Effects of myofascial release and mulligan sustained natural apophyseal glides with strengthening exercises on pain and disability in non-specific low back pain (#51682)

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Effects of myofascial release and mulligan sustained natural apophyseal glides with strengthening exercises on pain and disability in non-specific low back pain

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Background: Myofascial release (MFR) and Mulligan Sustained Natural Apophyseal Glides (SNAGs) are manual therapy techniques routinely practiced in the management of non-specific low back pain (NSLBP). Both techniques, as a sole intervention or along with other therapies, have reportedly positive results for individuals with NSLBP. However, which technique is better to improve NSLBP-related pain and disability, warrants further research. **Objective:** To study the comparative effects of MFR and SNAGs on pain, disability, functional ability and lumbar range of motion (ROM) **Method:** A parallel group study was conducted at tertiary care hospitals. Sixty-five Sub-acute or chronic NSLBP patients were allocated to receive either MFR (n=33) or SNAGs (n=32) along with strengthening exercises. Outcome measures such as Visual Analog Scale (VAS), Patient-Specific Function Scale (PSFS), ROM, and Modified Oswestry disability index (MODI) were evaluated at baseline, immediate (after 1st treatment) and post sixth day of the intervention. **Results**: Within-group analysis found to have similar immediate and short-term effects of MFR and SNAGs on NSLBP. Both groups showed clinically and statistically significant ($p<0.05$) improvement on all outcome measures over the short term but not immediately for MODI and lumbar ROM except extension. Between the groups, analysis observed no statistically significant difference ($p < 0.05$) at both the immediate and short-term. **Conclusions:** Non-specific low back pain related pain and disability can be improved using SNAGs or MFR along with strengthening exercises. For restricted ROM Mulligan SNAGs has a better outcome than MFR. Hence, both manual therapy techniques can be incorporated to treat sub-acute to chronic NSLBP effectively.

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Abstract

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Conclusions: Non-specific low back pain related pain and disability can be improved using SNAGs or MFR along with strengthening exercises. For restricted ROM Mulligan SNAGs has a better outcome than MFR. Hence, both manual therapy techniques can be incorporated to treat sub-acute to chronic NSLBP effectively.

[(https://ctri.nic.in) number- CTRI/2018/12/016787]

Keywords: Mulligan SNAGs; Myofascial release; Non-specific low back pain; strengthening exercises

Implications for practice

- Manual therapy techniques such as MFR and SNAGs can be considered as a first-line treatment approach for NSLBP related pain, disability, and functional improvement.

- To improve sagittal plane restricted lumbar ROM in NSLBP, Mulligan SNAGs technique should be delivered than MFR

Introduction

Low back pain (LBP) is a debilitating health condition, ranked first in terms of musculoskeletal disease burden worldwide.[1,2] It is reported to have an 18.3% mean point prevalence and 30.8% one-month prevalence.[3] According to the Global Burden of Disease study, LBP emerged as a primary cause for years lived with disability (YLD) for all age groups in both sexes.[1] From 1990 to 2007, YLDs due to LBP increased by 30% with a further increase of 17% in the last decade.[1]

Low back pain is defined as pain, fatigue, or stiffness between the lower margin of the last rib and inferior gluteal folds, with or without pain referral to one or both lower extremities.[2,4] Based on duration, LBP can be categorized as acute LBP, lasting for less than six weeks, sub-acute LBP, lasting between six to twelve weeks and chronic LBP with a duration of more than

twelve weeks.[4] Approximately 10% of LBP cases are termed specific LBP, with an identifiable pathology, whilst the remaining 90% is termed non-specific LBP (NSLBP), reflecting LBP of unknown underlying pathology, characterized by pain, muscle tension, and stiffness.[3]

One proposed mechanism underpinning NSLBP involves changes in lumbosacral proprioception and core muscle recruitment patterns due to atrophy of the lumbar stabilizes[5] and gluteus maximus[6] along with other hip muscles weakness.[7] The gradual decrease in motor control leads to uncontrolled and abnormal tissue loading on the myofascial complex,[8,9] stressing the lumbar spine leading to pain.[5]

The primary line management for NSLBP includes analgesics and physical therapy interventions[3,10] including transcutaneous electrical nerve stimulation, low-level LASER therapy, manual therapy,[11] back schools, exercise, and timely review.[10,11] Despite the range of interventions available, NSLBP leads to chronic loss of health by limiting activity participation and loss of function, potentially resulting in prolonged work disability.[4]

Manual therapy is a science of hands-on soft tissue or joint mobilization techniques, which are purportedly used to modulate pain, improve the extensibility of contractile tissues, and improve the restricted movement of joints.[11] Manual therapies such as Mulligan mobilization,[12–18] McKenzie exercises,[14] Maitland mobilization,[15,16] and Myofascial release therapy (MFR)[8,9,19–22] are used routinely in clinical practice for the management of NSLBP

The Mulligan concept is based on the theory that minor position faults of articulating surfaces of joints following injury or strain result in a painful and restricted range of motion (ROM).[11,12] Sustained Natural Apophyseal Glides (SNAGs) is a Mulligan's mobilization technique that adds a passive accessory glide, parallel to the joint plane using vertebral spinous process or transverse

process, after which patient performs an active movement which was previously painful or restricted.[12–18,23] It can be hypothesized that the effects of SNAGs on pain reduction could be due to the activation of central and peripheral pain mechanisms. [24] It has been proposed that stimulation of mechanical receptors by spinal mobilization activates large-diameter nerve fibers leading to pain inhibition at the spinal cord level[24] often termed the 'Gate control theory.' At the central level, descending pain pathways may be facilitated via the periaqueductal grey matter of midbrain.[24] Likewise, descending neurons may release the primary mediators' opioids, nor-adrenaline, and serotonin by the effect of spinal mobilization, which modulates pain, reduces the muscle spasm, and improve restricted lumbar movements.[16,24]

Three randomized clinical trials (RCT) have reported a reduction of pain in patients with NSLBP by the addition of SNAGs to conventional therapy, including stretching,[12,16] back extensor strengthening,[12,15,16] and thoracic postural exercises.[15,17] Immediate and short term effects on lumbar ROM, have also been reported when SNAGs was given as a standalone treatment in patients with NSLBP[13] as well as healthy individuals[23] compared to sham SNAGs. Waqqar et al. in their RCT study comparing SNAGs with McKenzie extension exercises in patients with mechanical LBP, found both the techniques resulted in immediate and short term improvements in lumbar ROM, pain and disability.[14]

Myofascial release (MFR) is a manual technique that utilizes a superintend force in a predetermined direction to stretch or optimize the myofascial complex's length and gliding properties.[8,9] The fascia, which is densely innervated by mechanoreceptors are highly responsive to manual pressure.[21] MFR has been shown to reduce pain and improve myofascial restriction and tissue extensibility.[8,9,19–22,24] It could be explained that the hypoalgesic effects achieved by MFR with the prolonged and constant release, which activates joint and

muscle mechanoreceptors, superimposes the stretch over the joint, which activates deep joint receptors.[22] The sympathetic system is activated by somatic efferent and local central grey matter, which helps in modulating the descending pain pathway, thus controlling pain at the posterior horn of the spinal cord.[19,22]

Two RCTs have reported beneficial effects of MFR on pain, fascial mobility when given as an adjunct therapy to specific back exercises[8] and occupational therapy[19] in NSLBP patients. Tozzi et al.[9] showed improved pain, fascial mobility, and functional abilities following the use of MFR in patients with non-specific neck and LBP as compared with the sham group. Two studies have shown short-term effects on pain reduction, performances of daily activities and fear of pain among patients with chronic NSLBP[20] and improvements in lumbar ROM among desk job workers with mechanical LBP when MFR was given as a standalone treatment.[21]

Both MFR and SNAGs have shown beneficial effects in managing NSLBP when used as an adjunct to other therapies. However, there is a dearth of evidence on the comparative effects of MFR and SNAGs as an adjunct to strengthening exercises in patients with NSLBP. Hence, this study sought to compare the effects (immediate and short term) of MFR and SNAGs as adjunct treatments in a cohort of patients with NSLBP.

Materials & Methods

The parallel group study was carried out at tertiary care hospitals from November 2018 to March 2020. Institutional Ethics Committee, Kasturba Medical College, Mangalore granted ethical approval (IEC KMC MLR 11-18/429) to carry out the study. The study design was registered under the clinical registry for India, https://ctri.nic.in with identifier CTRI/2018/12/016787. Written and oral instruction about the study procedure, intervention, and

possible benefits and risks of the study were given to the patients. Written informed consent was taken from all the patients before their allocation at 1:1 ratio to receive either intervention. Patients were unaware of the second intervention group. As it is an inherent issue to manual therapy trials, blinding of the Physical therapist, involved in intervention, to the group allocation of patients was not possible.

Patients

Patients referred by orthopaedic surgeons for physiotherapy were recruited. Sixty-five patients with sub-acute to chronic NSLBP were included in the study after screening for eligibility criteria. The inclusion criteria were patients with sub-acute to chronic NSLBP, either gender, 18-60 years old, and a minimum LBP Visual Analogy Scale (VAS) score of four.[25] Patients were excluded if they presented with any of the following conditions, disc hernia, radiculopathy, spinal pathology (fracture or tumors) or history of any spinal surgery, lumbar canal stenosis, osteoporosis and spinal deformities like scoliosis or kyphosis.

Outcome measures

The selected patients were allocated into either MFR or SNAGs groups in an alternate sequence. An independent blinded assessor collected all the outcome measures data from the patient at pre-treatment, immediately after the first treatment and after the sixth session (short term).

Pain levels were assessed with the VAS. It is a 100mm horizontal scale with 'no pain' and 'worst possible pain' labels at the line's extremes. The VAS has demonstrated good test-retest reliability, which is higher among literate ($r= 0.94$, $p< 0.001$) than illiterate ($r= 0.71$, $p<0.001$) subjects.[26]

Patient-Specific Function scale (PSFS) was used to assess functional ability. The patient was asked to write down three activities that were the most restricted or challenging to perform. All

153 the activities were scored on a scale of zero to ten, where 'zero' is unable to perform/challenging
154 to do, and 'ten' can do as before. Previous research on the PSFS has reported moderate to good
155 reliability with an intraclass correlation coefficient (ICC) of 0.713, and a minimal detectable
156 change (MDC) of three and minimal important difference (MID) of 1.2.[27]

157 Disability assessment was undertaken using the Modified Oswestry Disability Index (MODI)
158 questionnaire, which has ten sections and provides information on the effect of LBP on the
159 patient's ability to manage everyday life. Fritz and Irrgang (2001) reported a high test-retest
160 reliability of the MODI in 67 LBP patients with an ICC of 0.90 and a minimum clinically
161 important difference (MCID) of six points.[28]

162 Range of motion (ROM) was assessed in this study using a bubble inclinometer. A study on the
163 within and between-day reliability of bubble inclinometer in determining standing lumbar spine
164 ROM (Flexion, extension, and lateral flexion) in healthy individuals and chronic NSLBP patients
165 found ICCs ranged from 0.908 to 0.982 and between days standard error of measurement ranged
166 between 0.60 and1.18.[29]

167 **Intervention**

168 Procedure for SNAGs[30]

169 The SNAGs were applied in the sitting position with the patient's pelvic stabilized with a belt at
170 the level of the anterior superior iliac spine (ASIS). The ulnar aspect of the therapist's hand was
171 used over the spinous process of the superior vertebra of the involved segment to apply glide in
172 flexion and the spinous process of the inferior vertebra for extension glide. A passive accessory
173 glide was administered and maintained until the patient completed a full arc of movement, which
174 was restricted or painful earlier. The glides were given for six repetitions for three sets every

session. (Figure 1). The application of flexion or extension glide was decided based on the movement examination for restricted lumbar ROM and pain response. The level of the hypo mobility in the lumbar spine assessed by postero-anterior glides in prone lying. The glide was administered over the spinous process, where the force's amplitude was upheld within the patient's comfort as it has been previously described by Mulligan that SNAGs should not provoke any pain.

Procedure for MFR[19,31]

The patient was positioned comfortably in prone lying. Direct MFR was administered to the lower back muscles with the therapists' knuckles and the stretch held at the end range for up to 120 seconds or until the therapist felt giving away of the taut tissues before being released. (Figure 2)

Strengthening exercises[6,7,32]

Strengthening exercises are prescribed for all the patients with NSLBP, under the directive of the referring orthopaedic surgeon. Both the groups received strengthening exercises, which included lower abdominal draw-in manoeuvre to activate transverse abdominis in crook lying. Cat and camel exercises were carried out for lumbar multifidus training in a quadruped position. Strengthening of gluteal muscles (hip abductors and extensors) was performed in a side-lying, and prone lying position with straight leg raise exercises without any additional resistance with two sets of ten repetitions. Patients were also briefed about ergonomic advice on posture and lifting techniques to incorporated during routine activities

Power calculation

196 The sample size was calculated using the G*Power analysis software (version 3.0.10). The effect
197 size for VAS was estimated, d=20mm, and standard deviation (σ) =26.5mm from a previous
198 study. [14] With a power of 85% and α level of 0.05 total sample size estimated to be seventy
199 (35 in each group) considering 10% dropout rate.
200

201 **Statistical analysis**

202 Obtained data were analyzed using SPSS Version 25.0 (SPSS Inc, Chicago, IL, USA). Data were
203 assessed for normality using skewness and kurtosis values and observation of Q-Q plots, which
204 indicated that non-parametric tests were required. The demographic characteristics of the patients
205 were summarized with median and interquartile ranges. Data for the lost to follow-up patients
206 were analyzed using the intention to treat analysis by carrying forward the value of outcome
207 measures assessed at the last follow-up. P-values less than 0.05 were considered statistically
208 significant. A repeated measure ANOVA was used to assess within the group differences from
209 baseline to post-treatment sessions for VAS, MODI, PSFS, and lumbar ROM. Post-hoc analysis
210 using Bonferronis correction was performed for time*group differences, i.e., baseline to
211 immediate session and baseline to post-treatment session were calculated. Mann- Whitney U test
212 was used to analyse between the two groups' differences for all the outcome measures at
213 baseline, immediate, and post-treatment.
214

215 **Results**

216 The flow of patients throughout the phases of the trial is highlighted in the consort flowchart
217 (figure 3). One hundred and sixty-seven patients were screened for eligibility, of which 102

patients were excluded based on exclusion criteria. Sixty-five patients could be recruited within the study period and allocated to either MFR (n=33) and SNAGs (n=32) groups. Eight patients dropped out before the sixth session either because they dramatically improved before the sixth session and were discharged, or they migrated. Intention to treat analysis was considered to accommodate dropouts. The demographic data of all the participants are shown in Table 1. Baseline characteristics of all the outcome measures were homogenous and statistically insignificant between the groups. (Table 2) The within-group analysis identified statistically significant differences for VAS, MODI, PSFS, and extension ROM for both the groups but also flexion ROM in the SNAGs group. (Table 3)

Time*group : For both the groups, VAS and PSFS showed immediate and short-term improvement, while MODI improved only in the short term. Lumbar extension improved immediately and in the short term in both the groups; however, flexion in the SNAGs group showed improvement only by the sixth day treatment. Lateral flexion ROM did not show any significant change for both the groups (Table 4).

Post intervention comparison between the groups for VAS, MODI, PSFS, and ROM showed no statistically significant difference (Table 5).

Discussion

This study aimed to determine the benefits of MFR or SNAGs in combination with strengthening exercises on pain, disability, ROM, and functional ability in a cohort of patients with NSLBP. Although both MFR and SNAGs groups demonstrated statistically significant ($p < 0.05$)

239 improvements, for outcomes VAS, MODI, ROM, and PSFS, immediately and at the sixth
240 treatment, there were no significant differences between the groups ($p>0.05$).

241 Pain and disability

242 In this study, MODI demonstrated statistical ($p<0.05$) significant difference for both MFR and
243 SNAGs groups. The MCID for the MODI has been estimated to be six points.[28] The MFR
244 group showed an improvement of four points, while a change of six points was observed in the
245 SNAGs group after the sixth treatment session.

246 In this study, SNAGs with strengthening exercises were found to have statistical ($p<0.05$) and
247 clinically significant effects on pain. The MCID for VAS has been identified as 20mm[33] and
248 this study found a change of 30.5mm in median VAS scores immediately after the 1st session
249 and 41mm at the end of the sixth session. These results support earlier studies which showed
250 improvements when SNAGs were added to conventional therapy, including stretching,[12] back
251 extensor strengthening exercises and thoracic postural correction exercises.[17] SNAGs also
252 have short term beneficial effects on pain and disability when SNAGs was administered every
253 alternate day with similar exercises.[15,16] Waqqar et al. compared SNAGs mobilization to
254 McKenzie based extension exercises for pain and disability. They found both intervention to
255 have a similar effect with significant changes within the groups but no statistically significant
256 difference between the groups.[14]

257 Similar to the use of SNAGs, patients with NSLBP who had MFR also had statistical ($p< 0.05$)
258 and clinically significant improvements in VAS scores of 21mm immediately after the 1st
259 treatment session and 42mm change after the sixth treatment session. Earlier literature reported
260 that MFR, when administered as an adjunct to specific back exercises,[8] and occupational

therapy,[19] showed improvements in pain in patients with chronic NSLBP, and functional abilities among patients with non-specific neck and LBP.[9] Myofascial release as a standalone treatment[20,21] has been found to have short-term beneficial effects on pain reduction, performances of daily activities, and fear of pain among patients with chronic NSLBP.

Range of motion

Within-group analysis for lumbar ROM showed a statistically significant improvement in lumbar extension for both the groups and in lumbar flexion in the SNAGs group only. However, there was no significant change in lateral flexion ROM, within as well as between the groups. Earlier studies suggested that SNAGs application had an immediate and short term effect on lumbar flexion ROM among healthy individuals[23] as well as patients with mechanical LBP[14] and NSLBP.[15–18] It has been proposed that the passively administered spinal accessory glide over the vertebral spinous process, breaks adhesions, leading to increased facet joint vascular supply and necessary nutrients.[24] These physiological changes potentially clear nociceptive metabolites, enhancing the soft tissue healing around the injury site.[24] The application of the glides over the spinous process concentrated correcting flexion and extension positional faults and promoting pain-free physiological lumbar spine movement. [11] In this study, Mulligan mobilization was delivered with contact with the spinous process, which glides both facets in the same direction. In addition to that, patients also performed either lumbar flexion or extension movement along with mobilization, as it was primarily restricted movement. We hypothesize, this reason for no improvement observed in lateral flexion, as it requires ipsilateral facet to move in extension with contralateral facet moving to flexion and can be better-improved giving mobilization using unilateral transverse process.

Similarly, for MFR, researchers have reported that MFR as an adjunct to occupational therapy, which consisted of the back school along with isometrics or isotonic exercises[19] and work station modifications[22] improved lumbar flexion ROM. It has been proposed that MFR helps in breaking down the scar matrix, redistributes internal fluids, breaks intermolecular crosslinks, and collagen extensibility.[22] These effects of MFR may help in improving fascial mobility and soft-tissue extensibility.[22]

Functional ability

Within-group analysis for functional ability found a statistical ($p<0.05$) significant difference in PSFS scores by the sixth treatment session, but between the group, there was no significant difference. When the mean changes for the PSFS activities were calculated, there was a difference of 2.67 in both MFR and SNAGs groups after the sixth session. Abbott and Schmidt[34] reported that the MCID for PSFS in chronic LBP was 1.3 for small and medium change and a larger change of 3.3, whilst Vliet et al.[35] reported MCID for PSFS of 4.3 in patients with mechanical LBP. From our study, we assume that the useful improvement in functional activity could be due to reduced pain and disability levels.

Conclusions

Our results show that MFR and SNAGs, along with strengthening exercises found to have similar immediate and short-term effects on pain, disability, and lumbar extension ROM in NSLBP. Also, functional ability had an improvement in the short term. Hence, both the techniques can be implemented for short-term management of sub-acute to chronic NSLBP. Based on our study, therapists should consider implementing MFR or SNAGs as one of the

manual therapy treatments along with strengthening exercises among patients with NSLBP. Future trials should consider assessing the long-term effects of SNAGs. Varying duration of MFR hold can be assessed with a long-term follow-up.

Conflict of interest

The authors declare there are no conflict of interest

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430

Figure 1

Mulligan SNAGs Technique

Figure 2

Myofascial Release Technique

Figure 3

CONSORT Flow Diagram

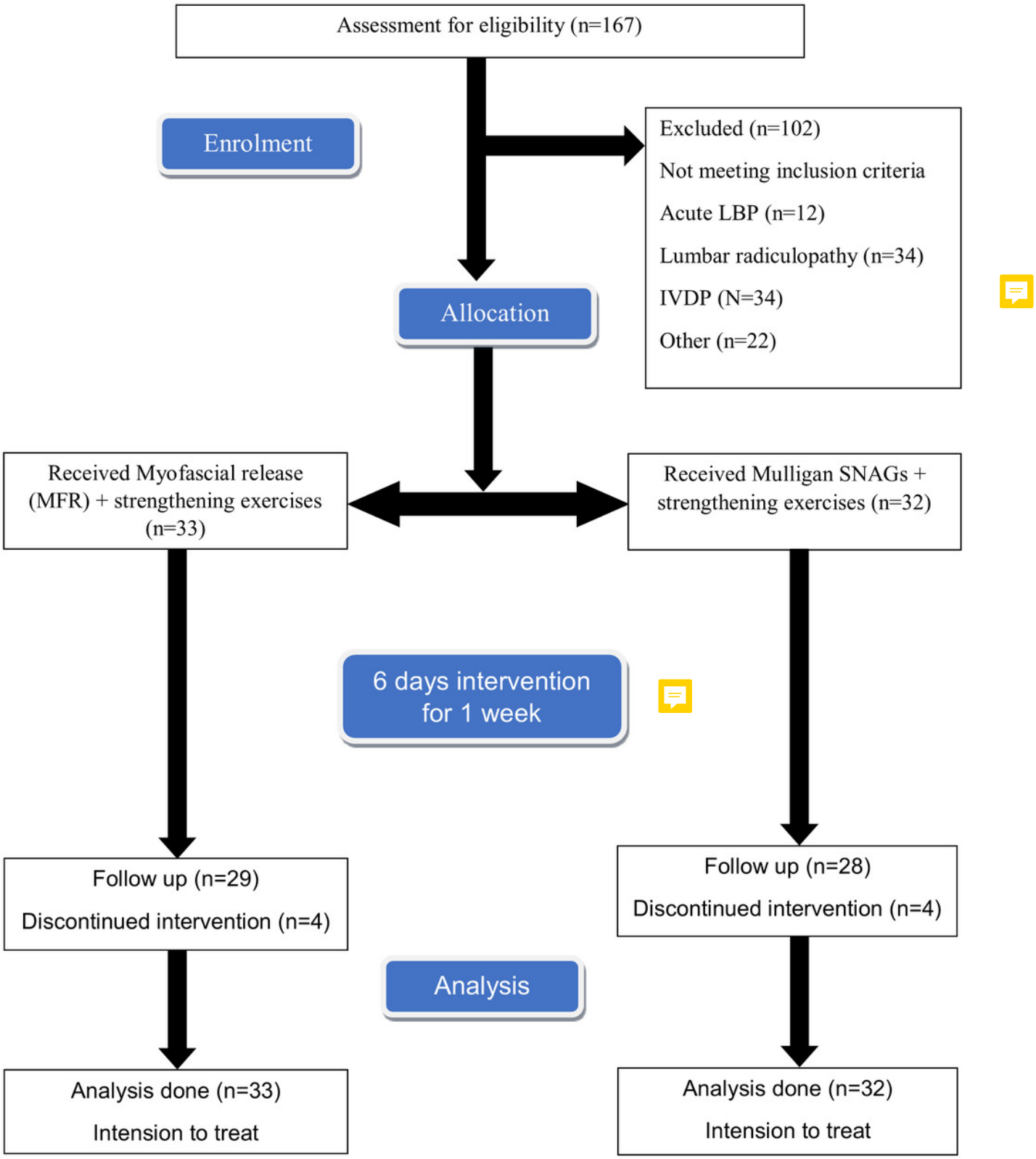
Assessment for eligibility (n=167)
Enrolment
Excluded (n=102)
Not meeting inclusion criteria
Acute LBP (n=12)
Lumbar radiculopathy (n=34)
IVDP (N=34)
Other (n=22)
Allocation
Received Myofascial release (MFR) + strengthening exercises (n=33)
Received Mulligan SNAGs + strengthening exercises (n=32)
6 days intervention for 1 week
Follow up (n=29)
Discontinued intervention (n=4)
Follow up (n=28)
Discontinued intervention (n=4)
Analysis
Analysis done (n=33)
Intension to treat
Analysis done (n=32)
Intension to treat

Table 1(on next page)

Demographic details of the participants

1

Variables		MEAN±SD	
		MFR (n=33)	SNAGs (n=32)
Age (in years)		25±7.11	24.34±5.37
Gender	Male	15	5
	Female	18	27
Duration of LBP	Sub-acute (6-12 weeks)	2	5
	Chronic (>12 weeks)	31	27

Table 2(on next page)

Baseline characteristics of VAS, MODI, PSFS and ROM for MFR and SNAGs groups

**p<0.05 statistical significant

Variables	MEDIAN (IQR)		p-value
	MFR	SNAGs	
VAS	6.2 (5.2-7.2)	6.1(4.5-4.7)	0.11
MODI	16(12-25)	14(1.5-25)	0.545
PSFS	4.33(3.83-5.33)	4.33(3.33-5.33)	0.232
Flexion	50(45-57.5)	50 (44.25-57.75)	0.712
Extension	18 (10-20)	16.5 (10.25-25)	0.889
Left lateral flexion	20 (15-25)	20 (15-28.5)	0.595
Right lateral flexion	20 (13-25)	20 (15-25)	0.633

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Table 3(on next page)

Within-group analysis of VAS, MODI, PSFS and ROM for MFR and SNAGsgroup at pre, immediate and post intervention

**p<0.05 statistical significant

Variable	Group	MEDIAN (IQR)			F	p-value
		Pre	Immediate	Post		
VAS	MFR	6.2 (5.2-7.2)	4.1(1.9-5.2)	2(1.0-3.45)	73.787	0.001**
	SNAGs	6.1(4.5-4.7)	3.05(2.05-4.37)	2(0.85-3.65)	81.333	0.001**
MODI	MFR	16(12-25)	16(9-23)	12(6-16)	23.26	0.001**
	SNAGs	14(1.5-25)	14(9-21.5)	8(6-15.5)	22.168	0.001**
PSFS	MFR	4.33(3.83-5.33)	5.33(4.49-6.16)	7(5.83-7.58	31	0.001**
	SNAGs	4.33(3.33-5.33)	5.33(5-6.66)	7(6.12-7.62)	69.865	0.001**
Flexion	MFR	50(45-57.5)	50 (45-59)	52 (45.5-60)	1.895	0.159
	SNAGs	50 (44.25-57.75)	52.5 (45-59.5)	55.5 (50-60)	6.254	0.004**
Extension	MFR	18 (10-20)	20 (15-30)	25 (19-30)	19.368	0.0001**
	SNAGs	16.5 (10.25-25)	21.5 (18.25-29.5)	25 (20-31.5)	13.717	0.0001**
Left lateral flexion	MFR	20 (15-25)	22 (15-30)	20 (20-25)	0.494	0.612
	SNAGs	20 (15-28.5)	20 (15-25)	24.5 (15-28)	1.24	0.296
Right lateral flexion	MFR	20 (13-25)	20 (17.5-26)	20 (17.5-26)	3.081	0.06
	SNAGs	20 (15-25)	20 (15-27.75)	20 (15.75-28)	1.001	0.325

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Table 4(on next page)

Time*group analysis for VAS, MODI, PSFS and ROM for MFR and SNAGs groups

**p<0.05 statistical significant

1

Variables	Group	Factors	Mean Difference	Std. Error	p-value	95% Confidence Interval	
VAS	MFR	Pre * Immediate	2.503	0.344	0.0001**	1.63	3.37
		Pre * Post	3.806	0.309	0.0001**	3.02	4.58
	SNAGs	Pre * Immediate	2.484	0.0322	0.0001**	1.66	3.3
		Pre * Post	3.544	0.315	0.0001**	2.74	4.34
MODI	MFR	Pre * Immediate	1.212	0.639	0.201	-0.403	2.82
		Pre * Post	6.727	1.23	0.0001**	3.61	9.82
	SNAGs	Pre * Immediate	0.812	0.346	0.076	-0.64	1.68
		Pre * Post	6.12	1.198	0.0001**	3.09	9.15
PSFS	MFR	Pre * Immediate	-1	0.175	0.0001**	-1.441	-0.559
		Pre * Post	-2.156	0.197	0.0001**	-2.655	-1.658
	SNAGs	Pre * Immediate	-1.495	0.212	0.0001**	-2.031	-0.959
		Pre * Post	-2.751	0.278	0.0001**	-3.454	-2.047
Flexion	MFR	Pre * Immediate	-0.545	1.112	1	-3.35	2.26
		Pre * Post	-1.879	0.894	0.13	-4.13	0.379
	SNAGs	Pre * Immediate	-1.875	1.24	0.422	-5.01	1.26
		Pre * Post	-4.594	1.489	0.013**	-8.36	-0.82
Extension	MFR	Pre * Immediate	-6.03	1.234	0.0001**	-9.14	-2.91
		Pre * Post	-7.455	1.258	0.0001**	-10.63	-4.27
	SNAGs	Pre * Immediate	-5.03	1.522	0.007**	-8.88	-1.17
		Pre * Post	-7.219	1.42	0.0001**	-10.81	-3.62
Left lateral flexion	MFR	Pre * Immediate	-1.27	1.366	1	-4.72	2.17
		Pre * Post	-0.97	1.413	1	-4.54	2.6
	SNAGs	Pre * Immediate	-0.375	0.912	1	-2.68	1.93
		Pre * Post	-1.688	1.283	0.594	-4.93	1.56
Right lateral flexion	MFR	Pre * Immediate	-2.242	1.059	0.126	-4.91	0.43
		Pre * Post	-2.758	1.416	0.181	-6.33	0.82
	SNAGs	Pre * Immediate	-1.06	1.033	0.934	-3.67	1.55
		Pre * Post	-1.594	1.19	0.57	-4.6	1.41

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Table 5(on next page)

Between-group analysis of VAS, MODI, PSFS and ROM for MFR and SNAGs groups post intervention

**p<0.05 statistical significant

Variable	MEDIAN (IQR)		p-value
	MFR	SNAGs	
VAS	2(1.0-3.45)	2(0.85-3.65)	0.674
MODI	12(6-16)	8(6-15.5)	0.472
PSFS	7(5.83-7.58	7(6.12-7.62)	0.51
Flexion	52 (45.5-60)	55.5 (50-60)	0.38
Extension	25 (19-30)	25 (20-31.5)	0.947
Left lateral flexion	20 (20-25)	24.5 (15-28)	0.754
Right lateral flexion	20 (17.5-26)	20 (15.75-28)	0.931

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