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ROLE OF CLOSED KINETIC CHAIN EXERCISES IN EARLY OSTEOARTHRITIS PATIENT WITH KNEE PAIN

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Abstract

The primary objective of the present study is to evaluate the effectiveness of closed kinetic chain exercises reducing pain and functional disability in individuals affected with Early osteoarthritis patient with knee pain. Pre and post evaluation was performed on 30 participants using the VAS (Visual analog scale) and KOOS (knee injury and osteoarthritis outcome score). The findings suggest a significant reduction in pain level and improvement in range of motion and functional abilities following the intervention. These data suggest that the application of close kinetic chain exercises is effective intervention for treating Early osteoarthritis.

INTRODUCTION

Osteoarthritis is common condition that primarily affects the joints[(1)] and cartilage as it is characterized by damage or loss of articular cartilage, osteophyte formation, ligament laxity muscle weakness. Common sites developing OA include knee, hand, hip, spine and foot[(2)] out of these knee is most commonly affected. OA Patient present with a combination of inflammation, pain, stiffness, atrophy and deformity. It is second

most common problem and most recurrent joint disease with a prevalence of 22% to 39% in india[4]. OA knee is more common in women[2] than men and the prevalence is increases with age. Radiological evidence is found more or less 45% of woman over the age of 65 years having symptoms of osteoarthritis[4]. The prevalence of knee osteoarthritis tends to rise with advancing age, primarily due to the cumulative effect of multiple risk factors along with age-related biological changes[5,6,7]. These changes include gradual cartilage degeneration, decline in muscle strength, impaired proprioception, and increased oxidative stress within the joint, all of which reduce the knee's ability to withstand mechanical demands. Knee OA is the greatest contributor to impairment of mobility, functional ability. The disability can be extensive, including mobility limitations[1], difficulty with limitations of activity of daily living and social isolation. The main factors that contribute to disability include pain, decrease joint range of motion and muscle weakness[3]. The knee joint optimally adjust the internal and external force and loading at and through the knee joint. Several additional factors contribute to the development of knee osteoarthritis, including gender, excess body weight, prior knee injuries, and occupational demands. A history of knee injury is considered a significant risk factor, as it may lead to structural damage within the joint. Studies have reported that individuals with previous knee injuries have a higher risk of developing osteoarthritis compared to those without such injuries. Furthermore, occupations involving repetitive stress, such as heavy lifting, prolonged squatting, or kneeling, can increase joint loading and accelerate degenerative changes, particularly in individuals who remain physically active into older age[8,9,10].

Knee osteoarthritis is commonly treated using a combination of conservative approaches, particularly during the early stages of the condition. Along with pain-relieving medications, exercise-based rehabilitation is considered a fundamental component of management. Regular participation in therapeutic exercise[1] has been associated with improvements in physical function, muscle strength[11,12], walking ability, and confidence in performing daily activities.Strength training, referred as resistance or weight training, involves contracting muscles against an external load in order to improve strength and muscular endurance. This can be performed using a variety of methods, including machines, free weights, resistance bands, body weight, or even water-based resistance.Regular strength training plays an important role in maintaining and enhancing muscle power, preserving lean muscle mass, and improving bone density. These benefits are especially important for older adults, as they support better performance of daily activities and help maintain overall functional independence. Strength training is not only beneficial for improving muscle strength but can also help in managing symptoms associated with conditions such as arthritis, osteoporosis, diabetes, and even depression[13,14]. According to the American College of Sports Medicine, older adults are encouraged to engage in strength training exercises at least 2–3 times per week.It is generally advisable to begin with a simple program that includes around 10–14 exercises targeting the major muscle groups. Each exercise can initially be performed for one set of 10–15 repetitions. As strength and endurance improve, the program can be gradually progressed by increasing the number of sets to two or three per exercise[11,12,13,14].

The concept of kinetic chains (KCs) provides a useful framework for

understanding and analyzing human movement. It helps in designing and performing multi-joint exercises that engage the entire chain, making it highly relevant in both conditioning and rehabilitation settings. Since the body segments are interconnected, movement in one part of the chain can influence both proximal and distal segments, allowing for coordinated motion with multiple degrees of freedom during functional and sport-specific activities[15,16].

In CKC the distal part of the limb is fixed i.e. contact with the ground and exercise equipment and it is more functional exercise[17,18,19,20,21]. For the lower limb, CKC exercises are considered more functional, as most daily activities involve weight-bearing positions. These exercises promote better muscle coordination through co-contraction and are particularly effective in facilitating eccentric muscle activity. In addition, they tend to reduce shear forces while increasing compressive forces across the joint, which helps improve overall joint stability, enhance muscle co-contraction, and decrease patellofemoral compressive forces near extension, all factors thought to restore knee function[22,23,24,25,26].In this study the assessment of outcomes is determined by using KOOS (knee injury and osteoarthritis outcome score) a patient reported knee joint specific scorecard which may be useful for assessing changes in knee activities over time, with or without treatment. Score ranges from 0 to 100 with a score of lowered the score indicating the worst possible knee symptoms and higher score indicates no knee symptom[27] and VAS (Visual analog scale) is a valid tool for measuring the subjective intensity of pain, especially in musculoskeletal disorders. Patients fill in the amount of pain they are feeling on a 10 cm line which starts from "No pain" to "Worst imaginable pain"[28]. This study aims to add the currently contribute literature by investigating the effects of closed kinetic chain exercise to decrease the pain and improve the muscle strength through identifying the extent to which a particular type of has a stronger effects.

AIM & OBJECTIVES OF THE STUDY

To assess the efficacy of closed kinetic chain in patient with early osteoarthritis and knee pain.

MATERIALS AND METHODOLOGY

The cross sectional research design was used in study. Which is a type of an observational study in which data is collected at a single moment in time to evaluate the relationship between variables. The study used randomized sampling as its sample design. The participants were individuals those who had symptoms of early osteoarthritis related knee pain. These people were involved in the study to see how close kinetic chain exercises affected their condition. Paper and pencil for data recording, chair for participants to sit on during assessment and treatment, a treatment couch, assessment form consent form, towel for comfort or support were all used in the study.

SELECTION CRITERIA

Inclusion Criteria:

- Both male and female.
- Age group between 35-65 years.
- Clinical diagnosis of early osteoarthritis changes, and patient with complain of knee pain.
- Symptoms like morning stiffness, crepitus bony tenderness.
- Informed consent/ willingness to participate in the study

Exclusion Criteria:

- Neurological disorder/problems.
- Autoimmune disorder (including RA).
- Unstable heart condition or rapid fluctuation in blood pressure.

- Total knee replacement and total hip replacement.
- Acute soft tissue injury.

SAMPLE SIZE AND STUDY DURATION

For this study the sample size was 30 people the individual were chosen at random from the research population to ensure representativeness and adequate data for analysis. The Study was carried out (5 times a week) for eight weeks, individuals in a clinical environment had therapy as part of the study in pacific college of physiotherapy, pacific medical university (Udaipur), after obtaining ethical committee approval dated 10-9-2025, **PMU/IEC/MPT/2025/11**. All participants completed information and consent form at recruitment. This time frame allowed for evaluation of subjects response to the therapy as well as any changes in their pain, range of motion and functional ability. Each session was scheduled for 40-45 minutes. This period was set aside to ensure the patient had enough time to execute the procedure correctly.

PROCEDURE

Permission for conduct Study is taken from the institutional ethical committee of PMCH **(PMU/IEC/MPT/2025/11)**, Pacific medical university bhilo ka bedla Udaipur(RAJ).

Individuals Diagnosed with early osteoarthritis related knee pain by the Physiotherapy department, Orthopedic department OPD; initially assessed for the inclusion or exclusion criteria. Prior to the treatment procedure, all participants were informed about the purpose, procedures, potential benefits, and possible risks of the study. Written informed consent was obtained from each participant prior to enrollment.

30 subjects were selected on the basis on inclusion criteria treated with closed kinetic chain exercise.

- Sit to stand
  Patient position - sitting on the chair/ stool
  Therapist position - side to the patient
  Procedure - Ask the patient to press the heel firmly to the ground than rise to a standing position. After standing up return to the starting position. Repeat it for 10 times.during exercises the arm should be extended and held together in front
- Mini squat
  Patient position - standing position
  Therapist position - side to the patient
  Procedure - patient assumed the standing position and bent both the knee up to about 30 degree and maintaining the trunk in upright position. Hold for 10 seconds and relax. Repeat for 5-10 times
- Anterior lunges
  Patient position - Standing
  Therapist position - side of the patient
  Stand with feet hip-width apart ,keep back straight ,shoulders back ,take a step forward and slowly bend both knees, until back knee is just above the floor hold for 10 seconds and relax.
- 3 side step up exercises in closed chain position
  Patient position – Standing
  Patients perform step up by stand in the front of an elevated Stepper. Place the one foot on top of elevated surface and push through the leg to lift body up onto it. Step down slowly with other leg and perform next repetition with other foot.
- Single leg toe raises and double leg toe raises

Patient position - Standing
Double log toe raises - Stand with support of bed or table and than raise the heel of both the foot hold for few seconds and than relax.
Single leg toe raises - Stand with support of the side of the couch. Ask the patient to raise one leg in flex position and do heel raise with another leg.

- Wall slides
  Patient position - Standing
  Start with a standing position with feet-shoulder width apart and back flat against a wall. Ask the patient to lower into a seated position by bending the knees at a 90 degree angle. Hold the position for 10 seconds and relax repeat this for 5 times.

RESULTS

A total of 30 participants were included in the study, 18 females and 12 males. In the 35-40 years age group 10 participants, 41–45 years age group,6 participants, 46-50years age group, 5 participants,51-55 years age group, 4 participants, 56-60 years age, 3 participants,61-65 years age; 2 participants were participated.

Table 1: VAS (0 Week vs 8 Weeks)

Timepoint	N	Minimum	Maximum	Mean	Std. Deviation	t-value	p-value	Result
0 Week	30	6	8	7.03	0.76	22.84	<0.001	Significant
8 Week	30	2	4	3.03	0.76			
Overall	60	2	8	5.03	2.02			

Graph 1: VAS (0 Week vs 8 Weeks)

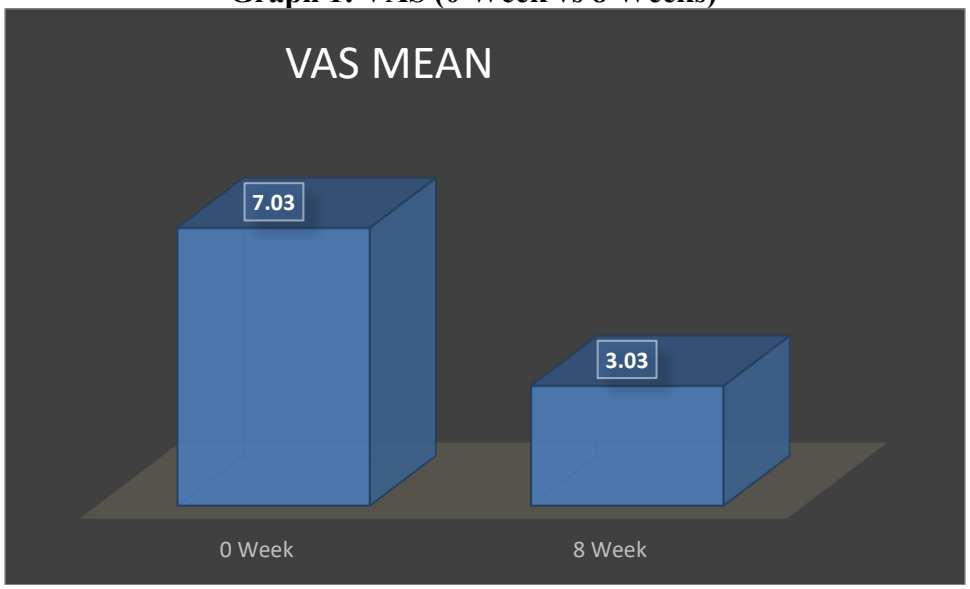

Table 1 shows the pain levels (VAS) before and after 8 weeks. At baseline, the mean VAS score was 7.03. After 8 weeks, the mean score reduced to 3.03, indicating a greater reduction in pain. The range decreased from 6–8 at baseline to 2–4 at 8 weeks. The t-value was 22.84 and the p-

value was less than 0.001, indicating a highly significant reduction in pain. This shows that the intervention was very effective in reducing pain.

Table 2: KOOS (0 Week vs 8 Weeks)

Timepoint	N	Minimum	Maximum	Mean	Std. Deviation	t-value	p-value	Result
0 Week	30	48	56	52.27	2.39	25.91	<0.001	Significant
8 Week	30	69	75	71.90	1.87			
Overall	60	48	75	62.08	9.84			

Graph 2 : KOOS (0 Week vs 8 Weeks)

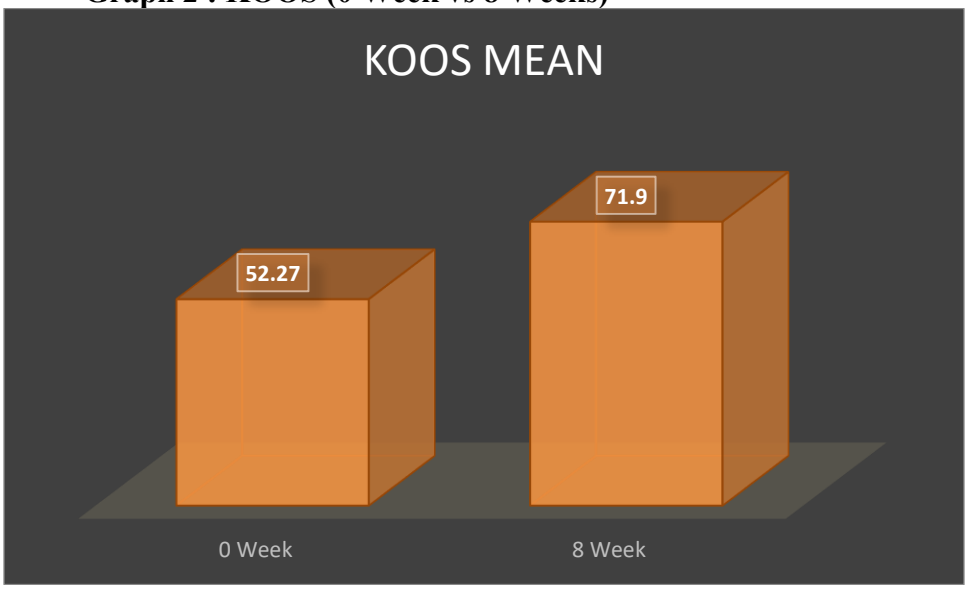

Table shows the functional improvement (KOOS score). At baseline, the mean score was 52.27,. After 8 weeks, it increased to 71.90, indicating a large improvement in function. The range improved from 48–56 at baseline to 69–75 at 8 weeks. The t-value was 25.91 and the p-value was less than 0.001, which indicates a highly significant improvement.

DISCUSSION

The present study was design to examine the effects of close kinetic chain exercise, in individuals affected with early osteoarthritis related knee pain. A total of 30 patients were included and assessed using pre- and post-intervention outcome measures. The outcome measures used were using the VAS (Visual analog scale) and KOOS (knee injury and osteoarthritis outcome score). The findings suggest a significant reduction in pain level and improvement in range of motion and functional abilities following the intervention. These data suggest that the application of close kinetic chain exercises is effective intervention for treating early osteoarthritis related knee pain.

Results of the present study are compared with existing study or literature which shows treatment procedure are consistent with and strongly support the findings reported in previous studies. Kwon YJ et.al,(2018) conducted a study that compare the efficacy of open kinetic chain and close kinetic chain exercise in healthy individuals to improve dynamic balance, findings of the study suggest CKC is more effective than OKC. These findings are consistent with the results

of the present study and further support our outcomes. A recent systemic by Pamboris GM et.al,(2024) on the management ACL rehab in knee joint pain reported that open kinetic and close kinetic chain exercise and effective in improving strength and reducing pain and functional debility. These findings are highly correlated with the results of the present study and support our findings. Therefore, the existing body of literature provides strong support for the present study findings, reinforcing the conclusion that closed kinetic chain exercises play a significant role in enhancing functional recovery and balance in individuals with knee pain and early osteoarthritis.

CONCLUSION

The findings of the study showed that CKC exercise programmes is statistically significant improvements over a 8-week intervention period in terms of pain, functional disability and functional performance. However, CKC exercises consistently demonstrated greater improvements across most primary and secondary outcome measures. Based on these findings, it can be concluded that the intervention are clinically safe and beneficial, closed kinetic chain exercises are effective in improving functional outcomes in individuals affected with early osteoarthritis related knee pain. Therefore, CKC exercises should be prioritized in evidence-based rehabilitation programs to facilitate optimal recovery.

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