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Immediate, short and long-term clinical results of combined Mulligan mobilization with movement techniques in non-specific chronic low back pain: a randomized placebo-controlled trial

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Abstract

Introduction: Although the effectiveness of many mobilization methods in chronic low back pain (CLBP) was shown, these effects were not monitored in the long term. This study aimed to identify the immediate, short, and long-term effects of mulligan mobilization with movement (MWM) in CLBP.

Material and methods: The study was designed in randomized-placebo controlled with 36 patients. Pain, range of motion (ROM), flexibility, endurance, functionality, and disabilities were evaluated in both groups. Sustained natural apophyseal glide (SNAG) was applied to the lumbar region, straight leg raise (SLR) with traction to the hip, and internal rotational mobilization techniques and home exercise program were applied in Group 1 (n=19); and the same techniques were applied as sham mobilization in Group 2 (n = 17), for 5 weeks for both. The evaluations were made post-intervention, at the 5th week, 3rd month, and 6th months. The evaluation was also made for pain in the 12th month.

Results: Significant differences were observed between the groups at the end of the treatment, except for The Biering-Sorensen test (SOR) and Sit and Reach Test (SRT) ($p < 0.05$). Although Real MWM showed its immediate effects on pain, internal rotation, and hip flexion ROMs ($p < 0.05$); its effect on flexibility, disability, functionality, endurance, and lumbar flexion ROM, SLR ROM were seen in the long term ($p < 0.0001$). These effects continued for flexibility, disability, functionality and endurance until the 6th month.

Conclusions: The long-term benefits of the MWM Technique, applied to the lumbar region including the hip techniques and its superiority to Sham MWM are the results of this study.

Keywords: low back pain, manual therapy, long-term outcomes, placebo, randomized controlled trial

Introduction

Low back pain (LBP) is a common and disabling disorder whose treatment is considered to be very important by patients, clinicians, and politicians. According to the Global Burden of Disease Study, it is the most common musculoskeletal problem, and its prevalence increased by 18% in the last decade [1].

Physiotherapy or LBP commonly employs the application of various oscillatory movements at different speeds on the spinal region [2,3]. However, no evidence exists on the physiological effects of the different manual techniques [4]. While the effectiveness of mobilization is usually found to be moderate in the literature, it is difficult to classify patients with LBP into homogeneous sub-groups. Although some attempts have been made to show the effects of mobilization on intervertebral movements, they have either been clinical studies or have failed to achieve significant results due to their being based on single-session applications [5,6]. Although the underlying mechanisms of spinal mobilization have not been investigated, previous studies have examined its benefits in terms of biomechanics, and neurophysiological, cellular and psychosocial effects [7−10].

Unlike other soft tissue mobilization methods, the Mulligan Mobilization with Movement (MWM) method targets joints and mechanical effects [11−14]. One of the techniques included in the Mulligan Concept is Sustained Natural Apophyseal Glide (SNAG), which acts by correcting positional errors in the facet joints. This was previously accomplished by identifying the painful and limited movements of the patient, resulting in increased range of motion (ROM) and reduced pain [15]. Briefly, during mobilization, the patient repeatedly performs movements in the direction that elicits pain, with the pain disappearing immediately during the movement [16], thus creating symptom-free movement series [17]. In this way, MWM can be used to allow the patient to move painlessly. MWM has been found to yield promising results in treating chronic LBP (CLBP) [4,12,18].

SNAG has been demonstrated in various studies to increase ROM, reduce pain and improve functional level when applied to the lumbar region [4,14,19]. Hussian et al. [20] found that lumbar SNAG provided an immediate improvement in postural stability and pain in individuals with CLBP. Another study found that SNAG significantly reduced pain and disability and increased back muscle endurance in patients with lumbar facet syndrome compared to Maitland mobilization and Ultrasound groups [21]. However, in contrast to previous studies, which have so far only examined the short-term effects of these methods in clinical practice, our present study examines their long-term effects. In addition, as LBP is known to be influenced by the hip and hamstring muscles, the patients received treatment to both the lumbar and hip area [22−24].

The purpose of the study was to investigate immediate, short-term, and long-term effects of 5-week Mulligan MWM applied to the lumbar and the hip region in patients with nonspecific CLBP, and to compare the results with sham mobilization in terms of disability, endurance, functionality, pain and ROM values.

Materials and methods

Participants

This study was performed as a single-center, prospective, randomized and placebo-controlled trial. Thirty-six patients with nonspecific CLBP were recruited from the faculty of Physical Therapy Outpatient Orthopedic Clinic of Hacettepe University. They were referred for physical therapy by their orthopedic surgeon. Recruitment was provided by verbal announcement in the physical therapy unit. After clinical examination and diagnosis of the degenerative spine and disc disease based on imaging by a specialist, the participants were registered. After screening, 36 (29 women, 7 men) participants aged 18 to 50 years who complained of nonspecific CLBP, mostly provoked by trunk flexion, were included in the study. All met the inclusion criteria.

To determine the minimum number of subjects required for the study, the statistical power was calculated using G* Power (version 3.1.9.2) software. In one study by Konstantinou et al., the mean score and standard deviation were found to be 4.2 (2.5) in the intervention and 4.3 (2.2) in the placebo control groups. This study required a total sample of 36 subjects to give 90% power at a 5% significance level to detect any differences [4].

The present study received approval from the Human Research Ethics committee of University Hacettepe under process number 12/113-03, and is registered with the registry of clinical trials under process number NCT04802850. The study was conducted in accordance with the Declaration of Helsinki. The data collection and statistical analyses were performed by an independent researcher. The inclusion criteria of the study were as follows: three months' continuous or intermittent LBP symptoms, without leg pain above the knee, and pain at VAS > 3/10, with nonspecific CLBP exacerbated by active lumbar flexion movement. The exclusion criteria were as follows: confirmed nerve root compression, neurological symptoms, lumbar spine stenosis, back surgery history, chronic pain syndrome, LBP from fracture, infection, or visceral disease, pregnancy, major clinical depression, cauda equina syndrome or significant osteoporosis. In addition, the participants were screened for the suitability of the Mulligan technique, and those showing adverse effects were excluded.

After signing a consent form, demographic data were collected. The participants were then randomly assigned into two groups. Randomization was simply performed by giving every participant an identification number, and then randomizing them into sham and real combined MWM groups using SPSS software (IBM, Armonk, NY); the latter stage was performed by an independent researcher.

The treatment was started from the day following the initial assessment. The sham combined MWM group consisted of 17 participants (41.8 ± 10.1 years) who received a home exercise program consisting of stretching and strengthening exercises plus sham combined MWM. The real combined MWM group consisted of 19 participants (36.4 ± 11.3 years) who received the same home exercise program of stretching and strengthening exercises plus Mulligan combined MWM.

Procedure

A randomized and placebo-controlled trial was implemented to investigate the immediate, short and long-term effects of adding lumbar SNAG, traction SLR, and hip internal rotation with traction to home exercise treatment of nonspecific CLBP. The following dependent variables were evaluated: lumbar spine flexion ROM, SLR ROM, hip flexion and internal rotation ROM, pain response during spinal flexion, flexibility, endurance, disability, and functionality. Data collection was performed on five occasions, pre-treatment (baseline) and post-intervention (immediate), after the five-week treatment program (fifth week-short-term), after three months (third month-long-term), and six months (sixth month-long-term) follow up; pain assessment was measured after 12 months (twelfth month-long-term) (Tab.1). As it was considered that there might be no immediate changes in the evaluations of endurance and disability, these were evaluated from week 5.

The first evaluation and treatment began in February 2013, and the follow-ups were completed in April 2014. However, follow-ups for pain continued until October 2014. During the first meeting, demographic data (i.e., age, weight, height, body mass index, pain, painful side, and LBP duration) were collected. Treatments were performed by the same specialist physiotherapist who had five years' experience in Mulligan Training. No additional treatments or medications were allowed during the treatments and follow-ups. The patients received a total of ten sessions of Real combined MWM or Sham combined MWM treatment for five weeks, two sessions a week. The sessions lasted 30 minutes. After five weeks of treatment, patients performed basic exercises at home and attended the clinic only for assessments.

At the end of week 5, no advice was given to the patients. The patients came to the clinic for assessments at three and six months for follow-ups.

Primary outcome measures

Flexibility

Flexibility was measured using the lateral side bending test (LBT). The patients stood upright against a wall on two parallel lines at right angles to the wall 15 cm apart. The arms were held straight at the sides of the body. On each side, the middle finger level was marked with a horizontal line on the side of the thigh. The patient was then asked to bend sideways slowly and maintain contact between the back and the wall. Two attempts were performed for each side. The distance between the first and final positions of the middle finger was recorded [25]. The participants were also tested using the sit-and-reach test (SRT), which evaluates the flexibility of the lumbar spine and ischia muscles. This has been used in many studies and has demonstrated high test-retest reliability. Briefly, the patient lay in front of a flat bench in bed, both legs in extension and together, with the feet fully leaned against the bench. He or she then leant forward from the trunk to the point where they could reach forward with both hands on top of each other. The distance was recorded in cm by shifting the patient's hands on a ruler pinned at the top of the bench [26].

Tab. 1. Schedule of assessments

Outcome measures	Pre-treatment (baseline)	Post intervention (immediate)	After 5th week (short-term)	After 3rd month (long-term)	After 6th month (long-term)	After 12th month (long-term)
SRT	√	√	√	√	√	–
LBT	√	√	√	√	√	–
SOR	√	√	√	√	√	–
ODI	√	–	√	√	√	–
PSFS	√	√	√	√	√	–
ROM	√	√	√	√	√	–
Pain	√	√	√	√	√	√

SRT: Sit and Reach Test; R-LBT: Right Lateral bending test; L-LBT: Left Lateral bending test; SOR: The Biering-Sorensen test; ODI: The Oswestry Disability Index; PSFS: The Patient-Specific Functional Scale; ROM: Range of Motion.

Oswestry low back pain disability questionnaire

The Oswestry Disability Index (ODI) was employed to evaluate functional disability [27]. The ODI is considered the gold standard for low back functional outcome measurement. It has 10 sections of six propositions, each of which is rated as 0–5. The maximum possible score is 50. The higher the score, the worst the disability. It has a good level of internal consistency and test-retest reliability for CLBP [28].

Endurance

The Biering-Sorensen (SOR) Test was employed to measure the static muscular endurance of the back extensors. The participant was asked to hold the body in a prone position, with the trunk horizontally outside the bed with hands on both sides. The time was recorded in seconds with a stopwatch. The test was ended at the point where the person was unable to maintain the position because of fatigue, pain or discomfort [29].

Function

The participant was asked to identify a maximum of three important activities, which they were unable to do or had moderate-extreme difficulty doing due to pain. The participant was then asked to rate the level of difficulty that activity caused between 0 and 10 using the Patient-Specific Functional Scale (PSFS) [30].

Secondary outcome measures

Pain intensity

During lumbar spine flexion, the pain intensity was measured with the visual analog scale (VAS), which is reported to be valid and reliable [31]. The VAS consisted of a 10-cm horizontal line with two-word descriptors at the limits of the scale: “no pain” at the left side and “maximum pain” at the right. The patient was asked to draw a line across the scale showing the pain level during active lumbar spine flexion in standing position.

Range of motion (ROM)

Active ROM for total lumbar spinal flexion was measured using a standard goniometer with the subject standing. Active hip internal rotation was measured when patients were sitting with knees bent at 90^o. Active ROM for true and total hip flexion and SLR were measured with a goniometer with the subject lying [32].

Intervention

Real Combined Mulligan Mobilization with Movement Protocol-Lumbar SNAG

– SNAGs were applied unilaterally or centrally with active lumbar flexion to the symptomatic spinal level to patients in the real combined MWM group. The techniques were applied in a sitting position on a plinth with the feet left on the ground. The patients were asked to bend down to the point where they could lean forward painlessly, and then return to the initial point. A mobilization belt was used to stabilize the pelvis and to ensure the safety of the patient when performing a full lumbar flexion to the front. The manual force, which was continued throughout the movement, was applied with the help of a light sponge that prevented slipping on the skin during active flexion to the region corresponding to spinous processes. The force was applied in a parallel direction to the lumbar facet joints. Each SNAG was maintained for several seconds at the end of the flexion range. Each session was implemented in 4–6 repetitions for 2–3 sets in total [15]. Modifications were made in terms of the amount, direction, and level of the force given according to the condition of the patient. It was determined that participants who experienced negative effects as a result of these changes would be excluded from the study, as an exclusion criterion. In the Mulligan Method, similar applications were made as 3–5 sets and 6–10 repetitions if the condition was chronic, with rests between each set [11] Mulligan Techniques, which are frequently used in clinical practice in the direction of flexion, were used in our study [2] (Fig. 1a).
– *Hip internal rotation with traction;* The patients were asked to lie on their backs. After measuring internal rotation ROM on both hips, the painless internal rotation movement was applied as 2–3 sets of six repetitions by applying a mobilization belt parallel to the ground to the hip on the restricted side, and grasping the thigh with both hands into traction in the direction of the abduction (Fig. 1b).
– *Traction SLR method;* Finally, the SLR traction method was applied with traction to the more painful and restricted side by measuring the SLR angles in both hips (Fig. 1c). These techniques were applied to all patients in addition to SNAGs to increase ROM and reduce shortness.

Sham Combined Mulligan Mobilization with Movement Protocol

Sham mobilization included only hand contact or active or passive ROM movements where there would be no therapeutic effects, as indicated in the literature [4,33]. Sham treatments and evaluations were performed by the same specialist physiotherapist.

– *Lumbar SNAG* sham mobilization was applied to include only hand contact or active or passive ROM movements with the same mobilization belt, similar to MWM for lumbar flexion. Each session was implemented as 2–3 sets of 4–6 repetitions in total.

Fig. 1. a – Lumbar SNAG (Sponge was not used to see finger placement clearly), b – Hip internal rotation with traction, c – Traction SLR method

– *Hip internal rotation with traction* sham mobilization was applied to include only hand contact or active or passive ROM movements with the same mobilization belt similar to MWM for hip internal rotation. Each session was implemented as 2–3 sets of 4–6 repetitions in total.
– *Traction SLR method* sham mobilization was applied to include only hand contact or active or passive ROM movements with the same mobilization belt, similar to MWM for hip flexion.

Home exercise program

The home exercise program, which was used in this study, consisted of manual passive stretching exercises for hamstrings, iliopsoas, and back extensors; these were performed in supine, prone, and cross-sitting positions, respectively. Each stretch position lasted for 30 seconds and was repeated three times in each session. The back extensors and abdominal strengthening exercise program included pelvic tilts, bridging, alternative arm and leg activities in the crawling position. Also, abdominal bracing was taught to patients to improve spine stability. The patients were advised to perform three sets of 5–10 repetitions. In both groups, home exercises were reviewed before therapeutic sessions and were recorded by the patients daily. The patients were asked not to continue the home exercise program after week 5.

Statistical analysis

All statistical analyses were performed using the Statistical Package for the Social Sciences, 25.0 software (IBM SPSS Statistics 25 software [Armonk, NY: IBM Corp.]). Continuous variables were expressed as mean ± standard deviation (SD); median (min-max). The

Shapiro-Wilk test was used for testing normality of distribution. When parametric test assumptions were met, the independent samples t-test was used for comparisons among groups. When the parametric test assumptions were not met, the Mann Whitney U-test was used for independent group comparisons. For pairwise comparisons, the Repeated Measures ANOVA was used as the parametric test (*post hoc*: Bonferroni test), and the Friedman test (*post hoc*: Wilcoxon signed-rank test with Bonferroni correction) as the non-parametric test. $P < 0.05$ was considered statistically significant.

Results

In the present study, six of the participants were excluded from the treatment before the beginning of the study for various reasons, and 36 participants completed the treatment and all evaluations at the end of the study. No patients were lost to follow-up (flow diagram of the subjects) (Fig. 2). The initial values and anthropometric data of the patients are given in Table 2. In this respect, no inter-group differences were observed in terms of age, height, weight, Body Mass Index (BMI), pain or ODI value. Significant differences were detected in pain durations ($p = 0.021$). No adverse effects were observed during the evaluations or treatment in the groups during the study period.

Between-Groups Comparison

Primary outcomes

A significant difference in initial SRT values was found between the groups ($p = 0.033$); however, no statistically significant difference was found in the measurements of the post-intervention, week 5, month 3, and

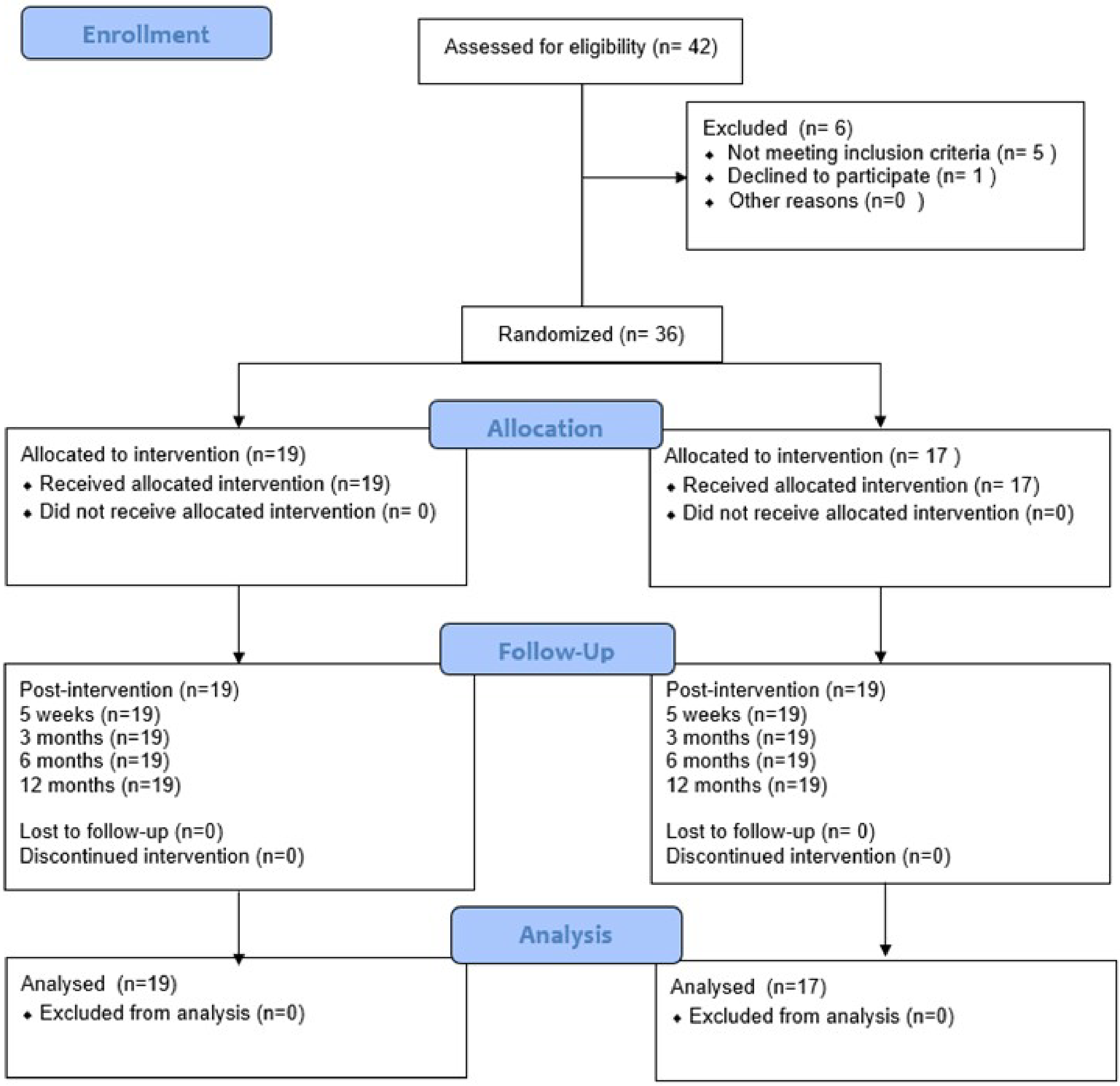

Fig. 2. CONSORT Flow Diagram Design demonstrating patient recruitment and timing of data collection of treatment groups

Tab. 2. Anthropometric data and outcome variables at baseline

Parameter	Real MWM (n = 19)	Sham MWM (n = 17)	t	p
	Mean ± SD	Mean ± SD		
Age (years)	36.4 ± 11.3	41.8 ± 10.1	–1.494	0.144
BMI (kg/m^2)	24.4 ± 3.3	26.5 ± 5.5	–1.401	0.170
Height (cm)	163.84 ± 6.14	163.24 ± 7.24	0.272	0.787
Weight (kg)	66.08 ± 10.18	72.76 ± 11.94	–1.813	0.079
LBP duration (months)	7.4 ± 8.8	4.7 ± 5.2	–2.435	0.021*
Pain at rest (VAS)	6.2 ± 1.9	6.4 ± 2.0	–0.221	0.826
ODI	43.37 ± 14.35	35.86 ± 20.18	0.238	0.813
Number of male/female	4/15	3/14	–	–
Number of painful side right/left	11/8	8/9	–	–

*p < 0.05 statistically significant; SD: Standard Deviation; LBP: Low back pain; MWM: Mobilization with movement; VAS: Visual Analogue Scale; BMI: Body Mass Index; ODI: Oswestry Disability Index.

month 6 (p > 0.05). Statistically significant differences in RLBT and LLBT values was observed between the groups at week 5 and month 3, in favor of the Real MWM Group: the significance values were p = 0.038 at week 5 and p = 0.034 at month 3 for RLBT, and p = 0.005 at week 5 and p = 0.026 at month 3 for LLBT. In addition, statistically significant differences were found between the groups in favor of the Real MWM group in ODI and PSFS at week 5, month 3 and month 6, respectively (p = 0.015, p = 0.004, p = 0.005) (p = 0.01, p = 0.0001, p = 0.0001). No difference was detected between the groups in SOR (p > 0.05) (Tab. 3)

Secondary outcomes

Statistically significant differences in pain (VAS) were noted between the groups at post-intervention, week 5, month 3, month 6, and month 12 (p < 0.05). In addition, significant differences in hip internal rotation and hip flexion ROM on the right and left sides (p < 0.05), and lumbar flexion ROM (p > 0.05) were noted between the groups at baseline, post-intervention, week 5, month 3, and month 6. No difference was detected between the groups in the SLR ROM (p > 0.05).

Within-Group Comparison

Primary outcomes

The SRT values were significantly higher at week 5, month 3 and month 6 compared to the baseline in the Real MWM Group. Also, the measurement at week 5 was significantly higher than at post-intervention. Although treatment was not found to have any no immediate effect for hamstring flexibility, a significant increase was detected at the end of five weeks of treatment, which lasted for up to six months (p = 0.0001). However, treatment did not appear to have any short or long-term effects on hamstring flexibility in the Sham MWM Group (p = 0.588).

In the Real MWM Group, RLBT was found to be significantly higher at week 5 than at baseline (p = 0.01), while LLBT was significantly higher at week 5, month 3, and month 6 compared to baseline (p = 0.0001). The treatment did not appear to have any short or long-term effect on RLBT or LLBT in the Sham MWM Group.

In the Real MWM Group, SOR was found to be significantly higher at week 5, month 3, and month 6 compared to baseline, and at month 3, it was also significantly higher than post-intervention (p = 0.0001). In the in the Sham MWM Group, the week 5 measurement was significantly higher than baseline (p = 0.005).

ODI in the Real MWM Group was found to be significantly lower than baseline at week 5, month 3 and month 6; it was also significantly lower at months 3 and 6 than week 5 (p = 0.0001). In the Sham Group, however, the value was significantly lower at months 3 and 6 than at week 5 (p = 0.028).

PSFS was significantly lower at months 3 and 6 than baseline in both groups. Also, month 3 and 6 were significantly lower than week 5 (p = 0.0001) (Tab. 2).

Secondary outcomes

A comparison of the observed changes of pain, hip internal rotation, flexion, and SLR and lumbar flexion ROM between the Real MWM and sham MWM groups is given in Figures 3–4.

Tab. 3. Intergroup and intragroup differences from baseline to six-month follow-up

Measures		Baseline	Post-int.	5 weeks	3 months	6 months	
		Mean ± SD Med (min–max)	Mean ± SD Med (min–max)	Mean ± SD Med (min–max)	Mean ± SD Med (min–max)	Mean ± SD Med (min–max)	Intragroup p
SRT	Real MWM	–10.04 ± 13.33 –8.75 (–53–8)	–6.69 ± 13.37 –6.25 (–50–13)	–0.72 ± 10.48 αβ 1 (–22–15)	–2.33 ± 9.28 α 0 (–19–12)	–2.19 ± 8.9 α 0 (–17–12)	< 0.0001 (Fr = 35.425)
	Sham MWM	–0.57 ± 10.18 –0.75 (–17–19)	0.57 ± 9.72 –0.25 (–16–19)	–0.64 ± 9.02 0 (–17–17)	0.3 ± 8.76 –1 (–15–19,2)	–0.71 ± 8.86 –2 (–16–19)	0.588 (F = 0.711)
Intergroup p		0.033* (z = –2.126)	0.138 (z = –1.507)	0.832 (t=0.214)	0.324 (t = –1.002)	0.643 (t = –0.468)	
R-LBT	Real MWM	19.08 ± 4.5 19 (10–27)	20.16 ± 4.67 20.5 (8.5–32)	22.14 ± 3.56 α 21.25 (16–30)	21.67 ± 2.45 21.5 (16–25.5)	20.5 ± 3.81 20 (10–26)	<0.01 (Fr = 13.192)
	Sham MWM	18.29 ± 4.03 17.5 (12–25)	18.14 ± 3.25 17.25 (12–24)	19.46 ± 3.34 19 (15–26)	19.82 ± 3.59 20 (12–27)	19.14 ± 3.44 19 (14–25)	0.223 (Fr = 5.696)
Intergroup p		0.466 (t = 0.738)	0.1 (t = 1.69)	0.038* (z = –2.067)	0.034* (t = 2.219)	0.305 (t = 1.043)	
L-LBT	Real MWM	17.92 ± 4.44 17.75 (8–27)	20.19 ± 4.78 19.75 (8–31)	22.25 ± 3.56 α 22 (13 – 28)	21.97 ± 3.15 α 22.5 (13–27.5)	21.56 ± 4.53 α 20.5 (12–33)	<0.0001 (Fr = 26.071)
	Sham MWM	19.04 ± 2.99 19 (15–25)	19.13 ± 2.84 18.5 (14–25)	19.14 ± 3.54 18.75 (14–24.5)	19.39 ± 4.12 20 (9.5–27)	18.93 ± 2.62 18 (15–24)	0.786 (Fr = 1.728)
Intergroup p		0.716 (t = –0.367)	0.244 (t = 1.185)	0.005* (t = 2.987)	0.026 *(t = 2.33)	0.063 (t = 1.931)	
SOR	Real MWM	20.67 ± 15.92 15 (7–65)	27.5 ± 17.55 23 (7–65)	35.28 ± 15.63 α 31 (13–65)	40.22 ± 16.77 αβ 40 (13–70)	40 ± 17.93 α 35 (13–90)	< 0.0001 (Fr = 30.257)
	Sham MWM	23.21 ± 18.44 15.5 (6–63)	25.93 ± 20.23 16 (5–64)	34.5 ± 19.5 α 38.5 (8–61)	35.36 ± 22.46 31.5 (7–80)	34 ± 21.97 31 (7–80)	0.005 (Fr = 15.026)
Intergroup p		0.257 (z = –1.142)	0.208 (z = –1.285)	0.384 (t = 0.884)	0.278 (t = 1.103)	0.401 (t = 0.851)	
ODI	Real MWM	43.37 ± 14.35 40 (22–72)	–	21.64 ± 13.07 α 20 (6–48)	13.11 ± 10.5 αγ 10 (0–42)	12.39 ± 11.08 αγ 10 (0–34)	<0.0001 (F = 62.658)
	Sham MWM	35.86 ± 20.18 37 (8–72)	–	34.29 ± 22.02 24 (4–72)	24.68 ± 14.13γ 20 (2–53)	24.93 ± 11.94γ 21 (2–50)	0.028 (Fr = 9.112)
Intergroup p		0.813 (t = 0.238)	–	0.015* (z = –2.432)	0.004* (t = –3.151)	0.005* (t = –3.07)	
PSFS	Real MWM	20.39 ± 4.1 20 (14–28)	–	9.28 ± 5.51 8 (0–18)	3.61 ± 4.16 αγ 2 (0–12)	2.83 ± 3.29 αγ 2 (0–10)	< 0.0001 (Fr = 51.144)
	Sham MWM	19.93 ± 6.21 21 (11–30)	–	14.57 ± 7.42 α 15 (0–27)	10.93 ± 6.07 αγ 11,5 (0 – 21)	10.21 ± 6.44 αγ 9.5 (0–28)	<0.0001 (F = 15.576)
Intergroup p		0.756 (t = 0.313)	–	<0.01 (t= –2.739)	< 0.0001 (z = –3.47)	< 0.0001 (z = –3.545)	

*p < 0.05 statistically significant; SD: Standard Deviation; Post-int.: Post intervention; MWM: Mobilization with movement; t: Independent samples ***t*** test; z: Mann Whitney U test; F: Repeated measures Anova; Fr: Friedman test; SRT:Sit and Reach Test; R-LBT: Right Lateral bending test; L-LBT: Left Lateral bending test; SOR: The Biering-Sorensen test; ODI: The Oswestry Disability Index; PSFS: The Patient-Specific Functional Scale; α: Significant difference at baseline; β: Significant difference at post-intervention; γ: Significant difference at 5 weeks; δ: Significant difference at 3 months.

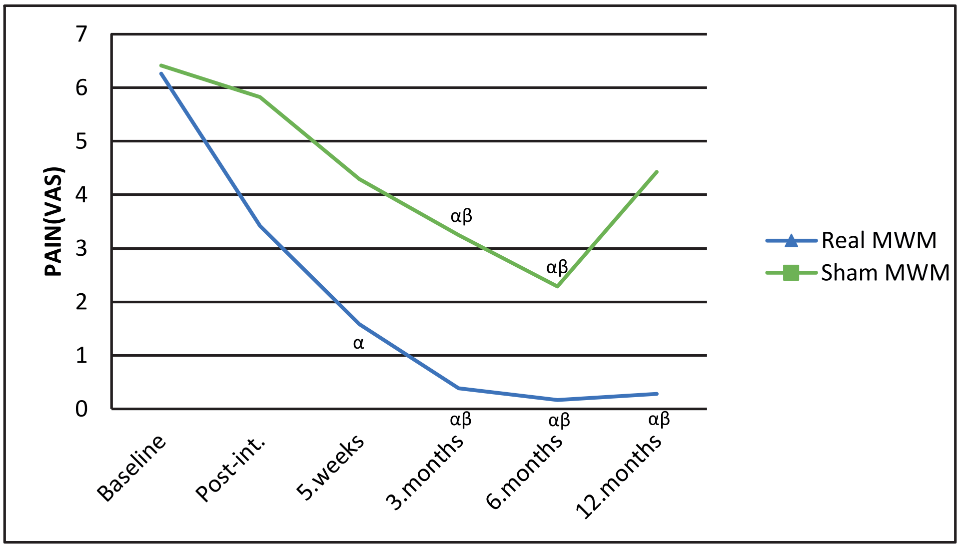

Fig. 3. Changes in Pain values for Real MWM and Sham MWM

$p < 0.05$ statistically significant; α: Significant difference at baseline; β: Significant difference at post-intervention; γ: Significant difference at 5 weeks; δ: Significant difference at 3 months.

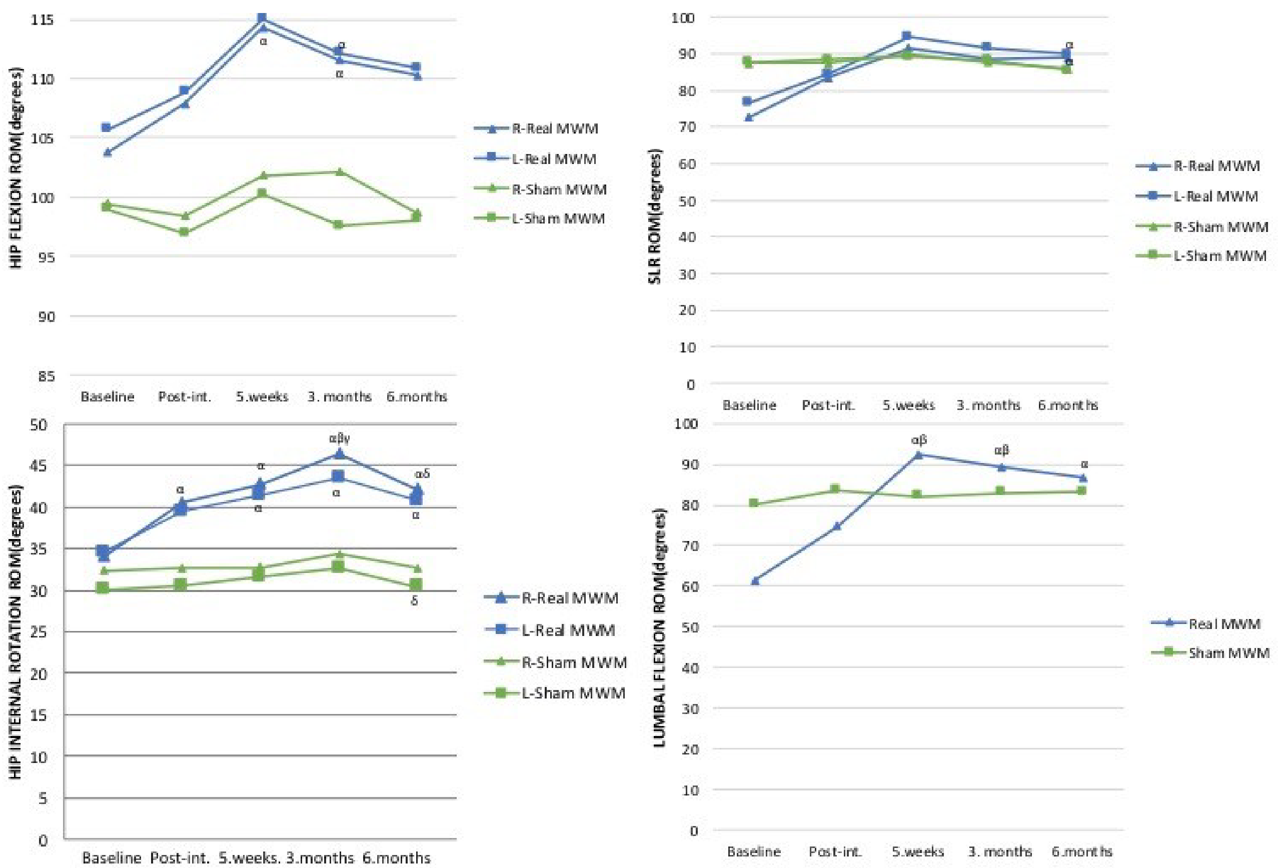

Fig. 4. Changes in Hip İnternal Rotation, Hip Flexion, Lumbar Flexion and SLR ROM values for Real MWM and Sham MWM

$p < 0.05$ statistically significant; α: Significant difference according to baseline; β: Significant difference according to post-intervention; γ: Significant difference according to 5weeks; δ: Significant difference according to 3months.

Discussion

The aim of the study was to determine the immediate, short-term, and long-term effects of disability, endurance, functionality, pain and ROM values associated with five-week Mulligan MWM applied to lumbar and to the hip region in patients with nonspecific CLBP, compared to a sham mobilization procedure. Although significant differences were observed between the Real MWM and Sham MWM groups in terms of lateral flexibility, disability, functionality, pain, hip internal rotation, and flexion ROMs, no differences were noted between groups in terms of hamstring flexibility, endurance, lumbar flexion or SLR ROM.

Most importantly, the Real MWM Group demonstrated short-term and long-term improvements in pain, hip internal rotation, and SLR ROM with immediate effect following mobilization. The achieved effect was maintained for six months. However, for other measured parameters, the effects began to appear in the short term, e.g. at the end of five weeks of treatment, with the effects typically lasting for up to six months. Although no changes in flexibility or ROM measurements were observed in the Sham MWM Group, long-term decreases in pain and disability were noted in the long term (i.e., after three and six months), and changes in endurance and functionality were found at the end of the five-week treatment.

The Mulligan MWM is a is a manual therapy method in which the physiotherapist passively and manually applying gliding movements to the joints at a constant force in a weight-bearing position during active movement. The method places an emphasis on the immediate effects of treatment, and requires the active participation of the patient [15,34]. Very few clinical trials have examined the long-term effectiveness of Mulligan MWM, and these have focused on follow-ups of ankle problems for periods of up to six months [35]. Therefore, our present study protocol included a 12-month follow-up for pain and six-month follow-up for other outcome measures; this is the first such study to do so in nonspecific CLBP.

The study protocol included a Sham MWM treatment, which was applied with an active placebo approach similar to the real one. Several comparisons of spinal mobilization with sham mobilization have been used previously [4,19,33]. Although the study did not evaluate the effect on pain, it did compare the functional effect of spinal mobilization with sham mobilization, especially for the first month [36]. However, when examining its application on peripheral joints, the Mulligan MWM was found to be clinically and statistically more effective at decreasing pain and achieving greater functionality than sham mobilization, or passive or no intervention [37].

In contrast, our present findings indicate that following the immediate efect of treatment, the pain decreased significantly in the Real MWM Group compared to the Sham Group, and this was still observed after 12 months. Mobilization was found to have an immediate effect on pain in the Real MWM Group, but not in the Sham Group; however, the pain was found to decrease from month 3 in the Sham Group, due to the nature of nonspecific CLBP. This decrease in Real MWM continued for 12 months in the Real MWM group, but started to increase clinically in the Sham Group at month 12.

A recent review found that Mulligan Mobilization Techniques provided moderate and short-term effects on pain and disability in LBP [38]; however, the review emphasized that long-term follow-up of the effectiveness of mobilization could not be investigated. In the present study, it was possible to monitor the long-term results of many outcome measures without deficiencies in the groups. Changes began to appear in many parameters in the Real MWM Group at the end of five weeks of treatment, and the effect of mobilization could be maintained for a long period of six months. Particular improvements in disability and functionality parameters were observed at months 3 and 6 compared to week 5, with significant differences in these parameters being detected between groups.

Pain and ROM are the primary targets of Mulligan MWM. In previous studies, 47.6% of therapists generally used active ROM as the most basic outcome measure, while 37% used pain relief [2]. These were supplemented by flexibility, disability, endurance, and functionality in the present study. As noted in previous studies, we believe that situations that would cause pain were prevented with Mulligan MWM by correcting positional errors in the joints and dissolving spasms in the muscles around the joints where the application was implemented [11]. The purpose of Mulligan techniques is to reduce the pain experienced continuously by patients with nonspecific CLBP. The SNAG Technique improved the ability of facet joints to slip in flexion in patients with nonspecific CLBP, normalized the forces coming to the disc, and reduced pain [19]. The pain was generally evaluated with VAS in previous studies, and functional disability was evaluated with ODI, and improvements were achieved [14,19]. In one study, in which lumbar spinal manipulation was examined in two groups, one who received a thrust and another that did not (non-thrust), a two-session application yielded observable improvements in disability in the thrust group after one and four weeks [3]. According to the literature, the acquisition in functional disability that was obtained in the 1st month was achieved in the 5th Week, 3rd month, and 6th month in present study in favor of the Real MWM Group. Although changes in ODI have been observed even immediately after treatment, no immediate change was noted in present study. It is considered that functional disability values decreased because the trunk could move more comfortably in the flexion, parallel to the reduction of pain in patients [34].

Hussien et al. [39] report that a combination of SNAG with conventional physical therapy caused a reduction in pain, increasing functionality in people with nonspecific CLBP. Also, another study found this technique to be more effective in increasing lumbar extension ROM than McKenzie Exercises; however, no such change was observed for pain and disability [40]. The endurance of the body extensors, which is generally increased by strength and stabilization training, did not differ between the groups in the present study. Increases were observed in the Real MWM Group at week 5, month 3 and month 6, compared to baseline, while in the Sham MWM Group, an increase was only noted at week 5. The Mulligan Bent Leg Raise (BLR) Technique was used frequently in Mulligan Technique; while it appears to be effective at increasing SLR ROM and reducing the pain, this effect could be maintained for 24 hours [41].

BLR and leg rotation techniques have been found to yield simialar increases in hamstring flexibility [42]. It has been emphasized that further analysis of many more techniques used in in Mulligan Method is needed [37]. A relationship has been shown between Recurrent LBP and limited hip internal rotation [22] and that patients with LBP demonstrate greater ROM for lateral rotation than for medial rotation [23]. Based on these studies, our present study used leg internal rotation with traction and traction SLR techniques in addition to SNAG techniques.

Hamstring tension is known to influence functional problems, as indicated by Hoffman et al. [43], and our study hence targeted mechanical restoration in the lumbar region and hips to ensure a healthy and functional low back. In the present study, neither hamstring nore lateral flexibility changed in the Sham Group; however, it was found to increase in the Real MWM group from week 5. In a previous placebo-controlled study, SNAG was applied during flexion in 26 people with nonspecific CLBP, with measurements made with an inclinometer. A 7-degree increase in lumbar flexion ROM was noted in the treatment group compared to the placebo group after a single session, but with no change in pain score [4].

Hidalgo et al. [19] recorded improvements in the ROM and speed of body movements compared to a sham group at the end of a single SNAG session applied to the lumbar region in nonspecific CLBP individuals. Improvements were also observed in pain and functional disability. In the present study, an increase in hip internal rotation and SLR was achieved immediately after treatment in the Real MWM Group; this increased further at week 5, and reached higher values than baseline in months 3 and 6, with the value being maintained. Positive changes in hip flexion and lumbar flexion ROMs were noted at the end of the 5-week treatment; in addition, hip internal rotation increased in month 3 compared to week 5 and post-intervention. The value later decreased in month 6, but remained high compared to baseline. It is possible that the observed differences in these values, especially the immediate values, were related to the protocols and techniques applied by focusing on these joint ROMs in the treatment.

Individuals with nonspecific CLBP have different spinal movements to healthy individuals [19]. Hence, it is possible to speculate about the superiority of Mulligan MWM Techniques, which are focused on painlessly developing the movement range of the spinal region. The mobilization method applied in the present study allowed easier and painless movements in our patients. This has been attributed to the adjustment and extinction theory. Immediate and long-term ongoing developments were achieved in patients who experienced painful trunk movements, and whose ability to move was restricted, through performing repeated painless and successful body movements. In other words, the normalization of the input in spinal mechanoreceptors was achieved [44]. Although the effect of spinal mobilizations on the activation of pain-associated areas of the brain and spinal cord has not been measured directly in patients with spinal pain, it is assumed that the hyperexcitability of the muscle spindle was reduced through the modulation of gamma motor neurons [45]. Also, it has been speculated that spinal applications performed with lower extremity movements give better results in pain, ROM, and functional disability [46]. Although these techniques were not used in this study, it has been proposed that the use of three separate techniques involving the lumbar region and hips yields more effective results. In the present study, the inclusion of a sham group using similar but ineffective MWM Techniques revealed more parameters that caused differences.

A limitation of the study was that socioeconomic status and education level were not included in the analysis, botht of which are considered to affect treatment. Another limitation is that the clinicians were not blinded to groups. Furthermore, the movements of the trunk and hip were not evaluated kinematically.

Furthermore, as a result, although treatment did not appear to result in any change in objective measurements such as ROM and flexibility in the Sham MWM Group, the placebo effect caused by Sham MMW was observed in other measurements.

Conclusion

Our findings confirm the positive effect of the MMW Technique on pain and ROM values, and that it could be observed immediately after treatment. Compared to Sham Mobilization, it was concluded that the observed gains in pain, ROM values, flexibility, disability, endurance, and functionality in the Real Group could be preserved in the long term.

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Conflicts of Interest
The authors have no conflict of interest to declare.

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