DOI: 10.7860/JCDR/2024/67663.19273

Original Article

Physiotherapy Section

Effectiveness of Hamstring Release and Neural Mobilisation in Improving Walking Capability and Physical Activity Associated with Intermittent Neurogenic Claudication in Patients with Lumbar Spinal Stenosis: A Quasi-experimental Study

GEETA YADAV[1], SAURABH KUMAR[2], VINIKA CHOUDHARY[3], PRIYANKA RISHI[4]

ABSTRACT

Introduction: In India, one of the most prevalent spinal pathologies is Lumbar Spinal Stenosis (LSS). It is characterised by the compression of neural structures in the spinal canal, resulting in symptoms such as neurogenic claudication, lower extremity radiculopathy, and gait impairment. Treatment involves various therapeutic modalities, with present study focusing on an integrated exercise method.

Aim: To evaluate the potential efficacy of hamstring release and neural mobilisation in LSS patients.

Materials and Methods: This quasi-experimental study was conducted at SGT Medical College Hospital and Research Institute, Gurugram, Haryana, India from September 2021 to May 2022. Total of 30 patients diagnosed with LSS were divided into two groups based on inclusion criteria: group A (experimental) and group B (control). Pain, neural flexibility, walking capacity, disability, and physical activity were assessed at baseline and after the 3rd week of the intervention. Treatment sessions were administered for 30 minutes per day, three times per week (on alternate days), for a duration of three weeks in both groups. Data analysis was done using the Windows version of Statistical Package for Social Sciences version 26.0 (SPSS, Chicago, IL, USA). The paired t-test was used to compare mean data within each group before and after the intervention. The Independent t-test formula was applied to compare pre and postintervention changes between group A and group B. Group B. A significance level of p-value <0.05 was considered statistically significant.

Results: Group A and group B had respective mean ages of 37.07±8.66 years and 41.07±8.66 years. Total of 30 LSS patients were treated. Significant differences were observed in the Numeric Pain Rating Scale (NPRS) (p-value <0.0001), Straight Leg Raise (SLR) (p<0.001), Slump Test (p-value <0.0001), and Self-paced Walking Test (SPWT) (p-value <0.0001). Minimal significance was noted in the Modified Oswestry Disability Index (MODI) (p-value=0.027) and Swiss Spinal Stenosis Questionnaire (SSSQ) (p-value=0.029).

Conclusion: Hamstring release and neural mobilisation improve pain, neural flexibility, walking capacity, disability, and physical activity in LSS patients.

Keywords: Neural flexibility, Radiculopathy, Spinal pathologies

INTRODUCTION

The prevalence of Low Back Pain (LBP) discomfort affects over 60% of the population in India. LBP can be categorised as either specific or non specific. Total 20% of LBP patients have Lumbar Spinal Stenosis (LSS), while in 80% of cases, it is attributed to lumbar disc herniation [1]. Epidemiological data indicates a rising frequency of LSS, with an incidence of five occurrences per 100,000 people. It is estimated that approximately 64 million adults will suffer from this debilitating condition in the next decade [2]. Degenerative spinal stenosis is 30% more common in older individuals based on radiographic and clinical data from cross-sectional research [3]. LSS is characterised by the anatomical narrowing of the lumbar vertebral canal, leading to intrusion into neural structures through nearby soft tissue and bones [4]. Cauda equina compression and emerging nerve roots contribute to low back discomfort. Lumbar canal stenosis is a potentially disabling cause of LBP that, although treatable, of 10 results in inactivity, decreased productivity, and potential loss of independence, particularly in older age groups [2]. Degenerative changes to the spine, such as facet joint hypertrophy, ligamentum flavum thickening, degenerative spondylolisthesis, and disc bulging, can result in spinal canal narrowing [1]. Anatomically, stenosis can manifest in two forms: central and lateral. Central stenosis can be caused by degenerative spondylolisthesis, retrolisthesis, osteophytic outgrowths of the facet joints, posterior disc bulging, and ligament thickening. Osteophytic overgrowth of the pedicles, superior lumbar facets, lateral disc bulging, and asymmetrical disc height loss are potential causes of lateral stenosis [5]. The symptoms of LSS can arise through several stages that may occur separately or simultaneously [6]. The primary symptom of LSS is neurogenic claudication, resulting in leg discomfort affecting various areas such as the buttocks, groin, and front of the thigh. This discomfort extends down the leg to the foot and includes sensations of weakness, heaviness, fatigue, and tingling. Patients may also experience bladder issues and leg cramps at night. These symptoms can occur on one or both sides and are more bothersome than associated back pain. A key characteristic is that discomfort worsens with arching the lower back but improves with bending forward. Standing up or walking exacerbates the symptoms, while sitting provides relief. For patients with neurogenic claudication, lying flat often provides less relief, whereas side lying (which allows for back flexion) is more comfortable [1,4].

In patients with Lumbar Spinal Stenosis (LSS), diagnosis is based on their clinical history, physical examination findings, and imaging, which is frequently required to assess the exact level and severity of the stenosis. Magnetic Resonance Imaging (MRI) is helpful for determining the size of the spinal canal and identifying the degree of degenerative changes [7,8]. The radiological criteria for LSS (L1-L5) using MRI to determine the site of the stenosis are spinal canal Anteroposterior (AP) diameter ≤12 mm for central canal stenosis, lateral recess height ≤3 mm and depth ≤5 mm in lateral stenosis, and foraminal stenosis with a foraminal diameter ≤5 mm.

The treatment of LSS involves both conservative and non conservative methods. When conservative or therapeutic approaches are unable to control persistent symptoms, surgical procedures may be preferred. Physiotherapy treatment can be effective for mild to moderate stenosis, incorporating multidisciplinary treatments such as strength training, traction, endurance training, flexibility exercises, manipulation treatment, lifestyle modifications, and conditioning exercises aimed at improving general spinal health and lower extremity fitness [9,10]. By using a variety of stretching techniques and strengthening lumbar flexors, the main goal is to gradually loosen tight muscles that encourage lumbar extension. Along with pelvic strengthening, core strengthening is an essential component. One of the most successful treatment methods is manual therapy, which includes lumbar flexion-distraction, joint, soft tissue, and neural mobilisation, as well as low-amplitude, high-velocity manipulation [11].

A highly effective treatment for symptomatic LSS is neural mobilisation exercise. Through these activities, noxious fluids are dispersed, tissue vascularity is improved, and neuronal gliding is facilitated. These effects could lead to increased health and functionality of the compressed neural tissue, enabling the tissue to meet the metabolic and functional demands imposed by walking activities. Patients can perform neural mobilisation exercises at home without any additional equipment and in a short amount of time as part of a daily maintenance program [12]. Given the lack of data presenting the effects of hamstring release and neural mobilisation or the combined results of these two interventions, there is a need for this study to examine the effect of hamstring release and neural mobilisation in LSS patients. Hence, present study aimed to evaluate the effectiveness of hamstring release and neural mobilisation in improving walking capability and physical activity associated with intermittent neurological claudication in patients with LSS.

MATERIALS AND METHODS

The quasi-experimental study was conducted at the SGT Medical College Hospital and Research Institute in Gurugram, Haryana, India from September 2021 to May 2022. The study protocol was approved by the Institutional Research Ethics Committee under the reference SGTU/FPHY/2022/17. In present study, the efficacy of hamstring release and neural mobilisation, along with conventional physiotherapy, was compared with conventional physiotherapy alone in LSS patients.

Sample size calculation: A sample size of 30 was calculated using G-power software with 10% power and a 95% confidence interval.

Inclusion criteria: The included participants were both male and female, cooperative, aged between 25-50 years, with clinical evidence of neurogenic claudication due to LSS, symptoms persisting for more than three months, LSS anteroposterior diameter ≤12 mm in MRI, and willing to participate in physical exercise.

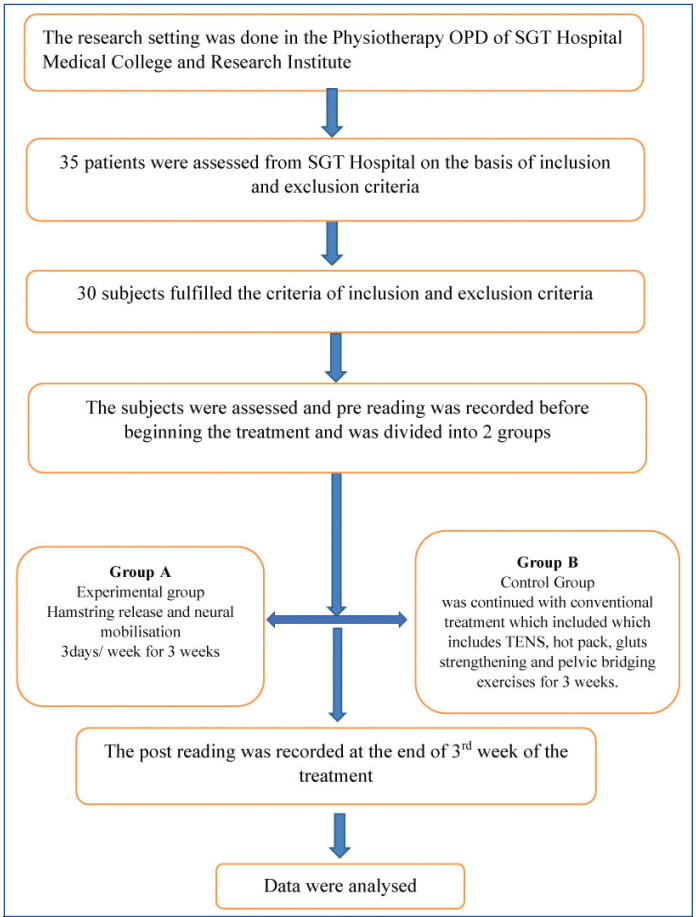
Exclusion criteria: Subjects with a history of spinal surgery, cognitive and psychiatric disorders, pregnancy, any major recurrent diseases such as cancer, diabetic neuropathy, renal failure, tumours, and those who were unwilling, unable to complete the study, or unresponsive were excluded.

Study Procedure

Using the inclusion and exclusion criteria, a sample of 30 patients was chosen from the population, by convenient sampling method. Each group consisted of 15 patients. Prior to testing, all participants signed written informed consent after the entire procedure and the purpose of the study had been disclosed to them. All the individuals included in the study were allocated into two groups: Experimental Group (Group A) and Control Group (Group B). Readings of NPRS, SLR, slump test, SPWT, MODI, and SSSQ [Table/Fig-1] [12-19] were recorded at baseline and at the end of the intervention after the 3rd week for both groups [12-19]. An identity code was assigned to each participant at the beginning to ensure the study's impartiality. The flowchart describing the study blueprint is displayed in [Table/Fig-2].

Outcome measures	Method of evaluation
Pain	Numeric Pain Rating Scale (NPRS) [12-14]
Neural flexibility	Straight Leg Raise (SLR) [15] and slump test [16]
Walking capability	Self-paced Walking Test [17,18]
Disability	Modified Oswestry Disability Index (MODI) [19]
Physical activity and Activities of Daily Living (ADLs)	Swiss Spinal Stenosis Questionnaire (SSSQ) [10]

[Table/Fig-1]: Outcome measures of the study [12-19].



[Table/Fig-2]: Flowchart of the study design.

Sampling method: Subjects were divided into two groups, Group A (Experimental group) and Group B (control group), using a convenient sampling method. Each group consisted of 15 patients.

Interventions: Group A (experimental group) patients received neural mobilisation, hamstring release, glute strengthening, and pelvic bridging exercises (three repetitions, 10 seconds hold in each and 10 seconds relaxation in between each set) along with Transcutaneous Electrical Nerve Stimulation (TENS) (four poles, 10 minutes duration) and hot pack for 10 minutes. For neural mobilisation of the sciatic nerve, the therapist decreased the hip flexion angle below the range by 5 to 10 degrees until the symptoms vanished. The next step in

the procedure to mobilise the sciatic nerve involved passively moving the ankle joint into alternate dorsiflexion and plantar flexion positions. With a ten-second break between each session, three sets of 10 repetitions of the oscillatory technique of neural mobilisation were performed. To determine whether the ranges that were previously reported had changed, the therapist again performed the test at the conclusion of the session after a 5-minute break [Table/Fig-3,4] [20]. Friction massage was applied through an electric massager and fingertips for the hamstring at the musculotendinous junction of the distal portion of the hamstring. Deep pressure was applied in a small circular motion. The patient was in a supine position with knees extended or a prone position. The therapist then grasped the subject's thigh with both hands (thumbs on the quadriceps) and applied friction pressure in circular motions with fingers at the musculotendinous junction of the hamstring for 30 seconds, three repetitions, with a gap of 10 seconds between each set.

[Table/Fig-3]: Showing mobilisation of sciatic nerve.

[Table/Fig-4]: Showing strengthening of gluteus-medius muscle.

Group B (control group) patients received conventional therapy, which included TENS (four poles, 10 minutes duration), hot pack for 10 minutes, glute strengthening, and pelvic bridging exercises (three repetitions, 10 seconds hold in each and 10 seconds relaxation in between each set). The above treatment protocol was given for three days (alternative days) per week for three weeks with a duration of 30 minutes for both groups.

STATISTICAL ANALYSIS

The Windows version of SPSS, version 26.0 (SPSS, Chicago, IL, USA), was used to analyse the data. As the data followed a normal distribution, all the descriptive statistics were expressed as means with standard deviations. To compare the mean data of the groups before and after the intervention within each group, a paired t-test was used. The pre- and post-intervention changes between group A and group B were compared using the Independent t-test formula. A p-value of <0.05 was considered to be statistically significant.

RESULTS

Total of 30 patients with LSS were recruited for present study, among which 19 were females and 11 males. Group A and group B had respective mean ages of 37.07±8.66 years and 41.07±8.66 years. The data were analysed, and the descriptive analysis described the age and gender distribution among group A and group B. There was no discernible age difference between the two groups. In terms of gender distribution among both groups, Group A included 5 (33.33%) males and 10 (66.67%) females, while in Group B, 6 (40%) were males and the remaining 9 (60%) were females within the study. There was no significant difference in gender distribution.

The comparison of mean values of NPRS at baseline and the end of the 3rd week after treatment between group A and group B has been displayed in [Table/Fig-5]. The comparison between NPRS scores of group A and group B showed highly significant values in the post-intervention (p-value <0.0001). An equal variance t-test reveals a statistical difference between the mean values of the SLR test and slump test scores for the right side (p=0.001) and left side (p-value <0.0001) at post-intervention between group A and group B. Similarly, an equal variance t-test reveals a highly significant difference between the mean values of SPWT at post-intervention (p-value <0.0001). There was a significant difference in MODI score (p=0.027) and SSSQ score (p=0.029) at the end of the 3rd week after treatment between group A and group B.

Outcome measures	Group A	Group B	t-value	p-value##
NPRS				
Pre-intervention	6.67±1.11	6.73±1.16	0.16	0.874 (NS) <0.0001***
Post-intervention	3.60±1.12	6.13±1.64	4.94	
SLR (Right-side)				
Pre-intervention	44.6±8.66	47.67±6.34	1.11	0.278 (NS) 0.001**
Post-intervention	74.53±3.56	59.13±7.16	7.46	
SLR (Left-side)				
Pre-intervention	52.80±7.94	52.80±9.38	0	1.00 (NS) <0.0001***
Post-intervention	76.80±2.96	64.67±4.00	9.61	
Slump test (Right-side)				
Pre-intervention	24.47±7.55	23.27±6.89	0.455	0.653 (NS) <0.0001***
Post-intervention	9.53±3.58	18.80±5.29	5.61	
Slump test (Left-side)				
Pre-intervention	25.53±4.61	23.80±3.83	1.12	0.273 (NS) <0.0001***
Post-intervention	9.67±2.53	21.00±4.17	8.99	
Self-paced Walking Test (SPWT)				
Pre-intervention	441.93±10.65	437.27±9.59	1.26	0.218 (NS) <0.0001***
Post-intervention	535.53±14.21	443.67±14.21	19.21	
MODI				
Pre-intervention	41.20±5.03	38.60±5.27	1.38	0.178 (NS)
Post-intervention	32.87±4.79	37.53±6.09	2.33	0.027*
SSSQ				
Pre-intervention	33.40±4.26	33.53±4.27	0.086	0.932 (NS)
Post-intervention	28.13±3.87	32.00±5.25	2.3	0.029*

[Table/Fig-5]: Pain on Numeric Pain Rating Scale (NPRS), neural flexibility on Straight Leg Raise (SLR) and slump test, walking capability on Self-paced Walking Test (SPWT), disability on Modified Oswestry Disability Index (MODI) and physical activity and Activities of Daily Living (ADLs) on Swiss Spinal Stenosis Questionnaire (SSSQ) score at baseline and end of 3rd week post-intervention between the groups. #Mean±standard deviation values for Group A (experimental group) and Group B (control group); ##Significance between groups: *p<0.05; **p<0.001, ***p<0.001; NS=Non significant

The analysis and comparison of the mean values of different outcome measures at baseline and the end of the 3rd week after treatment within group A and group B has been represented in [Table/Fig-6]. The calculated t-values for NPRS, SLR right side, SLR left side, Slump right, Slump left side, Self-paced walking test, MODI, and SSSQ for group A and group B at baseline and post-intervention

were 16.88, 12.48, 12.45, 9.36, 11.33, 20.79, 13.91, and 13.72, and 1.96, 7.54, 6.22, 6.91, 8.21, 3.26, 1.2, and 2.98, respectively. Group A shows a more significant difference (p-value <0.0001) at pre- and post-intervention than Group B.

Outcome measures		Group A		Group B	
		t-value	p-value##	t-value	p-value##
NPRS	Pre vs Post-intervention	16.88	0.0001***	1.96	0.070NS
SLR (Right-side)	Pre vs Post-intervention	12.48	0.0001***	7.54	0.0001***
SLR (Left-side)	Pre vs Post-intervention	12.45	0.0001***	6.22	0.0001***
Slump test (Right-side)	Pre vs Post-intervention	9.36	0.0001***	6.91	0.0001***
Slump test (Left-side)	Pre vs Post-intervention	11.33	0.0001***	8.21	0.0001***
Self-Paced Walking Test (SPWT)	Pre vs Post-intervention	20.79	0.0001***	3.26	0.006*
MODI	Pre vs Post-intervention	13.91	0.0001***	1.2	0.251NS
SSSQ	Pre Vs Post-intervention	13.72	0.0001***	2.98	0.010*

[Table/Fig-6]: Comparison of mean value of Pain on Numeric Pain Rating Scale (NPRS), neural flexibility on Straight Leg Raise (SLR) and slump test, walking capability on self-paced walking test, disability on Modified Oswestry Disability Index (MODI) and physical activity and Activities of Daily Living (ADLs) on Swiss Spinal Stenosis Questionnaire (SSSQ) score at baseline and end of 3rd week post-intervention between the groups.
#Mean±standard deviation values for Group A (Experimental group) and Group B (Control group); ##Significance between groups: *p<0.05; **p<0.001, ***p<0.001; NS=Non significant

DISCUSSION

Neurogenic claudication is considered the predominant symptom in LSS. It involves the buttocks, groin region, anterior side of the thigh, and radiates down to the back part of the leg to the feet. The aim of the current study was to investigate the effect of hamstring release and neural mobilisation techniques on walking capability and physical activity associated with intermittent neurogenic claudication in patients with LSS.

The data were analysed, and the descriptive analysis described the age and gender distribution among group A and group B. There was no discernible age difference between the two groups. In terms of gender distribution among both groups, Group A included 5 (33.33%) males and 10 (66.67%) females, while in Group B, 6 (40%) were males and the remaining 9 (60%) were females within the study. There was no significant difference in gender distribution.

In the present study, the comparison of the mean value of NPRS between both groups reveals a significant difference between the baseline and the end of the 3rd week score. When comparing the mean value of group A and group B, it was found that Group A showed significant improvement compared to Group B. The current study findings are in line with Mohamed SHP and Seyed MA and Sharaf MA et al., who also found statistically significant differences among the groups in the pain component (NPRS) and Oswestry Disability Index (ODI) [21,22]. However, Plaza-Manzano G et al., found no significant difference between the groups in pain when motor control was used along with neurodynamic interventions. Patients were given a neurodynamic program along with exercises [23]. With neural mobilisation, a variety of physiological advantages have been discovered that could contribute to pain relief. It was predicted that stretching the straight leg during neural mobilisation would oscillate between lengthening and shortening the nerve, causing a brief increase in intraneural pressure followed by a period of relaxation. By repeatedly pumping, the local inflammatory products in and around the nerve may be better dispersed, lowering hypoxia and discomfort [15].

In the present study, neural flexibility in LSS was improved by hamstring release and neural mobilisation technique. In support of these findings, Alshami AM et al., found a significant difference in SLR and Slump tests when compared with other groups [24]. Dwornik M et al., also reported that based on the observation that Postneural mobilisation resting muscle tone decreased, neural mobilisation has strong analgesic effects [25]. Both spinal and supraspinal mechanisms may be responsible for the analgesic effects of releasing the hamstrings; persistent release triggers the activation of both muscle and joint mechanoreceptors [26]. Neural mobilisation may have the power to modulate blood flow to brain areas linked to pain, to alter descending inhibitory pain processes, and to lessen the activation of supraspinal pain centers. These mechanisms could have an effect on patient-centred outcomes, including pain and impairment [27]. A tested method for determining a patient's capacity to walk while suffering from LSS is the SPWT. In this test, the patient is asked to walk comfortably at his or her own pace on a level surface until back or leg pain forces them to stop and rest [17]. The findings of the present study were supported by Gehring R et al., who conducted a prospective case series and received manual physical therapy interventions, concluding that neural mobilisation significantly improves walking capability in patients with LSS [12]. The present study found that disability due to LSS improved significantly in the experimental group compared to the control group. Many previous studies also found statistically significant differences in the improvement of disability between the groups in the Oswestry disability questionnaire score [1,26].

It is possible to attribute the large reduction in pain and functional disability seen in the neural mobilisation groups to the combined effects of the two types of physical treatment, conventional physical therapy, and neural mobilisation approaches. It was determined that neural mobilisation improves the mechanical characteristics of peripheral nerves. It can cause various levels of longitudinal nerve excursion and strain, aiding in restoring movement between the nerve and supporting components through gliding movement. As a result, the internal stresses on the nervous tissue may be reduced, improving nerve function [28].

Hamstring release and neural mobilisation techniques also improve physical activity and Activities of Daily Living (ADLs) in LSS patients. Ammendolia C et al., conducted a multimodal exercise program which consisted of myofascial release, neural mobilisation, manipulation, and muscle stretching. They found a significant difference in the SSS questionnaire [29]. Gehring R et al., conducted a prospective case series and received manual physical therapy interventions, concluding that patients with LSS benefit greatly from neural mobilisation in terms of physical activity. Treatment methods known as neural mobilisation maneuvers cause particular mechanical modifications in the nervous system that may lead to physiological changes which help relieve the symptoms [12].

Limitation(s)

The limitations of the present study was short duration of interval and treatment protocol and no long-term follow-up was conducted in present study.

CONCLUSION(S)

The results of present quasi-experimental study highlight the importance of including hamstring release and neural mobilisation in the rehabilitation program for patients with LSS to improve neural flexibility. Walking capability and physical activity associated with intermittent neurological claudication are important outcomes, demonstrating the efficacy of these interventions in enhancing the overall functional well-being of people with this illness.

REFERENCES

[1] Kumar S, Narkeesh A. Effect of Integrated Exercise Protocol in Lumbar Spinal Stenosis as Compare with Conventional Physiotherapy- A randomized control trial. Int J Neurorehabilitation Eng. 2017;4(6):01-06.
[2] Singh V, Sethi R, Chauhan BKS, Thukral BB. Lumbar spinal stenosis and morphometry of lumbar vertebral canal. Journal of the Anatomical Society of India. 2016;65:33-37.
[3] Kalichman L, Cole R, Kim DH, Li L, Suri P, Guermazi A, et al. Spinal stenosis prevalence and association with symptoms: The Framingham Study. Spine J. 2009;9(7):545-50.
[4] Kumar S, Arumugam N, Gambhir S. An integrated exercise approach for secondary lumbar spinal stenosis- A case report. IJPHY. 2017;4(4):201-06.
[5] Fritz JM, Delitto A, Welch WC, Erhard RE. Lumbar spinal stenosis: A review of current concepts in evaluation, management and outcome measurements. Arch Phys Med Rehabil. 1998;79(6):700-08.
[6] Lee BH, Moon SH, Suk KS, Kim HS, Yang JH, Lee HM. Lumbar spinal stenosis: pathophysiology and treatment principle: A narrative review. Asian Spine J. 2020;14(5):682-93.
[7] Murphy DR, Hurwitz EL, Gregory AA, Clary R. A non-surgical approach to the management of lumbar spinal stenosis: A prospective observational cohort study. BMC Musculoskelet Disord. 2006;7:16.
[8] Kumar S, Narkeesh A. Physiotherapeutic challenges in treatment of lumbar spinal stenosis: A review. Research and reviews. Journal of Neuroscience. 2017;7(2):6-12.
[9] Mazanec DJ, Podichetty VK, Hsia A. Lumbar canal stenosis: Start with nonsurgical therapy. Cleve Clin J Med. 2002;69(11):909-17.
[10] Deer T, Sayed D, Michels J, Josephson Y, Li S, Calodney AK. A review of lumbar spinal stenosis with intermittent neurogenic claudication: Disease and diagnosis. Pain Med. 2019;20(Suppl 2):S32-S44.
[11] Ammendolia C, Hofkirchner C, Plener J, Bussieres A, Schneider MJ, Young JJ, et al. Non-operative treatment for lumbar spinal stenosis with neurogenic claudication: An updated systematic review. BMJ Open. 2022;12(1):e057724.
[12] Gehring R, Potter-Brunet J, Sizer P, Gilbert K, Brismée JM. A neural mobilization treatment strategy for patients with neurogenic claudication related to degenerative lumbar spinal stenosis: A prospective case series. Int J Sports Exerc Med. 2021;7:191.
[13] Williamson A, Hoggart B. Pain: A review of three commonly used pain rating scales. J Clin Nurs. 2005;14(7):798-804.
[14] Childs JD, Piva SR, Fritz JM. Responsiveness of the numeric pain rating scale in patients with low back pain. Spine (Phila Pa 1976). 2005;30(11):1331-34.
[15] Malik N, Kataria C, Sachdev NB. Comparative effectiveness of straight leg raise and slump stretching in subjects with low back pain with adverse neural tension. International Journal of Health and Rehabilitation Sciences (IJHRS). 2012;1(1):02-10.
[16] Davis DS, Anderson IB, Carson MG, Elkins CL, Stuckey LB. Upper limb neural tension and seated slump tests: The false positive rate among healthy young adults without cervical or lumbar symptoms. J Man Manip Ther. 2008;16(3):136-41.
[17] Schneider M, Ammendolia C, Murphy D, Glick R, Piva S, Hile E, et al. Comparison of non-surgical treatment methods for patients with lumbar spinal stenosis: Protocol for a randomized controlled trial. Chiropr Man Therap. 2014;22:19.
[18] Rainville J, Childs LA, Peña EB, Suri P, Limke JC, Jouve C, et al. Quantification of walking ability in subjects with neurogenic claudication from lumbar spinal stenosis--A comparative study. Spine J. 2012;12(2):101-09.
[19] Nishant, Chhabra HS, Kapoor KS. New modified English and Hindi oswestry disability index in low back pain patients treated conservatively in Indian population. Asian Spine J. 2014;8(5):632-38.
[20] Kaur G, Sharma, S. Effect of passive straight leg raise sciatic nerve mobilization on low back pain of neurogenic origin. J Phys Occup Ther. 2011;5:179-84.
[21] Mohamed SHP, Seyed MA. Low back pain: A comprehensive review on the diagnosis, treatment options, and the role of other contributing factors. Open Access Macedonian Journal of Medical Sciences. 2021;9(F):347-59.
[22] Sharaf MA, Rezkallah SS, Fouda KZ, Gharib NM. Effects of adding neural mobilization to traditional physical therapy on pain, functional disability, and H-reflex in patients after lumbar laminectomy: A randomized controlled trial. Clin Rehabil. 2022;36(1):51-58.
[23] Plaza-Manzano G, Cancela-Cilleruelo I, Fernandez-de-Las-Penas C, Cleland JA, Arias-Buría JL, Thoomes-de-Graaf M, et al. Effects of adding a neurodynamic mobilization to motor control training in patients with lumbar radiculopathy due to disc herniation: A randomized clinical trial. Am J Phys Med Rehabil. 2020;99(2):124-32.
[24] Alshami AM, Alghamdi MA, Abdelsalam MS. Effect of neural mobilization exercises in patients with low back-related leg pain with peripheral nerve sensitization: A prospective, controlled trial. J Chiropr Med. 2021;20(2):59-69.
[25] Dwornik M, Kujawa J, Białoszewski D, Słupik A, Kiebzak W. Electromyographic and clinical evaluation of the efficacy of neuromobilization in patients with low back pain. Ortop Traumatol Rehabil. 2009;11(2):164-76.
[26] Ellythy MA. Efficacy of muscle energy technique versus myofascial release on function outcome measures in patients with chronic low back pain. Bull Fac Ph Th. 2012;17(1):51-57.
[27] Beneciuk JM, Lentz TA, He Y, Wu SS, George SZ. Prediction of persistent musculoskeletal pain at 12 months: A secondary analysis of the Optimal Screening for Prediction of Referral and Outcome (OSPRO) validation cohort study. Phys Ther. 2018;98(5):290-301.
[28] Rezkalla S, Gharib NM. Crossed straight leg raising versus straight leg raising in patients with lumbar disc herniation: Effects on pain, functional disability and balance. International Journal of Therapies and Rehabilitation Research. 2017;6(2):82.
[29] Ammendolia C, Stuber K, Tomkins-Lane C, Schneider M, Rampersaud YR, Furlan AD, et al. What interventions improve walking ability in neurogenic claudication with lumbar spinal stenosis? A systematic review. Eur Spine J. 2014;23(6):1282-301.

PARTICULARS OF CONTRIBUTORS:
1. Postgraduate Student, Department of Physiotherapy, SGT University, Gurugram, Haryana, India.
2. Associate Professor, Department of Physiotherapy, SGT University, Gurugram, Haryana, India.
3. Assistant Professor, Department of Physiotherapy, SGT University, Gurugram, Haryana, India.
4. Associate Professor, Department of Physiotherapy, SGT University, Gurugram, Haryana, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Saurabh Kumar,
Associate Professor, Department of Physiotherapy, SGT University,
Gurugram-400001, Haryana, India.
E-mail: saurabh04pt@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Sep 22, 2023
- Manual Googling: Jan 26, 2024
- iThenticate Software: Feb 01, 2024 (16%)

ETYMOLOGY: Author Origin

EMENDATIONS: 7

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: **Sep 22, 2023**
Date of Peer Review: **Dec 23, 2023**
Date of Acceptance: **Feb 03, 2024**
Date of Publishing: **Apr 01, 2024**