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EFFICACY OF NEURAL MOBILIZATION ON LOW BACK PAIN WITH S1 RADICULOPATHY

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ABSTRACT

Background: A definite conclusion about the effectiveness of neural mobilization on patients with radiculopathy can't be reached because of the lacks of well designed randomized controlled trials. The purpose of the study to investigate the effects of neural mobilization on low back pain subjects with S1 radiculopathy.

Methods: Sixty chronic low back pain subjects with S1 radiculopathy participated in this study. The participants were suffering from varying degrees of unilateral pain and paresthesia in the lumbosacral region and lower limb. The causes of radiculopathy were bulged disc, herniated disc or neuroforaminal stenosis at L5-S1 level. The participants were randomly assigned into two equal groups with 30 participants in each group. The experimental group received neural mobilization and conventional rehabilitation program in the form of infrared, ultrasonic and general exercises that involved stretching and strengthening exercises for the back muscles for 6 weeks. The control group received the same conventional rehabilitation program only for 6 weeks. The outcome measures were H-reflex latency, amplitude, and H/M ratio for assessing S1 nerve root function, visual analog scale (VAS) for assessing pain level, and Oswestry Disability Index (ODI) for assessing functional disability. All the participants were evaluated pre and post 6 weeks of treatment.

Results: Both groups showed significant improvements in all measured variables after 6 weeks, but neural mobilization showed more beneficial and statistically significant effect in all measured variables than the control group.

Conclusion: Neural mobilization technique is an effective intervention for reduction of pain, functional disability and enhancing physiological function of the nerve root in low back pain with lumbosacral radiculopathy.

Keywords: Neural mobilization, Low back pain, functional disability, Lumbosacral radiculopathy, nerve root function, H-reflex.

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INTRODUCTION

Low back pain (LBP) is still one of the most severe health problems in all developed societies despite of the increasing knowledge related to spinal diseases. The importance of the problem was attributed to its psychological and socioeconomic effects and the lack of the effective treatments that have been suggested [1,2,3]. Low back pain affects about 60% to 80% of adults during their lifetime [4,5]. There are many etiologies stated to be responsible for LBP as one of the possible causes of LBP is lumbosacral radiculopathy [6,7]. Lumbosacral disc herniation, discopathies or space-occupying lesion showed to be responsible for the wide range of the cases of lumbosacral radiculopathy that lead to inflammation of the nerve root, impingement, or both [6,7,8].

In the lumbosacral spine, the frequency of radiculopathy is high [9]. The location and pattern of the patient's manifestations may vary, according to the nerve root affected [10]. L5-S1 and L4-5 are the most common levels affected in lumbosacral radiculopathy [6,11] and the typical symptoms include radiating pain, often with numbness, paraesthesia, muscle weakness or a combination of all these symptoms [11,12,13,14] which often cause functional disability [10].

Because of human movements, various types of mechanical stresses are putted on nerves, and the nerves can withstand these stresses. When the nerve subjected to compressive, tensile or shear forces that exceed its capacity, the circulation within the nerve and axoplasmic flow are obstructed and this leads to ischemia and impaired function [15, 16]. Disc herniations, and stenosis of the spinal canal are the main causes of compressive stress that will hinder the flow of the blood to the nerve root [17]. Compressions of the nerve root can lead to both motor and sensory dysfunction [18,19]. Furthermore, compressions of the nerve root causes some changes in nerve microvascular circulation and release of some inflammatory mediators leading to pain [20]. Thus, adhesions are formed among the nerve root and the injured disc as a result of inflammation leading to entrapment of nerve root sliding. In addition, intraneural edema, neural conduction block, and mechanical sensitization are associated with nerve root compression [20,21,22]

Various Physical therapy interventions as exercise, manual therapy, and electrotherapy have been used for treatment of lumbosacral radiculopathy [23, 24, 25]. There has been a rising debate about the effectiveness of different interventions and a consensus has not been yet established [23,26,27,28]. One of the interventions used for treatment of lumbosacral radiculopathy is the neural mobilization technique which gained considerable attention among physical therapists. It aims to mobilize the peripheral neural tissue and the structures surrounding them thus influencing the mechanical properties of peripheral nerves [16,29,30,31]. Physical therapists used these techniques for management of different neural tissue compression disorders and other disorders that might include neuropathic pain to restore the

mechanical function of impaired neural tissue [16,29,32].

The proposed effects and underlying mechanisms of neural mobilization technique associated with clinical improvements were based on theory rather than research evidence and remain unclear [16,31,33]. There are many theories that have been postulated, including enhance circulation within the nerve, axoplasmic flow, viscoelasticity of the neural connective tissue, dispersion of intraneural oedema [34,35,36,37,38], reduction of dorsal horn and supraspinal sensitization [35,39] and promote nerve excursion [40,41].

Hoffmann reflex (H-reflex) is considered the electrical analog of the monosynaptic stretch reflex. H-reflex serves as a reliable estimate of spinal level motoneuron pool activity and accurate investigation of nerve root activity [42,43]. H-reflex is used for assessment of the peripheral nervous system in relation to conduction of the peripheral nerve and compression of the S1 nerve root. Assessment of the S1 nerve root function is the primary clinical application of the H-reflex such as radiculopathy [44,45,46].

Several studies had been conducted to clarify the impact of neural mobilization in LBP patients [32,47,48,49,50,51]. Although, the results from most of these studies indicated that there is a clinical improvement and a positive therapeutic benefit after treatment with different neural mobilization techniques; there is limited evidence that confirm using of neural mobilization techniques because of poor methodological quality and qualitative analysis of these studies [16,30]. According to Efstathiou et al 2015, and Ellis et al 2008 on their systematic review on the effect of neural mobilization, a definite conclusion about the effectiveness of neural mobilization on patients with radiculopathy can't be reached because of the lack of well designed randomized controlled trial that could investigate the effect of neural mobilization in radiculopathy [16,30].

Furthermore, the conducted case studies and clinical trials had small sample sizes. In addition, the pathologies treated in these studies by neural mobilization are non-specific and involved various neurological syndromes [16,30]. So, subgrouping and classification of the patients into several groups according to the reason of injury of the nerve root could help to identify the efficacy of neural mobilization on different subgroups of patients [16,30,52,53]. In addition, it is theoretically assumed that neural mobilization could affect H-reflex through its impact on the interconnection between the nerve mechanics and physiology [54,55]. It is important for a physiotherapist to understand the impact of neural mobilization on the mechanical and physiological aspect of the nervous system. So, there is a need to investigate the effect of a neural mobilization on H-reflex testing.

Existing research literature lacks well designed study regarding the effect of neural mobilization on radiculopathy [16,30]. There are needs to conduct randomized clinical trials with more consideration to pathology, study design, and intervention. So, the aim of the study is to explore the effect of neural mobilization on low back pain subjects with S1

radiculopathy aiming to provide an increment to the management of lumbosacral radiculopathy.

MATERIALS AND METHODS

Subject

Sixty chronic low back pain subjects with S1 radiculopathy whose age ranged from 30 to 50 years participated in this randomized controlled trial. The participants were selected randomly from Physical Therapy outpatient's clinic, Faculty of Medicine, Cairo University. Until fulfillment of sample size, about 84 participants were screened as a primary examination to identify any exclusion criteria. Participants met the inclusion criteria if they were suffering from LBP with unilateral S1 radiculopathy for more than 3 months. The participants with S1 radiculopathies were suffering from unilateral paresthesia and pain in the lumbosacral region and lower limb, weakness in the calf muscle and diminished Achilles tendon reflex. Herniated or bulged disc, or neuro foraminal stenosis at L5-S1 level were the causes of radiculopathy. Clinical examination, and MRI and CT radiological imaging were used to confirm the diagnosis of radiculopathy. Participants were excluded if they had a history of any surgery, trauma, or pathology of back, hip, knee, and ankle. Participants were also excluded if they had any systemic disease as diabetes or neurological condition that altered the function of the nervous system. The study was approved by Faculty of Physical Therapy -Cairo University ethical committee. Informed consent form was signed by each participant agreeing to participate in the study.

The participants were assigned randomly into two equal groups. To avoid selection bias, participants were randomly assigned to each group by selecting either an odd or even number from an opaque envelope. The first group was the experimental group which included 30 participants who received neural mobilization and conventional rehabilitation program for LBP with S1 radiculopathy. The conventional rehabilitation program consisted of therapeutic ultrasonic, infrared, and general exercises program which involved stretching and strengthening exercises for back muscles for 3 days / week for 6 weeks. The other group was the control group which included 30 participants who received the same conventional rehabilitation program for LBP with sciatica only for 3 days / week for 6 weeks.

Outcome measures

The H reflex was used for assessing S1 nerve root function, visual analog scale (VAS) for assessing pain level, and Oswestry Disability Index (ODI) for assessing functional disability for each patient. All the participants were evaluated at baseline (pretreatment) and after-treatment program (6 weeks posttreatment).

Evaluation procedures

Assessment of H-Reflex

Computerized Electromyography system (ToenneisNeuroscreen plus) was used to electrically stimulate and record the soleus H-reflex. H-reflex latency, amplitude, and H/M ratio were recorded while the participant in a prone lying

position. The participants were instructed to maintain the arms and legs position as much as possible throughout testing to allow for reliable H-reflex measures while their heads were maintained in the neutral position to prevent any influence of asymmetrical tonic reflex. The affected lower limb was slightly flexed 20° at the knee joint by putting a pillow beneath the knee joint to gain relaxation of the gastrocnemius muscle to avoid any interference with the recorded data. Two silver-silver chloride surface bar electrodes were used as the stimulating and recording electrodes and a rounded silver electrode 2 cm in diameter served as the ground electrode. In order to decrease the skin impedance, the skin under the electrodes was scrubbed with sand and finally cleaned with alcohol.

Stimulating electrode was putted longitudinally at the popliteal fossa midline to stimulate the tibial nerve with the cathode proximal to the anode while the recording electrode was placed above the soleus muscle two finger-breadths distal to the bifurcation of the gastrocnemius muscles.

The reference electrode was placed over the Achilles tendon distal to the active cathode electrode. The site of the ground electrode was at half distance between stimulating and recording electrodes on the skin of the calf muscle. The latency and amplitude, and H/M ratio of H-reflex were recorded pre and post treatment for all participants in both groups.

Assessment of Pain Level

By using VAS which is valid [56] and reliable [57,58] for detecting pain level. Each Participant was asked to put a mark along 10 cm line that indicated their perception of pain level with 0 representing no pain and 10 indicating worst pain.

Assessment of functional disability

ODI was used to assess the functional disability of each patient. It was a valid [59] and reliable [60,61] tool for measuring functional disability in LBP patients. It involved 10 questions about disability in daily function and leisure time activities. The participants selected an answer which explained their disability for each question. The maximal score was 50 (maximum disability) and the result was taken as a percentage from the total score. High score indicated greater disability. Score from 0 to 20% indicated minimal disability, score from 20 to 40% indicated moderate disability, score from 40 to 60% indicated sever disability, score from 60 to 80% indicated crippled disability, and score from 80 to 100% indicated that the patient was confined to bed [62].

Treatment procedures

Conventional rehabilitation Program

The participants in both groups received the conventional rehabilitation program for treatment of LBP with S1 radiculopathy. It consisted of therapeutic ultrasonic, infrared, and general exercises program which include stretching and strengthening exercises for back muscles for 3 days /

week for 6 weeks. Ultrasound was applied to patient's lower back with a frequency of 1 MHz at a continuous mode and 0.5 W/Cm² for 5 min using moving sound head technique. Non-luminous infrared generators were applied for 30 min on patient's lower back. The I.R lamp was parallel to the back with a distance from the skin about 60 to 90 Cm. The general exercises program consisted of stretching exercises according to Khalil et al [63] and strengthening exercises according to Weinhardt and Heller [64] and Deutsch [65] for back muscles. The stretching exercises were repeated for 5 times and each time was for 30 sec and the strengthening exercises were done for 3 sets with 5 to 10 repetitions in each set.

Neural Mobilization

The neural mobilization technique was done for the participants in the experimental group for inducing longitudinal tension on the sciatic nerve and its branch, lumbosacral nerve roots, and dura matter. The technique used was straight leg raise neural mobilization technique. For application of this technique, the participant was in supine lying position and the therapist raised the treated leg in standard straight leg raise till either pain in the back or leg hindered the movement then the affected leg was lowered a few degrees from this point. After that, the therapist applied a series of oscillatory movement in ankle dorsiflexion direction to mobilize the sciatic nerve [66]. According to Sarkari and Multani [32] the straight leg raise technique was given for approximately 10 minutes including 30 sec oscillations and 1 min rest in each session. According to the patient response, the amplitude of the neural mobilization progressively increased to a point where resistance of the movement was met or to a point where pain was generated. As pain was relieved, more tension on the sciatic nerve was put through the addition of planter flexion of the ankle, inversion of foot and hip medial rotation and adduction [66]. The therapist increased the range of movement gradually till accomplishing the maximum range of straight leg raise.

Statistical Analysis

Data were analyzed for this randomized controlled trial using descriptive statistics and with a 2×2 mixed model Analysis of variance (ANOVA) with the treatment groups (experimental vs. control) used as the between subjects factor and time of assessment (pretreatment, post 6 weeks of treatment) used as the within subjects factor. The software used for statistical analysis was the SPSS version 17. The P-value was set at 0.05. The dependent variables were pain level, functional disability, and H-reflex latency, amplitude and H/M ratio. Before data analysis, Shapiro–Wilk test was used to test the normality of the data and Levene's test was used to test the equality of variances. The differences in demographic characteristics for both groups were assessed using unpaired t-tests and Chi-square test. Unpaired t-tests were also used to assess if there was a difference in pretreatment dependent variables between the two groups. A preliminary power analysis with a power 80% determined

a sample size of 30 subjects in each group.

RESULTS

Demographic data of the participant is presented in Table (1). No statistical differences were found between both groups in demographic data. All data of the dependent variables are normally distributed as revealed by Shapiro–Wilk test and all data showed no violations of the assumptions of equality of variance as revealed by Levene's test. All pretreatment dependent variables showed no significant difference between the two groups (P>0.05).

Characteristics		Experimental Group	Control Group	P-value
Age		41.56± 4.09 (year)	40.8± 5.37 (year)	0.53
Weight		78.33± 8.69 (Kg)	76.23± 10.76 (Kg)	0.4
Height		168.73± 8.08 (Cm)	167.53± 7.39 (Cm)	0.55
Gender	Male	20 (66.67%)	18 (60%)	0.78
	Female	10 (33.33%)	12 (40%)	

Table 1: Demographic data of the participants

Descriptive statistics of pain level, functional disability, and H-reflex latency, amplitude and H/M ratio are demonstrated in Table (2). All participants followed the instructions and attended all treatment sessions with a percentage of 100% in both groups. The 2×2 mixed-model ANOVA analysis demonstrated significant reduction in the H-reflex latency post treatment in both groups as the main effect of time was statistically significant (p<0.0001). But experimental (neural mobilization) group showed significant improvement than the control group post 6 weeks of treatment as the main effect of group was statistically significant where (p<0.01) and interaction between time and group was also significant (p<0.0001) as presented in table (3).

Variables	Group	Pre treatment	Post treatment
H-reflex latency (ms)	Experimental Group	32.04±2.02	28.05±1.53
	Control Group	31.9±1.82	30.33±1.85
H-reflex amplitude (mv)	Experimental Group	3.26±0.3	3.96±0.27
	Control Group	3.31±0.38	3.51±0.35
H/M ratio	Experimental Group	0.35±0.02	0.41±0.02
	Control Group	0.36±0.02	0.38±0.03
Pain Level (VAS)	Experimental Group	7.9±1.09	1.96±0.71
	Control Group	7.66±1.42	3.86±1.07
Function Disability ODI (%)	Experimental Group	53.2±10.98	12.13±4.33
	Control Group	50.88±12.32	27.86±8.46

Table 2: Pain level, functional disability, and H-reflex latency, amplitude and H/M ratio for both groups pre and

post 6 weeks of treatment.

Source of variance		F-value	P-value
H-reflex latency (ms)	Between groups (Main effect of group)	5.71	<0.01*
	Within subjects (Main effect of time)	365.66	<0.0001*
	Interaction between time and group	69.51	<0.0001*
H-reflex amplitude	Between groups (Main effect of group)	5.94	<0.01*
	Within subjects (Main effect of time)	401.03	<0.0001*
	Interaction between time and group	123.77	<0.0001*
H/M ratio	Between groups (Main effect of group)	5.29	<0.02*
	Within subjects (Main effect of time)	548.41	<0.0001*
	Interaction between time and group	109.88	<0.0001*
Pain Level (VAS)	Between groups (Main effect of group)	11.9	<0.001*
	Within subjects (Main effect of time)	1021.75	<0.0001*
	Interaction between time and group	49.08	<0.0001*
Function Disability ODI	Between groups (Main effect of group)	11.07	<0.002*
	Within subjects (Main effect of time)	515.52	<0.0001*
	Interaction between time and group	40.94	<0.0001*

Table 3: 2 X 2 mixed-model ANOVA result

*significant at $\alpha = 0.05$

H-reflex amplitude was significantly increased post treatment in both groups as the main effect of time was statistically significant ($p < 0.0001$). Also, experimental group showed significant improvement in the H-reflex amplitude than control group post 6 weeks of treatment as the main effect of group was statistically significant ($p < 0.01$) and interaction between time and group was also significant ($p < 0.0001$) as shown in table (3).

Similar results were obtained for H/M ratio as it showed significant increase in both groups post treatment as the main effect of time was statistically significant ($p < 0.0001$) and also, experimental group was superior to control group post 6 weeks of treatment where the main effect of group was statistically significant ($p < 0.02$) and interaction between time and group was also significant ($p < 0.0001$) as shown in table (3).

Furthermore, pain level and functional disability showed significant reduction in both groups post treatment as the main effect of time was statistically significant ($p < 0.0001$) and ($p < 0.0001$) respectively. The experimental group

showed significant improvement than control group post 6 weeks of treatment in pain level and functional disability as the main effect of group was statistically significant ($p < 0.001$) and ($p < 0.002$) respectively, while interaction between time and group was also significant ($p < 0.0001$) and ($p < 0.0001$) respectively as shown in table (3).

DISCUSSION

Both the experimental and the control groups were found to enhance pain level, functional disability, and latency, amplitude and H/M ratio of H-reflex in LBP patients with S1 radiculopathy after 6 weeks of treatment. But the experimental group who received the neural mobilization technique proved to be superior and more effective than the control group. During this study, we investigated the effects of a neural mobilization in treatment of LBP with S1 radiculopathy in order to prescribe an effective intervention that can be used for management of LBP with S1 radiculopathy which can decrease patient's suffering and disabilities and provide an evidence supporting its use.

An appropriate explanation for the improvement of pain level and functional disability as by neural mobilization is that it affected the mechanical properties of peripheral nerves, and this alteration in nerve mechanics lead to direct effect on nerve physiology [31,54]. It has been reported that neural mobilization generated various amounts of longitudinal nerve excursion and strain [37,39,67]. Neural mobilization techniques helped in restoring the movement between the nerve and surrounding structures through the gliding movement. Therefore, the intrinsic pressures on the nervous tissue were decreased and consequently enhanced the nerve function [30,34,35,36].

Compression of the nerve root because of disc herniations hindered the blood flow of the nerve root [17], this alteration of the microcirculation of the nerve lead to pain and release of inflammatory mediators(20). Furthermore, block of neural conduction, edema, and mechanical sensitization resulted also from compression of nerve root [20,21,22]. Also, neural mobilization technique enhanced intraneural blood flow, axoplasmic flow, sympathetic activation. Furthermore, it help in dispersion of tissue fluid and diminishing intraneural oedema [34,35,36,37,38,67].

These findings came in concurrent with Cleland et al. (2006) who reported that nerve root compression impede nerve root microcirculation leading to nerve edema and demyelination and application of neural mobilization technique alleviate and dissipate the edema [50]. In addition, Santos et al (2012), reported that neural mobilization can be used effectively for reduction of inflammatory mediators and consequently pain after investigating its influence on sciatic nerve injury model in rats [68]. Furthermore, Bertolini et al, (2009), reported that intraneural edema and adhesions decreased and consequently recover nerve mechano sensitivity after stretching of the sciatic nerve after experimentally induced sciatica in rats [69].

In another study conducted by Brown et al (2011) in cadavers, neural mobilization technique can reduce or pre-

vent intraneural edema of the tibial nerve as result of increased fluid dispersion (33). Furthermore, Beneciuk et al (2009) reported that neural mobilization had hypoalgesic effect on C-fiber which transmit pain signal after application of some neural mobilization techniques on median nerve. The authors suggest that this hypoalgesic effect may be due to inhibition of pain signals at the dorsal horn[70].

The improvement in latency, amplitude and H/M ratio of H-reflex after neural mobilization could be attributed to that neural mobilization restored the neurophysiological and mechanical functions of the nerve [34,36]. Stretching of the connective tissues surrounding the nerve roots stimulate the sensory fibers within the dorsal root and consequently there is a summation of Ia afferent inputs at the spinal cord leading to increased response from alpha motoneuron[54,71]. Thus, the conduction at the nerve improved leading to decrease in latency and increase in amplitude and H/M ratio of H-reflex.

The findings were supported by Ha et al(2012) who found that neural mobilization increased median nerve conduction velocity [72]. Furthermore, kumar et al (2013) who examined the immediate influence of neural mobilization on monosynaptic H-reflex reported a significant influence of neural mobilization on the monosynaptic H-reflex which involved a decrease in H-reflex latency, and an increment in amplitude and H/M ratio of H-reflex [54].

The results of this study were consistent with the findings of Murphy et al (2009) who investigated the effect of a multimodal treatment approach that consisted of neural mobilization, myofascial therapy and manipulation in lumbosacral radiculopathy patients. Neural mobilization techniques were applied to minimize adhesions in the affected nerve root. About, 90% of the participants showed an appropriate outcome, 74% reported reduction in pain level, and 70% had an improvement in functional disability. But these findings can't be attributed to neural mobilization alone [48].

Moreover, Nagrale et al(2012) investigated the effect of neural mobilization in the form of slump stretching in patients with non-radicular LBP. Their study findings supported the use of slump stretching which lead to enhancement of functional disability, pain, and fear of movement in patients with non-radicular LBP [49]. Moreover, Cleland et al(2006) reported that neural mobilization had a positive effect for improving pain, functional disability, and centralization of symptoms [50]. A similar result was obtained by Cleland et al(2004) who supported for the use of neural mobilizations for LBP with neurogenic pain in lower extremity after a single-case study design [51]. Finally, Sarkari and Multani also reported beneficial effect of neural mobilization in patients with radiating low back pain [32].

On the other hand, Scrimshaw and Maher (2001) explored the effect of neural mobilization in lumbosacral radiculopathy patients who undergone spinal surgery in the form of lumbar discectomy, laminectomy or fusion. The authors

reported that neural mobilization did not have positive effect [47]. This contradiction of the results may be due to that the participants of their study were post surgical patients which differ from our study participants as the influences of surgical trauma on neural tissues may affect the response to neural mobilization techniques.

This trial was conducted aiming to demonstrate the effect of neural mobilization technique on the LBP with S1 radiculopathy to provide an effective intervention that can reduce the patients' suffering and disabilities and provide evidence that the neural mobilization can promote nerve root function. One possible limitation of the current study is that the beneficial effect obtained in this study in the experimental group cannot be attributed to neural mobilization alone because conventional program was received by the participant. Another possible limitation is the lack of some laboratory investigation of inflammatory mediators, which may be used as an evidence for alleviating the inflammation and oedema. Further studies are required to demonstrate the effect of other techniques of neural mobilization rather than straight leg raising. Furthermore, Studies should be performed to investigate the effect of neural mobilization techniques isolated from other treatment modalities.

CONCLUSION

Neural mobilization technique is an effective intervention for reduction of pain, functional disability and enhancing the physiological function of the nerve root in low back pain with lumbosacral radiculopathy. The findings of this study provide evidence that neural mobilization agrees with the theory related to such movements.

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