LUMBAR VERTEBRAL CANAL DIAMETERS IN ADULT UGANDAN SKELETONS

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Abstract

Background: Normal values of lumbar vertebral canal diameters are useful in facilitating diagnosis of lumbar vertebral canal stenosis. Various studies have established variation on values between different populations, gender, age, and ethnic groups.
Objectives: To determine the lumbar vertebral canal diameters in adult skeletons according to gender, ethnicity, and vertebral levels at Galloway osteological collection of Makerere university.
Methods: A descriptive cross-section study was carried out on 216 complete sets of male and female human lumbar vertebral bones. The midsagittal, transverse diameters of the lumbar vertebral canal and the anteroposterior diameter of the inferior vertebral notch were measured using an electronic digital caliper. Collected data was analyzed using SPSS 12.0 computer program.
Results and discussion: In both sexes, the midsagittal diameter of the canal was wider at the cephalic than at the caudal end; reflecting the size of the contents at this level and also an adaptation to ensure protection of these contents during complex movements of this transition region . A steady widening of the transverse diameter of the canal from L1 to L5 was also observed in both genders. The anteroposterior diameter of inferior vertebral notch was subject to gender and ethnic variation.
Conclusion: The narrowest midsagittal diameter is found at L3 in both genders, the widest transverse diameter on the other hand was at L5. Various diameters of the lumbar vertebral canal varied according to gender and ethnicity.

Key words: Lumbar, Vertebral, Canal, Diameters, Skeletons

Introduction

The lumbar vertebral canal is formed by five successive foramina of the lumbar vertebrae. It is roughly triangular in shape. It is narrowest in its anteroposterior diameter in the axial plane and has a gradual decrease in measurements between L1 and L5, with a greater relative width in the female[1]. It provides great protection to the spinal cord, roots of spinal nerves and the covering meninges, which lie within its cavity.[1]

Anatomical narrowing of the lumbar vertebral canal and intervertebral foramina has been reported as a cause of compression of the cauda equina and the emerging nerve roots [2,3]. The compression is associated with neurological symptoms and signs, such as pain in the back and lower limbs on walking, weakness and paraesthesiae along the distribution of the affected nerve roots. The narrowing could result from congenital or developmental causes and may involve the transverse, sagittal or both diameters of the lumbar canal [4].

Mean sagittal diameters of the lumbar vertebral canal in normal adult Nigerian skeletons were found to be 15.8mm in male and 14.8mm in female, and at all levels, the mean diameters were wider in male than in female.
It was also found that in both sexes, the midsagittal profile of the vertebral canal was wider at the cephalic end and showed a mid-lumbar narrowing. [5] In adult Cubans, the transverse diameters of lumbar vertebral canal increased progressively from L1 (25.1mm) to L5 (32.6mm) in masculine sex. The mean sagittal diameters diminished progressively from L2 (18.7±2.4mm) to L5 (16.2±1.8mm). In addition, it was also observed that the women's canal were smaller than that of men, whereas the canal of black persons were lower than those of Caucasians in the sagittal diameters. [6]

The mean mid-sagittal diameter of the lumbar spinal canal in the Korean population was significantly less than that of white and African populations, but there were no significant differences between the Korean, white, and African populations regarding the transverse diameter of the lumbar spinal canal.[7] This study was aimed at measuring various diameters of the lumbar vertebral canal according to gender, ethnicity and vertebral level to create baseline values for normal adult Ugandans which may be used to facilitate diagnosis of lumbar vertebral canal stenosis for Ugandan population.

Materials and Methods

This was a descriptive cross-sectional study involving skeletons of the Galloway osteological collection museum housed in the department of Anatomy, Faculty of medicine, Makerere University. A total of 216 complete sets of lumbar vertebrae (170 male and 46 female) aged at death between 18 and 60 years were studied. The full medical histories were not obtained for all subjects but it was ensured as far as possible that material from persons who had died of chronic skeletal disorders or related causes were not included. Care was also taken to exclude specimens showing osteophytes or evidence of congenital anomalies.

Direct measurements of the midsagittal, transverse diameter of the canal and the maximum anteroposterior diameters of the inferior vertebral notch were measured using an electronic digital caliper to the nearest 0.01mm. The midsagittal diameter of the canal was measured at the point where the canal is narrowest: near the upper border, at the level of a slight anterior bulge in the deep surface of the posterior wall of the canal (fig 1). The transverse diameter of the canal was taken as the greatest interpedicular distance. The maximum anteroposterior diameter of the inferior vertebral notch was taken as the maximum horizontal distance between the posterior surface of the lower part of the vertebral body and the deep surface of the lamina (figure 2). All measurements were taken in millimeters. Data analysis was performed using SPSS version 13.0.

Results

The midsagittal profile of the vertebral canal was wider at the cephalic end (16.40 ± 1.38 mm in males and 16.41 ± 1.50 mm in females) than it was at the caudal end (16.07 ± 2.27 mm in males and 15.74 ± 1.79 mm in females) and showed a mid lumbar narrowing (fig 3). The difference in this diameter between male and female was not significant.

A steady widening of the transverse diameter (table 1) from the first lumbar vertebrae (20.61 ± 1.70 mm) to the

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fifth lumbar vertebrae (25.01 ± 2.54 mm) was observed in male. A similar pattern was observed in female subjects, except that, the mean diameters were narrower than in the corresponding male subjects (19.69 ± 1.50 mm at L1 and 23.95 ± 2.17mm at L5). The inferior vertebral notch (table 2) showed a slight but steady decrease in diameter from L1 (10.37 ± 1.32 mm) to L5 (9.11 ± 1.43 mm) in males. However, this was not the case in females where a high degree of variation was observed. There was a significant difference between males and females at L1 and L5 (p-value of 0.010 and 0.001 respectively). Significant difference in the transverse diameter at L5 were observed between Bantu and Nilotics (p-value= 0.049) and Nilotics and Hamites. The difference in the anteroposterior diameter of inferior vertebral notch at L3 was significant between Bantu and nilotics (p-value= 0.021).

Table1. Sex and transverse diameter of vertebral canal

Vertebral Level	Sex	Mean transverse diameter of vertebral canal (mm)	P-value
L1	Male	20.61	0.001
	Female	19.69	
L2	Male	21.16	0.001
	Female	20.29	
L3	Male	21.75	0.007
	Female	20.95	
L4	Male	22.75	0.039
	Female	22.15	
L5	Male	25.01	0.010
	Female	23.95	

Table 2. Sex and anteroposterior diameter of the inferior vertebral notch

Vertebral Level	Sex	Mean transverse diameter of vertebral canal (mm)	P-value
L1	Male	10.37	0.010
	Female	7.79	
L2	Male	10.34	0.320
	Female	10.13	
L3	Male	9.88	0.626
	Female	9.88	
L4	Male	9.41	0.440
	Female	9.58	
L5	Male	9.11	0.001
	Female	9.95	

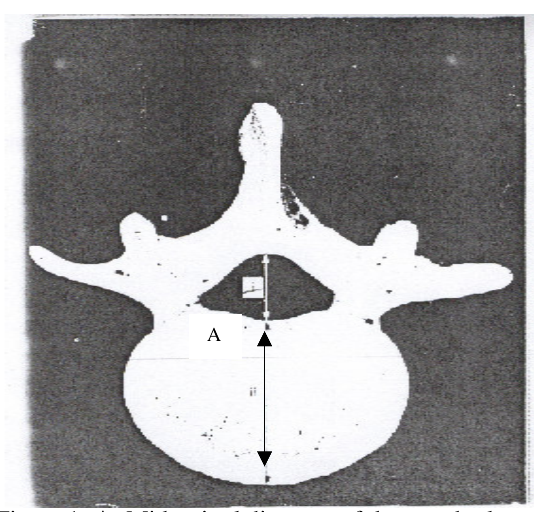


Figure 1: **A-** Midsagittal diameter of the vertebral canal

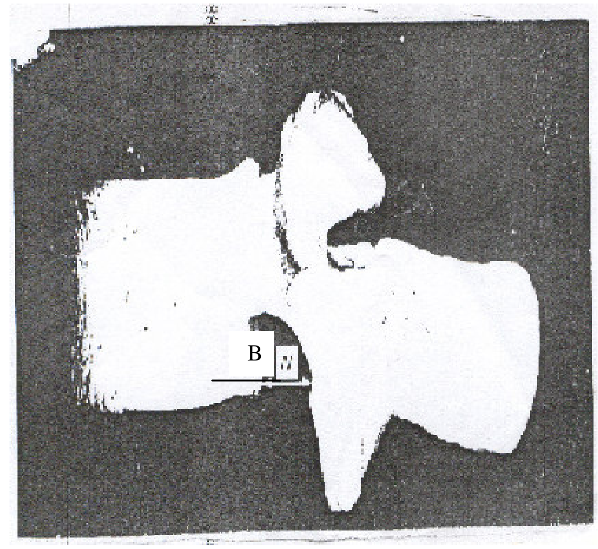


Figure 2: B- Measurement of the sagittal dimension of inferior vertebral notch

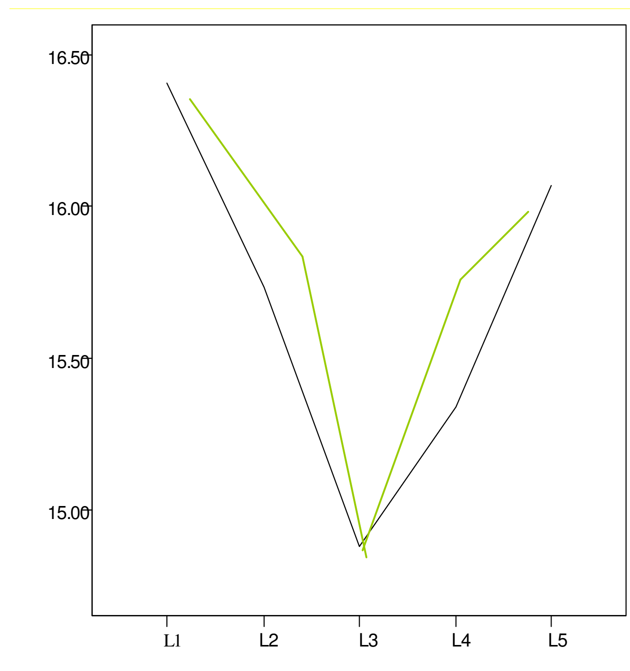
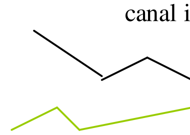


Figure 3: Mean sagittal diameters of the lumbar vertebral canal in males and females



MALE
FEMALE

Discussion

In both gender, the midsagittal diameter was wider at cephalic than at the caudal end, and showed a midlumbar narrowing. Thus the 'hour-glass' shape of the canal observed in other populations[5, 6] was also seen in the

Ugandan subjects in whom the narrowest diameter was found at L3.

As in other populations reported previously[5, 6], the widest midsagittal diameter measured in the present study was at L1 level. From normal anatomy it's known that in most individuals the first lumbar level coincides with the region of function transition between the relatively immobile thoracic spine and the mobile lumbar segment. In addition, this level houses the lower end of the lumbar enlargement of the spinal cord. Hence, the width of the canal at this level may have a reflection not only on the size of its contents, but also of an adaptation to ensure protection of those contents during complex movements of this transition region. At this level also, there is change in the curvature of the spine from the thoracic convexity to the lumbar concavity. The effect is that the lower end of the spinal cord would tend to be displaced posteriorly in the erect posture, and therefore the sagittal diameter has to be capacious enough to accommodate it.

A steady widening of the transverse diameter from the level of the first lumbar vertebrae to the fifth lumbar vertebrae was observed in both genders, the widest transverse diameter in this study was at L5. Since this is the site of the lumbosacral angulation, it is suggested that the tendency for the increase in this dimension at L5 is an adaptation to accommodate the sacral nerve roots; these would bowstring during angular movement between the mobile lumbar segment and the immobile sacrum at the lumbosacral segment[8].

The inferior vertebral notch forms the cephalic boundary, the anterior and posterior walls of the intervertebral foramen. In isolated vertebra, therefore, measurements of the maximum horizontal anteroposterior width of the notch could be used as an index to assess the size of the intervertebral foramen. Since the height of the pedicle contributes to the sagittal diameters of both the canal and the intervertebral foramen, it would be expected that, in the normal individual, the sagittal diameter of the intervertebral foramen and of the canal should show the same pattern of variation with given segmental levels. This study shows that, whilst the maximum anteroposterior diameter of the intervertebral foramen decreases from L1 to L5, the diameter of the canal presents an 'hour – glass' contour, indicating that the other factors, most probably the laminae, play a significant part in determining the dimensions of these two parameters[9]. It is suggested; therefore, that both measurements be employed in assessing stenosis as they evaluate different parts of the spinal canal, either of which may be abnormal[9,10].

Conclusion

In both gender, the midsagittal diameter was wider at the cephalic (16.40mm in males and 16.41 in females) than at the caudal (16.07mm in males and 15.74mm in females) ends, with a midlumbar narrowing. The results also showed that the midsagittal diameter of the canal was determined primarily by the thickness and orientation of the lamina and to a lesser extent by the height of the pedicle. The anteroposterior diameter of the inferior vertebral notch was subject to gender and ethnic variations.

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