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Estimation of Lumbar Lordotic Angle by Cobb's Method Using Plane Radiography in Patients with Low Back Pain: A Retrospective Study

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Abstract

Introduction: The lumbar spine's convex curve maintains an upward orientation by making up for the sacrum's tilt position. Inter-vertebral shearing arises due to an increase in non-normal forces acting between adjacent vertebrae as a function of the angle of inclination of vertebrae relative to the horizontal.

Objectives: To measure the LLA according to different age groups and different sex in patients with low back pain in standing position and comparison of LLA in different age groups and different sex with low back pain patients.

Materials and methods: The subjects were recruited from NIMS Hospital. The data, demographics, Cobb's angle were measured after taking informed consent from 600 subjects of different age groups and sex.

Result: This study included 600 samples in which 323 were males and 277 females. The descriptive stats of age and LLA was (43.832 ± 15.46) and (36.26 ± 12.45) respectively. Association between age and LLA in both gender was (for male, correlation 0.0131, t-test value 0.234, p-value-0.81508), (for female, correlation -0.0884, t-test value 0.786, p-value -0.43203).

Conclusion: Our study also demonstrated that LLA differed by gender and was shown to be higher in female participants having complain of low back pain. Additionally, our research found no significant association between age and LLA in patients with low back pain.

Keywords: Cobb's angle • LLA • Lordosis • Retrospective study

Introduction

Lordosis variation: A defining feature of the human spine is its unique S-shaped profile composed of two distinct curves. While the concave curvature of the upper spine is a characteristic humans share with closely related species such as great apes, the convex forward curvature of the lower spine, known as lumbar lordosis, is uniquely derived in the hominin lineage.

The lumbar spine's convex curve maintains an upward orientation by making up for the sacrum's tilt position [1].

It improves the vertebrae's capacity to absorb trauma and supports the stability and balance of each joint [2]. Its necessary to keep the spine curled normally to reduce the shock from unexpected forces. On the other hand, the benefits of a curved lumbar posture may come at the costs of reduced mechanical stability of the spine as a support structure while also increasing the risk of injury due to higher levels of intervertebral shearing forces [3-10]. Intervertebral shearing arises due to an increase in non-normal forces acting between adjacent vertebrae as a function of the angle of inclination of vertebrae relative to the horizontal. Although straighter lumbar spines are assumed to provide greater resistance to loading and lower intervertebral shearing, little is known about how natural variations in lordosis influence the lumbar spine's bending stiffness during loading.

Lordosis not only helps maintain postural balance especially during pregnancy but also may increase lower back mobility allowing the lumbar spine to serve as "shock absorber" to cope with impact-

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related accelerations generated by the foot's collision with the ground during running [11,12]. But few research has examined how lumbar lordosis affects shock accelerations that are transmitted through the spine while moving.

Lordosis evolved along with a combination of morphological changes including elongation of the lumbar vertebral column, wedging of the vertebral bodies, pelvic tilt, increased spinal mobility and reduced entrapment of the lower vertebrae between the iliac blades [13-18]. This suite of adaptations allowed the human lumbar spine to achieve its curved shape to balance the mass of the upright torso stably over two legs. The causes of lumbar lordosis in humans are still a subject of much debate. Because the entire series of lumbar vertebrae rarely survives in the fossil record, no one is certain of the exact time that lordosis first appeared. Hints of lumbar curvature appear in the 4.4-million-year-old fragmentary pelvic remains of *Ardipithecus ramidus*, suggesting that lordosis may have been present in early hominins.

During the process of embryonic development in humans, little or no lumbar lordosis is demonstrated. The extent of lumbar lordosis coincides with the stages of bipedal gait and increases from infancy to adulthood. Lumbar lordosis continues to develop till the completion of spinal growth, usually between the age group of 13 to 18 years. A delay in the development of the lumbar lordosis may be caused by growth retardation.

Development of any abnormality in this curvature leads to symptoms ranging from mild discomfort to severe back pain, thus highlighting the importance of this curvature and its normal variability.

Effect of lumbar lordotic angle on low back pain

Nowadays, low back pain is a major problem and is becoming more and more common among young people. It may have impact on people's functional level in everyday life, influencing its quality.

The correct shape of the spine in the frontal plane should appear to be a vertically straight line. Viewed from the lateral plane, the spine has an S-shape curve comprised of the cervical and lumbar lordosis and thoracic kyphosis. The biomechanical perspective on spinal curvature emphasizes its key function in absorbing loads in daily activities. The lowest part of the spine's force distribution is particularly affected by the way the Lumbar Lordotic Angle (LLA) is shaped. The shape of this part depends on individual predispositions, genetic features, size of vertebral bodies, intervertebral discs, body mass, sacrum position age and abdominal muscles.

A very contrasting perspective in some clinical sectors portrays the LLA as the primary cause of Low Back Pain (LBP), in stark contrast to the biomechanical approach, which underlines the LLA's critical evolutionary relevance in humans, certain clinical sectors present the LLA as the principal source of Low Back Pain (LBP). It's interesting to note that an increased lumbosacral angle is known to increase strain on the facet joints and posterior ligaments, which ultimately results in LBP. The fact that most clinicians counsel their patients to reduce increased lumbar lordosis angle to relieve LBP is proof of the widespread perception that LLA is a cause of LBP. Flexion exercises, so-called Williams's exercises, are well established and widely implemented in clinical fields for the conservative treatment of LBP. The conflicting evidence and attitudes surrounding the functions of the LLC and its interactions with diseased spines are surprising. Loss of LLC is the most distinctive finding of the aging spine and the prevalence of LBP increases with age. It seems illogical to think that reducing the LLC (increasing the LLA), a function that happens naturally as we age, may be a way to relieve LBP. Furthermore, it is contradictory because LLC is both a necessary part of ergonomic walking and the underlying cause of LBP. It is obvious that the linked component of the association between LLC and LBP is poorly understood, which raises severe concerns about whether the therapeutic low back exercises employed to lower LLC are in fact helpful or harmful. Only studies that link current LLC with potential low back problems in the future will be able to clearly demonstrate the cause and effect relationship between LLC and LBP. However, literature regarding this matter is extremely sparse. The next best way to examine this issue in a literature review is to review observational studies that report LLC in both patients with LBP and healthy controls. A previous systematic review pertaining to this subject, which involved a meta-analysis, concluded that LLC did not differ between subjects with and those without LBP. Although it appears that the variation of the documents included in this met analysis was underestimated. Additionally, this review dealt with studies that employed clinical measures, whereas radiological methods are more suitable for measuring the absolute parameters of LLC. Due to the extreme variability of curvature of lumbar spine, it may be difficult to identify a consistent pattern in the variations in lumbar curvature in LBP patients. Even in asymptomatic people, the spinopelvic complex's sagittal alignment varies greatly, making it impossible to distinguish patients with LBP from healthy normal controls by looking solely at LLC. Nonetheless, the continued development and refinement of our understanding of the sagittal profile of the lumbar spine in patients with LBP have immense clinical significance, as they directly impact the design and implementation of corrective exercises. The goal of this analysis was to determine whether there is a reliable and substantial connection between LLC and LBP. We sought to address mechanical or degenerative LBP, excluding LBP in the context of definite fractures; non-mechanical spinal conditions such as infection, neoplasia and inflammation; and visceral diseases. We also excluded the spondylolisthesis and scoliosis because they are both LBP-related diseases that can change the sagittal alignment of the spine without affecting the LLC.

Aim and objectives

Aim: To estimate and correlate the Lumbar Lordotic Angle (LLA) through Cobb's method with the help of plain radiography (lateral view) in patients with low back pain taken in standing position.

Objectives: To measure the LLA according to different age groups and different sex in patients with low back pain in standing position. Comparison of LLA in different age groups and different sex with low back pain patients.

Materials and Methods

Study will conducted in the department of anatomy with collaboration of department of orthopedic and department of radio diagnosis and imaging of NIMS Hospital Jaipur. Patient's undergone plain radiography (lateral view) for lumbar spine in department of radio diagnosis and imaging at NIMS Hospital.

Inclusion criteria

- Patients with the complained of low back pain undergone plain radiography of lumbar spine (lateral view) in standing position.
- Patients of both sex and different age groups (above 18 years of age).

Exclusion criteria

- Patients with preexisting lumbar spine infective pathology.
- Pre-existing history of any surgical implant.
- Presence of any congenital deformity that could affect the interpretation of radiographic image.
- Patients with presence of scoliotic deformity in anteroposterior view of radiograph.

Sample size

It is a retrospective type of study; complete enumeration will be done for previous six month cases in the patient of low back pain undergone plain radiography. Sample size- 600 cases.

Study design

This is a retrospective study.

Cobb method for measurement of LLA

It is deduced that the Cobb angle is the sum of upper and lower end vertebra tilt angles through the law of plane geometry. The parameters will be measured using the Picture Archiving and Communication System (PACS system). We measured lumbar lordotic angle on standard anteroposterior and lateral radiography.

Terminology

Vertebral end plate

- It is the transition region where a vertebral body and intervertebral disc interface with each other. A vertebral end plate is commonly described as consisting of 2 layers.
- Cartilaginous layer (also called cartilaginous endplate) that fuses with the disc.
- Thin layer of porous bone (also called bony endplate) that attaches to the vertebra.
- The vertebra the greatest distance from the midline with the most rotation.

Neutral vertebra

- A vertebra without axial rotation (In reference to the most cephalad and caudal vertebrae that are not rotated in a curve) non-structural curve.

Apex of curve

- In scoliosis this refers to the vertebra that is located at the farthest point out laterally from the midline of the body (convex side).
- The measuring steps of the lumbar lordotic angle are as follows:
- Draw the upper and lower end vertebra endplate connecting line on the radiography image.
- Measure the tilt angles of the upper and lower endplates. In case of lumbar lordotic angle it will be from upper end plate of L1 vertebra to lower end plate of L5 vertebra (Figures 1 and 2).
- Add the two measured results to get the LLA.

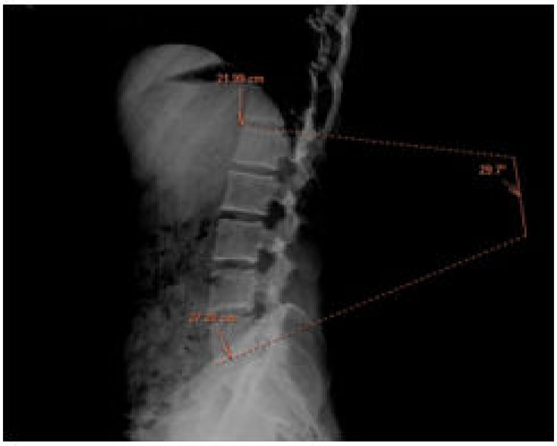

Figure 1. Representation of LLA using PACS.

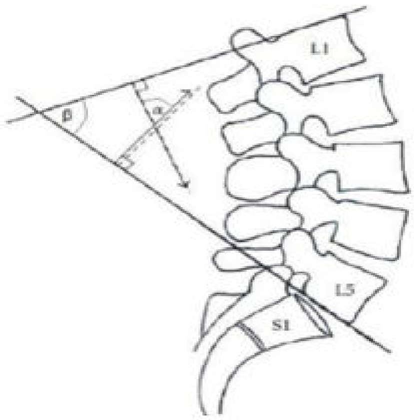

Figure 2. Representation of LLA using endplate line and perpendiculars (α: using the perpendiculars; β: endplate lines are able to meet directly; α and β are equal).

Results

Gender-wise distribution

Out of 600 patients in the study, 323 were men and 277 were women (Table 1 and Figure 3).

Gender	N=600	In%
Male	323	53.83%
Female	277	46.17%

Table 1. Frequency distribution of gender of patients.

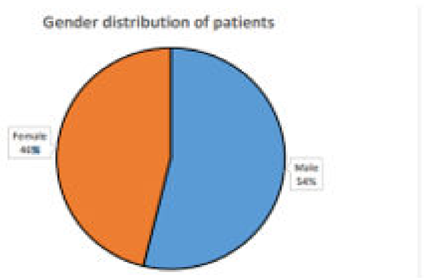

Figure 3. Gender distribution of patients.

Age-wise distribution

In the present study, out of the 600 participants, most of 144 were in age group of 30-40 years followed by 118 in age group of 40-50 years (Table 2 and Figure 4).

Age interval	N=600	In%
10-20	28	4.67
20-30	110	18.33
30-40	144	24
40-50	118	19.67
50-60	94	15.67
60-70	75	12.5
>70	31	5.17

Table 2. Frequency distribution of age of patients.

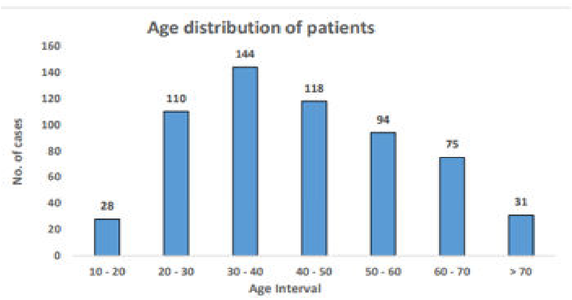

Figure 4. Age-wise distribution of patients.

LLA distribution among patients

In the present study, out of the 600 participants, most of the participants *i.e.*, 188 had LLA between 30-40 followed by 146 had LLA between 40-50 (Table 3 and Figure 5).

LLA interval	N=600	In%
0-10	5	0.83%
10-20	57	9.50%

20-30	125	20.83%
30-40	188	31.33%
40-50	146	24.33%
50-60	61	10.17%
60-70	16	2.67%
>70	2	0.33%

Table 3. Frequency distribution of LLA of patients.

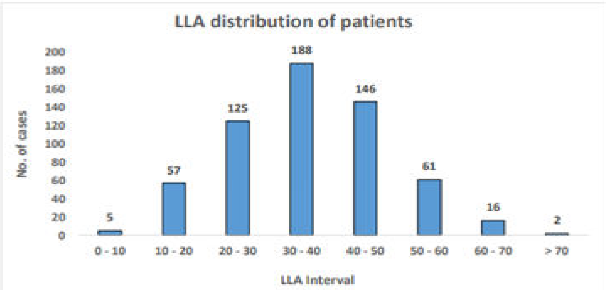

Figure 5. LLA distribution amongst patients.

Descriptive statistics of age and LLA

In our study, mean age of the study participants was 43.832± 15.46 years and mean LLA was 36.26 ± 12.45 (Table 4).

Variables	Minimum	Maximum	Median (IQR)	Mean ± SD
Age	12	89	43 (31-54.25)	43.832 ± 15.46
LLA	3.7	77.8	35.7 (28.5-45	36.26 ± 12.45

Table 4. Descriptive statistics of age and LLA.

Gender-wise distribution

In our study, no statistically significant age difference was found between male and female participants. But a statistically significant high LLA was found among the female participants compare to male (Table 5).

Variables	Male (Mean ± SD)	Female (Mean ± SD)	t-test	P-value	Significance
Age	43.67 ± 16.14	44.02 ± 14.65	-0.275	0.783173	Not significant
LLA	35.1 ± 11.87	37.61 ± 12.99	-2.453	0.014485	Significant

Table 5. Comparing mean of age and LLA between genders by using student's t-test.

Age-wise distribution of LLA

In our study, maximum LLA was found in 40-50 years age group participants followed by 30-40 years age group and least LLA was found in age group of >70 years (Table 6).

Age interval	N=600	Mean ± SD
10-20	28	35.85 ± 13.45
20-30	110	35.1 ± 13.01
30-40	144	37.19 ± 11.99
40-50	118	38.3 ± 12.23
50-60	94	35.60 ± 11.64
60-70	75	36.28 ± 12.45

>70	31	30.59 ± 13.54

Table 6. Age group wise mean and standard deviation of LLA.

Gender-wise LLA and age significance comparison

In our study, no statistically significant correlation was found between age and LLA in both male and female participants (Table 7 and Figures 6-8).

Age/LLA	Correlation	t-test	P-value	Significance
Male	0.0131	0.234	0.81508	Not significant
Female	-0.0884	-1.466	0.14381	Not significant
Total	-0.0322	-0.786	0.43203	Not significant

Table 7. Association between age and LLA in both gender and total cases.

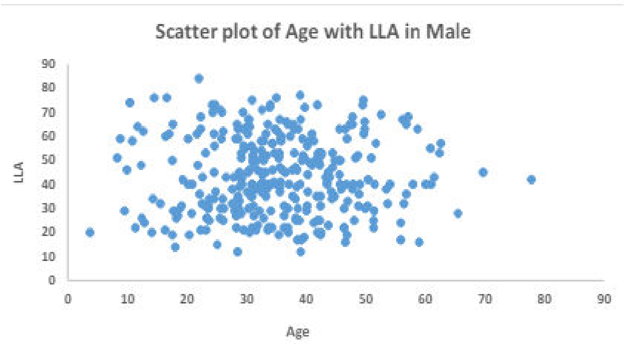

Figure 6. Age *vs.* LLA among males.

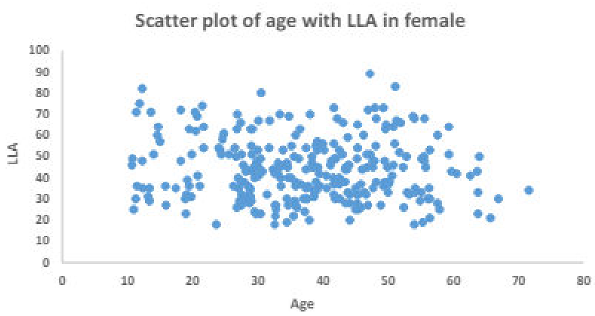

Figure 7. Age *vs.* LLA among females.

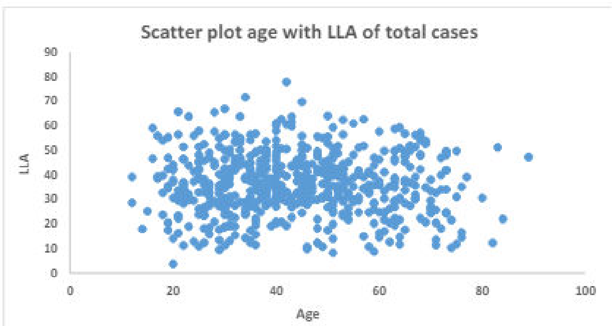

Figure 8. Age *vs.* LLA among total cases.

Discussion

The purpose of this research was to determine, by the use of plain radiography and Cobb's method, the Lumbar Lordotic Angle (LLA) in individuals who complained of low back pain. The Lumbar Lordotic Angle (LLA) is a crucial parameter that must be considered when analyzing the sagittal alignment of the spine and the biomechanics of the lumbar region. The spine is typically made up of sequential opposed convexities in the sagittal plane by the muscle forces of the core muscles, which include the rectus abdominis, internal and external oblique, transverse abdominis and gluteal muscles, in people who appear to be healthy and who do not have musculoskeletal disease. Even if the magnitude of each curve differs from one person to the next when it comes to keeping an upright position, they should be the consequence of a balance struck between the forces exerted by the core muscles and those exerted by the external force. It is possible for intervertebral discs to protrude from a spine that has a lesser curvature, while an excessively elevated curvature of the spine might lead to an overflow of "articular facets. The LLA can change according on factors such as the individual's posture, age, gender and any pathological disorders that affect the spine. According to the findings of a variety of writers who employed a variety of research approaches, the normal range of LLA is between 20° and 60°.

Throughout the course of this study, the LLA was identified by applying Cobb's method to lateral radiographs of the lumbar spine that were obtained from the participants while they were in a standing position. The Cobb method is a straightforward methodology that is considered to be the gold standard in its profession. This method is used for measuring the curvature of the spine. The procedure entails drawing two perpendicular lines from the upper endplate of the highest vertebra and the lower endplate of the lowest most vertebrae implicated in the curvature and then measuring the angle that is created between the two lines. This angle can be found by drawing a triangle with the upper endplate of the highest vertebra and the lower endplate of the lowermost vertebrae. When it comes to the measurement of LLA, it has been shown that the Cobb method possesses good levels of reliability both among and between observers, in addition to having a high level of validity.

Within the usual range that was published by Dreischarf M, et al., which offered values for lordosis (overall) 30.1 ± 8.7°(In men 25.9 ± 9.4° and in females 34.2 ± 5.6°), we discovered that the mean LLA in our research of low back pain patients was 36.26 ± 12.45°. This result did fall within the normal range. We found that there was a significant difference in the LLA between males and females, with males having a value of 35.1 ± 11.87° and females having a value of 37.61 ± 12.99°. Our findings were in line with those of some studies done by Dreischarf M, which found that males had a value of 25.9 ± 9.4° and females had a value of 34.2 ± 5.6°. According to the findings of Bailey JF et al., differences in LL between standing and supine positions are influenced by gender. It was shown that the angle of difference in lumbar flexion (LA) between standing and supine was on average 10.9° in females (P=0.007), which may reflect that males and females have distinct levels of lumbar range of motion.

In addition to this, we looked at whether or not there was a connection between LLA and the ages of the people who took part in the study. We found that there was an inverse association (a negative correlation) between LLA and age, which suggests that LLA decreased as age grew. This was demonstrated by the fact that the correlation was negative. This study is similar with findings from prior examinations that were conducted in Philadelphia, Pennsylvania in 1976 and demonstrated a drop in LLA with rising age. The findings of those earlier investigations were found to show a decline in LLA with increasing age. There are a number of disorders that could be the cause of this, including osteoporosis, arthritis in the facet joints, hypertrophy of the ligamentum flavum or muscle weakness. Alterations in the intervertebral discs that are caused by degenerative disease could possibly be a factor in this illness. A reduction in the height of the anterior column and an increase in the height of the posterior column, both of which can contribute to a flattening of the natural curve of the lower spine known as the lumbar lordosis, are two factors that can cause the lumbar lordosis to become flatter.

Due to the fact that this was a retrospective study based on radiographic scans, it suffers from the problem that is inherent to all studies of this type, which is that it is inconsistent. Because of this, we were unable to evaluate the clinical symptoms, functional status, or quality of life of the patients who suffered from low back pain. This resulted in the patients' inability to participate in the study. In addition, we were unable to control for additional parameters that may influence the LLA, such as body mass index, pelvic tilt, sacral slope or spinal balance. These factors could potentially have an effect on the LLA. It's possible that the angle of lumbar lordosis will change as a result of these circumstances. Assessment of the link between LLA and low back pain in upcoming study will require the utilization of prospective research designs and the incorporation of the aforementioned components.

This study concluded that the LLA could be determined by using Cobb's technique and plain radiography in patients who were experiencing low back pain. We found that the mean LLA was within the normal range and that there was no significant difference in LLA between males and females. Moreover, we found that there was no significant difference in LLA between age groups. We also discovered that there was a negative correlation between age and LLA. The physicians and researchers who are interested in the sagittal alignment of the lumbar spine and its link to low back pain may find these studies to provide relevant information.

Conclusion

With the use of PACS, our study provides solid evidence for the identification of LLA in patients with low back pain utilizing Cobb's approach and plain radiography. Our study also demonstrated that LLA differed by gender and was shown to be higher in female participants having complain of low back pain. Additionally, our research found no significant association between age and LLA in patients with low back pain.

Future Recommendations

This study was a single center; retrospective study so may not be generalized for other low back participants. Hereby we recommended a multicenter, prospective study. Due to single investigator and limited time span we could not separate the patients of different comorbidities as they may be affect the LLA so a large study with separating the different comorbidities would be recommended.

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