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LORDOTIC ANGLES IN LUMBAR SPONDYLOTIC PATIENTS IN RIVERS STATE UNIVERSITY TEACHING HOSPITAL: IMPLICATION FOR REHABILITATION.

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ABSTRACT
Introduction: Spondylosis is a degenerative disease affecting the spine, characterized by changes in the intervertebral discs, vertebrae, and facet joints, associated with aging, pain, and disability. The study evaluated lordotic angles across lumber spine among spondylotic patients and compared variations of these angles with respect to age and sex, which may point out the need for physiotherapy/rehabilitation.

Method: This was a retrospective study among 395 adult patients presenting with radiographic evidence of lumbar spondylosis. Lordotic angles were measured using Cobbs methods and analysed using statistical analysis tools. Descriptive statistics was used to get mean angles, independent samples t-tests was used to compare angles by sex, Pearson correlation to assess linear relationships with age.

Results: The result showed mean lumbar lordotic angle for both male and female was 49.29º ±0.56º exhibiting highly significant sexual dimorphism ($P<0.001$), with females (52.97º±0.90º) retaining a greater lordosis than males (46.69º ±0.65º).

Conclusions: The study concludes the degenerative changes of the lumbar spine among spondylosis patients is region specific. The lumbar spine showed preserved lordosis and significant sexual dimorphism. This reflects inherent anatomical and biomechanical adaptations. Conversely, the lack of a significant linear association with age is consistent across the lumbar segments.
Keywords: Spondylosis, Lordotic Angles, Lumbar, Radiography

INTRODUCTION
The human spine is a complex and vital structure, characterized by natural sagittal curvatures; lordosis in the lumbar region and kyphosis in the thoracic region. These curvatures are crucial for maintaining an upright posture, distributing weight, absorbing shock, and enabling balanced movement [1]. Disruptions to these normal angles, particularly the lordotic curves, can significantly compromise spinal biomechanics and overall function.
Spondylosis is a degenerative disease affecting the spine, characterized by changes in the intervertebral discs, vertebrae, and facet joints, associated with aging, pain, and disability [2]. It is more frequently seen in the spine's highest and lowest sections – the lumbar L1-L5 (low back) areas, [3]. Spondylosis is a major public health issue and important cause of physical impairment among the elderly populations of most developed countries [4]. The treatment and management of spondylosis varies on how severe it is and ranges from physical therapy to surgical intervention [5].
Lumbar lordosis constitutes the ventral curvature of the lumbar spine, along the wedging between the lumbar vertebral bodies and the intervertebral discs [6]. Lumbar lordotic curve is considered the key structural adaptation to bipedalism as it places the center of mass of the torso above the hip and enables the soft tissue around the spine to neutralize shear load while enhancing its capacity to bear gravitational force [7]. In this way, humans can maintain erect posture in everyday life in a stable and

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energy-conservative manner with minimal mechanical stresses [7]. Normal lumbar lordosis serves to provide strength against the compression forces of gravity, protects the posterior spinal ligament system from excessive stress and acts as a shock absorber during sudden applied vertical forces [8]. Increased lordosis is advocated as a major cause of postural pain, radiculopathy, and facet pain, it leads to increased compression of the apophyseal joint and increased anterior shear force at the lumbosacral joint [8].

Research confirms that spondylosis leads to alteration in lumbar lordotic angles, which contributes to pain, disability, and neurological complications [5]. It is thus necessary to establish more grounds whether these alterations in lordotic angles follows similar patterns in the lumbar regions among patients already diagnosed with spondylosis, as most studies have examined each region independently [9]. There is also limited knowledge on the age and sex specific changes in lordotic angles of lumbar spine among spondylotic patients. This limits the clinician's ability to provide appropriate management and treatment strategies [6].

METHODOLOGY

Study Design: This is a retrospective study where radiographs of patients diagnosed with lumbar spondylosis were analysed. The study utilized purposive sampling by taking X-ray films of patients diagnosed with lumbar spondylosis.

Study Area and Setting: This study was located in the Port town city of Port- Harcourt, the capital of Rivers state south-southern region of Nigeria. The study took place in the Radiology department in Rivers State University Teaching Hospital.

Sample size

The sample size (N) is determined using the Cochran formula [10]

$$N = \frac{Z^2(P)(Q)}{E^2}$$

Where:

Z = 1.96 (95% confidence interval)

P = 20% (estimated percentage of population) [11]

Q = 1 - P = 0.8

E = 0.05 (margin of error)

N= 246

10% attrition was included to the sample size

Final sample size for lumbar region =270

Data Collection

The Lumbar X ray films were sorted out by the record officer from 2021-2025. The films were viewed by the researchers. X ray films that showed scoliosis on anterioposterior (AP) view were not analysed, as well as images showing fracture, Open Reduction and Internal Fixation (ORIF). Images were assessed by the researchers and radiologist. Images showing bone lesions, scoliosis were not analysed. X-ray films for the lumbar spondylosis satisfied the sample size. The measurements for X rays were done on the viewing box with a plain A4 paper also attached to the viewing box. The lines were drawn on the plain A4 paper so the X ray films are not damaged or altered. The age, sex and angles were properly recorded in a book assigned for the study.

Measurement of Lordotic Angle

Cobbs method was used to measure the lordotic angle

From superior endplate of L1 to the superior endplate of S1.

A line was drawn along the superior endplate (border) of L1 and the superior endplate (border) of S1 and at the point of intersection was the angle. In cases where they could not meet, perpendicular

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lines are drawn across the first lines.

The angle formed between the intersecting perpendiculars was the lumbar lordotic angle.

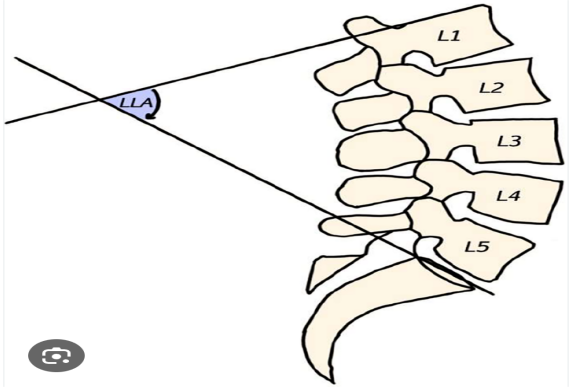

Figure 1: A Schematic Diagram of Lumbar lordotic angle Adapted from "Lumbar spine deformation between prone and supine CTs" (Fig. 1), [12]

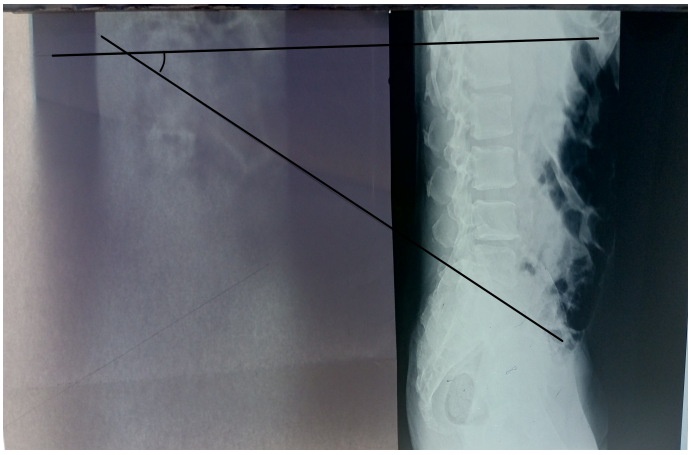

Figure 2: A lateral X ray of a 64year male lumbar lordotic angle

Inclusion Criteria

Adult male and female from 40 years and above diagnosed of lumbar spondylosis.

Clear radiographic images showing all the lumbar spines.

Exclusion criteria

Patients with spinal congenital anomaly eg Scoliosis as seen on anterioposterior view

Patients with visible fracture or Open Reduction & Internal Fixation (ORIF) as seen on **radiograph**

Data Analysis

The data were analysed using MS Excel 2013.

Descriptive analysis was used to determine mean, standard deviation, range.

Independent T-test was used to analyze sex variation in the lumbar region.

Pearson's Correlation was used to measure relationship with age.

Test of Reliability

Reliability is defined as the extent to which measurements can be replicated. In other words, it reflects not only degree of correlation but also agreement between measurements. Interrater reliability reflects the variation between 2 or more raters who measure the same group of subjects [13]. The Inter Class Coefficient (ICC) is a measure of reliability, specifically the reliability of two different raters to measure subjects similarly. Inter-rater reliability is important as it demonstrates that a scale is robust

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to changes in raters. Hence, scales with high inter-rater reliability are less prone to measurement error such as caused by variation in human judgement [14]. The ICC is a value between 0 and 1, where values below 0.5 indicate poor reliability, between 0.5 and 0.75 indicate moderate reliability, between 0.75 and 0.9 indicate good reliability, and any value above 0.9 indicates excellent reliability [14].
In the present study, the angles were measured by the researcher and a radiologist. The radiologist re-measured every 2 in 15 angles for lumbar spine measured by the researcher. Values were written and at the end of the data collection they were tested for validity and reliability.
ICC=

$$\frac{MS_{Rows} - MS_{Errors}}{MS_{Rows} + MS_{Errors}}$$

Where,
MS Rows = Mean Square for Rows
MS Errors = Mean Square for Error

Ethical Consideration

Ethical approval was obtained from the Research Ethics Committee of Rivers State University Teaching Hospital. Approval number: RSUTH/REC/2025751.

Every data gotten from this research was treated with confidentiality.

RESULTS

TABLE 1: DESCRIPTIVE STATISTICS OF MALE LUMBAR SPONDYLOTIC GROUP

Age Group	Frequency (F)	Percentage (%)	Mean Age ±SEM	Mean Lordotic Angle(º) ± SEM
40 - 49	33	20.88	45.50±0.47	47.74º±1.69
50 - 59	41	25.94	55.58±0.40	46.91º±1.05
60 - 69	42	26.58	65.30±0.39	46.32º±1,43
70 - 79	32	20.25	74.00±0.52	46.25º±1.30
80 - 89	10	6.32	84.60±1.17	45.30º±2.02
Total	158	100	-	-
Mean	-	-	61.84±0.94	46.69º±0.65

SEM= Standard Error of Mean

Table 1 shows the male lumbar lordotic angle across different age groups. The most frequent age group is 60-69. The lumbar lordotic angle does not show much change across the different age groups.

TABLE 2: DESCRIPTIVE STATISTICS OF FEMALE LUMBAR SPONDYLOTIC GROUP

Age Group	Frequency (F)	Percentage (%)	Mean Age ±SEM	Mean Lordotic Angle(º) ± SEM
40 - 49	25	22.32	44.00±0.59	50.48º±1.74
50 - 59	32	28.57	54.40±1.57	54.65º±0.56
60 - 69	34	30.35	63.88±0.52	53.58º±1.76
70 - 79	18	16.07	73.44±0.60	53.00º±2.71
80 - 89	3	2.67	81.00±1.20	51.33º±2.40
Total	112	100	-	-
Mean	-	-	58.82±1.03	52.97º±0.90

SEM= Standard Error of Mean

Table 2 shows the different lordotic angles across different age groups. The most frequent age group

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is 60-69. The lumbar lordotic angle shows a non-linear downward trend as age progresses.

TABLE 3: DESCRIPTIVE STATISTICS OF THE POOLED LUMBAR SPONDYLOTIC GROUP

Category		Frequency (F)	Percentage (%)	Mean Age ± SEM	Mean Lordotic Angle(º) ± SEM
Age Group	40 - 49	58	21.48	45.00±0.38	48.92º±1.22
	50 - 59	73	27.03	55.17±0.34	50.19º±1.00
	60 - 69	76	28.14	64.69±0.33	49.57º±1.18
	70 - 79	50	18.51	74.28±0.40	48.68º±1.35
	80 - 89	13	4.81	83.92±0.99	43.30º±2.07
	Total	270	100	-	
Female		112	41.48	58.82±1.03	52.97º±0.90
Male		158	58.51	61.84±0.94	46.69º±0.65
Total		270	100	60.59±0.70	49.29º ±0.56

SEM=Standard Error Mean

The subjects for the lumbar region were 270, with males greater in number at (58.51%) compared to females at (41.48%). The age distribution peaked at 60-69 years (28.14%), followed by the 50-59 (27.03%). The mean lumbar lordotic angle is 49.13º±0.57 with females having a significantly larger lordotic angle than males.

TABLE 4: RELATIONSHIP BETWEEN THE LUMBAR LORDOTIC ANGLE WITH GENDER

Region	Gender	Mean angle (º)	T stat	T-Value	Degree of freedom (DF)	P value
Lumbar	Male Female	46.69º 52.58º	-5.29	1.96	268	*<0.001

Table 4 shows a significant difference in the lumbar spine between male and female ($p<0.001$).
*$P \leq 0.05$ is considered statistically significant.

TABLE 5: RELATIONSHIP BETWEEN THE LUMBAR LORDOTIC ANGLE AND AGE

Region	Pearson's Correlation (r)
Lumbar	-0.07

Table 5 shows no correlation between age and angle in the lumbar spine at a 95% confidence interval.

The result showed excellent level of agreement between two raters. The Inter-rater class coefficient (ICC) for absolute agreement was 0.95 for lumbar region.

DISCUSSION

The study was conducted to evaluate the lumbar lordotic angles among adult spondylotic patients and

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to compare their variations with respect to sex and age.

The results showed the mean age of lumbar spondylosis patients to be 60.59±0.70 (Table .6) pooled sexes with males at 61.84±0.94 (Table 1) and females 58.82±1.03 (Table 2). The most prevalent age group was 60-69 at (28.14%) with a mean age of 64.69±0.33. The mean angle for the different age groups did not have a significant difference. The age group with the highest lordotic angle was 50-59 having a mean lumber lordotic angle of 50.19º±1.00. The highest age group of 80-89 had a mean lumbar lordotic angle of 43.30º±2.07. The mean lordotic angle of lumbar spondylosis as 49.13º ±0.57 with male and female having 46.69º ± 0.65 and 52.58º ±0.94 respectively (Table 4). These findings agree with the lordotic angle of pervious works done on; asymptomatic lumbar spine patients. Females show statistically significant lordotic angle when compared with males ($t = -5.29$, $p < 0.001$) (Table 4). Sexual dimorphism is represented here in the spines pathological state as this study shows that having spondylosis doesn't affect the larger lordotic angle of females. The wider and deeper lordosis in the female spine according to [15] is an evolutionary adaptation to compensate for the significant forward shift of the center of gravity (COG) incurred during pregnancy. This greater curvature is structurally enabled by differences such as increased lordotic wedging of the lumbar vertebrae and a greater sacral slope in females [15].

The present study agrees with that of [16] who conducted a study in Ghana and reported sexual dimorphism with females having greater lumbar lordotic angle than males (37.5º±11.32 and 34.3º±7.73) respectively, ($p=0.05$). Though [16] study had a much smaller mean of 35.9º compared to present study, this could be as a result of geographic or genetic morphological variation. [17] who carried out a study among Taiwan women in China reported the mean lordotic lordotic angle at 50.3º which is similar to the present study. [18] in North India also agrees with the present study with the females mean lordotic angle at 50.63º±7.26 and males at 48. 68º±5.91 ($p = 0.003$). The study also showed positive correlation with BMI, waist circumference and hip circumference. [19] who carried out a study on healthy Iran subjects showed females to have a higher lumber lordotic angle at 46º±13.38 and males 38.57º±11.44. [20] study in Erzincan, Turkey showed female lordotic angle to be greater at 54.10º±10.72 than males at 47.61º±9.50 ($p<0.001$). In contrast, a study in Delta State, Nigeria by [21] on a normal lumbar spine with age group from 18-60 years shows that males had a higher mean lordotic angle than females.

The present study shows a weak negative correlation between male and female lumbar lordotic angle with age ($r = -0.10$) (Table 8). The findings of the present study are not at large variance with [20] who carried out a study in Iran although a weak positive correlation is seen between age and lumbar lordotic angle in both male and female subjects ($r = 0.31$, $p= 0.001$). Meanwhile, [21] who carried out a study in Delta State, Nigeria showed a weak negative correlation in lordotic angle in males and females ($r= -0.149$, $p= 0.005$) This agrees with the findings of the present study. [20] showed a weak positive significant relationship between age and lordotic angle for male and female ($r=0.3$, $p<0.001$). The findings of both the present and previous studies therefore show poor correlation with age.

The correlation analyses showed the lack of a significant linear relationship between age and lordotic angle of males and females in lumbar spondylosis ($r = -0.10$) (Table 8). These findings show that spinal degeneration is not only affected by age and sex but also factors not considered in this study such as BMI, lifestyle etc could play a more significant role. This is supported as researches carried out show that due to slouched posture characterized by forward flexed neck, prolonged use of smart phones and computers result in larger biomechanical burden on the neck [22].

[23] stated that aging is associated with reduction in the muscle mass of the trunk muscles influencing the integrity of the lumbar spine. Aging in the lumbar spine in some previous studies have shown flattening of middle lumbar spine but no effect on the lower lumbar spine [24], [25]. Some previous studies have also failed to indicate correlation between age and lumbar lordosis [20]. This could be as a result of the fixed pelvic incidence that does not change with age in both males and females [26].

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The pelvic incidence helps maintain the sagittal balance of the spine [27]. This could be the reason why even despite aging and spondylosis the overall lumbar lordosis seems unchanging significantly.
The present study shows that females have statistically significant higher lumbar lordotic angle when compared with males ($t = -5.29$, $p < 0.001$) (Table 7). [26] stated that considering sex-specific loading demands (e.g. pregnancy loads), females exhibit greater lumbar lordotic angle than males for them to accommodate increased upper body load and an anteriorly displaced center of mass during pregnancy. Females show the greatest degree of dorsal vertebral wedging at L3-L5 [28]. This wedging allows them shift their center of mass during pregnancy reducing hip torque by 90% [29].
The absence of a significant linear relationship between lordotic angles and age in the lumbar regions implies that age alone is not a reliable predictor of sagittal alignment changes in spondylosis. This is in agreement with studies by [30]. However, this contrasts with the traditional assumption that spinal curvature progressively decreases with aging. The study shows that degenerative changes may occur in non-linear pattern, influenced by other variables such as body mass index, occupational loading, habitual postures.
In treatment, clinicians should recognize that the normal reference values for lumbar lordosis are significantly different between sexes, even when spondylosis is present. Failure to account for this sexual dimorphism could affect surgery or rehabilitation attempts to restore sagittal balance in females.

Conclusions

The study concludes the degenerative changes of the lumbar spine among spondylosis patients is region specific. The lumbar spine showed significant sexual dimorphism with females exhibiting greater lordotic angles. This reflects inherent anatomical and biomechanical adaptations. Conversely, the lack of a significant linear association with age is consistent across the lumbar segments. This suggests that factors beyond chronological age and localized disease including factors like lifestyle, BMI, and genetic architectural predisposition are critical determinants of sagittal balance of the spine.

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