Section: Radiodiagnosis

Research

LUMBO-SACRAL DISC DEGENERATIVE DISEASE AND LUMBAR SAGITTAL ALIGNMENT: ARE THEY ASSOCIATED IN INDIAN PATIENTS WITH CHRONIC LOW BACKACHE?

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Abstract

Background: Chronic low back pain affects 60-80% of the population wherein a specific underlying cause is unknown. It is attributed to sedentary lifestyle and reduced physical activity leading to obesity which is associated with lumbar disc herniation. Therefore, it is imminent to know etiological factors and its treatment at early stage. The aim and objective is to determine the correlation between the grades of lumbo-sacral disc degenerative disease and lumbar sagittal alignment in patients with chronic low backache using MRI. **Materials and Methods:** A prospective observational study conducted in Kempegowda institute of medical sciences with a study population of 500 patients with chronic low back pain for more than 3 months. All patients who met inclusion criteria underwent plain MR LS spine imaging with GE signa 1.5 tesla MR machine. Lumbar intervertebral disc degeneration was graded according to the Pfirrmann classification using T2 sequence on MRI sagittal plane. For the evaluation of the lumbar sagittal alignment, Cobb's angle and Global lumbo-sacral angles, sagittal T2-weighted slices were used. **Result:** A prospective observational study conducted in Kempegowda institute of medical sciences with a study population of 500 patients with chronic low back pain for more than 3 months. All patients who met inclusion criteria underwent plain MR LS spine imaging with GE signa 1.5 tesla MR machine. Lumbar intervertebral disc degeneration was graded according to the Pfirrmann classification using T2 sequence on MRI sagittal plane. For the evaluation of the lumbar sagittal alignment, Cobb's angle and Global lumbo-sacral angles, sagittal T2-weighted slices were used. **Conclusion:** Patients with intervertebral disc lesions seem to have more straightened lumbosacral profiles, but it hasn't been proven yet which comes first: disc degeneration or changes in sagittal alignment. Finding an answer to these demands more comprehensive prospective studies.

INTRODUCTION

Low back pain is a symptom, not a disease. It is the most common symptom, affecting 80% of the population during their lifetime.[1] Most commonly, elderly patients aged more than 60 years are more prone for low backache. Low back pain is a recurrent syndrome and no more considered a self-limiting symptom.[2,3,4] Deterioration of the mechanical and chemical properties of the disc results in lumbar disc degeneration which is caused by universal phenomenon of aging process and aggravated environmental factors like trauma, high impact activity, type of work and smoking.[5]

The functional and clinical importance of lumbar lordosis is being recognized increasingly.[6,7] Loss of normal lordotic alignment may induce pathologic changes in the spine from load bearing, and thereby accelerate degeneration of the functional motion units.[8] Consequently, the analysis of sagittal balance seems to be essential in the management of lumbar degenerative pathologies.[9] Clinicians have described different ways to evaluate lumbar

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lordosis, with the Cobb's method being the most prevalent.

Abnormal spinal sagittal alignment can be the cause of persistent chronic low back pain (LBP); the association of acute LBP with hyperlordosis, and the relationship of chronic LBP with hypolordosis have been demonstrated.[10,11]

In contrast to numerous discussions regarding the relationship between lordosis and LBP, only a few controlled studies have assessed the correlation of lumbar sagittal alignment to degenerative disc disease (DDD) / disc herniation (DH).[10]

Zohreh Habibi et al., compared the sagittal alignment of lumbosacral regions in two groups of chronic low back pain patients, one was with intervertebral disc pathologies and one without, to evaluate the correlation between lumbosacral sagittal alignment and disc degenerative disease. The objective of the study is to assess the correlation of lumbosacral sagittal alignment (using Global lumbo-sacral angle and Cobb's method) with disc degeneration, in young patients suffering from chronic LBP.[12,13,14]

MATERIALS AND METHODS

It was a prospective observational study conducted in Kempegowda institute of medical sciences, Bengaluru, from September 2021 to February 2022 with a study population of 500 patients.

Inclusion and Exclusion Criteria

Patients aged between 18-40 years with history of chronic low back pain (defined as back pain lasting for more than 3 months), were included in the study. Patients above 40 years, with spinal fractures, spinal cord injuries, spinal infections, spinal tumors, previous lumbo- sacral surgery and patients who were contraindicated for MRI were excluded from the study.

All patients underwent MR imaging protocols for lumbosacral with GE SIGNA 16 CHANNEL 1.5 TESLA. All the MRIs were reported by a single radiologist with a 12 years experience.

L4/L5 and L5/S1 vertebral spaces were evaluated. Lumbar intervertebral disc degeneration was graded according to the Pfirrmann classification using T2 sequence in the sagittal plane.[15,16]

Cobb's method: Lumbar lordotic angle was measured between the lines drawn along superior endplate of L1 and inferior end plate of L5 [Figure 1A].

The global lumbosacral angle (LS angle) was defined as an angle between the tangent lines passing through the anterior bodies of L1 and S1 [Figure 1B]. Avoiding pointed edges/ marginal osteophytes, the tangent lines were passed through the smooth middle portion of the anterior walls.

The measurements were performed twice using AutoCAD software (version 2012) by single author (F.M.) and then rechecked using random selection by another author (Z.H.). The inter-observer and intra-observer validity was checked, and an average of three records of each measurement were used for statistical analysis to minimize random error.

Pfirrmann Grading System[15,16]

- **Grade I:** The structure of the disc is homogeneous, with a bright hyperintense white signal intensity and a normal disc height. [Figure 2A].
- **Grade II:** The structure of the disc is inhomogeneous, with a hyperintense white signal. The distinction between nucleus and annulus is clear and normal disc height, with or without horizontal gray bands. [Figure 2B].
- **Grade III:** The structure of the disc is inhomogeneous, with intermediate gray signal intensity. The distinction between nucleus and annulus is unclear, and normal or slightly decreased disc height. [Figure 2C]
- **Grade IV:** The structure of the disc is inhomogeneous, with an hypointense dark gray signal intensity. The distinction between nucleus and annulus is lost, and normal or moderately decreased disc height. [Figure 2D].
- **Grade V:** Inhomogeneous structure of the disc, with a hypointense black signal intensity. The distinction between nucleus and annulus is lost and collapsed disc space. [Figure 2E]

Statistical Analysis

Pearson Chi Square tests was used to find the association between varying grades of disc degeneration and sagittal alignment at L4-L5 and L5-S1 levels. The level of significance [P-Value] was set at $P<0.05$.

Statistical Package for Social Sciences [SPSS] for Windows, Version 22.0. Released 2013. Armonk, NY: IBM Corp. was used to perform statistical analyses.

RESULTS

Fifty symptomatic patients were included in the study, out of which 74.4% (360) were males and 25.9% (140) were females. 18.5% (100) of the patients were below 25 years of age, 55.6% (300) between 26-30 years and 40% (100) were between 30-40 years of age. Mean age group was 33.

Table 1: Pfirmann Grading at L4-L5 Based on COBB'S Angle

		COBB'S ANGLE		ANOVA test
		Mean	Standard Deviation	
Pfirmann Grading at L4-L5	1	26	8	F=0.935 P=0.431
	2	29	9	
	3	31	13	
	4	26	11	

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Table 2: PFIRMANN GRADING at L5-S1 Based on COBB'S Angle.

		COBB'S ANGLE		ANOVA test
		Mean	Standard Deviation	
PFIRMANN GRADING L5-S1	1	27	8	F=0.171 P=0.952
	2	31	14	
	3	28	12	
	4	28	10	
	5	29	9	

Table 3: PFIRMANN GRADING at L4-L5 Based on Global LS angle

		GLOBAL LS ANGLE		ANOVA test
		Mean	Standard Deviation	
PFIRMANN GRADING L4-5	1	46	8	F=0.479 P=0.698
	2	49	8	
	3	49	10	
	4	51	8	

Table 4: PFIRMANN GRADING at L5-S1 Based on GLOBAL LS ANGLE

		GLOBAL LS ANGLE		ANOVA test
		Mean	Standard Deviation	
PFIRMANN GRADING L5-S1	1	51	8	F=0.384 P=0.819
	2	47	12	
	3	48	10	
	4	49	7	
	5	51	4	

Figure 1: Sagittal T2 weighted image of LS spine shows Cobb's angle: 22 and Global LS angle: 56 with Pfirmann grading at L4-5: 4; Pfirmann grading at L5-S1: 3

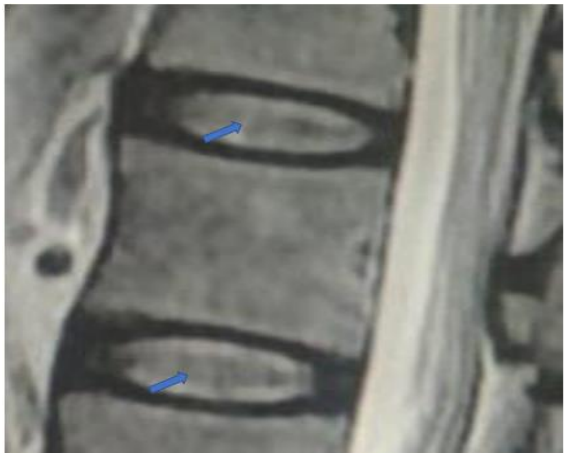

Figure 2A: Grade I (disc is homogeneous, with a bright hyperintense white signal intensity)

Nearly 36 % and 33% of the L4-L5 discs showed degeneration corresponding to Pfirrmann grade II in females and males respectively.

Nearly 35.7 % and 30% of the of L5-S1 discs showed degeneration corresponding to Pfirrmann grade I and IV in females and Pfirrmann grade III and IV in males respectively.

Most of the subjects presented with Grade III lumbar disc degeneration at L4/L5and Grade III lumbar disc degeneration at L5/S1regions.

Mean lumbar lordosis [Cobb Angle] values (± SD) for men and women were: 27 (± 10) and 33 (± 12.00) respectively. Similarly in our study, mean lumbar lordosis [Global LS Angle] values (± SD) for men and women were: 50 (± 8) and 46 (± 12.00) respectively. Therefore, the cases could be directly compared across sex.

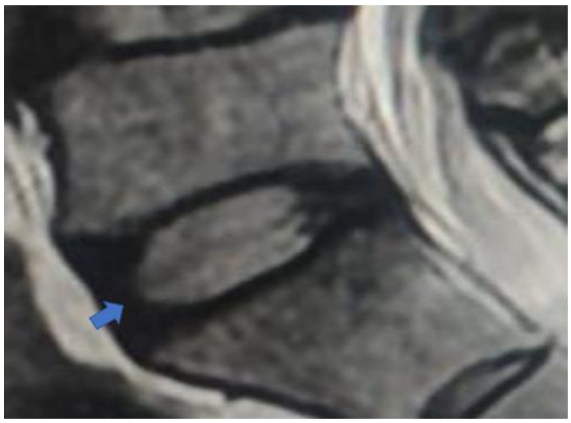

Figure 2B: Grade II (distinction between nucleus and annulus is clear and normal disc height)

A statistically insignificant difference with regard to the angles of lumbar lordosis was determined between individuals with Cobb's angle (28.6°±10.6)

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and inter-vertebral disc degeneration (26.94±11° with p=0.007)- [Table 1,2].

The mean global lumbo-sacral angle was between 32° and 70° (49.2°±8.2°) in subject group which was statistically significant (p=0.002)- [Table 3,4].

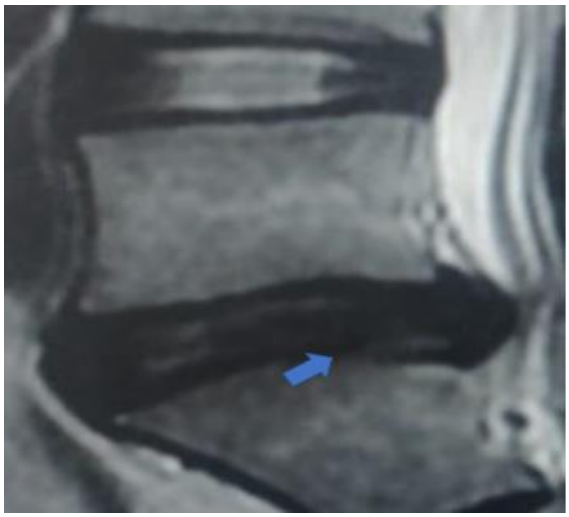

Figure 2C: Grade III (disc is inhomogeneous, with intermediate gray signal intensity)

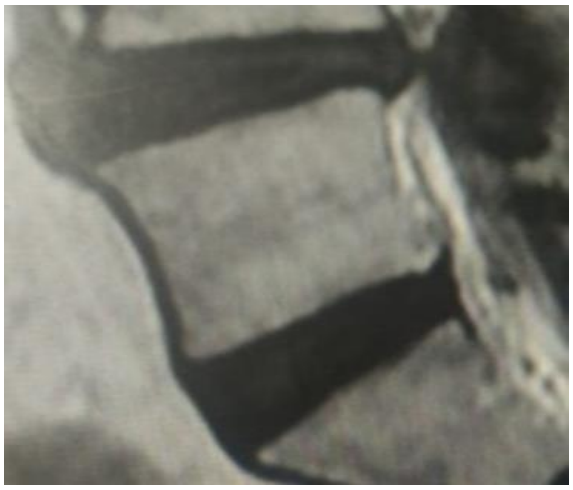

Figure 2D: Grade IV (disc is inhomogeneous, with an hypointense dark gray signal intensity)

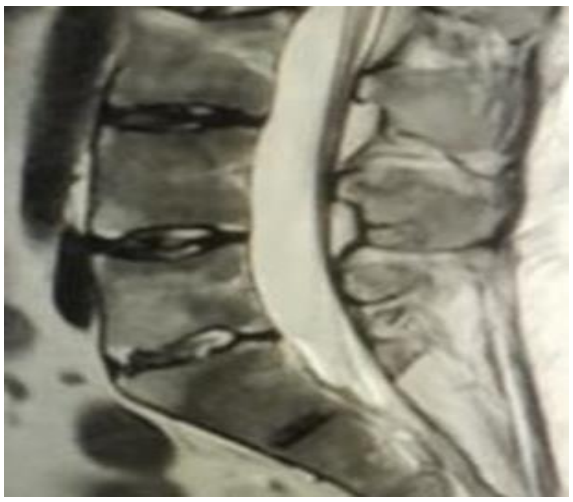

Figure 2E: Grade V (distinction between nucleus and annulus is lost and collapsed disc space.)

DISCUSSION

LBP is one of the most frequent causes of medical visits all throughout the world. The prevalence of LBP in adult population has been recorded as high as 60% to 90%.[12] The association between abnormal lumbar lordotic alignment and LBP is well described in medical literatures.[17,18,19,20,21] However, previous studies mainly assessed lumbar lordosis and pelvic parameters in LBP or spondylolisthesis, while few of them concerned these issues with disc degeneration.[9,10] Considering the fact that discogenic pain is one of the main causes of LBP,[22] evaluating its associated factors such as alteration in lumbar lordosis and sacral parameters seems invaluable.

Lumbar lordosis is formed by the wedging of the lumbar vertebral bodies and intervertebral discs.[23] Overall, the degree of lumbar lordosis decreases with increasing age.[24] The changes in sagittal alignment may lead to changes in the lumbar spine kinematics, which will subsequently influence the load bearing and the occurrence of disc degeneration.[8]

In current study, we analyzed lumbar/lumbosacral alignment for potential associations to intervertebral disc pathologies. All measurements were performed on supine MRI, as done in some of the other analogous studies.[7,12] Standing MRI which was the alternative method to standing X-ray was not available in our center, so we chose the method of supine MRI. The logic behind performing MRI instead of standing X-ray was to avoid unnecessary irradiation to the population because most of them were in their reproductive age (18 to 40 years). Moreover, recent investigations revealed that lumbar lordosis measured on horizontal MRI in supine position with straight legs were comparable to that measured on vertical standing images,[25] and sagittal balance obtained in supine MRI is reliable for investigational studies.[7]

This is the first study where young patients(<40yrs) with low backache were taken and association between lumbar disc degeneration and sagittal alignment was demonstrated.

Fifty symptomatic patients were included in the study, out of which 74.4% (360) were males and 25.9% (140) were females. 18.5% (100) of the patients were below 25 years of age, 55.6% (300) between 26-30 years and 40% (100) were between 30-40 years of age. Mean age group was 33.

Nearly 36 % and 33% of the L4-L5 discs showed degeneration corresponding to Pfirrmann grade II in females and males respectively.

Nearly 35.7 % and 30% of the of L5-S1 discs showed degeneration corresponding to Pfirrmann grade I and IV in females and Pfirrmann grade III and IV in males respectively.

Mean lumbar lordosis [Cobb Angle] values (± SD) for men and women were: 27 (± 10) and 33 (± 12.00) respectively. Similarly, mean lumbar

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lordosis [Global LS Angle] values (± SD) for men and women were: 50 (± 8) and 46 (± 12.00) respectively. Therefore, the cases could be directly compared across sex.

In this study, a statistically insignificant difference with regard to the angles of lumbar lordosis was determined between individuals with Cobb's angle (28.6°±10.6) and inter-vertebral disc degeneration (26.94±11° with p=0.007). Although statistically insignificant, this finding is in concordance with the results of few similar studies.

Ergun et al,[12] investigated the relationship between the lumbosacral morphology and degree of intervertebral disc degeneration in a large sample of young patients and found that the degree of intervertebral disc degeneration increased in parallel to the decrease in the sacral kyphosis and lumbar lordosis angles, and also to the increase in sacral table angle. A statistically significant difference with regard to the angles of lumbar lordosis, sacral kyphosis, and sacral table was determined between individuals with and without intervertebral disc degeneration. Thereby, the degree and risk of intervertebral disc degeneration and herniation increases in parallel to the decrease in sacral kyphosis and lumbar lordosis.

Kalichman et al,[7] and Lebkowski et al,[26] found that the lordosis angle was slightly lower than the normal range and no difference was found between males and females. In this study, the mean global lumbo-sacral angle was between 32° and 70° (49.2°±8.2°) in subject group which was statistically significant (p=0.002).

Zohreh Habibi et al,[17] reported that the proposed global lumbo-sacral angle was between 53° and 103° (76.5°±11.018°) in subject group which was less than the values in control group (52°–101°; mean, 80.18°±9.95°), with the difference being statistically significant (p=0.002).

The present study shows that inter-vertebral discs are subject to degeneration more easily and at a more distinct level as the lumbo-sacral column gets straighter. Those individuals with a straighter vertebral column have a greater risk of low back pain, more severe symptoms and greater risk of developing disc herniation throughout their lives than individuals with normal lumbo-sacral slope/ alignment.

Postural changes that alter the lumbar lordosis within the 'normal' range are likely to significantly change the load distribution of compressive forces over the spinal joints and lead to DJD. Lumbar lordosis can be modulated by exercise and postural habits.[18,19] This makes lumbar lordosis a potential therapeutic target for exercise rehabilitation and ergonomic intervention.

This study has important implications in prevention and treatment of lumbar spinal disc degenerative disease whose findings may be of relevance to the spinal pain management and spinal rehabilitation.

CONCLUSION

There is a strong association between varying grades of disc degeneration and sagittal alignment with respect to Global lumbo-sacral angle in both L4-L5 and L5-S1 disc spaces in young patients with chronic low back pain. Grade III and grade IV disc degeneration is more common in lumbar spine at L4-5 and L5-S1 levels respectively. Thereby, chronic low backache in young patients should not be neglected and prompt treatment should be considered at the earliest.

Limitations of Study

There are several limitations in the current study.

The sample size was relatively small and longitudinal follow-ups were not performed so as to assess the influences of lumbo-sacral profile on disc degeneration, or vice versa. This was due to the cross-sectional design of this study.

Moreover, all measurements were performed in supine position. Although both groups had identical positions during imaging and also some former studies had demonstrated that sagittal alignment measured in supine position is reliable for investigational analyses,[7,12,13,14] standing position may be a standard one in general.

Other supplementary parameters affecting sagittal balance, such as sacral slope and pelvic incidence, were not considered in this study due to lack of standing film.

This conclusion is only applicable to "global lumbosacral angle", and not to the whole sagittal balance. Therefore, the results of this study need to be replicated in larger sample, preferably by using longitudinal design and also by incorporating all the possible variables.

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