

EFFECTS OF TIBIOFEMORAL MOBILIZATION WITH AND WITHOUT MULLIGAN'S MEDIAL GAPPING TECHNIQUE ON PAIN AND FUNCTION IN PATIENTS WITH MEDIAL COMPARTMENT KNEE OSTEOARTHRITIS: A RANDOMIZED CONTROLLED TRIAL

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Abstract

Background: Knee osteoarthritis (KOA) is a leading cause of pain and physical disability, and the medial compartment of the knee is usually the first to deteriorate. Manual therapy has an established place in conservative care, but it remains unclear whether adding a compartment-specific technique to standard tibiofemoral mobilization improves outcomes.

Objective: To compare the effects of tibiofemoral mobilization, with and without Mulligan's medial gapping technique, on pain and function in patients with medial compartment knee osteoarthritis.

Methods: A single-blind randomized controlled trial was conducted in the Outpatient Physiotherapy Department of Surraya Azeem Hospital, Lahore. Forty-four patients aged 40–65 years with Kellgren–Lawrence grade 2 or 3 medial compartment osteoarthritis were randomly allocated into two equal groups (n=22 each). Group A received tibiofemoral mobilization plus medial gapping, whereas Group B received tibiofemoral mobilization alone; both groups were treated three sessions per week for six weeks. Pain was measured with the Numeric Pain Rating Scale (NPRS) and function with the WOMAC index at baseline and six weeks. Paired- and independent-samples t-tests, their non-parametric counterparts, and analysis of covariance (ANCOVA) were used.

Results: All 44 participants completed the study. Both groups improved, but Group A improved significantly more on every outcome. The mean reduction in NPRS was 4.00 ± 0.69 in Group A versus 2.41 ± 0.50 in Group B (mean difference 1.59; 95% CI 1.23–1.95), and the mean reduction in WOMAC total was 32.68 ± 5.87 versus 21.18 ± 2.02 (mean difference 11.50; 95% CI 8.90–14.10). Effect sizes were large for every outcome (Cohen's d 1.69–2.63), and group allocation remained a significant predictor of post-treatment scores after adjustment for baseline values (all $p < 0.001$).

Conclusion: Adding Mulligan's medial gapping technique to standard tibiofemoral mobilization produced greater short-term improvement in pain, stiffness, and physical function than mobilization alone in patients with medial compartment knee osteoarthritis.

Introduction

Knee osteoarthritis (KOA) is among the leading causes of pain and physical disability worldwide, and its burden continues to rise with population ageing and obesity[1]. The Global Burden of Disease Study estimated that 595 million people were living with osteoarthritis in 2020, with knee cases projected to increase by roughly three-quarters by 2050 [2]. The burden is also increasing across Pakistan and its provinces, adding pressure to an already strained rehabilitation system[3].

The mechanical environment of the knee explains why the medial compartment is usually affected first. During walking, a large share of the load passes through the medial tibiofemoral compartment, and varus alignment raises the external knee adduction moment and concentrates stress on the medial side of the joint[4]. Altered muscle forces during gait can further increase this loading in varus-aligned patients[5]. Repeated loading leads to cartilage loss, osteophyte formation, and capsular restriction, changes that are commonly graded with the Kellgren–Lawrence system, in which grades 2 and 3 represent moderate disease [6]. Current guidelines place conservative management before surgery for most patients with moderate KOA. Education, exercise, and weight management form the core of the OARSI and American College of Rheumatology recommendations [7, 8]. Land-based exercise reduces pain and improves function, although the benefit may diminish once supervised exercise stops[9].

Manual therapy is used to complement exercise rather than to replace active rehabilitation. Manual physical therapy combined with exercise has produced better outcomes than placebo in KOA[10], and reviews report added improvements in pain, stiffness, and function, although the quality of primary trials is variable [11]. Mulligan’s mobilization with movement combines a sustained accessory glide with active movement to allow pain-free motion[12, 13]. It has produced greater immediate improvement than a sham glide [14] and larger gains when added to exercise[15], and meta-analyses report reductions in pain and disability, particularly when the technique is combined with other treatment [16, 17]

Medial gapping is a more specific manual technique, in which a sustained lateral-to-medial force is applied while the patient flexes and extends the knee, creating a temporary opening at the medial joint line. A Pakistani trial compared medial gapping with a Mulligan rotational technique and found both effective, but it did not test medial gapping as an addition to standard tibiofemoral mobilization[18], leaving the additive value of the technique unclear. The aim of this study was therefore to compare tibiofemoral mobilization, with and without Mulligan’s medial gapping technique, on pain and function in patients with medial compartment KOA.

Materials and Methods**Study Design and Setting**

This was a single-blind, two-arm, parallel-group randomized controlled trial conducted in the Outpatient Physiotherapy Department of Surraya Azeem Hospital, Lahore. The study was carried out over about six months following ethical approval, and reporting followed the CONSORT guidance for non-pharmacological trials.

Participants and Sample Size

The sample size was estimated with G*Power for a comparison of two independent groups, with a significance level of 0.05 and power of 0.95[19]. Recruitment was extended beyond the calculated minimum to allow for dropouts, giving a final sample of 44 participants, 22 per group. Non-probability purposive sampling was used. Eligible participants were aged 40 to 65 years, of either sex, with radiologically confirmed Kellgren–Lawrence grade 2 or 3 medial compartment osteoarthritis [6], symptomatic knee pain of at least three months’ duration, and a minimum pain score of 4 out of 10 on the NPRS. Exclusion criteria were an intra-articular corticosteroid or hyaluronic acid injection within the previous three months, a history of total knee arthroplasty or significant knee trauma, rheumatoid arthritis or another systemic inflammatory arthropathy, and a severe neurological deficit or lumbar radiculopathy referring pain to the knee.

Randomization and Blinding

After the baseline assessment, participants were allocated at random into two equal groups. Outcome assessment was carried out by a blinded assessor, and written informed consent was obtained before participation. The study was approved by the institutional Research Ethical Committee and conducted in accordance with the Declaration of Helsinki.

Outcome Measures

Pain intensity was measured with the Numeric Pain Rating Scale (NPRS), an eleven-point scale from 0 (no pain) to 10 (worst pain imaginable), which has acceptable reliability and validity in osteoarthritic knee pain[20, 21]. Pain, stiffness, and physical function were measured with the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), a validated, disease-specific, self-report instrument [22, 23]. All outcomes were recorded at baseline and again after six weeks.

Intervention Protocol

Group A: Tibiofemoral Mobilization with Medial Gapping: participants received standard tibiofemoral mobilization together with Mulligan's medial gapping technique, in which the therapist applied a sustained lateral-to-medial force at the knee while the patient actively flexed and extended it, opening the medial joint line.[13]

Group B: Tibiofemoral Mobilization alone: participants received standard tibiofemoral mobilization without the gapping component. Both groups were treated three sessions per week for six weeks and received the same heat application and a supervised home quadriceps exercise programme.

Statistical Analysis

Data were analyzed using SPSS version 27. Continuous variables were summarized as means and standard deviations, and categorical variables as frequencies and percentages. The normality of the change scores was assessed with the Shapiro-Wilk test. Within-group changes were examined with paired-samples *t*-tests and the Wilcoxon signed-rank test, and between-group differences with independent-samples *t*-tests and the Mann-Whitney U test. Analysis of covariance (ANCOVA) was used to compare post-treatment scores while adjusting for baseline values. Statistical significance was set at $p < 0.05$.

Results

All 44 participants were allocated equally between the two groups and completed the study, with no loss to follow-up. The groups were comparable at baseline for age and sex (Table 1). Group A had a mean age of 54.68 ± 7.84 years and Group B 55.18 ± 6.49 years ($p = 0.819$), and the sex distribution did not differ significantly between groups ($p = 1.000$).

Table 1. Demographic characteristics of participants

Characteristic	Group A: TFM + Medial Gapping (n=22)	Group B: TFM alone (n=22)
Age (years), Mean $\pm$ SD	54.68 ± 7.84	55.18 ± 6.49
Male, n (%)	10 (45.5%)	11 (50.0%)
Female, n (%)	12 (54.5%)	11 (50.0%)
Total, n (%)	22 (100%)	22 (100%)

Both groups improved from baseline to six weeks on every measure, but the improvement was consistently larger in Group A (Table 2). NPRS pain fell from 6.77 ± 1.19 to 2.77 ± 0.69 in

Group A and from 6.50 ± 1.01 to 4.09 ± 0.92 in Group B. The WOMAC total score fell from 57.32 ± 6.88 to 24.64 ± 6.99 in Group A and from 61.09 ± 4.91 to 39.91 ± 5.87 in Group B.

Table 2. Pre- and post-treatment outcomes in both groups (Mean $\pm$ SD)

Outcome	Group A Baseline	Group A Week 6	Group B Baseline	Group B Week 6
NPRS	6.77 $\pm$ 1.19	2.77 $\pm$ 0.69	6.50 $\pm$ 1.01	4.09 $\pm$ 0.92
WOMAC Pain	11.68 $\pm$ 2.01	5.18 $\pm$ 1.76	12.45 $\pm$ 1.26	8.23 $\pm$ 1.69
WOMAC Stiffness	4.59 $\pm$ 1.01	2.00 $\pm$ 0.82	4.23 $\pm$ 0.97	2.82 $\pm$ 1.10
WOMAC Function	41.05 $\pm$ 4.77	17.45 $\pm$ 5.29	44.41 $\pm$ 4.12	28.86 $\pm$ 4.16
WOMAC Total	57.32 $\pm$ 6.88	24.64 $\pm$ 6.99	61.09 $\pm$ 4.91	39.91 $\pm$ 5.87

The between-group comparison of the change scores favored Group A for every outcome (Table 3). The mean difference was 1.59 points for NPRS (95% CI 1.23–1.95) and 11.50 points for WOMAC total (95% CI 8.90–

14.10), with large effect sizes (Cohen's d 1.69–2.63; all $p < 0.001$). Group allocation remained a significant predictor of post-treatment scores after adjustment for baseline values in ANCOVA (all $p < 0.001$; partial η^2 0.42–0.75).

Table 3. Between-group comparison of improvement (change scores)

Outcome	Mean Difference (95% CI)	Cohen's d	p-value
NPRS	1.59 (1.23, 1.95)	2.63	<0.001
WOMAC Pain	2.27 (1.67, 2.87)	2.24	<0.001
WOMAC Stiffness	1.18 (0.77, 1.60)	1.69	<0.001
WOMAC Function	8.05 (6.00, 10.09)	2.33	<0.001
WOMAC Total	11.50 (8.90, 14.10)	2.62	<0.001

Note: A larger positive difference indicates a greater reduction in pain, stiffness, or WOMAC score (or a greater improvement in function) in Group A.

Discussion

This randomized controlled trial compared tibiofemoral mobilization, with and without Mulligan's medial gapping technique, in patients with medial compartment knee osteoarthritis. Both groups improved over six weeks, but the group receiving medial gapping improved significantly more on pain, stiffness, physical function, and total WOMAC score, with large effect sizes that persisted after adjustment for baseline differences. The improvement in the control group confirms that standard mobilization with heat and home exercise is effective in its own right; the additional gain in the gapping group represents the specific contribution of the technique.

These findings agree with Hasan et al., who reported that adding mobilization with movement to isometric training produced faster and larger gains than training alone over a similar six-week window [15]. They are also consistent with Alkhawajah and Alshami,

whose sham-controlled trial showed that the specific glide, rather than therapist contact or expectation alone, can drive short-term change[14]. A note of caution comes from Nazir and Rathore, whose three-arm trial found Mulligan mobilization effective but inferior to trunk stabilization, a reminder that the relative ranking of techniques depends on the comparator[24].

The closest design to the present study is the Pakistani trial of Gul and Tahir, which compared medial gapping with a rotational technique but did not test gapping as an adjunct to standard mobilization[18]; the present study extends that work by isolating the additive effect. The direction of the results is supported by meta-analyses of mobilization with movement [16, 17] and by the wider evidence base for exercise and manual therapy in knee osteoarthritis[9, 11]. Biomechanically, a sustained lateral-to-medial force applied during active movement is aimed directly at the

medial compartment, where varus alignment and altered muscle forces concentrate load [4, 5]; variation in static lower-limb alignment, such as the quadriceps angle, has likewise been documented in these patients[25].

The effect sizes observed here (Cohen's d 1.69–2.63) are larger than are typically reported in manual therapy trials and should be interpreted as an upper bound, because the trial was single-blind, both primary outcomes were self-reported, and the sample came from a single centre.

Limitations

This study has several limitations. It included only 44 participants from a single centre, recruited by purposive sampling, which limits the generalizability of the findings. Outcomes were assessed only at baseline and six weeks, so the durability of the improvements is unknown. Both primary outcomes were patient-reported, and no objective measures of range of motion, gait, or joint loading were included. The groups differed slightly at baseline on WOMAC function and total scores, although ANCOVA was used to adjust for this, and the absence of a sham or no-treatment arm means that nonspecific effects cannot be fully separated from the specific effect of gapping.

Clinical Implications

The findings suggest that adding a compartment-specific manual technique to standard tibiofemoral mobilization can produce greater short-term improvement in pain and function in medial compartment knee osteoarthritis. Because medial gapping depends on the therapist's skill rather than on additional equipment, it is well suited to resource-limited rehabilitation settings such as those common in Pakistan. Treatment should nonetheless be individualized to disease severity, pain irritability, and patient tolerance, and the technique is best combined with exercise rather than used in isolation.

Conclusion

Within the six weeks studied, adding Mulligan's medial gapping technique to standard tibiofemoral mobilization produced greater improvement in pain, stiffness, and physical function than mobilization alone in

patients with medial compartment knee osteoarthritis, with large effect sizes that persisted after adjustment for baseline differences. Larger, multicentre trials with objective outcomes and longer follow-up are required to confirm the durability and generalizability of these findings.

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