JHWCR JOURNAL OF HEALTH, WELLNESS AND COMMUNITY RESEARCH 3007-0570

https://doi.org/10.61919/58645150

Original Article

Effectiveness of Mobilization with Movement Versus Proprioceptive Neuromuscular Facilitation Hold-Relax Technique on Pain and Functional Mobility in Patients with Chronic Knee Osteoarthritis: A Randomized Controlled Trial

Aafeen Maham[1], Hamid Ali[2], Mohammad Jawad Khan[3], Iqrash Fatima[1], Saira Muzaffar Shah[4], Soom Khalil[5]

[1] Physiotherapist, Rawalpindi Medical University, Rawalpindi, Pakistan
[2] Physiotherapist, MTI Hayatabad Medical Complex, Hayatabad, Peshawar, KP, Pakistan
[3] Khyber Medical University, Peshawar, KP, Pakistan
[4] Lecturer, Shaheed Zulfiqar Ali Bhutto Medical College, Islamabad, Pakistan
[5] Physiotherapist, Mufti Mehmood Memorial Teaching Hospital, MTI, Dera Ismail Khan, KP, Pakistan

***Corresponding author: Aafeen Maham, aafeen.maham.2@gmail.com**

"Cite this Article" Received: 23 February 2026; **Accepted**: 14 April 2026; **Published**: 29 April 2026

Author Contributions: Concept: AM; Design: HA and MJK; Data Collection: AM and IF; Analysis: SMS; Drafting: SK and AM **Ethical Approval**: Margalla Institute of Health Sciences, Rawalpindi, Pakistan. **Informed Consent**: Written informed consent was obtained from all participants; **Conflict of Interest**: The authors declare no conflict of interest. **Funding**: No external funding; **Data Availability**: Available from the corresponding author on reasonable request; **Acknowledgments**: N/A.

ABSTRACT

Background: Knee osteoarthritis is a common degenerative musculoskeletal disorder associated with pain, stiffness, reduced mobility, and functional limitation. Manual therapy and neuromuscular facilitation techniques are frequently used in conservative rehabilitation, but direct comparative evidence between Mobilization with Movement and Proprioceptive Neuromuscular Facilitation Hold-Relax remains limited. Objective: To compare the short-term effectiveness of Mobilization with Movement and Proprioceptive Neuromuscular Facilitation Hold-Relax on pain, stiffness, physical function, and total WOMAC score in patients with chronic knee osteoarthritis. Methods: This randomized controlled trial was conducted at Khan Rehab Centre, Haleema Siraj Hospital, Rawalpindi, from 1 August 2021 to 31 January 2022. Thirty patients aged 40–60 years with chronic knee osteoarthritis were recruited through convenience sampling and randomized into two groups. Group A received Mobilization with Movement with conventional exercises, while Group B received PNF Hold-Relax with the same conventional program. Outcomes were assessed using WOMAC at baseline and after two weeks. Results: Group A showed reductions in pain, stiffness, physical function, and total WOMAC scores of 66.0%, 60.8%, 52.2%, and 55.0%, respectively, while Group B showed reductions of 56.0%, 53.5%, 50.1%, and 51.4%. Pain differed significantly between groups post-intervention, favouring Group A, while stiffness, physical function, and total WOMAC were comparable. Conclusion: Both interventions improved WOMAC outcomes, but Mobilization with Movement showed a greater short-term pain reduction. Keywords: Knee osteoarthritis; Mobilization with Movement; Proprioceptive Neuromuscular Facilitation; Hold-Relax; WOMAC; Physical therapy.

INTRODUCTION

Osteoarthritis is a multifactorial degenerative joint disorder characterized by progressive structural and functional deterioration of synovial joints, resulting from the interaction of mechanical overload, biochemical changes, metabolic dysfunction, previous injury, and age-related tissue degeneration (1). Knee osteoarthritis is particularly important because the knee is a major weight-bearing joint, and progressive cartilage loss, subchondral bone involvement, synovial inflammation, osteophyte formation,

pain, stiffness, and reduced functional capacity collectively contribute to disability and impaired quality of life (2,3). The burden is substantial globally and locally, with knee osteoarthritis affecting a large proportion of older adults and reported as a common cause of functional limitation in both urban and rural populations of Pakistan (3,4).

Clinical diagnosis is usually based on characteristic symptoms such as activity-related knee pain, stiffness, crepitus, swelling, difficulty rising from a chair, kneeling, stair climbing, and reduced mobility, supported where required by radiographic evidence such as joint-space narrowing and osteophyte formation (5,6). Physical examination findings, including joint tenderness, crepitus, effusion, quadriceps weakness, altered gait, reduced range of motion, and functional limitation, further assist in clinical assessment and treatment planning (7). Because knee osteoarthritis is chronic and progressive, conservative management remains central to symptom control, functional preservation, and delay of disability, with physiotherapy-based interventions forming a key component of non-surgical care (6).

Mobilization with Movement is a manual therapy technique that combines therapist-applied accessory glide with active physiological movement, aiming to reduce pain, correct positional faults, improve joint mechanics, and enhance functional mobility in patients with knee osteoarthritis (8). Proprioceptive Neuromuscular Facilitation Hold-Relax is another therapeutic approach commonly used to reduce muscle tightness, improve flexibility, modulate pain, and support functional movement, particularly where hamstring tightness and periarticular soft-tissue restriction contribute to knee dysfunction (10,12). Previous studies have reported beneficial effects of Mobilization with Movement, Maitland mobilization, muscle energy techniques, and PNF-based stretching on pain, range of motion, and functional outcomes in knee osteoarthritis and related musculoskeletal conditions (10–12). However, direct comparative evidence between Mobilization with Movement and PNF Hold-Relax for short-term improvement in WOMAC pain, stiffness, physical function, and total WOMAC score in chronic knee osteoarthritis remains limited.

On the basis of this gap, the present study was designed using a PICO framework in which patients with chronic knee osteoarthritis represented the target population, Mobilization with Movement was compared with Proprioceptive Neuromuscular Facilitation Hold-Relax, and outcomes were assessed through changes in WOMAC pain, stiffness, physical function, and total score after two weeks of intervention. The objective of this study was to compare the effectiveness of Mobilization with Movement and Proprioceptive Neuromuscular Facilitation Hold-Relax technique in reducing pain, decreasing stiffness, and improving functional mobility among patients with chronic knee osteoarthritis.

MATERIALS AND METHODS

This randomized controlled trial was conducted in the Physiotherapy Department of Khan Rehab Centre, Haleema Siraj Hospital, Rawalpindi, over six months from 1 August 2021 to 31 January 2022. Participants were recruited through non-probability convenience sampling and were subsequently randomized into two intervention groups using the sealed-envelope method. A total of 30 patients fulfilling the eligibility criteria were included, with 15 participants allocated to Group A and 15 participants allocated to Group B. The sample size was calculated using the OpenEpi calculator at a 5% level of significance and 95% confidence interval.

Patients aged 40–60 years of either gender with diagnosed knee osteoarthritis and knee pain for at least three months were eligible for inclusion. Patients were excluded if they had a history of knee trauma such as ligamentous injury or fracture, previous knee surgery, or prior intra-articular steroid injection. Participants who met the eligibility criteria and provided consent underwent baseline assessment before group allocation and intervention delivery.

The primary outcomes were pain, stiffness, physical function, and total functional disability as measured by the Western Ontario and McMaster Universities Osteoarthritis Index. Baseline WOMAC assessment

was performed before treatment, and post-intervention assessment was completed after two weeks of intervention. Group A received Mobilization with Movement applied to the tibiofemoral joint along with conventional exercises, including vastus medialis oblique strengthening and quadriceps isometrics. Group B received the Proprioceptive Neuromuscular Facilitation Hold-Relax stretching technique for the hamstrings along with the same conventional osteoarthritis exercise program. Both groups received treatment on alternate days for two weeks, with each session consisting of three sets of 10 repetitions.

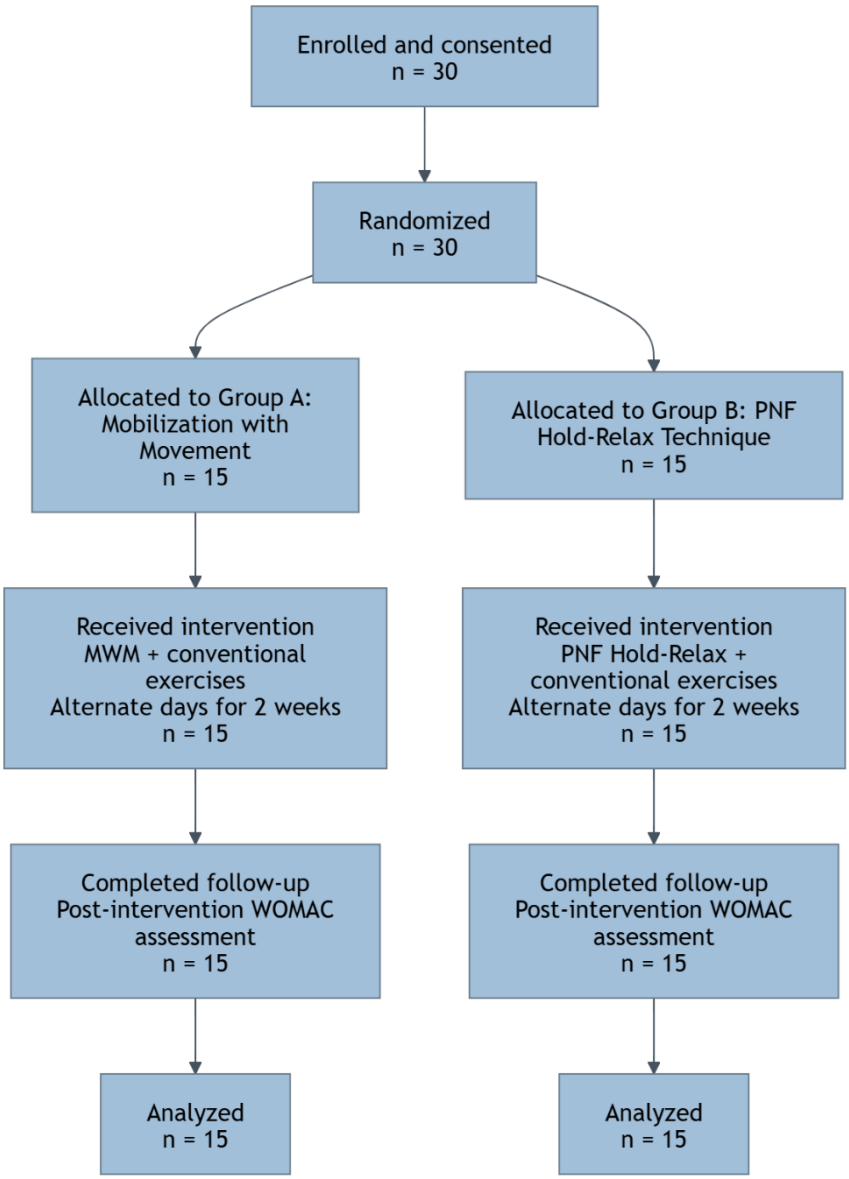

Figure 1 CONSORT Flowchart

Data were entered in Microsoft Excel and analyzed using SPSS version 21. Continuous variables were summarized as mean and standard deviation, while categorical variables were summarized as frequency and percentage. Within-group pre- and post-intervention changes were analyzed using paired-samples t-tests, and between-group comparisons were performed using independent-samples t-tests. Statistical significance was set at $p \leq 0.05$. The intervention protocol, outcome timing, eligibility criteria, group allocation procedure, and statistical tests were defined before analysis to improve reproducibility and maintain consistency between data collection and reporting. Written consent was obtained from participants before enrollment, and participant information was handled confidentially throughout the study.

RESULTS

A total of 30 patients with chronic knee osteoarthritis were included, with 15 participants allocated to Group A receiving Mobilization with Movement and 15 participants allocated to Group B receiving Proprioceptive Neuromuscular Facilitation Hold-Relax. The overall mean age was 49.10±2.97 years, and the sample included 6 males (20.0%) and 24 females (80.0%). Both groups demonstrated clinically meaningful reductions in WOMAC pain, stiffness, physical function limitation, and total WOMAC score after two weeks of intervention. The between-group comparison showed a statistically significant post-intervention difference for pain favouring Group A, while stiffness, physical function, and total WOMAC scores did not differ significantly between groups.

Table 1. Pre- and Post-Intervention WOMAC Scores in Group A and Group B

Outcome	Group	Pre-Intervention Mean±SD	Post-Intervention Mean±SD	Mean Reduction	% Reduction
Pain	Group A: MWM	15.87±3.98	5.40±1.92	10.47	66.0%
Pain	Group B: PNF-HR	16.20±1.97	7.13±1.41	9.07	56.0%
Stiffness	Group A: MWM	6.13±2.20	2.40±1.06	3.73	60.8%
Stiffness	Group B: PNF-HR	6.60±1.64	3.07±1.16	3.53	53.5%
Physical Function	Group A: MWM	53.93±11.32	25.80±6.17	28.13	52.2%
Physical Function	Group B: PNF-HR	57.13±7.77	28.53±6.59	28.60	50.1%
Total WOMAC	Group A: MWM	75.93±16.97	34.20±8.59	41.73	55.0%
Total WOMAC	Group B: PNF-HR	79.27±10.40	38.53±8.12	40.74	51.4%

Table 2. Between-Group Post-Intervention Comparison

Outcome	Mean Difference, Group A–Group B	95% CI	Cohen's d	p-value
Pain	-1.73	-2.99 to -0.47	-1.03	0.009
Stiffness	-0.67	-1.50 to 0.16	-0.60	0.111
Physical Function	-2.73	-7.51 to 2.05	-0.43	0.371
Total WOMAC	-4.33	-10.58 to 1.92	-0.52	0.167

Pain decreased from 15.87±3.98 to 5.40±1.92 in Group A and from 16.20±1.97 to 7.13±1.41 in Group B, representing reductions of 66.0% and 56.0%, respectively. The post-intervention between-group difference was statistically significant, with a mean difference of -1.73 points, 95% CI -2.99 to -0.47, and a large standardized effect size favouring MWM. Stiffness improved by 60.8% in Group A and 53.5% in Group B, but the between-group difference was not statistically significant. Physical function scores improved similarly in both groups, with reductions of 52.2% in Group A and 50.1% in Group B. Total WOMAC score improved from 75.93±16.97 to 34.20±8.59 in Group A and from 79.27±10.40 to 38.53±8.12 in Group B, showing comparable overall improvement without statistically significant between-group superiority.

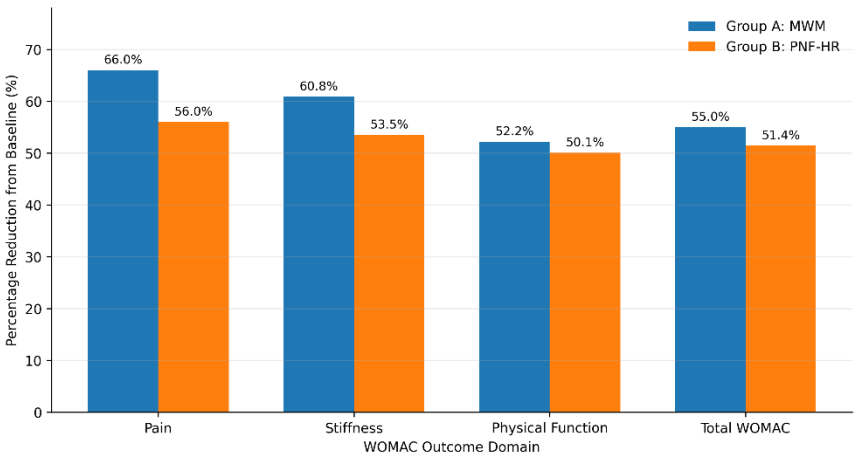

Figure 2 Relative Improvement in WOMAC Domains After Two Weeks of Intervention

The relative improvement profile showed that Group A achieved greater percentage reductions across all WOMAC domains, with the largest advantage observed for pain, where scores decreased by 66.0% in Group A compared with 56.0% in Group B. Stiffness improved by 60.8% and 53.5%, physical function by 52.2% and 50.1%, and total WOMAC score by 55.0% and 51.4% in Group A and Group B, respectively, indicating that both interventions produced clinically meaningful short-term improvement, while the clearest between-group separation was observed in pain reduction.

DISCUSSION

The present randomized controlled trial compared Mobilization with Movement and Proprioceptive Neuromuscular Facilitation Hold-Relax in patients with chronic knee osteoarthritis and demonstrated clinically meaningful short-term improvements in WOMAC pain, stiffness, physical function, and total WOMAC score in both groups after two weeks of intervention. The corrected interpretation of the available data indicates that Group A receiving Mobilization with Movement showed a larger percentage reduction in pain than Group B receiving PNF Hold-Relax, with pain decreasing by 66.0% in Group A compared with 56.0% in Group B. The post-intervention between-group comparison for pain was statistically significant, whereas stiffness, physical function, and total WOMAC score did not show statistically significant between-group differences. These findings suggest that both approaches may be useful in short-term conservative rehabilitation of knee osteoarthritis, while Mobilization with Movement may provide a stronger immediate pain-modulating effect in this sample.

The observed improvement following Mobilization with Movement is consistent with previous evidence suggesting that Mulligan-based mobilization techniques can reduce pain and improve functional performance in patients with knee osteoarthritis when combined with conventional therapy (13). The clinical benefit may be explained by the combined effect of accessory tibiofemoral glide and active movement, which may improve joint mechanics, reduce movement-associated pain, and facilitate more efficient functional loading. Similarly, the improvement observed in the PNF Hold-Relax group supports previous findings that PNF stretching can improve physical function, proprioceptive control, and symptoms in individuals with knee osteoarthritis (14). The reduction in pain and functional limitation in the PNF group may be related to decreased hamstring tightness, improved periarticular flexibility, and neuromuscular modulation of movement patterns.

The findings also align with studies reporting that combined manual therapy, proprioceptive exercise, and conventional strengthening interventions may improve knee range of motion, function, and symptom burden in osteoarthritis (15). However, the absence of statistically significant between-group differences for stiffness, physical function, and total WOMAC score indicates that neither intervention can be considered clearly superior for global functional improvement over two weeks. This is clinically important because both groups received conventional strengthening exercises, including vastus medialis oblique strengthening and quadriceps isometrics, which may have contributed substantially to functional recovery in both arms.

Previous comparative studies have reported beneficial effects of Mobilization with Movement when compared with other manual therapy approaches such as Maitland mobilization, although the magnitude and direction of superiority may vary depending on treatment duration, sample characteristics, outcome timing, and co-interventions (16). Similarly, studies comparing PNF Hold-Relax with related stretching approaches have shown improvements in pain and range of motion, supporting its role as a useful adjunct in knee osteoarthritis rehabilitation (17). In the present study, however, the available numerical results do not support the earlier manuscript claim that PNF Hold-Relax was superior for pain reduction; instead, the tabled data favour Mobilization with Movement for post-intervention pain reduction.

Several limitations should be considered when interpreting these findings. The sample size was small, recruitment was based on convenience sampling before random allocation, and the study was conducted

at a single center, which limits generalizability. The intervention period was short, and no long-term follow-up was performed, so durability of treatment effects cannot be established. The manuscript does not report assessor blinding, trial registration, detailed allocation-sequence generation, missing-data handling, normality testing, or adjustment for potential confounders such as body mass index, disease severity, baseline activity level, or duration of symptoms. Future trials should use larger adequately powered samples, concealed allocation, blinded outcome assessment, longer follow-up, and reporting of mean change scores with 95% confidence intervals and standardized effect sizes.

CONCLUSION

Both Mobilization with Movement and Proprioceptive Neuromuscular Facilitation Hold-Relax produced meaningful short-term improvements in pain, stiffness, physical function, and total WOMAC score among patients with chronic knee osteoarthritis. Based on the available post-intervention data, Mobilization with Movement demonstrated a statistically significant advantage for pain reduction, while both interventions showed comparable effects on stiffness, physical function, and total WOMAC improvement. These findings support the use of both techniques as part of conservative physiotherapy management for chronic knee osteoarthritis, although larger randomized trials with longer follow-up and stronger methodological controls are needed before firm conclusions regarding comparative superiority can be made.

REFERENCES

1. Garstang SV, Stitik TP. Osteoarthritis: epidemiology, risk factors, and pathophysiology. Am J Phys Med Rehabil. 2006;85(11 Suppl):S2-S11.
2. Glyn-Jones S, Palmer AJR, Agricola R, Price AJ, Vincent TL, Weinans H, et al. Osteoarthritis. Lancet. 2015;386(9991):376-387.
3. Mora JC, Przkora R, Cruz-Almeida Y. Knee osteoarthritis: pathophysiology and current treatment modalities. J Pain Res. 2018;11:2189-2196.
4. Bannuru RR, Schmid CH, Kent DM, Vaysbrot EE, Wong JB, McAlindon TE. Comparative effectiveness of pharmacologic interventions for knee osteoarthritis: a systematic review and network meta-analysis. Ann Intern Med. 2015;162(1):46-54.
5. Heidari B. Knee osteoarthritis diagnosis, treatment and associated factors of progression: part II. Caspian J Intern Med. 2011;2(3):249-255.
6. Sinusas K. Osteoarthritis: diagnosis and treatment. Am Fam Physician. 2012;85(1):49-56.
7. Decary S, Ouellet P, Vendittoli PA, Desmeules F. Reliability of physical examination tests for the diagnosis of knee disorders: evidence from a systematic review. Man Ther. 2016;26:172-182.
8. Kulkarni AV, Kamat MM. A study to determine the effectiveness of mobilization with movement techniques in knee osteoarthritis pain. Int J Health Sci Res. 2017;7(4).
9. Ringdahl E, Pandit S. Treatment of knee osteoarthritis. Am Fam Physician. 2011;83(11):1287-1292.
10. Masekar B, Rayjade DA, Yadav DT, Chotai DK. Effectiveness of muscle energy technique and proprioceptive neuromuscular facilitation in knee osteoarthritis. Int J Pharma Bio Sci. 2021;11(1):16-22.
11. Mehmood Z, Anwar N, Tauqeer S, Shabbir M, Khalid K, Mehmood S. Comparison of Maitland mobilization and Mulligan mobilization with movement in knee osteoarthritis patients. Pak J Med Res. 2021;60(3):126-130.

12. Ghanbari A, Ebrahimian M, Mohamadi M, Najjar-Hasanpour A. Comparing hold relax-proprioceptive neuromuscular facilitation and static stretching techniques in management of hamstring tightness. Indian J Physiother Occup Ther. 2013;7(1):126.

13. Weleslassie GG, Temesgen MH, Alamer A, Tsegay GS, Hailemariam TT, Melese H. Effectiveness of mobilization with movement on the management of knee osteoarthritis: a systematic review of randomized controlled trials. Pain Res Manag. 2021;2021.

14. Nathani S, Tank KD. Effect of PNF stretching on proprioception and physical function in individual with knee osteoarthritis: an experimental study. Int J Sci Healthc Res. 2020;11(7):779.

15. Gupta R, Heggannavar A. Quantitative effects of proprioceptive exercises and Mulligan's mobilization with movement in subjects with osteoarthritis knee: a randomized controlled trial. Int J Ther Rehabil Res. 2015;4(4):191.

16. Kiran A, Ijaz MJ, Qamar MM, Basharat A, Rasul A, Ahmed W. Comparison of efficacy of Mulligan's mobilization with movement with Maitland mobilization along with conventional therapy in patients with knee osteoarthritis: a randomized clinical trial. Libyan Int Med Univ J. 2018;3(1):26.

17. Halimah A, Muthiah S. The different effect of hold relax and contract relax on pain and range of motion in knee joint osteoarthritis. Urban Health. 2021;3(1).