Original article

Study of relationship between area of lumbar spinal canal and severity of symptoms in cases of lumbar canal stenosis

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Abstract:

Introduction: With relation to the numerous difficulties one encounters in going ahead with the therapy for patients with lumbar canal stenosis,this study aims to find anycorrelation between imaging of spine at the level of stenosis and the patientsfunctional status based onOswestry disability index scores to provide a definitive management guideline

Methodology: 60 patients were studied wherein the area of lumbar spinal canal was evaluated by means of an MRI and those patients who had a spinal canal area of less than 100 mm ^{2}were evalauated by means of ODI(Oswestry disability index) and a relationship between the two was established.

Observations and Results: Patients were classified separately on the basis of central canal stenosis, lateral recess stenosis and foraminal stenosis depending on their MRI findings. Percentages of patients belonging to each group was determined.

Oswestry Disability Indices for each of these three radiological groups and the ODI scores were classified as mild, moderate, severe, crippled and bedridden and with the help of a chi square test a correlation was established between severity of radiological stenosis and clinical function.

Conclusion: There is no significant correlation between area of lumbar spinal canal and severity of symptoms in cases of lumbar spinal stenosis.

Keywords: Lumbar canal stenosis, MRI(magnetic resonance imaging),ODI(Oswestry Disability Index)

Introduction

Degenerative spinal stenosis is a progressive disorder that involves the entire spinal motion segment. It can involve either the cervical , thoracic or the lumbar spine, though the lumbar spine is the one that is most commonly involved.[1]] As greater percentage of the general population becomes older, lumbar spinal stenosis (LSS) becomes a frequently encountered painful and potentially disabling condition [2,3]. The spinal canal demonstrates narrowing, attributed most frequently to acquired degenerative or arthritic changes such as hypertrophy of the articulationssurrounding the canal, intervertebral disc herniation or bulges, hypertrophy of the ligamentumflavum, osteophyte formation and degenerative spondylolisthesis. [2,4,5]

Anatomically, spinal stenosis is classified as [6] central,when it affects the spinal canal and dural sac, [2] foraminal,when it affects the spinal foramina, or [4] lateral, when it affects the lateral recess [3, 7, 8].]. Although classically central and lateral stenosis is described as distinct entities, central and lateral lesions are linked to the genesis of complaints in elderly patients with marked degenerative changes [8,

9]. In addition to its structural aspects, the pathology of LSS also has a dynamic component.

Extension of the spine and axial loading contribute to further narrowing of both the central canal and the lateral recess. [10,11,12,13].

The process is a sequence of events where degeneration of intervertebral disc results in instability and hypermobility of facet joints which in turn results in hypertrophy of facet joints, which eventually results in ankylosis. This together with the calcification and coexistent hypertrophy results in reduced spinal canal dimensions, referred to as spinal stenosis

The diagnosis is often delayed due to the insidious onset and slow

progression of the disease and further complicated by frequent concomitant pathologies that coexist in the aging population, obscuring

diagnosis.

Accurate diagnosis is critical to appropriate selection of therapy.

The clinical appearance and the degree of radiologically verified constriction is also not well understood, a correlation of a patient's disability level and radiographic constriction of the lumbar spinal canal is of interest.

Lumbar spinal stenosis continues to be misunderstood and under-diagnosed or misdiagnosed, and many patients are never offered effective treatment for their symptoms.The diagnosis can be more difficult due to the frequent coexistence of other degenerative disease processes in the age group, such as degenerative disc disease, facet arthropathy of the spine

With relation to the numerous difficulties one encounters in going ahead with the therapy for patients with lumbar canal stenosis ,this study aims to find if there is any significant correlation between radiological imaging of spine at the level of stenosis and the patients functional status based on his oswestry disability index scores from the point of view of providing a definitive management guideline.

Materials and methods

This was a prospective, observational, cohort study.The study was conducted at a tertiary health care center from September 2013 to November 2016.60 patients with any symptom suggestive of lumbar canal stenosis visiting the OPD of a tertiary care hospital between August 2013-2015 were included in the study. They were subjected to history taking, clinical examination and radiological investigations.

Inclusion Criteria:

Following patients were included in our study:

- Patients presenting with:
  Signs and symptoms suggestive of lumbar canal stenosis

Exclusion criteria:

Following patients were excluded from our study:

- Single or multiple level fractures
- Patients having preexisting neurological disorders
- Patients with spinal malformations and developmental anomalies.
- Patients previously operated for spine or administered with epidural steroid injections.
- Patients with X-ray findings suggestive of disease pathologies contributing to low

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back pain but not related to lumbar canal stenosis.

- Patients who on MRI were found to have an area at the level of dural sac of more than 100mm$^{2.}$

- **METHODS:**

1) Assessment of functional ability of selected patients

Functional outcome scale:

Functional assessment in the patients selected for study was done by the oswestry disability index .[14]The Oswestry Disability Index (also known as the Oswestry Low Back Pain Disability Questionnaire) is an extremely important tool that researchers and disability evaluators use to measure a patient's permanent functional disability. The test is considered the 'gold standard' of low back functional outcome tools.

We devised an ODI questionnaire in the vernacular language of the patient (two sets of questionnaire were used. One in Hindi and other in Marathi and the patients were given either of the sets depending on the language the patient was comfortable in).Every patient satisfying the inclusion criteria was asked to fill up the ODI questionnaire which was then scored to evaluate the patients' functional ability.

Scoring instructions

For each section the total possible score is 5: if the first statement is marked the section score = 0; if the last statement is marked, it = 5. If all 10 sections are completed the score is calculated as follows:

Example: 16 (total scored) x 100=32%
50 (maximum possible score)

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

16 (total scored) x 100 = 35.5%
45 (maximum possible score)

Interpretation of scores

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

B. 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.

C. 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.

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

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

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2) MRI:

Patients suspected of having lumbar canal stenosis on the basis of clinical examination and plain radiographs were investigated for stenosis at the levels of dural sac, lateral recess and foramen with the help of MRI imaging.

1.5 tesla GE healthcare MRI machine was used for doing dedicated lumbar spine MRIs for the patients included in the study.

Assessment of lumbar canal dimensions with the help of MRI:

Once the functional outcome was calculated on the basis of Oswestry disability index, then the stenosis was quantified on the basis of MRI imaging.Quantitative and qualitative image evaluation for LSS was performed. The cross-sectional area of the dural sac was measured on the transverse angled sections through the central part of the disc on conventional MR images.

The dural sac cross-sectional area (DSCSA) was quantitatively calculated by using a measurement program on a MRI imaging machine. The quantitative criteria used for central anatomical LSS were as follows: The DSCSA greater than 100 mm2 was considered normal; 76 to 100 mm2 was considered to be moderately stenotic and less than 76 mm2 was classified as severely stenotic.

Nerve root compromise was subjectively analyzed in the lateral recess and foramina of the selected lumbar intervertebral levels independently by two observers. Nerve root compromise in the lateral recess was graded as follows: Grade 0: no contact of the disc with the nerve root;

Grade 1: contact without deviation;

Grade 2: nerve root deviation;

Grade 3: nerve root compression. Nerve root compression was considered to be present when the root was deformed [15].

Criteria for foraminal qualitative assessment were as follows:

Grade 0: normal foramina with normal dorsolateral border of the intervertebral disk and normal form of the foraminal epidural fat (oval or inverted pear shape);

Grade 1: slight foraminal stenosis and deformity of the epidural fat with the remaining fat still completely surrounding the exiting nerve root;

Grade 2: marked foraminal stenosis and deformity of the epidural fat

with the remaining fat only partially surrounding the exiting nerve root; Grade 3, advanced stenosis with obliteration of the epidural fat. [15,16].

Statistical Analysis

The statistical analysis was done in SPSS-20 software.

Types of data in our study –

a) Numerical: Age
b) Nominal: Sex
c) Ordinal: Severity of ODI, Grades of Dural Sac Stenosis, Grades of Lateral Recess Stenosis, Grades of Foraminal Stenosis

Following tests were applied.

Pearson's Chi Square Test for -

1) Correlation of Age with Severity of ODI
2) Correlation of Sex with Severity of ODI
3) Correlation of Dural Sac Stenosis with Severity of ODI

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4) Correlation of Lateral Recess Stenosis with Severity of ODI
5) Correlation of Foraminal Stenosis with Severity of ODI

In the analysis by Chi Square test, following parameters were calculated:

A) Pearson's Chi Square value – this absolute value (calculated at a confidence interval of 95%) indicated degree of correlation between the severity of ODI and various other parameters
B) P value – <.05 was considered statistically significant. > 0.05 was considered statistically not significant
C) Likelihood Ratio – to know, "how likely" is the correlation among the parameters being compared.

Observations and results

1. On comparison of dural sac stenosis on MRI with the ODI:

Count		**Dural sac stenosis**			**Total**
		Mild	Moderate	Severe	
Severity of ODI	Bedridden	2	0	1	**3**
	Crippled	5	2	1	**8**
	Mild	6	7	3	**16**
	Moderate	7	4	4	**15**
	Severe	12	2	4	**18**
	Total	**32**	**15**	**13**	**60**

Pearson's Chi Square	6.846
P value	0.553 (NS)
Likelihood Ratio	7.603

NS = Not Significant

On statistical analysis after applying Pearson's chi square test to look for association between the level of stenosis at the level of dural sac in the patients evaluated and the ODI, p value was found to be 0.553 which shows that there is no significant statistical correlation for the parameter assessed with the ODI.

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2. On comparison of lateral recess stenosis on MRI with the ODI:

Count		**Lateral recess stenosis**				**Total**
		Grade 0	Grade 1	Grade 2	Grade 3	
Severity of ODI	Bedridden	2	1	0	0	**3**
	Crippled	4	1	2	1	**8**
	Mild	10	5	1	0	**16**
	Moderate	10	3	2	0	**15**
	Severe	9	8	1	0	**18**
	Total	**35**	**18**	**6**	**1**	**60**

Pearson's Chi Square	6.846
P value	0.553 (NS)
Likelihood Ratio	7.603

NS = Not Significant

On statistical analysis after applying Pearson's chi square test to look for association between the level of stenosis at the level of dural sac in the patients evaluated and the ODI, p value was found to be 0.553 which shows that there is no significant statistical correlation for the parameter assessed with the ODI.

3.On comparison of foraminal stenosis on MRI with the ODI:

Count		**Foraminal Stenosis**				**Total**
		Grade 0	**Grade 1**	**Grade 2**	**Grade 3**	
Severity of ODI	Bedridden	1	1	0	1	**3**
	Crippled	3	2	2	1	**8**
	Mild	7	3	3	3	**16**
	Moderate	6	4	5	0	**15**
	Severe	5	7	6	0	**18**
	Total	**22**	**17**	**16**	**5**	**60**

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Table: Comparison of severity of ODI score with Foraminal stenosis

Pearson's Chi Square	10.946
P value	0.534 (NS)
Likelihood Ratio	12.967

NS = Not Significant

On statistical analysis after applying Pearson's chi square test to look for association between the degree of stenosis at the level of foramina in the patients evaluated and the ODI, p value was found to be 0.534 which shows that there is no significant statistical correlation for the parameter assessed with the ODI.

4.Classification on the basis of oswestry disability scores

Classification of patients on the basis of ODI	**NO OF CASES**	**PERCENTAGE**
MILD (0-20%)	16	26.67%
MODERATE (20-40%)	15	25%
SEVERE (40-60%)	18	30%
BEDRIDDEN (60-80%)	8	13.33%
CRIPPLED (80-100%)	3	5%
TOTAL	60	100%

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Correlation between severity of ODI score and other variables

Severity of ODI compared with	**Age**	**Sex**	**Lumbar canal stenosis at the level of dural sac**	**Lateral recess nerve root compromise**	**Foraminal stenosis**
Pearson Chi Square	111.65	0.719	6.85	12.507	10.946
P value	0.597	0.949	0.553	0.40	0.534
Level of significance	NS	NS	NS	NS	NS

NS = Not Significant HS = Highly Significant

Based on the results of our study in comparing the degree of stenosis in MRI findings at the level of dural sac ,lateral recess and foramina with the ODI , the p value was found to be >0.05 for stenosis at all the three levels. A p value of >0.05 implies that there is no significant statistical correlation between the degree of stenosis in MRI and functional outcome for the patient assessed by ODI.

Discussion:

In our study of 60patients, there were 44 (73.3%) females and 16 (26.7%) males.In our study of 60 patients, there were no cases below the age group of 45 years,49 cases (81.67%) between the age group of 45-70 years and 11 cases (18.33%) above the age group of 70 yearsIn our study of 60 patients, maximum involvement was seen at L4-L5 level with 29 cases (48.3%).L5-S1 level was the second most commonly involved level with 19 cases (31.6%).

Rest there were 2 cases (3.3%) at L1-L2 level, 7 cases (11.6%) at L2-L3 level and 3 cases (5%) at L3-L4 levelIn our study of 60 patients, we have classified the patients into mild, moderate and severe grade stenosis on the basis of area of lumbar spinal canal at the level of intervertebral disc corresponding to the dural sac.

If more than one level was involved we have considered the level of maximum stenosis for the measurements. Stenosis was graded into mild, moderate and severe.Area of lumbar spinal canal >100mm^2 was classified as no stenosis.

Area between 76-100 mm^2 was classified as mild stenosis.

Area between 50-75 mm^2 was classified as moderate stenosis.

Area <50 mm^2 was classified as severe stenosis.

Following the above mentioned classification of mild, moderate and severe,

we had 32 patients (53.34%) with mild grade stenosis, 15 patients (25%) with moderate grade stenosis and 14 patients (21.66%) with severe grade stenosis.

We have classified lateral recess stenosis into 4 grades (grade0,1,2,3)

Nerve root compromise in the lateral recess was graded as follows:

Grade 0, no contact of the disc with the nerve root;

Grade 1, contact without deviation;

Grade 2, nerve root deviation;

Grade 3, nerve root compression. Nerve root compression was considered to be present when the root was deformed.[15]

Following the above grading on the basis of MRI findings,in our study we had 35 patients(58.33%) in grade 0,18 patients(30%) with grade 1 ,6 patients(10%) with grade 2 and 1 patient(1.67%) with grade 3 lateral recess stenosis.

Foraminal stenosis was graded as follows:

Criteria for foraminal qualitative assessment were as follows

Grade 0, normal foramina with normal dorsolateral border of the intervertebral disk and normal form of the foraminal epidural fat (oval or inverted pear shape);

Grade 1, slight foraminal stenosis and deformity of the epidural fat with the remaining fat still completely surrounding the exiting nerve root;

Grade 2, marked foraminal stenosis and deformity of the epidural fat with the remaining fat only partially surrounding the exiting nerve root; and

Grade 3, advanced stenosis with obliteration of the epidural fat.[15,16]

Following the above grading with the help of detailed MRI evaluation,

In our study we had 22 patients(36.67%) with grade0, 17 patients(28.33%) with grade1, 16 patients(26.67%) with grade 2and 5 patients(8.33%) with grade 3 foraminal stenosis.

In our study of 60 patients we evaluated MRI findings to look for the no of patients who had nucleus pulposusherniation(ranging from disc bulge, disc protrusion or disc extrusion or a sequestered disc).

And in our study a total of 54 patients(90%) out of 60 had some degree of nucleus pulposus herniation, while only 6 patients(10%) had no evidence of nucleus pulposus herniation.

In our study of 60 patients we evaluated MRI findings to look for the no of patients who had facetalarthropathy. And in our study a total of 41 patients (68.33%) out of 60 had some degree of facetalarthropathy, while 19 patients (31.67%) had no evidence of facetalarthropathy. In our study of 60 patients we evaluated the patients for evidence of spondylolisthesis. In our study out of 60, total of 12 patients (20%) had evidence of spondylolisthesis. 8 patients had spondylolisthesis at the level of L4-L5, 3 had it at the level of L5-S1 and one had it at the level of L2-L3. Also out of these 12 patients with spondylolisthesis, 11 patients had maximum degree of stenosis in lumbar spine at the same level as that of the level of spondylolisthesis. On the basis of the percentage disability score of the ODI, out of the 60 patients, 16 patients(26.67%) demonstrated mild disability; 15 patients(25%) moderate disability, 18 patients(30%)severe disability; 8 patients(13.33%) were crippled and 3 patients(5%)were bedridden.

In conclusion, data collected and analyzed in the current study demonstrate no significant correlation between imaging appearances and levels of disability in patients with LSS. The fact that in some patients the radiological changes were more extensive than expected from the clinical picture and the degree of narrowing did not correspond to the severity of ODI percentage disability further establishes that degenerative LSS is a clinico-radiological syndrome. When evaluating and discussing surgery in patients with this diagnosis, both clinical symptoms and MR imaging are important, especially to determine the levels to be decompressed.

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Conclusion:

Magnetic resonance imaging alone should not be considered in isolation when assessing and treating patients diagnosed with lumbar canal stenosis.

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