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Kinetic Control versus Mulligan Mobilization Effect on Functional Outcomes in Patients with Lumbar Radiculopathy: Randomized Comparative Study

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Abstract

Objective: To investigate the effect of kinetic control retraining versus the hands-on Mulligan SMWLM on functional outcomes in patients with lumbar radiculopathy. Methods: Design: Randomized Comparative Study. Setting: Outpatient, faculty of physical therapy clinic of Cairo university. Participants: Sixty subjects, suffered from chronic LBP with radiculopathy randomized equally into two groups. Intervention: The Kinetic control group, thirty subjects received kinetic control retraining plus convectional physical therapy. Mulligan group, thirty subjects received Mulligan`s mobilization plus convectional physical therapy, (for 3setions/week, for 8weeks). Outcome measures: All patients were examined by inclinometer (for trunk range of motion), Oswestry disability index (for functional ability), pain detect questionnaire (neuropathic pain) and visual analogue scale(for pain intensity). All outcomes were measured initially at baseline and after intervention. Results: After the intervention, both groups showed significant improvement on the outcome measures with superior improvement of the kinetic control group for Oswestry Disability Index ($P < 0.001$, from 76.93 ± 6.87 to 14.8±2.27 and pain detect questionnaire ($P < 0.001$, from 34.26±1.98 to 12.66±2.16, pain intensity including visual analogue scale ($P < 0.001$, from 7.53±0.52 to 2.06±0.7, Lumbar ROM using Inclinometer: flexion ($P < 0.001$, from 55.86±3.1 to 67.93±2.21, extension ($P < 0.001$, from 18.13±1.72 to 25.73±1.62 and lateral flexion ROM from 19.6±1.72 to 27.06±1.87.Conclusion: Kinetic control retraining intervention gave a superior effect on improving functional outcomes in patients with lumbar radiculopathy compared to Mulligan's mobilization.

Keywords: Low back pain, kinetic control, mulligan concept.

1. Introduction

Low back pain (LBP) is a worldwide-recognized disabling condition. It is a primary cause of work illness leaves, seeking medical support, limitations of functional ability and medical costs globally. It`s episodes have dramatic consequences and places large economic impact on individuals, families and the systems of health insurance, so affect the overall society quality of life[1,2,3,4]. Low back pain has a high incidence worldwide and is the most common musculoskeletal disorder among either developing or developed nations and all age groups are affected with at least one episode throughout the life span[1,5,4]. It has a global prevalence up to 10.2 % and the lifetime prevalence LBP with leg pain ranges up to 43% which has the unfavorable recovery[4]. According Liledahl and his colleges, low back pain treatments cost billions annually in the United States of America (USA); also, there is indirect and incremental costs estimated by billions for this neuromusculoskeletal disorder[6,7]. Specific pathology for Low Back Pain diagnosis accounts about only 15% of all back pain conditions. A prolapsed intervertebral disc represents about 50 % of this specific diagnosis where the prolapsed disc compresses the nerve roots resulting in an inflammatory process, pain and limb radiculopathy (radiating pain in the nerve course due to compression at the nerve root or near it`s

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foramen)[8]. So, in 85%-95% of the patients that suffers from LBP, the recognizable diagnosis of specific pathology related to structural problem is deficient. For this fact, all subjects are identified as "non- specific" LBP[7,4].

Recent evidence of the LBP course suggests that It is a long-term health problem characterized by symptomatic episodes interrupted by pain free periods then recurrence. While most acute LBP patients recover quickly, recurrences are common and cause the great burden of LBP[9].

There is no strong literature that donate superiority of one treatment approach over the other[4]. The global systems of health care pursue to decrease LBP incidence by different approaches such as surgical procedures in addition to physiotherapy rehabilitation like the hands-on manual therapy concepts [10], therapeutic modalities[11,12,13,14], support, advice, and psychological therapies[15], and the hands off concepts including the Motor Control approach [16,17,18,19,20].

Neuromuscular impairments and deficits are a primary contributor to the inception and chronicity of LBP with the psychological and social competes. Specific-oriented retraining has a major effect in modulating biopsychosocial competes severity and peculiarity and crucial for controlling chronic LBP. Interventions targeting neuromuscular impairments of the movement system are the most promising movement control concepts in these LBP treatment approaches[20].

Movement is fundamental for function and participation in lifestyle choices, work, recreation sport, social activities and allows people to live the lives their choose, not to be constrained by their mobility or limited by their pain[17]. Once movement meets control, they can regain the choices lost in the presence of pain and give people the optimal choice in how they move, these choices are lost with movement impairment[21,22,23,18]. So, the movement value is a central theme in the physical therapy profession and functional concepts which build on movement therapy. These concepts are built on motor control approach under umbrella of different terms for example motor control, neuromuscular control, and core muscle stabilization, with different terminologies and roles for each concept giving to deliberations about these foundations and roles inside the evidence based clinical practice, and research which takes the insights in the last 25 years[24].

All concepts apply a detailed assessment to guide specific treatment plan tailored for everyone and based on assessment and using specific assessment and treatment battery that approach their movement coordination strategies trying to set up and restore optimal and functional movement control, coordination strategy, and introduce complimentary applied guide for individualized treatment in the clinical setting[23,25,24].

One component of movement controlling approaches assessment is to assess the presence of uncontrolled movement (UCM) , which is a musculoskeletal motor control disorder, where the body movement is operated without complete controlled pattern over the involved muscle synergies, created stressed segment that reflect the translational segmental hinge or the range UCM leading to loss of movement health[26,17,27].There is a growing literature that correlate UCM to neuromusculoskeletal pain, pathology and dysfunctions[27].

The kinetic control comprises balanced presentation of the movement choices with ideal interaction among the key components for the sensorimotor neuromuscular control that mediated by afferent sensory input, particularly the proprioceptive input, CNS integration, optimal motor co-ordination, and physiological stresses to assure functional dynamic stability and controlled mobility[20,17].

Manual therapy, based on hands-on movements or techniques that manipulate body joints or soft tissues, is the highly popular therapy approach utilized by clinicians in the neuromusculoskeletal disorders including LBP[29].

The Mulligan`s mobilization with movement (MWM) is a precise manual therapy strategy with specific roles that fit with specific patients[29]. In the late 1990s, Mulligan develop neurodynamic technique for radiculopathy that's called SMWLM[6]. It encompasses a transverse vertebral mobilization that is resemble Maitland technique to the vertebrae spine while applying a limb neurodynamic or neural stretching actively or passively from this foraminal opened position with sustained gliding mobilization. The patient must experience symptoms free movement in the post-

application assessment e.g., if the pain is seven out of ten, after application must almost disappear or become improve around two out of ten[29]. Thus, this study aims to compare the effectiveness of the hands-off retraining with patient education represented in the kinetic control concept with the hands-on specific manual therapy approach represented in mulligan concept to help clinician, based on an evidence base knowledge, to target the most effective treatment strategies in LBP patients with radiculopathy, with hypothesizing that, there is no significant difference between the effect of Kinetic control and Mulligan's mobilization on functional outcome in patients with lumbar radiculopathy.

2. Experimental

2.1. Materials

The study was conducted as a randomized comparative study. This study was registered for the Pan African Clinical Trials Registry (PACTR) and the unique identification number for the registry is PACTR202010685660957. The study procedures were authorized in the ethical committee of the faculty of physical therapy, Cairo University (no. P.T.REC/012/002782). All participants got clear knowledge concerning this study purpose and a through description of the procedures and the management details has explained. Each subject initialed a consent form to participate in this research program. This comparative study was conducted between June and December 2020. All subject's diagnosis was chronic LBP with radiculopathy by the referred physician, were referred to the outpatient, Faculty of physical therapy clinic of Cairo university. Subjects were included in this study when the inclusion criteria were met.

2.2. Inclusion Criteria

Inclusion criteria: includes: Subjects from both sexes diagnosed low back pain with radiculopathy and flexion uncontrolled movement, (which is posterior vertebral translation during trunk flexion movements and it was assessed using the motor control rating scale[17], due to lumbar disc prolapse (posterolateral or lateral disc prolapse (L4-L5/ L5-S1 levels) with clinical confirmation through the applied examination with MRI, aging range from 25-45 years, and BMI of 25 - 30 kg/m2. The radiculopathy signs will be identified by the presence of LBP with numbness radiating below the knee, and the duration of illness will be from 3-6 months[3].

2.3. Exclusion Criteria

The subject's exclusion criteria were: if there were a previous spinal surgery, other radicular symptoms causes (e.g.: piriformis syndrome, diabetic neuropathy), patients with extension uncontrolled movement related to symptoms, (which is anterior vertebral translation during trunk extension movements and it was assessed using the motor control rating scale[17], red flag signs including unwanted weight loss, less than three months symptoms persistence, malignancies of the spine, spinal instability due to structural cause for example: ligamentous sprain or spondylolisthesis. Gynecological problems in females that may cause low back pain, psychological disorders affecting the subject`s ability to follow the instructions[3].

2.4. Subjects and Randomization

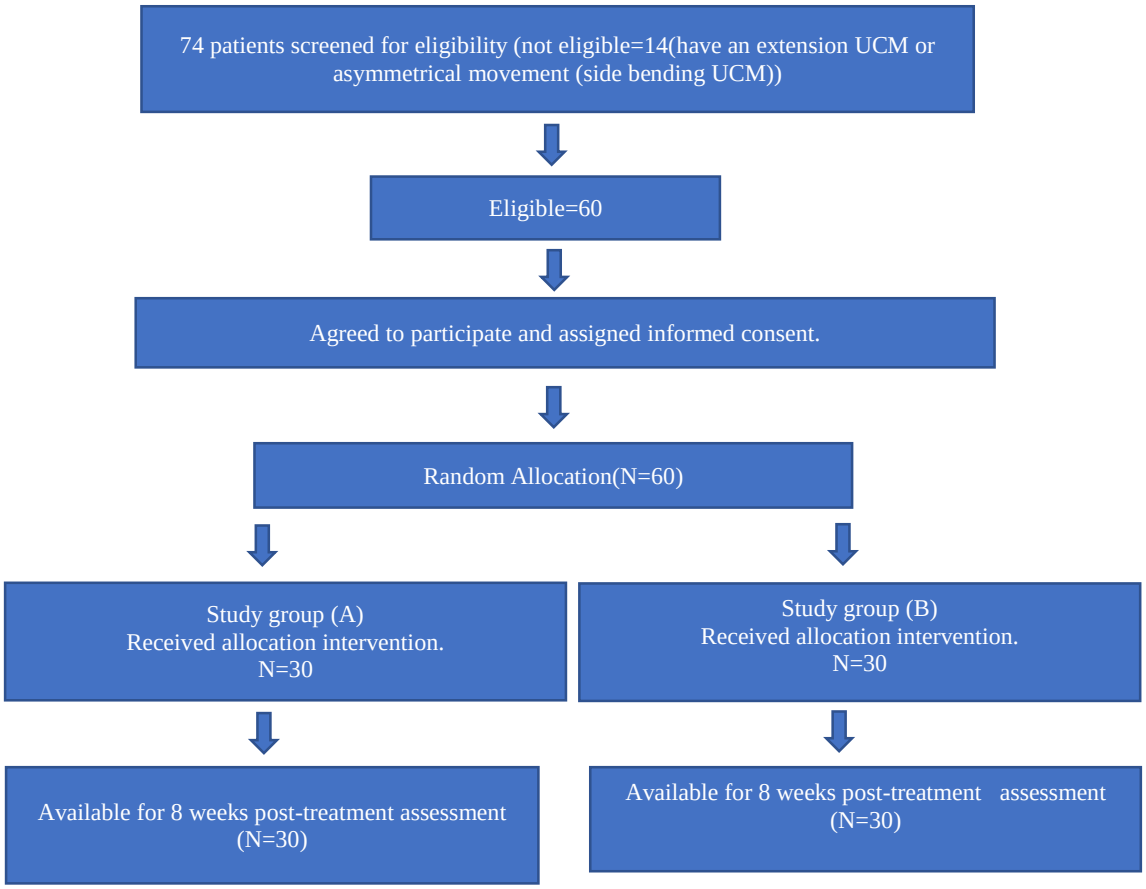
A Graph of patient selection and randomization within this study is showing in figure 1. The figure illustrates that 74 subjects were initially checked for eligibility, after these procedures, 60 subjects were eligible to contribute in this study and 14 subjects were not eligible as those subjects were not met the inclusion criteria. Most of the excluded subjects have extension UCM or asymmetrical movement (side bending UCM). Subjects were randomly allocated into a study group using opaque envelope with 30 patients in each study group.

2.5. Procedures

With regard to the assessments, it was applied before and after 8 weeks of management program, and included the following domains:

* Assessment of neuropathic component of pain, utilizing the arabic version of Pain detect questionnaire (PD-Q) which is highly valid and reliable questionnaire used with chronic pain conditions [32].

*Assessment of Pain intensity, using the Visual Analogue Scale (VAS) which is valid & reliable scale to assess pain intensity. The patient was asked to give a numerical number from zero to ten indicating the pain intensity instantly. It takes from 30 seconds to 2 minutes to marking this scale.



Fig(1): Flow chart of patient`s participation in the study.

*Assessment of disability, using ODI, before and after 8 weeks of management program. It covered 10 divisions; each division scored by six different circumstances from no disability (zero scoring) to total disability (five scoring) conditions[33].

* Assessment of Trunk range of motion (ROM), for all subjects before and after 8 weeks of management program. The inclinometer was placed on the lumbar L3-L4 vertebrae. The subject was instructed to move anterior (in case of assessing the flexion range of motion), posterior (in case of assessing the extension range of motion) and right and lift bending (in case of assessing the side flexion range of mobility). Subjects` instructions were granted for isolated back movement, without chest or hip substitutions.

Considering the treatment procedures, the kinetic control study group received kinetic control retraining and the conventional physical therapy program. Each session is based on the progression on the motor control rating scale (MCRS) related to kinetic control management frame[17]. The treatment program is scheduled for 3 treatment visits per week for 8 weeks. The session time was nearly 60 minutes. Each subject received the conventional physical therapy, including TENS current, heat application, lumbar spine stability exercising, neurodynamic mobilization with manipulating the lumber vertebrae, for 60 minutes, three sessions weekly, 8 weeks program. Regarding to TENS parameters, a cross over manner with four electrodes on the lumbar spine is utilized, using burst mode, 20 seconds duration and 3 seconds interval, intensity of 20-50 mA, application duration of 20 minutes. For heating technique,

application was for 10 minutes. For lumbar spine stability exercising, curl up, bridge, prone bridge, side bridge, bridge with knee extension, quadruped opposite arm/opposite leg exercises and neck and shoulder elevation from crock lying were applied through neutral training region of the lumbar spine, 3 sets for 10 rep. each, 10 minutes duration. neurodynamic mobilization was applied for the sciatic nerve, as follow; the clinician makes flection of the hip joint SLR with concurrent dorsiflexion till reaching before pain limit then planter flex. The sciatic neural glide was performed by 2 sets about 20-30 repetitions. After All, the subject was instructed for relaxation with deep breathing. Also, low amplitude high velocity thrust lumbar manipulation is applied to mobilize the restricted lumber levels, but not applied for the involved disc protruded level[31].

The Mulligan study group received SMWLM plus the previous conventional physical therapy.

Regarding the Kinetic Control retraining, the movement coordination tests involved were flexion coordination tests, tests for uncontrolled extension and rotation/side bending movement control tests. This uncontrolled movement may be segmental hinge at one level or multisegmented hypermobility[17,23].

The Kinetic Control retraining strategy consists of patient education about his/her uncontrolled movement, retraining the coordination of movement direction control and muscle synergy retraining. Coordination retraining for the UCM site and direction is the same as the testing but more reptations with the correct pattern. The person actively practiced the retraining through visual and palpatory feedback, unloading, clinician support and verbal modification. When the subject understood the movement or action, the subject is obliged to do the movement without feedbacking (visually or palpatory) or verbal instruction for correction. Then, progression of the positions was applied to more challenging positions[24,23,17].

Regarding the Mulligan mobilization group: It received Mulligan`s SMWLM plus the conventional physical therapy treatment. Subjects were asked to lie on their unaffected side and take the symptomatic limb to the pain-free limit of SLR. Then, application of transverse vertebral pressure was applied to the above vertebral spinous process, level (L4 or L5). Then, Participant was directed to stop at the pain barrier with three seconds maintenance then come back to the initial position. Also, a neural mobilization was applied by flexing the hip and knee joints then making extension for 30 seconds and 5 repetitions. This technique was repeated three times (according to the role of three) then reassessment of patient's symptoms was done for immediate relief. Also, progress more by applying pain-free terminal pressure application to the range of hip flexion[15].

3. RESULTS AND DISCUSSION

3.1. Results

Descriptive statistics and t-test were conducted for comparison of subject characteristics between groups. Chi squared test was conducted for comparison of sex distribution between group Normal distribution of data was checked using the Shapiro-Wilk test. Levene's test for homogeneity of variances was conducted to test the homogeneity between groups. Mixed design MANOVA was performed to compare within and between groups effects on VAS, PD-Q, ODI and trunk ROM. Post-hoc tests using the Bonferroni correction were carried out for subsequent multiple comparison. The level of significance for all statistical tests was set at $p < 0.05$. All statistical analysis was conducted through the statistical package for social studies (SPSS) version 25 for windows (IBM SPSS, Chicago, IL, USA).

- Results - Subject characteristics:

Table (1) showed the subject characteristics of the group A and B. There was no significant difference between both groups in the mean age, weight, height and BMI ($p > 0.05$).

Effect of treatment on VAS, PD-Q, ODI and trunk ROM scores:

Mixed MANOVA revealed that there was a significant interaction of treatment and time ($F = 59.11$, $p = 0.001$). There was a significant main effect of time ($F = 777.12$, $p = 0.001$). There was a significant main effect of treatment ($F = 12.02$, $p = 0.001$). Table 2 showed descriptive statistics of VAS, PD-Q, ODI and trunk ROM scores and the significant level of comparison between groups as well as significant level of comparison between before and after treatment in each group.

Table 1. Comparison of subject characteristics between the group A and B:

	x̄±SD		MD	t- value	p-value
	Group A	**Group B**			
Age (years)	36.73 ± 5.05	37.13 ± 5.13	-0.4	-0.21	0.83
BMI (kg/m²)	27 ± 1.96	27.46 ± 1.73	-0.46	-0.69	0.49
Females/males	14 (47%)/16 (53%)	12 (40%)/18 (60%)		(χ2 = 1.36)	0.71

x̄, **Mean; SD, Standard deviation; MD, Mean difference; χ2, Chi squared value p value, Probability value**

Within group comparison

There was a significant decrease in VAS, PD-Q and ODI scores after treatment in both groups compared with that before treatment ($p < 0.001$). Also, both groups showed a significant increase in trunk flexion, extension and lateral flexion after treatment compared with that before treatment ($p < 0.001$).

Between group comparison

There was no significant difference between both groups in all measured variables before treatment ($p > 0.05$). Comparison between groups after treatment revealed a significant decrease in VAS, PD-Q and ODI scores of the group A compared with that of the group B ($p < 0.001$). There was a significant increase in trunk flexion, extension and lateral flexion of the group A compared with that of the group B after treatment ($p < 0.001$).

Table 2. Mean scores of VAS, PD-Q, ODI and trunk ROM before and after treatment of the group A and B:

	Group A	**Group B**	
	x̄±SD	**x̄±SD**	**P value**
VAS			
Before treatment	7.53 ± 0.52	7.2 ± 0.77	0.17
After treatment	2.06 ± 0.7	3.33 ± 0.72	0.001
	p = 0.001	***p = 0.001***	
PD-Q			
Before treatment	34.26 ± 1.98	33.53 ± 1.8	0.29
After treatment	12.66 ± 2.16	23.46 ± 2.3	0.001
	p = 0.001	***p = 0.001***	
ODI (%)			
Before treatment	76.93 ± 6.87	74 ± 7.01	0.25
After treatment	14.8 ± 2.27	29.8 ± 3.34	0.001
	p = 0.001	***p = 0.001***	
Flexion ROM (degrees)			
Before treatment	55.86 ± 3.1	56.8 ± 3.27	0.42
After treatment	67.93 ± 2.21	62.73 ± 3.84	0.001
	p = 0.001	***p = 0.001***	
Extension ROM (degrees)			
Before treatment	18.13 ± 1.72	18.06 ± 1.8	***0.91***
After treatment	25.73 ± 1.62	22.53 ± 1.8	***0.001***
	p = 0.001	***p = 0.001***	
Lateral flexion ROM (degrees			
Before treatment	19.6 ± 1.72	19.33 ± 2.05	***0.7***
After treatment	27.06 ± 1.87	23.46 ± 1.84	***0.001***
	p = 0.001	***p = 0.001***	

x̄, Mean; SD, Standard deviation; p-value, Level of significance.

3.2 DISCUSSION

The study was conducted for comparing the effect of kinetic control concept with Mulligan mobilization on functional disability, neuropathic pain, pain intensity and trunk ROM in patients with LBP with radiculopathy. This study results demonstrated that both groupings revealed major improvements in functional disability, pain aspects, and trunk range of motion with superior effect for the kinetic control retraining.

The results of this study agreed with a study by Luomajoki and his colleges, who conducted a meta-analysis reviewing revealing that approaching the movement impairments has the instant and extended improvement in pain and dysfunction for people with LBP compared to other interventions. More pain improving will occur in the short term with considering other factors, such as pain duration[16].

Also, the study results agree with Barr et al., who refer to an essential point about the low threshold muscle activation that has large contribution in functional tasks that need endurance more than strength. By utilizing surface electromyography, he found that lumbar spine stability exercising optimizes the stability muscle synergies and increase endurance more than the strength that optimize dynamic stability of the spine and therefore, it is important in improving low back pain[34].

Falla and hodges Identified that exercise is the highly valuable approach for treating and approaching the spine pain and has till moderate long lasting effect[35]. In 2020 Sarah Mottram et al., clarify the evidence that restoring the movement retraining choices has great clinical effect on improving pain and function. This approach targets special focus for restoring the functional control of movement system[24].

The findings of the current study were consistent with Shamsi and his colleagues for examining the effect of lumbar spine stability exercising on pain, stability index in the chronic LBP subjects. He found that there was a considerable change in disability, symptoms and stability index after the training recognized to more ideal performance of back muscles[36].

Also, McGill, suggested that simultaneous training for abdominal obliques and the spinal multifidus through SLR bridging and quadruped with upper and lower limbs movement while keeping the spine in neutral has improvement effect on pain intensity and functional stability of the patients with chronic LBP[37]. The current study coincides also with Maher et al., who showed that, specific lumbar exercises improve the trunk range of movement and decrease the disability and attribute this to the modulation mechanism of pain and decrease the pain avoidance behavior with increase the self-confidence by exercising and after the training[19].

Stochkendahl et al., demonstrated that cognitive training combined with the training therapy had elevated evidence for improving the disability and the pain scoring in the chronic LBP individuals[38].

Comerford and Mottram had a similar evidence that kinetic control retraining combines between physical retraining and mental retraining through the patient education, feedback during the training and, home exercising which contribute to improve the patient outcomes in disability, pain, ROM and returning to the functional activities of daily livings[17].

Sahrmann mentioned that low back pain patients have different uncontrolled movements strategies leading to symptoms. Kinetic control retraining modifies this strategies and movement synergies exercises help to reduce symptoms, disability and recurrences of LBP for the patients. Patient education with feedback had short- and long-term improving effect[39].

Another finding from Barr et al., study concluded that segmental stability during the activities of daily living and optimum postural stability and control is enhanced by low threshold core muscle activation (especially the multifidi, the oblique and transverse abdominal muscles)[34].

Regarding the effect of SMWLM, the current study agreed with Das who found that adding SMWLM to nerve neurodynamic and traditional therapy revealed improvement in pain, disability and straight leg raise (SLR) contrasted to traditional therapy only or nerve neurodynamic with traditional therapy[40].

Another study by Satpute favored the symptoms improvement in lower extremity and back pain, functional disability, hip flexion SLR, with instant and extended patient satisfaction by addition of SMWLM to the conventional therapy in the management of subjects with lumbar radicular pain[15].

Muhammad Usman Riaz et al., stated that SMWLM gave a superior effect than nerve

neurodynamic on enhancing function in limb radiculopathy[41].

The finding of the present study matches with the study by Fiaad, who reported that spinal stabilization exercise is more effective than mulligan mobilization. Also, spinal stabilization exercise and spinal manipulation has the greatest results in terms of reducing pain intensity level, increasing ROM, and improving function in LBP[42].

Contrary to results of the current study was the review published by Saragiotto et al., that gave very minimal evidence to support kinetic control exercises effect on chronic LBP. This result might be attributed to the very low quality studies that the data was collected from. Additionally, the investigators didn`t determine a particular age limit and didn`t clarify whether the chronic low back pain was linked with radicular leg pain or not [43].

Conclusion

The current study showed that, Kinetic control retraining intervention gave a superior effect in improving functional outcomes represented in functional disability, neuropathy and the intensity pain aspects and trunk range of motion in subjects with lumber radiculopathy compared to Mulligan's mobilization.

Conflicts of interest

The author(s) asserted no conflicts of interest regard to the study, authorship, and/or publication of this study.

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