

A radiological study of anteroposterior diameter of lumbar spinal canal in western Maharashtra population

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Abstract

Background: The vertebral column, also known as the spinal column, is the central axis of the skeleton in all vertebrates. The vertebral column provides attachments to muscles, supports the trunk, protects the spinal cord and nerve roots. Evolution made humans to acquire an upright posture and since then man has had complaints of back pain. One of the commonest cause of lower backache is stenosis or narrowing of lumbar spinal canal. Stenosis is a quantitative diagnosis which is made when an individual's measurement lie outside the normal range. The present study thus aims to determine the normal range of lumbar vertebrae measurements in plain lateral radiographs of Western Maharashtra population. The anteroposterior diameter of spinal canal and vertebral body of lumbar vertebrae from L1 to L5 were measured. Mean anteroposterior diameter of spinal canal was found to be decreasing from L1 to L5 while the anteroposterior diameter of vertebral body was increasing cranio- caudally. From the parameters, values indicating spinal canal stenosis and intraspinal tumour were calculated. The findings also showed regional variations thus further emphasizing the need to carry out similar studies in different regions so as to determine the normal range of values for those populations.

Key Words: Lumbar canal, anteroposterior diameter, Lumbar canal stenosis

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INTRODUCTION

The vertebral column also called as backbone or spine is a part of axial skeleton. It contains a spinal canal that encloses and also protects the spinal cord. The lower back is formed by lumbar vertebrae, intervertebral discs, ligaments, muscles, nerves and blood vessels. The spinal cord ends at the level of lower border of first lumbar vertebrae (L₁) and the remaining nerve roots, known as the cauda equina, descend down the remainder of the spinal canal. The lumbar spine is subjected to high degree of

stress and load, that may cause many problems resulting in pain. Various causes have been associated with lower backache like degenerative disc disease, osteoarthritis etc. Certain pathological causes may lead either narrowing or enlargement of spinal canal causing backache. However narrowing of lumbar canal plays a significant role. The narrowing of the canal may be either due to congenital or acquired conditions while conditions like intraspinal tumour may lead to enlargement of the spinal canal. The pioneering work of Hinck V.C. *et al.* (1962, 1965),^{1,2} Hawkes C. H. and Roberts G.M. (1980)³ Amonoo-Kuofi H. S. *et al.* (1990)⁴ have established the importance of measurement of sagittal diameter of spinal canal. These studies also showed gender and regional variations. So, the present study was undertaken with an aim to present a set of normal range of measurements of lumbar vertebrae in Western Maharashtra population by studying the anteroposterior diameters of spinal canal and vertebral bodies and also to find out if there is any regional or sex difference in the dimensions of lumbar vertebrae by plain radiographs.

MATERIALS AND METHODS

For the present study, plain lateral radiographs of lumbar spine of hundred adult male and female each of Western Maharashtra were utilized. These radiographs were of known sex and of known age group (between twenty five and fifty years of age). The radiographs of both sexes were taken in lying down position with an anode- film distance of one meter, centered on L₃. The roentgenograms were screened for readability and attempts to eliminate subjects with significant anomalies and other problems. The measurements were made by using a scale calibrated to 0.5 mm. The dimensions of all vertebrae were studied. Following measurements were obtained from lateral radiographs of lumbar spine: (Photograph 1)

A) The anteroposterior diameter of spinal canal:

This corresponds to the minimum distance between the posterior border of the vertebral body shadow and shadow of spinolaminar junction of the same vertebra. The spinolaminar junction was identified by tracing the shadow of inferior margin of spinous process, first anteriorly and then superiorly⁵. Accordingly antero-posterior diameter of spinal canal was measured for each lumbar vertebra.

B) The anteroposterior diameter of vertebral body:

This was measured as the midvertebral distance between the points on anterior border and posterior border of the

vertebral body shadow. This was measured accordingly for each lumbar vertebral body.

The data that was collected was then subjected to the following statistical tests: Mean, Standard deviation, Calculated range, P-value.

The above dimensions of spinal canal and vertebral body in males and females were evaluated for statistical significance. Also, by using statistical tests, conditions like intraspinal tumour and spinal canal stenosis were evaluated.

DATA ANALYSIS: The observations were tabulated and analysed using Microsoft Excel software. Range, Mean and standard deviations were obtained for each of the parameters. However when dealing with normal distributions, maximum and minimum limits can safely be calculated on the basis of standard deviation.⁶ So for better accuracy, the maximum and minimum limits were calculated by adding or subtracting 3 standard deviation to the mean value of each measurement. This gives the calculated range. Carefully measured individual dimensions falling outside the limits given should thus be viewed with suspicion of pathology or anomaly⁷. It must be borne in mind on the other hand that, some abnormal figures may fall within these limits. The ‘P’ value was calculated by applying ‘Z’ test to know whether difference observed between means of male and female were significant or not.

RESULTS

Table 1: The mean anteroposterior diameter of spinal canal in whole sample size

Level	Anteroposterior diameter of Spinal Canal (mm)		
	RANGE	MEAN	STANDARD DEVIATION (SD)
L1	13-25	18.96	2.40
L2	13-24	17.99	2.45
L3	13-24	17.00	2.41
L4	12--23	16.16	2.20
L5	10--20	15.01	2.20

As per Table 1, the mean anteroposterior diameter of spinal canal in the whole sample size was decreasing from L₁ to L₅. The anteroposterior diameter being widest at L₁ while it is narrowest at L₅.

Table 2: The mean anteroposterior diameter (mm) of spinal canal in both sexes

Level	Sex Group	Range	Mean	Standard Deviation	Calculated Range $\pm 3SD$	P Value
L ₁	Male	15-25	20.22	1.74	15.01-25.43	<0.001
	Female	13-22	17.41	2.20	10.80-24.02	
L ₂	Male	15-24	19.25	1.85	13.69-24.82	<0.001
	Female	13-22	16.44	2.20	9.85-23.04	
L ₃	Male	14-24	18.25	1.91	12.52-23.99	<0.001
	Female	13-21	15.47	2.06	9.30-21.64	
L ₄	Male	14-23	17.34	1.69	12.26-22.42	<0.001
	Female	12--20	14.71	1.86	9.14-20.28	
L ₅	Male	13-20	16.38	1.35	12.32-20.45	<0.001
	Female	10--19	13.33	1.85	7.77-18.90	

It is also evident that there is difference in the measurements of anteroposterior diameter of spinal canal in males and females (Table 2). The difference in their means was statistically highly significant (P value <0.001) at each lumbar vertebral level.

Table 3: The mean anteroposterior diameter (mm) of vertebral bodies in both sexes.

Level	Sex Group	Range	Mean	Standard Deviation	Calculated Range \pm 3SD	P Value
L ₁	Male	29-44	37.97	3.07	28.76-47.19	<0.001
	Female	24-37	31.13	3.17	21.62-40.64	
L ₂	Male	29-44	38.37	3.05	29.23-47.51	<0.001
	Female	24-40	32.22	3.45	21.84-42.56	
L ₃	Male	30-46	39.05	3.04	29.94-48.15	<0.001
	Female	25-42	33.08	3.55	22.43-43.72	
L ₄	Male	32-47	39.66	2.98	30.72- 48.61	<0.001
	Female	25-42	33.91	3.72	22.75-45.07	
L ₅	Male	32-48	40.23	3.06	31.04-49.42	<0.001
	Female	25-42	34.61	3.86	23.03-46.19	

The anteroposterior diameter of the vertebral body goes on increasing from L₁ to L₅ (Table 3). It is evident that, there is difference in the means of anteroposterior diameters of the vertebral bodies in males and females and this difference is statistically highly significant (P value <0.001) at each lumbar vertebral level

DISCUSSION

The clinical value of spinal canal measurement is already been established by various studies. The enlargement of spinal canal due to causes like intraspinal tumour can be detected. Also bony encroachment on the spinal canal can also be detected. In 1803, narrowing of the vertebral canal produced by abnormal curvature of the spine was first reported by Portal⁸ In 1934, Elseberg and Dyke established the importance of the radiographic measurement of the spinal canal⁹. Low backache is a very common clinical problem but the narrowing of lumbar spinal canal plays an important role. The study by R.H.Bhatt *et al.* (1990) found that the anteroposterior diameter of canal is the most important parameter for diagnosing spinal stenosis¹⁰. The study by Lee H.M. reported that the mid sagittal diameter of lumbar spinal canal in the Korean population was less than that in white and African populations¹¹. As this parameter is of paramount significance for diagnosing Lumbar spinal stenosis, therefore its normal values in a population are essential for its diagnosis. The present study was conducted to present the normal standards for the dimensions of lumbar spinal canal by plain radiography in Western Maharashtra population. As per table no. 1, and 2, the anteroposterior diameter of spinal canal is decreasing from L₁ to L₅ which is seen in both the sexes however, the mean values are lower in females than in males. The difference in males and females is highly significant. The gradual decrease in the anteroposterior diameter of spinal canal is mainly because of the transition of spinal canal from lumbar type to sacral type.

Table 4: Shows the values (mm) suggestive of spinal stenosis and intraspinal tumour

LEVEL	ANTEROPOSTERIOR DIAMETER OF SPINAL CANAL			
	Suggestive of Spinal Stenosis		Suggestive of Intraspinal Tumour	
	MALE	FEMALE	MALE	FEMALE
L ₁	<15.01	<10.80	>25.43	>24.02
L ₂	<13.69	<9.85	>24.82	>23.04
L ₃	<12.52	<9.30	>23.99	>21.64
L ₄	<12.26	<9.14	>22.42	>20.28
L ₅	< 12.32	<7.77	>20.45	>18.90

As per table no. IV, considering the calculated range, the values less than the lower limits of the calculated range is suggestive of spinal canal stenosis. Similarly, the values more than the upper limits of the calculated range are suggestive of intraspinal tumor (Table 4). Table 3 shows that the mean anteroposterior diameter of vertebral body progressively increases from L₁ to L₅ thus suggesting this increasing trend with respect to its weight bearing functions. The difference between the means of male and female is statistically highly significant. This difference is because of the general somatic size in males and females.

TABLE 5: Comparison of the mean anteroposterior diameter of spinal canal in whole sample size of previous and present studies

Authors	Anteroposterior diameter of spinal canal					
	n	L ₁	L ₂	L ₃	L ₄	L ₅
Hinck V.C <i>et al.</i> 1965	49	21.8	21.7	21.5	21.6	21.4
K.S.Singh <i>et al.</i> 1982	25	20.2	19.8	18.8	18.0	16.9
Present study	200	18.96	17.99	17.00	16.16	15.01

Table 5 shows comparison of the mean values of anteroposterior diameter of spinal canal in whole sample size irrespective of the sex. The mean values of the present study lie in between the values of Hinck *et al.*¹ and those

of K.S.Singh *et al.*¹². The values of all these studies differ with respect to regional selection of population sample thus showing ethnic variations because of environmental factors.

CONCLUSION

In the present study, anteroposterior diameter of lumbar spinal canal and vertebral body were measured on plain lateral radiographs in Western Maharashtra population. It was found that these mean values for males and females were showing statistically significant differences thus indicating sexual dimorphism. Comparison of anteroposterior diameter of spinal canal with other studies showed ethnic variations thus emphasising the need for obtaining the data which will help in radiological diagnosis of lumbar spinal stenosis. The baseline standards will have to be evaluated from time to time for their validity.

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