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Physiotherapy Section

Effectiveness of Mulligan's Spinal Mobilisation with Leg Movement Technique and Specific Exercise Therapy in Improving Clinical Outcome in Individuals with Lumbar Radiculopathy: A Randomised Controlled Study

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ABSTRACT

Introduction: Low Back Pain (LBP) is a common musculoskeletal problem affecting the general population and involvement of Sciatic nerve is the common cause for leg Pain dominance. Mulligan's Spinal Mobilisation With Leg Movement (SMWLM) technique is recommended as management. Limited data is available regarding the combined effect of SMWLM and specific exercises.

Aim: The aim of the study was to find the effectiveness of Mulligan's SMWLM technique with self GATE mobilisation and sustained lumbar rotation exercise on the clinical outcome compared to conventional care in individuals with Lumbar Radiculopathy (LR).

Materials and Methods: The present randomised controlled study was conducted in a tertiary care hospital during March to August 2024, around 69 participants were included after receiving the informed consent and are divided into three groups. The leg pain intensity using Visual Analogue Scale (VAS), Numerical Pain Rating Scale (NPRS), disability using Oswestry Disability Index (ODI), Abdominal core muscle strength, passive Straight Leg Raise (SLR) range self-perceived improvement were measured before and after treatment. group 1 received Neural Mobilisation (NM), lumbar spine range of motion exercises. group 2 received SMWLM, NM and lumbar spine range of motion exercises. group 3 SMWLM, NM, self GATE mobilisation and sustained lumbar rotation exercise. All participants received electrotherapy for pain modulation. The treatment was given to all three groups for one week, and the Global Rating of Change (GROC) scale was evaluated after 1st treatment and end of therapy. The outcomes were analysed using paired t-test, and ANOVA with a significance set at <0.05.

Results: The mean age of the participants in group 1,group 2,group 3 were 44.21,47.78,46.52 respectively. The findings reveal that group 3 had greater improvement in leg pain ($p<0.001$), back pain ($p<0.001$), disability ($p<0.001$), core muscle strength ($p<0.001$), SLR range ($p<0.0042$) and GROC ($p<0.0001$) post-treatment.

Conclusion: Mulligan's SMWLM self GATE mobilisation and lumbar rotational exercises improved the clinical outcomes when compared to SMWLM alone and general exercises in individuals with LR. Mulligan's SMWLM can be combined with technique specific exercise for maximum clinical improvement.

Keywords: Lower lumbar spine, Lumbar rotational exercises, Numbness, Radiating pain

INTRODUCTION

The LR is a condition characterised by pain, numbness, weakness, and altered reflexes caused by compression or irritation of nerve roots in the lower lumbar spine [1]. The global burden of LBP is expected to increase from 619 million people in 2020 to 843 million by 2050. Lifetime prevalence rates of LBP ranging from 60 to 90%, and 5 to 10% of these cases progress to radiculopathy [2].

Symptoms of LR include radiating pain, tingling, numbness, weakness, and abnormalities in gait, which can vary in severity. These symptoms typically follow specific patterns affecting specific dermatomes or myotomes, depending on the nerve roots affected by the condition. The irritation of spinal nerve roots generates abnormal nerve signals perceived as pain, numbness, tingling, and weakness in corresponding areas of the body [3]. Degenerative conditions involving a motion segment led to disc desiccation, fibrosis, alter facet approximation and possible herniation, collectively can compress nerve roots and trigger radiculopathy. In severe cases, disc at multiple levels get involved and affect nerve roots, potentially leading to cauda equina syndrome. Other than degeneration trauma or inflammation, can also irritate spinal nerve roots and contribute to radiculopathy [4].

LBP can be either back or leg pain dominant, and the causes were multifactorial but mostly arises due to vertebral, rarely of non-vertebral and visceral aetiology. Leg pain is mostly the disease of spinal nerve root, which leads to radicular pain in a dermatomal distribution. The management of LR aims to influence and reduce this leg pain severity. Individuals with LR respond well to conservative management such as medication, physical therapy, chiropractic therapy, spinal manipulation, traction, and corticosteroid injections [5]. Significant symptoms in LR were leg pain, which causes more significant disability when compared to other sub types [6]. Recent literature has shown that local strengthening or stretching, and various forms of manipulative therapy were effective for LR [7].

Manual therapy approaches in the management of LR focuses on the correction of altered biomechanics and segmental mal alignments. Mulligan's SMWLM is one such manual therapy technique, recommended to correct the segmental positional fault. SMWLM is the application of continuous lateral gliding force on the spinous process while actively or passively performing affected limb movement [8]. It aims to correct the intervertebral disc position or open the facet and creates more space in the intervertebral foramen. No guidelines or recommendations are available for manual therapy and individual technique, as an effective intervention for LR [9].

NM is an effective means of treatment for radicular symptoms as it decreases intra-neural Oedema and improve neural mobility [10]. Therefore, it is possible that combining NM with manual therapy interventions like SMWLM may also be effective in the treatment of LR. Many lumbar radiculopathies symptom persist for more than 4 weeks and have high chance for chronicity and individuals belonging to subacute category usually benefit from manipulation [11].

Mulligan's technique claims to yield immediate effect provided the same technique is given in the form of technique-specific exercises as home program. SMWLM technique has been analysed so far in combination with NM, osteopathy and general exercises. Current evidence is insufficient in supporting the benefits of Mulligan techniques on pain, disability, and range of motion in LBP patients [12]. There is a connection between LR and physical functioning, lumbar mobility restriction, and LBP [13].

The impact on the quality of life for patients with LR is huge, affecting both objective health status and subjective well-being. Establishing the effectiveness of treatments plays a crucial role in improving this limitation, and the ongoing research should address this for more clinical information [13]. More studies are recommended to establish the effect of lesion specific manual therapy treatment [14]. Hence, the aim of the study was to identify the combined effect of Mulligan's SMWLM, self GATE mobilisation and sustained lumbar rotation exercise on the clinical outcomes compared to SMWLM alone and general care in individuals with LR. Secondarily to know the effect of each treatment on LBP and leg pain severity, abdominal core muscle strength, SLR range of motion, self-rated improvement, and regional disability.

Null hypothesis: There would be no significant difference between the groups in terms of leg, back pain, abdominal core muscle strength, regional function, SLR range in individuals with LR.

Alternate hypothesis: There would be a significant difference between the groups in terms of leg, back pain, abdominal core muscle strength, regional function, SLR range in individuals with LR.

MATERIALS AND METHODS

The present randomised controlled study was approved by the Institutional Ethics Committee for students' projects (REF: CSP/23/SEP/136/824). This study was registered in Clinical Trial Registry-India (CTRI/2024/03/063510). Patients from the Orthopaedics Department, and Medical Centre were enrolled for this study. The study process was started in March 2024 and completed by August 2024.

Sample size selection: A total of 69 participants were included after obtaining written informed consent and after enrollment the participants were randomly divided into three groups; two experimental and one control with 23 individuals each. The sample size was estimated to ensure that this trial was powered to detect a difference of 1.6±2.4 points out of 11 points in leg pain severity based on previous studies with 80%, a 2-tailed alpha of 5%, and an expected dropout rate of 20% [15]. This sample size also had 80% power to detect a difference of 9±12 points on the 100-point ODI [11].

Inclusion criteria:

- Patients with Lumbar Radiculopathy (LR);
- Age from 18 to 60 years;
- Both male and female;
- No previous history of LBA;
- Painful/Hypomobile lumbar segments.

Exclusion criteria:

- Contraindications for manual therapy;
- Age more than 60 years;
- Bladder and bowel dysfunction;
- Similar episode of pain;
- Lower extremity vascular disease.

Individuals in group 1 (general care) received NM, lumbar spine range of motion exercises, and electrotherapy for pain modulation. group 2 (SMWLM) received spinal mobilisation with leg movement, NM, lumbar spine range of motion exercises, and electrotherapy for pain modulation. group 3 (SMWLM + self GATE mobilisation + Lumbar rotational exercise) received SMWLM, NM, self GATE mobilisation, sustained lumbar rotation exercise and electrotherapy for pain modulation. The treatment was given to all three groups for one week, and the outcome measures were repeated after the completion of treatment by a therapist who was blinded to group allocation and subjected to analysis.

Study Procedure

Standard clinical examination: Subjects with unilateral LR underwent a standardised clinical examination consisting of self-report and physical examination. Demographic data including patient name, hospital ID, age, gender, and Body Mass Index (BMI) [16], were collected along with symptoms duration, and severity of pain using patient-reported outcome measures- Visual Analog Scale- Leg Pain Intensity [17], ODI [18], Numeric Pain Rating Scale (NPRS) [19]. Physical performance tests would include abdominal core strength and passive SLR was also measured. The above-mentioned assessment was done by a therapist who was blinded to the group allocation and the treatment was carried out by principle investigator.

BMI measurement: The BMI classification for the Indian population is like the World Health Organisation (WHO) guidelines. The BMI is calculated by dividing weight in kilograms by height in meters squared BMI= weight in kg/height in meter squared. It is classified underweight: less than 18.5 kg/m^2, normal weight: 18.5-24.9 kg/m^2, Overweight: 25-29.9 kg/m^2 and Obese: 30 kg/m^2 or more [16].

Straight Leg Raise (SLR) range of motion: Patients were instructed to lie supine to align the greater trochanter of the femur with the fulcrum in the anatomical position. The goniometer's moving arm was then placed along the lateral midline of the femur, and the stationary arm was located along the lateral midline of the belly, using the pelvis as a reference [20].

Abdominal core muscle strength: It is a form of biomechanical biofeedback that offers visual biofeedback and aids in retraining muscular movement. In contrast to several other procedures, it is comparatively cheap, non-invasive, portable, and simple to use in a clinical context. For measuring deep abdominal function, it is a helpful instrument. It is utilised in abdominal drawing tests to gauge transversus abdominis activation, strength, and endurance [21].

VAS- leg pain intensity: Participants' leg Pain perception was evaluated using a 10-cm VAS. On a 100mm pain rating VAS, patients were requested to rate the degree of their pain. Patients were informed about rating their pain intensity on a VAS of zero (0 mm) to one hundred (100 mm), with zero being no pain and one hundred being the tremendous discomfort they could conceive [17].

Numerical pain rating scale: A respondent chooses a whole number (0-10 integers) on the NPRS, a segmented numerical version of the VAS that most accurately represents the degree of their suffering. A line or bar that is horizontal is the standard format. The NPRS is anchored by phrases that describe extremes of pain severity, just like the VAS [17].

Oswestry Disability Index (ODI): The ODI is a back impairment questionnaire designed to assess a patient's level of impairment. The test has become the gold standard for low back clinical outcome instruments [18]. There are ten parts in all, and the scores for each go from 0 to 5.

Global rating of scale: The authors used the GROC Score, an outcome measure that is used independently to measure improvements in a patient's co-rating scale, to assess the overall outcome of your disease with physical therapy intervention. It enables us to assess the outcomes of your physical treatment, which guides our future care for you. The GROC has a long history of use in research as an outcome measure and for comparing outcome measures. It is also well documented [22]. The GROC has 15 possible choices, with 0 indicating no change, -1 to -7 indicating a negative change and +1 to +7 indicating a positive change. A change in score of three rating points (+3) are considered as clinically significant [23].

Spinal Mobilisation with Leg Movement (SMWLM): Participants were instructed to extend their affected limb to its maximum pain-free range while lying on their non-affected side. Simultaneously, the physiotherapist applied firm transverse pressure to the superior vertebrae of affected spinal level. Spinal mobilisation away from the affected side for LR (L4 in case of L4 or L5 and L5 in case of L5 or S1). Participants were asked to stop moving their legs when they felt pain, then ease back and hold the posture for three seconds before returning to the starting position. The technique was progressed from a single set of three repetitions to two to three sets of six to eight repetitions with a 30-second rest period in between sets on successful applications [11]. Applying painless overpressure to the SLR range also resulted in progress. When the SLR's range reached 50% of the unaffected side, progression took place [Table/Fig-1].

[Table/Fig-1]: Spinal mobilisation with leg movement (SMWLM).

Neural Mobilisation (NM): A neural slider mobilisation was applied with the subject inside lying in which a rhythmical movement of hip and knee flexion followed by hip and knee extension was carried out for 30 seconds and repeated five times [Table/Fig-2] [24].

[Table/Fig-2]: Neural Mobilisation (NM).

Exercise program: Each participant performed two sets of five to seven repetitions of lumbar spine range of motion exercises while kneeling in a four-point position. The activities included heel sitting (lumbar flexion) and pelvic tilting. The exercise was done by the participants once a day at home in three sets of ten repetitions. When it becomes comfortable, one could increase the repetitions to make progress.

self GATE mobilisation: Everyone on supine lying flexes his/her hip and knee to a position identified by the therapist and rotate the knee to the side of pain keeping the hip flat on the floor and upon completion the individual uses their hand to apply over pressure to the side of rotation. This technique is believed to break adhesions and improve neural mobility within the foramen by widening it [Table/Fig-3] [25].

[Table/Fig-3]: Self GATE mobilisation.

Lumbar sustained rotation exercise: Lumbar rotation is done in supine (laying on your back), rotating your lower extremities while maintaining your upper extremity fixed. Your lower trunk area is twisting in this motion. Assume a flat lying position on the floor, with your feet flat on the ground. Tighten your abdominal muscles throughout the exercise. Slowly and deliberately rotate your knees to one side while maintaining your hips in contact with the floor. Hold the position for ten seconds before switching to the other side. Extend your top leg while keeping your bottom leg bent, then move your arms in the other way for a more difficult variation of this exercise [26].

Treatment dosage [Table/Fig-4]:

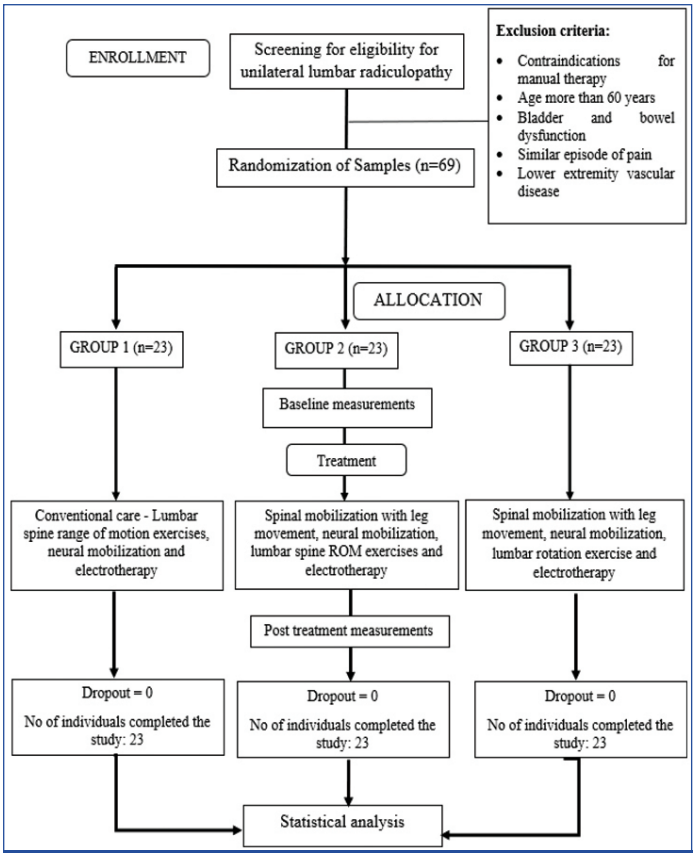
- **Group 1:** (General Care) received NM, lumbar spine range of motion exercises, and electrotherapy for pain modulation.
- **Group 2:** (SMWLM) received spinal mobilisation with leg movement, NM, lumbar spine range of motion exercises, and electrotherapy for pain modulation.
- **Group 3:** (SMWLM + self GATE mobilisation + Lumbar rotational exercise) received SMWLM, NM, self GATE mobilisation, sustained lumbar rotation exercise and electrotherapy for pain modulation. The study procedure and the flow of the study has been explained in [Table/Fig-5].

Treatment	Dosage
SMWLM	First session- a single set of 3 repetitions From 2nd Session- 2-3 sets of 6-8 Repetitions
Neural Mobilisation (NM)	Sliders 20-30 repetitions of 2 -3 sets
Self GATE mobilisation	First session- a single set of 3 repetitions From 2nd session- 2-3 sets of 6-8 Repetitions
Lumbar rotational exercise	Sustained movements 10 repetitions with active contraction at end range
Lumbar spine ROM exercises- 4-point kneeling, pelvic tilting and heel sitting	2 sets of 5-10 repetitions
Electrotherapy	Duration- 15 minutes Base frequency- 100 hz Spectrum frequency- 60hz Program no- 6 Electrodes- 4

[Table/Fig-4]: Treatment dosage.

STATISTICAL ANALYSIS

The data was analysed using One-way ANOVA test and paired t-test. The level of significance was considered at $p<0.05$.



[Table/Fig-5]: CONSORT flow chart.

RESULTS

A total of 69 individuals were recruited for the study. The baseline and demographic data were presented in [Table/Fig-6].

The post-treatment scores of VAS, NPRS, ODI, Abdominal (AB.) core muscle strength, Passive SLR, and GROC improved in group 3, indicating an increase in lumbar function as compared to the control group ($p<0.005$) [Table/Fig-7].

[Table/Fig-8]: Shows between group analysis and their significance of the variables belonging to three groups.

DISCUSSION

The present study showed that SMWLM along with self GATE mobilisation, lumbar rotational exercise is effective in reducing leg pain, back pain, and disability and in increasing core muscle strength and SLR ROM in individuals with LR. The findings of the current study substantiate that manual therapy when combined with exercise is beneficial in musculoskeletal disorders as concluded by many guidelines addressing both general and spine problems.

Leg pain and back pain severity improved in all three groups with the improvement exceeding the MCID of two points supporting the application of conservative treatment and manual therapy. The post-treatment leg pain severity significantly differed between groups 1 and 3. Individuals in groups 2 and 3 were able to reduce their discomfort near similarly. This supports the application of SMWLM for LR.

The sympathoexcitatory response and segmental mobilisation relieves the nerve root compression and the accompanying hypoalgesic effect following SMWLM would have resulted in this

Variables		Group 1 (n=23) Mean (SD)	Group 2 (n=23) Mean (SD)	Group 3 (n=23) Mean (SD)	F value	p-value
Age (years)		44.21 (10.72)	47.78(9.50)	46.52 (11.09)	0.68	0.506
Gender, n (%)	Male	7 (30.4%)	11 (47.8%)	7 (30.4%)		NA
	Female	16 (69.6%)	12 (52.2%)	16 (69.6%)		
VAS-Leg pain		6.82 (0.71)	6.65 (0.71)	6.86 (0.69)	0.57	0.554
Numeric Pain Rating Scale (NPRS)		6.47 (0.99)	7 (0.79)	6.73 (0.91)	1.99	0.156
Oswestry Disability Index (ODI)		56.78 (8.2)	63.39 (5.73)	58.08 (7.51)	0.4	0.607
Abdominal core muscle strength (kg)		4 (0.85)	4.3 (1.39)	3.78 (1.31)	1.07	0.345
Passive Straight Leg Raise (SLR) range		52.82 (7.04)	49.78 (9.1)	48.47 (8.31)	1.7	0.189
Global rate of change		1.39 (1.23)	1.6 (1.07)	1.52 (1.2)	0.18	0.828

[Table/Fig-6]: Baseline and demographic data of Participants in intervention and control group.
*ANOVA, $p<0.05$

Variables	Group 1				Group 2				Group 3			
	Premean (SD)	Post mean (SD)	t -value	p-value	Premean (SD)	Post mean (SD)	t -value	p-value	Premean (SD)	Post Mean (SD)	t -value	p-value
VAS- leg pain	6.82 (0.71)	3.78 (0.42)	17.67	<0.001	6.65 (0.71)	2.43 (0.50)	23.30	<0.001	6.86 (0.69)	1.82 (0.65)	25.49	<0.001
NPRS	6.48 (0.99)	3.13 (0.75)	23.30	<0.001	7 (0.79)	2.73 (0.61)	20.39	<0.001	6.73 (0.91)	1.73 (0.54)	22.66	<0.001
ODI	56.78 (8.30)	24.08 (3.64)	17.30	<0.001	63.39 (5.73)	25.39 (3.88)	26.33	<0.001	58.08 (7.51)	12.86 (3.55)	26.07	<0.001
AB. core strength	4 (0.85)	8.86 (0.75)	20.56	<0.001	4.3 (1.39)	11.26 (1.54)	16.09	<0.001	3.78 (1.31)	14.03 (1.29)	26.73	<0.001
Passive SLR	52.82 (7.04)	77.82 (7.04)	12.04	<0.001	49.78 (9.10)	80.21 (8.59)	11.66	<0.001	48.47 (8.31)	85 (5.64)	17.44	<0.001
Global rate of change	1.39 (1.23)	3.82 (1.46)	6.10	<0.001	1.60 (1.07)	4.86 (1.32)	9.20	<0.001	1.52 (1.2)	6.173 (0.65)	16.34	<0.001

[Table/Fig-7]: Shows within group analysis and their significance of the variables belonging to three groups.
*Paired t-test; $p<0.05$

Variables		Group 1 (n=23) Mean (SD)	Group 2 (n=23) Mean (SD)	Group 3 (n=23) Mean (SD)	F-value	p-value
VAS	Pre	6.82 (0.71)	6.65 (0.71)	6.86 (0.69)	0.57	0.554
	Post	3.78 (0.42)	2.43 (0.50)	1.82 (0.65)	81.77	>0.0001
NPRS	Pre	6.47 (0.99)	7 (0.79)	6.74 (0.915)	1.99	0.156
	Post	3.13 (0.75)	2.73 (0.62)	1.74 (0.54)	28.52	>0.0001
ODI	Pre	56.78 (8.30)	63.39 (5.73)	58.08 (7.52)	0.4	0.607
	Post	24.08 (3.64)	25.39 (3.88)	12.87 (3.55)	79.87	>0.0001

Abdominal core muscle strength	Pre	4 (0.85)	4.3 (1.39)	3.78 (1.31)	1.07	0.345
	Post	8.86 (0.75)	11.26 (1.54)	14.03 (1.29)	90.44	>0.0001
Passive SLR	Pre	52.82 (7.04)	49.78 (9.10)	48.47 (8.31)	1.7	0.189
	Post	77.82 (7.04)	80.21 (8.59)	85 (5.64)	5.94	0.004
GROC	Pre	1.39 (1.23)	1.6 (1.07)	1.52 (1.2)	0.18	0.828
	Post	3.82 (1.46)	4.86 (1.32)	6.17 (0.65)	22.27	>0.0001

[Table/Fig-8]: Between group analysis.
*ANOVA, p<0.05

change [27]. Findings of the current study go in accordance with a study where the result explain the addition of SMWLM to exercise and TENS provided significantly improved benefits in leg and back pain, disability, as well as patient satisfaction in the short and long term [28]. The results of the present study are identical to a study that investigated 40 individuals with LR in which SMWLM treatment was given where back pain, leg pain, and bothersome Ness got significantly reduced [26]. SLR range improved in all the three groups post-treatment and analysing the degree of improvement individuals who underwent SMWLM with rotational exercises has gained maximum improvement than general exercises.

The SLR improvement between group 2 and 3 were nearly similar and as participants in all three groups had performed NM exercises, the foraminal effect following SMWLM could be the reason for improvement. In contrast to the present study observation Thackeray A et al., did not find any improvement in SLR range following similar treatment in short term [29].

The ODI improved in all three groups with an improvement exceeding the MCID of 12.8 points. Comparing the post-treatment means difference individuals who received SMWLM, and lumbar rotation exercises improvement significantly differed from other groups. The disability score had resulted in better improvement following 10 days of treatment, which usually resulted in long-term and a recent meta-analysis had reported lot of heterogenicity towards this [30]. Relevant to this study functional improvement following 10 days of treatment in manual therapy groups reflects the techniques and concept superiority.

Abdominal core muscle strength has improved in all three groups which have a normative value ranging between 5 to 10 mmHg supporting lumbar rotation exercise. When the post-treatment mean difference was compared, the group that underwent lumbar rotation exercises and SMWLM showed a significant difference from the other groups. GROC values increased in all three groups after the treatment and had a mean value ranging from 3 to 6. In which the group that received SMWLM and lumbar rotational exercise revealed a significant difference from the other groups.

In a recent systematic review, it was concluded that the group receiving spinal manual therapy had a better treatment functional outcome compared to other interventions in short-term, like the current study [30]. There is enough data to conclude that spinal manual therapy has comparable results to suggested therapies for pain management and functional status enhancement [31]. Consequently, The present research has shown greater efficacy in raising quality of life. No adverse effects were found in the participants in all three groups after the completion of treatment. This combined manual therapy and participants self-management with exercises had resulted in significant change in the clinical outcomes and function hence the null hypothesis could be rejected. In combination Mulligan's SMWLM, self GATE mobilisation and sustained lumbar rotation exercise improved the clinical outcomes than routine exercises in individuals with LR- is a progressive and safe approach.

Limitation(s)

The study was conducted in a short period of time. A longer duration and long-term follow-up can show better improvement. The predictors for prognosis following SMWLM and the factors that could favor outcome can be analysed in future studies. The technique effectiveness in maintaining vertebral neural foramen diameter can be analysed using high precision imaging. Presence of systemic illness, the site of lesion for adverse neural tension and pain modulation with electrotherapy would have influenced the results of this study but all these can be adjunct to treatment.

CONCLUSION(S)

Mulligan's SMWLM, Self GATE mobilisation and lumbar rotational exercises improved the clinical outcomes when compared to SMWLM alone and general exercises in individuals with LR. Mulligan's SMWLM can be combined with technique specific exercise for maximum clinical improvement.

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