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METHODOLOGY TO SURGICALLY APPROACH FOR LUMBAR CANAL STENOSIS;"WHEN TO" AND "WHEN NOT TO" DO INSTRUMENTAL FUSION- A PROSPECTIVE STUDY.

Orthopaedics

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ABSTRACT

Introduction: Lumbar canal stenosis is defined, as an abnormal narrowing of the ligamento-osseous canal of the lumbar vertebra or of the foramina intervertebralis, causing a direct compression or a compromise of either the dural sac or the nerve root or indirectly to their vasculature producing symptoms of radiculopathy or and claudication.Patient whose symptoms do not show improvement after non-surgical or conservative trial, become eligible for surgical relief.

AIM: To Prospectively analyze, Canal decompression, interbody Lumbar fusion with or without posterior stabilization with postero-lateral bone grafting, in cases presenting with MRI proven Lumbar Canal Stenosis, not responding to conservative management.

Materials and Methods: Our study was done in Chettinad Hospital and Research Institute from January 2016 to December 2020, Follow-up period was for a minimum period of 12 months. 54 patients participated in the study.JOA and VAS score was recorded at the end of 12 months post-surgery to analyze the functional outcome.

Results: There were 32 males and 22 females in the study.Our mean male JOA score was pre-operatively 9.88 which improved to 14.8 at the 12th month follow-up. Our mean JOA for females was at 8.3 which improved post operatively to 13.8.The mean VAS score pre-operatively in the men and women were 7.4 and 8.6 respectively. This, at the 12^{th} month follow up dropped to 0.8 and 1.2 for men and women respectively.The complications encountered in the study patients are Dural tears in 6 patients, superficial infection in 8 patients, Deep infection and Neurological deficit in 4 and 3 patients respectively. All of these complications subsequently got resolved without any long term sequelae.

Conclusion: In patients with lumbar canal stenosis whose symptoms do not abate, with conservative management, surgical lumbar spinal canal decompression, whether it is single level or dual level, does provide for a good clinico- functional outcome.

KEYWORDS

Lumbar canal stenosis, Decompression Laminectomy lumbar spine, Postero-lateral interbody fixation, Cage fusion with instrumentation.

INTRODUCTION:

The word stenosis is derived from a Greek word to imply 'narrowing in a tubular organ or structure'. Lumbar canal stenosis is defined, as an abnormal narrowing of the ligamento-osseous canal of the lumbar vertebra or of the foramina intervertebralis, causing a direct compression or a compromise of either the dural sac or the nerve root or indirectly to their vasculature producing symptoms of radiculopathy or and claudication. In 1803 a French anatomist by name Portal, reported cord compression and subsequent paralysis in Rickets of children. In 1891 Gowers expressed the possibility of lateral stenosis, which he referred to as the foraminal compromise, compressing the exiting nerve roots and thereby causing radiculopathy(4). In 1910, it was Sumita who described that, in Achondroplastic dwarf, the vertebral canal was narrow. In 1920, Putti wrote about facetal degenerative changes, leading to nerve root entrapment (1). It was in the year 1949, that Verbiest described the narrow vertebral canal could occur without any disease or pathological condition, in its most classical sense. He attributed it to as an isolated growth disturbance of the vertebral arch. He also coined the term "Developmental Stenosis" (2). In 1954 he went on to describe this clinical syndrome with his operative studies, showing osseous changes, causative of narrowed spinal canal especially in the sagittal plane.

It was C.K.Lee et al (3), who classified the spine(Phila pa 1976) surgical decompression methodology:

(a) Entrance zone (retro-discal segment).
(b) Mid zone (para-appendicular segment).
(c) Exit zone (the III segment).

In the "Entrance zone", stenosis is caused by facetal arthrosis, spurs in the vertebra and or disc or annulus pathology. In the "Mid zone" there is stenosis from lateral disc herniation or from spur at the under surface of pars-interarticularis. In the "Exit zone", is the area lateral to the facet joint and it contains nerve roots, here the fibrosis and stenosis is by the "far-lateral" disc, spondylolisthesis, and hypertrophic facets with subluxation, manifest themselves.

Patient whose symptoms do not show improvement after non-surgical or conservative trial, become eligible for surgical relief. Upon contemplating on the surgical options, one has to bear in mind, the underlying pathology, patient specific goals, and the overall functional status. The solution lies in surgical decompression laminectomy. Fusion with or without instrumentation, will have to be opted, if there is concomitant, deformity, instability or listhesis.

This study focuses on clinico-functional outcomes of surgical management of uni- and multilevel LCS, (Lumbar canal stenosis).

Fig.1 : Degenerative bony spurs along with herniated disc contributing to Lumbar Canal Stenosis.

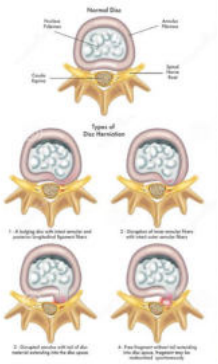


Fig.2: Sequential disc pathology showing degeneration of the nucleus pulposus and herniating its way through the annulus fibrosis, into the canal causing canal stenosis.

MATERIALS AND METHODS:

Our study started in 2016 January and recruitment of new cases was stopped by December 2019. Thereafter follow-up continued till the end of December 2020. Thus the follow-up period was for a minimum period of 12 months (Range 12-59months; Mean 24.5 months). The aim of the study was to analyze the clinico- functional outcome of the surgically managed uni- and multi-segmental Lumbar canal stenosis. Written consent was obtained from all patients, to publish their clinico radiological data while preserving their privacy.

INCLUSION CRITERIA:

- Adult patients in the age group 31 to 60years of both sex presenting with back pain, sciatica or neurogenic claudication.
- MRI findings confirming presence of Lumbar canal stenosis.
- Multiple level Lumbar canal stenosis were also included. (Single level, Dual level)

EXCLUSION CRITERIA:

- Congenital Lumbar canal stenosis.
- Stenosis resulting from trauma.

Pre-operative evaluation:

- A detailed patient history and neurological examination was done.
- Preoperative clinical evaluation was done by Japanese orthopaedic association (JOA) Score (Maximum score of 17).
- For the back pain and neurogenic claudication the visual analogue scale (VAS) was used (Maximum score of 10).

Radiography of the Lumbo-sacral spine:

- Standard AP and Lateral views were obtained for all the patients.
- To rule out inherent instability dynamic Flexion-Extension Lateral view was also obtained.
- MRI of lumbar spine was sought when conservative clinical management failed to reduce symptoms over a period of 8 weeks.

Surgical Technique:

All procedures were done in prone position under GA with the knee chest position, in a Hall's frame. Standard posterior midline approach was used after skin infiltration with adrenaline and lignocaine mixture.

Posterior midline approach:

Skin incision was centered over the stenotic area and the length of incision was adjusted, as per levels of stenosis. The skin , subcutaneous tissue and para-vertebral fascia were incised. The para-spinal muscles, were then elevated sub-periosteally from the spinous process and the lamina. The facet joints were identified. Decompression was achieved by removal of the lamina and the ligamentum flavum. This lamina removal, was done upto the medial border of the pedicle. The adequacy of decompression was then assessed and then discectomy was done. In appropriate cases interbody cage were used. Through the Roy Camille approach posterior stabilization done. The para-spinal muscles were closed in layers with absorbable sutures. The subcutaneous tissue and skin were closed in layers, over a DT.

Intra operative assessment:

- Operative time.
- Blood loss and transfusion.
- Thorough inspection of all the neural elements.

Post operative protocol:

- Immediately after extubation, neurological assessment was done.
- Patients were kept on suction drain and was removed on POD 2.
- Patients were kept on lumbo-sacral belt for 12 weeks after surgery.
- Patients were encouraged to walk with walker as early as POD 3, and went on to walking without aid.
- Sutures were removed on POD 12.
- Neurological charting was done after 2 weeks of surgery along with JOA score and VAS Score.
- Patients were followed up regularly every month during the first 3 months and thereafter every 3 months upto 12 months.
- JOA and VAS score was recorded at the end of 12 months post-surgery for tabulation and comparison.

RESULTS:

Our study started in 2016 January and recruitment of new cases was stopped by December 2019. Thereafter follow-up continued till the end of December 2020. Thus the follow period was for a minimum period of 12 months (Range 12-59 months; Mean 24.5 months). Thus there was a recruitment period of 4 years, in which 54 cases satisfying, our inclusion criteria got included in the study. There were 32 males and 22 females in the study. The Mean age group was 44 years (Range 31 to 60).

Table 1: Sex and Age distribution.

Age group in years	Male	Female	'N'	Percentage Age
31-40	04	08	12	22.22
41-50	21	12	33	61.11
51-60	07	02	09	16.67
Total	32	22	54	100

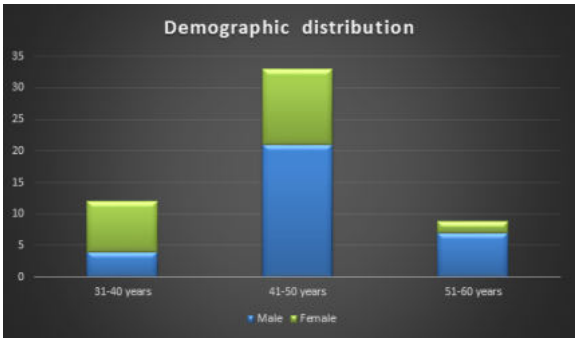
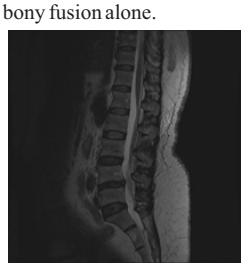


Fig.3: Graphical representation of age and sex distribution

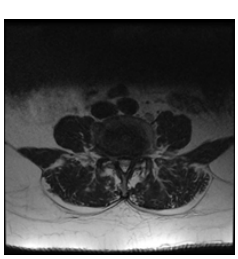
Table 2: The distributions of Single/Multiple levels of canal stenosis are summarized in the table below:

Levels of Spinal Canal Stenosis	Male	Female	'n'	% Age
L3L4, L4L5	05	05	10	18.52
L4L5, L5S1	15	12	27	50.00
L4L5	06	02	08	14.81
L5S1	06	03	09	16.67
Total	32	22	54	100

The most common multiple canal stenosis, in our study was at the levelofL4-L5, L5-S1 at 50% (n=27). The single level canal stenosis at L4-L5 and L5-S1 level were at 14.81% (n=8) and 16.677% (n=9). For single level canal stenosis interbody cage insertion was done and postero-lateral fusion was carried out without instrumentation. Stabilisation with instrumentation and bone grafting was done for cases having (Dual) multiple level canal stenosis. Thus 68.52% (n=37) patients underwent bony fusion and instrumentation. The remaining 31.48% (n=17) patients underwent decompression and postero-lateral bony fusion alone.



(a)



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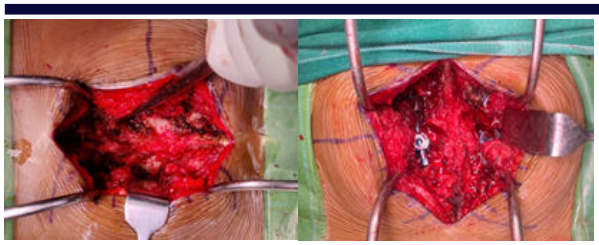

(a) (b)

Fig. 4 (a-d): Depicting the Preoperative MRI pictures showing the Lumbar canal stenosis due to disc herniation and later intraoperative pictures of canal decompression and subsequent posterior stabilization.

Functional Evaluation:

Japanese Orthopaedic Association Score:

Japanese Orthopaedic Association score pre-operatively was 9.09 (6-12). Mean JOA score for men and women were 9.88 and 8.30 respectively.

Visual Analogue Score:

The mean Visual analogue score was 8 (6-9). The VAS for men and women were 7.4 and 8.6 respectively.

54 patients were followed up for a minimum follow period of 12 months (Average 24.5 months, Range 12-59 months). 37 patients underwent decompression with instrumented inter-body fusion and the remaining 17 patients who had a single level pathology had decompression alone without instrumentation.

Table 3: Demographic distribution and the number of levels of lumbar vertebrae that were decompressed.

S.No.	Content	Decompression with Instrumented Interbody Fusion	Decompression without Instrumented Interbody Fusion
01	No. of patients	37	17
02	Average Age	45.2	46.2
03	Male: Female	5:4	1:3.5
04	Mean No. of spinal level decompressed	2	1
05	Average duration of follow-up	25 months	27 months

Table 4: List of Complication encountered:

S.No.	Parameters	'n'	% age	Recovered/ Not recovered
01	Dural tears	6	11.11	Recovered
02	Superficial Infection	8	14.81	Recovered
03	Deep Infection	4	07.40	Recovered
04	Neurological Deficit	3	05.56	Recovered

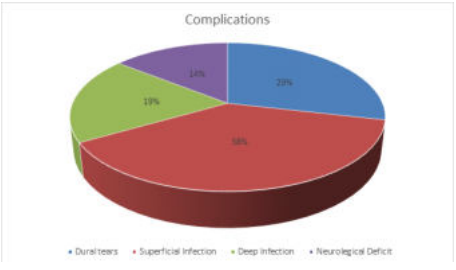

Fig. 5: Pie chart showing the complications encountered.

The complications encountered in the study patients are Dural tears in 6 patients, superficial infection in 8 patients, Deep infection and Neurological deficit in 4 and 3 patients respectively. All of these complications subsequently got resolved without any long term sequelae.

Functional Outcome scores:

Japanese Orthopaedic Association score:

Our mean male JOA score was pre-operatively 9.88 which improved to 14.8 at the 12th month follow-up. Our mean JOA for females was at 8.3 which improved post operatively to 13.8. The JOA (Total of 17 points) takes into consideration the sensory and motor function of the trunk and the lower limbs and also the bladder function. On an average, the group that underwent decompression with posterior stabilization had 20% better JOA scores than their other counterparts who underwent decompression alone, without instrumentation.

Visual Analogue Scale:

The mean VAS score pre-operatively in the men and women were 7.4 and 8.6 respectively. This, at the 12th month follow up dropped to 0.8 and 1.2 for men and women respectively. Here again the group that underwent decompression with posterior stabilization had 20% better VAS score than their other counterparts who underwent decompression alone, without instrumentation

DISCUSSION:

All our patients who underwent surgery for lumbar canal stenosis, had been suffering from both low back-ache, as well as neurogenic claudicating pain for close to 3 years, with exacerbation for the last 3 months. This was comparable with the study reported by Amundsen et al (5); who in their series had patients with complaint of back pain in 95% and neurogenic claudication in 91%. We had the most mobile lumbar levels at L4-L5 and L5-S1 predominantly involved, 74% of our sample group had established EHL/FHL weakness with complaints of paresthesia.12 patients had bowel and bladder symptoms. All patients in our series had undergone conservative treatment in the form of pain relieving medication and physiotherapy. Some had even undergone epidural steroid injection and had reported intermittent period of pain relief.

The goal of the surgery in lumbar canal stenosis is to achieve satisfactory decompression and sound bony fusion in the involved segments.

In trying to understand the biomechanics of lumbar spine, we get to know that, during flexion the lamina of the two adjacent vertebrae moves apart. The inter-laminar space widens producing the lengthening and thinning of the ligamentum flavum. The posterior elements of the two adjacent vertebral bodies move apart, this causes a stretch in the posterior position in the annulus fibrosis. In the process spinal lumbar extension the ligamentum flavum shortens, it becomes thicker and buckles into vertebral canal. Further the annulus fibrosus bulges posteriorly thereby decreasing the sagittal diameter. In this lumbar canal stenosis the patho-anatomy could either be of the narrowing or the encroaching variant. The narrowing pathology is the developmental ones while the encroaching pathology are the degenerative ones. The degenerative encroaching pathologies could further be divided into static and dynamic pathology.

Static Encroachment:

Anteriorly,

- Upper and lower osteophytes from the body.
- Calcified annulus with or without the nucleus.

Posteriorly,

- Inturned proximal margin of the lamina.
- Osteophytes at the laminar attachment of the ligamentum flavum.

Postero-laterally,

- Thickened and enlarged superior articular process.
- Low lying ligamentum flavum forming roof of the root canal.
- Thickened and hypertrophied antero-medial capsule of the facet joint.

Dynamic Encroachment:

Anteriorly – Bulging lax annulus.
Posteriorly – Buckling of ligamentum flavum.
Postero-lateral – Lax and bulging facet capsule accompanied by synovial thickening and with effusion.

Degenerative Stenosis:

With age in the disc, the water content decreases. As the nucleus pulposus dehydrates, its ability to distribute stress uniformly diminishes, leading to fissures and tears within the annulus. The type-I collagen content also increases in the discs of individuals who are middle aged and older. With age and subsequent degeneration, the total proteoglycan content also decreases. The rate of proteoglycan synthesis also decreases with age. The Biomechanics and Biomechanical changes lead to decrease in the disc height, annular bulging, disc herniation, and early osteophyte formation. Increased Biomechanical stresses are transmitted posteriorly to the facet joints, may lead onto arthritic changes and occasionally, facet hypertrophy,

instability of the facet joints may develop. As the disc degenerates and the cephalo-caudal foraminal space narrows, nerve roots get compressed.

Neurogenic Claudication:

Verbiest defined neurogenic intermittent claudication as the onset of pain, tension and weakness upon walking in one or both legs progressively increasing until walking becomes impossible and subsequent disappearance of symptoms after a period of rest (20 minutes) (1). Should not be present before walking but should occur during walking. Disappear after a short rest by sitting and bending forward or crouching. Pain increases with standing and walking. The patient may obtain the 'Simian stance' to obtain relief. Hypoasthesia, paraesthesia are often precipitated by exercise. Walking uphill or riding a bicycle may be done with ease but walking down hill produces pain.

MRI is an excellent diagnostic tool and gives us the exact dimensions of the canal and details about cord and nerve root impingement. It further gives us details as to the size and contour of the foramen. This investigation is indeed a must before embarking on any spinal surgery for relief of lumbar canal stenosis. Myelography has now-a-days become obsolete.

Electrodiagnostic studies is abnormal in about 80% of patients with spinal canal stenosis and provides for confirmatory evidence of level of nerve root involvement. The goal of the surgery are pain relief, increased mobility and prevention of neurological deficit.

The indication for surgery includes pain that is resistant to conservative management, presence of neurological deficit, and interference in activities of daily living of the patient. Posterior decompression with postero-lateral fusion addresses the problem of lumbar canal stenosis in an effective manner. If instrumentation is done, return to ambulatory status is achieved within in 3 weeks. At the time of decompression while all the neural elements are to be decompressed, care is taken tp preserve the facetal joint integrity and the protection of pars-interarticularis. Fusion carried out simultaneously with bone graft obtained autologously, results in a sound fusion by around six months.

Spinal Canal Lumbar Stenosis is characterized by neurogenic claudication as described by Arbit E et al;(6), Spivak J et al;(7), BridwellKH et al;(8), Garfin SR et al(9) and Hall S et al(10); call this claudication as “pseudoclaudication”. Arnoldi et al (11); had proposed a classification for spinal stenosis and is still very pratical. The complaints of the patients include paraesthesia, pain, heaviness or weakness in the region of the buttocks radiating to the lower extremity. These symptoms are aggravated by walking or prolonged standing, but relieved by forward bending and sitting, according to Rajendranath et al (12); Weinstein JN et al (13); and Herron LD et al (14). Weinstein et al (2010) showed that substantial improvement in function and pain occurs at 2 year follow up for surgical treatment of listhesis and spinal stenosis. In our series, as comparable to the study of Herron et al (14); (1991), the average leg pain improved to 84% and average back pain improved by 76%. These similar outcomes were also reported by Weinstein JN et al;(13). Our results compare well with the study of Getty et al (15); who had 55 to 84% patients reporting well to satisfactory results. If interbody fusion and posterior stabilization are not done, in cases withlisthesis or instability as reported by Postacchini F et al;(1992), bone re-growth could pose a problem (16,17). All outcomes of our study showed their improvements within the first 12 months post operatively as was the reported finding by Rajendranath et al;(12) When multiple levels are involved, decompressive surgery alone may not be effective, and we must address the associated instability or listhesis with interbody fusion and posterior instrumentation, coupled with postero-lateral, autogenous bone grafting.

CONCLUSION:

In patients with lumbar canal stenosis whose symptoms do not abate, with conservative management, surgical lumbar spinal canal decompression, whether it is single level or dual level, does provide for a good clinico- functional outcome. The addition of instrumentation along with bone grafting, enhances the stability and prevents future spinal events requiring re-surgery. Hence this study concludes that the surgical decompression and posterior instrumentation gives excellent results.

REFERENCES:

1. Verbiest H. A radicular syndrome from developmental narrowing of the lumbar vertebral canal. J Bone Joint Surg Br 1954;36-B:230-7. [Crossref] [PubMed]
2. Putti V. New conceptions in the pathogenesis of sciatic pain. Lancet 1927;ii:53-60. [Crossref]
3. Weinstein JN, Tosteson TD, Lurie JD, Tosteson A, Blood E, Herkowitz H, Cammisa F, Albert T, Boden SD, Hilibrand A, Goldberg H, Berven S, An H. Surgical versus nonoperative treatment for lumbar spinal stenosis four-year results of the Spine Patient Outcomes Research Trial. Spine (Phila Pa 1976). 2010 Jun 15;35(14):1329-38. doi: 10.1097/BRS.0b013e3181e0f04d. PMID: 20453723; PMCID: PMC3392200.
4. Gowers WR. *Disease of the Nervous System.* 2. London, UK: Churchill; 1892. [Google Scholar]
5. Amundsen T, Weber H, Nordal HJ, Magnaes B, Abdelnoor M, Lilleås F. Lumbar spinal stenosis: conservative or surgical management?: A prospective 10-year study. Spine (Phila Pa 1976). 2000 Jun 1;25(11):1424-35; discussion 1435-6. doi: 10.1097/00007632-200006010-00016. PMID: 10828926.
6. Arbit, Ehud MD; Pannullo, Susan MD Lumbar Stenosis, Clinical Orthopaedics and Related Research: March 2001 - Volume 384 - Issue - p 137-143
7. Spivak J. Degenerative spinal stenosis. J Bone Joint Surg 1998;80:1053–66.
8. Bridwell KH. Lumbar spinal stenosis. Diagnosis, management, and treatment. Clin Geriatr Med 1994;10:677–701.
9. Garfin SR, Herkowitz HN, Mirkovic S. Spinal stenosis. AAOS Instructional Course Lectures 2000;49:361–74.
10. Hall S, Bartleson J, Onofrio B, Baker H Jr, Okazaki H, O' Duffy D. Lumbar spinal stenosis-clinical features, diagnostic procedures, and result of surgical treatment in 68 patients. Ann Intern Med 1985;103:271–5
11. Arnoldi CC, Brodsky AE, Cauchoix J, Crock HV, Dommisse GF, Edgar MA *et al.* Definition and classification of lumbar spinal stenosis and nerve root entrapment syndromes. Clin Orthop 1976;115:4–5.
12. Nath, R., Middha, S., Gupta, A.K. *et al.* Functional outcome of surgical management of degenerative lumbar canal stenosis. *IJOO* **46**, 285–290 (2012). https://doi.org/10.4103/0019-5413.96380
13. Weinstein JN, Lurie JD, Tosteson TD, Hanscom B, Tosteson AN, Blood EA, *et al.* Surgical versus nonsurgical treatment for lumbar degenerative spondylolisthesis. N Engl J Med 2007;356:2257–70.
14. Herron LD, Mangelsdorf C. Lumbar spinal stenosis: Results of surgical treatment. J Spinal Disord 1991;4:26–33.
15. Getty CJ. Lumbar spinal stenosis: The clinical spectrum and the results of operation. J Bone Joint Surg Br 1980;62:481–5.
16. Postacchini F, Cinotti G. Bone regrowth after surgical decompression for lumbar spinal stenosis. J Bone Joint Surg 1992;74B:862–9.
17. Postacchini F. Surgical management of lumbar spinal stenosis. Spine (Phila Pa) 1999;24:1043–7.