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Lumbar canal stenosis and its clinical outcome after laminectomy

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Abstract

Introduction: Backache has been the scourge of mankind ever since man assumed the erect posture. The pain has troubled patients and treating doctors alike. Pin pointing the cause of backache and treating it successfully has been the constant endeavor of clinicians. Degenerative disease of the spine is one of the common and frequently encountered causes of low back pain in the elderly.

Aim of the study: To compare the functional outcome in single level lumbar canal stenosis of fluorotic and non-fluorotic patients treated with decompressive laminectomy.

Materials and Methods: All patients who presented to the hospital for back ache were evaluated clinically and MRI was done to identify the pathology and level of lesion. All patients identified as single level LCS was further investigated for serum and urinary Fluoride and then dividing the patients into two groups-Fluorotic Group (10 cases) and Non-Fluorotic Group (10 cases).

Results: Caludication distance, visual analogue score, Oswestry disability score and Japanese orthopedics association score increased in both group.

Conclusion: Decompression laminectomy is considered as a gold standard treatment in the cases of lumbar canal stenosis when the conservative management doesn't give proper relief to the patient.

Keywords: Lumbar canal stenosis, neurogenic claudication, radicular pain, lumbar decompression, decompression laminectomy

Introduction

Lumbar spinal stenosis (LSS) is a common spinal disorder in the older population, and a clinical syndrome consisting of pain in the buttock or lower extremity, with or without low back pain and corresponding imaging findings of narrowing of spaces around neural and vascular elements in the lumbar spine [1-3]. Degenerative With the median age of population rising and more elderly people maintaining an active life style, functional limitation due to symptomatic degenerative disease of spine is becoming more common. Lumbar Canal Stenosis remains one of the frequently encountered, clinically important degenerative spinal disorders in the ageing population. LSS is the most common reason for spinal surgery in patients >65 years old [4, 5]. Lumbar Canal Stenosis is the terminology used to describe developmental or congenital narrowing of the spinal canal that produces compression of the neural elements before their exit from the neural foramen. The narrowing may be limited to a single motion segment or it may be more diffuse spanning two or more motion segments. The narrowing of the spinal canal can be attributed to various reasons, one such reason is fluorosis. Endemic skeletal fluorosis is widely prevalent in India and is a major public health problem. The first ever report of endemic skeletal fluorosis and neurological manifestation was from Prakasam district in Andhra Pradesh in the year 1937. Neurological complications of endemic skeletal fluorosis, namely radiculopathy, myelopathy or both are mechanical in nature. Facet joint arthritis, thickening and ossification of ligamentum flavum and formation of irregular osteophytes also contribute to the problem. The classical symptom of Central Canal Stenosis is pseudoclaudication also known as neurogenic claudication. Patients typically complain of pain, paraesthesia, weakness, or heaviness in the buttocks radiating into the lower extremities with walking or prolonged standing, relieved with flexion or sitting. Though many patients have significant lumbar pain due to degenerative joint and disc changes, most have lower extremity discomfort rather than spinal pain.

Aim of the study

To compare the functional outcome in single level lumbar canal stenosis of fluorotic and non-fluorotic patients treated with decompressive laminectomy

Materials and methods

The present study was conducted in department of orthopaedics, Kamineni Institute of Medical Sciences Hospital (KIMS), Narketpally on the patients who presented with single level Lumbar Canal Stenosis and required surgical intervention and satisfied the Inclusion Criteria. It is a comparative prospective non-randomised study. The study duration was between October 2015 and September 2017 – 2 years. All patients who presented to the hospital for back ache were evaluated clinically and MRI was done to identify the pathology and level of lesion. All patients identified as single level LCS was further investigated for serum and urinary Fluoride and then dividing the patients into two groups- Fluorotic Group (10 cases) and Non-Fluorotic Group (10 cases).

Inclusion criteria

- Age between 20yrs and 70 yrs.
- All cases diagnosed with single level Lumbar Canal Stenosis
- Patients who were fit to undergo Decompressive Laminectomy under general anaesthesia.
- NASS (North American Spine Society) score of more than 7

Exclusion criteria

- Age below 20yrs and above 70 yrs.
- Cases of LCS involving multiple levels.
- All cases with spinal deformity and skeletal dysplasia.
- Fracture spine, tumours or infection of spine
- Cases associated with spondylolisthesis and disc Herniation
- Prior surgery at same level
- Cases with renal failure

Pre-Operative Evaluation

Seventy Three patients attending KIMS orthopaedic spine clinic with complaints of low backache and associated neurogenic claudication have been evaluated for Lumbar Canal Stenosis with following Tools:

1. Clinical assessment done for complete spine examination, neurological status and score given using NASS (North American Spine Society) guidelines.
2. Investigation for fluoride levels with serum fluoride and urinary fluoride.
3. Imaging studies using X-rays and MRI (Magnetic Resonance Imaging)
4. Twenty patients with NASS score more than 7 and satisfying other inclusion criteria form the study group.
5. NASS scoring includes both symptoms and signs and score range from -2 to 3 given to each parameter.
6. The Total range of score varies from -2 to 16, and score value more than or equal to 7 is diagnostic of Lumbar Canal Stenosis

Table 1: Clinical diagnosis according to NASS guidelines

	Points
Age: 60-70	1
>70	2
Absence of Diabetes	1
Intermittent Claudication	3
Exacerbation of symptoms when standing up	2
Symptom improvement when bending forward	3
Symptoms induced by having patients bend forward	-1
Good peripheral artery circulation	3
Abnormal achilles tendon reflex	1
Straight leg raising test positive	-2

All Patients with clinical symptoms and signs of single level LCS, who met the inclusion criteria, were further investigated for serum fluoride and urine fluoride levels. Visual analogue scale, Japanese orthopedic association score and Oswestry disability index were used for interpretation.

Results

Out of the 73 patients 20 patients were included in the study, 10 patients of fluorotic group and 10 patients of non-fluorotic group.

Table 2: Fluoride levels in the present study-Fluorotic group

S. No	Serum fluoride	Urine fluoride
1	0.8	2.4
2	0.8	2.5
3	0.6	3.2
4	0.4	3.6
5	1.2	3.8
6	0.9	2.8
7	1.0	2.4
8	1.8	3.9
9	1.9	2.7
10	1.2	3.4

Table 3: Fluoride levels in the present study- Non-fluorotic group

S. No	Serum fluoride	Urine fluoride
1	0.6	1.8
2	0.8	1.2
3	0.6	1.2
4	0.8	1.5
5	0.7	1
6	0.5	1.8
7	0.6	1.4
8	0.8	1.2
9	0.6	0.9
10	0.7	1.6

Serum fluoride value above 1ppm and urine fluoride value above 2 ppm considered for fluorotic group. Urinary fluoride is better indicator compared to serum fluoride. The value of fluoride in the study ranges from 0.5-3.6.

In this study, higher levels of serum fluoride and urine fluoride levels were noted in fluorotic group. Patients are evaluated by radiographs.

- Anteroposterior view of Lumbar Spine.
- Lateral view of Lumbar spine.

To identify any other pathology such as spondylolisthesis, hyper sclerosis, osteophytes formation etc. Then patients are subjected to MRI.

Magnetic Resonance Imaging

MRI is considered the Gold Standard Investigation for diagnosis of Lumbar Canal stenosis. Patients are subjected to MRI after explaining the procedure and taking informed consent.

MRI of all the patients in the study group was evaluated qualitatively and quantitatively for degree of stenosis which are explained in subsequent text. All lumbar spine MRI exams were performed using a 1.5 T MR scanner (SIEMENS) at our hospital. The patients were placed in the supine position with a cushion under both knees.

Types of Stenosis on MRI

1. Central canal stenosis
2. Lateral canal stenosis
3. Foraminal canal stenosis

Various criteria have been mentioned in the literature, regarding the diagnosis of LCS. The most effective and reliable measures practiced in our institution by Department Of Radiology have been considered in the present study.

1) Quantitative criteria

Antero-Posterior diameter of canal on sagittal view for T2 weighted image.

With help of tools on computer, the distance from the posterior body of the vertebrae to the anterior border of spinous process at mid vertebral level taken as point of measurement for spinal canal diameter on T2 W sagittal image. Diameter of less than 12mm is considered as stenosis and the diameter of less than 10 mm as absolute stenosis.

2) Qualitative measurement

Sedimentation Sign: This is considered as qualitative measurement for diagnosing the LCS-Central Stenosis. This measurement is taken on the T2 W axial image. According to sedimentation sign, Lumbar Canal Central Stenosis (LCCS) is defined as the obliteration of the CSF space in front of the cauda equina in the dural sac on T2-weighted axial images. LCCS was divided into four grades according to degree of separation of the cauda equina on T2-weighted axial images:

Grade 0: defined as no LCCS as the anterior CSF space was not obliterated;

Grade 1: defined as mild LCCS, in which the anterior CSF space was mildly obliterated, but all cauda equina could be clearly separated from each other.

Grade 2: defined as moderate LCCS, in which the anterior CSF space was moderately obliterated and some of the cauda equina were aggregated, making it impossible to visually separate them

Grade 3: defined as severe LCCS, in which the anterior CSF space was obliterated so severely as to show marked compression of the dural sac, and none of the cauda equina could be visually separated from each other, appearing instead as one bundle.

For Lateral and Foraminal stenosis, which are few in number, the lateral recess height taken by tools on computer on axial imaging of MRI. For foraminal stenosis, fat sign is considered as index of stenosis. In the present study patients with lateral and foraminal stenosis are also associated with central stenosis. Pure lateral stenosis and pure foraminal stenosis are not generally seen in our study.

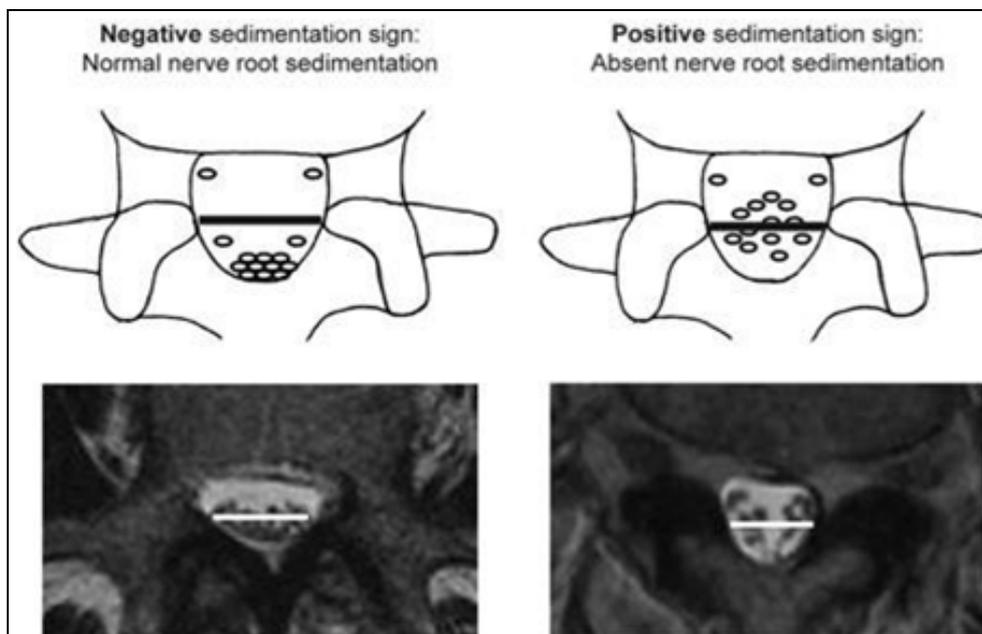


Fig 1: Sedimentation sign on axial image -predictor for surgical intervention.

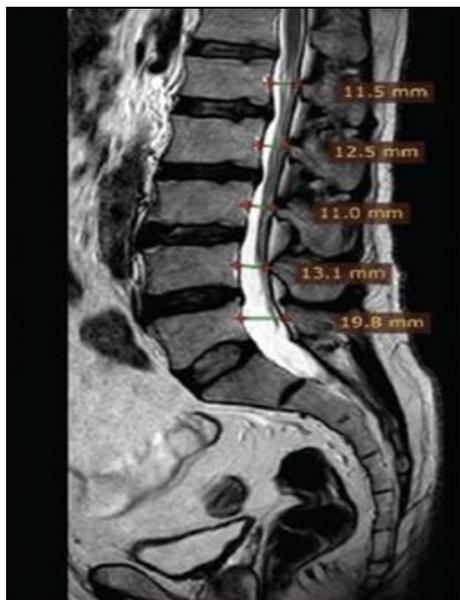


Fig 2: MRI Image showing sagittal view of lumbar spine-measurement of canal diameter -at mid vertebral level from posterior surface of vertebrae to anterior surface of spinous process.

Evaluation of functional outcome in patients undergoing surgical intervention done using

- Claudication distance measurement
- Visual Analog scale score (VAS) for pain
- Japanese Orthopaedic Association scoring (JOA)and
- Oswestry Disability Index (ODI) for disability assessment.

All the above mentioned data were recorded for all the patients’ pre operatively on the day of admission and done post operatively, on the day of discharge and after 1 month follow up and again scoring was done at end of 3 months of surgery.

These pre operative and post operative scores (3 month follow up) are index for improvement of patients undergoing laminectomy. The results are compared between the Fluorotic and Non-fluorotic group.

Claudication Distance Measurement

Neurogenic claudication (NC) is the most important clinical parameter in diagnosing lumbar stenosis. The distance patient is able to walk without the symptoms of claudicating are called claudication distance.

The claudication distance is measured for all cases in the study group. Patient is asked to walk from a fixed point along the Hospital corridors marked from 500 mts to 2kms, then based on the walking capacity and development of symptoms, the claudicating distance is measured.

The ability of the walking test to produce NC was recorded as a “positive” result. The test was terminated when participant symptoms reached the intensity at which participants would usually stop walking in a community setting. The tests were stopped immediately for reasons of fatigue, and the results were recorded as “negative - fatigue”. Results for each test were recorded for walking time in minutes (min.), and distance in meters (m). This exercise was done pre operatively on the day of admission, then after 1 month after surgery (follow up), and again after 3 months (final follow up).

Table 4: Claudication distance measurement in flourotic patients

Claudication Distance in meters	Pre-Operative (no. of patients)	Post-Operative-1months (no. of patients)	Post-Operative-3months (no. of patients)
< 200 meters	3	1	0
200 to 500 meters	4	5	1
500- 1000 meters	2	2	3
1000-2000 meters	1	2	6

Table 5: Claudication distance measurement in Non-flourotic patients

Claudication Distance in meters	Pre-Operative (no. of patients)	Post-Operative-1months (no. of patients)	Post-Operative-3months (no. of patients)
< 200 meters	1	0	0
200 to 500 meters	2	1	1
500- 1000 meters	4	3	1
1000-2000 meters	3	6	8

In this study, flourotic group, very less patients (30%) were able to go beyond 500 meters distance when compared to non-flourotic group and good results were noted after 3 months of follow up.

Visual Analog Score

A Visual Analogue Scale (VAS) is a measurement instrument that tries to measure a characteristic or attitude that is believed

to range across a continuum of values and cannot easily be directly measured. The pain VAS is a one-dimensional measure of pain intensity, which has been widely used in diverse adult populations. The pain VAS is a continuous scale comprising of a horizontal (HVAS), usually 10 centimeter (100 mm) in length, anchored by 2 verbal descriptors, one for each symptom extreme.

Table 6: Visual Analog Score in flourotic (n=10) and non-flourotic group (n=10)

Flourotic Group		Non-Flourotic Group	
Vas Score-pre operative	Vas Score–post operative (3 months)	Vas Score–preoperative	Vas Score –post operative (3months)
9	1	8	1
8	1	9	1
6	2	6	1
6	1	7	1
7	1	7	1
8	1	8	1

8	1	6	1
9	1	6	1
9	1	6	1
8	1	7	1

Response options/scale: For pain intensity, the scale is most commonly anchored by “no pain” (score of 0) and “pain as bad as it could be” or “worst imaginable pain” (score of 10 [100-mm scale]). To avoid clustering of scores around a preferred numeric value, numbers or verbal descriptors at intermediate points are not recommended. Respondents are asked to report “current” pain intensity or pain intensity “in the last 24 hours.

Score interpretation: A higher score indicates greater pain intensity. Based on the distribution of pain VAS scores in their pre-operative and post-operative pain intensity classified as mild, moderate, or severe, the following cut points on the pain VAS have been recommended: mild pain (0–30 mm), moderate pain (40–70mm), and severe pain (88–100 mm). The VAS score was more in flourotic group patients preoperatively and they showed better VAS score post-operatively.

Japanese orthopaedic association score

This scale consists of THREE domains excluding the bladder dysfunction.

- Subjective symptoms
- Clinical signs
- Activities of daily restriction

Each domain has three components which are pain, associated symptoms, gait (subjective). Least score is 0 and highest is 3 in each component.

Clinical signs domain has three components with similar least and highest scores.

1. SLRT(straight leg raising test)
2. Sensory Disturbances
3. Motor disturbances. The last domain is activities of daily living.

The subjective symptoms are explained to patients and answers are recorded.

Then clinical signs are elicited and the motor examination is done. Mainly power of Ankle and EHL (Extensor Hallucis Longus) and graded according to MRC grading.

Least score would be 0 and highest 29. These scores are obtained pre operatively and post operatively after three month in all the patients and results compared to assess the functional outcome.

Table 7: Japanese orthopedic association score

Number of patients	Average pre-operative score	Average post-operative score after 3 months follow up
Flourotic Group (n=10)	10.5	25
Non-Flourotic Group (n=10)	13	26

In this study, the average pre-operative score in the flourotic group was 10.5 and improved to 25 during the follow-up. Similarly, in non-flourotic group the average pre-operative score was 13 and improved to 26 during the follow-up visits. After the surgery the results grading was done and was give excellent results.

Oswestry disabilty index

The Oswestry Disability Index (ODI) is one of the principal condition-specific outcome measure used in the management of spinal disorders. The ODI is the most commonly used outcome measures in patients with low back pain. It has been extensively tested, and has showed good psychometric properties, and is applicable in a wide variety of settings.

Structure/Content

There are 10 questions. The questions are designed in a way that to realize how the back or leg pain is affecting the patient's ability to manage in everyday life.

Scoring Method: Each of the 10 items is scored from 0 - 5.

The maximum score is therefore 50. The obtained score can be multiplied by 2 to produce a percentage score.

If the FIRST statement is marked, the section score = 0, If the LAST statement is marked, it = 5

If all ten sections are completed the score is calculated as followed:

Example: 10 (total score of the patient), 50 (total possible raw score), 10/50 x 100 = 20%

If one section is missed or not applicable, the score is calculated as followed:

Example: 15 (total score of the patient), 45 (total possible score), 15/45 x 100 = 30%

The patients are clearly explained about all the items in the scoring system in their own language and asked to tell the near answer which suits them the best. All the answers given by the patient are recorded.

These results are again given in terms of percentage and the disability is calculated.

Odi Scoring

0% to 20%: minimal disability: The patient can cope with most living activities. Usually no treatment is indicated apart from advice on lifting weights, sitting and exercise.

21%-40%: moderate disability: The patient experiences more pain and difficulty with sitting lifting and standing. Travel and social life are more difficult and they may be disabled from work. Personal care sexual activity and sleeping are not grossly affected and the patient can usually be managed by conservative means.

41%-60%: severe disability: Pain remains the main problem in this group but activities of daily living are affected. These patients require a detailed investigation.

61%-80%: crippled: Back pain impinges on all aspects of the patient's life. Positive intervention is required.

81%-100%: These patients are either bed-bound or exaggerating their symptoms



Fig 3: Midline incision with dissection of para-spinal muscles done, sub periosteum exposed.

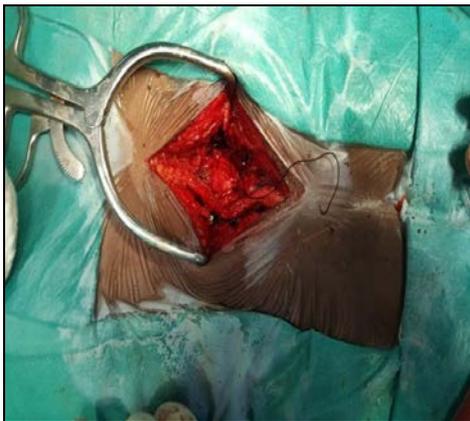


Fig 4: Removal of the spinous process at the desired level with exposure of the flavum

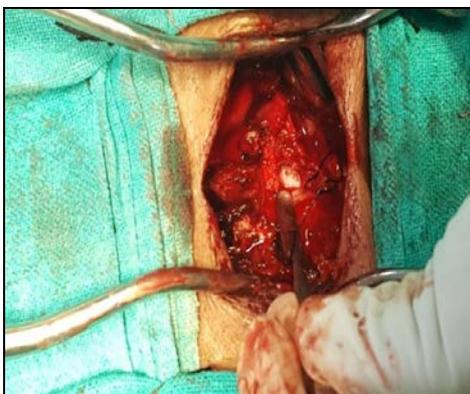


Fig 5: Exposure of the duramater after removing hypertrophied flavum



Fig 6: Surgical site closure with surgical staples.

Discussion

Spinal stenosis is classified as primary, caused by congenital abnormalities or secondary or acquired stenosis resulting from degenerative changes or as consequences of local infection, trauma or surgery [6]. The history of spinal stenosis still remains unclear with many studies reporting about more than half of the patients remain clinically stable or with minor symptoms, and a quarter of patients show either worsening or improving symptoms [7].

Degenerative Lateral canal stenosis (LCS) anatomically can involve the central canal, lateral recess, foramina or any cusp of these locations. Central canal stenosis may result from a decrease in the antero-posterior, transversal or combined diameter secondary to loss of disc height with or without bulging of the intervertebral disc, and hypertrophy of the facet joints and the ligamentum flavum. Fibrosis is the main cause of ligamentum flavum hypertrophy and is caused by accumulated of mechanical stress, especially along the dorsal aspect of the ligamentum flavum.

Foraminal stenosis can be either anteroposterior resulting from a combination of disc space narrowing and overgrowth of structures anterior to the facet joint capsule, and/or vertical resulting from posterolateral osteophytes from the vertebral endplates protruding into the foramen along with a laterally bulging annulus fibrosis or herniated disc that compresses the nerve root against the superior pedicle [8]. Foraminal stenosis more frequently involves the L5 nerve root, as the L5-S1 foramen is the one with the smaller foramen/root area ratio [8]. The available space in the central canal decreases in loading and extension and increases with axial distraction and flexion [9]. The same dynamics also affect the foramen with flexion causing a 12% increase, and extension a 15% decrease, in surface area [10].

Signs and symptoms are thought to result from vascular compromise to the vessels supplying the cauda equina (central stenosis) or from pressure on the nerve root complex (lateral stenosis) by the degenerative changes. Experimentally, it has been shown that moderate constriction induced pressure involving the cauda nerve roots will disturb their nutrition and further experimental studies have given support to this hypothesis and the clinical impact of these changes is related to the speed by which the compression develops [11, 12, 13, 14].

The symptom most commonly attributed to LSS is neurogenic claudication, also referred to as pseudoclaudication. Neurogenic claudication refers to leg symptoms encompassing the buttock, groin, and anterior thigh, as well as radiation down the posterior part of the leg to the feet. In addition to pain, leg symptoms can include fatigue, heaviness, weakness and/or paresthesia. Patients with LSS also can report nocturnal leg cramps and neurogenic bladder symptoms [15, 16].

Diagnosis of the LCS is made by questionnaires, radiological imaging studies, and electromagnetic studies. Treatment includes medications such as analgesics, muscle relaxants and opioid analgesics. An old randomized cross-over trial of low methodological quality found a positive effect of intramuscular calcitonin but two more recent studies using intranasal calcitonin could not replicate the findings [17, 18, 19]. In patients with neurogenic claudication and imaging confirmed LSS, the addition of gabapentin to standard therapy (NSAIDs, physical therapy and steel bracing) was superior to placebo both in terms of pain sensory disturbances and walking distance [20]. Physiotherapy, bracing and epidural injections work very well in some of the patients. Decompression Laminectomy has proved to be effective in

most of the patients in terms of pain and walking, in this study all 20 patients decompression laminectomy was done and they have improved very well. The long term success rates with decompression laminectomy were 45-72 %.

In this study, the visual analogue score (VAS), Japanese orthopedic association score and Oswestry disability index (ODI) score consistent with the findings by the authors Maeda T *et al.* Seung Yeop Lee *et al.* Bagley C *et al.* and Atul Goel *et al.* [21, 22, 23, 24].

Conclusion

Patients with symptomatic stenosis may present with axial pain, radiculopathy and neurogenic claudication or clasp of any of these. Decompressive laminectomy surgery is the gold standard for treatment of central or lateral recess lumbar stenosis. The patient response after the surgery in both the group was good and satisfactory.

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