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Case Report: Combined Chain Exercises for Functional Recovery After Total Hip Replacement

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Abstract

Introduction: The hip joint is a major weight-bearing joint that is vulnerable to degeneration and injury. Severe hip pathology may cause pain, restricted mobility, and limitations in daily activities. Total Hip Replacement (THR) aims to relieve pain and restore function; however, postoperative pain, muscle spasm, limited range of motion (ROM), and muscle weakness may delay recovery. Combined open kinetic chain (OKC) and closed kinetic chain (CKC) exercises may enhance functional outcomes during post-THR rehabilitation.

Objective: This case report aimed to evaluate the effectiveness of combined OKC and CKC exercises in reducing pain and improving ROM, muscle strength, and functional ability following THR.

Methods: A post-THR patient underwent a physiotherapy program consisting of combined OKC and CKC exercises for six treatment sessions. Outcome measures included pain intensity using the Numeric Rating Scale (NRS), ROM, muscle strength assessed by Manual Muscle Testing (MMT), and functional ability evaluated using the Harris Hip Score (HHS) and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC).

Results: After six sessions, pain decreased from 5/10 to 2/10 on palpation and from 7/10 to 3/10 during movement. Improvements were observed in hip flexion, adduction, and endorotation ROM. Muscle strength of the hip and knee increased. Functional outcomes improved, with HHS increasing from 43.9% to 70.75% and WOMAC decreasing from 44.7% to 23.95%.

Conclusion: Combined OKC and CKC exercises were effective in reducing pain, improving ROM, enhancing muscle strength, and restoring functional ability in a post-THR patient. This approach may serve as an adjunct to standard postoperative rehabilitation.

Keywords
Arthroplasty, Replacement, Hip; Rehabilitation; Exercise Therapy; Resistance Training; Weight-Bearing

Introduction

The hip joint is a key structure of the musculoskeletal system and plays a vital role in daily functional activities such as standing, walking, sitting, and transferring positions.[1] As a major weight-bearing joint, it is highly susceptible to degeneration, trauma, and other pathological conditions. One of the most common disorders is femoral neck fracture, which frequently occurs in older adults with osteoporosis and in younger adults as a result of direct trauma, including traffic accidents or falls from height.[2]

When conservative treatment is no longer sufficient, surgical intervention in the form of Total Hip Replacement (THR) becomes the treatment of choice. This procedure aims to restore joint function, reduce pain, and improve patients' quality of life.[3] Although THR has demonstrated favorable long-term outcomes, patients often experience persistent postoperative problems such as residual pain, muscle spasm, decreased muscle strength and flexibility, limited range of motion (ROM), and difficulties in performing functional activities.[4]

Physiotherapy plays a pivotal role in optimizing recovery during the postoperative rehabilitation phase. One promising approach is the combination of open kinetic chain (OKC) exercises (e.g., supine hip range of motion, leg extension, clamshell exercise, ankle pumps, toe raises, standing hip extension) and closed kinetic chain (CKC) exercises (e.g., bridging, mini squats, sit-to-stand, gait retraining). OKC exercises emphasize movement of the distal segment without simultaneous motion at proximal joints, while CKC exercises involve coordinated movement across multiple joints to enhance joint stabilization and functional muscle strength. The combination of OKC and CKC exercises is believed to be more effective in improving muscle performance, joint stability, and mobility compared with the application of a single exercise approach.[5]

Several studies support the effectiveness of combined chain exercises in post-THR rehabilitation. Koyuncu and Yurdalan demonstrated that the integration of OKC and CKC exercises significantly improved muscle strength and functional capacity in post-THR patients.[6] Similarly, Colibazzi et al. reported that exercise programs incorporating stabilization, strengthening, and mobilization enhanced gait function and accelerated recovery following hip arthroplasty.[7]

Although the prevalence of post-THR cases in Indonesia remains relatively low, the cases that do occur require comprehensive rehabilitative management. Data from ABR Physiotherapy Bojonegoro reported only one case of post-THR between January and February 2025. Nevertheless, the patient's condition highlighted the need for structured and targeted interventions. This case report is therefore important to evaluate the effectiveness of combined chain exercises in improving functional ability following THR. Based on this background, the present study aims to investigate the benefits of physiotherapy management using combined chain exercises to enhance functional ability in a post-THR patient at ABR Physiotherapy Bojonegoro and to contribute to the scientific literature that may serve as a clinical reference for physiotherapy practice in Indonesia.

The patient in this report was a 72-year-old female with a history of osteoporosis who underwent THR following a right femoral neck fracture. Prior to physiotherapy intervention, the patient reported movement-related pain with an intensity of 7/10,

restricted ROM in the hip and knee, and lower-limb muscle weakness that interfered with activities such as walking and stair climbing. The patient had not previously received postoperative physiotherapy, resulting in suboptimal joint function and muscle strength. A case study design was employed, applying a combination of OKC and CKC exercises over six sessions within four weeks to evaluate changes in pain, ROM, muscle strength, and functional ability.

Methods

This study employed a case study design to evaluate in detail the effects of a structured physiotherapy intervention on a single post-THR patient over a defined period. The intervention was conducted between January and February 2025 at ABR Physiotherapy Bojonegoro in a 72-year-old female patient who underwent Total Hip Replacement (THR) due to a right femoral neck fracture with a history of osteoporosis.

Clinical assessment included anamnesis, observation, and measurement of pain intensity using the Numeric Rating Scale (NRS), range of motion (ROM) assessment with a standard goniometer in accordance with the protocol of the American Academy of Orthopaedic Surgeons (AAOS), muscle strength assessment using Manual Muscle Testing (MMT) according to Kendall's method, and functional evaluation using the Harris Hip Score (HHS) and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC).

Baseline findings were as follows: movement-related pain NRS 7/10, palpation pain NRS 5/10, and resting pain NRS 0/10. Hip ROM: flexion 60°, adduction 5°, endorotation 10°; knee ROM: flexion 90°. MMT results: hip flexors 3-, hip extensors 0, knee extensors 3+. Functional scores: HHS 43.90% (severe category) and WOMAC 44.7% (moderate category).

Based on the initial condition, the patient's prognosis was considered favorable, with potential for significant functional recovery if provided with a structured rehabilitation program. The primary challenges included high movement-related pain, limited ROM, muscle weakness, and the risk of reduced motivation due to restrictions in daily activity.

To provide a clearer overview of the structured intervention process and the patient's progression throughout the sessions, a detailed timeline of the therapeutic program is presented. This timeline outlines the sequence of activities, the progression of training intensity, and the corresponding focus at each stage of therapy.

Table 1. Case Timeline of Intervention Sessions and Training Progression

Week / Session	Main Activities	Training Progression
Week 1 – Session 1	Baseline evaluation; light OKC; minimal-load CKC	Focus on basic muscle activation and movement control
Week 1 – Session 2	Low-intensity OKC and CKC	Increased repetitions without resistance
Week 2 – Session 3	Increased exercise intensity	Theraband resistance added to OKC
Week 2 – Session 4	More demanding CKC (deeper mini squats)	Longer walking distance with walker
Week 3 – Session 5	Full OKC–CKC combination	Greater resistance and additional movement variations
Week 4 – Session 6	Final evaluation	Functional training simulating daily activities

The exercise protocol was structured into three main components. Each session began with a warm-up consisting of light joint mobilization and dynamic stretching for approximately 5–10 minutes. This was followed by the core exercise phase, which involved a progressive combination of Open Kinetic Chain (OKC) and Closed Kinetic Chain (CKC) exercises. The session concluded with a cool-down, including targeted muscle stretching and a brief evaluation of the patient's condition. The overall program was conducted over a period of four weeks, comprising six therapy sessions, each lasting between 45 and 60 minutes. The OKC exercises included supine hip flexion, leg extension, clamshell exercise, ankle pumps, toe raises, and standing hip extension. Meanwhile, the CKC exercises consisted of bridging, mini squats, sit-to-stand practice, and gait retraining.

Each exercise was performed for 2–4 sets of 15–20 repetitions, with a one-minute rest between sets. Intensity and movement variation were progressively increased every two sessions, including resistance addition for leg extension, increased squat depth, and reduced dependence on walking aids.

Results

This study was conducted in January 2025 on a 72-year-old female patient who underwent Total Hip Replacement (THR) following a right femoral neck fracture. The intervention consisted of a combination of open kinetic chain (supine hip range of motion, leg extension, clamshell exercise, ankle pumps, toe raises, standing hip extension) and close kinetic chain (bridging, mini squat, sit-to-stand, gait re-training) exercises, delivered over six therapy sessions. Evaluation was conducted both pre- and post-therapy and encompassed several key outcome measures, including pain intensity, range of motion (ROM), muscle strength, and functional ability, assessed using the Harris Hip Score (HHS) and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)**.** Examples of the chain exercises prescribed are shown in Figures 1–4, which exhibit the Open Kinetic Chain (OKC) and Closed Kinetic Chain (CKC) movements used in the intervention.

Figure 1. Supine Hip ROM

Figure 2. Clamshell Exercise

Figure 3. Bridging

Figure 4. Mini-Squat**.**

All exercises were performed in 2–4 sets of 15–20 repetitions, with 1-minute rest intervals between sets, tailored to the patient's tolerance. Table 1 presents the evaluation of pain intensity using the Numerical Rating Scale (NRS), measured both at rest and during movement to capture changes in the patient's perceived pain levels.

Table 1. Pain Assessment Using NRS

NRS	Session 1	Session 2	Session 3	Session 4	Session 5	Session 6
Rest pain	0/10	0/10	0/10	0/10	0/10	0/10
Palpation pain	5/10	5/10	4/10	3/10	2/10	2/10
Movement pain	7/10	7/10	6/10	5/10	4/10	3/10

Pain evaluation demonstrated a reduction in palpation pain from 5/10 at baseline to 2/10 in session 6, and in movement pain from 7/10 to 3/10, as measured by the NRS. Table 2 describes the assessment of hip joint range of motion (ROM), highlighting improvements across various directions of movement.

Table 2. Range of Motion (ROM) Evaluation

Region	Movement	S1	S2	S3	S4	S5	S6
Hip	Extension/Flexion	15°–0°–60°	15°–0°–60°	15°–0°–70°	15°–0°–75°	15°–0°–85°	15°–0°–85°
	Abduction/Adduction	45°–0°–5°	45°–0°–5°	45°–0°–10°	45°–0°–10°	45°–0°–10°	45°–0°–10°
	External/Internal Rot	45°–0°–10°	45°–0°–10°	45°–0°–15°	45°–0°–20°	45°–0°–25°	45°–0°–25°
Knee	Extension/Flexion	5°–0°–90°	5°–0°–100°	5°–0°–105°	5°–0°–110°	5°–0°–110°	5°–0°–120°

ROM evaluation revealed notable improvements, particularly in hip flexion (60° to 85°) and knee flexion (90° to 120°), alongside gains in adduction and internal rotation. These results suggest that progressive chain exercises enhanced soft tissue elasticity and joint mobility in the post-THR patient. Table 3 shows the results of muscle strength testing using Manual Muscle Testing (MMT), reflecting changes in the strength of key lower limb muscle groups.

Table 3. Muscle Strength Evaluation (MMT)

Region	Movement	S1	S2	S3	S4	S5	S6
Hip	Flexors	3-	3-	3+	3+	3+	3+
	Extensors	0	2-	3-	3-	3+	3+
	Abductors	4	4	4	5+	5+	5+
	Adductors	3-	3-	3+	3+	3+	3+
	External Rot	4	4	4	4	5+	5+
	Internal Rot	3-	3-	3	3	3	3
Knee	Flexors	3+	3+	4	4	4	5+
	Extensors	3+	3+	4	4	5+	5+

Muscle strength improved across most hip and knee groups. For example, hip flexors increased from MMT 3- to 3+, and hip extensors improved from 0 to 3+. These outcomes reflect the effectiveness of active and resisted exercises in promoting neuromuscular activation. Table 4 presents the functional outcomes based on the Harris Hip Score (HHS), which evaluates pain, function, deformity, and range of motion of the hip joint.

Table 4. Harris Hip Score (HHS)

Parameter	Pre-Test (%)	Post-Test (%)	Pre-Test Category	Post-Test Category
HHS Subscale	43.90	70.75	Severe	Moderate

HHS improved from 43.90% to 70.75%, indicating a transition from severe to moderate functional limitation. Table 5 outlines the results of the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), focusing on pain, stiffness, and functional limitations associated with hip osteoarthritis.

Table 5. WOMAC

Parameter	Pre-Test (%)	Post-Test (%)	Pre-Test Category	Post-Test Category
WOMAC Subscale	44.7	23.95	Moderate	Mild

WOMAC decreased from 44.7% to 23.95%, reflecting reductions in pain and functional limitations, alongside improvements in quality of life. Table 6 provides a comprehensive summary of the overall intervention outcomes, integrating pain, mobility, muscle strength, and functional scores to illustrate the therapeutic effects.

Table 6. Summary of Intervention Outcomes

Parameter	Result	Description
Pain	Decreased	Palpation pain reduced from 5 to 2; movement pain reduced from 7 to 3.
Range of Motion	Improved	Hip flexion increased from 60° to 85°; adduction and internal rotation improved.
Muscle Strength	Improved	Significant gains in most hip and knee muscle groups (MMT).
Functional Activities	Improved	HHS improved from 43.90% to 70.75%; WOMAC decreased from 44.7% to 23.95%.

One month after program completion, follow-up evaluation demonstrated stable outcomes: palpation pain remained at 2/10, movement pain at 3/10, hip flexion at 85°, hip flexor strength at 3+, hip extensor strength at 3+, HHS at 71.20%, and WOMAC at 23.50%. These findings indicate that therapeutic benefits persisted for at least one month post-intervention.

The patient adhered to all six scheduled therapy sessions and consistently performed prescribed home exercises. No adverse events or complications were reported during the intervention period, and all exercises were performed safely within the patient's tolerance.

Discussion

Based on Table 1, the application of combined chain exercises proved effective in significantly reducing pain levels. This was demonstrated by a decrease in palpation pain on the Numeric Rating Scale (NRS) from 5 to 2 and in movement pain from 7 to 3. These reductions indicate the effectiveness of chain exercises in minimizing nociceptive stimulation caused by muscle tension and local inflammation. The structured implementation of both open kinetic chain (OKC) and closed kinetic chain (CKC) exercises contributed to pain relief through increased blood circulation and the release of endorphins during activity. Kim et al. reported that a six-week program of OKC and CKC exercises, performed three times per week, was effective in reducing pain and improving joint

function in post-Total Hip Replacement (THR) patients. Their findings also highlighted that CKC exercises produced greater pain reduction on the Visual Analogue Scale (VAS) and enhanced joint stability and comfort during functional activities such as walking and sitting.[8]

As shown in Table 2, the assessment of range of motion (ROM) revealed notable improvements across nearly all hip and knee movements. For instance, hip flexion increased from 60° to 85°, while knee flexion improved from 90° to 120°. These gains demonstrate that active interventions using chain exercises can enhance muscle flexibility and soft tissue elasticity around the joint, thereby supporting functional recovery. Sharma and Kaur observed that CKC exercises provided greater improvements in hip ROM—particularly in flexion and abduction—as well as in overall stability and neuromuscular control among post-THR patients undergoing a six-week rehabilitation program with both OKC and CKC exercises performed three times weekly.[9]

Based on Table 3, Manual Muscle Testing (MMT) results indicated significant improvements in muscle strength, particularly in the hip and knee muscles of the right lower limb. The combination of OKC and CKC exercises facilitated optimal recruitment of muscle fibers in both segmental and functional movements. Increased muscle strength was also closely associated with improved stability and load-bearing capacity during standing and walking. Kim et al. compared OKC and CKC exercises separately in post-THR patients and found that while both modalities enhanced muscle strength, the CKC group exhibited greater improvements in pelvic stability and functional abilities, such as walking and sit-to-stand performance—key outcomes in the rehabilitation phase following THR.[10]

As demonstrated in Tables 4 and 5, the Harris Hip Score (HHS) increased from 43.90% to 70.75%, indicating an improvement in functional status from severe dependence to moderate limitation. Meanwhile, the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) decreased from 44.7% to 23.95%, reflecting reduced disability and enhanced daily functioning. These findings underscore the effectiveness of physiotherapy interventions in improving functional capacity, mobility, and quality of life after THR. Nambi et al. reported similar results in a randomized clinical trial, showing that although both OKC and CKC exercises improved functional outcomes, CKC exercises provided superior benefits in balance, mobility, and neuromuscular control among post-THR patients.[11]

Several limitations must be acknowledged in this study. First, the sample size was limited to a single patient, restricting the generalizability of the findings. Second, the intervention period was relatively short (four weeks, six sessions), leaving the long-term sustainability of the outcomes uncertain. Third, the absence of a control group limited the ability to compare the effectiveness of this intervention against other therapeutic modalities. Finally, potential measurement bias may have occurred since all assessments were conducted by the same therapist. Future research with comparative designs, larger sample sizes, and longer intervention durations is recommended to strengthen the evidence base.

From a practical perspective, these findings provide valuable guidance for physiotherapists in designing rehabilitation programs for post-THR patients. Integrating OKC and CKC exercises progressively not only enhances physical recovery but may also improve patient motivation through pain reduction, ultimately contributing to better quality of life. In Indonesia, these results could serve as a foundation for developing more standardized and evidence-based rehabilitation protocols for post-THR care.

Overall, the combination of OKC and CKC exercises is effective in reducing pain, improving muscle strength, enhancing joint ROM, and restoring functional abilities in post-THR patients. This method can be recommended as a safe, practical, and clinically relevant rehabilitation intervention, particularly in the Indonesian context.

Conclusion

This case report presents the physiotherapy management of a patient following Total Hip Replacement (THR) due to femoral neck fracture, using a combination of open kinetic chain (OKC) and closed kinetic chain (CKC) exercises over six sessions within four weeks at ABR Physiotherapy, Bojonegoro.

The evaluation demonstrated significant reductions in pain, improvements in range of motion (ROM), increased muscle strength, and enhanced functional capacity. These outcomes were reflected in an improvement of the Harris Hip Score (HHS) from 43.90% to 70.75% and a reduction in the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) from 44.7% to 23.95%. Collectively, these results indicate that the patient progressed from a state of severe dependency to moderate dependency in functional status.

The findings reinforce that the combination of OKC and CKC exercises is effective in post-THR rehabilitation—reducing pain, increasing muscle strength and joint ROM, and restoring functional daily activities. Physiotherapists are encouraged to adopt this approach as a safe, practical, and evidence-based functional exercise option for patients recovering from hip replacement surgery.

Nevertheless, these results are derived from a single case study and therefore cannot be generalized. Further research with larger sample sizes and comparative study designs is necessary to strengthen the evidence regarding its effectiveness. From a practical standpoint, this method has the potential to be incorporated into standardized post-THR rehabilitation protocols in Indonesia, assisting physiotherapists in developing structured programs that focus on functional recovery.

Author Contribution

Rizanah Agustina contributed to patient assessment, intervention implementation, data collection, and manuscript drafting.
Yeni Tri Nur Hayati contributed to study conceptualization, supervision, methodological review, and critical revision of the manuscript.
Dimas Arya Nugraha contributed to data analysis, interpretation of results, and manuscript editing.
All authors read and approved the final manuscript.

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Conflict of Interest Statement

The authors declare that there is no conflict of interest related to this study.

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Ethics Statement

Ethical approval was obtained in accordance with institutional regulations at ABR Physiotherapy Bojonegoro. Written informed consent was obtained from the patient prior to participation in this study.

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