A STUDY OF LUMBAR CANAL BY M.R.I. IN CLINICALLY SYMPTOMATIC AND ASYMPTOMATIC SUBJECTS

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ABSTRACT
The study of lumbo sacral canal becomes important in persons with low back ache and other related complaints. The present study "Radiological Evaluation of the Diameters of Vertebral Canal in Lumbosacral Region in Clinically Symptomatic and Asymptomatic Subjects" is aimed to evaluate the clinical relevance of stenosis of spinal canal through MRI. Three parameters of the central canal, i.e., anteroposterior diameter, transverse diameter and cross sectional area are taken into account to ascertain any deviation from normalcy. The study was conducted on 59 subjects including 43 symptomatic and 16 apparently healthy volunteers. The total symptomatic cases were further grouped as stenosed and nonstenosed. 79.0% cases were having stenosis whereas 21.0% cases were nonstenosed. Among 79% of the symptomatic stenosed cases hardly any narrowing of canal was seen at L1 and L2 levels whereas from the L3 level a possibility of narrowing increases as we go down upto S1. A few asymptomatic cases were also found to have narrow canal.

INTRODUCTION
Spinal stenosis is defined as the narrowing of central spinal canal. This stenosis of spinal canal becomes important only when it causes interference with the normal functions of the canal contents (spinal cord/cauda equina, meninges and vessels, etc), leading to clinical manifestations like back ache and leg pain etc. Measurement of the diameters of bony canal represents merely one side of equation, on the other side being the volume of the nervous tissue contents within the canal and the variations that exists between individuals of the same and different racial groups and sexes. Measurement of spinal canal diameter either through radiological studies or surgery or in cadaver spine can act only as a rough guide to the condition.

The fundamental concepts of this abnormality (spinal stenosis) were laid down by Verbiest (1950)[1] who evaluated the size of spinal canal in developmental stenosis for the first time. Epstein et al (1976)[2] gave a much clear classification of spinal stenosis as general, segmental or local.

Obliteration of subarachnoid space at the level of lesion in MRI or CT confirms the diagnosis of canal stenosis. The amount of CSF progressively diminishes as the stenosis increases and the nerve roots become crowded together.

The two main types of spinal stenosis, i.e. developmental and degenerative, are differentiated with the help of both MRI and CT. In developmental type of stenosis, there is typical narrowing in several or all lumbar segments.[3,4]

In contrast to this, degenerative stenosis is typically segmental rather than uniform and stenosis characteristically occurring at the level of disc spaces and articular processes. Between these stenotic segments, the spinal canal and the thecal sac may remain normal in size. This degenerative stenosis is also named as acquired type which primarily is a disease of adulthood with moderate to severe degenerative spine disease.[5,6]

Besides these developmental/congenital and degenerative/acquired types, the spinal canal may show some senile alterations as well. These senile changes are mainly concerned with ligamentum flavum[7,8]

On CT scan, electronic measurement of the sagittal diameter of the normal bony canal are >11.5 mm.[9]

Hamanishi et al (1994) reported that 90% of patients with neurogenic claudication had a cross sectional area of spinal canal <100 mm^2 at two or more levels. They considered double lesion with a cross sectional area below 100 mm2 to be a critical factor for spinal stenosis symptoms.[10]

Sometimes a trefoil shaped canal may be mistaken as a cause of stenosis. In fact, trefoil shaped canal is a common nonpathological condition seen in

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approximately 15% skeleton and is prevalent at L5 level. The trefoil shape of the canal cannot be a cause of stenosis by itself and can only predispose lateral recess stenosis with associated osteophyte and bulging disc.[11,12]

In another study Boden et al (1990) found MR signs of stenosis in 28% of asymptomatic subjects.[13]

Anatomical studies to determine the dimensions of the normal canal lay emphasis on mid sagittal diameter. It is accepted unanimously that a midsagittal diameter >12.5 mm is normal whereas <12 mm is considered as pathological.[14,15,16]

The difference between the normal limit and the point where cauda equina is subjected to compression is very less, therefore these normal individual variations of the canal has a very narrow range. This fact makes the transverse area of the dural sac a more reliable parameter for the diagnosis of central canal stenosis as has been suggested by Jenson et al (1994).[17]

MATERIAL AND METHODS

The present study was carried out in the Department of Anatomy in collaboration with the Department of Radiodiagnosis and NMC Sky Centre, LLRM Medical College, Meerut, during the session 2005-2006.

With a sample size of 59 cases, the study is longitudinal comparative type. All the cases, either symptomatic or asymptomatic, were enrolled randomly coming with the referral from the Neurosurgery and Orthopedic departments to the Radio diagnostic Centre for MRI. Out of total 59 cases, 43 were symptomatic having the complaints suggestive of spinal cord/spinal nerve compression. Rests of the 16 cases were asymptomatic volunteers included in the study for the sake of comparison.

Cases related to trauma, neoplasm, cysts, disc displacement or herniation, soft tissue encroachment and postoperative cases were not included in the study.

All the cases included in the study were between 20 and 70 years without any discrimination of sex.

Apparatus and Technique: The MRI machine of 1.5 Tesla of G.G. Company with LCD projector was used in NMC Sky Centre, LLRM Medical College, Meerut for the study.

Measurement: Vertebral foramina were measured by anteroposterior diameter, transverse diameter and by cross sectional area. All diameters were measured in mm.

Result

Stenosis of spinal canal becomes important only when it results in interference with the normal functions of the contents of canal resulting in low back ache and other related complaints. The present study "Radiological Evaluation of the Diameters of Vertebral Canal in Lumbosacral Region in Clinically Symptomatic and Asymptomatic Subjects" is aimed at to evaluate the clinical relevance of stenosis of spinal canal through the most recent technique MRI.

	Symptomatic Cases (Mean ± S.E.M.)					
	Stenosed Cases			Non-Stenosed Cases		
Level	CSA	APD	TD	CSA	APD	TD
L_1	162.26 ±6.46^{NS}	14.38 ±0.28^{NS}	21.70 ±0.25^{NS}	174.88 ±5.19	15.00 ±0.23	21.33 ±0.28
L_2	156.88 ±6.31^{NS}	14.11 ±0.28^{NS}	21.88 ±0.38^{NS}	167.33 ±6.36	14.66 ±0.28	21.77 ±0.27
L_3	130.73 ±4.83**	12.91 ±0.23**	21.35 ±0.53^{NS}	155.77 ±6.93	14.11 ±0.30	22.44 ±0.37
L_4	118.05 ±5.05**	12.26 ±0.26***	19.76 ±0.52***	142.88 ±5.48	13.55 ±0.25	22.88 ±0.26
L_5	94.85 ±3.78***	11.00 ±0.23***	19.76 ±0.69***	155.55 ±10.52	14.11 ±0.45	26.44 ±0.60
S_1	82.88 ±3.55***	10.26 ±0.22***	21.64 ±0.62***	132.66 ±2.66	13.11 ±0.11	25.44 ±0.44

Table - 1 Diameter of Vertebral Canal in clinically Symptomatic cases.

Asymptomatic Cases (Mean ± S.E.M.)						
	Stenosed Cases			Non-Stenosed Cases		
Level	CSA	APD	TD	CSA	APD	TD
L_1	142.5 ±31.50^{NS}	13.5 ±1.5^{NS}	19.5 ±2.50^{NS}	192.14 ±6.26	15.71 ±0.26	22.42 ±0.38
L_2	142.00 ±12.00^{NS}	13.5 ±0.50^{NS}	21.00 ±3.00^{NS}	180.85 ±6.89	15.21 ±0.29	22.85 ±0.41
L_3	142.00 ±12.00^{NS}	13.5 ±0.50^{NS}	18.5 ±0.50^{NS}	170.42 ±5.94	14.78 ±0.26	23.07 ±0.39
L_4	176.00 ±22.00^{NS}	15.00 ±1.00^{NS}	19.5 ±1.50^{NS}	168.28 ±8.24	14.64 ±0.35	24.5 ±0.47
L_5	102.00 ±9.00^{NS}	11.5 ±0.50^{NS}	17.00 ±2.00^{NS}	146.57 ±5.54	13.71 ±0.24	26.85 ±0.55
S_1	93.00 ±0.00^{NS}	11.00 ±0.00^{NS}	18.00 ±3.00^{NS}	135.14 ±2.73	13.28 ±0.12	25.64 ±0.57

Table -2 Diameter of Vertebral Canal in clinically Asymptomatic cases.

Mean ± S.E.M.						
	Symptomatic Stenosed Cases			Asymptomatic Stenosed Cases		
Level	CSA	APD	TD	CSA	APD	TD
L_1	162.26 ±6.46^{NS}	14.38 ±0.28^{NS}	21.70 ±0.25^{NS}	142.5 ±31.50	13.5 ±1.5	19.5 ±2.50
L_2	156.88 ±6.31^{NS}	14.11 ±0.28^{NS}	21.88 ±0.38^{NS}	142.00 ±12.00	13.5 ±0.50	21.00 ±3.00
L_3	130.73 ±4.83^{NS}	12.91 ±0.23^{NS}	21.35 ±0.53**	142.00 ±12.00	13.5 ±0.50	18.5 ±0.50
L_4	118.05 ±5.05^{NS}	12.26 ±0.26^{NS}	19.76 ±0.52^{NS}	176.00 ±22.00	15.00 ±1.00	19.5 ±1.50
L_5	94.85 ±3.78^{NS}	11.00 ±0.23^{NS}	19.76 ±0.69^{NS}	102.00 ±9.00	11.5 ±0.50	17.00 ±2.00
S_1	82.88 ±3.55^{NS}	10.26 ±0.22^{NS}	21.64 ±0.62^{NS}	93.00 ±0.00	11.00 ±0.00	18.00 ±3.00

Table -3 Diameter of Vertebral Canal in clinically Symptomatic and Asymptomatic Stenosed cases

	Mean ± S.E.M.					
	Symptomatic Non-Stenosed Cases			Asymptomatic Non-Stenosed Cases		
Level	CSA	APD	TD	CSA	APD	TD
L_1	174.88 ±5.19*	15.00 ±0.23*	21.33 ±0.28*	192.14 ±6.26	15.71 ±0.26	22.42 ±0.38
L_2	167.33 ±6.36^{NS}	14.66 ±0.28^{NS}	21.77 ±0.27*	180.85 ±6.89	15.21 ±0.29	22.85 ±0.41
L_3	155.77 ±6.93^{NS}	14.11 ±0.30^{NS}	22.44 ±0.37^{NS}	170.42 ±5.94	14.78 ±0.26	23.07 ±0.39
L_4	142.88 ±5.48**	13.55 ±0.25*	22.88 ±0.26**	168.28 ±8.24	14.64 ±0.35	24.5 ±0.47
L_5	155.55 ±10.52^{NS}	14.11 ±0.45^{NS}	26.44 ±0.60^{NS}	146.57 ±5.54	13.71 ±0.24	26.85 ±0.55
S_1	132.66 ±2.66^{NS}	13.11 ±0.11^{NS}	25.44 ±0.44^{NS}	135.14 ±2.73	13.28 ±0.12	25.64 ±0.57

Table-4 Diameter of Vertebral Canal in clinically Symptomatic and Asymptomatic Non-Stenosed cases.

CSA = Cross Sectional Area (mm2)
APD = Antero-Posterior Diameter (mm)
TD = Transverse Diameter (mm)
Significance = * mild, ** Moderate, *** Highly significant; NS nonsignificant; SEM Standard error of mean

Age Groups (Years)	Symptomatic Cases					Asymptomatic Cases				
	Stenosed		Nonstenosed		Total	Stenosed		Nonstenosed		Total
	M	F	M	F		M	F	M	F	
20-36	1	–	–	2	3	–	2	1	1	4
37-53	6	8	4	1	19	–	–	3	3	6
54-70	14	5	2	–	21	–	–	4	2	6
	21 (49.0)	13 (30.0)	6 (14.0)	3 (7.0)	43	–	2 (12.5)	8 (50.0)	6 (37.5)	16

Table- 5 Age and Sex Distribution of Symptomatic and Asymptomatic Cases

(Figures in parenthesis show percentage)

Three parameters of the central canal, i.e., anteroposterior diameter, transverse diameter and cross sectional area are taken into account to ascertain any deviation from normalcy. The study was conducted on 59 cases including 43 symptomatic and 16 apparently healthy volunteers.

Out of the total 43 symptomatic cases, backache alone was present in 14 (32.5%) cases, unilateral leg pain was present in 12 (28.0%) cases, bilateral leg pain was present in 6 (14.050 cases. 11 (25.6%) cases were having backache along with leg pain and leg weakness.

Measurements of each case at different level from L1-S1 vertebral level were noted in the master chart. The data was statistically analysed using unpaired't' test with Welch correction. For the sake of feasibility, the whole data was tabulated in 4 different tables. Table 1 depicts the diameter of vertebral canal in clinically symptomatic cases. Table 2 is concerned with the diameter of the vertebral canal in clinically asymptomatic cases. Table 3 is related with the diameter of vertebral canal in clinically symptomatic and asymptomatic stenosed cases. Table 4 is about the diameter of vertebral canal in clinically symptomatic and asymptomatic nonstenosed cases. The data is represented as mean ± S.E.M. A probability 'p' value of less than 5% is considered as statistically significant.

Out of the 43 (73%) symptomatic cases, 34 (79%) cases were found to have narrow canal whereas 9 (21%) cases were having normal diameters of the spinal canal.

Among 34 (79%) symptomatic stenosed cases, stenosis at L1 level was seen in 6 (14%) cases, at L2 level, stenosis was seen in 5 (11.6%) cases, at L3 level, stenosis was seen in 14 (32.5%) cases and at L4 level, stenosis was seen in 18 (41.8%) cases. At L5 level stenosis was seen in 29 (67.4%) cases whereas at S1 level, stenosis was recorded in 30 (69.7%) cases.

Generalized stenosis was seen in 2 cases (4.6%), multiple segment involvement in 20 cases (40.6%), multiple level involvement in 11 (25.6%), and single segment involvement in 1 (2.32%).

The above mentioned data shows that there is hardly (only in 5-6 cases) any narrowing at L1 and L2 levels whereas from the level L3 the possibility of narrowing increases as we goes downwards up to S1.

Out of the total 16 asymptomatic cases, two cases are showing narrow canal whereas rest of the 14 cases are having normal canal diameters. Among the two cases of narrow canal, narrowing in one case is seen at L1, L5 and S1 levels while the other one case shows narrowing at L5 and S1 levels.

The total symptomatic cases were further grouped as stenosed and nonstenosed. 34 (79.0%) cases were having stenosis whereas 9 (21.0%) cases were nonstenosed. Among the stenosed cases, 12 (49.0%) cases were male and 13 (30.0%) cases were female. Similarly in nonstenosed cases, the number of male cases was 6 (14.0%) and 3 (7.0%) cases were female.

Asymptomatic (16) cases were also grouped as stenosed and nonstenosed. Only 2 (12.5%) cases were found to have stenosis and both of them were females.

All the cases were also grouped according to age in three slabs as 20-36 years, 37-53 years and 54-70 years. Out of the total 43 symptomatic cases, 3 cases were in the age group 20-36 years, 19 cases were in the age group 37-53 years and 21 cases were in the

age group 54-70 years.
Similarly, out of 16 asymptomatic cases, 4 were in the age group 20-30 years, 6 cases were in the age group 37-53 years and 6 cases belonged to the age group 54-70 years, as given in table-5.

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