



Predictability of Degree of Degenerative Disc Disease by Lumbar Sagittal Alignment on Conventional Radiograph and Correlation with MRI

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Abstract:

Degenerative Disc Disease (DDD) affects more than 80% of the population. It is one of the common causes for chronic low back ache leading to significant health burden. In our Study we assess the predictability of lumbar disc degenerative disease on radiograph, in comparison with cross sectional imaging- MRI. Pfirrmann grading system was used to assess the lumbar disc degeneration, according to which DDD is graded into 5 grades. Out of 100 patients, 65 patients have Grade III, IV and V degenerative changes, out of which 40 were females and 25 were males. Our results are consistent with the notion that lumbar spine under optimal weight bearing conditions shows optimal lordotic angle and also available literature supports that hypo and hyper lordosis resulted in DDD. DDD correlated with deviation from optimal lumbar lordotic angle (Cobb's angle) of 45 to 75 degrees. Deviation from optimal values would compromise the optimal weight bearing conditions on lumbar spine resulting in DDD. However, the dilemma of which coming first, sagittal imbalance or DDD needs to be answered.

IndexTerms - Degenerative disc disease, low back ache, Pfirrmann grading, Cobb's angle.

I. INTRODUCTION

Degenerative Disc Disease (DDD) affects approximately 80% of the population. It is one of the common causes for chronic low back ache. Hence, amounts to significant health burden (1). Aetiology of DDD is multi factorial. It is influenced by genetics, systemic diseases, occupation, obesity and excessive or abnormal joint loading. Among these, mechanical loading has been identified as major extrinsic component in the onset and progression of degenerative disc disease (2). The normal orientation of lumbo-sacro-pelvic structure plays an important role in the determination of shear and compressive forces applied on the anterior (vertebral bodies and inter vertebral discs) and posterior elements (facet joints) of lumbar inter vertebral column. Degenerative Disc Disease (DDD) affects approximately 80% of the population. It is one of the common causes for chronic low back ache. Hence, amounts to significant health burden.

II. AIM:

To assess the predictability of lumbar disc degenerative disease on radiograph, in comparison with cross sectional imaging- MRI.

III. OBJECTIVES:

- To predict development of degenerative disc disease in cross sectional imaging - MRI, based on the lumbar sagittal alignment degree of lumbar lordosis in conventional radiograph.
- To assess the optimal lordotic angle that corresponds to minimal DDD.

IV. STUDY DESIGN

A cross sectional retrospective study was conducted in the Department of Radiology, Shadan Institute of Medical Sciences for a period of 18 months , between December 2021 to June 2022.

3.1 Study sample and patient selection

100 subjects, both males and females.

3.2 Inclusion criteria:

- Age group of 25-60 years
- Patients with low back ache
- Undergone X-ray lumbosacral spine lateral view and MRI lumbosacral spine.

3.3 Exclusion criteria:

Trauma, Congenital anomalies, Spondylolisthesis, Infective pathologies, neoplastic pathologies, previous spinal surgeries.

V. IMAGING PARAMETERS:**5.1 Radiography:**

All standing lateral radiographs were taken using the standard positioning methods. The lateral radiographs were done with patient standing with arms crossed over the chest. This position has been found to be suitable for measurement of lumbar lordosis.

5.2 MRI:

MRI was performed with GE 1.5 T machines using a standard protocol for all patients in supine position with extended lower limbs. Sagittal T1 and T2 and axial T2 weighted sequences were used in imaging protocol and were used to assess and grade the disc degenerative pathologies.

VI. METHODS:

Lumbar lordosis was measured using the commonly used gold standard Cobb's angle i.e. the angle subtended by intersection of lines drawn along the inferior end plate of the D12 and superior end plate of the S1 vertebrae.

6.1 Evaluation of disc degenerative disease:

The presence and the degree of intervertebral disc degenerative disease was assessed on T2 weighted images of sagittal and axial cuts in the intervertebral discs (6). The Pfirrmann grading system was used to assess the lumbar disc degeneration, according to which DDD is graded into 5 grades.

- Grade I and II - Normal
- Grade III to V suggests degenerative changes. These grades were sometimes associated with disc bulge, protrusion, and extrusion.

Table 1: Pfirrmann Grading of DDD

Grade	Structure	Distinction of nucleus pulposus and annulus fibrosis	Signal intensity	Height of intervertebral disc
I	Homogenous bright white	Clear	Hyper-isointense to CSF	Normal
II	Inhomogeneous with or without horizontal bands	Clear	Hyper-isointense to CSF	Normal
III	Inhomogeneous Grey	Unclear	Intermediate	Normal to slightly decreased
IV	Inhomogeneous grey to black	Lost	Intermediate-hypo intense	Normal to moderately decreased
V	Inhomogeneous black	Lost	Hypo intense	Collapsed disc space

Figure 1: Pfirrmann Grading of DDD

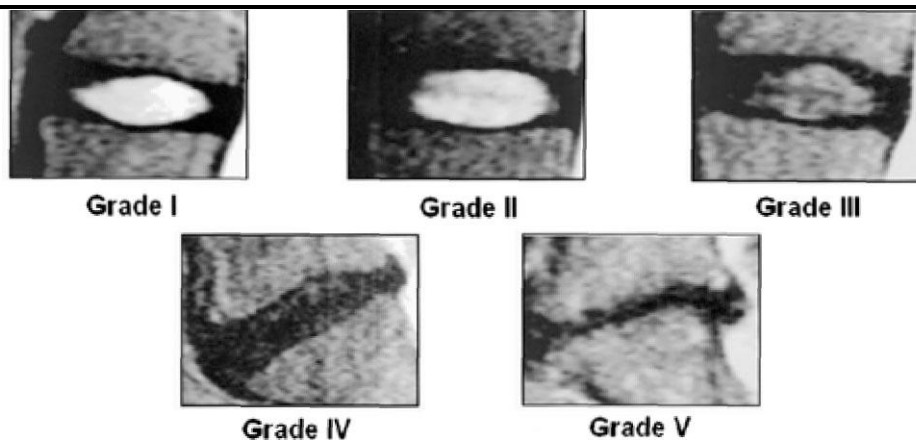


Figure 2: Measurement of Cobb's angle in Lateral Radiograph



6.2 Statistical analysis:

Mean and Standard deviations were calculated for each variable. Independent t-test was used to calculate the differences between the normal subjects and patients with disc pathologies. Level of significance was decided by P-value less than 0.05. Statistical analyses were performed by SPSS version 23.0.

VII. RESULTS

Out of 100 subjects included in the study, 60 were females and 40 were males. The age group of study population ranged from 25-60 years. Mean age of the study population is 43+5 years. Mean age among females in the study population is 40.3+3 years. Out of 100 patients, 35 were normal. Among them, 23 were females and 12 were males. 65 patients have Grade III, IV and V degenerative changes, out of which 40 were females and 25 were males. 15 patients have grade I and 20 patients have grade II changes. Among 35 normal individuals, Cobb's angle was 45-75 degrees.

Table 2: Comparison of Cobb's angle measured in radiograph in males and females (Normal Pfirrmann grades)

	No	Cobbs angle Mean	P value
Male	23	49.9 +/- 2.1	0.49
Females	12	60.1 +/- 2.4	

There was no statistically significant difference between Cobb's angles among both sexes, in normal group (P value > 0.05). Among 65 individuals with DDD, Cobb's angle was found to range between 20-44 degrees (hypo-lordosis) and 76-95 degrees (hyper-lordosis). 32 patients had hypo-lordosis, mean in males= 32.2+2 and mean in females= 30+2.5 33 patients had hyper-lordosis, mean in males= 81.2+2.5 and mean in females= 83+2.3. There was no statistically significant difference between Cobb's angle measurements among both sexes, in degenerative disc disease group (P value > 0.05).

Correlation between Cobb's angle measured in Radiograph and Grade III, IV and V Pfirrmann (DDD group) assessed on MRI was done by independent t test. Mean Cobb's angle in normal group (N= 35) was 55.7±2.1 degrees. Mean Cobb's angle in DDD group- hypo lordosis (N= 32) was 31.2+2.2 degrees. Mean Cobb's angle in DDD group- hyper lordosis (N= 33) was 82.1+2.2 degrees.

Table 3: Comparison of Cobb's angle measurement in normal and DDD groups.

	Normal group (35)	DDD group (65)		P value
Cobb's angle	45-70 degrees	20-44 degrees (32)	76-95 degrees (33)	0.009
Mean (degrees)	55.7+2.1	31.2+2.2	82.1+2.2	

There was statistically significant difference between Cobb's angle in normal and DDD patients with P value 0.009 (<0.05).

Table 4: Cobb's angle and Pfirrmann grading

Cobb's angle	Mean	Pfirrmann grading	No of patients
50-65°	58.3	I	15
45-50°	48.1	II	8
65-75°	70.6		12
35-45°	41.2	III	9
70-80°	76.4		12
25-35	29.6	IV	15
80-85°	83.1		12
<25°	22.1	IV	8
>85°	88.3		9

VIII. DISCUSSION

It is a proven fact that decreased lordosis increases the load on intervertebral discs and increased lordosis increases the load on facet joints (7). Thus, it is important to determine the ideal or optimal range of lumbar sagittal alignment to prevent or manage the disc pathologies (5). In the current study, we analysed the lumbar sagittal alignment for potential associations to intervertebral disc pathologies. It is significant to note that mean lordotic angle in normal males and females was 50.1 and 61.3 degrees respectively. The higher values in females could be due to position of the pelvis and because they are morphologically suited to have increased lordosis (8, 9). There was no statistically significant difference among males and females among normal population and DDD regarding lordotic angle (3). Our results are consistent with the notion that lumbar spine under optimal weight bearing conditions shows optimal lordotic angle and also available literature supports that hypo and hyper lordosis resulted in DDD (4, 10).

IX. LIMITATIONS

- Retrospective study.
- Difficult to analyse if DDD led to changes in lordotic angle or vice versa.
- Small sample size, hence, cannot be extrapolated with general population.
- Study was not correlated with clinical data.

X. CONCLUSION

DDD correlated with deviation from optimal lumbar lordotic angle (Cobb's angle) of 45 to 75 degrees. Deviation from optimal values would compromise the optimal weight bearing conditions on lumbar spine resulting in DDD. These results will have implications on diagnosis, prevention, treatment and rehabilitation of DDD. However, the dilemma of which coming first, sagittal imbalance or DDD needs to be answered.

XI. REFERENCES

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