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COMPARATIVE EFFECTS OF CLOSED KINETIC CHAIN EXERCISES AND MOBILIZATION EXERCISES IN ELDERLY FEMALES WITH NECK OF FEMUR FRACTURE

Original Research

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ABSTRACT

Background: Neck of femur fractures are among the most common hip injuries in elderly individuals, particularly postmenopausal women, due to osteoporosis and increased fall risk. These fractures significantly contribute to morbidity, functional disability, and mortality in older populations. Effective post-operative rehabilitation is crucial in restoring mobility, reducing pain, and preventing further complications in elderly females recovering from such fractures.

Objective: This study aimed to compare the effects of Closed Kinetic Chain Exercises (CKCE) and Mobilization Exercises (ME) on pain intensity, hip joint range of motion (ROM), gait performance, and fall risk in elderly females with post-operative neck of femur fractures.

Methods: A single-blinded randomized controlled trial was conducted over six months at a tertiary care hospital. A total of 49 elderly females aged ≥65 years with post-operative neck of femur fractures were initially enrolled; 44 participants completed the study. They were randomly assigned into two equal groups: Group A received Mobilization Exercises, and Group B received Closed Kinetic Chain Exercises. Both groups underwent 40-minute sessions, three times per week, for six weeks. Pain intensity, ROM, and risk of fall were assessed using the Visual Analogue Scale (VAS), goniometer, and Dynamic Gait Index (DGI), respectively. Data were analyzed using paired and independent t-tests after confirming normality with the Shapiro-Wilk test.

Results: Group B (CKCE) showed a reduction in VAS from 8.07 ± 1.35 to 2.50 ± 1.44 and an increase in DGI from 9.82 ± 2.13 to 21.45 ± 1.99. Hip ROM improved post-intervention: flexion 97.91 ± 9.12, extension 20.73 ± 3.39, abduction 33.36 ± 3.55, adduction 32.50 ± 3.39, internal rotation 31.82 ± 3.91, external rotation 33.36 ± 3.55. Group A (ME) had VAS reduced from 6.58 ± 1.70 to 4.19 ± 1.80 and DGI improved from 11.23 ± 1.90 to 19.23 ± 1.99. Post-treatment ROM for Group A included: flexion 86.27 ± 9.43, extension 14.50 ± 2.57, abduction 29.64 ± 5.05, adduction 29.45 ± 5.61, internal rotation 26.95 ± 4.85, and external rotation 29.68 ± 5.18.

Conclusion: While both interventions significantly improved outcomes, Closed Kinetic Chain Exercises were more effective in reducing pain, enhancing hip mobility, improving gait, and lowering fall risk in elderly females with post-operative neck of femur fractures.

Keywords: Exercise Therapy, Femoral Neck Fractures, Gait, Hip Joint, Pain Measurement, Postoperative Care, Range of Motion, Articular.

BACKGROUND

Neck of femur fracture is a common cause of disability and falls in older women.

AIM

Compare exercise effects in elderly females with neck of femur fracture

METHODS

Randomized controlled trial

Group A
Mobilization Exercises

Group B Exercises

Kinetic Exercises

Group B
Kinetic Exercises

9,82-> 21,45

9,82-> 19,23

Range of motion

CONCLUSION

Kinetic exercises were more effective

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INTRODUCTION

Neck of femur fractures are among the most prevalent types of hip fractures, particularly affecting the elderly population, with an estimated occurrence rate of approximately 50%. These fractures are a significant source of morbidity, disability, and mortality, especially in older females worldwide (1). The World Health Organization reports that nearly 1.6 million hip fractures occur globally each year, with the majority occurring in elderly women (2). In the United States alone, more than 300,000 elderly individuals are hospitalized annually due to hip fractures, as reported by the Centers for Disease Control and Prevention (CDC) (3). These injuries are not only associated with a heightened risk of death and long-term disability but also lead to a substantial decline in quality of life for affected individuals. Advancing age, particularly above 65 years, is a well-established risk factor for neck of femur fractures (4). A key contributor to this vulnerability is osteoporosis, characterized by low bone mineral density that renders bones fragile and more susceptible to fractures (5,6). The incidence of hip fractures increases markedly with age, with reported rates of 1.4 per 1,000 in females aged 65–69 years and 13.4 per 1,000 in those older than 85 years (7). Hormonal changes in postmenopausal women contribute further to the heightened risk, making females significantly more prone to fractures than males. Falls are the leading cause of neck of femur fractures among older females, with epidemiological evidence from a large cohort study involving over 10,000 participants indicating that 72% of those who sustained hip fractures were women (2).

Rehabilitation following such fractures is crucial in minimizing long-term complications and promoting functional recovery. Among various physiotherapeutic strategies, kinetic chain exercises (KCEs) have gained recognition for their role in enhancing coordinated joint movement and muscular function (8). Closed kinetic chain exercises (CKCE), where the distal limb is fixed and bears weight, have demonstrated effectiveness in improving balance, proprioception, and functional activities (9). These exercises also play a pivotal role in stimulating bone remodeling by promoting weight-bearing through the affected limb, thus reducing the risk of future fractures. Complementing CKCE, mobilization exercises are employed to restore joint mobility, alleviate stiffness, and relax surrounding musculature. These low-intensity, controlled movements can be passive, active, or self-directed, depending on the patient's condition and rehabilitation goals (10). Their primary objective is not muscle strengthening, but rather enhancing joint flexibility, reducing inflammation, and relieving pain and muscle tension (11). Given the debilitating consequences of neck of femur fractures and the pressing need for effective rehabilitation strategies, this study aims to evaluate the efficacy of kinetic chain and mobilization exercises in improving functional outcomes and quality of life in elderly females recovering from such fractures.

METHODS

This single-blinded randomized controlled trial (RCT) was conducted over a period of six months at Bajwa Hospital, Shadrah, following ethical approval from the institutional review board (IRB). The study aimed to compare the effects of mobilization exercises and closed kinetic chain exercises on functional outcomes in elderly females with post-operative neck of femur fractures. G*Power software version 3.1.9.7 was utilized to calculate the sample size, which determined a minimum of 44 participants; accounting for a 10% dropout rate, a total of 49 participants were initially estimated to be enrolled (12). A convenient sampling technique was employed to recruit the participants. Forty-four elderly female patients who met the eligibility criteria were randomly allocated into two groups: Group A received mobilization exercises (n = 22), while Group B received closed kinetic chain exercises (n = 22). Participants were included if they were aged 65 years or older (5), had a confirmed diagnosis of neck of femur fracture by an orthopedic surgeon supported by X-ray findings (13), and had undergone surgical treatment for the fracture within the past year (14). All participants were enrolled at least 12 weeks post-operatively (15), and X-rays were repeated before intervention to confirm the absence of residual fracture or dislocation (16). Additionally, participants were included if they were previously ambulatory (with or without crutches) before injury (6,7), had an undisplaced fracture according to the Garden Classification (8), and had been treated with internal fixation (9). Only female patients were considered for inclusion (3). The exclusion criteria were bilateral hip fractures (7), patients who were bedridden prior to the fracture (12), those with a history of lower limb surgeries (13), and individuals with any neurological conditions (14).

Informed consent was obtained from all participants prior to inclusion. The interventions were carried out over six weeks, with three supervised sessions per week, each lasting 40 minutes. Prior to each session, participants in both groups received a 5-minute warm-up using hot packs. An independent evaluator, blinded to group allocation, assessed outcomes approximately one minute after the warm-up. The primary outcome measures included pain intensity, hip range of motion (ROM), and risk of fall, which were assessed using the Visual Analogue Scale (VAS), goniometry, and the Dynamic Gait Index (DGI), respectively. Group A underwent mobilization exercises, which targeted improved joint mobility and pain relief. Techniques included anterior-posterior glides, caudal glides, and posterior-

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anterior glides performed with abduction, flexion, and lateral rotation. Each technique was administered in three sets of ten repetitions, with 30-second rest intervals between sets, and mobilization grades were adjusted based on the patient's tolerance level. In addition to mobilizations, patients performed strengthening exercises for the hip, including side-lying hip abduction, prone hip extension, sideway walking, and standing hip abduction—each executed in three sets of ten repetitions (15). Group B received closed kinetic chain exercises aimed at improving joint stability, proprioception, and weight-bearing function. Exercises included horizontal leg presses, stationary bicycling, and stair climbing, initiated with a 5-minute warm-up and followed by structured routines lasting the remainder of the 40-minute session (17,18). The same frequency and duration as Group A were maintained for consistency.

RESULTS

A total of 44 elderly female participants were enrolled in the study, with a mean age of 72.20 ± 5.696 years, mean weight of 90.14 ± 18.202 kg, mean height of 5.157 ± 0.5986 feet, and mean BMI of 37.698 ± 9.59. Normality of data was confirmed using the Shapiro-Wilk test, allowing for the application of parametric tests. Paired sample t-tests were used for within-group analysis and independent t-tests for between-group comparisons. Within Group B (Closed Kinetic Chain Exercises), the mean Visual Analogue Scale (VAS) score decreased significantly from 8.07 ± 1.35 to 2.50 ± 1.44 post-intervention. The Dynamic Gait Index (DGI) improved from 9.82 ± 2.13 to 21.45 ± 1.99. Post-treatment range of motion (ROM) outcomes included hip flexion at 97.91 ± 9.12, extension at 20.73 ± 3.39, abduction at 33.36 ± 3.55, adduction at 32.50 ± 3.39, internal rotation (IR) at 31.82 ± 3.91, and external rotation (ER) at 33.36 ± 3.55. In Group A (Mobilization Exercises), the VAS score decreased from 6.58 ± 1.70 to 4.19 ± 1.80, while the DGI improved from 11.23 ± 1.90 to 19.23 ± 1.99. Post-intervention hip ROM values included flexion at 86.27 ± 9.43, extension at 14.50 ± 2.57, abduction at 29.64 ± 5.05, adduction at 29.45 ± 5.61, IR at 26.95 ± 4.85, and ER at 29.68 ± 5.18. Between-group comparisons revealed statistically significant differences favoring Group B in most outcome measures. The post-treatment VAS showed a greater reduction in Group B (mean difference = 1.689, p = .001), while post-treatment DGI scores were significantly higher in Group B (mean difference = -2.227, p = .001). Hip ROM comparisons post-treatment also demonstrated significant superiority of Group B across flexion (mean difference = -11.636, p = .000), extension (-6.227, p = .000), abduction (-3.727, p = .007), adduction (-3.045, p = .026), IR (-4.864, p = .001), and ER (-3.682, p = .009).

Table 1: Independent T test Results comparable pre and post values of Both Groups

	GROUPS	Mean	Std. Deviation	Mean Difference	P-Value
PRE_VAS	A	6.58	1.703	-1.483	.003
	B	8.07	1.358		
POST_VAS	A	4.19	1.813	1.689	.001
	B	2.50	1.445		
PRE_DGI	A	11.23	1.901	1.409	.026
	B	9.82	2.130		
POST_DGI	A	19.23	1.998	-2.227	.001
	B	21.45	1.993		
PRE_HIP_FLEXION	A	65.64	7.901	7.227	.002
	B	58.41	6.284		
POST_HIP_FLEXION	A	86.27	9.432	-11.636	.000
	B	97.91	9.123		
PRE_HIP_EXTENSION	A	9.59	2.153	1.892	.002
	B	7.70	1.568		
POST_HIP_EXTENSION	A	14.50	2.577	-6.227	.000
	B	20.73	3.397		
PRE_HIP_ABDUCTION	A	11.32	1.887	1.500	.018
	B	9.82	2.130		
POST_HIP_ABDUCTION	A	29.64	5.057	-3.727	.007
	B	33.36	3.553		

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	GROUPS	Mean	Std. Deviation	Mean Difference	P-Value
PRE_HIP_ADDCTION	A	11.18	1.943	1.364	.032
	B	9.82	2.130		
POST_HIP_ADDCUTION	A	29.45	5.161	-3.045	.026
	B	32.50	3.391		
PRE_HIP_IR	A	10.73	1.667	1.636	.001
	B	9.09	1.306		
POST_HIP_IR	A	26.95	4.855	-4.864	.001
	B	31.82	3.911		
PRE_HIP_ER	A	11.59	1.532	1.364	.030
	B	10.23	2.409		
POST_HIP_ER	A	29.68	5.186	-3.682	.009
	B	33.36	3.553		

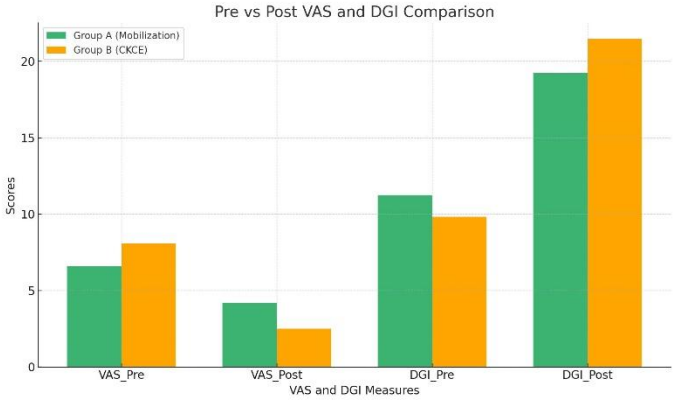

Figure 1 Pre vs Post VAS and DGI Comparison

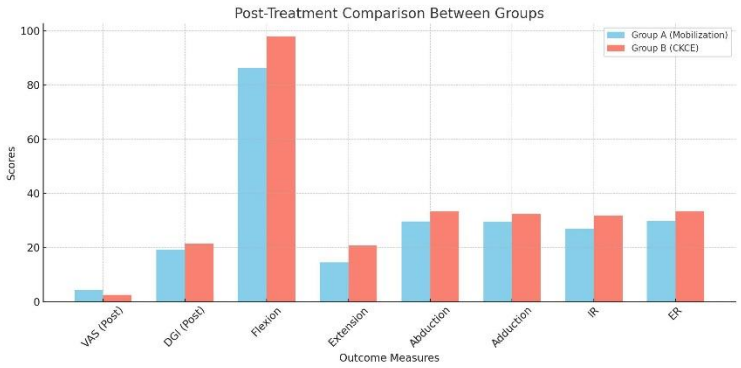

Figure 2 Post-Treatment Comparison Between Groups

DISCUSSION

The findings of the present study demonstrated that closed kinetic chain exercises (CKCE) yielded significantly greater improvements in pain reduction, functional mobility, and hip joint range of motion compared to mobilization exercises in elderly females recovering from neck of femur fractures. The post-intervention values of Visual Analogue Scale (VAS), Dynamic Gait Index (DGI), and range of motion (ROM) parameters favored the CKCE group, highlighting the efficacy of weight-bearing, multi-joint exercises in restoring functional outcomes in the geriatric population. The CKCE group exhibited marked reductions in pain intensity and enhancements in gait stability, risk of fall, and joint mobility, with statistically significant differences compared to the mobilization group. These outcomes are in alignment with previous controlled trials and experimental studies conducted in similar populations, where CKCE interventions were found to significantly improve postural control, muscle strength, and dynamic balance in elderly individuals with hip pathologies or general musculoskeletal deconditioning (19-21). Furthermore, the results correspond with prior literature indicating that CKCE promotes neuromuscular control, stimulates proprioceptive feedback, and enhances muscle co-contraction, thereby contributing to improved joint stability and gait performance (16,22). Studies examining rehabilitation protocols for post-operative femur fractures have also underscored the benefit of early, structured kinetic chain training in accelerating recovery and regaining independence in activities of daily living (23).

Despite the favorable outcomes, the study has certain limitations. The sample size, although statistically justified, remained limited, potentially affecting the generalizability of the findings. The exclusive inclusion of female participants over the age of 65 may limit the applicability of results to a broader population, including males and younger age groups. Additionally, the use of convenience sampling could have introduced selection bias, reducing the internal validity of the study. Follow-up beyond the 6-week intervention period was

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not included, thus long-term sustainability of the observed benefits remains undetermined. Furthermore, muscle strength and postural sway—two crucial determinants of fall risk—were not directly assessed, despite being relevant to the study objectives. Nonetheless, the study holds notable strengths. It was conducted using a randomized controlled design with clearly defined inclusion and exclusion criteria, validated assessment tools (VAS, DGI, goniometry), and blinded outcome assessment, ensuring methodological rigor. The intervention protocols were structured, clinically feasible, and based on established physiotherapeutic principles. Moreover, by comparing two distinct exercise modalities, the study contributes to the growing evidence base guiding post-operative rehabilitation for hip fractures in the elderly. Future research should explore the combined effects of CKCE and mobilization techniques to determine whether a multimodal approach may provide synergistic benefits (24-26). Larger, multicentric trials with longer follow-up durations and broader population samples would enhance external validity and establish clearer guidelines for clinical practice. Investigating additional outcome parameters such as muscular strength, balance testing, and quality-of-life indices would also provide a more comprehensive understanding of functional recovery. Overall, the current study supports the clinical utility of closed kinetic chain exercises in optimizing rehabilitation outcomes in elderly females with neck of femur fractures.

CONCLUSION

This study concluded that while both mobilization exercises and closed kinetic chain exercises positively influenced pain reduction, functional mobility, risk of fall, and hip joint range of motion in elderly females with neck of femur fractures, closed kinetic chain exercises demonstrated superior efficacy. The structured, weight-bearing nature of CKCE more effectively enhanced functional outcomes, particularly in restoring gait stability and reducing pain intensity. These findings emphasize the value of incorporating closed kinetic chain exercises into post-operative rehabilitation programs for elderly patients, offering a more impactful approach to improving recovery and overall quality of life following femoral neck fractures.

AUTHOR CONTRIBUTION

Author	Contribution
Fatima Liaquat*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Gulnaz Zaheer	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Sara Afzal	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Khansa Muqadas	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Fatima Razzaq	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Rimsha Arshad	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Momina Akram	Contributed to study concept and Data collection Has given Final Approval of the version to be published
Kiran Samdani	Writing - Review & Editing, Assistance with Data Curation

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