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Original Article

Morphometric Study of Lower Lumbar spinal canal and canal/body ratio Using Computed Tomographic Images among apparently normal adult Nigerians

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Abstract

INTRODUCTION AND AIM: Lumbar spinal canal play an important role in causes of low back pain, with lumbar spinal canal stenosis being the major causative factor for back pain. Accurate morphometry of the Lumbar vertebrae may be needed for various purposes including spinal fixation in case of fracture. The aim of this study was to determine the morphometry of the lumbar spinal canal as well as the canal/body ratio.

MATERIALS AND METHODS: Four hundred (200 males and 200 females) adults Nigerians with age ranged from 18-65 years. Sagittal diameter of spinal canal (SDC) and Sagittal diameter of vertebral body (SDB) were measured from the third to fifth lumbar vertebrae (L3 to L5) and their ratio calculated. The sexes of 3rd, 4th and 5th lumbar vertebrae were determined by demarking points using the formula: Mean ± 3×Standard Deviations. A probability value <0.05 were considered as statistically significant.

RESULTS: The results showed mean SDC and SDB increased gradually from L3 to L5 with minimum at L3 and maximum at L5. On comparing SDC and SDB between male and female subjects, it was observed that both SDC and SDB were greater at all levels in male subjects compared to female subjects and were all statistically significant (p<0.001). Canal/body ratio ranged between 0.56 to 0.59 in male subjects and 0.59 to 0.62 in female subjects from L3 to L5 respectively.

CONCLUSION: Transverse diameter was the largest dimension of spinal canal and proportional to the size of vertebral body at each level.

Keywords:
Spinal canal; Lumbar Vertebrae; Transverse Diameter; Vertebral Body; Adults; Nigerians

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INTRODUCTION

There are five lumbar vertebrae which forms the largest and movable segments of the vertebral column. They lack foramen trasversarum and costal articular facets which reflect the unique resistance to stresses yet flexible enough to allow the needed mobility (Hussein *et al.,* 2009).

Anatomical variations have been reported on the lumbar shape, size and angulations among same population (Arora *et al.,* 2006). According to Pal (2004), knowledge of lumbar parameters are critical for sex differentiation. Most of the previous studies conducted on the morphometry of lumbar were based on white populations and X-rays (Zindrick, *et al*, 1986, Amonoo-Kuofi, 1995 & Arora, *et al*, 2006).

Dimensions of lumbar vertebrae have importance in clinical diagnosis of lower backache (LBA) and lumbar spinal stenosis. In the stenosis of the lumbar spinal canal there is anteroposterior and transverse dimensions of the neural canal are less than normal for the particular age and sex of the individuals. One of the symptoms of neural canal stenosis is low backache. Both occupational and non–occupational individuals are affected by lower backache with various degree of debilitation. The combined stenosis shows overall narrowing of spinal canal or segmental narrowing, protrusion of disc or any combination of these, associated with more neurological symptoms than any developmental and degenerative types (Azu *et al,*. 2016).

Patients with lumbar pain, the asymptomatic

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group proved to have wider foramina from L3-L5 and wider sagittal diameters in S1 and the patients with canal stenosis revealed lower figures for all diameters of the central canal, lateral recess of L4 and foramina of L4 and L5 (Santiago *et al.,* 2001). Narrowing of the lumbar vertebral canal referred to lumbar canal-stenosis is most typically due to degenerative changes (El-Rakhawy *et al.,* 2010). Population specific variations are common in many body dimensions, hence it imperative to generate populations specific measurements for body dimensions that could hold clinical relevance, providing a baseline data and guide medical and diagnostic knowledge of experts (Clinicians, Orthopedic surgeons, and Radiologist) in their practice.

Anatomists and Forensic anthropologists are often involved in age and sex determination of human from their skeletal remains. It is necessary sometimes to determine age and sex and of isolated bones other than the bones which sexually dimorphic (Gumsu and Asala, 2007). Jit and Singh (1966) suggested demarking point which identifies the sex of the individual with almost 100% accuracy. Singh and Gangrade (1968) reported that even within the same general population mean value may be significantly different in bones from different zones. Singh and Singh (1972) observed that, demarking point should be calculated individually for different regions of the population, because mean parameter may differ in values from region to region. To be certain in identification, calculated ranges have to be considered which could be worked out by adding and subtracting 3 x standard deviation (SD) to and from the mean of any parameter. Jit and Singh (1966), called the limiting point of such calculated range as demarking points, which identify sex with 100% accuracy from any given population or region.

Computed tomography (CT) is advance to magnetic resonance (MRI) and ultrasound for imaging the skeleton because CT performs multiple two-dimensional slices of three-dimensional objects and mathematically reconstructs the cross-sectional image (Haughton, 2006).

The main objective of this research was to determine the morphometry of the lumbar spinal canal as well as the lumbar canal/body ratio with respect to age and sex among adult Nigerians. Presently there is paucity of quantitative data concerning the lower lumbar pedicle using CT scan among Nigerian population. This research focused on age and sex differences of the third, fourth and fifth lumbar vertebrae only.

MATERIALS AND METHODS

Materials

The present study was conducted on four hundred (400) Computed Tomographic (CT) images of apparently healthy adult Nigerians (200 males and 200 females), with age range between 18 and 65 years. The CT images were classified into six age groups. The Sagittal diameter of spinal canal (SDC) and sagittal diameter of vertebral body (SDB) were measured on the third to fifth lumbar vertebrae (L3 to L5) using CR 35X digitizer (Agfa-Gevaert N.V. Belgian-German). Normal CT images between 2019 and 2023 (eight years interval) were used for this study. Abnormal CT images of lumbar vertebrae either due to fractures or bone diseases as well as normal radiographs of individuals less than 18 years of age were excluded from the measurements. This retrospective study was carried out using collections of the Records Unit of the Radiology Departments four hospitals namely; Departments of Barau Dikko Teaching Hospital, Ahmadu Bello University Teaching Hospital, Hospital 44 and Air force Hospital all in Kaduna State, Nigeria. CT data of the subjects were reviewed for age, sex and evidence of bone trauma or any bone related disease. Subjects younger than 18 years were excluded from the study as well as those older than 40 years because of possibility of degenerative changes to the lumbar spine (Kirkaldy-Willis e*t al.,* 1999). Any subject with a clinical or radiographically detectable scoliosis and/or kyphosis of the lumbar spine were also be excluded from the study.

Determination of Sample Size

The minimum sample size was determined using the formula:

$n = 4p\ (1\text{-}p)/w^2$

Where: n= minimum sample size, w= maximum width (precision level)

p= proportion of patients who come for CT Scan of Lumbar or Lumbo-Sacral.

In this study, the value for p =0.5., hence q= 1.0-p=0.5

d=absolute level of precision=0.05 (5%)

Therefore:

$n=4x0.5x\ (1\text{-}0.5)/0.05^2 = 400$. (Pal *et al*., 2004)

Methodology

The Digital Imaging and Communications in Medicine (DICOM) Viewer, INFINITT PACS tool, was used to measure the thin-cut (1 mm) CT scan images. DICOM Viewer is the leading standard for image data management in medical applications. The measurements were being done by a single observer to avoid inter-observer errors and were recorded in millimeters. Parameters measured were the sagittal diameters of the canal and vertebral body where two landmarks at the extremes of the diameter were used respectively. For the sake of consistency, all measurements were taken by one observer and results were recorded as the average of the two measurements per dimension. To evaluate the significance of the results obtained, Student t-test were carried out, made by calculating the ratio between the mean sagittal diameter of the canal and the mean sagittal (antero-posterior) diameter of the vertebral body at the various vertebral levels (L3, L4 and L5).

The sagittal diameter of the spinal canal was measured as the maximum distance between the external cortices of the posterior border of the vertebral body to the external cortex of the union of the vertebral lamina (A to B in Figure 1).. The sagittal diameter of the vertebral body measured as the maximum distance on the midline of the vertebral body from the external cortex of the anterior border to the external cortex of the posterior border (A to B in figure 2). Each CT image was measured twice, with the second measurement serving as a check on the first reading (Jones & Thomson, 1968). Canal body ratio (CBR) was determined by the ratio of the two parameters measured (SDC and SDB).

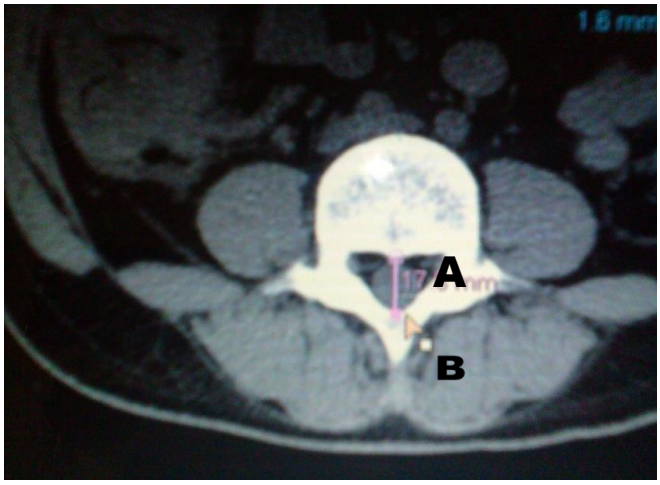

Figure 1: Showing measurement of Sagittal (Antero-Posterior) Diameter of the Spinal Canal in Millimeter (mm)

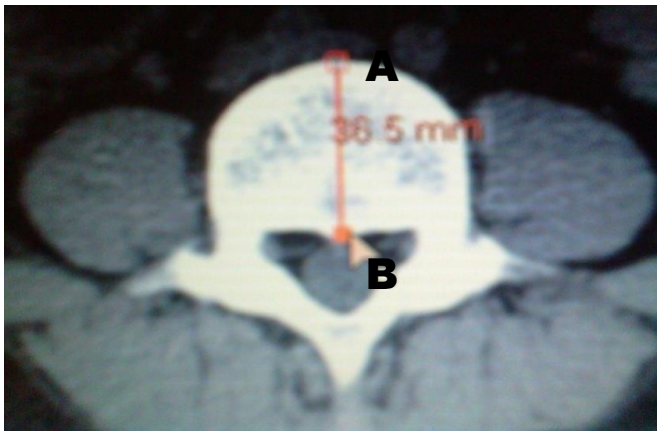

Figure 2: Showing measurement of the Sagittal (Antero-Posterior) diameter of the vertebral body in Millimeter (mm)

Statistical Analysis

Data obtained was subjected to statistical analysis using Instat GraphPad (version 3.05). The level of significance for difference in the parameters tested was placed at $p<0.05$. (http://www.graphpad.com. The sex of the 3rd, 4th and 5th lumbar vertebrae were determined by demarking points using the formula: Mean ± Standard Deviations. A probability value <0.05 was considered statistically significant. Index for sexual dimorphism (ISD) was used to assess whether the parameters measured were sexually dimorphic.

ISD was calculated thus:

$$ISD = \frac{Males' mean\ value}{Females' mean\ value} \times 100$$

ISD is expressed as a percentage and a value greater than 100% indicates sexual dimorphism while value less than 100% is considered not sexually dimorphic (Marin *et al.,* 2006).

For Demarking Points (DPs), a value greater than the upper limit of females' estimated range (ER) was considered a male, and a value less than the lower limit of males'

ER was considered a female. ER was calculated according to the following formula:

ER = M ± 3SD

Where: ER = Estimated range; M = Mean and SD = Standard deviation

RESULTS

Table 1 showed the distribution of measured subjects (males and females) according to age groups in years.

Table 2 showed the antero-posterior diameter in mm of spinal canal of males were greater than the female counterparts (significant P value) across all the age groups studied from 18-25 through 58-65 years.

Table 3 showed the antero-posterior diameter in mm of spinal canal of males were greater than the female counterparts (significant P value) across the age groups studied except in 26-33, 42-49 and 50-57 years.

Table 4 showed the antero-posterior diameter in mm of spinal canal of males were greater than the female counterparts (significant P value) across the age groups studied except in 42-49 and 50-57 years.

Table 5 showed the antero-posterior diameter in mm of spinal canal of were males greater than the female counterparts (significant P value) from L3 through to L5.

Table 6 showed the Demarking Point (DP) antero-posterior diameter in mm of spinal canal of were males greater than the female counterparts (significant P value) from L3 through to L5, similarly the Indices of Sexual Dimorphism were all more than 100 from L3 through L5 suggesting that male parameters were all greater than female parameters.

Table 7 showed the antero-posterior diameter in mm of vertebral body of males were greater than the female counterparts (significant P value) across all the age groups studied from 18-25 through 58-65 years except at 34-41 years age group.

Table 8 showed the antero-posterior diameter in mm of vertebral body of males were greater than the female counterparts (significant P value) across all the age groups

studied from 18-25 through 58-65 years except at 42-49 years age group.

Table 9 showed the antero-posterior diameter in mm of vertebral body of males were greater than the female counterparts (significant P value) across all the age groups studied from 18-25 through 58-65 years except at 42-49 and 50-57 years age group.

Table 10 showed the antero-posterior diameter in mm of vertebral body of are males greater than the female counterparts (significant P value) from L3 through to L5.

Table 11 showed the Demarking Point (DP) antero-posterior diameter in mm of vertebral body of were males greater than the female counterparts (significant P value) from L3 through to L5, similarly the Indices of Sexual Dimorphism were all more than 100 from L3 through L5 suggesting that male parameters were all greater than female parameters.

Table 12 showed that the antero-posterior canal and vertebral body ratio of lumbar vertebrae L3, L4 and L5 (in mm) were 17.4, 17.7 & 18.0 and 31.3, 32.4 & 34.3 for male while the values in females were 15.7, 16.3 & 16.6 and 28.9, 29.5 & 31.9 respectively. The canal body ratio for the male and female were 0.56, 0.55 & 0.52 and 0.55, 0.55 & 0.52 respectively.

Table 1: Distribution of Subjects (Males and Females) According to Age Group (Yrs)

Age Groups (Years)	Males (n)	Females (n)	Total
18-25	25	33	58
26-33	25	33	58
34-41	51	34	85
42-49	35	25	60
50-57	22	16	38
58-65	42	59	101
TOTAL	200	200	400

N = number of CT images measured per age group among males and females

Table 2: Mean Antero-Posterior diameter (mm) of spinal canal in both sexes at L3:

	Male		Female		
Age (Yrs)	Mean ± SD	95% CL	Mean ± SD	95% CL	P-Value
18-25	17.2±1.4	16.6-17.8	15.5±1.6	15.0-16.1	P<0.001
26-33	17.3±1.6	16.6-17.9	15.8±1.5	15.2-16.3	P<0.01
34-41	17.6±1.4	17.2-18.0	16.1±1.3	15.6-16.5	P<0.001
42-49	17.7±1.3	17.2-18.1	16.5±1.2	16.0-16.9	P<0.05
50-57	17.3±1.2	16.7-17.8	15.3±1.5	14.5-16.1	P<0.001
58-65	17.2±1.1	16.9-17.5	15.3±1.3	15.0-15.7	P<0.001

S.D. = Standard Deviation, 95% CI = 95% Confidence interval, P - Value=significance between male and female, Yrs = years, N = number of sample

Table 3: Mean Antero-Posterior diameter (mm) of spinal canal in both sexes at L4:

	Male		Female		
Age (Yrs)	Mean ± SD	95% CL	Mean ± SD	95% CL	P-Value
18-25	18.0±1.5	17.4-18.7	15.4±1.4	14.9-15.9	P<0.001
26-33	17.0±1.8	16.3-17.8	15.9±1.4	15.4-16.4	NS
34-41	17.9±1.3	17.6-18.3	16.4±1.4	15.9-16.9	P<0.001
42-49	18.0±1.5	17.3-18.4	17.0±1.3	16.5-17.5	NS
50-57	17.0±1.5	16.3-17.7	16.4±1.4	15.6-17.1	NS
58-65	17.9±0.7	17.7-18.1	16.6±1.7	16.2-17.1	P<0.001

S.D=Standard Deviation, 95% CI=95% Confidence Interval, P - Value=significance between male and female, Yrs = years, N = number of samples.

Table 4: Mean Antero-Posterior diameter (mm) of spinal canal in both sexes at L5:

	Male		Female		
Age (Yrs)	Mean ± SD	95% CL	Mean ± SD	95% CL	P-Value
18-25	17.8±1.5	16.9-18.1	16.1±1.5	15.5-16.6	P<0.01
26-33	17.7±1.8	16.9-18.4	16.3±1.3	15.9-16.8	P<0.05
34-41	17.9±1.3	17.6-18.3	16.4±1.4	15.9-16.9	P<0.001
42-49	18.3±1.3	17.9-18.8	17.2±1.3	16.7-17.8	NS
50-57	17.7±1.3	17.1-18.2	16.9±1.4	16.1-17.6	NS
58-65	17.9±0.7	17.7-18.1	16.8±1.7	16.4-17.3	P<0.05

S.D=Standard Deviation, 95% CI=95% Confidence Interval, P - Value=significance between male and female, Yrs = years, N = number of samples.

Table 5: Mean Antero-Posterior diameter (mm) of spinal canal in both sexes for L3-L5:

	Male		Female		
VL	Mean ± SD	95% CL	Mean ± SD	95% CL	P-Value
L3	17.4±1.3	17.2-17.6	15.7±1.4	15.5-15.9	P<0.001
L4	17.7±1.4	17.5 - 17.9	16.3±1.6	16.1 - 16.5	P<0.001
L5	18.0±1.3	17.7 - 18.1	16.6±1.5	16.4 - 16.8	P<0.001

VL= Vertebral Level, S.D=Standard Deviation, 95% CI=95% Confidence Interval, P Value=Level of significance, yrs. = years

Table 6: Demarking Point and Index of Sexual Dimorphism for Antero-Posterior diameter of Spinal Canal for Male and Female from L3-L5:

	Male			Female			
VL	Mean ± SD	C.R.	D.P	Mean ± SD	C.R.	D.P.	P-value
L3	17.4 ± 1.3	13.5 - 21.3	>19.9	15.7 ± 1.4	11.5- 19.9	<13.5	110.8
L4	17.7 ± 1.4	13.5 - 21.9	>21.1	16.3 ± 1.6	11.5- 21.1	<13.5	108.6
L5	18.0 ± 1.3	14.1 - 21.9	>21.1	16.6 ± 1.5	12.1- 21.1	<14.1	108.4

S.D = Standard Deviation, C.R = Calculated Range, ISD= Index of Sexual Dimorphism and D.P = Demarking Point, VL = Vertebral Level

Table 7: Mean Antero-Posterior diameter (mm) of Vertebral Body and age (years) at L3:

	Male		Female		
Age (Yrs)	Mean ± SD	95% CL	Mean ± SD	95% CL	P-Value
18-25	32.2±2.2	31.2-33.1	28.6±3.9	27.2-30.0	P<0.001
26-33	31.0±2.7	29.9-32.1	28.1±3.8	26.8-29.4	P<0.01
34-41	30.7±2.0	30.1-31.3	29.8±3.2	28.7-30.9	NS
42-49	30.9±2.2	30.2-31.7	28.5±3.3	27.1-29.8	P<0.05
50-57	31.5±2.1	30.6-32.5	28.4±3.7	26.4-30.4	P<0.05
58-65	31.9±1.6	31.4-32.4	29.4±2.3	28.8-30.0	P<0.001

S.D=Standard Deviation, 95% CL=95% Confidence Limit, P - Value=significance between male and female, Yrs = years, N = number of samples.

Table 8: Mean Antero-Posterior diameter (mm) of Vertebral Body and age (years) at L4:

	Male		Female		
Age (Yrs)	Mean ± SD	95% CL	Mean ± SD	95% CL	P-Value
18-25	32.9±1.7	32.2-33.6	29.8±3.4	28.6-31.0	P<0.001
26-33	32.0±1.9	31.2-32.8	28.9±3.9	27.6-30.3	P<0.001
34-41	32.3±2.1	31.7-32.9	29.8±3.3	28.6-30.9	P<0.001
42-49	32.7±1.9	31.5-32.8	30.7±1.9	29.9-31.5	NS
50-57	32.9±2.2	31.9-33.9	28.4±3.1	26.7-30.0	P<0.001
58-65	32.6±1.6	32.1-33.1	29.3±2.5	28.6-29.9	P<0.001

S.D=Standard Deviation, 95%CL=95% Confidence Limit, P - Value=significance between male and female, Yrs = years, N = number of samples

Table 9: Mean Antero-Posterior diameter (mm) of Vertebral Body and age (years) at L5:

	Male		Female		
Age (Yrs)	Mean ± SD	95% CL	Mean ± SD	95% CL	P-Value
18-25	34.5±2.1	33.6-35.3	31.9±1.3	31.4-32.4	P<0.001
26-33	36.6±3.0	33.3-35.8	32.2±1.6	31.7-32.8	P<0.001
34-41	34.5±2.9	33.7-35.3	32.1±1.8	31.5-32.7	P<0.001
42-49	33.9±3.0	32.8-34.9	32.4±1.6	31.7-33.0	NS
50-57	33.8±2.3	32.8-34.8	32.0±2.6	30.6-33.4	NS
58-65	34.6±2.2	33.9-35.3	31.3±1.5	30.9-31.6	P<0.001

S.D=Standard Deviation, 95%CL=95% Confidence Limit, P - Value=significance between male and female, Yrs = years, N = number of samples.

Table 10: Mean Antero-Posterior diameter (mm) of Vertebral Body and age (years) at L3-L5:

	Male		Female		
VL	Mean ± SD	95% CL	Mean ± SD	95% CL	P-Value
L3	31.3±2.2	31.0-31.6	28.9±3.3	28.5-29.4	P<0.001
L4	32.4±1.9	32.2 - 32.7	29.5±3.0	29.1 - 29.9	P<0.001
L5	34.3±2.6	34.0 - 34.7	31.9±1.7	31.6 - 32.1	P<0.001

VL= Vertebral Level, S.D=Standard Deviation, 95%CL=95% Confidence Limit, P Value=Level of significance, yrs. =years.

Table 11: Demarking Point and Index of Sexual Dimorphism for Antero-Posterior diameter of Lumbar Vertebral Body for Male and Female from L3-L5:

	Male			Female			
VL	Mean ± SD	C. R.	D.P.	Mean ± SD	C. R.	D.P	ISD
L3	31.3 ± 2.2	24.7 - 37.9	>38.8	28.9 ± 3.3	19.0- 38.8	<24.7	108.3
L4	32.4 ± 1.9	26.7 - 38.1	>38.5	29.5 ± 3.0	20.5- 38.5	<26.7	109.8
L5	34.3 ± 2.6	26.5 - 42.1	>37.0	31.9 ± 1.7	26.8- 37.0	<26.5	107.5

S.D = Standard Deviation, C.R = Calculated Range, ISD= Index of Sexual Dimorphism and D.P = Demarking Point, VL = Vertebral Level

Table 12: Ratio of Antero-posterior diameter of the lumbar spinal canal to antero-posterior diameter vertebral body in male and female.

	Male			Female		
VL	Canal	Body	Ratio	Canal	Body	Ratio
L3	17.4	31.3	0.56	15.7	28.9	0.55
L4	17.7	32.4	0.55	16.3	29.5	0.55
L5	18.0	34.3	0.52	16.6	31.9	0.52

VL= Vertebral Level,

DISCUSSION

The present study showed steady increase in mean antero-posterior diameter of lumbar spinal canal among both males and females. It was observed that the antero-posterior diameter of male subjects were significantly greater than those of the female counterpart in all the age groups studied (from 18-25 through 58-65 years) with at least significant differences between males and females (P<0.05). The antero-posterior diameter also increased steadily along the vertebral segments from L3 to L5 in both sexes with significant differences (P<0.001). Male mean antero-posterior diameter ranged from 17.4mm at L3 to 18.0mm at L5, while female mean antero-posterior diameter increased from 15.7mm to 16.6mm at the same vertebral levels with the male counterpart respectively. Study by Jadhav *et al.,* (2011) showed that the mean antero- diameter of the spinal canal goes on increasing from L3 to L5. The antero-posterior diameter is minimum at L3 and maximum at L5, this corresponded with the present study along the vertebral levels. Jadhav *et al.,* (2011), however, that observed the increased trend in antero-posterior diameter of spinal canal was also seen in both the sexes, however, the mean values were lower in females than males. The present study observed that the antero-posterior diameter of the spinal canal was also sexually dimorphic, because the demarking points of male were higher than those of the female counterparts. The Indices of sexual dimorphism were all greater than 100 from L3-L5. Almost all studies conducted on the antero-posterior diameter of the spinal canal showed that male had higher antero-posterior diameter over female counterparts from L3-L5.

The present study showed steady increase in mean antero-posterior diameter of lumbar vertebral body from age groups 26-33 through 58-65 years, with highest values recorded at the 18-25 year of age among both males and females in L3-L5. It was observed that the antero-posterior diameter of male subjects were significantly greater than those of the female counterpart in all the age groups studied (from 18-25 through 58-65 years) with at least significant differences between males and females (P<0.05) except at the age group of the middle age groups at L5, where a decrease in antero-posterior diameter was noted in both males and females (P>0.05) which indicated that the older individual have a relatively smaller vertebral body. This might be due to the progression of the vertebral body collapse and deterioration in older people. Vertebral body anterior-posterior heights and ratios are used in the assessment of vertebral fractures and related to the deformity changes across the vertebrae (Eisenstein, 1977). The antero-posterior diameter also increased along the vertebral segments from L3 to L5 in both sexes with significant differences (P<0.001). Male mean antero-posterior diameter ranged from 31.3mm at L3 to 34.3mm at L5, while female mean antero-posterior diameter increased from 28.9mm to 31.9mm at the same vertebral levels with the male counterpart respectively. Study by Jadhav *et al.,* (2011) showed that the mean antero- posterior diameter of the spinal canal goes on increasing from L3 to L5. The antero-posterior diameter is minimum at L3 and maximum at L5, this corresponded with the present study along the vertebral levels. Jadhav *et al.,* (2011), however, observed that the increased trend in antero- posterior diameter of spinal canal was also seen in both the sexes, however, the mean values are lower in females than males. The present study observed that the antero- posterior diameter of the spinal canal was also sexually dimorphic, because the demarking points of male were higher than those of the female counterparts. The Indices of sexual dimorphism were all greater than 100 from L3-L5.

Almost all studies conducted on the antero-posterior diameter of the spinal canal showed that, male had higher antero-posterior diameter over female counterparts from L3-L5. The size of vertebral body varies proportionately with the build of the individual. In order to find out the relationship between the canal and body size, a comparison was made by finding the ratio between the mean antero-posterior diameter of canal and mean antero-posterior diameter of vertebral body at various vertebral levels (Abdul Rahman (2008) and Jadhav *et al.,* 2011).

Recently, it has been pointed out that instead of measuring the vertebral canal for evaluating the degree of stenosis, it would be more reliable if the ratio of vertebral canal and of vertebral body i.e. canal body ratio (Gupta *et al.,* 1998) is taken as index for calculating the degree of stenosis. Thus, the present study aims to present a set of normal range of measurements of lumbar vertebrae in Nigerian population by studying antero-posterior diameters of spinal canal and vertebral bodies and to find out if there are any regional and sex differences in the dimensions of lumbar vertebrae by CT scan. The results showed that as the size of vertebral body changes, the antero-posterior diameter of canal also varied, maintaining a ratio of at each vertebral level in both the sexes. In this study the antero-posterior canal/body ratio were all 0.6 at L3, L4 and L5 which corresponded with the study by Abdul Rahman (2008) and Abdul Rahman (2009) as well as Jadhav *et al.,* (2011). However it was observed in this study that the antero-posterior canal/body ratios were also 0.6 at both L3 and L4, but at L5 the ratio decreased to 0.5. Thus any deviation of the canal body ratio from its approximate value of 0.6 to one or the other side indicates possibility of intra-spinal tumour or regional difference. Calculation of canal body ratio for different segments can also help in specifying whether an individual's measurement on spinal canal are within the normal limits for the respective body size or not, thus helping to identify a stenosis or enlargement of the spinal canal.

The Demarking Point (DP) antero-posterior diameter in mm of the spinal canal and vertebral body of are males greater than the female counterparts (significant P value) from L3 through to L5, similarly the Indices of Sexual Dimorphism were all more than 100 from L3 through L5 suggesting that male parameters were all greater than female parameters.

Conclusion

The antero-posterior and transverse diameters in mm of spinal canal as well as the vertebral body of males were greater than the female counterparts (significant P value) across the age groups studied and also along the vertebral levels from L3 to L5, though the vertebral body diameter decrease at the L4 and L5 in older age groups. The Demarking Point (DP) antero-posterior diameter in mm of vertebral body of were males greater than the female counterparts (significant P value) from L3 through to L5, similarly the Indices of Sexual Dimorphism were all more than 100 from L3 through L5 suggesting that male parameters were all greater than female parameters. Transverse diameter of the spinal canal at any segmental level is proportional to the size of vertebral body at that level. So, the present study may help the clinicians and spinal surgeons while assessing the spinal canal.

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