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A study of lumbar lordosis angle on digital radiographs and its co-relation with demographic parameters and occupation in north Indian population

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***Abstract*---**Introduction: Lumbar lordosis can be defined as the curvature assumed by intact lumbar spine to provide resilience and protection from the compressive forces. Measurement of lumbar lordosis angle is used to evaluate the stability of this region. The purpose of the study was to assess lumbar lordosis angle and its correlation with demographic parameters and occupation in the North Indian population as there is relative paucity of data.Materials and Methods: This was a retrospective study in 500 subjects. The digital radiographs in lateral view of the lumbo sacral spine in erect position were obtained and lumbar lordosis angle were evaluated using Radiant Dicom Software. The lumbar lordosis angle was measured along with demographic parameters were noted. Results: The mean values of lumbar lordosis angle was found to be LLA=39.40^0±9.20^0. There was a positive correlation of lumbar lordosis angle with weight, BMI, HC and WC of the subjects. The lumbar lordosis angle didn't observe any significant relationship with occupation.Conclusion: The mean value of lumbar lordosis angle was 39.40^0±9.20^0. The results of the present study show significant greater angle in females. The results of the present study may be of use to health care providers for treating different spinal disorders of North Indian population.

***Keywords*---**lumbar lordosis angle, lumbo-sacral region, evaluation, spinal disorders.

Introduction

Lumbar lordosis can be defined as the convex curvature of the lumbar spine to compensate for the inclination of the sacrum and restores an upward orientation. The process of attaining bipedal gait and erect posture is an evolutionary mechanism thus leading to development of lumbar lordosis. The lumbar lordosis is not observed in embryonic life, however it gradually develops in the later stages of life and complete maturity is attained in adulthood[1]. A delay in the development of the lumbar lordosis may be caused by growth retardation.[2] When spine is seen from sagittal plane it is anteriorly convexed (lordotic) in the cervical and lumbar regions and posteriorly convexed in the thoracic and sacral region. The human lumbar vertebrae support the weight of the trunk. The lumbosacral region holds clinical importance due to its main load-bearing function, so any abnormality in this region may contribute to the development of low back pain.[3] Radiography has been considered as the gold standard to study the various lumbar angles in lumbosacral region including the lumbar lordosis angle. It has been reported that ageing, posture and obesity can influence lumbar lordosis angle.[4] The main aim of the study was to determine the lumbar lordosis angle in the North Indian population and study the correlation of the angle with gender, BMI, age and occupation.

Patients and Methods

This was a retrospective study conducted in the North Indian Population (Himachal Pradesh). The lumbar lordosis angle was measured in the 500 patients with complaint of low back pain without radio graphically detected abnormality. The digital radiographs in lateral erect position were obtained from the subjects who came into the department of Radiology, SLBS GMCH Mandi at Ner Chowk (Himachal Pradesh). The age limit of the patients was 18-45 years to ensure that subjects who had not attained spinal maturity or with osteoporotic changes observed in the later ages of life could be excluded from the study. The patients with past fracture and traumatic injury were also excluded.

Technique

The data collection included the age, sex, and occupation of the subject. The X-ray imaging of the lumbosacral region in the patients with low back pain was done in lateral erect position with X-ray tube placed 100 m away from the subject and focussed at the level of L-3 vertebra. The X- ray machine used was Allengers D500 Digital X Ray system. The presence of all 5 lumbar and sacral vertebrae with preservation of lumbar lordosis was the criteria considered for normality of the radiographs. The increase in thickness of intervertebral disc from L1-L5 and absence of congential abnormality or disease were also considered.

The lumbar lordosis angle was measured using the RaDiant DICOM software by the intersection of two lines drawn through the superior end plates of L1and S1

(Fig 1). The angles were read by two authors with no significant inter- observer error.

Results

The statistical analysis was done using SPSS Version 20P-value to ≤ 0.05 was considered as significant value. The data of 500 subjects who met the eligibility criteria were analyzed. There were 169 males (33.8%) and 331 females (66.2%). The mean LLA of the subjects was 49.9 with a range of 31.3-75.9. The values for LLA in females were significantly higher than males. The LLA had significant association with weight, waist and hip circumference. The lumbar lordosis angle was greater in working population , however no significant results were observed.

Discussion

The mean lumbar lordosis angle noted in present study population was 49.9±6.8. The lumbar lordosis angle reported by other two authors were 49 and 52 respectively, thus showing coherent results with the present study.[5,6] However, present study was in contrast with the results obtained by Farfan HF[7] et al and Onyemaechi[3] who reported the mean lumbar lordsis angle to be 42^0 (table 1). The present study is coherent with the study reported by Caglyan[11] et al who found the value of LLA in the healthy control group to be 49.9 ± 11.5. In addition, the author also observed a non-significant rise in LLA in patients with low back pain and has concluded that the rise in LLA increases the risk of LBP approximately by 1.04 times. Chemukha[7] et al in his study reported the LLA to be 52^0 and concluded that normal angle prevent the spinal disorder. Lord MJ[5] et al measured the LLA angle in sitting and standing posture and found that lordosis angle increased form sitting to standing position by 44%. Similar results have been obtained by Endo[9] et al in the Japanese population. The other studies reported by various other authors showing wide range of angle is due to various methodologies applied to measure the angle.

Nakipoglu[12] et al studied the lumbar lordotic angles in patients with acute low back pain and chronic low back and observed non-significant rise of the lumbar lordotic angle in chronic low back pain patients. The variation observed in the range of mean value of LLA seems to be dependent on the tonicity of abdominal and back muscles along with proper functioning of pelvic/back ligaments. The tension in ligaments and muscles may be caused by abnormal posture eventually affecting the lumbar spine curvature. The increased shear stress or strain in lumbosacral region is directly proportional to lordotic angle thus responsible for shifting the centre of gravity more anteriorly. So in order to reduce the risk of low back pain, it is necessary to maintain the lumbar lordosis.

In the present study, females had significantly higher LLA than males (table 2). The present study is supported by Fernand[10] et al who observed higher LLA in females. Nakipoglu[12] et al observed weak relationship of lumbar lordosis angle with gender. However, the present study is supported by the observations made by Esmailiejah[13] et al who found significantly higher LLA in females. The study is in contrast to the results obtained by Onyemaechi[3]et al and Farfan[7] et al who did not find significant variation in mean lumbar lordosis angle between males and

females. Stagnara[14] et al assumed larger lumbar lordosis in females on physical examination citing the reason of presence of greater curves at pelvic region, however little gender difference was only found in mean values of LLA. Farfan[7] et al measured the LLA in 130 cadaveric specimen and found no statistical significant values of LLA in males and females and assumed the findings to be artifactual due to removal of spinal segments while performing autopsy. Lord MJ[5] et al observed raised LLA by 4^0 in females when angle was measured from the level of L2-S1 spinal segment. However, the results of the present study are supported by studies reported by other authors.[15,16,17] The authors found that females have greater lordosis angle than males. The difference significantly higher mean values of mean LLA in females might be due to the reason that females have a larger sacral slope than the males and they usually have greater buttock size which is why they have greater lumbar lordosis. In addition, history of pregnancy could influence LL; females considerably gain weight during pregnancy, go through biomechanical and hormonal changes such as the adaptation of LL possibly due to weak abdominal muscles or postpartum joint laxity; thus, increasing lumbar lordosis.

In the present study, the value of the mean lumbar lordosis angle didn't show any significant difference with the BMI and observed a steady rise with increasing BMI as seen from fig 2. The mean BMI and the value of mean LLA was significantly more in females. Similar results have been obtained by Caglyan[11] et al who recorded higher value of mean BMI and LLA in females, thus supporting the present study. However the present study was not favoured by Song[18] et al who noted the LLA in Korean females and found negative relationship of BMI with LLA. The author found significant correlation of BMI with lumbar lordosis along with other measurements also showing slight correlations; however the significance disappeared once the body weight was adjusted. As in the present study females have high BMI with greater values of mean LLA, similar observations were made by Tsuzi[19] et al who found greater LLA in females with higher BMI and suffering from low back pain, thus indicating the rise of BMI to be the causative factor for low back pain. However, Vialle[20] et al detected no significant correlation of BMI with LLA. The present study is slightly similar with the study conducted by Onyemaechi[2] et al who detected positive correlation of BMI with LLA.

The positive correlation was observed between lumbar lordosis angle, weight, BMI & WHR (table 3) which may be due to more weight which adds more load to the lumboscaral spine eventually leading to increase in lumbar lordotic angle. In the present study, the lumbar lordosis angle did not show much variation with age (fig 3). In the present study the age group ranged from 18-45 years which is different from the other studies. The present study differed from the observations made by Tuzun[21] et al., who claimed that lumbar lordosis increased with age; maybe because the age of the subjects of ranged from 20- 63 years which is different than our range (18-45 years). Another study reported by Amonoo-Kuofi[17] et al, showed that it decreases after the 6th decade; maybe due to degenerative disc disease or increasing kyphosis that pushes the body's center of gravity forward with compensatory straightening of the lumbar spine which causes decreased lordosis. Furthermore, the commonly held view is that LL decreases with subsequent age-related degenerative changes and spinal problems. However, studies reported by Murrie[15] et al and Youdas[16] et al did not find any association

between lordosis and age.

With aging, the trunk muscles lose its balance due to weakness of abdominal muscles, increase in lumbar lordotic angle (decrease in lordosis), which would lead to an increase in intervertebral disc stress with eventually changing the pressure points to move upwards along the lumbar spine. So it can be concluded that changing lumbar lordosis is dependent on the tone of muscles of abdomen and back along pelvic ligaments and thus influence the diagnosis and treatment in LBP patients.

The present study observed greater mean value of lumbar lordosis angle in subjects of working population without statistical significance (fig 4). The literature has not reported any other study which has explained the above relation; however Esmailiejah[13] et al has explained the importance of evaluation of lumbar angles in patients with LBP who are usually soldiers, miners and work in abnormal posture for prolonged duration. The LLA was significantly influenced by weight, waist and hip circumference and negative co-relation of LLA was observed with height. These observations were similar with the study conducted by Onyemaechi[3] et al. The LLA and height of the subjects were negatively associated with each other thus leading to the assumption that taller subjects might have a straighter lumbar spine than shorter ones.

Conclusion

The mean value of Lumbar Lordosis angle was found to be 49.9 in the study population. The present study found significantly higher angle in females. The present study found insignificant relation of occupation with lumbar lordosis angle. The mean values of Lumbar Lordosis Angle may form the reference values for the North Indian population. The lumbar lordosis angle in the present study shows variability when compared to other similar studies. This further strengthen the fact that normal variation in this angle of lumbo-sacral region differs among different geographical region and races.

What is already known on this topic

- Mean values of the lumbar lordosis angle in various populations of racial and ethnic groups.
- Guidance to clinicians for the evaluation and treatment of low back pain

What this study adds

- Database for the mean lumbar lordosis angle in the present study population, holding the medico legal significance.
- Mean values of the lumbar lordosis angle obtained from the present study may be of use for the orthopaedic surgeon in the spinal instrumentation and formation of spinal implants.

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Authors Contribution

BhawnaThakur: study concept, design, data collection, analysis, manuscript writing
Rekha Parashar: analysis, proof reading, supervision.
Navneet Parashar: analysis, proof reading, supervision

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Tables

Table 1
Comparison of various studies done on LLA with the present study

Serial no.	Author's name	Mean value of LLA
1.	Present study	49.9±6.8
2.	Onyemaechi[3](2016)	42
3.	El-Sayed[8] et al(2014)	71.8±12.8
4.	Endo[9] et al(2010)	49±10
5.	Chemukha[6] et al(1998)	52
6.	Lord MJ[5] et al(1997)	49
7.	Fernand[10] (1985)	46.5
8.	Farfan[7] (1972)	42

Table 2
Gender relationship of Lumbar lordosis angle

Variable	Number (500)	Mean	SD	t-test
LLA				
Male	169	48.68	5.91	t = -3.01
Female	331	50.63	7.26	P = 0.003

Table 3
Co- relation of LLA with demographic parameters

Variables	LLA	
	Co-relation	P value
Weight (kg)	0.115	0.010
Height (cm)	-0.065	0.148
WC	0.132	0.003
HC	0.115	0.010
WHR	0.021	0.644

Images

Fig 1: Image showing measurement of lumbar lordosis angle on the digital radiograph

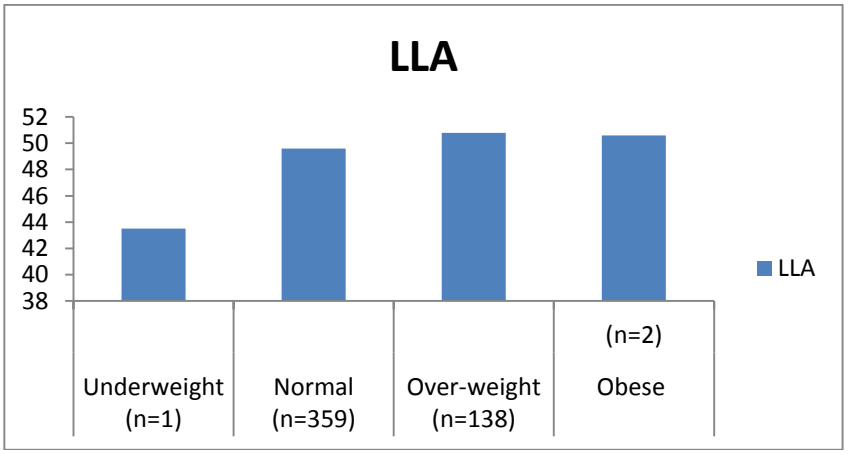

Fig 2: Graph showing relation of lumbar lordosis angle with BMI

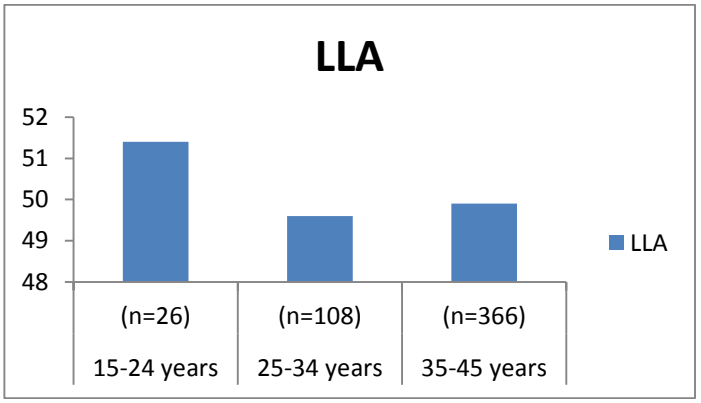

Fig 3: Graph showing relation of lumbar lordosis angle with Age

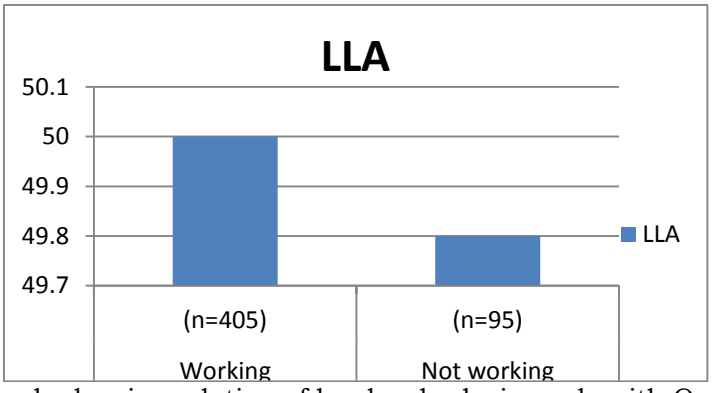

Fig 4: Graph showing relation of lumbar lordosis angle with Occupation