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Effect of Maitland mobilisation on lumbar proprioception, pain, and disability in patients with chronic non-specific low back pain

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Abstract

Introduction. To investigate the short-term effect of Maitland mobilisation on lumbar proprioception, pain intensity, and functional disability in patients with chronic non-specific low back pain (CNSLBP).

Methods. Fifty-four subjects aged 18–30 years old with CNSLBP were randomly assigned into two groups. The experimental group received a selected exercise program (stretching, strengthening, and lumbar stabilisation exercises) and Maitland posterior-anterior vertebral mobilisation three sessions per week, whereas the control group received the exercises only. Lumbar repositioning error (LRE), pain intensity, and function disability were measured using an isokinetic dynamometer, the visual analogue scale (VAS), and the Arabic version of the Oswestry Disability Index (ODI), respectively. Measurements were taken at baseline and four weeks after intervention.

Results. Within-group analysis showed a significant decrease in LRE, VAS, and ODI after treatment ($p < 0.001$). Between-group analysis revealed a significant difference between groups post-intervention favouring the Maitland mobilisation group ($p < 0.001$) where the mean differences at 95% confidence interval were (–2.10, –1.36) for LRE, (–34.53, –25.61) for VAS and (–9, –7.07) for ODI.

Conclusions. Maitland lumbar mobilisation is effective in improving lumbar proprioception, pain intensity, and functional disability in patients with CNSLBP.

Key words: Maitland mobilisation, chronic non-specific low back pain, functional disability, lumbar proprioception

Introduction

Low back pain (LBP) is considered one of the most widespread musculoskeletal disorders, impacting over 80% of the world's population, resulting in work absence, medical consultation, a decline in quality of life, and financial burden. Moreover, 10–40% of subjects with LBP progress to chronic LBP (CLBP) [1, 2]. LBP is classified into specific and non-specific types [3]. Non-specific LBP (NSLBP) is the most widespread type of LBP. It is the painful sensation or discomfort below the costal margin and above the inferior gluteal cleft and not due to a known disease or specific cause; it accounts for 90% of all individuals with LBP [4].

Proprioception describes the complex integration between afferent and efferent input that allows the body to move and maintain its posture [5]. Proprioception plays an important role in maintaining proper spinal segmental function, appropriate motor control, and dynamic joint stabilisation [6]. Different tissues in the lumbar area, such as the intervertebral disk, muscles, tendons, and joint capsule, provide proprioceptive sense [7]. According to a systematic review, patients with CLBP had lower proprioception accuracy than their healthy counterparts [8]. Lumbar repositioning error was high around 30° of trunk flexion in individuals with CLBP [9, 10].

When lumbar proprioceptive deficiencies arise, the activation pattern of the back muscles is disturbed, the mechanics of the spinal unit differs from that of a healthy spine, and the recurrence rate of LBP increases [6]. CLBP is managed using various intervention modalities, including drug therapy and physical therapy approaches [11]. Physical therapy modalities, such as manual therapy, therapeutic exercises, and biopsychosocial techniques, are used for treating LBP. Manual therapy is a common and suggested modality for treating CLBP that is supported by strong evidence [12]. It is employed in physical therapy practice, including Maitland mobilisation and Mulligan mobilisation [13].

Maitland mobilisation is passive low-velocity oscillatory movement, applied over the symptomatic or hypomobile vertebra [14]. One of the joint mobilisation techniques considered a cornerstone of manual treatment is posterior-anterior vertebral mobilisation (PAVM) [15]. It corrects the misalignment and enhances muscle function, mobility, flexibility, and psychological response [16, 17]. It is also used to control pain by descending and ascending neuronal mechanisms [15].

Maitland mobilisation has varied mechanisms of action on pain and functional activity [18]. However, its effect on lumbar proprioception is still unknown. Therefore, this study was designed to examine the impact of Maitland mobilisation on lumbar proprioception, pain intensity, and functional disability in patients with CNSLBP. We hypothesised that patients assigned to the Maitland mobilisation treatment would achieve greater improvements.

Subjects and methods

This randomised controlled trial was conducted at the physical therapy outpatient clinic of Cairo University from June 2020 to June 2021.

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Sample size determination

G*Power (version 3.0.10) was employed to calculate the sample size. Based on *F* tests (MANOVA: effects and interactions), Type I error (α) = 0.05, power (1-α error probability) = 0.95, and an effect size = 0.50, with two groups and three response variables, fifty-four patients were an adequate sample size.

Subjects

Sixty patients with LBP from the outpatient clinic of the Faculty of Physical Therapy, Cairo University, were selected. After screening, 54 subjects aged 18–30 years were included in the study as they met the inclusion criteria. They had interrupted or continuous LBP symptoms for 3 months and could perform at least 40° of forward trunk flexion. Patients who had specific LBP, those who were pregnant, those with neurological problems, those who were obese, and those who were contraindicated to undergo physical or manual therapy were excluded from this study. Each subject signed a consent form to participate in this study and personal and demographic data were obtained. Randomisation was performed by providing each subject with a specific number. Then, Statistical Package for the Social Sciences (IBM Corporation, Armonk, NY) was used to randomly distribute them into two groups.

Over the course of a four-week intervention, 26 patients in the control group received strengthening, stretching, and lumbar stabilisation exercises (a selected exercise program) three times per week. The Maitland group comprised 28 subjects who received the same exercises as the control group, in addition to Maitland lumbar PAVM. There were no dropouts and all subjects could attend all sessions.

Clinical assessment

Proprioception assessment

An isokinetic machine (Biodex System 3, Shirley, Medical Inc., NY) was employed to measure the lumbar repositioning error (LRE). It is valid and reliable [10, 19]. Every subject was instructed to sit on the back-attachment unit of the dynamometer with their hips and knees flexed at 90°. The subjects were strapped around their thigh, pelvis, and trunk in the test position and were instructed to fold their arms above their chest [10]. The selected test was active repositioning error per speed of 30°/s [20]. The 'target position' for the subjects during the testing protocol was a preset spinal range of motion ranging from neutral spinal posture to 30° lumbar flexion [21].

According to the literature, the lumbar repositioning error around 30° of trunk flexion in patients with CLBP is clearly high [9, 10], so this angle was used to investigate lumbar proprioception [9, 10, 19].

During all trials, the device was locked in the 0° position to provide a consistent beginning position for all the subjects. The chosen protocol required the subjects to perform one familiarising trial, followed by one real test, which was then repeated three times for a total of three familiarising trials and three real testing procedures. The software incorporated in the isokinetic device was used to calculate the mean of the three real testing results [10].

During the learning session, the subjects were instructed to flex their trunk until the machine stopped them at 30° of trunk flexion, then sustain that position for 10 s. With their eyes closed, the subjects clicked a hold button after they achieved the target position during the real test procedure, so the dynamometer could record and preserve the achieved angle [5, 22].

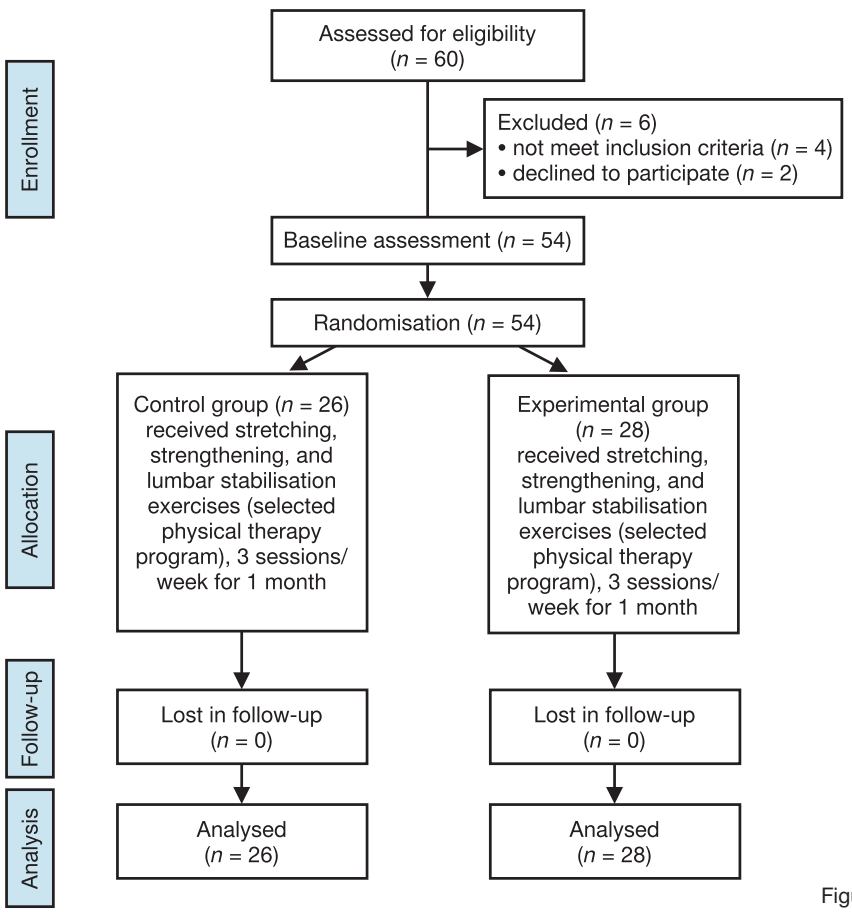

Figure 1. Flow diagram of the study

Pain intensity

The pain intensity was quantified using the visual analogue scale (VAS). The VAS is a 10-cm horizontal line with two ends, where one end expresses no pain on the left side and the other end expresses maximal pain on the right side [23]. Each patient was instructed to mark the horizontal VAS line to determine the current pain level. Using a ruler, the distance from the left side was measured (in millimetres) and recorded on the patient sheet.

Functional disability

The Arabic version of the Oswestry Disability Index (ODI) was used to assess the functional level. The ODI is a 10-item questionnaire, with each item answered using a 6-point Likert scale, ranging from 0 to 5. Pain severity, self-care, sitting, lifting, sleeping, walking, travelling, sex life (if founded), and sociality are all items considered by the ODI [24].

Each patient was instructed to complete an Arabic version of the ODI that described their current functional status. Then, we tallied the overall score for each patient (raw score).

Using the raw scores in the analysis of the data in this study could be more sensitive than using the percentage scores to reflect small changes in the functional status scores [19].

Spinal segmental mobility assessment

Posterior-anterior intervertebral pressure was used to assess the pain or hypomobile spinous level. While the patient was prone, the therapist applied rhythmic pressure (by the thumb or ulnar side of the hand) in the posterior-anterior direction on each spinous process of all lumbar vertebrae (from L5 to L1) and asked the patient if they felt any pain or not. You must feel the mobility of the spinous process and determine if it is normal or hypomobile. The intra rater reliability was moderate at 0.6 [25].

Outcome measures

The primary outcome was the LRE, whereas the secondary outcomes were the changes in pain intensity and functional disability measured by the VAS and ODI, respectively.

Intervention

Maitland posterior-anterior lumbar mobilisation

The subjects were placed in the prone position on a plinth with their hands beside them, and the therapist stood on the subject's side. The ulnar surface of the hand (between the pisiform and hamate) was placed over the hypomobile spinous process. The second hand was placed on top of the first to enhance its force. With the therapist's elbows slightly bent and shoulders exactly above the spinous process, an oscillatory movement of the vertebra was executed by applying a posterior-anterior force to the hypomobile or painful spinous process [15, 26].

Grade III mobilisation was applied four times, each with 60 s of oscillation and 20 s of rest in between them (2 or 3 oscillations per second) [27].

Selected exercise program

The selected exercise program used in this study comprised manual passive stretching, strengthening, and lumbar stabilisation exercises. Passive manual stretching of the iliopsoas, hamstrings, and lower back extensors were performed from three positions: prone, supine, and supine with knee-to-chest positions, respectively. The positions were held for 30 s. The exercises were repeated three times per session. Handling and manoeuvres were performed in accordance with those described in the literature [28, 29].

The supine and prone positions were used to perform abdominal and back extensor strengthening exercises, respectively, for two sets of ten repetitions. For abdominal exercises, both lower limbs were fixed, and the subject was instructed to clasp their hands behind their head and elevate their head, neck, and shoulder blades, then relax. Back strengthening was performed by instructing the subject to elevate their head, shoulders, and upper torso while the subject's lower limbs and pelvis were fixed [29].

Lumbar stabilisation exercises comprised abdominal bracing, side support, and quadruped exercises; the subject started with ten repetitions (hold 8 s) and then progressed to 30 repetitions. In the abdominal bracing exercises, the subject was in a crook lying position and was instructed to tighten their stomach. The subject was instructed to hold the position for 8 s, relax, and repeat. In the side support, the subject was placed in a side-lying position resting on one elbow and one foot and directed to tighten their stomach and lift their hips for 8 s, relax, and repeat on both sides. In the quadruped, the subjects used their arms and legs as levers to train the lower back muscles; initially, the subject elevated one leg and extended the hip to 30° while supporting the trunk on the remaining three limbs and tightening the stomach. The subject then alternated onto the other leg [30].

Data analysis

Before the final data analysis, data were examined for homogeneity of variance and normality assumption. There were no data violations for all dependent variables according to the results of Levene's test and the Shapiro–Wilk test. A 2×2×3 mixed MANOVA was performed to determine differences within and between groups of the chosen measured variables – LRE, VAS, and ODI – before and after treatment. The *F*-value was based on Wilks' lambda. When the MANOVA concluded a significant group × time interaction effect, a univariate analysis of variance (two-way mixed model) was executed. Statistical Package for the Social Sciences (version 24) was used to perform all statistical procedures. The α level was set at $p < 0.05$.

Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the Ethics Committee of Cairo University (approval number P.T.REC/012/00261935). This study was registered in the Pan African Clinical Trial Registry (Registry ID PACTR 202004688).

Informed consent

Informed consent has been obtained from all individuals included in this study.

Results

MANOVA revealed a significant combined impact of time and treatments on LRE, VAS, and ODI ($F = 7.07$, Wilks' $\lambda = 0.7$, $p < 0.001$, $\eta^2 = 0.30$). Furthermore, time had a sig-

nificant major impact ($F = 319.70$, Wilks' $\lambda = 0.05$, $p < 0.001$, $\eta^2 = 0.95$). Univariate ANOVAs showed a significant decline in LRE (F = 210.60, $p < 0.001$, $\eta^2 = 0.80$), VAS ($F = 462.59$, $p < 0.001$, $\eta^2 = 0.89$), and ODI ($F = 477.02$, $p < 0.001$, $\eta^2 = 0.90$). This combined impact suggests that the change between both groups on the linear interaction of outcomes varies between before and after the intervention.

Before the intervention, no significant differences in the clinical and demographic data were observed between the control and experimental groups ($p > 0.05$) (Table 1).

After the intervention, statistically significant decreases in LRE, VAS, and ODI were observed in the two groups compared with those before the intervention ($p < 0.001$).

Pairwise comparison analysis revealed a significant difference between the two groups in showing the most significant changes, where the mean differences at 95% confidence interval were (–2.1, –1.36) for LRE; (–34.53, –25.61) for VAS; and (-9, -7.07) for ODI, respectively (Table 2 and 3).

Table 1. Baseline clinical and demographic characteristics of patients

Characteristics	Maitland group (mean ± *SD*)	Control group (mean ± *SD*)	*p*-value
Age (years)	21.6 ± 3.2	22.3 ± 3.5	0.45
Sex	23 males 5 females	21 males 5 females	0.82
Height (cm)	171.5 ± 8.7	169.5 ± 6.6	0.37
Weight (kg)	68.9 ± 8.7	67.7 ± 6.9	0.55
BMI (kg/m^2)	23.1 ± 1.94	23.2 ± 1.9	0.77
LRE (°)	3.5 ± 0.55	3.34 ± 0.89	0.49
VAS	44.1 ± 10.00	42.6 ± 10.2	0.57
ODI	11.8 ± 2.4	11.2 ± 2	0.34

LRE – lumbar repositioning error, VAS – visual analogue scale, ODI – Oswestry Disability Index, level of significance at $p < 0.05$

The percentages of improvements were (62.7%, 78%, and 76.3%) for the study group and (40.7%, 60.7%, and 62.9%) for the control group for LRE, VAS and ODI, respectively. This indicated greater improvement in the Maitland group than the other group.

Discussion

The findings of this study revealed that there was an improvement in LRE, pain intensity, and functional disability in both groups, however, the Maitland mobilisation group showed greater improvements.

There are many explanations for the effect of Maitland mobilisation on lumbar proprioception. First, this effect could be related to relief of the lumbar facet joint capsular strain. Facet joints play an important role in stability, pain, and proprioception [31]. As a result, mobilising the affected facet helps relieve excessive tension on the apophyseal capsule and improves joint movements, which may improve joint position sense (JPS) through normalising proprioceptive function [32].

Second, Maitland mobilisations stimulate mechanoreceptors while inhibiting nociceptors, resulting in normal signals being transmitted to the motor control unit, which builds muscular patterns for activating and coordinating lumbar muscles to achieve adequate lumbar stabilisation [33]. Lumbar mobilisation may rectify the aberrant activity of spinal muscles, which is crucial for central nervous modulation and better motor interaction of the spinal muscles [34], which improves the JPS.

Third, PAVM lengthens tightened structures containing proprioceptors, such as muscles, capsules, fibrosed discs, and ligaments, allowing them to regain mobility limited by these tight tissues and augmenting their signal transmission to the somatosensory cortical area [6, 33].

The findings of this study on LRE are consistent with those of Gong, who investigated the effect of Gong vertebral mobilisation on LRE and reported that it improved LRE [32].

Table 2. Lumbar proprioception, pain intensity, and functional disability post-intervention[a]

Characteristics	Maitland group (mean ± *SD*)	Control group (mean ± *SD*)	Mean difference	95% CI	*p*-value
LRE (°)	1.4 ± 0.68	1.98 ± 0.62	0.58	(0.23, 0.95)	0.002
VAS	9.6 ± 2.9	16.96 ± 3.3	7.35	(5.66, 9.04)	< 0.001
ODI	2.8 ± 1.4	4.15 ± 1.9	1.35	(0.42, 2.24)	0.005

LRE – lumbar repositioning error, VAS – visual analogue scale, ODI – Oswestry Disability Index CI – confidence interval
[a] – adjustment for pairwise multiple comparison: Bonferroni, level of significance at $p < 0.05$

Table 3. Lumbar proprioception, pain intensity, and functional disability pre- and post-intervention[a]

Characteristics		Pre-intervention (mean ± *SD*)	Post-intervention (mean ± *SD*)	Mean difference	95% CI	*p*-value
LRE (°)	Maitland group	3.5 ± 0.55	1.4 ± 0.68	–2.1	(–2.42, –1.76)	< 0.001
	control group	3.34 ± 0.89	1.98 ± 0.62	–1.36	(–1.71, –1.02)	< 0.001
VAS	Maitland group	44.1 ± 10	9.6 ± 2.9	–34.53	(–38.43, –30.64)	< 0.001
	control group	42.6 ± 10.2	16.96 ± 3.3	–25.61	(–29.65, –21.7)	< 0.001
ODI	Maitland group	11.8 ± 2.4	2.8 ± 1.4	–9	(–10.02, –7.97)	< 0.001
	control group	11.2 ± 2	4.15 ± 1.9	–7.07	(–8.14, –6.01)	< 0.001

LRE – lumbar repositioning error, VAS – visual analogue scale, ODI – Oswestry Disability Index, CI – confidence interval
[a] – adjustment for pairwise multiple comparison: Bonferroni, level of significance at $p < 0.05$.

Similarly, Patel [35] found that Maitland mobilisation was effective in reducing neck pain and improving cervical proprioception compared with conventional therapy and sustained natural apophyseal glide mobilisation. Furthermore, Hussien et al. [19] demonstrated that Mulligan mobilisation improves LRE more than conventional therapy, which supports our findings.

The improvement in VAS scores in the Maitland mobilisation group was due to the activation of mechanoreceptors located in the joint. This modulates the pain-spasm cycle by presynaptically blocking pain signals and inducing the relaxation of muscle spasms, reducing pain and improving function [36].

The higher functional scores in the Maitland group are attributed to the fact that Maitland mobilisation enhances the range of motion, reduces pain, and facilitates painless movement [13]. Painless mobility enhances self-confidence and lowers depression and fear associated with LBP [37]. Therefore, painless movement allows those patients to accomplish activities of daily living easily.

Our findings are consistent with those reported by Baig et al. [38], as Maitland posterior-anterior mobilisation has a greater impact on pain and functional disability associated with NSLBP than thermal therapy. In a similar study, Sharma et al. [33] compared the efficacy of Maitland PAVM to conventional physical therapy on pain response and functional ability in individuals with CNSLBP and found that Maitland PAVM was superior.

The findings of this study contradict those of Sakulsriprasert et al. [39], who found a reduction in pain level as well as improvements in lumbar range of motion and functional status in a group of NSLBP patients who received conventional therapy versus a group that received lumbar mobilisation in addition to conventional therapy. They concluded that Maitland's mobilisation had no additional effect [39]. This variation could be explained by the onset of LBP in their study, which was conducted on individuals who had acute NSLBP. In addition, Abe et al. [16] conducted a trial to investigate the acute effects of Maitland's central posterior-anterior mobilisation on subjects with LBP and found that it had no influence on pain intensity. The small sample size and short treatment period could account for this disparity. Furthermore, Mackawan et al. [40] compared the efficacy of Thai massage and mobilisation on substance P and pain perception in patients with CNSLBP and found that Thai massage reduces pain more effectively than mobilisation. This difference could be attributed to the fact that this trial concentrated on the immediate effects of these interventions and employed a different grade of mobilisation.

The limitations of this study are worth mentioning. Firstly, the force of the mobilisation could not be objectively quantified. However, all mobilisation procedures were applied by the principal investigator. Furthermore, there are no follow-up details that would allow us to track the long-term effects of this intervention; therefore, addressing this in future studies would be beneficial.

Conclusions

Overall, Maitland mobilisation combined with a selected exercise program is more effective than exercises alone to augment lumbar proprioception, alleviate pain, and improve functional disability in patients with CNSLBP.

Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

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