

# A Comparative Study to Determine the Effectiveness of Three Modes of Kinetic-Chain Exercises on Pain, Range of Motion and Functional Performance in Patients with Osteoarthritis of Knee

Mehta Krupa<sup>1</sup>, Sorani Dinesh<sup>2</sup>

<sup>1</sup>Consultant Physiotherapist at PDU Hospital, Rajkot, Gujarat, India.

<sup>2</sup>I/C Principal, Government Physiotherapy College, Rameshwernagar, Jamnagar, Gujarat, India.

Corresponding Author: Mehta Krupa

## ABSTRACT

**Aim:** To compare and determine the effect of Open kinetic chain exercise (OKCE), Close kinetic chain exercise(CKCE) and combined open and closed kinetic chain exercises (CCE) on pain, range of motion and functional performance in patients with knee osteoarthritis.

**Method:** Ninety patients with knee OA were divided into 3 groups. Subjects in Group A received OKCE, Group B received CKCE and Group C received CCE. All the 3 groups were given hot packs before the exercises for 20 minutes. The treatment period was of 2 weeks for all the groups. Comparison of Pre and Post effect on pain, range of motion and functional performance was done in all 3 groups.

**Results:** Within and between group analyses in all 3 groups were done after 2 weeks of intervention for NPRS (rest and activity), range of motion and WOMAC scale.

**Conclusion:** Among 3 modes of kinetic – chain exercises the CCE is more effective than OKCE and CKCE alone in reducing pain, improving range of motion and functional performance in patients with knee osteoarthritis.

**Key Words:** Knee osteoarthritis, Kinetic-chain exercises, Hot packs, Numerical Pain Rating Scale (NPRS), Range of motion, WOMAC Scale.

## INTRODUCTION

Osteoarthritis (OA) defined as “A heterogeneous group of conditions that lead to joint symptoms and signs which are associated with defective integrity of articular cartilage, in addition to related changes in the underlying bone at the joint margins”.<sup>[1]</sup> Though OA can occur in all joints due to ageing, it is more commonly seen in weight bearing joints like hip, knee, spine etc.<sup>[2]</sup>

OA is characterized by progressive loss and degeneration of articular cartilage, sclerosis of the sub-chondral bone, and formation of osteophytes. These changes often lead to pain, loss of mobility and

muscle function, restriction in activities of daily living such as walking, bathing, dressing, use of toilet and performing household chores as a consequence of it there is decrease in quality of life.<sup>[3, 4]</sup> Prevalence of osteoarthritis of knee rises in frequency with age; it does affect substantial numbers of people of working age. The prevalence of risk factors such as obesity and poor levels of physical fitness also continues to rise.

Some researchers have demonstrated that physiotherapy interventions are effective in reducing pain and improving activity in people with knee pain. These studies have included combinations of

patella-femoral-tapping, muscle stretching, thermotherapy, various pharmacological drugs, strengthening and coordination exercises along with techniques, various exercise protocols and recent advances like Manual therapy aimed at decreasing tightness of the lateral structures and are individually responsible for the improvement of the joint. [5-13]

It has been demonstrated that conventional treatment methods such as exercises and wax therapy are effective in reducing pain and improving activity in people with knee pain. [10,11] Heat therapy helps to relax muscles and increase circulation to the affected area, thus reducing pain and stiffness. [11] So, we can say that heat therapy can be useful in relieving pain and stiffness in arthritic joints which will further prevent joint deformity. [12, 14]

Although it is well established that various forms of exercise are effective in reducing pain and increasing physical function in people with knee OA, there is still little knowledge about which forms of exercise are most effective. [13,15] Exercises used for treatment of knee complaints are performed either in open or closed kinetic chain. [16] There are researches available which compares the effect of open kinetic chain exercise and close kinetic chain exercise in OA knee patients. [17, 18]

But there are very few studies [19, 20] available in literature showing the effectiveness of combined kinetic chain exercises. Hence this study is to determine and compare the effectiveness of three modes of kinetic-chain exercises (OKCE, CKCE and CCE) on pain, range of motion and functional performance in patients with OA knee.

## **MATERIALS AND METHODS**

Comparative interventional study was conducted in GG Hospital and Government physiotherapy college

Jamnagar OPD. Ethical clearance was obtained from ethical committee of M P Shah medical college, Jamnagar.

The present study consisted of 90 subjects and they were divided into 3 groups randomly. Subjects in group A received OKCE, group B received CKCE and group C received CCE. All the 3 groups were given hot packs before the exercises for 20 minutes. Before giving the intervention subjects were screened for eligibility criteria and informed consent was obtained from them.

### **INCLUSION CRITERIA:** [1, 19, 20]

Both male and female subjects fulfilling the clinical criteria of American college of rheumatology for OA knee (which were pain in the knee for most days of prior month, crepitation on active joint motion, morning stiffness less than 30 min in duration, patient's age 38 years and above, and bony enlargement of the knee on examination), Radiological investigations suggestive of OA and Painful restricted movement of knee.

### **EXCLUSION CRITERIA:**

Subjects having any surgical procedure done on the involved lower extremity, post traumatic stiffness and deformity over knee joint were excluded from the study.

Materials and apparatus used:

- Consent form
- Pen
- Plinth
- Pillow
- Towel
- Hot packs
- Stepper
- Rowing machine
- Numerical pain rating scale (NPRS)
- Universal goniometer
- Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) Scale

**INTERVENTION:**

Group A (OKCE)	Group B (CKCE)	Group C (CCE)
Hot Packs (20 minutes)	Hot Packs (20 minutes)	Hot Packs (20 minutes)
1. Quadriceps Setting exercise 2. Straight-Leg raise exercise 3. Short-Arc Terminal Knee Extension exercise 4. Full-Arc Knee Extension exercise  Each exercise was done in 3 sets of 10 repetitions. The subject rested for 1 minute after the conclusion of each set.	1. Rowing machine exercise 2. Standing wall slides 3. Lunges 4. Step up-step down exercise  Each exercise was done in 3 sets of 10 repetitions. The subject rested for 1 minute after the conclusion of each set.	1. Quadriceps Setting exercise 2. Straight-Leg raise exercise 3. Short-Arc Terminal Knee Extension exercise 4. Full-Arc Knee Extension exercise 5. Rowing machine exercise 6. Standing wall slides 7. Lunges 8. Step up-step down exercise  Each exercise was done in 3 sets of 5 repetitions. The subject rested for 1 minute after the conclusion of each set. This was done because in group C the dosage of the exercises got doubled as compared to group A and B so to make the intensity of exercises equal in all the 3 groups, patients were made to do 5 repetitions instead of 10.



**Figure 1: Rowing machine exercise**

Patients were treated with one session per day for 2 weeks. Outcome measures: Numerical pain rating scale (rest and activity) was taken to measure pain intensity, range of motion of knee joint was measured using universal goniometer & WOMAC scale was taken to measure functional activity before & after completion of intervention that is on 1<sup>st</sup> day & 14<sup>th</sup> day.

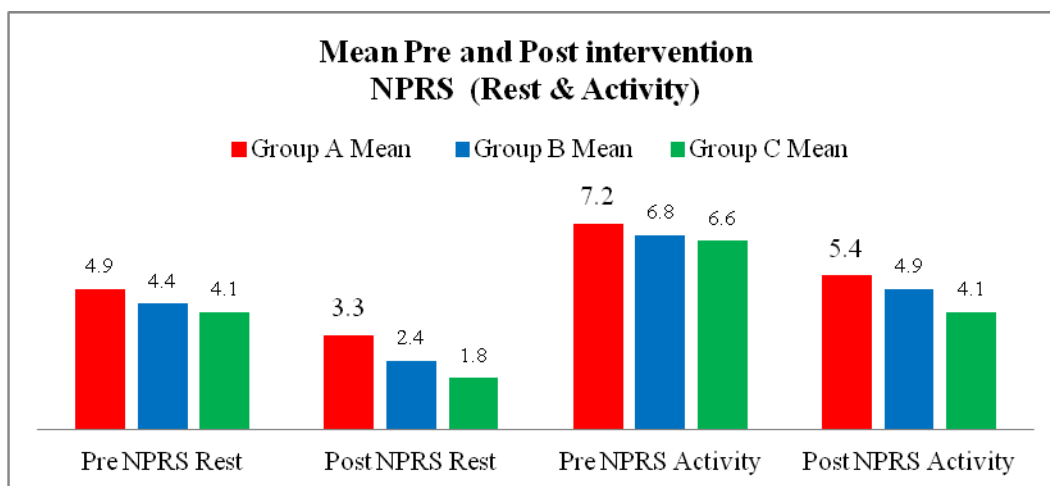
**STATISTICAL ANALYSIS**

All Statistical analysis was done by software SPSS 20.0 version & Microsoft Office Excel 2007 version. Means & Standard Deviation (SD) were calculated as a measure of central tendency & measure of

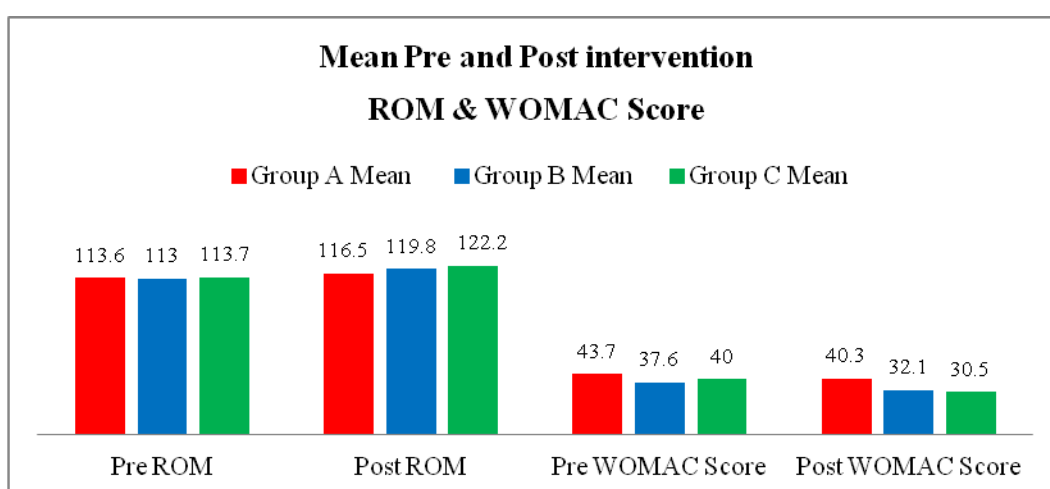
dispersion respectively. ANOVA analysis was done for evaluating the difference between NPRS (rest & activity), range of motion & the WOMAC score between & within the groups & Tukey Post Hoc analysis was used to compare the between NPRS (rest & activity), range of motion & WOMAC score differences of all the three groups.

**RESULTS**

As shown in table 1, there is significant difference in values between 3 group comparison of NPRS (rest & activity), ROM & WOMAC score after 14 days of intervention.



Graph 1: Within group comparison of all the groups for NPRS (Rest and Activity)



Graph 2: Within group comparison of all the groups for ROM and WOMAC Score

Table 1: Between group analysis of intervention for difference in NPRS (Rest & Activity), ROM & WOMAC Score

Outcome measures	Mean of difference (SD)			F ratio	P value	Result
	Group A	Group B	Group C			
NPRS (REST)	1.60 (0.85)	1.93 (1.04)	2.30 (0.91)	4.136	0.019*	Significant
NPRS (ACTIVITY)	1.83 (0.87)	1.96 (1.09)	2.46 (1.04)	3.284	0.042*	Significant
ROM	2.96 (3.05)	6.80 (5.20)	8.50 (3.83)	14.155	0.000*	Significant
WOMAC SCORE	3.36 (1.12)	5.43 (3.52)	9.46 (4.40)	26.228	0.000*	Significant

## DISCUSSION

In the present study total 90 subjects were taken and they were divided into 3 groups, A group (OKCE), B group (CKCE) and C group (CCE). If patients' activities of daily living are restricted due to pain associated with OA knee, movements will become further restricted due to joint deformation, and the formation of osteophytes on articular surfaces will further restrict activities, forming a vicious circle. Therefore, the maintenance of activity through exercise therapy has been presented as a major treatment option for OA knee. [21]

The present study analysis shows that in group A, 'NPRS at rest' difference is  $1.60 \pm 0.85$ , 'NPRS during activity' difference is  $1.83 \pm 0.87$ , 'ROM' difference is  $2.96 \pm 3.05$  and 'WOMAC score' difference is  $3.36 \pm 1.12$ ,  $p < 0.05$ ; in group B, 'NPRS at rest' difference is  $1.93 \pm 1.04$ , 'NPRS during activity' difference is  $1.96 \pm 1.09$ , 'ROM' difference is  $6.80 \pm 5.20$  and 'WOMAC score' difference is  $5.43 \pm 3.52$ ,  $p < 0.05$  and in group C, 'NPRS at rest' difference is  $2.30 \pm 0.91$ , 'NPRS during activity' difference is  $2.46 \pm 1.04$ , 'ROM' difference is  $8.50 \pm 3.83$  'WOMAC score' difference is  $9.46 \pm 4.40$ ,  $p < 0.05$ . Thus

there is significant difference in values between 3 group comparison of NPRS (rest and activity), ROM and WOMAC score after 14 days of intervention. Along with it Tukey Post Hoc analysis shows that CCE is more effective than OKCE and CKCE alone.

From this study we can state that there is significant difference between open kinetic chain, closed kinetic chain and combined kinetic chain exercises in reducing pain and improving range of motion and functional ability in patients with knee osteoarthritis. Similarly **Olagbegi OM et al., (2016)** in their study found that CCEs are better than OKCEs and CKCEs for pain reduction in though all three exercise regimens are singly effective. CCEs are recommended for improving treatment outcome for pain in patients with knee osteoarthritis. <sup>[19]</sup>

Open and closed kinetic exercises have been used by investigators as a rehabilitation protocol for patients with osteoarthritis. <sup>[22]</sup> Furthermore, from this study it seems CCEs are more effective than either OKCEs or CKCEs for pain relief, increase in range of motion and improvement in functional performance in patients with knee OA. **Alghamdi et al., (2004)** <sup>[23]</sup> did a review of literature to support the use of CCEs submitting that clinicians should not discard CKCEs in the management of knee OA because of the concerns of the possibility that CKCEs induce wear and tear of joint cartilage which might accelerate disease progression. Alghamdi and his colleagues submitted further that the use of OKCEs alone in managing knee OA compromises the specificity and selectivity principles of training which state that optimal gains in a motor activity are made when the exercise most closely resembles the activity. So in accordance to this concern we can use CCEs for management in patients with OA knee.

Open kinetic chain exercises involves open chain motions which can be easily replicated with open chain exercises, first by developing isolated control and

strength of the week musculature, then combining motions to stimulate functional patterns. <sup>[16]</sup> Similar results were seen in a study done by **Shyam D. Ganvir et al., (2015)** <sup>[24]</sup> who found significant reduction occurs in pain and improvement in function due to improved quadriceps strength and therefore increase stability of the knee joint.

CKC exercises consist of movements over multiple joints involving two or more muscles or muscle groups. These exercises will recruit more muscles in shorter period of time, with less shearing force, increased compression and improved joint stability. Using CKC exercises will enhance the way a person moves his body throughout the day as the exercises mimic the functional movements of daily life. It also helps in walking, running, jumping and squatting by work as a team to help the patient. Means hip, knee, ankle joints comprise the lower extremity kinetic chain and they work in combination to move the body. <sup>[25]</sup>

**Guillherme Lotierse Fehr et al., (2006)** <sup>[26]</sup> suggested that CKC exercises presented better performance than OKC exercises to treat the patellofemoral syndrome. Similar results were found by **Gbiri et al., (2013)** in his study done to compare the efficacy of open and closed chain kinematics on proprioception, muscles' strength and functional performances in individual with knee osteoarthritis and concluded that closed chain kinetics is more effective in improving proprioception functional performances in individuals with OA knee. <sup>[18]</sup> Closed kinetic chain exercises involve more eccentric muscle work, and because it is known that eccentric exercise develops more tension in the muscle and thereby obtains a grater training effect, this may be the primary factor in improving function and reducing pain more than the open kinetic chain group. <sup>[22]</sup>

The findings of the present study confirmed that CCE is better than CKCE or OKCE alone in patients with OA knee. It is seen that in same amount of treatment time

for all the three exercises i.e., OKCE, CKCE and CCE more benefits were found in CCE. By the application of combined kinetic-chain exercises for 2 weeks which has 1 session per day have shown significant improvement in knee related quality of life. CCE provides better results in less time so it can be incorporated in the treatment of patients having osteoarthritis of knee.

Limitations of the study were Male: Female ratio was not equally distributed in the sample and study duration was short. Onset and severity of the disease was not taken into account in the study. For future recommendations study can be done in patients with age above 65 years and by considering different grades of knee osteoarthritis. In addition to it study can be done to know long term effects of these exercises.

## CONCLUSION

The results of the present study suggest that subjects who received CCE along with hot packs showed more benefits than subjects who received OKCE and CKCE alone in terms of reduction in pain, improving range of motion and overall functional performance, as measured by WOMAC score in patients with osteoarthritis of knee. So, CCE can be further recommended to be included in treatment regime for patients with osteoarthritis of knee joint.

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