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Magnetic Resonance Imaging Findings in Lumbar Disc Degeneration in Symptomatic Patients

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ABSTRACT

Background: The sequel of disc degeneration is one of the leading causes of functional incapacity that leads to chronic disability. The study aims to evaluate the MRI findings of degenerative changes in symptomatic patients.

Methods: The study was a retrospective study for the duration of 3 years. Symptomatic patients undergoing MRI of LS spine were included in the study. Patients undergoing MRI for neurological symptoms alone and acute trauma or suspected infection or tumor were excluded from the study. MRI of patients was evaluated for degenerative changes and their sequel. Data was entered in a predesigned proforma and analysis was done with SPSS version 19.0.

Results: A total of 2037 MRIs of LS spine of symptomatic patients were included in the study. Degenerative changes were demonstrated in 1906 (93.8 %) patients, which comprised 1039 (54.5 %) males and 867 (45.4 %) females. Disc bulge along with disc desiccation was the most common degenerative findings noted in 1667 (81.8 %). Disc herniation was seen in 1032(50.6%), neural foraminal stenosis in 1220 (59.8 %), central spinal canal in 1136 (55.8%) and nerve root compression in 650 (31.9%). Disc bulge, neural foraminal stenosis, central spinal canal stenosis was significantly more common in patients older than 40 years. Disc herniation was however significantly more frequent in patients younger than 40 years.

Conclusions: Degenerative changes are common in symptomatic patients and increase in frequency with aging. Disc herniation is however more common in younger patients.

Keywords: Degenerative Disc Disease, Disc herniation, MRI, Nerve root compression

INTRODUCTION

Low back pain is a problem faced by a wide variety of people throughout the world.[1, 2]The most frequent cause of this problem is disc degeneration of spine. Degeneration of the spine is the most prevalent cause of disability in the adult working population. This is the most common infirmities in life and it usually results in profuse medical spending. [3, 4]

Various imaging modalities are used for back pain, starting from basic imaging techniques such as plain X-ray and myelography. With advances in cross sectional imaging CT (Computerized Tomography) scanning and CT myelography (CT scanning with intrathecal contrast) were used for evaluation. Magnetic Resonance Imaging (MRI) proved to be a more sensitive modality to evaluate the causes of backache and radiculopathy and soon became the imaging modality of choice. It is noninvasive diagnostic tool with no risk involvement of ionizing radiation and excellent soft tissue contrast between disc soft tissue and neural elements.[5, 6]

Intervertebral discs consist of an inner nucleus pulposus and outer annulus fibrosus and it is one of the largest avascular tissues in the body.The disc's ability to resist compression as well as anterior and lateral shears has enabled it to be the most important load bearing component of the spine, which is also assisted by the facet joint.[7]

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Degenerated disc is a spectrum of pathologies like disc bulge, disc herniation, central spinal canal and neural foraminal stenosis, facet joint arthropathy or a combination of these.[8] Normal axial loading on the spine stretches and lengthens the annular fibres resulting in bulge of the disc beyond the margin of the vertebral body. There may be annular tears where the nucleus pulposus gradually protrudes into the lumbar spinal canal, producing disc herniation. Neural foraminal stenosis occurs due to various causes in the spine such as disc bulge, disc herniation and ligamentum flavuor facetal joint hypertrophy.[9]

This study was undertaken to evaluate MRI findings in disc degeneration of lumbosacral spine in symptomatic Nepalese patients.

METHODS

The study was a retrospective cross sectional study conducted among symptomatic patients who underwent MRI of Lumbosacral spine at Kathmandu Imaging in Kathmandu, Nepal. The duration of the study was three years, from May 2010 to May 2013. All the patients who presented with symptoms of back pain or numbness or pain radiating to lower limbs up to buttock, knee or foot and underwent MRI of lumbosacral spine were included in the study.

MR images were acquired by 0.35 Tesla Siemens MRI machine (Magnetom C). The MRI images of the symptomatic patients were obtained by medium and large sized body coil with read matrix of 256. Images were acquired in sagittal plane in T1 weighted spin echo (Repetition time (TR)/ Echo time (TE) -400/12) and T2 weighted spin echo (TR/TE -4240/136) with slice thickness of 5 mm; gap of 20% of slice thickness and FOV of 320 mm. Images were also obtained in axial plane in T1 weighted spin echo (TR/TE - 578/ 13) and T2 weighted spin echo (TR/TE - 5610/131) with slice thickness of 5 mm; slice gap of 10 % of slice thickness and FOV of 230 mm. Coronal images and Short Tau Inversion Recovery (STIR) sequences were acquired in some cases for further evaluation.

Three radiologists, one of them with more than 10 years experience in Spine MRI, reported the MRI images with mutual consensus in disputed issues.

The nomenclatures for disc changes were adopted in accordance to the recommendation of the Combined Task Forces of the North American Spine Society, American Society of Spine Radiology, and American Society of Neuroradiology.[10] The imaging findings were recorded and plotted in SPSS data sheet and statistical analysis was obtained from SPSS version 19.

RESULTS

A total of 2037 MRIs of LS spine of symptomatic patients were included in the study. The age of the patients range from 11 to 94 years and the mean was 44.66 years. The maximum number of patients was in 41-50 years age group (23.5 %). More than 80 % of patients were in 21-60 years age group as represented in Figure 1. Out of the total patients of 2037, 1118 (54.9 %) were male and 919 (45.1 %) were female.

Degenerative changes were demonstrated in 1906 (93.8 %) patients, non-degenerative pathologies were seen in 183 (8.98%) patients and 80 (3.93%) MRIs were normal. Degenerative changes were demonstrated in 1039/1118 (92.9%) MRIs in male patients and 867/919 (94.34%) MRIs in female patients.

Disc bulge along with disc desiccation was the most common degenerative findings noted in 1667 (81.8 %) patients. The most common level of disc bulge was L4-L5 (1319; 64.75%) followed by L5-S1 (969; 45.57%). Disc bulge was most commonly seen in 41- 50 yrs age group (400/1667; 24.0%) followed closely by 31-40 yrs (382/1667; 22.91%) and 41-50 yrs age group (304/1667; 18.24%) as shown in Table 1. Global disc bulge was seen slightly more frequently in males (910; 54.5 %) than in females (757; 45.4 %), however the difference was not statistically significant as shown in Table 2. Disc bulge was note at multiple levels in 1117 (54.8%) and single level in 550 (27.0%) patients. Disc bulge was noted more frequently in patients more than of 40 years and above compared to younger patients which was significant at $P<0.05$ with OR of 1.12. (Table 3). Involvement of multiple level was also more frequent in older patients as compared to those of less than 40 years of age which was significant at $P<0.05$ with OR of 1.24.

Table 1. Distribution of Disc bulge according to age groups and levels.

	11-20	21-30	31-40	41-50	51-60	61-70	71-80	80+	Total
L1-L2	0	5	15	23	33	36	18	6	136
L2-L3	3	11	27	57	68	62	33	6	267
L3-L4	12	61	116	171	149	99	48	9	665
L4-L5	34	203	292	315	239	151	70	15	1319
L5-S1	30	144	213	224	180	111	58	9	969
Total	**41**	**255**	**382**	**400**	**304**	**185**	**82**	**18**	**1667**

Disc herniation was seen in 1032 (50.6%) patients. Disc herniation at single level was seen in 845 (81.8 %) patients and multiple level (more than one) in 187 (18.1 %) patients. Disc herniation was most common in L5-S1

(583; 28.62%) followed by L4-L5 level (547; 26.85%). Disc herniation was most common in 31 to 40 years age group with a total of 282 (27.3 %) patients followed by 41-50 years (25.1 %) and 21-30 (17.6 %) years age group as shown in Table 4. Paramedian disc herniation was seen in 51.45% patients among which right paramedian herniation was seen in 26.2% and left paramedian disc herniation was seen in 25.2% cases. Central disc herniation was seen in 48.5% cases.(Table 5) There was higher association of disc herniation in male (X^2 - 18.72; p<0.001) with odd's ratio of 1.21 as shown in Table 2. Also disc herniation was noted to occur more frequently in patients younger than 40 years as compared to those 40 years and above with Odd's ratio of 1.16 as shown in Table 3.

Table 2. MRI findings according to sex.

Findings	Male N=1118	Female N=919	p-value
Disc bulge	910 (81.39)	757 (82.3)	x^2- 0.324; p-0.57
Disc herniation	615 (55.01)	417 (45.39)	x^2 - 18.72; p<0.001 OR -1.21 (CI-1.11-1.32)
Neural foraminal stenosis	668 (59.74)	552 (60.01)	x^2 - 0.02; p-0.88
Central spinal canal stenosis	656 (58.7)	480 (52.23)	x^2 - 8.49; p-0.004 OR-1.12 (CI-1.04-1.21)
Nerve root compression	412 (36.85)	238 (25.90)	x^2 - 27.85; p<0.001 OR-1.42 (CI-1.24-1.62)

***OR-ODD's Ratio**

Out of the total, 1220 (59.8 %) patients had neural foraminal stenosis among whom 54.7 % were male and 45.2 % patients were female as shown in Table 1 and Table 2. The foraminal stenosis was most common at the level of L4-L5 (51.8 %), which was followed by at L5-S1 level (28.9 %). Neural foraminal stenosis was noted at single level in 605 (29.7%) patients and at multiple levels in 615 (30.2%) patients. Severe neural foraminal stenosis was however noted only in 58 (2.8%) patients. The foraminal stenosis as well as severe neural foraminal stenosis was seen more frequently in patients 40 years and above as with other degenerative changes as shown in Table 3.

Table 3. Distribution of various degenerative disc pathologies above and below 40 years of age.

Findings	Less than 40 years N=887	More than and equal to 40 years N=1150	Significance
Disc bulge	678 (76.4)	989 (86.0)	x^2 -30.8; p<0.001 OR-1.12(CI-1.07-1.17)
Disc herniation	487 (54.9)	545 (47.4)	x^2 -11.30; p=0.001 OR-1.16(CI-1.06-1.26)*
Neural foraminal stenosis	398 (44.9)	822 (71.5)	x2 -147.59; p<0.001 OR-1.59(CI-1.47-1.73)
Central spinal canal stenosis	460 (51.9)	676 (58.8)	x2 -9.73; p=0.002 OR-1.13(CI-1.05-1.23)
Nerve root compression	299 (33.7)	351 (30.5)	x2 -2.34; p<0.13

OR-Odd's Ratio. *-more frequent in younger than 40 years with OR for age less than 40-1.16

Central spinal canal stenosis was noted in 1136(55.8%) patients. Central canal stenosis was noted at single level in 814 (40.0%) patients and at multiple levels in 322 (15.8%) patients. Central canal stenosis was noted more frequently in males as compared to females which was statistically significant at P<0.05 with OR of 1.12. (Table 2) Stenosis was most frequently observed at L4-L5 level (697; 34.2%) followed by L5-S1 level (575; 28.2%). The occcurence of central spinal canal stenosis was also noted to be more frequent in patients 40 years and above similar to other degenerative changes as shown in Table 3.

Table 4.Disc herniation according to age group and level.

Level Age group	Total patients with herniation (%)	L1-L2	L2-L3	L3-L4	L4-L5	L5-S1
11-20	23 (2.2)	0	2	1	15	10
21-30	182 (17.6)	1	0	10	102	98
31-40	282 (27.3)	2	1	13	146	180
41-50	260 (25.1)	7	7	13	132	157
51-60	175 (16.9)	1	3	19	93	86
61-70	72 (6.9)	1	1	11	41	39
71-80	30 (2.9)	2	2	7	13	11
80+	8 (0.7)	0	0	1	5	2
Total	**1032**	**14**	**16**	**75**	**547**	**583**

Nerve root compression was noted in 650 (31.9%) cases. The root compression was noted at single level in 599 (29.4%) cases and involving two levels in 51 (2.5%) cases. The most common root compressed was S1 traversing nerve root at L5-S1 level in 383 (18.8%) patients followed by L5 nerve root at L4-L5 level 288 (14.1%) cases. Nerve root compression was noted more frequently in male patients as compared to female patients, which was statistically significant at P<0.05 with odd's ratio of 1.4. The compression was also significantly associated with disc herniation with x^2 - 839.19; p-<0.001 and odd's ratio of 38.58 (CI- 23.68-62.89) No significant difference of nerve root compression was noted between younger and

older patients as shown in Table 3.

Table 5.Levels and site of disc herniation

Disc protrusion	L1-L2	L2-L3	L3-L4	L4-L5	L5-S1	Total	Percent
C (Central)	10	8	46	331	322	717	48.5 %
RPM (Right paramedian)	3	7	23	163	191	387	26.2 %
LPM (Left paramedian)	3	1	18	158	192	372	25.2 %
Total	**16**	**16**	**87**	**652**	**705**	**1476**	

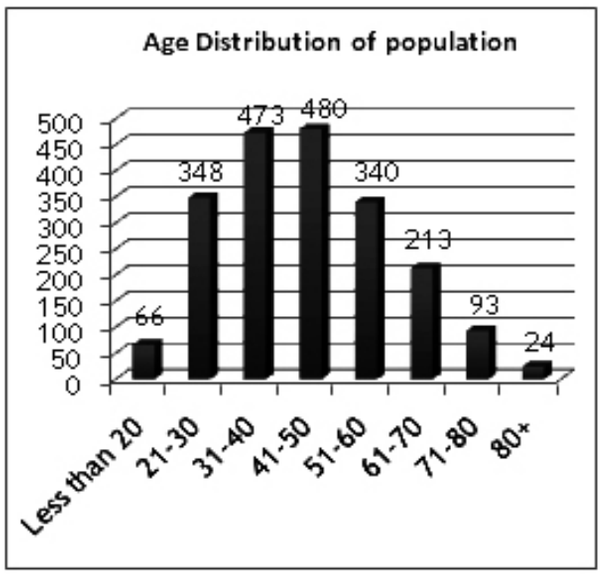

Figure 1. Distribution of age group

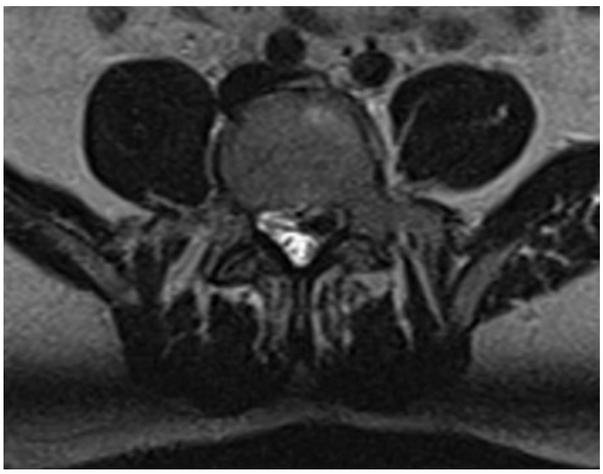

Figure 2. MRI Lumbar Spine T2 Axial

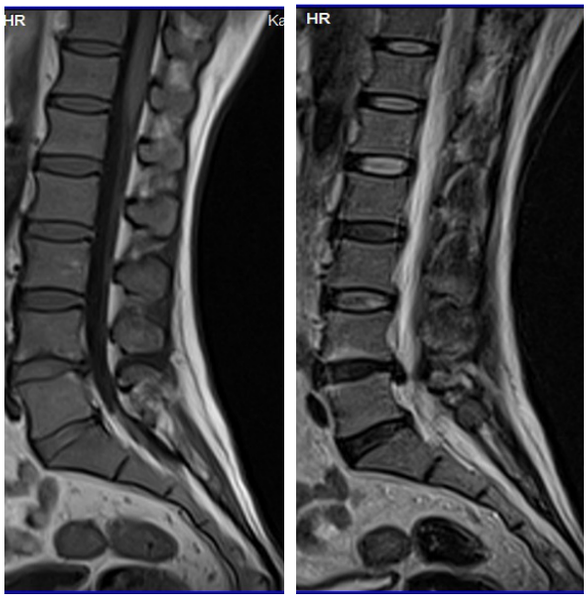

Figure 3. MRI Lumbar Spine T1 and T2 Sagittal

Figure 4. MRI Lumbar Spine T1 Axial

DISCUSSION

The sequel of disc degeneration is one of the leading causes of functional incapacity that leads to chronic disability as well.[11] Disc degeneration is almost universal in adult population with aging. MRI has been applied for the evaluation of spinal anatomy and its various pathologic conditions from 1980s and is currently the gold standard to study the relationship between disc material soft tissue and neural elements.[5, 6] MRI in our study was performed using a low field strength MRI (0.35 Tesla) which is however shown equally reliable as high field MRI machines and capable of demonstrating the features of lumbar disc degeneration along with nerve root compression.[12]

The study population demonstrated slightly higher

proportion of male patients, which might be due to the higher risk of disc degeneration in males as has been reported in previous studies.[13, 14] The higher proportion of males may also indicate health-seeking practice in our country where male dominance is prevalent.

Degenerative changes assessed in our study were disc desiccation with disc bulge, disc herniation, spinal stenosis including central canal stenosis and neural foraminal stenosis and nerve root compression. The most prevalent finding was disc desiccation change with disc bulge. Disc bulge though is the diffuse bulging of the annulus beyond the disc space is not considered as herniation and is also part of degenerative changes.[10] Disc bulge was seen more prevalent in older patients however there was no significant sex difference. The findings are consistent with the increasing prevalence of degenerative changes with age, which has been established by several previous studies.[6, 13, 15] Disc bulge was most prevalent at L5-S1 and L4-L5 levels; these are the levels where degeneration occurs most commonly and the earliest.[11, 15, 16]

Herniation was noted in 50% of the patients in our study. Also disc herniation was significantly more common in male as compared to female. Disc herniation has been implicated as one of the most common degenerative changes in back pain and radiculopathy.[6] The sex difference is supported by previous studies, which has established males to be more prone for degenerative changes as compared to females probably related to increased mechanical stress and injury.[13, 14, 17]In this study, disc herniation was noted significantly more frequently in younger patients than those above 40 years of age. Saleem et at.(2013) established that mean age of disc herniation was also less than the mean age for degeneration.[13] The findings are however contrary to previous reports which reported an increase in prevalence of disc herniation with aging.[18]Multiple level involvement of disc herniation was uncommon and was seen only in 18.1% which is however higher than that noted by Saeid Abrishamkar et al who reported the prevalence of 9%.[19]

Sequela of disc degenerations, which might directly cause symptoms like neural foraminal stenosis, nerve root compression and central spinal canal stenosis were fairly common with neural forminal stenosis being the commonest followed by central canal stenosis and nerve root compression. Neural foraminal stenosis and central canal stenosis were seen to increase with age however nerve root compression did not show significant difference between the two age groups. The increase in neural foraminal stenosis and central canal stenosis with age probably represents changes of age related degeneration in lumbar spine. However nerve root compression was significantly associated with disc herniation. Radicular pain in disc herniation is associated with nerve root compression and inflammatory change, which explains the association of nerve root compression with disc herniation.[6]Herniated disc are also the most common cause of nerve root compression.[20] Nerve root compression was also noted to be more frequent in males that probably related to increased disc herniation in males in our study. Nerve root compression in lumbar spine is most common at the level of disc at the lateral recess which involves the nerve root of spinal nerve.[21] The commonest nerve roots compressed in our study were S1 traversing and L5 traversing nerve roots, which is probably, related to high incidence of L5-S1 and L4-L5 disc herniation in our study and which is also shown to be the most common levels involved in disc degeneration and herniation in other studies.[9, 13, 19] The longer oblique course of lower lumbar nerve roots also make them more susceptible to the effect of pedicular kinking and foraminal stenosis.[22]

Degenerative changes in disc, disc herniation, neural foraminal narrowing, central spinal canal stenosis and nerve root compression has all been reported as being present in even in asymptomatic patients so their significance and association with pain and radiculopathy is controversial.[6, 11]

CONCLUSION

This study had certain limitations. It includes symptomatic patients who came for MRI in the imaging centre and may not represent general population. Direct correlation of clinical symptoms i.e. radiculopathy with MRI findings was not performed in our study.

This study however established a baseline of morphological changes in patients with low back pain in various age groups. In this study, degenerative changes including disc bulge, neural foraminal stenosis and central spinal canal stenosis were seen to increase with age while disc protrusion and nerve root compression were noted to be commoner in younger patients.

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