ORIGINAL ARTICLE ASIAN JOURNAL OF MEDICAL SCIENCES

To validate and correlate radiologic grading of central and foraminal stenosis post-surgical decompression on degenerative lumbar canal stenosis

Niraj Narayan Singh[1], Kumar Rohit[2], Mahipal Ajitsinh Padhiyar[3]

[1]Associate Professor, [2]Assistant Professor, Department of Orthopaedics, ESIC Medical College, Patna, Bihar, [3]Senior Resident, Department of Orthopaedics, GMERS Medical College, Valsad, Gujarat, India

Submission: 04-07-2024 Revision: 03-09-2024 Publication: 01-10-2024

ABSTRACT

Background: Lumbar canal stenosis (LCS) is characterized as a narrowing of the canal diameter with age, which can lead to degenerative bone and soft-tissue changes. **Aims and Objectives:** The aim of the study is to validate the radiologic grading of central and foraminal through correlation with outcome after surgical decompression in degenerative LCS. **Materials and Methods:** A total of 23 patients with degenerative LCS who satisfied inclusion criteria and consented to participate in the study were selected and their Oswestry Disability Index (ODI) and Visual Analog Scale (VAS) for back and leg pain were recorded and their magnetic resonance imaging (MRI) was graded. **Results:** LCS is the reduction in the dimension of the central or lateral lumbar canal that occurs most frequently as a result of chronic degenerative changes at the lumbar motion segments. In our study, ODI has comparable improvement in all groups and it does not correlate with the severity of stenosis. However, VAS for leg pain has a greater prevalence in the shorter durations group (<60 months) which had an average of 8.0. If VAS for leg pain was more preoperatively, a better outcome was seen postoperatively. **Conclusion:** Decompression surgery for degenerative LCS shows significant improvement in ODI and VAS for back pain and leg pain irrespective of the severity of the stenosis by MRI grading or the severity of symptoms as assessed by VAS or ODI.

Key words: Lumbar canal stenosis; Oswestry disability index; Visual Analog Scale; CT myelography; Magnetic resonance imaging

Access this article online

Website: http://nepjol.info/index.php/AJMS

DOI: 10.3126/ajms.v15i10.67624

E-ISSN: 2091-0576

P-ISSN: 2467-9100

INTRODUCTION

Lumbar canal stenosis (LCS) is characterized as a narrowing of the canal diameter with age, which can lead to degenerative bone and soft-tissue changes, as well as his thesis. Neurogenic claudication, back pain, leg discomfort, and paresthesia are the most typical symptoms of this condition, which can be linked with neurological deficits (motor weakness and sphincteric involvement), especially during dynamic testing. Neurological claudication is characterized by poorly localized pain, paresthesia, and cramping in one or both lower extremities that arise when walking and subside when resting.[1]

The patient's clinical and radiological results, as well as his mental state and environment, as well as his and his family's expectations, are all factors in determining the patient's outcome.[2] In ordinary practice, the patient's history of pain and numbness is noted, and walking ability is determined by the distance he or she can walk before having to sit down or developing significant numbness or weakness in the legs, also known as saddle anesthesia. All of these factors are used to evaluate the surgical result. Treadmill test, Visual Analog Scale (VAS), Oswestry Disability Index (ODI), SF36 score, Japanese orthopedic association score, and cross-sectional area (CSA) of the lumbar canal are some of the methods

Address for Correspondence:
Dr. Kumar Rohit, Assistant Professor, Department of Orthopaedics, ESIC Medical College, Patna, Bihar, India.
Mobile: +91-7000414479. **E-mail:** rohit.singh3926@gmail.com

that have been described and are internationally accepted for the clinical and radiological evaluation of patients.[3]

Prasad et al. included all of these variables for assessment in their 48 recruited cases, which comprised clinical, radiological, and functional evaluation of patients having surgical therapy, in their research of patients with degenerative LCS. They looked at the VAS and ODI scores for back and leg pain with a satisfactory surgical outcome, as well as the treadmill test for neurogenic claudication by the first symptom time and evaluated the maximum walking distance and maximum walking time.[4] CSA was measured radiologically both before and after surgery. The overall recovery grades were graded using the JOA score. The benefits of the various scores listed above, as well as the general (SF-36) and disease-specific health status index ODI, have been advocated in the literature for clinical evaluation and surgical outcome assessment.[5]

Spinal stenosis is classified into four types: Central spinal stenosis, foraminal stenosis, lateral recess stenosis, and mixed stenosis, which is a combination of central and lateral recess stenosis. To confirm the diagnosis of LCS, computed tomography (CT) or magnetic resonance imaging (MRI) scans might be employed.

MRI and CT myelography (CTM) have both been recognized as useful pre-operative supplementary diagnostic techniques for LCS.

In this study, we proposed categorizing LCS based on MRI findings and assessing clinical outcomes after surgical decompression.

Aims and objectives

To validate the radiologic grading of central and foraminal through correlation with outcome after surgical decompression in degenerative LCS.

MATERIALS AND METHODS

The present study was conducted at the Indian Spinal Injuries Centre, New Delhi, and ESIC Bihta during the period January 2009–January 2014 and 2019–2021, respectively. The Ethics Committee's approval was taken before the study. The consent form of the participant was taken before the study. There were 23 patients with degenerative LCS who met the inclusion criteria and agreed to take part in the study. A total of 23 patients were selected who were included.

Inclusion criteria

Inclusion criteria were as follows: All cases above 50 years with MRI findings of degenerative LCS and with significant ODI scores who did not improve with conservative treatment were included.

Exclusion criteria

Exclusion criteria were as follows: Patients who had a history of previous spinal surgery, traumatic spondylolisthesis, spinal trauma, congenital stenosis, peripheral neuropathy, and comorbidities including diabetes, peripheral vascular disease.

Methodology

Patients were given questionnaires and told to fill them out with the help of an observer. The selected patient's ODI, VAS for back and leg pain, and MRI were recorded and graded. The central canal MRI stenosis ratio was calculated in the axial and midsagittal sections at the pedicle level. Based on the most severe grade, each patient with LCS was classified as having mild, moderate, or severe central or foraminal stenosis. Improvement in claudication distance, VAS for leg discomfort and back pain, and ODI were used to assess the outcome.

Statistical analysis

The data collected into an Excel sheet were entered into a Statistical Package for the Social Sciences 16.0 version. Frequency tables were generated.

RESULTS

In the present study, there were 16 patients who belonged to the 50–65-year age group and seven patients were above 66 years of age. There were 17 females and six males. Table 1 shows that VAS for back pain was compared preoperatively and postoperatively which shows significant improvement. VAS for leg pain has significant improvements postoperatively.

ODI also improved significantly in the post-operative group of patients (Figures 1-3).

Table 2 shows that 13/23 of the patients had severe central canal stenosis and 7/23 of the patients had moderate central canal stenosis. Post-operative canal diameter increased in all groups of patients.

Table 3 shows that 73% of patients having left foraminal stenosis were moderate-to-severe stenosis. 73% of patients having left foraminal stenosis had moderate-to-severe stenosis. 73 % of the patients having left foraminal stenosis were moderate to severe. There was increase in foraminal diameter on post operative MRI images as anticipated, an indirect manifestation of better claudication distance.

MRI illustrations are shown in Figures 4 and 5 (pre-operative as well as post-operative).

Table 1: VAS

Back pain	n	Range	Minimum	Maximum	Mean	Standard Deviation
VAS for back pain pre-operative	23	7	2	9	5.86	2.73
VAS for back pain post-operative	23	5	1	6	1.95	1.29
Leg pain						
VAS for leg pain Pre-operative	23	6	3	9	7.43	2.4
VAS for leg pain post-operative	23	6	1	7	2.39	1.6
ODI						
ODI pre-operative	23	44.4	40	84.4	62.6	12.05
ODI post-operative	23	47.1	24	71.1	37.7	12.32

VAS: Visual Analog Scale, ODI: Oswestry Disability Index

Table 2: MRI central canal (pre- and post-surgery)

MRI Central canal (pre-operative)			MRI Central canal (post-operative)
1 (mild)	2 (moderate)	3 (severe)	0
Count	Count	Count	Count
3	7	13	23

MRI: Magnetic resonance imaging

Table 3: Right and foraminal stenosis

Right	L4	L5	Total
Mild (1)	4	4	8
Moderate (2)	6	8	14
Severe (3)	4	10	14
Total	14	22	36
Left			
Mild (1)	4	5	9
Moderate (2)	3	7	10
Severe (3)	5	9	14
Total	12	21	33
Right foraminal stenosis (Pre and Post)			
Pre			
Right – 1 (mild)	4	4	8
Right – 2 (moderate)	6	8	14
Right – 3 (severe)	4	10	14
Post			
0 (no stenosis)			11
Missing (cannot measure)			12
Total	14	22	36
Left foraminal stenosis (Pre and Post)			
Pre			
Left–1 (mild)		5	9
Left– 2 (moderate)		7	10
Left– 3 (severe)		9	14
Post			
0 (no stenosis)			11
Missing (cannot measure)			12
Total		21	33

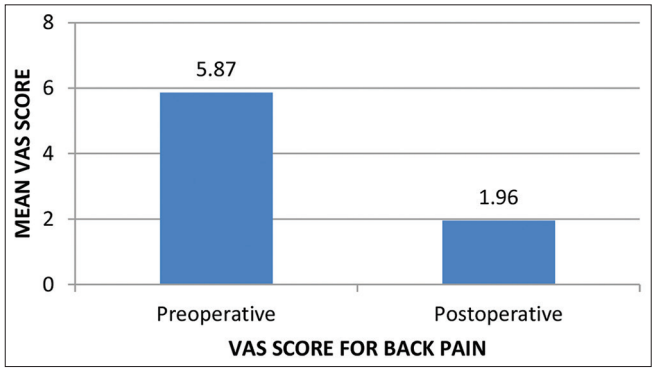

Figure 1: Visual Analog Scale for back pain

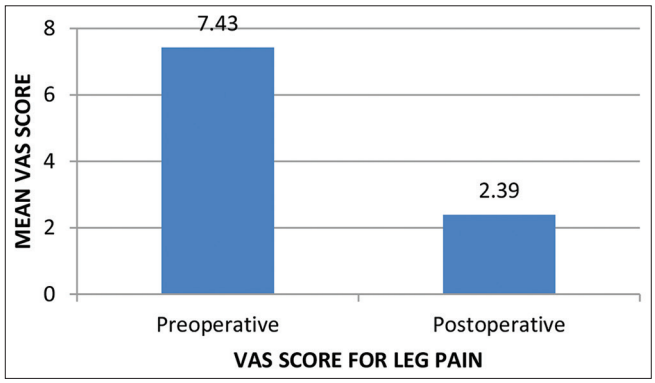

Figure 2: Visual Analog Scale for leg pain

DISCUSSION

LCS is a narrowing of the central or lateral lumbar canal caused most commonly by chronic degenerative alterations in the lumbar motion segments.

However, there is no agreement in the literature about the advantages of surgical decompression versus conservative treatment. However, there is sufficient data in the literature to show that surgical decompression provides long-term good outcomes in patients who do not respond to conservative treatment. As a result, we took a step toward evaluating the clinical outcome of a patient who had decompressive spinal surgery for the central canal and foraminal stenosis. However, we do not have long-term follow-up.

The success of the VAS regimen was defined as a two-point improvement in VAS from baseline to week 26.[6] Similarly, in our study, pre-operative and post-operative VAS for back pain were evaluated, and there was a significant improvement ($P<0.05$). At the last follow-up, the mean VAS for back pain improved by 3.91 points

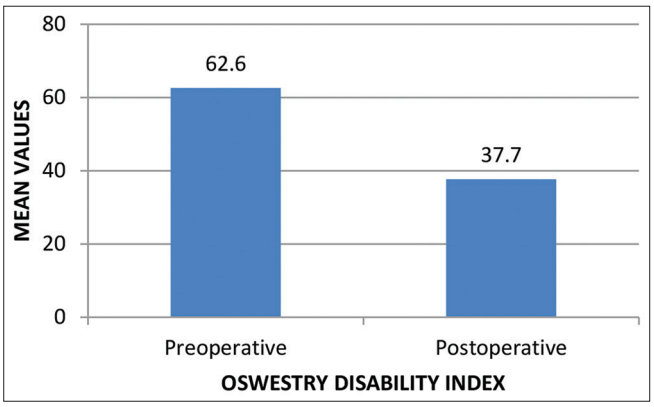

Figure 3: Oswestry Disability Index

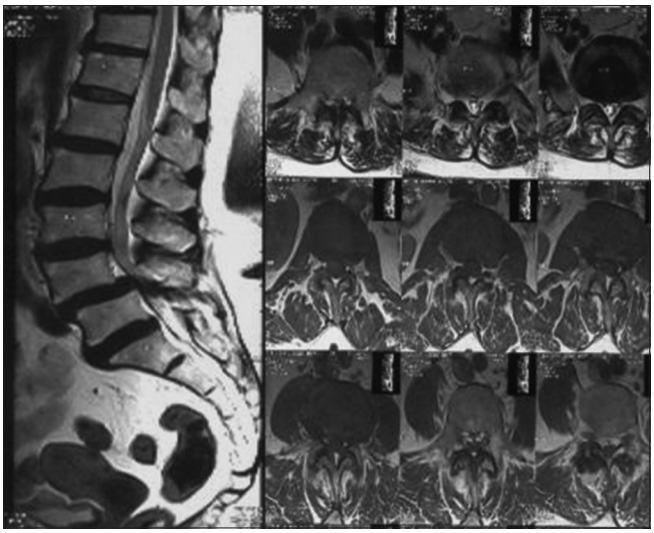

Figure 4: Pre-operative magnetic resonance imaging – sagittal view suggestive of grade 1 Lr/L5 listhesis with moderate-to-severe stenosis. In axial view-diffuse disc bulge at L4/L5 causing compression of the central cord and bilateral foramina with facetal and ligamentum hypertrophy

from baseline, which was statistically significant. VAS for leg pain improved significantly postoperatively ($P<0.05$), with a mean VAS for leg pain improvement of 5.04 points from baseline being statistically significant. ODI improved considerably in the post-operative group of patients (average 62 preoperatively vs. 38 postoperatively) ($P<0.05$).

According to Herno[7] research, patients' perceptions of improvement had a far better link with long-term surgical prognosis than structural findings observed on post-operative MRI.

Grob et al.[8] compared the results of spinal decompression with and without arthrodesis for the treatment of lumbar spinal stenosis and found that there was a significant improvement in the distance that patients could walk at the time of the latest follow-up examination compared to before the operation.

Figure 5: Post-operative magnetic resonance imaging shows laminectomy and decompression of central canal and pedicle screw *in situ*

In our study, 95% of patients were able to walk fewer than 500 m preoperatively (average 326 m), whereas 82% of patients were able to walk more than 500 m postoperatively (average 1283 m). There was a significant improvement in claudication distance compared to preoperative stage as patients were able to walk a greater distance.

Yamazaki et al.[9] studied serial intradural and extradural alterations in patients and reported that following bilateral fenestration for LCS, some improvement in clinical symptoms was observed in all patients, although clinical results during follow-up were poor in 19% of patients. They also found that 83% of patients had good expansion in the CSA of the dural tube and 17% had poor expansion. Poor dural tube extension, cauda equina grouping, and a decrease in CSA of the dural tube were all associated with a poor prognosis, according to post-operative MRI scans. However, in our investigation, the diameter of the central canal improved markedly after surgery in all three stenotic patient groups (mild, moderate, and severe). All patients who received laminectomy had lateral recess and foraminal decompression, as well as nerve root expansion, but measurement of foraminal decompression could not be done in patients who underwent fusion owing to implant.

However, in our study, good outcomes were seen in 21/23 (91%) of patients, whereas only 2/23 (9% of

patients) had poor outcomes, which could be related to poor dural tube expansion or cauda equina grouping. In our study, the mean length of symptoms preceding surgery was 39.8 months, ranging from a minimum of 1 month to a maximum of 120 months.

Ng et al.,[10] investigated the effect of symptom duration on the outcome of lumbar decompression surgery. Patients with symptoms lasting <33 months performed better in subgroup studies. In addition, those who thought the surgery was outstanding reported a statistically significant reduction in the duration of their symptoms. However, in our study, the VAS for leg pain was more prevalent in the shorter periods group (60 months), with an average of 8.0. A higher pre-operative VAS for leg pain resulted in a better post-operative prognosis. According to pre-operative MRI, 91% of patients had severe stenosis and 9% had moderate stenosis, and they improved in post-operative VAS score for back pain, with excellent to good in 70% and fair in 21% of patients. The VAS for leg pain was outstanding to good in 87% of patients and fair in 4.3%.

Whereas 9% of patients had a bad outcome for both VAS for back pain and VAS for leg pain. Similarly, just 9% of patients saw an improvement in their ODI. Sixty-five percent of patients improved their ODI from outstanding to good, whereas 26% improved very little.

In our investigation, however, two patients exhibited mild stenosis. One had a positive consequence, while the other had a negative outcome. In our study, the reason for this could not be associated because the number of subjects in this group was insignificant.

Weiner et al.[11] investigated the outcomes of lumbar spinal canal stenosis decompression based on pre-operative radiographic severity, hypothesizing that patients with more severe spinal canal stenosis had roots that are physiologically better equipped to withstand increased neurologic compression.

Another study done by Herno et al.,[12] the degree of decompressive relief and its relation to clinical outcome in patients undergoing surgery for lumbar spinal stenosis, concluded that patient satisfaction with the results of surgery was more important in the surgical outcome than the degree of decompression detected on the CT scan, however, surgical decompression for lumbar spinal stenosis must be adequate without compromising spinal stability.

According to Herno et al.,[13] the result link is stronger with ODI and claudication distance, but it is not affected by stenosis severity.

Limitations of the study

In the present study, lesser number of sample size was the major limitation. We recommended that postoperative follow up duration should be longer for a better long term outcomes.

CONCLUSION

Foraminal stenosis is almost always bilateral, necessitating bilateral foraminal decompression. Decompression surgery for degenerative LCS improves ODI and VAS for back pain and leg discomfort regardless of the severity of the stenosis as determined by MRI grading or the intensity of symptoms as determined by VAS or ODI. As a result, surgery is advantageous to individuals who have not been relieved by conservative treatment. Claudication distance is an excellent criterion for assessing clinical outcomes.

ACKNOWLEDGMENT

The completion of this research paper would not have been possible without the support and guidance of Dr Rajat Charan Professor and Head at Department of Orthopedics ESIC Medical College Bihta. The encouragement and insightful feedback were instrumental in accomplishing this task.

I thank all the Anesthesia Faculty and staff at ESIC Bihta for their cooperation and kind support throughout my research period.

Special thanks to Dr, Manish Kumar (M.D. Community Medicine) for data analysis and technical assistance. Their extraordinary contributions have greatly improved the quality of this thesis paper.

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Authors' Contribution:
NNS- Definition of intellectual content and prepared the first draft of the manuscript; **KR-** Concept, design, manuscript preparation, editing, and manuscript submission/revision; **MAP-** Editing, data analysis, manuscript preparation; and review of the manuscript.

Work attributed to:
Department of Orthopaedics, ESIC Medical College Bihta, Patna, Bihar, India.

Orcid ID:
Niraj Narayan Singh - https://orcid.org/0000-0001-7967-1437
Kumar Rohit - https://orcid.org/0009-0001-7604-788X
Mahipal Ajitsinh Padhiyar - https://orcid.org/0009-0009-1006-4351

Source of Support: Nil, **Conflicts of Interest:** None declared.