening and isometrics exercise

Procedure

Informed consent form was filled by osteoarthritis of knee patients. Patients were divided into two groups randomly according to their BMI: Group A (non-obese OA knee patients) and Group B (obese OA knee patients). Quadriceps dynamic strengthening and isometrics exercise were introduced to them for treatment of OA knee joints. Isometric strengthening of knee and Strengthening exercises quadriceps dynamics were introduced (13). The treatment protocol was given for fifteen days.

Range of Motion: Goniometre was used to measure knee extension & flexion.

Knee Flexion: In the starting position for measuring knee flexion ROM, subject was in supine position. The axis was placed at the femoral condyle. The stationery arm was placed parallel to the thigh of femur and movable arm was placed parallel to the fibular head & patient was asked to flex the knee & ROM was taken. Normal knee flexion range is 0 degree to 135 degree.

Knee Extension: The right lower extremity was at the end of knee flexion ROM. The examiner right hand was on the proximal rather than the distal femur so that the posterior surface of the distal thigh could make contact without interference. The knee flexion ROM was limited by the length of rectus femoris muscle as well as contact between posterior thigh & lower leg.

Normal knee extension range is – 135 to 0 degree.

Pain: It was measured by VAS scale. It is a 10 point scale in which the 0 indicates no pain, 5 indicate neutral pain and 10 indicate severe pain (14).

MMT: It is a specific technique for grading of muscle. MMT was measured for both extensor and flexor muscle.

Statistical Analysis

Unpaired t – test was applied. the pearson's correlation test was applied to find out correlation between BMI and OA knee . The level of significance was set at $p < 0.05$

RESULTS

Table 1
Demographics of the Participants

Sl. No	Parameters	Group A (Non-obese OA knee group)	Group B (Obese OA knee group)
1	Number	30	30
2	Age (years)	56.3 ± 1.5	54.5± 0.9
3	BMI (kg/m ²)	24. 02±1.41 kg/m ²	35. 14±0.21 kg/m ²

Values were Expressed in Mean ± Standard Deviation

Table 1. Analysis of pain, ROM and MMT of non-obese OA knee patients before and after quadriceps dynamic strengthening and isometrics exercise.

S. No.	Variables		pre test Mean ±SD	post test Mean ±SD	t-value	p-value
1.	Pain	VAS	5.5±1.17	4.3±1.09	2.51*	P<0.05
2.	ROM	flexion	114.0±5.51	121±2.09	8.25*	P<0.001
		extension	132.5±2.63	134±1.48	2.33*	P<0.05
3.	MMT	flexor	4.0±0.44	4.8±0.42	2.42*	P<0.01
		extensor	3.7±0.47	5.6±0.96	5.04*	P<0.001

*= significant, VAS = visual analogue scale, MMT= manual muscle test, ROM = range of motion

Table 2
Analysis of Pain, ROM and MMT of Obese OA Knee Patients before and after Quadriceps Dynamic Strengthening and Isometrics Exercise

S. No.	Variables		pre test mean±SD	post test mean± SD	t-value	p-value
1	Pain	VAS	5.8±0.78	4.3±.82	3.73*	P<0.05
2	ROM	Flexion	108±6.32	118±4.20	9.75*	P<0.001
		Extension	130±6.66	134±3.16	0.43	P>0.05
3	MMT	Flexor	3.9±0.02	4.6±.50	0.95	P>0.05
		Extensor	3.5±0.05	4.6±1.10	2.73*	P<0.01

*= significant, VAS = visual analogue scale, MMT= manual muscle test, ROM = range of motion

In group A (non obese), the isometric exercise was given for 15 days on the knee joint in osteoarthritis of knee joint patients. **Pain:** The mean difference for pretest and post test was highly significant ($p < 0.05$). Hence the pain was decreased with the intervention exercise. **ROM:** The mean for the pretest and post test for flexion were 114.0 ± 5.51 and 121 ± 2.09 and for the extension were 132.5 ± 2.63 and 134 ± 1.48 respectively. When t-values were calculated, it was found highly significant in both the cases ($p < 0.001, 0.05$ respectively). Therefore when ranges of motion compared between pretreatment and post treatment conditions, it improved significantly. **MMT:** The mean for pretest and post test muscle strength for flexor group of muscle were 4.0 ± 0.44 and 4.8 ± 0.42 and for extensors were 3.7 ± 0.47 and 5.6 ± 0.96 . The calculated t value were greater than critical value hence it was significant ($p < 0.01, 0.001$). Therefore muscle strength improved significantly in post treatment intervention. The details of results were presented in table 2.

In group B (obese patient) isometric strengthening exercise was given for 15 days on the knee joint in osteoarthritis of knee patients. **Pain:** The mean for the pretest and post test were 5.8 ± 0.78 and $4.3 \pm .82$ respectively. When compared with t value, it was more than critical value. Hence it was significant. **ROM:** The mean for the pretest and post test for flexion were 108 ± 6.32 and

118 ± 4.20 degree and for extension were 130 ± 6.66 and 134 ± 3.16 degree respectively. Therefore when compared with t table the calculated t values were significant for flexion ($p < 0.001$). In case of extension ROM, the calculated t value was lower and hence it was insignificant ($p > 0.05$). **MMT:** The mean for pretest and post test for flexor group of muscle were 3.9 ± 0.02 and $4.6 \pm .50$ and for extensor group of muscle were 3.5 ± 0.05 and 4.6 ± 1.10 respectively. When compared with t table, the calculated t value was less than the critical value for flexors, hence it was insignificant. For the extensor group, it was significant ($p < 0.01$). The details of results were presented in table 3.

DISCUSSION

Knee osteoarthritis is a growing problem in the elderly, resulting in pain, functional limitations, disability and decreased quality of life leading to lost productivity and increased health care costs (21, 22). The pathophysiological basis of knee OA is multifaceted and includes intra-articular inflammation and collagen degradation, impaired muscle function, reduced proprioceptive acuity and the psychological traits of chronic pain (23, 24). Currently, there are neither feasible preventive intervention strategies nor effective medical remedies for the management of knee OA.

This study demonstrated that the fifteen days treatment regimen comprising the

isometric strengthening was given to both the groups: group A (non obese OA knee) and group B (obese OA knee). It was found that the exercises given to group A (non obese) were more effective than group B (obese). In group A examined variables i.e. pain, ROM and MMT were improved significantly but in group B, pain had reduced but MMT and ROM had no significant improvements. The results of the present study supported the previous study in which systemic reviews concluded that because of more BMI in group B (obese group) effect of exercise for treatment of OA knee was not as significant as in case of group A subjects (non obese group).

Isometric exercise improves muscle strength. Researchers focusing on exercise has shown that patients with osteoarthritis have dramatic improvement in muscle strength and endurance and contraction speed of the muscle surrounding joints. Exercise may play prevention and possibly a restrictive role in combating declines in health and functional capacity caused by chronic disease such as osteoarthritis. The limitation in our study was only 15 days exercise regimen was provided for treatment which was very less. The other limitation was the use of the goniometer which has limited reliability thus there may be differences in the ranges of flexion and extension measure.

Obesity has become a major health problem of global significance. Several chronic illnesses are associated with obesity, such as hypertension, type 2 diabetes mellitus, cardiovascular diseases, respiratory problems, and osteoarthritis (OA). Although the cause of knee osteoarthritis is multifactorial, but obesity is a primary risk factor. Human obesity is associated with an increase risk of knee osteoarthritis specifically in patellofemoral compartment and the tibiofemoral compartment and most noticeably with simultaneous osteoarthritis at both the sites and in the knees bilaterally.

CONCLUSION

It was evidenced from this study that exercise had beneficial effects in the treatment of OA knee but due to higher body mass in case of obese subjects the effect of exercise was less significant when compared with non-obese OA knee subjects and prognosis was not as good as in case of non obese OA knee patients. However quadriceps dynamic strengthening and isometrics exercise should be recommended for the treatment of OA knee patients for longer regimen to get beneficial effects for obese patients.

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