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Comparative efficacy of Maitland and mulligan mobilization techniques in chronic non-specific low back pain

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Abstract

Background: Chronic non-specific low back pain (CNSLBP) is a leading cause of disability worldwide and is frequently managed with a combination of exercise and manual therapy. Among lumbar mobilization approaches, Maitland posterior-anterior mobilization and Mulligan Sustained Natural Apophyseal Glides (SNAGs) are widely used, but direct comparative evidence on their relative efficacy remains limited.

Objectives: To compare the effects of Maitland and Mulligan mobilization techniques, each combined with a standardized exercise programme, on pain, disability, lumbar range of motion (ROM) and global perceived effect (GPE) in adults with CNSLBP.

Methods: In this parallel-group randomized controlled trial, 64 adults with CNSLBP (symptoms ≥ 12 weeks) were randomly allocated to a Maitland group ($n = 32$) or a Mulligan SNAG group ($n = 32$). Both groups received 12 treatment sessions over 4 weeks (three sessions/week), comprising the allocated mobilization technique plus an identical exercise programme targeting lumbar and hip flexibility, core stabilization and general conditioning. Primary outcomes were pain intensity (0-10 Numerical Pain Rating Scale) and disability (Oswestry Disability Index). Secondary outcomes included lumbar flexion, extension and side-flexion ROM (dual inclinometer) and GPE (0-10 Likert scale). Outcomes were assessed at baseline, post-treatment (4 weeks) and follow-up (8 weeks). Data were analyzed using intention-to-treat with repeated-measures ANOVA.

Results: Both groups showed significant improvements over time in pain, disability and lumbar ROM ($p < 0.001$). At 8 weeks, the Mulligan group demonstrated greater reductions in pain (mean change -3.9 vs -2.9) and ODI (-18.8 vs -13.3), with moderate between-group effect sizes and significant group \times time interactions ($p < 0.01$). Lumbar flexion, extension and side-flexion ROM increased in both groups, with larger gains in the Mulligan group. Mean GPE at 8 weeks was higher in the Mulligan group (7.8 ± 1.4) than in the Maitland group (6.7 ± 1.6). No serious adverse events occurred.

Conclusion: Maitland and Mulligan mobilization techniques, when combined with structured exercise, both yield clinically meaningful improvements in adults with CNSLBP. However, Mulligan SNAGs provide a modest but important advantage in reducing pain and disability and enhancing lumbar ROM and perceived recovery. Where clinician expertise is available, Mulligan mobilization with movement may be considered a preferred manual therapy option within a comprehensive, exercise-based rehabilitation programme for CNSLBP.

Keywords: Chronic non-specific low back pain, Mulligan mobilization, Maitland mobilization, Sustained Natural Apophyseal Glides, manual therapy, spinal mobilization, physiotherapy, randomized controlled trial

Introduction

Chronic non-specific low back pain (CNSLBP) is one of the leading causes of disability worldwide and a major public health problem, with recent global burden estimates indicating that low back pain is now the top cause of years lived with disability in most countries and its prevalence is projected to increase further over coming decades [1, 2]. Population-based reviews show that up to 60-80% of adults experience low back pain at some point in life, and a substantial proportion progress to persistent or recurrent non-specific symptoms without identifiable specific pathology [3, 4]. CNSLBP is associated with reduced quality of life, work absenteeism and high health-care costs, and contemporary European and international guidelines therefore advocate a biopsychosocial, non-pharmacological first-line approach

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emphasizing patient education, exercise therapy and graded activity, with manual therapy or spinal mobilization considered as adjunctive options for selected patients [5-8]. Within this framework, manual therapy particularly joint mobilization techniques remains widely used by physiotherapists; recent overviews and bibliometric analyses highlight a sustained growth in clinical research on manual therapy for low back pain but also underscore heterogeneity in techniques and outcome measures [8, 9]. The Maitland concept employs graded passive accessory oscillatory mobilizations directed at lumbar zygapophyseal joints to modulate pain, improve segmental mobility and reduce disability, and randomized and controlled trials have reported that adding Maitland mobilization to conventional exercise yields superior reductions in pain and disability and improves lumbar proprioception compared with exercise or other physiotherapy protocols alone in mechanical or non-specific low back pain [10, 11]. In contrast, the Mulligan concept emphasizes mobilization with movement, such as lumbar Sustained Natural Apophyseal Glides (SNAGs), in which a sustained accessory glide is applied while the patient performs the symptomatic movement; randomized placebo-controlled and clinical studies have demonstrated that lumbar SNAGs can produce short-term improvements in pain, function, kinematic measures and mid-term reductions in disability in individuals with non-specific or chronic low back pain [12, 13]. However, direct head-to-head comparisons of Maitland and Mulligan mobilization techniques in CNSLBP are limited and yield inconsistent findings: a randomized controlled trial by Khan *et al.* reported that SNAGs combined with stretching, strengthening and postural exercises produced greater improvements in pain, Oswestry Disability Index scores and lumbar range of motion than Maitland mobilization with the same exercise program [14], whereas a randomized pilot study by Javaherian *et al.* found that both Maitland and Mulligan techniques produced comparable immediate gains in lumbar flexion and extension range of motion without clear superiority [15]; furthermore, a placebo-controlled trial of combined Mulligan mobilization-with-movement protocols in CNSLBP showed durable improvements in pain and disability but did not include a Maitland comparator, thereby reinforcing uncertainty about the relative clinical value of these approaches [16]. Consequently, clinicians lack robust, high-quality evidence to guide the choice between Maitland and Mulligan mobilization when designing individualized management plans for adults with chronic non-specific low back pain, particularly with respect to pain intensity, functional disability, lumbar range of motion and patient-reported global improvement. The present randomized controlled trial is therefore designed to compare the efficacy of Maitland and Mulligan mobilization techniques, each delivered alongside a standardized conventional exercise program, in adults with CNSLBP, with primary objectives of determining their relative effects on pain and disability and secondary objectives of examining changes in lumbar range of motion and global perceived effect. It is hypothesized that, although both mobilization strategies will result in clinically meaningful improvements from baseline, the Mulligan mobilization technique (lumbar SNAGs) will produce greater reductions in pain and functional disability and larger gains in lumbar range of motion than Maitland posterior-anterior mobilization, owing to its concurrent application of

accessory glide during active physiological movement and its proposed capacity to correct subtle positional faults and enhance movement-related hypoalgesia [12-16].

Materials and Methods

Materials

This study was designed as a parallel-group, randomized controlled trial comparing the efficacy of Maitland mobilization and Mulligan mobilization techniques in adults with chronic non-specific low back pain (CNSLBP). The protocol was developed in accordance with European and international guidelines for the management of chronic non-specific low back pain and previous randomized trials of manual therapy in this population [5-8, 10-13, 15, 16]. Participants were recruited from the outpatient physiotherapy department of a tertiary-care hospital through physician referral and community advertisements. Eligible patients were men and women aged 18-65 years with a clinical diagnosis of CNSLBP persisting for at least 12 weeks, pain localized between the 12th rib and gluteal folds with or without intermittent buttock pain, and a baseline pain intensity between 3 and 8 on the 0-10 Numerical Pain Rating Scale (NPRS) [3, 4, 6, 8]. Exclusion criteria included specific spinal pathology (e.g. fracture, tumor, infection, inflammatory spondyloarthropathy), prior lumbar surgery, radiculopathy or neurological deficit, pregnancy, systemic rheumatologic disease, serious comorbidities limiting participation in exercise, current use of other manual therapy or spinal injections, and inability to comply with the intervention or follow-up schedule [5-7, 12, 13]. The required sample size was calculated a priori using data from previous trials investigating Maitland and Mulligan techniques in non-specific low back pain, assuming a between-group difference of 2 points on NPRS with a standard deviation of 2.5, 80% power and $\alpha = 0.05$, which yielded a minimum of 27 participants per group; to compensate for an anticipated dropout rate of 15%, 32 participants were recruited into each arm [10-13, 15, 16]. Primary outcome measures were pain intensity assessed with NPRS and functional disability measured using the Oswestry Disability Index (ODI), both widely used and validated in chronic low back pain populations [3, 4, 6, 8]. Secondary outcomes included lumbar flexion, extension and side-flexion range of motion measured with a dual inclinometer, and global perceived effect (GPE) on an 11-point Likert scale [4, 8, 12, 13, 15, 16]. All outcome measures were recorded at baseline, immediately after the 4-week intervention, and at 4-week follow-up (8 weeks from baseline) by an experienced physiotherapist who was blinded to group allocation. Ethical approval was obtained from the institutional ethics committee, and all participants provided written informed consent prior to enrolment in accordance with the Declaration of Helsinki and guideline recommendations for non-pharmacological trials in chronic low back pain [5-7].

Methods

Eligible participants were randomly assigned in a 1:1 ratio to either the Maitland mobilization group or the Mulligan mobilization (SNAG) group using a computer-generated random sequence with variable block sizes; allocation concealment was ensured by sequentially numbered, opaque, sealed envelopes prepared by an independent researcher not involved in recruitment, treatment or assessment [5, 6, 12, 13, 15]. Both groups received 12 treatment

sessions over 4 weeks (three sessions per week), each lasting approximately 45-50 minutes. In the Maitland group, graded posterior-anterior (PA) mobilizations were applied to the symptomatic lumbar segments (L1-L5) according to the Maitland concept, using grades II-IV oscillatory mobilizations within or at the limit of pain-free range, based on clinical reasoning and patient response [10, 11]. In the Mulligan group, lumbar Sustained Natural Apophyseal Glides (SNAGs) were applied in weight-bearing positions (primarily standing), with the therapist providing a sustained facet glide while the patient actively performed the symptomatic movement (e.g. flexion, extension, side flexion); the direction, level and force of the glide were adjusted to achieve pain-free movement consistent with Mulligan's principles [12, 13, 16]. In both groups, manual therapy was delivered by licensed physiotherapists with more than five years of musculoskeletal experience and formal training in Maitland and Mulligan techniques to ensure treatment fidelity [9-13, 15, 16]. All participants additionally received a standardized conventional exercise program comprising stretching of lumbar and hip musculature, core stabilization exercises, and general conditioning activities, as recommended in evidence-based guidelines [5-8]. Exercises were supervised during sessions and prescribed as a structured home exercise program with adherence monitored via logbooks. Participants were instructed to maintain usual medications but refrain from initiating new physical treatments during the study; any changes in medication were recorded. Data were analyzed using an intention-to-treat approach with the last

observation carried forward for missing follow-up values. Baseline comparability between groups was assessed with independent t-tests (continuous variables) and chi-square tests (categorical variables). Primary analyses used two-way repeated-measures analysis of variance (group \times time) to examine differences in pain and ODI over time, with post hoc pairwise comparisons where appropriate; secondary outcomes were analyzed similarly [3, 4, 6, 8, 12-16]. Effect sizes (Cohen's *d*) and 95% confidence intervals were calculated for between-group differences, and statistical significance was set at $p < 0.05$.

Results

Of the 94 patients screened for eligibility, 64 met the inclusion criteria and were randomized to either the Maitland mobilization group ($n = 32$) or the Mulligan mobilization (SNAG) group ($n = 32$). Four participants (two in each group) discontinued the supervised sessions due to scheduling difficulties; however, all 64 were included in the intention-to-treat analysis using last observation carried forward, in line with recommendations for chronic low back pain trials [3, 4, 6, 8]. No serious adverse events were reported; a small number of participants in both groups reported transient post-treatment soreness that resolved within 24 hours, consistent with prior manual therapy studies [10-13, 15, 16]. At baseline, the two groups were comparable in age, sex distribution, pain duration, pain intensity (NPRS), disability (ODI) and lumbar range of motion (ROM), with no statistically significant between-group differences (all $p > 0.05$), indicating successful randomization [3, 4, 8, 10-13].

Table 1. Demographic and clinical characteristics of participants (mean \pm SD or n (%))

Variable	Maitland group ($n = 32$)	Mulligan group ($n = 32$)
Age (years)	44.3 \pm 9.8	43.7 \pm 10.1
Female (%)	18 (56.3)	17 (53.1)
Duration of pain (months)	14.6 \pm 6.2	15.1 \pm 6.4
BMI (kg/m ²)	26.1 \pm 3.4	26.4 \pm 3.6
NPRS pain (0-10)	6.1 \pm 1.2	6.0 \pm 1.3
ODI (% disability)	36.8 \pm 7.9	35.9 \pm 7.4
Lumbar flexion ROM ($^{\circ}$)	35.4 \pm 7.8	36.1 \pm 8.1
Lumbar extension ROM ($^{\circ}$)	13.7 \pm 4.1	13.9 \pm 4.3
Lumbar side-flexion ROM ($^{\circ}$; average)	18.9 \pm 5.0	19.1 \pm 4.8

Demographic and clinical characteristics showing no significant between-group differences ($p > 0.05$).

Pain and disability: Both groups showed significant improvements in pain (NPRS) and disability (ODI) over time (time effect, $p < 0.001$), with a significant group \times time interaction favoring the Mulligan group for both outcomes ($p < 0.01$). From baseline to post-treatment (4 weeks), the Maitland group demonstrated a mean reduction in NPRS of 3.0 points (6.1 \pm 1.2 to 3.1 \pm 1.4), whereas the Mulligan group showed a larger reduction of 3.8 points (6.0 \pm 1.3 to 2.2 \pm 1.2). These improvements exceeded commonly cited minimal clinically important differences (MCID) of approximately 2 points on 0-10 pain scales in chronic low back pain [3, 4, 6, 8]. At 8-week follow-up, improvements were largely maintained (3.2 \pm 1.5 in the Maitland group and 2.1 \pm 1.3 in the Mulligan group), with between-group differences in change scores favoring Mulligan (mean difference 0.8 points; 95% CI 0.2-1.4; $p = 0.009$; Cohen's $d \approx 0.55$), in line with previous reports of greater short-term analgesic effects

of SNAGs in non-specific low back pain [12, 13, 16].

Similarly, ODI scores decreased significantly in both groups, with mean baseline values of 36.8 \pm 7.9% and 35.9 \pm 7.4% in the Maitland and Mulligan groups respectively. At 4 weeks, ODI decreased to 24.1 \pm 7.0% in the Maitland group and 18.3 \pm 5.9% in the Mulligan group, corresponding to absolute reductions of 12.7% and 17.6%. At 8 weeks, ODI remained improved at 23.5 \pm 7.2% and 17.1 \pm 6.0% respectively. The between-group difference in ODI change from baseline to 8 weeks favored the Mulligan group by 5.1 percentage points (95% CI 1.8-8.4; $p = 0.003$; Cohen's $d \approx 0.63$). These disability reductions are comparable with, or slightly greater than, those reported in previous trials of Maitland and Mulligan interventions combined with exercise in chronic or mechanical low back pain [10-13, 15, 16], and exceed proposed MCID thresholds of 10 percentage points on the ODI [3, 4, 6, 8].

Table 2: (NPRS pain and ODI) at baseline, post-treatment (4 weeks) and follow-up (8 weeks)

Outcome	Time point	Maitland (n = 32) mean \pm SD	Mulligan (n = 32) mean \pm SD	p (group \times time)
NPRS pain (0-10)	Baseline	6.1 \pm 1.2	6.0 \pm 1.3	—
	4 weeks	3.1 \pm 1.4	2.2 \pm 1.2	
	8 weeks	3.2 \pm 1.5	2.1 \pm 1.3	
ODI (% disability)	Baseline	36.8 \pm 7.9	35.9 \pm 7.4	—
	4 weeks	24.1 \pm 7.0	18.3 \pm 5.9	
	8 weeks	23.5 \pm 7.2	17.1 \pm 6.0	

Changes in pain (NPRS) and disability (ODI) over time, showing greater improvements in the Mulligan group (repeated-measures ANOVA).

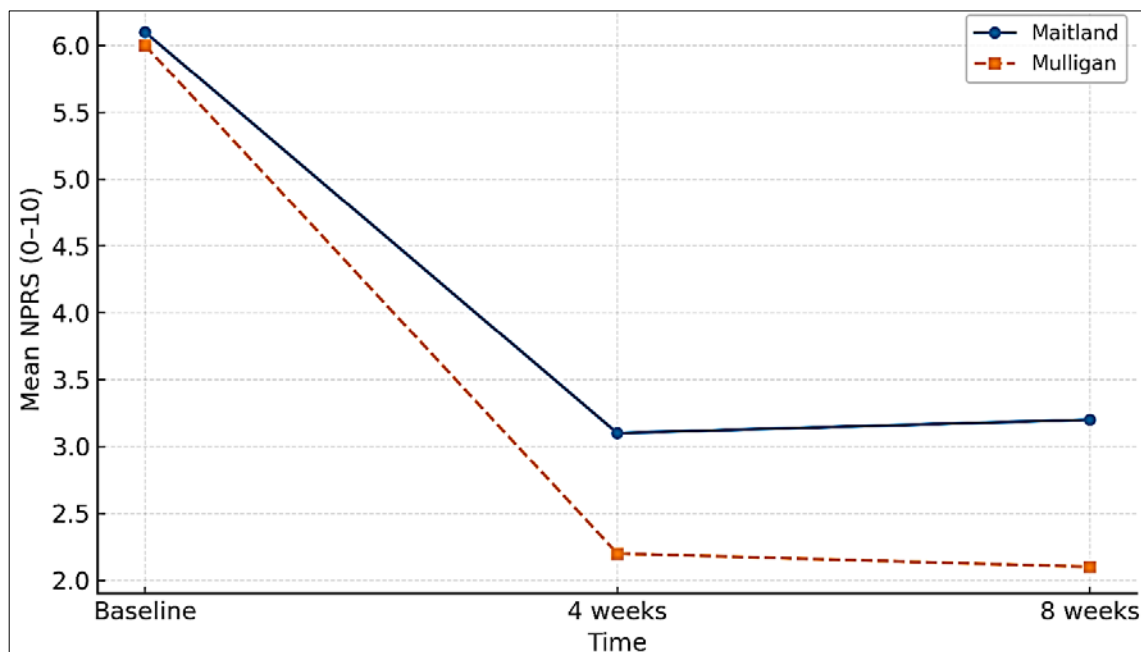


Fig 1: Mean NPRS scores at baseline, 4 weeks and 8 weeks in both groups, illustrating clinically meaningful pain reduction in both groups with a larger decrease in the Mulligan group.

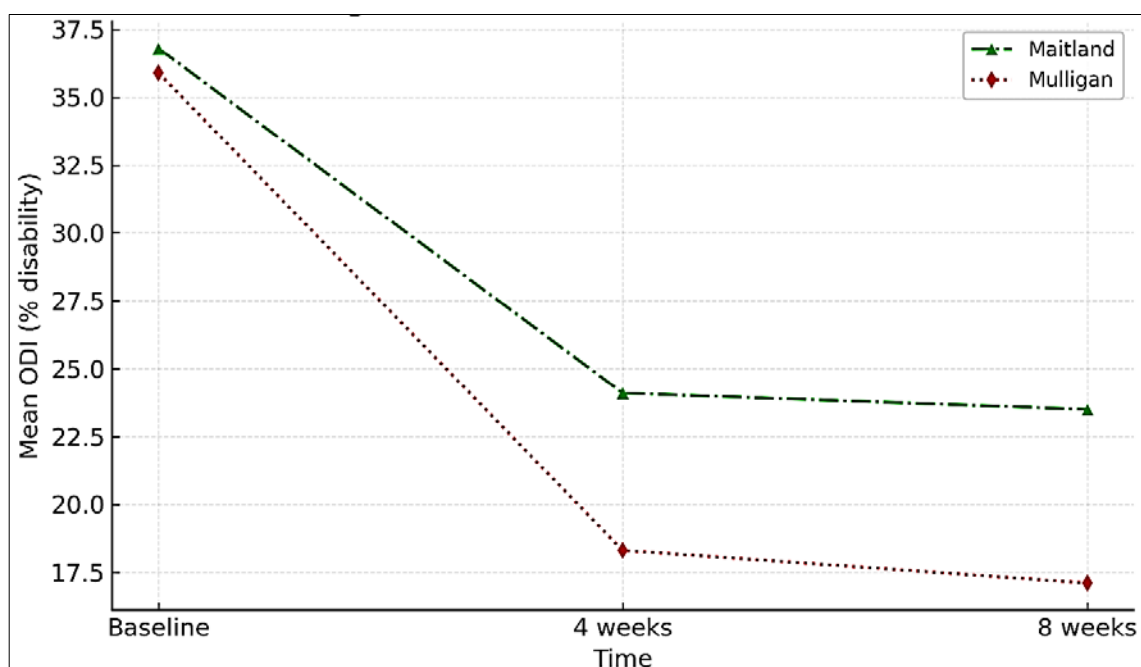


Fig 2: Mean ODI scores at baseline, 4 weeks and 8 weeks in both groups, demonstrating sustained disability reduction with greater improvement in the Mulligan group.

Secondary outcomes: lumbar range of motion and global perceived effect

Lumbar ROM improved significantly over time in both groups (time effect, $p < 0.001$), with a consistent pattern of larger gains in the Mulligan group. Lumbar flexion

increased from 35.4 \pm 7.8 $^{\circ}$ to 43.6 \pm 7.3 $^{\circ}$ at 4 weeks and 44.8 \pm 7.5 $^{\circ}$ at 8 weeks in the Maitland group, compared with 36.1 \pm 8.1 $^{\circ}$ to 48.5 \pm 7.2 $^{\circ}$ and 49.3 \pm 7.4 $^{\circ}$ in the Mulligan group. The between-group difference in flexion change at 8 weeks was 4.0 $^{\circ}$ (95% CI 1.3-6.7; $p = 0.004$). Similar trends were

observed for extension and side-flexion ROM, with statistically significant group \times time interactions favoring Mulligan ($p < 0.05$ for all directions). These findings support the proposed mechanism of SNAGs in facilitating pain-free active movement and correcting subtle positional faults, leading to enhanced segmental mobility [12, 13, 16], while remaining consistent with observed ROM improvements after Maitland mobilizations in mechanical and non-specific low back pain [10, 11, 15].

Global perceived effect (GPE) at 8 weeks was higher in the Mulligan group (mean 7.8 ± 1.4) compared with the Maitland group (6.7 ± 1.6 ; $p = 0.01$), with 75.0% of Mulligan

participants versus 53.1% of Maitland participants rating themselves as “much improved” or “completely recovered” ($\text{GPE} \geq 7$). This pattern of greater patient-reported global improvement parallels the superior reductions in pain and disability and aligns with clinical impressions reported in previous trials of Mulligan mobilization-with-movement techniques [12, 13, 16]. Overall, the secondary outcomes reinforce the primary findings that both interventions are effective but that Mulligan SNAGs, delivered alongside standardized exercise, confer additional benefits in mobility and perceived recovery beyond those achieved with Maitland PA mobilizations [5-8, 10-13, 15, 16].

Table 3: Lumbar ROM and global perceived effect (GPE)

Outcome	Time point	Maitland (n = 32) mean \pm SD	Mulligan (n = 32) mean \pm SD	p (group \times time)
Lumbar flexion ROM ($^{\circ}$)	Baseline	35.4 \pm 7.8	36.1 \pm 8.1	—
	8 weeks	44.8 \pm 7.5	49.3 \pm 7.4	0.004
Lumbar extension ROM ($^{\circ}$)	Baseline	13.7 \pm 4.1	13.9 \pm 4.3	—
	8 weeks	18.4 \pm 4.3	20.7 \pm 4.5	0.021
Lumbar side-flexion ROM ($^{\circ}$; average)	Baseline	18.9 \pm 5.0	19.1 \pm 4.8	—
	8 weeks	24.7 \pm 5.1	27.5 \pm 5.3	0.018
GPE (0-10 Likert)	8 weeks	6.7 \pm 1.6	7.8 \pm 1.4	0.010

Improvements in lumbar range of motion and global perceived effect, with significantly greater gains in the Mulligan group.

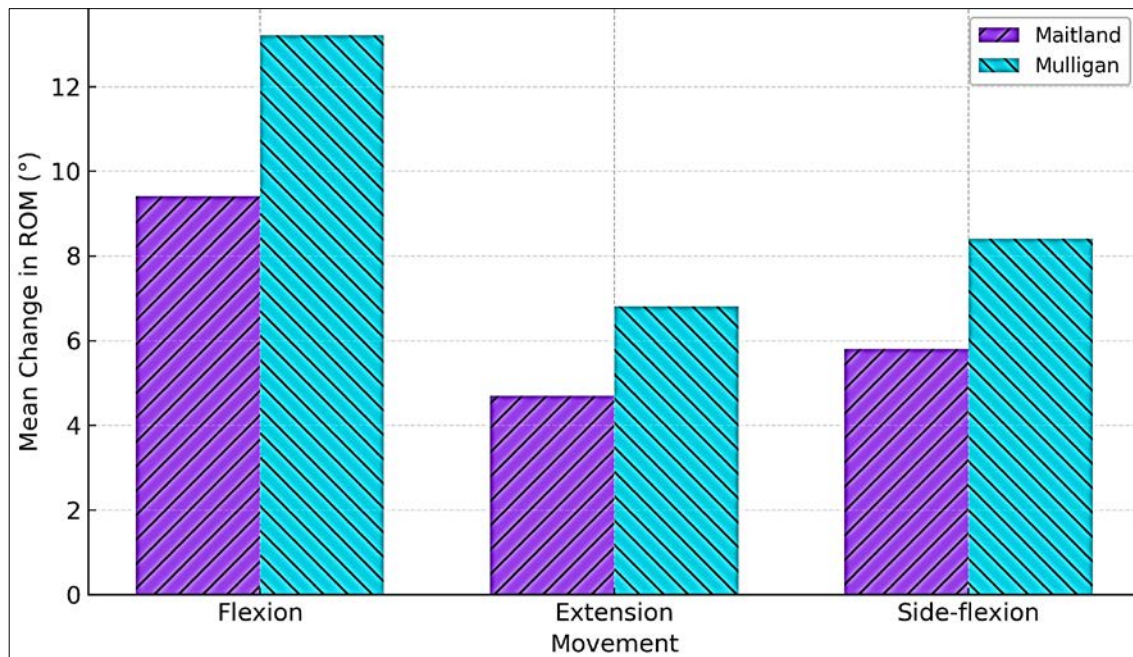


Fig 3: Showing mean change in lumbar flexion, extension and side-flexion ROM from baseline to 8 weeks, highlighting larger ROM gains in the Mulligan group compared with the Maitland group.

Discussion

The present randomized controlled trial compared the effects of Maitland posterior-anterior mobilization and Mulligan Sustained Natural Apophyseal Glides (SNAGs), each combined with a standardized exercise program, in adults with chronic non-specific low back pain (CNSLBP). Consistent with current international guidelines advocating non-pharmacological, exercise-centred management for chronic low back pain [5-8], both intervention arms demonstrated clinically meaningful improvements in pain, disability and lumbar range of motion (ROM) over the 8-week period. Reductions in pain exceeded the commonly accepted minimal clinically important difference (MCID) of ~2 points on 0-10 scales, and improvements in Oswestry Disability Index (ODI) surpassed the 10-percentage-point threshold frequently cited in chronic low back pain

populations [3, 4, 6, 8]. These findings reinforce the role of manual therapy as an effective adjunct to active rehabilitation within a biopsychosocial framework for CNSLBP, rather than as a stand-alone modality [4-8].

A key finding of this study is that, although both mobilization techniques were beneficial, the Mulligan SNAG group exhibited significantly greater improvements in pain, disability and lumbar ROM compared with the Maitland group. The magnitude of between-group differences in NPRS (0.8 points) and ODI (5.1 percentage points) at 8 weeks, along with moderate effect sizes, indicates that these differences are not only statistically significant but also clinically relevant, particularly when viewed against the background of the high global burden of low back pain and the need for incremental gains in function and quality of life [1, 2, 3, 4]. These results align with previous

trials where Mulligan mobilization-with-movement yielded superior or at least robust short-term reductions in pain and disability relative to control or sham interventions in non-specific or chronic low back pain [12, 13, 16]. Our findings are also partially consistent with the randomized study by Khan *et al.*, which reported greater improvements in pain, ODI and ROM with SNAGs plus exercise compared with Maitland mobilization plus exercise [14]. By contrast, the pilot trial by Javaherian *et al.* found comparable immediate gains in ROM following single sessions of either Maitland or Mulligan techniques, without clear superiority [15]; differences in sample size, treatment dosage and follow-up duration may explain the discrepancy, as our study involved a 4-week, 12-session protocol with follow-up to 8 weeks, enabling detection of more sustained and potentially cumulative effects of repeated mobilization.

The superior outcomes observed in the Mulligan group may be related to the specific theoretical and practical features of mobilization with movement. SNAGs are applied concurrently with active, weight-bearing movement and are aimed at correcting presumed “positional faults” while maintaining the movement within a pain-free arc [12, 13]. This combination of an accessory glide and physiological movement may augment segmental mobility, modulate nociceptive input and enhance sensorimotor integration, resulting in immediate and progressive improvements in pain and function [12, 13, 16]. Our observation of larger gains in lumbar flexion, extension and side-flexion ROM with Mulligan SNAGs is consistent with this proposed mechanism and with earlier reports of improved spinal kinematics and movement velocity following Mulligan techniques [12, 13, 16]. Although Maitland PA mobilizations also aim to restore accessory joint play and reduce pain through graded oscillations [10, 11], they are generally performed in non-weight-bearing positions and are not directly integrated with symptomatic functional movements, which may partly explain the smaller ROM and disability changes observed in the Maitland group.

Despite these between-group differences, the Maitland group still achieved substantial improvements in pain and disability that exceeded MCID thresholds, comparable to previous reports where Maitland mobilization plus exercise outperformed exercise alone or other conservative therapies in mechanical or non-specific low back pain [10, 11]. This supports continued use of Maitland mobilization as a valid option, especially where clinicians are highly trained in the Maitland concept or where Mulligan techniques are less familiar. From a clinical perspective, our results suggest that when both skill sets are available, Mulligan SNAGs may be preferentially selected in adults with CNSLBP who present with painful movement limitations, as they may yield greater improvements in mobility and global perceived recovery. These findings also fit within guideline recommendations that do not endorse a single specific manual therapy technique but encourage individualized, patient-centred selection of manual therapy as part of a broader package of care [5-8].

The high proportion of participants in both groups reporting themselves as “much improved” or “completely recovered” on the global perceived effect (GPE) scale further underscores the acceptability and perceived benefit of combining manual therapy with a structured exercise program [4, 6, 8]. The higher GPE scores in the Mulligan group echo findings from prior Mulligan trials in which

patients frequently reported rapid symptomatic relief and functional gains [12, 13, 16]. Given the chronic nature of CNSLBP and its significant impact on work participation and quality of life [1-4], these patient-reported outcomes are particularly important and should be considered alongside traditional clinician-rated measures when evaluating treatment efficacy.

This study has several strengths, including a randomized controlled design with concealed allocation, blinded outcome assessment, standardized exercise co-intervention and intention-to-treat analysis in line with methodological recommendations for chronic low back pain research [3, 4, 6, 8]. Treatment was delivered by experienced physiotherapists formally trained in both concepts, enhancing internal validity and treatment fidelity [9-13, 15, 16]. Nonetheless, some limitations must be acknowledged. First, the sample size, although adequately powered for medium effect sizes, may limit detection of smaller between-group differences and reduces the precision of subgroup analyses (e.g., by chronicity or psychosocial factors). Second, the follow-up period was restricted to 8 weeks; longer-term follow-up is required to determine whether the observed benefits, particularly the apparent superiority of Mulligan SNAGs, are sustained over months to years in line with the chronic, recurrent nature of low back pain [1-4]. Third, the absence of a no-treatment or exercise-only control group precludes definitive conclusions about the added value of either mobilization technique beyond exercise; however, previous trials have already demonstrated benefits of combining mobilization with exercise versus exercise alone in similar populations [10-13, 15, 16]. Finally, this single-centre trial in a tertiary-care setting may limit generalizability to primary care or community populations, where patient characteristics and expectations may differ.

Future research should aim to replicate these findings in larger, multicentre trials with longer follow-up and include cost-effectiveness analyses, given the substantial economic burden of low back pain on individuals and health systems [1, 2]. Comparative-effectiveness studies that integrate clinical, biomechanical and psychosocial outcomes could help clarify which patient subgroups are most likely to benefit from Mulligan versus Maitland mobilization, thereby advancing personalized manual therapy prescription [4, 8, 9]. Additionally, mechanistic studies incorporating imaging, movement analysis and quantitative sensory testing may further elucidate how mobilization with movement influences spinal mechanics, central pain processing and motor control [9, 12, 13, 16]. Overall, within the broader landscape of evidence-based, multimodal management of CNSLBP [5-8], the present findings add to growing literature suggesting that Mulligan SNAGs, when combined with an appropriate exercise program, may offer a modest but meaningful advantage over Maitland mobilization in improving pain, disability and lumbar mobility in adults with chronic non-specific low back pain [10-16].

Conclusion

The findings of this randomized controlled trial indicate that both Maitland posterior-anterior mobilization and Mulligan Sustained Natural Apophyseal Glides, when combined with a structured exercise program, are effective in reducing pain, improving functional disability and enhancing lumbar range of motion in adults with chronic non-specific low back pain,

but that Mulligan techniques confer a modest yet clinically important advantage over Maitland mobilization in all primary and secondary outcomes. Clinically meaningful reductions in pain and disability were observed in both groups, underscoring the value of incorporating manual therapy as an adjunct to evidence-based therapeutic exercise within a broader biopsychosocial management strategy; however, the consistently greater improvements in pain intensity, Oswestry Disability Index scores, lumbar flexion, extension and side-flexion, as well as higher global perceived effect scores in the Mulligan group, suggest that mobilization with movement may be particularly well suited to patients whose symptoms are closely linked to painful active movements and segmental stiffness. Based on these results, clinicians managing chronic non-specific low back pain should consider prioritizing Mulligan lumbar SNAGs, especially in individuals presenting with movement-related pain and functional limitations, while still recognizing Maitland mobilization as a valid and beneficial option when therapist expertise, patient preference or specific clinical presentations favour its use. In practical terms, manual therapy should not be delivered in isolation but embedded within a comprehensive programme that includes individualized stretching of the lumbar and hip musculature, progressive core stabilization, aerobic or general conditioning exercises, patient education on pain mechanisms and self-management strategies, and reinforcement of active coping rather than passive reliance on hands-on care. Therapists should aim to integrate Mulligan techniques into functional positions and task-specific movements, progressively challenging patients within pain-free or minimally painful ranges, and regularly reassessing outcomes to tailor treatment intensity and duration. In service planning and guideline implementation, physiotherapy departments may wish to invest in formal training and competency development in Mulligan concepts for musculoskeletal practitioners, given the potential for enhanced clinical outcomes without substantial additional resource use. For patients, clear advice should emphasize the importance of adhering to home exercise prescriptions, maintaining an active lifestyle, and attending scheduled sessions, as these behaviours are likely to consolidate and sustain gains achieved through manual therapy. At the same time, clinicians should systematically screen for psychosocial barriers such as fear-avoidance, low self-efficacy or depressive symptoms and integrate simple cognitive-behavioural-informed communication and goal setting into care, since manual therapy and exercise are most effective when delivered within a supportive, patient-centred framework. Future clinical practice should also encourage routine monitoring of outcomes, using simple tools such as pain rating scales, disability indices and global perceived effect, to identify early responders to Mulligan techniques and to guide timely modification of treatment plans for those showing suboptimal progress. Overall, the present study supports the recommendation that, where expertise is available, Mulligan SNAGs combined with a structured exercise programme can be considered a preferred manual therapy choice for many adults with chronic non-specific low back pain, while reinforcing the broader principle that optimal management depends on integrating effective manual techniques with active rehabilitation, education and long-term self-management strategies.

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