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COMPARATIVE STUDY TO ANALYZE THE EFFECT BETWEEN CLOSED KINETIC CHAIN EXERCISE AND OPEN KINETIC CHAIN EXERCISE IN EARLY OSTEOARTHRITIS PATIENT WITH KNEE PAIN

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KEYWORDS

Knee pain,
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Abstract

Background: Osteoarthritis is common condition that primarily affects the joints 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 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. In this study open kinetic chain exercises and close kinetic chain exercises has been introduce to reduce and improve function.

Objective: The objective of the study is to i) Assess the efficacy of open kinetic chain in patient with early osteoarthritis and knee pain. ii) Assess the efficacy of closed kinetic chain in patient with early osteoarthritis and knee pain.iii) Finally study will compare of both procedure i.e. open kinetic chain and closed kinetic chain in improving functional outcomes in early osteoarthritis and knee pain.

Methods: 60 patient diagnosed with the early osteoarthritis and knee pain by orthopedic OPD or physiotherapy department were initially assessed for the inclusion or exclusion criteria. Prior to the treatment procedure patient are oriented to the study. Participants are divided into 2 groups and both groups assessed for the pre test parameter.

Outcome measure: **VAS** (Visual analog scale) **and KOOS** (knee injury and osteoarthritis outcome score) is used for measuring pre and post intervention evaluation.

Results: The Study was significant in reducing pain level and improving functional ability. At the end of eight week intervention, for both group: Group A (open kinetic chain exercises) and Group B (close kinetic chain exercises) showed improvement in the symptoms. Based on the results the study supports research hypothesis that there was a significant improvement in the ROM and functional ability or ADL performance associated with early osteoarthritis and knee pain.

Conclusion: Findings of the study showed that both OKC and CKC exercise programmes is statistically significant improvements over a 8-week intervention period in terms of pain, gait functional ability, and overall functional performance. However, CKC exercises consistently demonstrated greater improvements across most primary and secondary outcome measures.

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[3]. 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[3]. The knee joint is the largest weight-bearing joint in the human body and plays a vital role in almost all lower limb activities. Owing to its frequent use and exposure to mechanical stress, the knee is highly susceptible to overuse and overload injuries, which can result in pain and reduced functional capacity. Lack of treatment and unmanaged joint structure, may progress into chronic conditions affecting long-term mobility and quality of life[4,5].

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[6,7,8]. 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[9]. 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. Evidence suggest 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[10,11,12].

Studies have suggest that a huge number of adults are likely to experience painful knee osteoarthritis in at least one knee at some point in their lives. The condition does not develop due to a single reason but rather a combination of factors. These include increased stress on the tibiofemoral joint, changes in bone alignment, growth of bone marrow lesions, gradual loss of cartilage, narrowing of joint space, and compression of the tibial surface. From a biomechanical point of view, all these changes disturb the normal alignment of the knee and affect how body weight is distributed across the joint[12,13]. Over time, this uneven loading speeds up the degenerative process. People with knee osteoarthritis often show noticeable changes in the way they walk. Their walking speed tends to decrease, steps become shorter, and overall knee movement

is reduced. There is usually a slightly increased bending of the knee when the heel first touches the ground, along with less variation in movement during the stance phase[12]. In individuals with medial knee osteoarthritis, these changes are even more pronounced, with slower walking, shorter step length, longer time spent on each step, and reduced knee mobility during daily activities[12,14].

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[15,16], 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[17,14].

The kinetic chain concept is a biomechanical model that describes the human body as a series of interconnected segments[18] working together to produce efficient movement. According to this model, movement is generated through the coordinated interaction of multiple body segments, with force typically being transferred from the proximal segments to the distal segments. This sequential transfer of energy plays a crucial role in the performance of various sporting and functional activities. Rehabilitation of knee OA targets static and dynamic stability it include range of motion, muscle strength. Muscle can be strengthened through strength training programme or resistance training which can be divided into open kinetic chain exercises and closed kinetic chain exercises.OKC allows distal part of the limb is move freely while proximal part is fixed and its importance is to isolate individual muscle group. However, they tend to produce greater distraction and rotational forces at the joint and are commonly performed using concentric muscle contractions. 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[19,20,21,22,23]. 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[24,25,26,27,28]. Many article were found on the comparison of open kinetic chain and close kinetic chain and all the article suggests that both(OKC and CKC) exercise programmeare helpful in patient with knee pain or OA Knee but no literature suggest wether the isolate or

individual muscle exercise (OKC) Or functional exercise (CKC) are helpful in chronic knee pain, multifactorial knee pain as we know it is not a localized disease it is also affect by generalized factors like muscle imbalance, improper gait pattern etc. This study aims to add the currently contribute literature by investigating the effects of Open kinetic chain exercises and 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. This research may provide invaluable information to clinician, physiotherapists and occupational therapist and the results may contribute to evidence-based remedies for proper performance and injury risk reduction.

MATERIAL & METHOD

METHODOLOGY

Study Design: Comparative study.

Sample Design: Purposive Sampling technique.

Study Setting: Patient were treated 5 times per week for 8 week at Department of physiotherapy, Pacific Medical college and hospital. UDAIPUR

Study Population: Male & Female both the patients with early osteoarthritis and knee pain of age group of 35-65 years of age related injury or trauma and are willing to participate in this study.

Sample Selection: 60 Patient will be selected and Will be assessed for the pre-test parameter.

Study Duration: one year

Sample Size: 60 participants

Treatment Duration: single session 45-60 minutes for (5 days per week) for 8 weeks.

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.

PROCEDURE

The present study was commenced following approval from the institutional ethical committee**(PMU/IEC/MPT/2025/11)** of PMCH, Pacific medical university bhilo ka bedla Udaipur (RAJ).

Individuals Diagnosed with early osteoarthritis and 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. Following the consent process, the participants were randomly allocated into two groups.

- 60 subjects were selected on the basis on inclusion criteria for and randomly divided into Group-A and Group B.
- Group A (n=30) treat with Open kinetic chain exercises.
- Group B (n=30) treat with Closed kinetic chain exercise.

Group A (n=30) will be treated with open kinetic chain exercises:-

- Terminal knee extension
  Patient position – high sitting
  Therapist position – sode of the couch
  Procedure – Ask the patient to perform knee extension and maintain isometric contraction at quadriceps muscle. Hold for 10 sec and then relax and repeat for 10-15 times.
- Concentric quadriceps
  Patient position - Supine lying
  Therapist position - side of the couch
  Procedure - Place a foam roll or towel roll just below the knee of affected leg of the patient and ask the patient to perform isometric contraction of the quadriceps, maintain knee in extension. The contraction is hold for 10 sec and relax for a while and repeat for 10-15 times.
- 4 ways straight leg rise exercises as hip flexion, extension, abduction, adduction
  Patient position - Supine lying
  Therapist position - side of the couch
  Procedure – command the patient to isometrically contract the quadriceps and lift the or lower extremity up to about 60 degree hip flexion while maintain knee extension. Hold for 10 seconds and than lower the limb on the couch. Repeat for 10-15 times.
  For extension – position prone. Command the patient to lift the lower extremity eith knee extension uo to 45 degree. Hold for 10 seconds and than lower the limb on the couch. Repeat for 10-15 times.
  For abduction and adduction – position supine lying. Ask the patient to contract the quadriceps muscle and lifts the lower limb with extension up to about 45 degree and perform abduction of hip and adduction of the hip.
- Resisted knee extension
  Patient position - High sitting with weight strap or weight cuff just above the ankle
  Therapist position - side of the couch
  Procedure - Ask the patient to perform isometric contraction of the quadriceps, maintain knee in extension. The contraction is hold for 10 sec and relax for a while and repeat for 10-15 times.
- With warm up and cool down phase exercises

Group B (n=30) will be treated with close kinetic chain exercises:-

- 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.

DATA ANALYSIS AND RESULTS

Findings of the study showed that both OKC and CKC exercise programmes is statistically significant improvements over a 8-week intervention period in terms of pain, gait functional ability, and overall functional performance. However, CKC exercises consistently demonstrated greater improvements across most primary and secondary outcome measures. Particularly, the CKC group showed superior reductions in all dimesmsion related to KOOS i.e. pain, symptoms, ADL Function, Sport and Recreation Function, Quality of Life.

Results are presented as Patient participated in group B shows more significant changes. Group B result were found better than group A, results as data analysis showed visual analogue scale (VAS) of group A mean±SD is 7.03±0.76 improve to 5.03±0.76 post intervention. Group B data of visual analogue scale (VAS) pretest mean±SD is 7.03±0.76 improve to 3.03±0.76 post intervention. Data analysis of KOOS (knee injury and osteoarthritis outcome score) also significant for group B Compared to group A for group A pretest value of all component of KOOS is mean±SD is 52.27±2.39 improve to 64.27±2.39 in post test. The group B value of all component of KOOS before intervention mean±SD is 52.27±2.39 improve to 71.90±1.87 in post test. After comparing all the data it was observed that both KOOS and VAS demonstrated significant improvement in both group. However, CKC exercises (Group B) consistently demonstrated greater improvements across most primary and secondary outcome measures. Based on

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these outcomes the study rejects null hypothesis and accept the alternate hypothesis for selected parameters.

TABLE 1 AGE DISTRIBUTION OF PATIENTS

Age Group (Years)	Group A (n)	Group A (%)	Group B (n)	Group B (%)	Total (n)	Total (%)
35–40	8	13.30%	10	16.70%	18	30%
41–45	7	11.70%	6	10%	13	21.70%
46–50	6	10%	5	8.30%	11	18.30%
51–55	5	8.30%	4	6.70%	9	15%
56–60	3	5%	3	5%	6	10%
61–65	1	1.70%	2	3.30%	3	5%
Total	30	50%	30	50%	60	100%

GRAPH 1 AGE DISTRIBUTION OF PATIENTS

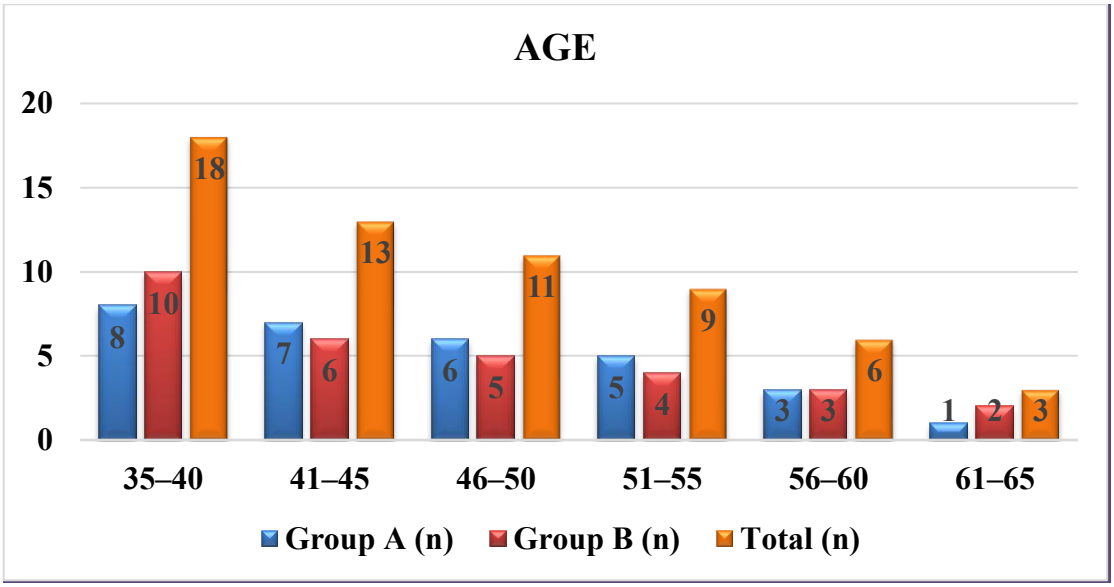

TABLE 2 GENDER DISTRIBUTION OF PATIENTS

Gender	Group A (n)	Group A (%)	Group B (n)	Group B (%)	Total (n)	Total (%)
Male	14	23.30%	12	20%	26	43.30%
Female	16	26.70%	18	30%	34	56.70%
Total	30	50%	30	50%	60	100%

GRAPH 2 GENDER DISTRIBUTION OF PATIENTS

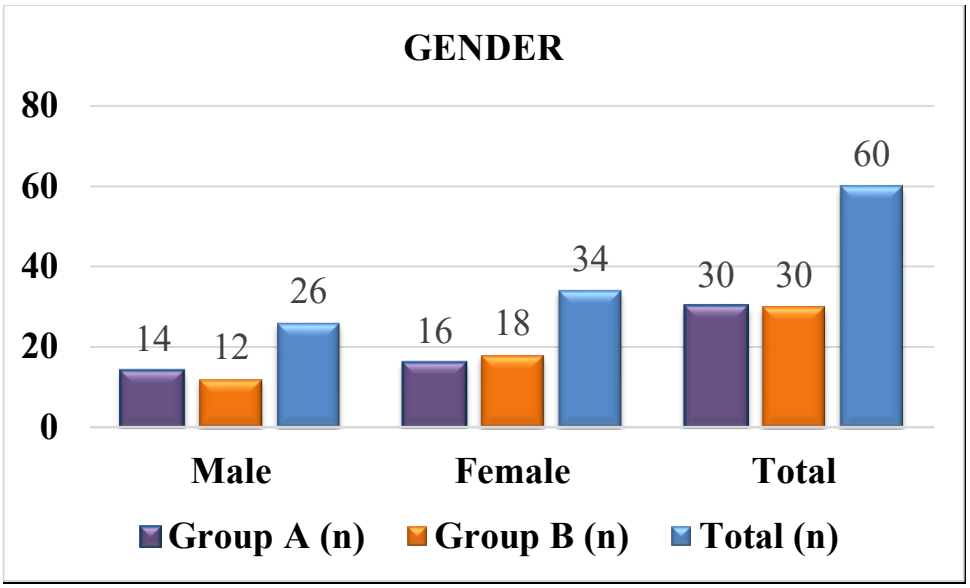

TABLE 3 BMI DISTRIBUTION OF PATIENTS

BMI Category	Range (kg/m²)	Group A (n=30)	Group B (n=30)	Total (n=60)
Underweight	<18.5	1 (3.3%)	1 (3.3%)	2 (3.3%)
Normal	18.5–24.9	10 (33.3%)	10 (33.3%)	20 (33.3%)
Overweight	25–29.9	16 (53.3%)	14 (46.7%)	30 (50.0%)
Obese	≥30	3 (10.0%)	5 (16.7%)	8 (13.3%)

GRAPH 3 BMI DISTRIBUTION OF PATIENTS

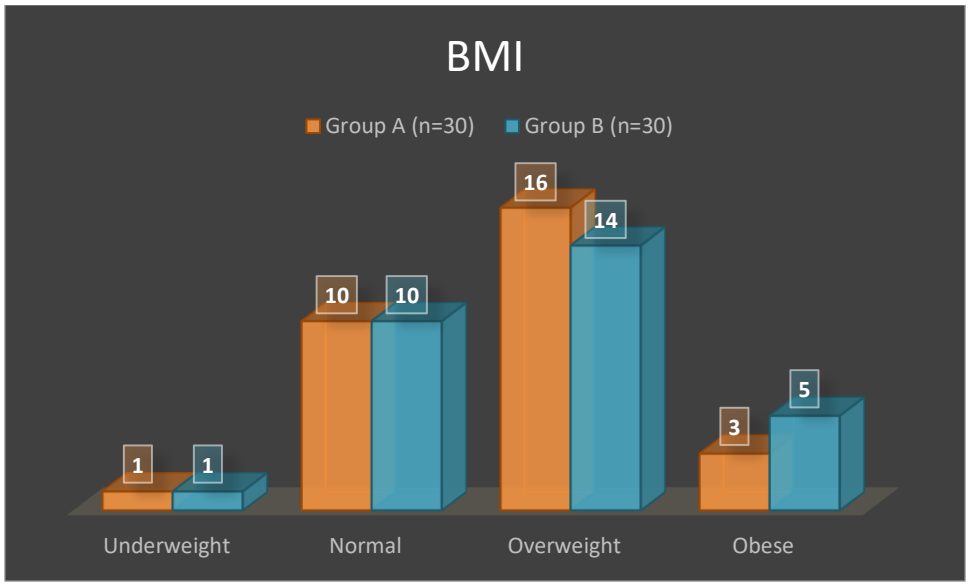

TABLE 4 AREA DISTRIBUTION OF PATIENTS

Area	Group A (n=30)	Group B (n=30)	Total (n=60)
Urban	15 (50.0%)	16 (53.3%)	31 (51.7%)
Rural	15 (50.0%)	14 (46.7%)	29 (48.3%)

GRAPH 4 AREA DISTRIBUTION OF PATIENTS

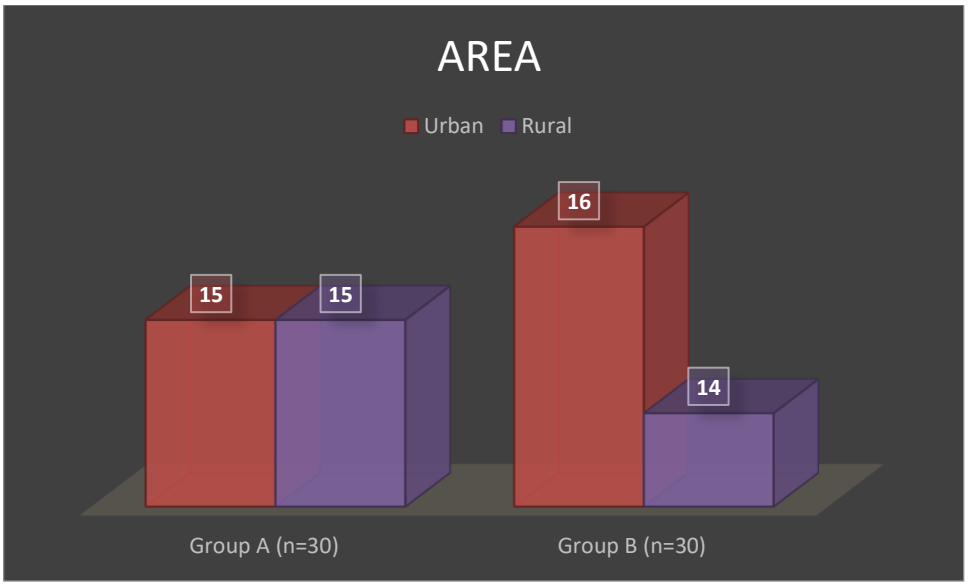

Table 5: Group A – VAS (0 Week vs 8 Weeks)

Timepoint	N	Minimum	Maximum	Mean	Std. Deviation	t-value	p-value	Result
0 Week	30	6	8	7.03	0.76	13.42	<0.001	Significant
8 Week	30	4	6	5.03	0.76			
Overall	60	4	8	6.03	1.12			

Graph 5: Group A – VAS (0 Week vs 8 Weeks)

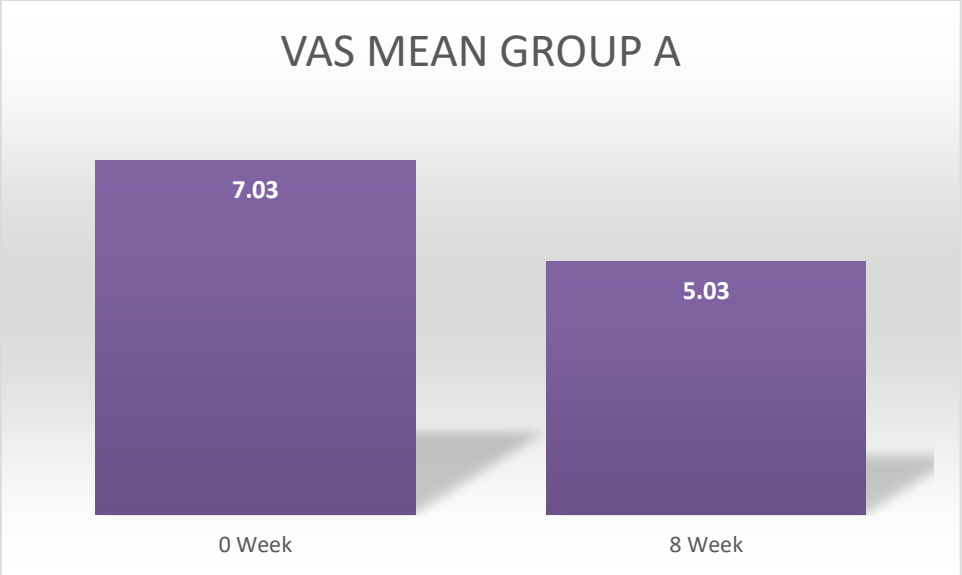

Table 6: Group A – KOOS (0 Week vs 8 Weeks)

Timepoint	N	Minimum	Maximum	Mean	Std. Deviation	t-value	p-value	Result
0 Week	30	48	56	52.27	2.39	18.76	<0.001	Significant
8 Week	30	60	68	64.27	2.39			
Overall	60	48	68	58.27	6.13			

Graph 6: Group A – KOOS (0 Week vs 8 Weeks)

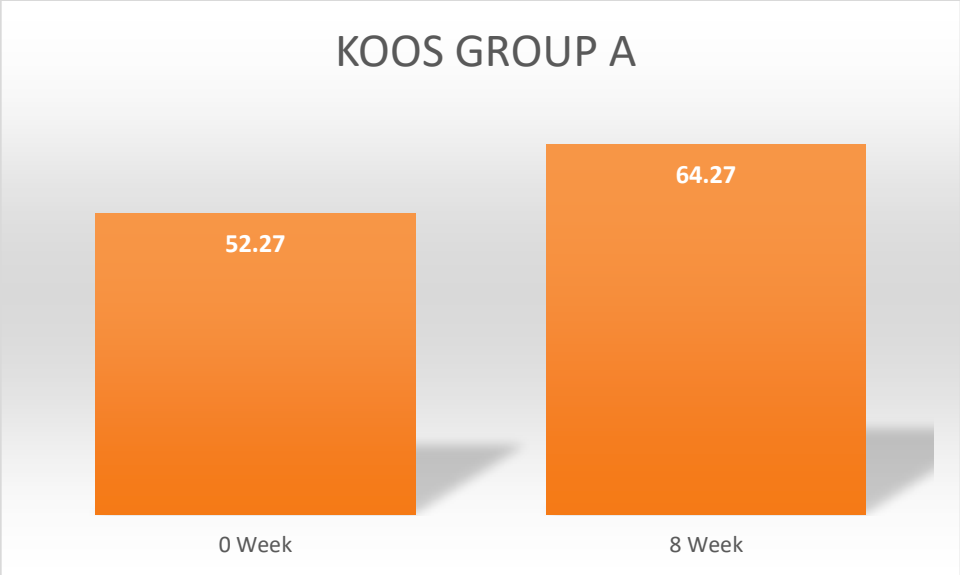

Table 7: Group B – VAS (0 Week vs 8 Weeks)

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 7: Group B – VAS (0 Week vs 8 Weeks)

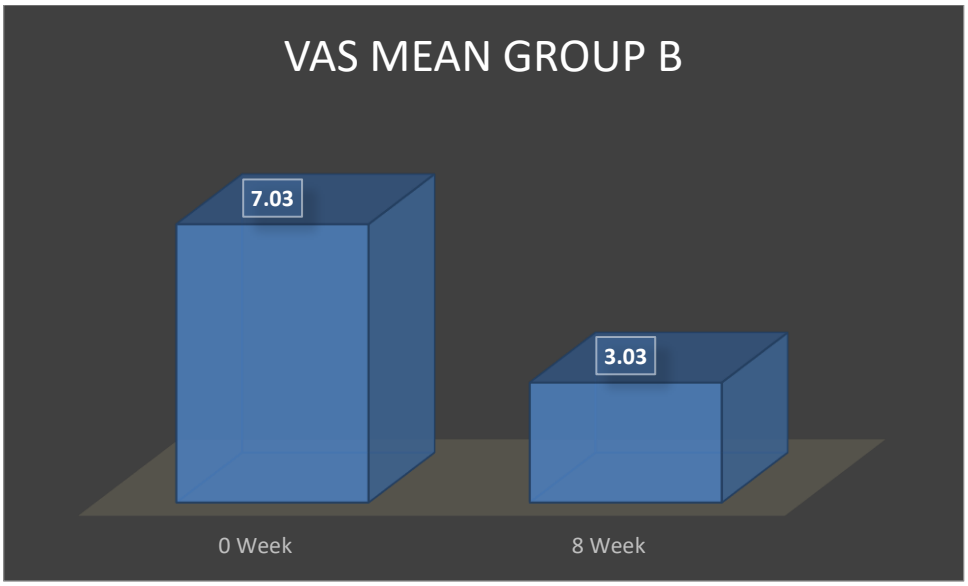

Table 8: Group B – KOOS (0 Week vs 8 Weeks)

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 8: Group B – KOOS (0 Week vs 8 Weeks)

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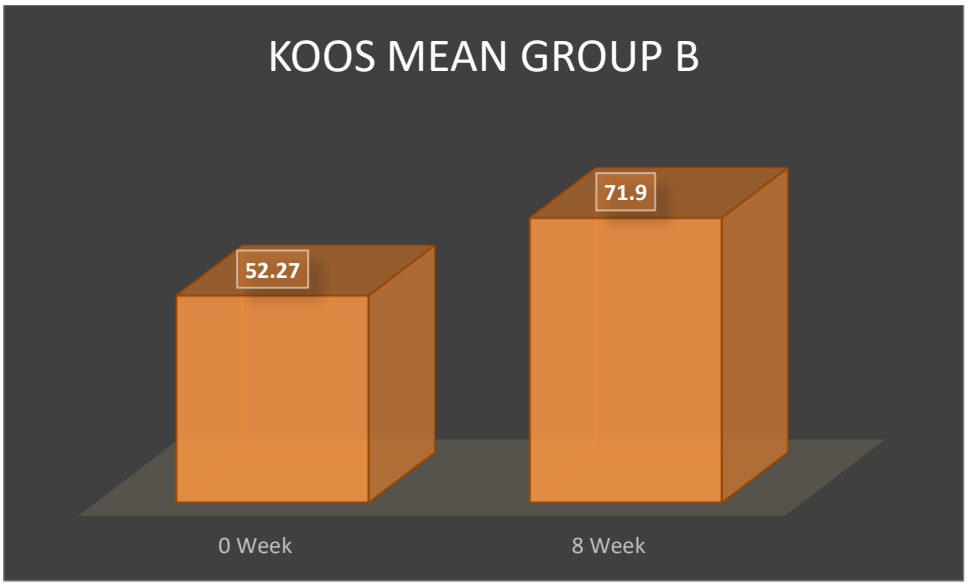

DISCUSSION

The present comparative study was conducted to evaluate the effects of open kinetic chain (OKC) and closed kinetic chain (CKC) exercises in generalized knee pain and early osteoarthritis population, with the primary aim of determining which intervention provides better functional outcomes. A total of 60 participants were included and assessed pre and post-intervention using standardized outcome measures; the VAS (Visual analog scale) and KOOS (knee injury and osteoarthritis outcome score). The findings of the study showed that both OKC and CKC exercise programmes is statistically significant improvements over a 8-week intervention period in terms of pain, gait functional ability, and overall functional performance. However, CKC exercises consistently demonstrated greater improvements across most primary and secondary outcome measures. Particularly, the CKC group showed superior reductions in all dimesmsion related to KOOS i.e. pain, symptoms, ADL Function, Sport and Recreation Function, Quality of Life.

Results of the present study are compared with existing study or literature which shows both treatment procedures 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.

The findings of both procedures support improvement in the measured outcomes. However, the effect observed with open kinetic chain exercises appears comparatively lower than the close kinetic chain exercises. The most possible explanation for the findings of present study that may be explained by the fact that the open kinetic chain exercises and close kinetic chain chain exercises are effective in improving quadriceps muscle strength while optimizing the function of knee extensor mechanism. These adaptation may contribute to reduction in pain and joint stiffness, prevention of contractures and correction of muscular imbalance. Similar mechanism have also been reported in previous studies, supports the present findings of the study.

As observed, knee pain and early osteoarthritis is a common condition affecting individuals across middle-aged and older populations. Several factors may contribute to the development of this condition, including both pathological and traumatic causes. However, one of the major contributing factors is age, soft-tissue imbalance, postural insufficiency. Considering these contributing factors, the present study was conducted to address these impairments. After implementing a 8-week treatment program and the results of the interventions indicate that both OKC and CKC exercise programmes is statistically significant improvements over a 8-week intervention period in terms of pain, gait functional ability, and overall functional performance. However the group which performed close kinetic chain exercises demonstrated slightly better outcomes compared to the group which perform open kinetic chain exercises.

CONCLUSION

The present comparative study was conducted to evaluate the effects of open kinetic chain (OKC) and closed kinetic chain (CKC) exercises in generalized knee pain and early osteoarthritis population, with the primary aim of determining which intervention provides better functional outcomes. A total of 60 participants were included and assessed pre and post-intervention using standardized outcome measures; the VAS (Visual analog scale) and KOOS (knee injury and osteoarthritis outcome score).

The findings of the study showed that both OKC and CKC exercise programmes is statistically significant improvements over a 8-week intervention period in terms of pain, gait functional ability, and overall functional performance. However, CKC exercises consistently demonstrated greater improvements across most primary and secondary outcome measures. Particularly, the CKC group showed superior reductions in all dimesmsion related to KOOS i.e. pain, symptoms, ADL Function, Sport and Recreation Function, Quality of Life.

Based on these findings, it can be concluded that while both interventions are clinically safe and beneficial, closed kinetic chain exercises are more effective in improving functional outcomes and activity of daily living in patients with knee pain and early osteoarthritis. Therefore, CKC exercises should be prioritized in evidence-based rehabilitation programs to facilitate optimal recovery, improve loading patterns, and support a safe and efficient quality of life while reducing the risk of injury and functional disability.

The findings and results of the present study are clinically important for physiotherapists involved in

musculoskeletal and orthopedic rehabilitation, as well as for rehabilitation professionals and rehabilitation specialists. The use of Close kinetic chain exercises may contribute to improving treatment strategies in the field of knee rehabilitation. The results of this study can be applied clinically to assist healthcare professionals in the better management. However, further studies with a larger sample size and more rigorous inclusion and exclusion criteria are required to validate and generalize these findings.

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