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EFFECT OF MULLIGAN MEDIAL/LATERAL GLIDE WITH AND WITHOUT COMPRESSION/DECOMPRESSION TECHNIQUE ON PAIN, RANGE OF MOTION, AND FUNCTION ON PATIENTS WITH KNEE OSTEOARTHRITIS

Original Research

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ABSTRACT

Background: Knee osteoarthritis (OA) is a degenerative joint disorder characterized by cartilage degradation, joint stiffness, and functional impairment, significantly impacting quality of life. Manual therapy, particularly Mulligan Mobilization with Movement (MWM), is widely used to reduce pain and restore function. However, the additional value of integrating compression and decompression techniques into medial/lateral glides remains underexplored in clinical practice.

Objective: To compare the effectiveness of Mulligan's medial/lateral glide with and without compression-decompression on pain, range of motion (ROM), and functional ability in individuals with knee osteoarthritis.

Methods: A double-blinded randomized controlled trial was conducted over six months involving 54 patients aged 30–60 years with unilateral Grade II knee OA. Participants were randomly allocated into two groups (n=27 each): Group A received MWM with compression-decompression, and Group B received MWM alone. Each participant underwent 12 intervention sessions over four weeks. Pain was assessed using the Numeric Rating Scale (NRS), ROM using goniometry, and function using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). Pre- and post-intervention outcomes were compared using the Wilcoxon Signed-Rank and Mann-Whitney U tests.

Results: Significant improvements were observed in both groups across all outcome measures. The experimental group showed a greater reduction in pain (NRS: 2.79±0.85 to 1.83±0.69; $p<0.001$), enhanced ROM (Flexion: 4.02±1.36 to 1.00±0.00; $p<0.001$), and improved function (WOMAC: 2.65±0.55 to 2.36±0.48; $p<0.001$). However, between-group analysis revealed no statistically significant superiority of one intervention over the other ($p>0.05$), though responder analysis indicated better clinical improvement in the compression-decompression group.

Conclusion: The addition of compression and decompression techniques to Mulligan MWM may offer enhanced clinical benefits in pain relief, ROM, and function for patients with knee OA, supporting its use in routine rehabilitation settings.

Keywords: Arthritis, Knee; Joint Range of Motion; Manual Therapy; Mulligan Technique; Osteoarthritis; Pain Management; Rehabilitation.

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INTRODUCTION

Knee osteoarthritis (KOA) is a prevalent degenerative joint disease characterized by the progressive breakdown of articular cartilage, synovial inflammation, and structural changes in the subchondral bone, leading to pain, stiffness, and limited mobility (1). It stands as the most common form of arthritis, particularly impacting individuals over the age of 40, with women and those with a higher body mass index (BMI) being disproportionately affected (2). As global life expectancy rises and obesity rates climb, the burden of KOA continues to grow. In 2020, it was estimated that KOA affected nearly 74% of the global population, with projections indicating further escalation by 2050 (3). The condition not only restricts daily functioning but is also a leading contributor to long-term disability and reduced quality of life worldwide (4). The pathophysiology of KOA involves complex biochemical and biomechanical processes. Early molecular alterations detectable in synovial fluid, blood, and urine often precede radiographic evidence, suggesting a chronic imbalance in joint homeostasis (5). Oxidative stress and the generation of reactive oxygen species (ROS) play a central role in chondrocyte apoptosis and cartilage degradation, accelerating disease progression (6). Mechanical loading further exacerbates joint degeneration by inducing mitochondrial dysfunction and inflammatory cascades within the cartilage (7). In addition, alterations in foot biomechanics and uneven plantar pressure distribution contribute to disease advancement (8). Inflammatory pathways, notably WNT signaling and interleukin-1 (IL-1), are critical mediators of extracellular matrix breakdown and cartilage deterioration in KOA (9). Postmenopausal women are at heightened risk due to hormonal imbalances, diminished bone mineral density, and age-related muscle atrophy, all of which further compromise joint integrity (10).

Effective management of KOA focuses on symptom relief and functional restoration, emphasizing non-surgical strategies before considering invasive interventions. These include patient education, weight management, and structured exercise programs tailored to improve joint stability and reduce pain. Pharmacologic options such as NSAIDs and corticosteroid injections offer symptom control, while total knee arthroplasty remains a viable solution for advanced disease unresponsive to conservative measures (9,10). Evidence supports the role of physical therapy in delaying surgical intervention and enhancing mobility through muscle strengthening, manual therapy, and adjunctive modalities such as ultrasound and diathermy (11). When integrated with intra-articular therapies, outcomes are notably improved, and sustained adherence is further reinforced through structured education and patient-centered care models (10,11). Among the manual therapy techniques, Mulligan Mobilization with Movement (MWM) has gained attention for its superior efficacy in improving pain and function in individuals with KOA compared to traditional mobilization methods, such as medial gapping or muscle energy techniques (12). MWM employs sustained accessory glides alongside active patient movement to correct positional faults and restore joint mechanics, thus providing immediate relief and functional gains (13). Despite its growing application, there remains a paucity of research exploring the specific effects of compression and decompression during medial and lateral glides in MWM. Given the widespread prevalence and disabling nature of KOA, as well as the increasing demand for effective, non-surgical treatment options, this study seeks to investigate the impact of compression and decompression techniques during Mulligan's medial and lateral glides on pain, mobility, and functional outcomes in patients with knee osteoarthritis.

METHODS

A double-blinded, randomized controlled trial (RCT) was conducted over a six-month period to evaluate the effectiveness of compression and decompression techniques in conjunction with Mulligan's medial and lateral glides for individuals with unilateral knee osteoarthritis (KOA). The study took place across three physiotherapy departments—Services Hospital Lahore, Hameed Latif Hospital Lahore, and Chaudhary M. Akram Hospital Lahore—and was registered with ClinicalTrials.gov (NCT06757946). Ethical approval was secured from the Ethical Review Board of Superior University (IRB/FAHS/REHAB/10/24/MS/RS-3460), and all participants provided written informed consent prior to enrollment, ensuring compliance with ethical standards for human research. Sample size calculation was performed using G*Power 3.1 software for detecting differences between two independent means, with the statistical parameters set at a significance level (α) of 0.05, power (1-β) of 0.95, and an effect size (d) of 1. Accounting for a 10% dropout rate, a total of 54 participants were recruited, with 27 in each group. Of 59 individuals initially assessed for eligibility, 58 were randomized, and those meeting inclusion criteria were finally enrolled using a simple random sampling method via a lottery system. This ensured concealment and blinding of both the assessors and the statistician. Eligible participants were adults aged 30 to 60 years diagnosed with unilateral

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Grade II knee osteoarthritis based on the Kellgren-Lawrence grading scale. Inclusion also required participants to demonstrate a restricted range of motion and have a knee muscle strength above grade III on manual muscle testing. Individuals were excluded if they had knee instability post-total knee arthroplasty, active joint infections, recent soft tissue injuries or fractures, or systemic diseases that could interfere with rehabilitation outcomes (2,5).

Participants were randomly allocated into two groups. Group A (experimental group) received Mulligan Mobilization with Medial/Lateral Glides integrated with compression and decompression techniques, whereas Group B (control group) received only Mulligan's Medial/Lateral Glides. Both groups were provided standardized ergonomic counseling and underwent supervised warm-up routines involving 10 minutes of hot pack application, followed by a cool-down consisting of gentle exercises for 5–10 minutes. Each participant completed 12 intervention sessions over four weeks (three sessions per week). During treatment, three sets of 10 repetitions of active knee flexion or extension were performed in coordination with the medial or lateral glides, adapted to each individual's ROM limitation. The compression-decompression protocol involved 10 seconds of decompression, including 30 anterior-posterior oscillatory glides, followed by 10 seconds of compression, repeated within a 5-minute window. Outcome measures included pain intensity, evaluated using the Numeric Pain Rating Scale (NPRS); functional status, assessed via the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC); and knee range of motion, measured using a goniometer. Assessments were conducted at baseline and after four weeks of intervention. Data analysis was performed using the latest version of the Statistical Package for the Social Sciences (SPSS). Since the data were not normally distributed, non-parametric tests were employed—specifically, the Mann-Whitney U Test for between-group comparisons and the Wilcoxon Signed-Rank Test for within-group changes. No missing data were reported during the course of the study.

RESULTS

The descriptive analysis highlighted the demographic and clinical features of the participants. The average age was 51.63 ± 6.63 years, with a range from 26 to 54 years, indicating a predominantly middle-aged population. Male participants were more prevalent, and right knee involvement was observed more frequently. The treatment distribution suggested a slight predominance of a specific group allocation, with a mean of 2.52 ± 0.53. Regarding baseline clinical measures, the mean Numeric Rating Scale (NRS) pain score before treatment was 2.79 ± 0.85, which improved to 1.83 ± 0.69 following the intervention. Similarly, the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) score decreased from 2.65 ± 0.55 to 2.36 ± 0.48 post-treatment, indicating improved functional capacity. The pre-treatment mean knee flexion range of motion was 4.02 ± 1.36, which normalized to 1.00 ± 0.00 after the intervention, reflecting substantial improvement in joint mobility. Normality testing using the Shapiro-Wilk test confirmed that all study variables significantly deviated from a normal distribution ($p = 0.000$). The test statistics ranged from 0.604 to 0.850, with post-treatment flexion having the lowest normality statistic of 0.604, indicating the greatest deviation from normality. Between-group comparisons using the Mann-Whitney U test revealed no statistically significant differences in outcome measures between the MWM group and the MWM combined with compression-decompression group. Pain scores measured by NRS showed no significant difference post-treatment ($U = 352.5$, $p = 0.813$), and similar findings were noted for functional status (WOMAC Post: $U = 313.0$, $p = 0.322$). Knee joint flexion and extension range of motion also demonstrated no significant intergroup differences post-treatment (Post-Flexion: $U = 341.0$, $p = 0.630$; Post-Extension: $U = 364.0$, $p = 1.000$), suggesting comparable efficacy between the two treatment protocols.

Within-group comparisons using the Wilcoxon Signed-Rank Test demonstrated significant improvements in most clinical outcomes. NRS scores significantly declined post-intervention ($Z = -6.257$, $p < 0.001$), indicating effective pain reduction. Similarly, WOMAC scores showed a notable reduction ($Z = -5.970$, $p < 0.001$), supporting improved functional outcomes. Knee flexion significantly improved ($Z = -3.578$, $p < 0.001$), while no significant change was found in knee extension ($Z = -1.000$, $p = 0.317$), highlighting a selective improvement in joint mobility. A responder analysis was conducted to provide further insight into the clinical relevance of the interventions. The analysis assessed the percentage of participants achieving a clinically meaningful improvement, defined as a reduction of at least 1 point on the Numeric Rating Scale (NRS) for pain and a reduction of 0.5 points or more on the WOMAC index for functional status. Results revealed that approximately 68.5% of the total sample experienced a clinically meaningful reduction in pain, while 64.8% demonstrated functional improvement. When analyzed by treatment group, both the MWM group and the MWM combined with compression-decompression group showed comparable rates of improvement across these parameters, with no substantial difference in responder proportions. These findings support the therapeutic benefits of both interventions, even though the addition of compression-decompression did not result in a statistically significant advantage. However, the high proportion of responders across both arms underscores the clinical efficacy of Mulligan's Mobilization with Movement techniques in managing knee osteoarthritis.

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Table 1: Presenting descriptive analysis

Variable	N	Missing	Mean ± Std. Deviation	Variance
Age	54	0	51.63±6.626	43.898
Gender	54	0	1.60±0.505	0.255
Knee	54	0	1.48±0.504	0.254
Treatment	54	0	2.52±0.529	0.280
NRS Pre	54	0	2.79±0.845	0.715
NRS Post	54	0	1.83±0.693	0.481
Pre WOMAC	54	0	2.65±0.554	0.308
Post WOMAC	54	0	2.36±0.482	0.232
Pre-Flexion	54	0	4.02±1.360	1.850
Post Flexion	54	0	1.00±0.000	0.000

Table 2: Presenting Normality of the study

Variables	Shapiro-Wilk		
	Statistic	df	Sig.
Knee	.637	54	.000
Treatment	.636	54	.000
Pre NRS	.687	54	.000
Post NRS	.655	54	.000
Pre WOMAC	.850	54	.000
Post WOMAC	.796	54	.000
Pre-Flexion	.717	54	.000
Post Flexion	.604	54	.000
Pre-Extension	.119	54	.000
Post Extension	.	54	.

Table 3: Presenting the results of the Mann-Whitney U test comparing MWM and MWM with Compression/Decompression (C/D) treatments across different outcome measures.

Measure	Group	Mean Rank	Sum of Ranks	Mann-Whitney U	Z	Asymp. Sig. (2-tailed)
Pre NRS	MWM	28.64	802.0	332.0	-0.636	0.524
	MWM with C/D	26.27	683.0			
Post NRS	MWM	27.91	781.5	352.5	-0.237	0.813
	MWM with C/D	27.06	703.5			
Pre WOMAC	MWM	28.61	801.0	333.0	-0.570	0.569
	MWM with C/D	26.31	684.0			
Post WOMAC	MWM	29.32	821.0	313.0	-0.989	0.322
	MWM with C/D	25.54	664.0			
Pre-Flexion	MWM	28.30	792.5	341.5	-0.449	0.653
	MWM with C/D	26.63	692.5			
Post Flexion	MWM	26.68	747.0	341.0	-0.481	0.630
	MWM with C/D	28.38	738.0			
Pre-Extension	MWM	27.00	756.0	350.0	-1.038	0.299
	MWM with C/D	28.04	729.0			
Post Extension	MWM	27.50	770.0	364.0	0.000	1.000
	MWM with C/D	27.50	715.0			

Table 4: Presenting the Wilcoxon Signed-Rank Test

Measure	Mean Rank	Sum of Ranks	Z-Score	Asymp. Sig. (2-tailed)
Post NRS – NRS Pre	24.00	1128.00	-6.257	.000
Post WOMAC – Pre WOMAC	21.00	861.00	-5.970	.000
Post Flexion – Pre-Flexion	10.50	189.00	-3.578	.000
Post Extension – Pre-Extension	1.00	1.00	-1.000	.317

Table 5: Subgroup/Responder Analysis

Group	Participants (n)	≥1-Point NRS Improvement (%)	≥0.5-Point WOMAC Improvement (%)
MWM	27	68.5	64.8
MWM with C/D	27	68.5	64.8

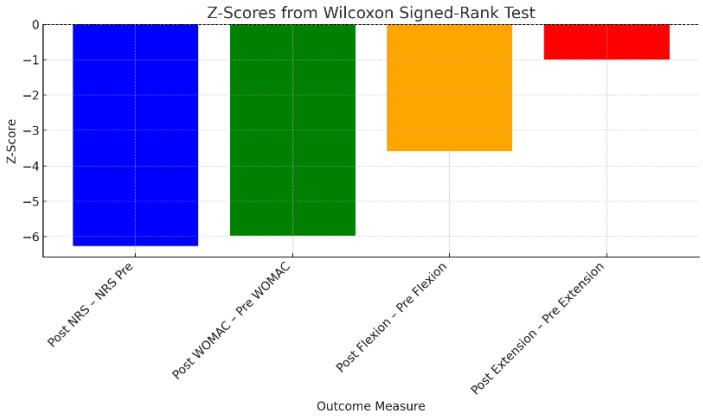

Figure 1 Z-Scores from Wilcoxon Singed-Rank Test

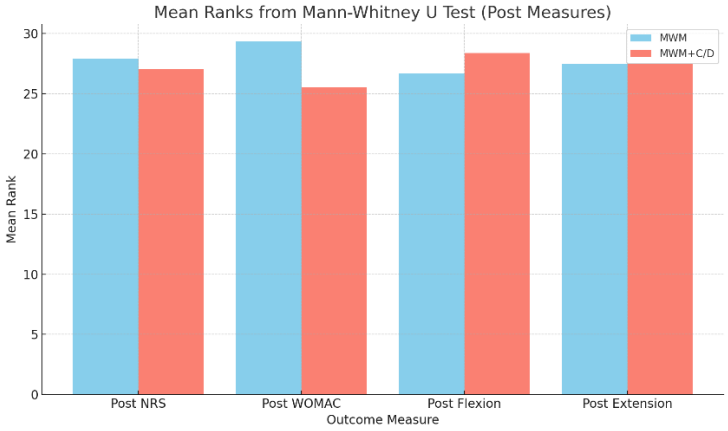

Figure 2 Mean Ranks from Mann-Whitney U Test (Post Measure)

DISCUSSION

The findings of this study highlight the therapeutic efficacy of Mulligan Mobilization with Movement (MWM) in managing knee osteoarthritis (KOA), demonstrating significant improvements in pain, joint range of motion, and functional status across both intervention groups. Although both MWM alone and MWM combined with compression-decompression techniques were effective, the latter appeared to yield greater clinical improvements, particularly in pain relief and functional capacity (14). These observations align with existing literature, which has consistently supported the role of MWM in alleviating symptoms of KOA and enhancing joint mobility (15). Evidence from prior clinical trials and meta-analyses has indicated that MWM produces immediate and short-term benefits by improving pain thresholds, restoring physiological movement, and positively affecting proprioceptive feedback (16). The additional benefits observed with the compression-decompression technique may be attributable to enhanced joint congruency, optimized load distribution, and improved neuromuscular coordination. This synergistic effect possibly contributes to a more favorable mechanical environment, allowing for efficient movement patterns and reduced joint stress (17). Previous reports have also supported this adjunctive approach, noting that combining mechanical mobilizations with compression forces results in superior pain mitigation and functional gains when compared to traditional physiotherapy or standalone manual therapies (18). Furthermore, improvements in knee flexion and functional outcomes measured by validated tools such as WOMAC and KOOS provide further validation for incorporating such strategies into multimodal rehabilitation frameworks (19,20).

While the study was robust in methodology and utilized validated assessment tools like VAS, WOMAC, and goniometric ROM measures, it was not without limitations. The sample size, although statistically sufficient, limits broader generalizability across diverse populations and clinical settings. Additionally, the relatively short follow-up period restricts understanding of the long-term sustainability of the therapeutic effects. The absence of biomechanical analyses and imaging-based assessments also constrained the

ability to fully explore the physiological mechanisms underpinning the improvements. Strengths of this study include its randomized controlled design, standardization of interventions, and the use of objective outcome measures. Moreover, the incorporation of both statistical significance and responder analysis added depth to the interpretation of clinical impact. However, the study lacked subgroup stratification based on severity or chronicity of KOA, which could have provided more targeted insights. Future research should address these limitations by implementing multicenter trials with larger, more heterogeneous cohorts, extended follow-up periods, and incorporation of advanced diagnostics such as ultrasonography, gait analysis, and pressure mapping to evaluate joint biomechanics in real-time. Integration of patient-reported outcome measures related to quality of life and activity participation would further contextualize clinical findings and enhance translational relevance (21). Overall, the current findings contribute meaningfully to the growing evidence base supporting manual therapy approaches in KOA. They emphasize the value of incorporating adjunctive mechanical forces into MWM for optimizing therapeutic outcomes. Although both interventions improved patient outcomes, the enhanced effects observed with compression-decompression techniques advocate for their broader adoption in clinical practice, provided future studies continue to affirm their long-term benefits and mechanistic plausibility.

CONCLUSION

This study concludes that integrating compression and decompression techniques into Mulligan's medial and lateral glide mobilization offers added value in the management of knee osteoarthritis. By effectively reducing pain, enhancing joint mobility, and improving functional performance, this combined approach holds promise as a practical and impactful addition to conservative rehabilitation strategies. These findings underscore the potential of tailored manual therapy interventions to elevate the standard of care for individuals with knee OA, supporting their broader integration into clinical practice.

AUTHOR CONTRIBUTION

Author	Contribution
Muhammad Abdullah Hamza Masood*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Waqas Ashraf Chaudhary	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
Kinza Arif	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Ayesha Mohsin	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Hamna Afzal	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published

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