Clinical evaluation of lumbar spinal stenosis and its correlation with the MRI findings

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Abstract

Financial Disclosure: There are no financial relationship for this study to disclose.
Study Design: Cross sectional prospective study to evaluate the Clinical findings of lumbar spinal stenosis and correlated to the MRI findings.
Objectives: To examine the clinical presentation in lumbar spinal stenosis, also the radiologic features of lumbar spinal stenosis on MRI SCAN and to correlate the both.
Summary of Background Data: Several studies have been performed regarding the correlation of clinical findings with the radiologic findings, it is important to find out the sensitivity, efficacy and lapses of both the methods and to formulate an effective diagnostic plan for management of patients with lumbar spinal stenosis specially in a rural setup in Indian population.
Methods: Cross sectional prospective study to evaluate the clinical findings of lumbar spinal stenosis and correlated to the MRI findings.

Clinical findings which were evaluated included Age, Occupation, Duration of symptoms, claudication distance, clinical level for disc protrusion, motor and sensory deficits, bladder bowel involvement.

MRI findings which were noted as related to lumbar spinal stenosis were canal diameter, level of disc protrusion, ligamentum flavum hypertrophy.
Results: Many clinical parameters do correlate with the MRI features of lumbar spinal stenosis. This may not be true in all cases and hence clinical parameters are of paramount importance while considering the treatment option for the patient evenly supported by the MRI findings.
Conclusion: To conclude with MRI is the modality of choice in patients with lumbar spinal stenosis but needs to be correlated with clinical findings to ascertain or diagnose or classify LSS in terms of severity and before planning for surgical decompression.

Keywords: Lumbar Spinal stenosis; MRI; Clinical and radiological correlation; Canal stenosis.

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Introduction

Lumbar spinal canal stenosis being the most common spinal disorder in elderly patients, which may lead to low back and leg pain, and paresis. The classic presentation of LSS is neurogenic claudication.

Substantial reduction in walking distance because of neurogenic claudication is the reason for seeking medical intervention.

Anatomically, spinal stenosis is classified as (1) central, when the spinal canal and dural sac is affected, (2) foraminal, when it affects the spinal foramina, or (3) lateral, when the lateral recess is affected.

Narrowing of the spinal canal is usually the result of degenerative changes of the spine but may also be due to developmental or congenital narrowing of the spinal canal, e.g. achondroplasia. Spinal canal stenosis can be secondary to facet joint hypertrophy, thickening of the ligamentum or disc bulge.

The diagnosis of spinal stenosis is mainly based on the patient's clinical symptoms and signs. However, the confirmation of a clinical diagnosis is only made by imaging studies. Radiological imaging can be regarded as the most important investigation and it is essential for the diagnosis, pre-surgical evaluation and follow- up of patients with spinal stenosis.

The diagnosis is often delayed due to the insidious onset and slow progression of the disease and further complicated by other pathologies that coexist in the aging population, obscuring differential diagnosis. Although there is a wide range of conservative treatments, the goal of surgery is to decompress the stenotic area to relieve pressure on the neurovascular structures. Thus, accurate diagnosis is essential to select the treatment option. Since the degree of constriction of the spinal canal essential for symptoms to develop for LSS is not clear, and the relationship between the clinical appearance and the degree of constriction verified on MRI is also not well understood, a correlation of a patient's clinical level and radiographic constriction of the lumbar spinal canal is of interest.

The sensitivity and specificity of magnetic resonance (MR) imaging for assessing LSS is reported to be higher, with MR imaging outperforming computed tomography and myelography. Measurements of the cross-sectional area of the dural sac are considered more effective than measurements of the bony spinal canal in diagnosing central stenosis.

MRIs are most effective because it provides detailed information as regarding nerves, muscles, and ligaments, than seen on X-rays or CT scans. Inward bulging of discs and ligamentum flavum usually plays a significant role in narrowing of the bony spinal canal and can be depicted excellently by MRI. Recent advances in magnetic resonance imaging (MRI) have improved the ability to evaluate the spinal canal and neural structures. Ross and Modic found an 82.6% accuracy between MRI and surgical findings for the type and location of the disease. In addition, noninvasive nature of MRI has revolutionized the technique as far as spine problems are concerned. There is persistent uncertainty regarding the relationship between abnormalities observed at imaging and clinical symptoms and secondly the cost of MRI is relatively high, a cost-effective diagnostic plan is necessary for the management of patients with lumbar canal stenosis.

The correlation between clinical presentation and MRI findings should be made so that maximum benefit can be achieved from MRI of the lumbosacral spine. Thus, the purpose of this study was to investigate the correlation between clinical presentation and the MRI features in patients with lumbar spinal stenosis in Indian population.

Materials and Methods

This cross sectional prospective study was done to correlate the clinical features and MRI findings in patients of lumbar spinal stenosis. Total 100 patients were enrolled in the study from July 2011 to September 2013 who had low back pain with positive signs and symptoms of lumbar spinal stenosis with or without neurological deficit and diagnosed as spinal stenosis on MRI.

The Institutional ethics committee approved the study. Patients between the age group 20-70 years were included in the study after they gave their consent after understanding the study. Patients with spinal neoplasm, infection, traumatic fractures, metabolic disorders, congenital anomalies were excluded from the study.

In standardised format, data concerning patients' history and clinical symptoms were collected. Patients having a clinical suspicion of Lumbar spinal stenosis were subjected to Magnetic Resonance Imaging Scan (MRI Scan). MRI was performed using GE 1.5 Tesla BRAVO Magnetic Resonance System (General Electric, USA). The MRI of lumbar spine was performed using sagittal T1, T2, axial T1, T2 weighted and STIR weighted coronal STIR sequences.

Statistical analysis was done by using descriptive statistics using mean, standard deviation and percentage. The other analytical method applied was inferential statistics using Chi square test. Software used in analysis was SPSS 17.0 version and Graph Pad Prism 5.0. The results were tested at 5% level of significance.

Results

In the study population of 100 patients, incidence of LSS was found to be maximum in age group of 41-50 years, accounting for 34% of the patients and the mean age was 46.91 years.

Table 1: Gender wise distribution of patients

Gender	No. of patients	Percentage(%)
Male	51	51.00
Female	49	49.00
Total	100	100.0

Table 2: Age wise distribution of patients

Age Group (yrs)	No. of patients	Percentage (%)
21-30	6	6
31-40	8	28
41-50	34	34
51-60	18	18
61-70	14	14
Total	100	100.00
Mean$\pm$SD	46.91$\pm$11.76	
Range	21-70 Years	

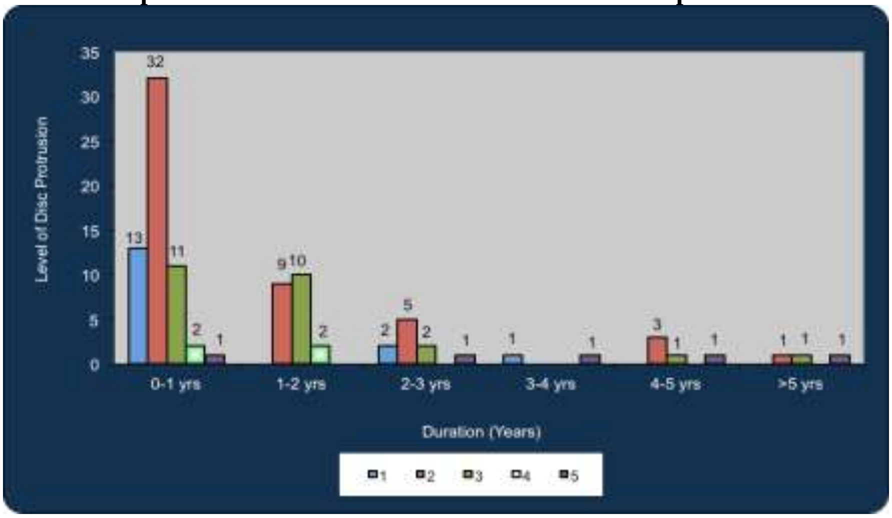
Correlation of duration with level of disc protrusion

The Correlation of duration with level of disc protrusion by using Chi square test statistically significant association was found between duration of the complaints and level of disc protrusion, with p value of 0.017 and chi sq. value 35.56 Patients with longer duration of the symptoms were having multilevel disc bulge as compared to those with single level or 2 level disc protrusion, having lesser duration of symptoms. (Table 3, Graph 3)

Table 3: Correlation of duration with level of disc protrusion

Duration	Duration (yrs)	Level of disc protrusion					Total
		1 Level	2 Levels	3 Levels	4 Levels	5 Levels	
	0-1 Yrs.	13	32	11	2	1	59
	1-2 Yrs.	0	9	10	2	0	21
	2-3 Yrs.	2	5	2	0	1	10
	3-4 Yrs.	1	0	0	0	1	2
	4-5 Yrs.	0	3	1	0	1	5
	>5 Yrs.	0	1	1	0	1	3
Total		16	50	25	4	5	100
ℵ2-value		35.66					
p-value		0.017, S, p<0.05					

Graph 1: Correlation of duration with level of disc protrusion



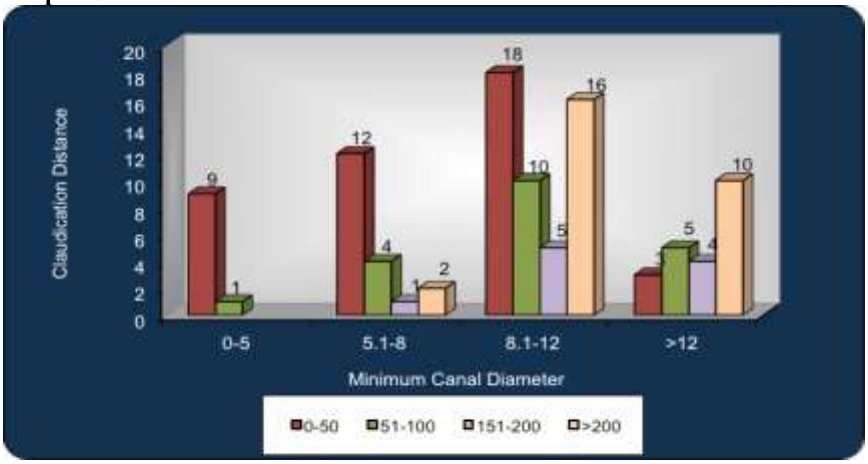
Correlation of claudication distance with minimum canal diameter

The correlation of claudication distance with minimum canal diameter, on analyzing the association between minimum canal diameter and claudication distance, 9% patient with canal diameter less than 5mm had claudication distance of less than 50 feet as compared to 26% patient with canal diameter more than 8.1 mm who had claudication distance more than 200 feet. Suggestive of statistically significant correlation with Chi square value 23.19 and p < 0.05.(Table 4, Graph 4)

Table 4: Correlation of claudication distance with minimum canal diameter

Minimum Canal Diameter	Claudication Distance (meters)					Total
		0-50	51-150	151-200	>200	
	0-5	9	1			10
	5.1-8	12	4	1	2	19
	8.1-12	18	10	5	16	49
	>12	3	5	4	10	22
Total		42	20	10	28	100
ℵ2-value		23.19				
p-value		0.006, S, p<0.05				

Graph 2: Correlation of claudication distance with minimum canal diameter



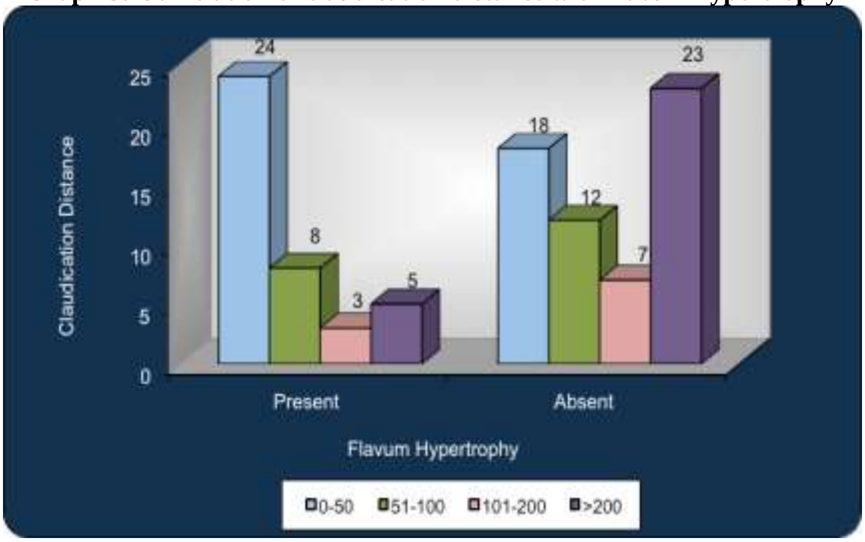
Correlation of claudication distance with flavum hypertrophy

Correlation of claudication distance with flavum hypertrophy, statistically significant association was found between claudication distance and presence of flavum hypertrophy, 24% patients with claudication distance less than 50 feet were having flavum hypertrophy, as compared to 23% patients who had distance more than 200 feet with no abnormality in ligamentum flavum. (Table 5 and Graph 5)

Table 5: Correlation of claudication distance with flavum hypertrophy

Minimum Canal Diameter		Claudication Distance (meters)				Total
		0-50	51-100	101-200	>200	
	Absent	24	8	3	5	40
	Present	18	12	7	23	60
Total		42	20	10	28	100
ℵ2-value		11.28				
p-value		0.006, S, $p<0.05$				

Graph 3: Correlation of claudication distance with flavum hypertrophy



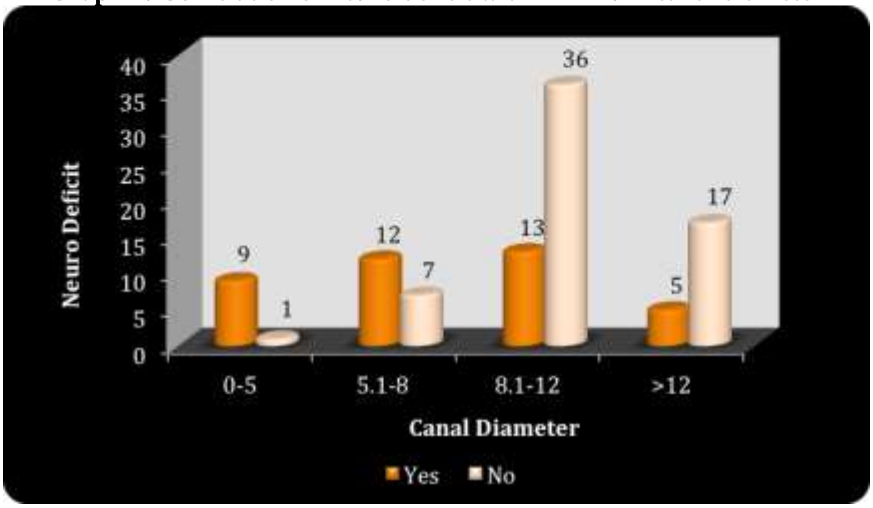
Correlation of neuro deficit with minimum canal diameter

Correlation of neuro deficit with minimum canal diameter, the association between minimum canal diameter and neuro deficit was found to be highly significant, with p value of 0.000. Of the 39% patients with neuro deficit 9% had canal diameter less than 5mm and of the 61% patients without neuro deficit 53% patients had minimum canal diameter more than 8.1 mm.(Table 6, Graph 6)

Table 6: Correlation of neuro deficit with minimum canal diameter

Minimum Canal Diameter		Claudication Distance (meters)				Total
		0-5	5.1-8	8.1-12	>12	
	Yes	9	12	13	5	39
	No	1	7	36	17	61
Total		10	19	49	22	100
ℵ2-value		25.11				
p-value		0.010, S, p<0.05				

Graph 4: Correlation of neuro deficit with minimum canal diameter



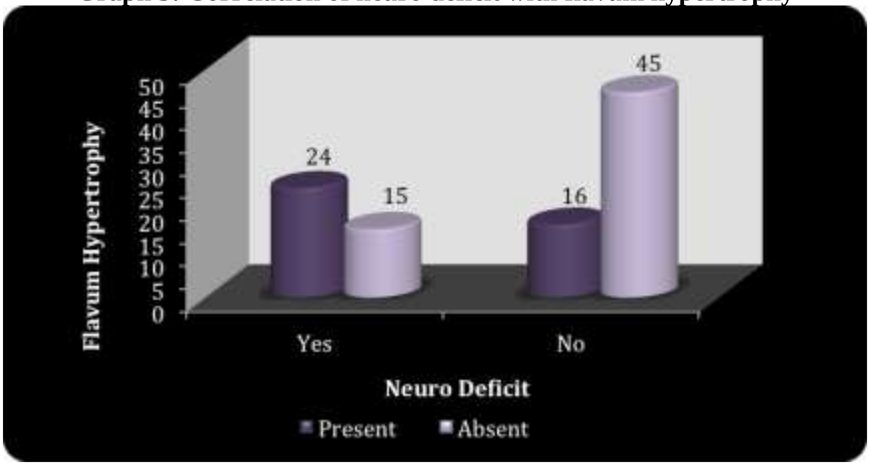
Correlation of neuro deficit with flavum hypertrophy

Correlation of neuro deficit with flavum hypertrophy, statistically significant association with p value 0.000 and Chi sq. value 12.35 was found between presence of neuro deficit and flavum hypertrophy, 24% were true positive and 45% true negative. (Table 7, Graph 7)

Table 7: Correlation of neuro deficit with flavum hypertrophy

Neuro Deficit		Flavum Hypertrophy		Total
		Present	Absent	
	Yes	24	15	39
	No	16	45	61
Total		40	60	100
ℵ2-value		12.35		
p-value		0.000, S, p<0.05		

Graph 5: Correlation of neuro deficit with flavum hypertrophy



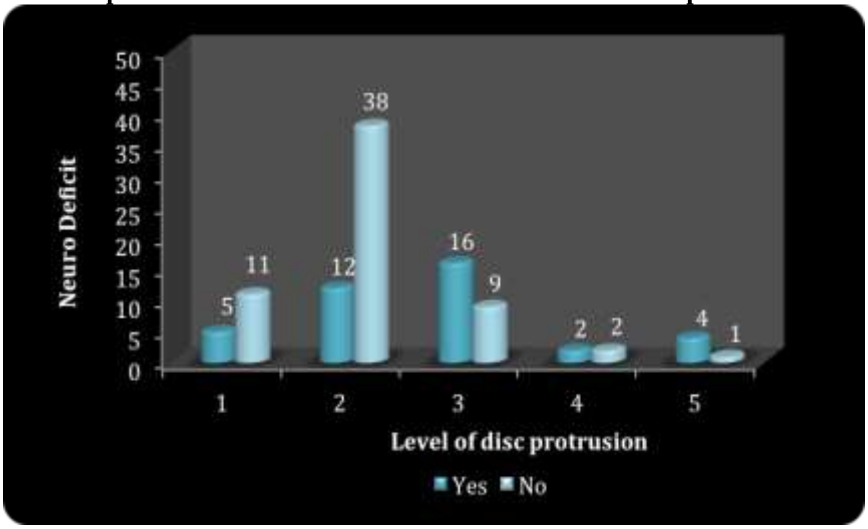
Correlation of neuro deficit with level of disc protrusion

Correlation of neuro deficit with level of disc protrusion, out of the total 66 patients with upto 2 level disc protrusion 49 patients had no neuro deficit, higher incidence of neuro deficit in patients with multilevel disc bulge. Suggestive of a statistically significant association with Chi sq. value of 14.02 and p value 0.007. (Table 8, Graph 8)

Table 8: Correlation of neuro deficit with level of disc protrusion

Neuro Deficit	Neuro Deficit	Level of disc protrusion					Total
		1 Level	2 Levels	3 Levels	4 Levels	5 Levels	
	Yes	5	12	16	2	4	39
	No	11	38	9	2	1	61
Total		16	50	25	4	5	100
ℵ2-value		14.02					
p-value		0.007, S, p<0.05					

Graph 6: Correlation of neuro deficit with level of disc protrusion



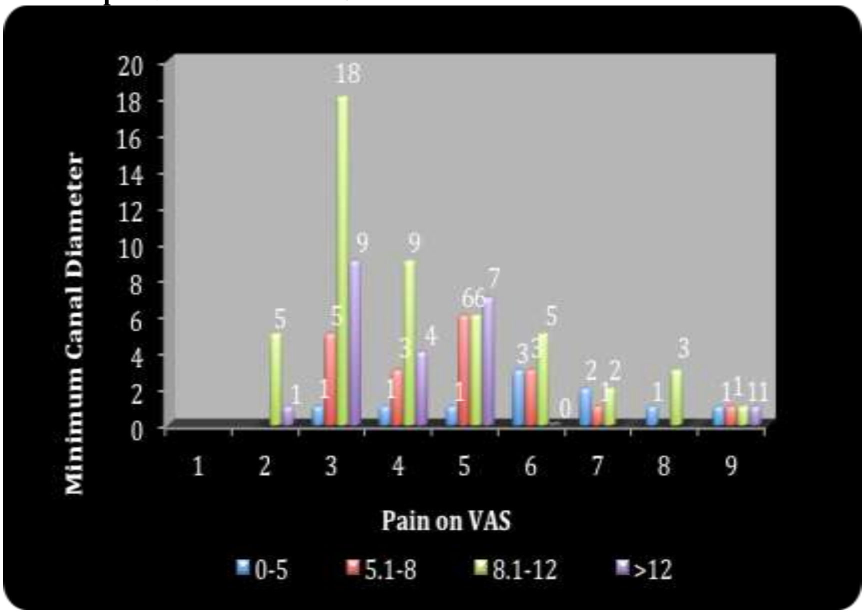
Correlation of VAS score with minimum canal diameter

Correlation of VAS score with minimum canal diameter, no statistically significant association was found between minimum canal diameter and VAS score, p > 0.05 and Chi square value 23.46. (Table 9, Graph 9)

Table 9: Correlation of VAS score with minimum canal diameter

VAS Score	VAS Score	Minimum Canal Diameter				Total
		0-5	5.1-8	8.1-12	>12	
	1					
	2			5	1	6
	3	1	5	18	9	33
	4	1	3	9	4	17
	5	1	6	6	7	20
	6	3	3	5	0	11
	7	2	1	2		5
	8	1		3		4
	9	1	1	1	1	4
Total		10	19	49	22	100
ℵ2-value		23.46				
p-value		0.32, NS, p>0.05				

Graph 7: Correlation of VAS score with minimum canal diameter



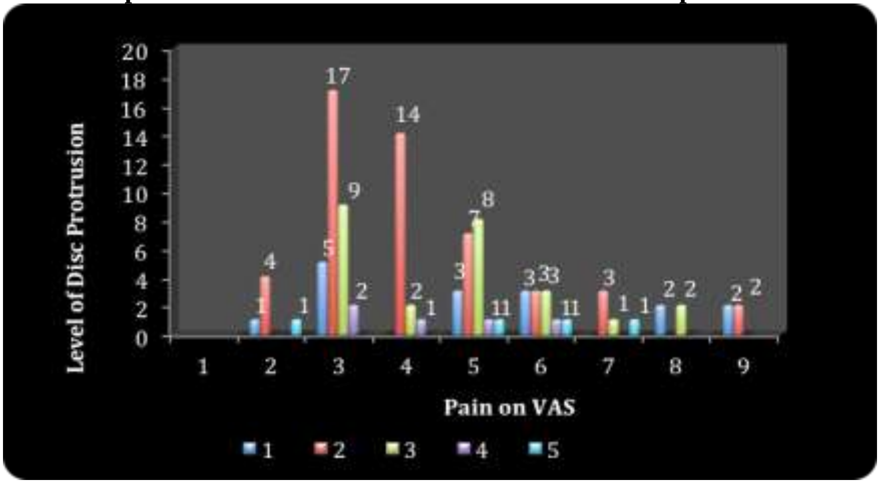
Correlation of VAS score with level of disc protrusion

Correlation of VAS score with level of disc protrusion, no statistically significant association was found between number of level of disc protrusion and VAS score. p > 0.05 and Chi square value 34.98. (Table 10, Graph 10)

Table 10: Correlation of VAS score with level of disc protrusion

VAS Score	VAS Score	Minimum Canal Diameter					Total
		1 level	2 level	3 level	4 level	5 level	
	1						
	2	1	4			1	6
	3	5	17	9	2		33
	4		14	2	1		17
	5	3	7	8	1	1	20
	6	3	3	3	1	1	11
	7		3	1		1	5
	8	2		2			4
	9	2	2				4
Total		16	50	25	4	5	100
א2-value		34.98					
p-value		0.17, NS, p<0.005					

Graph 8: Correlation of VAS score with level of disc protrusion



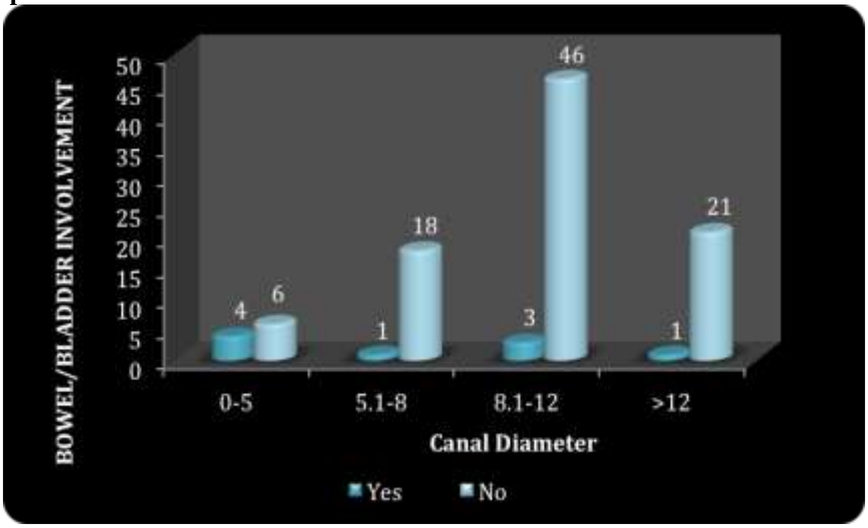
Correlation of bowel/bladder involvement with minimum canal diameter

Correlation of bowel/bladder involvement with minimum canal diameter, out of the 9 patients in whom bowel/bladder involvement was present 4 patient had minimum canal diameter less than 5 mm, as compared to 67 patients with canal diameter more than 8.1 mm without bowel/bladder involvement suggestive of highly significant association with a p 0.00 and chi square value 11.38. (Table 11, Graph 11)

Table 11: Correlation of bowel/bladder involvement with minimum canal diameter

Bowel/ Bladder Involvement		Minimum Canal Diameter (mm)				Total
		0-5	5.1-8	8.1-12	>12	
	Yes	4	1	3	1	9
	No	6	18	46	21	91
Total		10	19	49	22	100
א2-value		11.38				
p-value		0.00, S, $p<0.05$				

Graph 9: Correlation of bowel/bladder involvement with minimum canal diameter



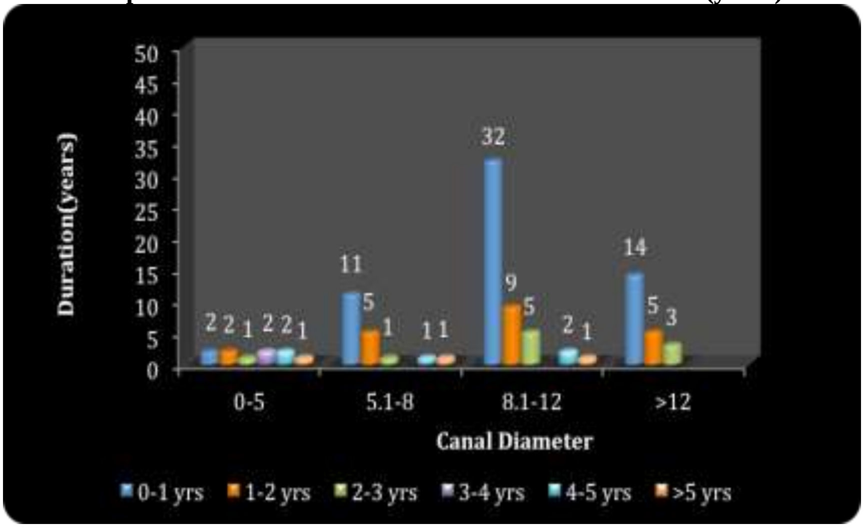
Correlation between duration of the complaints and minimum canal diameter

Table 12 and Graph 12: Shows that statistically significant association was found between duration of the complaints and minimum canal diameter with higher percentage of patients with lesser canal diameter having longer duration symptoms, with a Chi square value 30.39 and p value 0.002.

Table 12: Correlation of canal diameter with duration(years)

Duration (Yrs.)		Minimum Canal Diameter (mm)				Total
		0-5	5.1-8	8.1-12	>12	
	0-1 Yrs	2	11	32	14	59
	1-2 Yrs	2	5	9	5	21
	2-3 Yrs	1	1	5	3	10
	3-4 Yrs	2				2
	4-5 Yrs	2	1	2		5
	>5 Yrs	1	1	1		3100
Total		10	19	49	22	
א2-value		30.39				
p-value		0.002, S, p<0.05				

Graph 10: Correlation of canal diameter with duration(years)



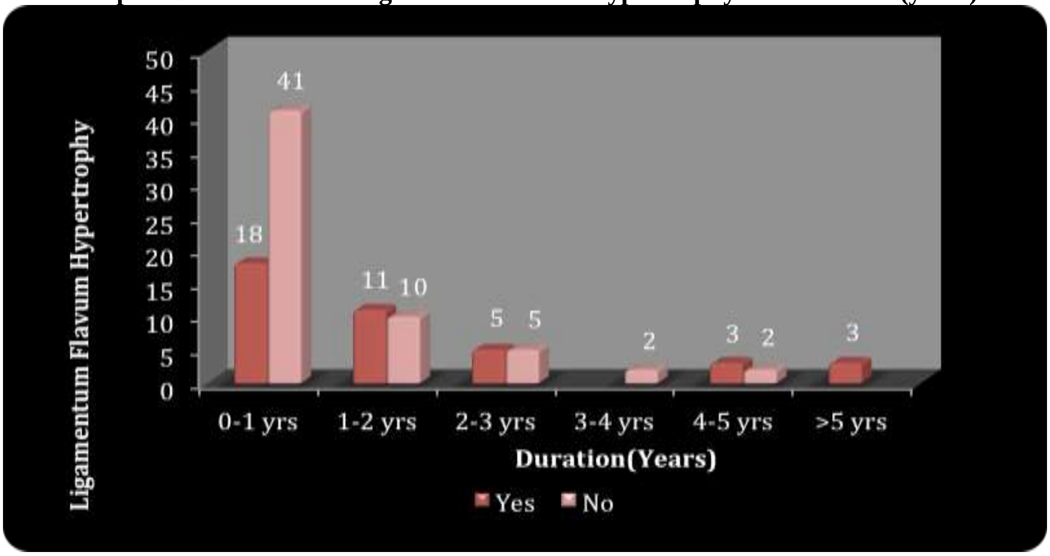
Correlation of ligamentum flavum hypertrophy with duration (years)

Table 13 and Graph 13: Demonstrates correlation of ligamentum flavum hypertrophy with duration(years) Statistically significant association was found between flavum hypertrophy and duration of complaints, hypertrophy was present in 40% of the patients and 55% patients with hypertrophy had duration more than 1 year as compared to 68.33% patients without hypertrophy in whom duration was less than one year.

Table 13: Correlation of ligamentum flavum hypertrophy with duration(years)

Duration (Yrs.)	Ligamentum Flavum Hypertrophy			Total
		Yes	No	
	0-1 Yrs.	18	41	59
	1-2 Yrs.	11	10	21
	2-3 Yrs.	5	5	10
	3-4 Yrs.		2	2
	4-5 Yrs.	3	2	5
	>5 Yrs.	3		3
Total		40	60	100
א2-value		11.09		
p-value		0.049, S, p<0.05		

Graph 11: Correlation of ligamentum flavum hypertrophy with duration(years)



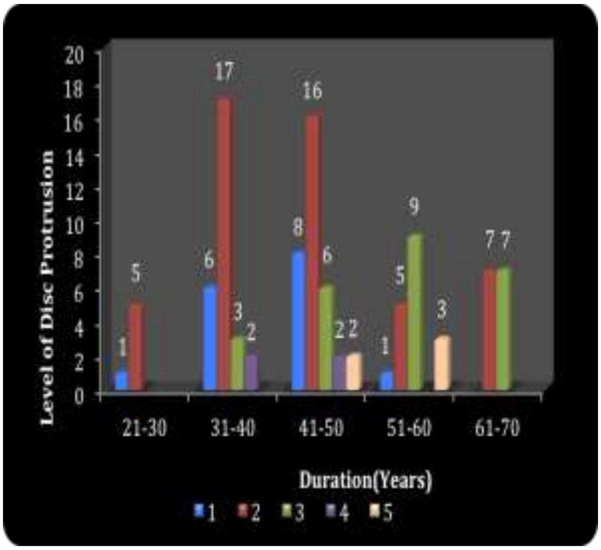
Correlation of age with level of disc protrusion

Table 14 and Graph 14: Demonstrates the Correlation of age with level of disc protrusion, no statistically significant correlation was found between age of the patient with no of level of disc protrusion, Chi square value was 31.15 and p > 0.05.

Table 14: Correlation of age with level of disc protrusion

Age (Years)	Level of Disc Protrusion						Total
	Age	1 Level	2 Level	3 Level	4 Level	5 Level	
	21-30	1	5				6
	31-40	6	17	3	2		28
	41-50	8	16	6	2	2	34
	51-60	1	5	9		3	18
	61-70		7	7			13
Total		16	50	25	4	5	100
א2-value		31.15					
p-value		0.05, NS, p>0.05					

Graph 12: Correlation of age with level of disc protrusion



Correlation of sensory deficit with minimum canal diameter,

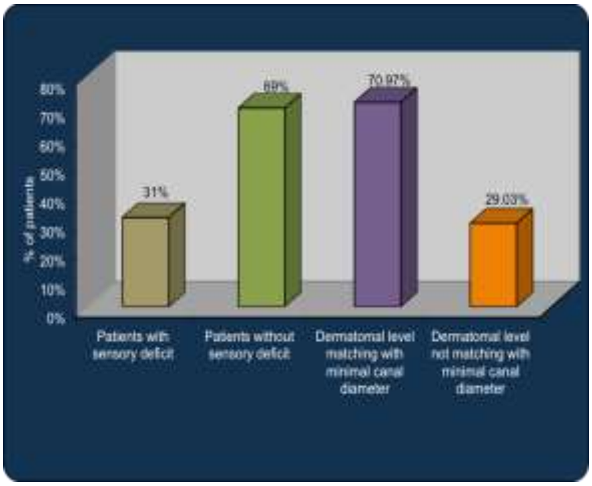
Table 15 and Graph 15: Shows the correlation of sensory deficit with minimum canal diameter, out of the 31% patients who had neuro deficit almost 71% patients the level of sensory deficit clinically was matching with the minimum canal diameter, suggestive of a good linear correlation.

Table 15: Correlation of sensory deficit with minimum canal diameter

	No. of Patients	Percentage (%)
Total Patients	10	100
Patients with sensory deficit	31	31.00
Patients without sensory deficit	69	69.00
Dermatomal level matching with minimal canal diameter	22	70.97

Dermatomal level not matching with minimal canal diameter		

Graph 13: Correlation of sensory deficit with minimum canal diameter



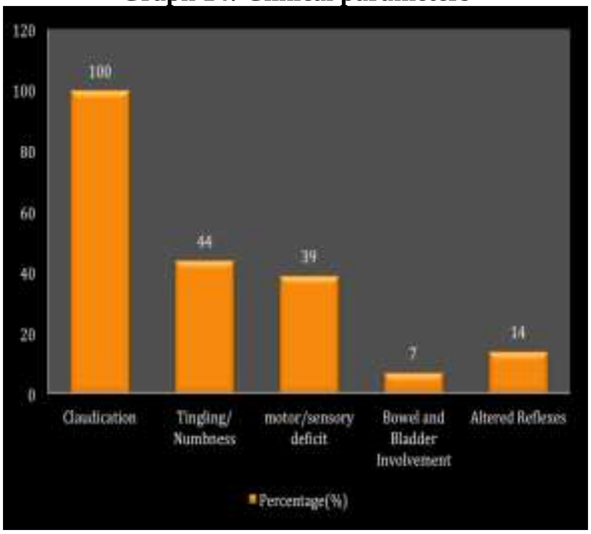
Clinical parameters

In our study, Neurogenic claudication was present in 100% patients followed by tingling numbness in 44% and motor/sensory deficit was present in 39% patients and altered reflexes in 14% and visceral involvement in 7% patients. (Table 16)

Table 16: Clinical parameters

Clinical Parameters	No. of Patients	Percentage (%)
Claudication	100	100
Tingling/ Numbness	44	44
Motor/ Sensory Deficit	39	39
Bowel & Bladder Involvement	7	7
Altered Reflexes	14	14

Graph 14: Clinical parameters



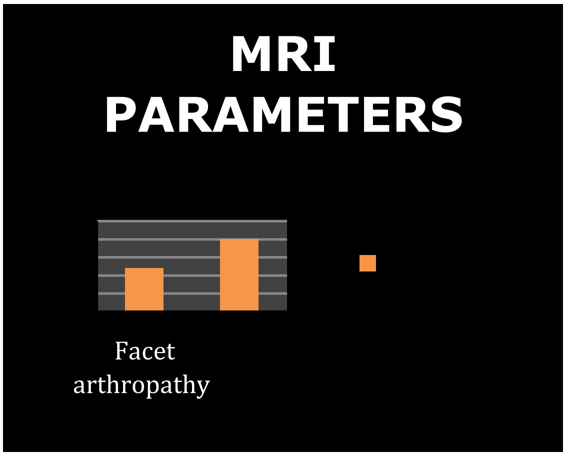
MRI Parameters

Table 17 and Graph 17: Shows the MRI parameters, 24% patients had facet arthropathy on MRI and 40% patients had flavum hypertrophy.

Table 17: MRI parameters

MRI Parameters	No. of Patients	Percentage (%)
Facet Arthropathy	24	24
Flavum Hypertrophy	40	40

Graph 15: MRI parameters



Occupation wise distribution

Table 18 shows Majority of the study population was constituted by farmer/labourer accounting to 43% followed by 27% housewives, 12% skilled workers such as mechanic and machine workers, 9% were shop owner and 8% were having sedentary life style.

Table 18: Occupation wise distribution

Occupation	No. of Patients	Percentage (%)
Farmer/ Labourer	43	43
Shopowner	9	9
Housewife	27	27
Skilled worker	12	12
Student	1	1
Sedantary	8	8

Management

Table 19 shows 59% of the patients were managed conservatively, 36% were managed with surgical decompression and 5% of the patients were advised surgery.

Table 19: Management

Management	No. of Patients	Percentage (%)
Surgically managed	36	36
Conservative	59	59
Planned for surgery	5	4

Discussion

The pathoanatomy of Lumbar Spinal Stenosis is well defined but it's clinical features are heterogenous.

In our cross sectional study we carried out a comprehensive prospective review of 100 patients with the clinical features and their correlation with radiological changes visible on MRI.

The males and females contributing to the study were in equal proportions 51% being males and 49% females, the mean age in our study is 47 years, 43% of the study population were farmers/labourer, patients with spinal malformations, infections or congenital and developmental abnormalities were not included in the study.

Neurogenic claudication, regarded as pathognomonic of lumbar spinal stenosis, was the presenting symptom in all 100% of the patients. In our study good correlation was observed between neuro deficit and number of level of disc protrusion with higher incidence of neuro deficit in patients with multilevel disc bulge. We observed statistically significant association with chi sq. value of 14.02 and p value 0.007.

Similarly moderate to severe central stenosis correlated with the occurrence of motor weakness and patients with multilevel involvement who had more sensory symptoms. Suggesting a good correlation between imaging studies and clinical neurological abnormalities. These findings are consistent with study done by Khean Jin Goh et al.

In this study, good linear correlation was observed between canal diameter and claudication distance ($p < 0.05$). This corresponds with the study of Freys G Sigmundsson et al (115)who showed that pre-operative reduction of walking capacity tended to correlate with width of spinal canal and Ogikubo et al (116) have shown correlation between pain and walking distance on one hand and spinal canal on other, patients with clinical spinal stenosis usually report with reduced walking distance as was the case in our study.

In our study statistically significant association was found between flavum hypertrophy and duration of complaints ($p < 0.05$). The study conducted by Moon HJ et al(117) also states that longer duration in maximal stenotic level could be considered as high mechanical stress that may lead to development of LF hypertrophy another study by and Junseok W Hur et al (118) states that LF hypertrophy could be the major anatomical cause of central LSS, which shows similar results to our study.

Also ligamentum flavum hypertrophy contributing to LSS correlated very well with claudication distance ($p < 0.05$).

Using Chi square test there was no significant correlation between low back pain and leg pain (VAS score) and spinal stenosis, in a similar study by Freys G Sigmundsson et al (115) found no correlation between leg and back pain scores and canal size, however Ogikubo et al (116) have reported a positive correlation between high pre-operative VAS score and spinal stenosis on MRI. In 71% patients it was found that dermatomal level was matching with minimum canal diameter. Hence it can be said that sensory deficit predicts the level of spinal stenosis. In a study by PY Yong, NAA Alias, IL Shuaib (119) similar results were observed.

Spinal canal narrowing is considered to cause more problems when it occurs at multiple level (120) in our study multiple level stenosis was observed in 84% patients, according to studies by Portar and Ward (120) and Hamanishi C et al (121), the correlation between radiological and clinical findings is more obvious in multiple level spinal narrowing compared to single level stenosis. In our study similar results were found with significant correlation between no of levels with spinal stenosis (absolute or relative) and the clinical findings.

Lumbar spinal canal imaging is currently definitive diagnostic test for Lumbar spinal stenosis, the absolute degree of stenosis can be assessed by measuring the diameter of lumbar spinal canal. (122) to reduce the radiation load the MR images were obtained at lumbar spinal level only.

MRI is considered the best approach for the workup of spinal stenosis [123-125]. The reported sensitivity and specificity of MRI for the diagnosis of spinal stenosis varies from 77% to 90% and 72% to 100%, respectively, with the reference standard in these studies consisting of either surgical findings or adequate clinical follow-up [124, 126–128].

T1-weighted images can clearly visualise stenosis and provide valid information regarding the underlying cause of stenosis [129].

MRI is recognized as being accurate for detecting intervertebral disc herniation. In addition, MRI has high accuracy in differentiating the subtype of disc herniation. Forristall et al reported 90% accuracy for MRI compared with 78% for CT myelography.

Conclusion

A prospective study of 100 patients of Lumbar Spinal Stenosis diagnosed clinically and on MRI after appropriating inclusion criteria during the year 2011 to 2013, the correlation between the clinical findings and MRI findings was made.

Clinical presentation of lumbar spinal stenosis (LSS) is variable. The presence of symptoms associated with walking is helpful but its absence by no means excludes the diagnosis. As LSS is commonly seen in the elderly other associated neurological diseases are likely to be present which can contribute to the presenting symptoms.

Though the severity of stenosis does correlate with the neurological presentation, prospective randomised studies are needed to define those group of patients with lumbar stenosis who may benefit from surgical decompression.

Magnetic resonance imaging (MRI) provides non-invasive mechanism to view the spinal anatomy in great detail specially the soft tissue structures.

MRI SCANS with high resolution images have given clinicians definite advantage over Computed Tomography and Myelography and has revolutionised the diagnostic workups for low back pain and radicular pain. 11, 34.

However large variations have been found in the radiological and clinical findings in symptomatic and asymptomatic individuals, the correlation of MRI findings and clinical findings may not be significant always.

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