Original Article

DOI: 10.7860/JCDR/2026/85848.24210

Physiotherapy Section

Effect of 3-Dimensional Myofascial Release Therapy on Pain and Range of Motion in Subjects with Non Specific Low Back Pain: A Randomised Controlled Trial

RANI HUBLI[1], APEKSHA HUNGUND[2]

ABSTRACT

Introduction: Non Specific Low Back Pain (NSLBP) is the most common form of LBP and is often associated with mechanical and postural factors. Disrupted soft-tissue tension, particularly in the hamstrings and lumbar myofascial system, affects lumbar mechanics. Myofascial Release Therapy (MFRT) has shown improvement in pain and disability; however, evidence for three-dimensional MFRT (3D MFRT), which addresses fascial restrictions across multiple planes, remains scarce.

Aim: To determine the effect of 3D MFRT on pain, lumbar Range Of Motion (ROM), lumbar spinal curvature and functional disability in individuals with NSLBP.

Materials and Methods: This randomised controlled trial was conducted at the Department of Orthopaedic Manual Therapy, KLE Institute of Physiotherapy, Belagavi, Karnataka, India, from October 2024 to March 2025. A total of 36 participants with NSLBP were randomly assigned to an intervention group (Group-A) that received 3D MFRT plus conventional therapy (n=18) or a control group (Group-B) that received conventional therapy alone (n=18). Both groups underwent six treatment sessions over two weeks, on alternate days. Pain intensity {Visual Analogue Scale (VAS)}, lumbar ROM {Modified-Modified Schober's Test (MMST)}, lumbar lordosis angle (flexicurve) and disability (Oswestry Disability Index) were recorded at baseline and after the sixth session. Between-group comparisons were used to determine treatment effects.

Results: Baseline comparisons showed no significant differences in demographics or outcome measures between groups. Post-intervention, the intervention group demonstrated significant improvements ($p<0.05$) in spinal curvature (Flexicurve), lumbar ROM, pain intensity and disability index compared to the control group. Effect sizes ranged from moderate to large.

Conclusion: The present study supports 3D MFRT as an effective adjunct to conventional therapy for NSLBP in improving pain, mobility and function.

Keywords: Disability evaluation, Fascia, Hamstring tightness, Lumbar vertebrae

INTRODUCTION

Low back pain (LBP) is one of the most common musculoskeletal disorders worldwide, with a lifetime prevalence as high as 84%, affecting more than 619 million people globally [1,2]. Out of all LBP cases, 90% individuals are attributed to non specific causes, a disorder that is a health problem of high economic importance [3]. NSLBP is characterised by LBP that cannot be linked to a specific condition like infection, trauma, fracture, inflammatory disease, radiating syndrome, or cauda equina involvement [2]. Its causes are multidimensional, often related to mechanical or postural problems, as well as repetitive minor strains from lifting, bending, long working hours, obesity, flat feet, poorly designed footwear and poor posture, which may lead to muscle imbalance and spasms [4]. People with NSLBP typically demonstrate reduced trunk flexion, extension and lateral flexion compared to those without symptoms [2]. In addition to its high prevalence, LBP also imposes a significant economic burden due to healthcare costs, work absenteeism and reduced productivity. Furthermore, 60-80% of individuals experience recurrence after an acute episode of NSLBP, contributing further to disability and socioeconomic burden [5].

The myofascial system acts as an integrated continuum, connecting muscle and fascia while encompassing both contractile and non-contractile components. Fascia provides structural support, helps tissues glide smoothly, assists muscle movement and contributes to the body's ability to sense position and transmit forces [6]. Postural muscles like the hamstrings and broad back muscles are vital for preserving lumbar alignment and dynamic balance [7]. Tight hamstrings and limited pelvic mobility, often alongside weak core muscles, can hinder pelvic movement and increase mechanical stress on the lumbar spine, leading to NSLBP [2]. Poor posture further fosters muscle imbalances and fascial tightness, sustaining pain and dysfunction [7].

Physiotherapy management for NSLBP typically includes exercise therapy, manual therapy and postural re-education. Strengthening programs enhance lumbar stability, while targeted stretching reduces soft-tissue tightness [1,8,9]. Manual therapy approaches-including MFRT, joint mobilisation and soft-tissue techniques are used to relieve restrictions and improve alignment. Postural education reinforces optimal body mechanics to prevent recurrence [7,10].

Manual therapies focusing on the myofascial system aim to improve tissue pliability and inter-layer gliding. Activation of mechanoreceptors within connective tissue enhances proprioception, reduces excessive paraspinal activity and modulates sympathetic output, providing therapeutic benefit. Evidence suggests that 3D MFRT may decrease lumbar lordosis and improve lumbar ROM in asymptomatic hyperlordosis [10].

Previous studies show that traditional MFRT typically applies sustained pressure or stretch to muscles and fascia to alleviate tension and restrictions and restore natural movement patterns, decrease discomfort and enhance tissue mobility [6,11]. In contrast, 3D MFRT is an advanced, multiplanar approach that addresses fascial restrictions across longitudinal, lateral and rotational planes, reflecting the three-dimensional nature of the fascial network [4,8]. This multidirectional engagement may offer more comprehensive release of fascial adhesions and restoration of functional mobility. A study done by Welling A et al., on 3D MFRT in patients with asymptomatic hyperlordosis has an effect in decreasing lumbar lordosis and increase in lumbar ROM [10].

Given the limited supporting evidence on the application of 3D MFRT in symptomatic NSLBP populations, the present study aimed to determine its effect as an adjunct therapy for reducing pain and improving lumbar ROM in individuals with NSLBP.

The primary objective of the study was to evaluate the effect of 3D-MFRT on pain in individuals with NSLBP, while the secondary objective was to determine its effect on ROM and Quality Of Life (QOL) in individuals with NSLBP.

The null hypothesis stated that there would be no significant difference in pain, lumbar ROM and disability between participants receiving 3D MFRT and those receiving conventional physiotherapy treatment. The alternate hypothesis stated that 3D MFRT would result in significant improvement in pain, lumbar ROM and disability in individuals with NSLBP compared to conventional physiotherapy treatment.

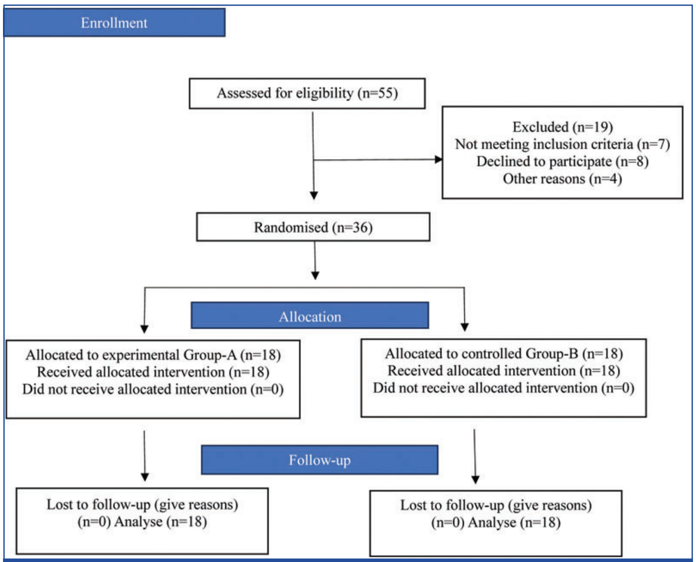
MATERIALS AND METHODS

A randomised controlled trial was conducted involving subjects with NS-LBP from tertiary health care centres in the Department of Orthopaedic Manual Therapy, KLE Institute of Physiotherapy, Belagavi, Karnataka, India, from October 2024 to March 2025. Ethical approval was acquired from the Institutional Research and Ethics Committee (Ref No. KIPT/885/23/11/2024) and written informed consent was collected from all the participants before participation. The study adhered to the outlined principles of the Helsinki Declaration of 1975 (revised 1983). The trial was prospectively registered with the Clinical Trials Registry of India (CTRI/2024/12/077723).

Sample size: The sample size for the research study was determined using G*Power software, based on an effect size of 1.25, an alpha level of 0.05 and a statistical power of 85%. Based on the calculated values, it indicated that each group required 18 participants [12]. A total of 55 participants were screened for the study, of whom 36 met the inclusion criteria.

Inclusion and Exclusion criteria: The study included participants aged 20 to 50 years who were suffering from NSLBP and were willing to participate [4] and also had pain intensity between 4 to 6 on a Visual Analogue Scale (VAS) [12] with hamstring tightness of more than 23.40 based on the Active Knee Extension Test (AKET) [13,14]. Exclusion criteria included individuals with malignant tumours, spinal cord infections or fractures, who had undergone orthopaedic surgery on the lower back, pelvis or hips, individuals with neurological symptoms such as radiating pain, paraesthesia and muscle paralysis, inflammatory disease such as spinal tuberculosis or rheumatism, muscle rupture and pregnant females [15].

The participants were randomly assigned to two groups using the chit method, maintaining a 1:1 to each study group: Group-A, the intervention group (n=18) and Group-B, the control group (n=18). To ensure comprehensive reporting of the trial, the study followed the Consolidated Standards of Reporting Trials (CONSORT) 2010 statement, including its extensions for pilot and feasibility studies [Table/Fig-1].



[Table/Fig-1]: CONSORT flow diagram.

Outcome Measures

To measure the pain intensity VAS was used, to assess the lumbar curvature flexicurve was used, the MMST was used to check the lumbar ROM and the Oswestry disability index was used to check the disability in daily activities of an individual.

Visual Analogue Scale (VAS): The VAS was used to measure the degree of pain, demonstrating an Intraclass Correlation Coefficient (ICC) value of (95% CI: 0.989 to 0.992). The assessment involved a 10-centimetre linear line with one end marked as ‘0’, which is “no pain” and the other end marked as ‘10’ with “extreme pain”. Participants were instructed to mark their current pain level on the linear line and it was recorded [16].

Flexicurve: A 61 cm Surveyor’s flexi curve was used, having an ICC value of (95% CI: 0.88 to 0.97). The flexible ruler was placed over the spinous process of the lumbar spinal curve. It was moulded according to the curve of the spine and then traced on graph paper to calculate the index of spinal curvature. The maximum width and the total length of the curve were measured using the formula $\theta = 4 \times \arctan(2H/L)$, where θ ‘represents the magnitude of the lordotic curve. ‘L’ is the vertical line joining the T 12 and S 2 vertebrae and ‘H’ is the maximum width, which is the deepest part of the curve [17].

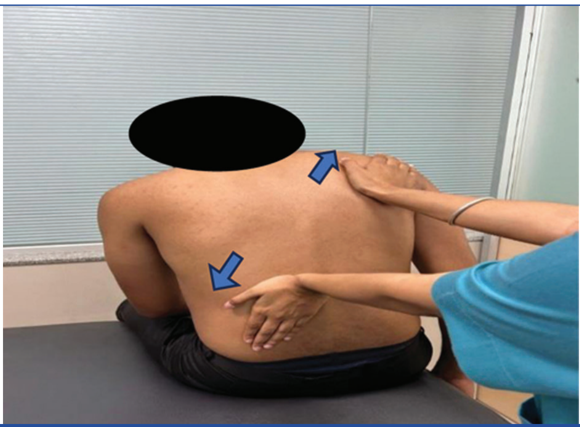
Modified-modified Schober’s Test (MMST): The MMST was used to assess the lumbar ROM of flexion and extension, which has an ICC value of (for flexion-0.91 and extension-0.94) The patient was in a standing position and the examiner located the inferior margin of both Posterior Iliac Spines (PSIS) by palpating the iliac crest with the thumbs. The intersection of the PSIS is marked by drawing a horizontal line. A 15 cm is marked above the midpoint, then the patient is instructed to flex forward as if attempting to touch his/her toes, the examiner re-measures the distance between the top and bottom line. The difference between these two measures in an erect position and flexion position indicates lumbar flexion. For extension, the patient is asked to bend backwards and again the measurement is taken as mentioned below [18].

Oswestry disability index: The Oswestry Disability Index (also known as the Oswestry LBP Disability Questionnaire) is an extremely important tool that measures patients’ functional disability due to LBP. Participants were given a questionnaire consisting of 10 items addressing various domains of the Oswestry disability index [19].

Study Procedure

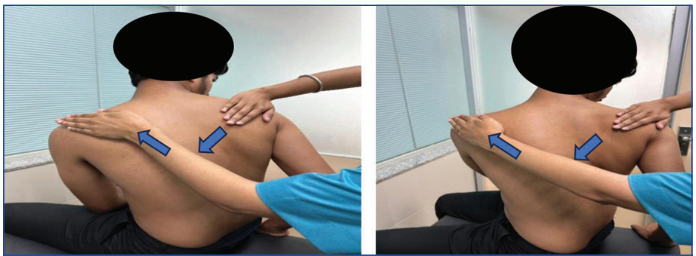
Intervention group (Group-A): The 3D MFRT was applied using specific techniques at three separate levels, performed on both sides of the body as described below:

- **A 3D Stretch:** This stretch was carried out with the patient seated on the treatment table while the therapist stood behind them. The therapist positioned their hands diagonally across the patient’s back and applied a simultaneous lateral and slightly forward stretch on both sides [Table/Fig-2] [4].
- **The 3D Stretch with trunk rotation:** In this technique, the patient was seated on the treatment table while the therapist stood behind. The therapist applied a downward diagonal



[Table/Fig-2]: Three-dimensional stretch [4].

stretch on one shoulder using one hand and an upward, slightly forward diagonal stretch on the opposite shoulder with the other hand to initiate trunk rotation. Based on the patient's feedback, the movement was progressively enhanced, increasing both trunk rotation and shoulder mobility [Table/Fig-3a,b] [4].



[Table/Fig-3]: (a,b) Three-dimensional stretch with trunk rotation. (Images from left to right) [4].

- **The 3D Stretch with head tilt:** While the patient remained seated, the therapist stood behind and placed one hand on top of the patient's head to guide cervical spine extension from front to back. At the same time, after the initial three-dimensional stretch, the therapist applied counter pressure to the upper thoracic spine using a clenched fist to create a fulcrum, pushing from back to front. The patient contributed to the stretch by pressing their back backward and applying forward pressure with their head [Table/Fig-4a,b] [4].

[Table/Fig-4]: (a,b) Three-dimensional stretch with head tilt. (Images from left to right) [4].

Participants underwent 3D MFRT consisting of three sets of myofascial release, each held for 90 seconds. Each treatment session had a total duration of 30 minutes. The manual pressure applied during 3D MFRT stretch was adjusted based on the patient comfort and tissue resistance. Patient tolerance was continuously monitored through verbal feedback and observation of pain or discomfort [6].

Along with 3DMFRT the participants received Interferential Therapy (IFT) on their lower back with following parameters, the input frequencies were set on 4000 Hz and 3900 Hz to achieve a resultant interference (beat frequency) of 100 Hz, the sweep frequency was 20 Hz and the swing pattern was 6:6 for a duration of 15 minutes and also core stability exercises like bilateral bridging, back isometrics and tummy tucks with pelvic tilt exercises like cat-camel, pelvic tilts in standing, sitting and bridging position. The intervention was given for six sessions, for two weeks on alternate days. To ensure treatment fidelity, a standardised intervention protocol was followed for all participants. All treatment sessions were administered by the same physiotherapist trained in 3D MFRT and the intervention procedures were performed consistently according to predefined protocol [11,20,21].

Control group (Group-B): A Generic Vectrostim 100 5 in 1 IFT machine was used for the conventional treatment, where the participants were positioned in a comfortable prone position on the treatment table and received IFT on their lower back with following parameters, the input frequencies were set on 4000 Hz and 3900 Hz to achieve a resultant interference (beat frequency) of 100 Hz, the sweep frequency was 20 Hz and the swing pattern was 6:6 for a duration of 15 minutes. Along with this the participants were asked to perform core stability exercises like bilateral bridging, back isometrics and tummy tucks and pelvic tilt exercises like cat-camel, pelvic tilts in standing, sitting and bridging position under supervision with three sets of ten repetitions [22,23]. Blinding of the treating therapist was not feasible as the intervention consisted of manual therapy procedures performed physically by the therapist

STATISTICAL ANALYSIS

Analysis was conducted using the Statistical Package for the Social Sciences (SPSS) software (SPSS Inc.; Chicago, IL) version 29.0.10. The Shapiro-Wilk test was used to identify the normality of the data which showed data to be normally distributed. Within-group (pre-post) comparisons were performed using the paired t-test, whereas between-group comparisons were performed using the independent sample t-test. A p-value <0.05 was considered statistically significant.

RESULTS

Descriptive statistics showed that participants (n=36) had a mean age of 35.81±10.98 years (range: 20-50 years), mean height 155.61±3.93 cm (range: 150-164 cm), mean weight 60.56±6.12 kg (range: 48-78 kg) and mean Body Mass Index (BMI) 25.02±2.65 kg/m^2 (range: 20-33.8 kg/m^2) [Table/Fig-5].

Variables	Range	Mean±SD
Age (Years)	20 to 50	35.81±10.98
Height (cm)	150 to 164	155.61±3.93
Weight (kg)	48 to 78	60.56±6.12
BMI (kg/m^2)	20 to 33.8	25.02±2.65

[Table/Fig-5]: Descriptive statistics for age, height, weight and BMI.
*Values are expressed as mean±Standard Deviation (SD). BMI: Body mass index

At baseline, there were no significant differences between males and females in Flexicurve angles, lumbar ROM (flexion and extension), pain intensity, or disability index (p>0.05). Irrespective of group allocation, significant improvements were observed from pre- to post-intervention in Flexicurve angle (p=0.007), lumbar ROM flexion and extension (p<0.001), pain intensity (p<0.001) and disability index (p<0.001) [Table/Fig-6].

Within-group analysis showed that participants in the intervention group had significant improvements only in lumbar ROM flexion and extension, pain intensity and disability index (p<0.001), and a statistically significant but clinically minimal change in Flexicurve scores (p=0.005) [Table/Fig-7].

Between-group analysis revealed that at post-test, the intervention group had significantly greater improvements compared to the control group in Flexicurve angles (p=0.043), lumbar ROM flexion (p=0.010), lumbar ROM extension (p=0.046), pain intensity (p<0.001) and the intervention group showed a greater reduction in ODI scores. Additionally, post-intervention ODI scores were significantly lower in the intervention group (p=0.011) [Table/Fig-8].

Further, the effectiveness (pre-post change) was significantly higher in the intervention group for Flexicurve, lumbar ROM flexion and extension, pain intensity and disability index. (p<0.05) [Table/Fig-9].

Variables		Mean±SD	Mean difference	95% C.I for mean difference	Effect size	"t"	df	p-value
Flexicurve (degrees)	Pre	44.09±7.88	0.57	0.17 to 0.9 7	0.381	2.87	35	0.007
	Post	43.53±7.75						
Lumbar ROM: Flexion (cm)	Pre	6.26±1.36	1.60	1.36 to 1.83	0.845	13.79	35	<0.001*
	Post	4.67±1.16						
Lumbar ROM: Extension (cm)	Pre	3.89±1.09	1.54	1.32 to 1.77	0.945	13.82	35	<0.001*
	Post	2.35±0.88						
Pain intensity	Pre	5.31±0.68	2.51	2.17 to 2.86	0.864	14.72	35	<0.001*
	Post	2.80±0.99						
Disability index (%)	Pre	31.89±5.27	6.36	4.57 to 8.15	0.559	7.23	35	<0.001*
	Post	25.53±5.65						

[Table/Fig-6]: Pre to post-comparison of flexicurve, lumbar ROM, pain intensity and disability index irrespective of groups.
*p<0.05 is considered statistically significant

Within the groups		Mean±SD	Mean±SD	Mean difference	95% C.I for mean difference	Effect size	"t"	df	p-value
Flexicurve (Degrees)	Intervention	42.07±9.11	40.94±8.56	1.13	0.39 to 1.87	0.381	3.24	17	0.005*
	Control	46.11±6.01	46.11±6.01	--	--	--	--	--	--
Lumbar rom: Flexion (cm)	Intervention	6.83±1.15	4.81±1.14	2.03	1.77 to 2.29	0.940	16.30	17	<0.001*
	Control	5.69±1.34	4.53±1.19	1.17	0.88 to 1.45	0.817	8.70	17	<0.001*
Lumbar rom: Extension (cm)	Intervention	3.97±1.12	2.06±0.94	1.92	1.70 to 2.13	0.955	18.97	17	<0.001*
	Control	3.81±1.09	2.64±0.74	1.17	0.84 to 1.50	0.766	7.45	17	<0.001*
Pain intensity	Intervention	5.17±0.71	2.06±0.64	3.11	2.70 to 3.53	0.937	15.86	17	<0.001*
	Control	5.47±0.62	3.59±0.62	1.88	1.48 to 2.28	0.861	9.94	17	<0.001*
Disability index (%)	Intervention	29.72±4.06	27.39±3.65	2.33	1.95 to 2.72	0.907	12.91	17	<0.001*
	Control	34.06±5.55	23.67±6.71	10.39	8.03 to 12.75	0.836	9.30	17	<0.001*

[Table/Fig-7]: Comparison of flexicurve, lumbar ROM, pain intensity and disability index within intervention group and controlled group.
*p<0.05 is considered statistically significant

Between the groups		Intervention	Control		
		Mean±SD	Mean±SD	"t"	p-value
Flexicurve (Degrees)	Pre	42.07±9.11	46.11±6.01	-1.57	0.126
	Post	40.94±8.56	46.11±6.01	-2.10	0.043*
Lumbar ROM: flexion (cm)	Pre	6.83±1.15	5.69±1.34	0.71	0.480
	Post	4.81±1.14	4.53±1.19	2.74	0.010*
Lumbar ROM: extension (cm)	Pre	3.97±1.12	3.81±1.09	0.45	0.653
	Post	2.06±0.94	2.64±0.74	-2.07	0.046*
Pain intensity	Pre	5.17±0.71	5.50±0.62	-1.51	0.141
	Post	2.06±0.64	3.59±0.62	-7.20	< 0.001*
Disability index (%)	Pre	34.06±5.55	29.72±4.06	-1.94	0.052
	Post	23.67±6.71	27.39±3.65	2.68	0.011*

[Table/Fig-8]: Comparison of flexicurve, lumbar ROM, pain intensity and disability index between the groups.
*p<0.05 is considered statistically significant

Effectiveness (Pre-Post)		Mean±SD	"t"	p-value
Flexicurve (Degrees)	Intervention	1.13±1.49	3.24	0.003*
	Control	0.00±0.00		
Lumbar ROM: Flexion (cm)	Intervention	2.03±0.53	4.71	<0.001*
	Control	1.17±0.57		
Lumbar ROM: Extension (cm)	Intervention	1.92±0.43	4.03	<0.001*
	Control	1.17±0.66		
Pain intensity	Intervention	3.11±0.83	4.50	<0.001*
	Control	1.88±0.78		
Disability index (%)	Intervention	10.39±4.74	-7.12	<0.001*
	Control	2.33±0.77		

[Table/Fig-9]: Comparison of effectiveness of the intervention (Pre-Post) in flexicurve, lumbar ROM, pain intensity and disability index between the groups.
*p<0.05 is considered statistically significant

Normality testing using the Shapiro-Wilk test confirmed that all outcome variables were normally distributed at both pre- and post-assessment points (p>0.05).

DISCUSSION

The present randomised controlled trial evaluated the effectiveness of 3D MFR as an adjunct to conventional therapy in participants with NSLBP. Key findings demonstrated that 3D MFR significantly improved pain intensity, lumbar ROM and functional disability. However, no significant changes were observed in lumbar curvature as measured by the Flexicurve.

The present study demonstrated improvement in pain following the intervention. Pain intensity is an important clinical indicator of symptom severity in individuals with NSLBP and is commonly assessed using standardised pain scales. The reduction in pain intensity observed in the present study is consistent with previous research investigating myofascial release techniques in LBP. Chen Z et al., reported in a systematic review and meta-analysis that myofascial release significantly reduces pain in individuals with chronic LBP when used alongside conventional physiotherapy interventions [21]. Similarly, Wu Z et al., (2021) demonstrated that MFR improves pain, pressure threshold and overall physical function in chronic LBP cases, which supports the current study's findings. The reduction in pain can be attributed to the fascial release mechanism, which enhances blood flow, reduces localised ischaemia and modulates the nociceptive threshold through myofascial relaxation. Furthermore, the dynamic nature of 3D MFR engaging both therapist-applied pressure and patient movement may enhance neuromuscular feedback and tissue pliability, improving pain perception [22].

Significant improvement in lumbar ROM, assessed through the MMST, was observed in the 3D MFR group. Lumbar ROM reflects the functional mobility of the lumbar spine and is often restricted in individuals with LBP due to muscle tightness and fascial restrictions. This aligns with the findings by Tamartash H and Bahrpeyma F, (2022), who reported enhanced lumbar flexibility and reduced pelvic inclination following MFR intervention in NSLBP patients [23]. Also, Phansopkar PA (2014) demonstrated that flexibility-focused interventions such as Mulligan's TLR and BLR techniques improve lumbar motion and reduce discomfort in acute LBP cases. These results support the principle that MFR facilitates deeper fascial plane mobilisation, allowing for increased segmental mobility and improved functional biomechanics of the lumbar spine [2].

The findings of present study are also comparable with other manual therapy approaches used in the management of NSLBP. Previous systematic reviews have reported that conventional MFR techniques can significantly reduce pain and improve functional outcomes in individuals with NSLBP [21]. Similarly, lumbar MFR interventions have been shown to improve spinal mobility and reduce mechanical restrictions in the lumbar region [22]. Other soft-tissue manual therapies, such as instrument-assisted techniques like the Graston technique, have also demonstrated improvements in hamstring extensibility and pain reduction in patients with NSLBP [24]. These findings suggest that manual therapy interventions targeting fascial and soft-tissue restrictions may contribute to improved mobility and pain reduction.

Functional disability, as measured by the Oswestry Disability Index (ODI), is widely used to assess the extent to which LBP affects ADLs and functional independence. In the present study ODI scores improved significantly post-treatment in the intervention group. Previous studies have similarly reported improvements in functional outcomes following myofascial release interventions. Chen Z et al., (2021) and Wu Z et al., (2021), both of whom highlighted the impact of MFR on reducing disability levels and improving Activities of Daily Living (ADLs) [21,22]. Restoration of fascial mobility, enhanced lumbar function and pain alleviation contribute to improved independence and reduced perceived disability [21]. The 3D MFR's ability to target restrictions across multiple fascial planes makes it especially suitable for individuals with complex postural and mobility impairments.

Despite positive outcomes in pain, function and mobility, the intervention group demonstrated a statistically significant but clinically minimal change in lumbar curvature as assessed via Flexicurve. Although the within-group analysis showed significance, the magnitude of change was small, indicating limited clinical relevance. Lumbar curvature plays an important role in spinal alignment and load distribution, however short-term interventions may not produce substantial postural changes.

This finding is consistent with previous studies such as Tamartash H and Bahrpeyma F, who reported improvements in lumbar flexibility with minimal alterations in spinal alignment over a short duration [23]. One possible explanation is the biomechanical interaction between hamstring tightness and pelvic tilt. Hamstring tightness, commonly seen in individuals with NSLBP, is associated with posterior pelvic tilt and reduced lumbar lordosis, often resulting in relatively flattened lumbar curve [2].

Additionally, 3D MFRT has been shown to be more effective in conditions involving excessive lordosis rather than reduced or neutral curvature. For instance, Welling A et al., (2024) reported reductions in lumbar lordosis in individuals with hyperlordosis [10]. In contrast, participants in present study may have a relatively compensated or flattened lumbar posture, thereby limiting the extent of observable structural change.

In the current study, although 3D MFR may have addressed fascial restrictions and improved segmental mobility, the complex and often opposing effects of pelvic alignment (anterior versus posterior tilt) likely balanced each other out, resulting in no significant change in spinal curvature during the short intervention period. This aligns with D'hooge et al., (2013), who emphasised that functional improvements do not always translate to measurable postural or structural change, especially over a short timeframe [24]. Additionally, Tamartash H and Bahrpeyma F, (2022) observed similar outcomes, enhanced lumbar ROM but minimal alteration in pelvic inclination or spinal lordosis following myofascial interventions [23].

Furthermore, according to a study done by Welling A et al., (2024) reported a decrease in lumbar lordosis in asymptomatic individuals with hyperlordosis, suggesting that structural change is more likely when the baseline curvature is significantly abnormal. In contrast, participants in the present study, who had NSLBP without extreme deviations in lordosis, may have started from a compensated or relatively neutral baseline, offering limited scope for measurable correction [10].

The present study utilised a three-dimensional myofascial release technique, which differs from traditional MFR approaches that typically focus on releasing fascial restrictions in a single direction. Conventional MFR techniques have been shown to reduce pain by restoring fascial mobility and reducing soft tissue restrictions [21,22]. However, three-dimensional approach used in this study addresses fascial restrictions across multiple directions, this technique may enhance spinal mobility and reduce mechanical stress surrounding structures, thereby contributing to improved pain relief and functional outcomes [6].

The above results reflect that the present study demonstrated both statistical and clinical significance of the intervention. Pain intensity in the intervention group decreased from 5.17±0.71 to 2.06±0.64 with a mean reduction of 3.11 points ($p<0.001$), which is considered clinically meaningful since a reduction of ≥2 points on pain scales is regarded as an important improvement in LBP. Significant improvements were also observed in lumbar flexion and lumbar extension, indicating enhanced spinal mobility. Furthermore, large effect sizes (0.94-0.95) suggest a strong treatment effect, supporting the clinical relevance of the intervention in addition to its statistical significance.

From a clinical perspective, NSLBP constitutes almost 90% of all LBP cases and is frequently caused by factors like postural imbalances, muscle tightness and poor biomechanics and can severely impact an individual's QOL by limiting mobility, increasing pain and reducing independence in daily activities. As NSLBP continues to affect a large portion of the population and significantly diminishes QOL, incorporating 3DMFRT into routine physiotherapy practice offers a promising approach to holistic and patient-centred care.

The findings of the study indicated that the alternate hypothesis was accepted and the null hypothesis was rejected, demonstrating that 3D MFRT was effective in reducing pain and improving ROM and QOL in individuals with NSLBP.

Certain confounding factors include variations in participants' daily physical activity levels, occupational demands, posture etc., which may affect pain and functional outcomes. Additionally, individual differences in lifestyle habits, psychological factors and previous treatment history could influence the response to therapy. These confounding variables can be controlled by closely monitoring participant activity levels, recording occupational and lifestyle factors and using stricter inclusion criteria to minimise their potential impact on study outcomes.

The study focused on NSLBP. Since older individuals often have LBP due to specific pathologies (e.g., degenerative or structural conditions), they were excluded to avoid confounding factors. Therefore, the age was limited to 20-50 years to ensure a more homogeneous NSLBP sample.

Participants with moderate pain (VAS 4-6) were included to ensure a homogeneous sample with sufficient symptoms for measurable improvement, while avoiding minimal change in mild cases and confounding factors in severe cases.

Participants in the present study were treated as routine Outpatient Department (OPD) patients and the interventions were provided as part of standard physiotherapy care under regular OPD billing.

Limitation(s)

The present study included a short intervention period of two weeks, which may not reflect long-term outcomes and also the sample comprised a higher number of female participants compared to males, which limits the generalisability of results to the broader population.

Further studies with a larger and more diverse sample size are recommended to improve the generalisability of the findings. Additionally, research with a longer follow-up period is required to evaluate the long-term effects of 3D MFRT in individuals with NSLBP. Further studies may also compare 3D MFRT with other manual therapy techniques to determine its relative effectiveness in the management of NSLBP.

CONCLUSION(S)

The findings of the present study highlight the clinical utility of 3D MFRT as an effective adjunctive treatment for NSLBP. It significantly reduces pain, improves lumbar ROM and decreases disability when compared to conventional therapy alone. Its incorporation into physiotherapeutic practice in patients with postural or myofascial contributors to LBP, is strongly supported.

Acknowledgement

The authors I sincerely thank all the faculty of KAHER Institute of Physiotherapy, Belagavi and KLE's Dr. Prabhakar Kore Hospital and MRC who have helped directly and indirectly for making the present study.

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PARTICULARS OF CONTRIBUTORS:
1. Postgraduate Student, Department of Orthopaedic Manual Therapy, KLE Institute of Physiotherapy, Belagavi, Karnataka, India.
2. Assistant Professor, Department of Orthopaedic Manual Therapy, KLE Institute of Physiotherapy, Belagavi, Karnataka, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Rani Hubli,
Postgraduate Student, Department of Orthopaedic, KLE Institute of Physiotherapy,
KLE Academy of Higher Education and Research J.N. Medical College Campus,
Nehru Nagar, Belagavi-590010, Karnataka, India.
E-mail: ranihubli2411@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Jan 03, 2026
- Manual Googling: May 09, 2026
- iThenticate Software: May 12, 2026 (1%)

ETYMOLOGY: Author Origin

EMENDATIONS: 6

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. Yes

Date of Submission: **Dec 15, 2025**
Date of Peer Review: **Mar 05, 2026**
Date of Acceptance: **May 14, 2026**
Date of Publishing: **Aug 01, 2026**