

Dimensions of Lumbar Spinal Canal in subjects with and without low back pain

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ABSTRACT

Background: Degenerative changes and mechanical stress lead to lumbar spinal canal stenosis resulting in low back pain. Various factors such as genetic, malnutrition, systemic disturbance and trauma may affect the size of lumbar spinal canal.

Aim: To record the dimensions of lumbar spinal canal in symptomless adult male and female subjects and compare them with those with low back pain.

Study design: Cross-sectional population study

Study place Allama Iqbal Memorial Teaching Hospital Khawaja Muhammad Safdar Medical College, Sialkot

Study duration February to November 2020

Material and methods: Anteroposterior and transverse diameters and cross sectional areas of the spinal canal were measured on CT scans using ImageJ1.47v at levels L1 to L5 in adult male and female subjects with and without low back pain.

Results: Anteroposterior diameter was smaller at level L1 in females with pain. Transverse diameter was significantly smaller in females with pain at L2, L3 and L5 and at L3-5 than in those without pain. Comparison of male subjects with and without pain showed significant difference at L5 while similar comparison was significant at L1 and L4 in the females. Highly significant difference ($p < 0.0001$) was observed at L2 to L5 among the males and L1 to L5 in the females when cross sectional areas were compared for the two groups.

Conclusion: Subjects with pain had significantly lower values of various dimensions of the lumbar spinal canal in both sexes. The study has provided gender specific reference data which could be helpful in clinical assessment of spinal canal stenosis

Keywords: Lumbar spine, spinal canal, morphometry, low back pain, spinal canal stenosis

INTRODUCTION

Lumbar spinal canal stenosis (LSS) with an incidence of one in thousand is on the increase due to increased longevity; the pathology is a concentric narrowing of the spinal canal¹. Congenital or developmental stenosis is not common. Acquired spinal canal stenosis remains the prevalent type due to degenerative changes and prevailing mechanical stress². Narrowing of the canal is due to changes in the bone and soft tissue resulting in compression of nerve roots and causing symptoms such as low back pain and intermittent claudication² coupled with disability in walking necessitating surgery especially in older patients^{2,3}. Various factors such as genetic, malnutrition, systemic disturbance and trauma may affect the size of lumbar spinal canal¹. It is well established that the skeletal features of a population are specific depending upon its race, geography and socioeconomic status⁴.

The objectives of our study were (1) to record the normal values of anteroposterior and lateral diameters along with cross sectional area of the lumbar spinal canal at different levels in symptomless male and female subjects in our population and (2) to compare these values with those having low back pain.

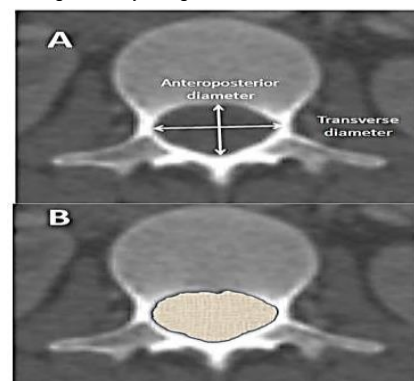
MATERIAL AND METHODS

This prospective cross sectional population study was carried out over a period of eleven months starting March 2020 at Khawaja Muhammad Safdar Medical College and affiliated Allama Iqbal Memorial Teaching Hospital, Sialkot after obtaining approval by the ethical committee for medical research. Individual consent of patients was taken to be included in the study.

A thorough clinical history was taken to exclude those with inflammatory disease, tumor or trauma and only patients with mechanical low back pain were selected. This included 16 male (mean age 54 ± 8.9 years) and 18 female (mean age 49 ± 6.4 years)

subjects. The symptomless control group comprised of 12 males (mean age 48 ± 9.7 years) and 14 females (mean age 45 ± 7.3 years) subjects. Anteroposterior and transverse diameters and cross sectional areas of the spinal canal were measured on CT scans at levels L1 to L5 (Fig. 1). All measurements were made in ImageJ1.47v radiological image processor. The data were tabulated and means and SD drawn. Student's t-test was used for comparison and statistical significance considered at 95% CL.

Figure 1: Scheme of measurements. A: The anteroposterior diameter was taken in the median sagittal plane and the transverse diameter at the largest breadth of spinal canal. B: Area of the canal (shaded) was measured by drawing a line along the bony margin.



RESULTS

The values of anteroposterior and transverse diameters in millimeters and cross sectional area in mm^2 in male and female subjects with and without low back pain along with the p -values for significance of various statistical comparisons are given in Table 1.

Anteroposterior diameter was significantly smaller only at level L1 in the females when comparison was done with subjects without pain; other comparisons were insignificant. Transvers diameter was found to be significantly smaller in the females at L2, L3 and L5 in subjects without pain and at L3-5 in those with pain; comparison of male subjects with and without pain showed significant difference at L5 while similar comparison was significant

at L1 and L4 in the females. Highly significant difference was observed at L2 to L5 among the males when cross sectional areas were compared for the two groups; the value of cross sectional area was lesser in subjects with low back pain. Similar observation was made for the females at L1 to L5 where the cross sectional area was smaller in subjects with pain.

Table 1: Values of anteroposterior and transverse diameters in millimeters and cross sectional areas in mm² in male and female subjects with and without low back pain along with the p-values for significance of various statistical comparisons.

Parameter	WITHOUT PAIN			WITH PAIN			P-value Male without vs Male with pain	P-value Female without vs Female with pain
	Male n=12	Female n=14	P-value Male vs Female	Male n=16	Female n=18	P-value Male vs Female		
Anteroposterior Diameter (mm)								
L1	15.2±0.9	15.1±1.1	0.8040	14.3±1.6	14.0±1.3	0.5509	0.0924	0.0167*
L2	15.6±1.6	15.2±1.8	0.5580	14.7±1.4	14.1±1.5	0.2386	0.1253	0.0690
L3	15.5±1.3	15.4±2.1	0.8875	15.1±1.7	14.6±1.8	0.4128	0.5034	0.2553
L4	16.1±1.7	16.2±2.2	0.8992	15.7±2.5	15.2±2.1	0.5307	0.6376	0.2005
L5	16.7±2.1	16.3±2.4	0.6579	16.2±3.2	15.8±2.9	0.7047	0.6426	0.6064
Transverse Diameter (mm)								
L1	19.8±2.1	19.2±1.8	0.4402	18.3±2.3	17.9±1.3	0.5038	0.0882	0.0242*
L2	21.6±2.4	19.8±1.9	0.0432*	19.9±2.6	18.8±1.7	0.1296	0.0887	0.1273
L3	23.3±1.9	21.6±2.2	0.0474*	23.1±1.7	20.4±2.1	0.0004**	0.7718	0.1267
L4	25.7±3.1	23.7±2.6	0.0861	24.3±2.2	21.8±2.3	0.0029**	0.1734	0.0364*
L5	27.9±2.7	25.4±2.4	0.0197*	25.6±1.8	24.3±1.8	0.0435*	0.0119*	0.1485
Cross-sectional Area (mm²)								
L1	258.9±33.4	249.8±46.8	0.5797	231.6±61.6	202.3±52.3	0.1434	0.1776	0.0122*
L2	266.6±47.3	254.6±55.4	0.5618	202.5±45.4	188.7±44.1	0.3758	0.0012**	0.0008**
L3	271.3±39.8	261.9±61.6	0.6546	187.2±38.7	172.5±39.6	0.2830	< 0.0001**	< 0.0001**
L4	277.8±52.3	268.4±55.3	0.6618	192.4±51.3	184.9±42.4	0.6440	0.0002**	< 0.0001**
L5	283.2±41.6	274.7±48.7	0.6398	198.1±44.6	178.2±57.9	0.2745	< 0.0001**	< 0.0001**

*Significant **Highly significant

DISCUSSION

Since racial, geographic and gender differences in dimensions of lumbar spinal canal exist^{4,5}, it is desirable that each group of population should have their own reference range. Current study has attempted to provide the same in adult male and female subjects of our population.

We observed a gradual increase in anteroposterior and transverse diameters and cross-sectional area from L1 to L5 in both male and female subjects without pain; the values of all these dimensions were comparatively lower in the females. The cross-sectional area was significantly smaller in both male and female subjects with pain as compared to the control group. These observations are consistent with previous studies⁵⁻⁹.

It has been proposed that anteroposterior diameter less than 11 mm should be considered as spinal canal stenosis^{3,10}. Our results in contrast have given a larger value in subjects of both sexes with pain. This could be due to genetic peculiarity of the regional population.

Our results have clearly indicated significant comparative morphometric changes in various dimensions of lumbar spinal canal in subjects with low back pain. This could assist clinical deliberations by the physician by making comparison with the normal reference values in an individual case^{2,11-12}.

A limitation of the study is the small number of sample. A study with larger number of subjects would be desirable. Also the height and weight of the subjects were not taken into account; these confounding factors have been reported to affect the dynamic changes in response to prevailing stress and aging in lower lumbar spine^{1,5,13,14}. Nevertheless the study has provided some gender specific basic reference values of the lumbar spinal canal. Further work in this direction would be of interest not only to the anatomist and radiologist but also to the practicing physician.

CONCLUSION

The study has shown comparatively significantly lower values of various dimensions of the lumbar spinal canal in subjects with low back pain in both sexes. It has also provided gender specific basic

reference data which could be helpful in clinical assessment of spinal canal stenosis.

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