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ORIGINAL ARTICLE

Lumbar Vertebral Body and Disc Morphometry in Punjab

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ABSTRACT

Background and objective: Low back pain is common in the elderly due to adaptive changes to stress and osteoporosis of the lumbar spine. Skeletal geometry varies in different population groups. Objective of this study was to record reference values of morphometric data of lumbar spine in normal adult male and female subjects of Punjab.

Study design: Cross-sectional population study

Material and methods: Anterior and central height and concavity index for each vertebra were measured and calculated from radiographs. Anterior and posterior height and anteroposterior diameter were measured for each disc and wedge index was calculated.

Results: All parameters were significantly larger in the males as compared to the females. Significant difference was found in the anterior height of the intervertebral discs at L1-2 to L4-5 while it was insignificant at L5-S1. Posterior height of discs was significantly larger in the male group at L1-2 to L3-4. Wedge index (WI) for discs was relatively larger in the female group.

Conclusion: The study has provided some reference values of measurements of lumbar spine in adult male and female population of Punjab which may be valuable for better assessments of morphological changes by the clinician and for further research in this area.

Keywords: Lumbar vertebrae, intervertebral disc, morphometry, concavity index, wedge index, lumbar spine

INTRODUCTION

Lumbar spine consistently undergoes dynamic changes and remodeling in response to the prevailing stress pattern. Lower back pain is as common a symptom as 60 to 90 percent in a general clinic[1] and its association with age related changes in lumbar vertebrae and degeneration of the intervertebral disc has been reported[2]. Shao et al[3] have suggested that irreversible histological changes in lumbar spine occur as a result of adaptation to the prevalent mechanical stress conditions with advancing age. As a consequence the height of vertebrae and intervertebral discs are reduced along with an overall curvature of the spine[4].

Current approach to develop lumbar spine models such as finite element model to study physiological response under various loading conditions requires specific geometrical information of lumbar spine in a population[5]. Total disc arthroplasty has also become a more common surgical procedure for disc-related pathology[6]. More recently inter-body fusion with a variety of methods has become popular for constructing a solid anterior column to restore height and sagittal alignment [7,8]. Precise description of lower lumbar morphometry therefore may be beneficial for designing and selection of spinal implants[5].

Since skeletal morphology varies in various population groups depending upon their genetic, geographic location and socioeconomic status [5,7] the current study was planned to record morphometric values of lumber vertebrae and discs on lateral view radiographs in normal adult male and female population in Punjab.

MATERIAL AND METHODS

The study was carried out at Lahore General Hospital, Lahore during the period February to November 2020 after obtaining approval by the Ethical Committee for Medical Research.

The scheme of measurements is shown in Figure 1. Various dimensions of the lumbar vertebrae and discs were recorded from a lateral view radiograph of symptomless adult 44 male (mean age 34+7.6 max: 42, min: 26) and 37 female (mean age 29+6.9 max: 37 min: 22) volunteers who consented to be included in the study.

Anterior (Va) and central (Vc) height of each lumbar vertebra was measured along with the anteroposterior diameter (VapD). Concavity index (CI) for each vertebra was calculated by dividing the central height by the anterior height i.e., Vc/Va. Similarly height of each disc was recorded at two points: anterior (Da) and posterior (Dp). Anteroposterior diameter (DapD) was also recorded. Wedge index (WI) was calculated after the method described by Kunkel et al[9] as the anterior height divided by posterior height of each disc i.e., Da/Dp.

All measurement were taken by one investigator and independently repeated by another observer. Data were tabulated and means drawn. Statistical comparisons were made using students t-test at 95% CL.

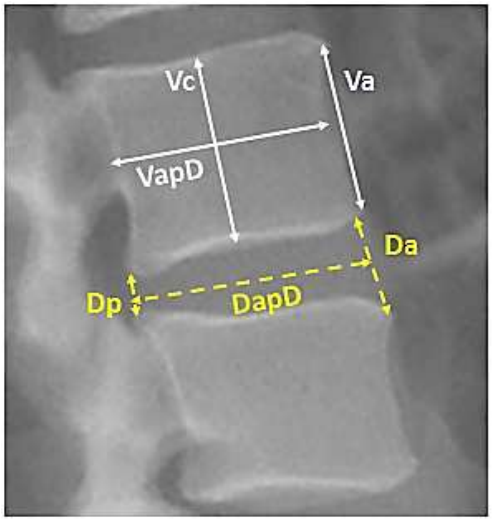

Figure 1: Showing the scheme of various measurements. Va: anterior height of vertebra, Vc: central height of vertebra, VapD: anteroposterior diameter of the vertebra, Da: anterior height of intervertebral disc, Dp: posterior height of intervertebral disc, DapD: anteroposterior diameter of the intervertebral disc

RESULTS

Tables 1 and 2 show the means+ SD values of measurements and convexity index of each lumbar vertebra and measurements of

intervertebral discs and wedge index in the male and female subjects. Statistical comparison of various measurements is presented in Table 3.

Anterior height, central height and anteroposterior diameters in all the lumbar vertebrae were highly significantly larger in the male as compared to the female group. Only anterior height of L1 was statistically not different. Concavity index (CI) of all lumbar vertebrae was comparatively larger in the male. Significant difference was found in the anterior height of the intervertebral discs at L1-2 to L4-5 while the difference was insignificant at L5-S1. Posterior height of the discs was significantly larger in the male group at L1-2 to L3-4. The anteroposterior diameter of the discs was highly significantly larger in male group at all levels. Wedge index (WI) for discs was relatively larger in the female group.

Table 1: Showing the mean + SD values of various measurements in millimeters and concavity index (CI) of lumbar vertebrae on lateral view radiographs in the male (n=44) and female (n=37) subjects.

VERTEBRA	Va (Mean + SD)		Vc (Mean + SD)		VapD (Mean + SD)		CI (Vc/Va)	
	Male	Female	Male	Female	Male	Female	Male	Female
L1	23.21+0.14	23.17+0.16	23.10+0.16	22.34+0.17	36.41+0.14	33.31+0.12	0.99	0.96
L2	23.74+0.11	24.66+0.11	23.11+0.13	22.76+0.21	37.63+0.26	35.66+0.19	0.97	0.92
L3	25.78+0.18	26.13+0.17	24.61+0.21	22.44+0.14	39.12+0.19	36.43+0.21	0.95	0.85
L4	25.91+023	26.74+0.21	25.13+0.19	23.12+0.24	41.54+0.31	38.74+0.23	0.96	0.86
L5	27.47+0.19	28.11+0.25	26.10+0.22	23.41+0.29	42.44+0.28	39.22+0.31	0.95	0.83

Table 2: Showing the mean + SD values in millimeters of various measurements of lumbar intervertebral discs and their wedge index on lateral view radiographs in the male (n=44) and female (n=37) subjects

DISC LEVEL	Da (Mean + SD)		Dp (Mean + SD)		DapD (Mean + SD)		WI (Da/Dp)	
	Male	Female	Male	Female	Male	Female	Male	Female
L1-2	11.3+1.2	9.5+1.4	5.7+0.7	5.1+0.9	44.7+2.1	42.2+1.9	0.12	0.15
L2-3	12.9+0.9	11.4+1.2	6.1+0.6	5.7+1.1	45.4+1.9	42.8+1.8	0.16	0.18
L3-4	14.2+1.4	13.2+1.8	6.9+1.1	6.4+0.8	46.3+3.2	43.6+2.4	0.18	0.22
L4-5	16.4+1.1	14.3+2.2	7.4+1.4	7.3+1.2	46.7+2.7	44.1+2.7	0.21	0.24
L5-S1	17.3+2.0	16.8+2.3	8.1+1.9	7.8+1.0	46.2+2.9	43.7+3.1	0.23	0.26

Table 3: Showing P-values of statistical comparison for significance of difference between the various measurements of male and female subjects

Lumbar Vertebrae			
Level	Anterior Height	Central Height	Anteroposterior diameter
L1	0.2337	< 0.0001**	< 0.0001**
L2	< 0.0001**	< 0.0001**	< 0.0001**
L3	< 0.0001**	< 0.0001**	< 0.0001**
L4	< 0.0001**	< 0.0001**	< 0.0001**
L5	< 0.0001**	< 0.0001**	< 0.0001**
Intervertebral Discs			
Level	Anterior Height	Posterior height	Anteroposterior diameter
L1-2	< 0.0001**	0.0012**	< 0.0001**
L2-3	< 0.0001**	0.0413*	< 0.0001**
L3-4	0.0062**	0.0241*	0.0001**
L4-5	< 0.0001**	0.7336	< 0.0001**
L5-S1	0.2985	0.3900	0.0003**

*Significant **Highly significant

DISCUSSION

Every patient complaining of low back pain will routinely get an x-ray done. Morphometric assessment of various parameters of lumbar vertebrae and discs on radiographs therefore would be an appropriate approach for the clinician especially in rural and remote areas where more sophisticated techniques may not be available. Since the skeletal geometry is variable the availability of reference values in a specific population group for comparison is germane in this regard[10] and justifies the objective of the study.

Although lumbar spinal morphometry has remained a subject of interest since long[11], measurements on cadaveric material in earlier studies are not reliable because of postmortem changes such as dehydration and the possible effects of preservation chemicals and freezing, and may not reflect the same geometric characteristic as in vivo. Measurement on radiographs is a relatively better and more suitable option in a clinical setting.

Observations on lateral view radiographs in our study revealed a gradual increase in anterior and posterior heights and anteroposterior diameter of the intervertebral discs from L1-L2 to L5-S1 both in the male and female groups. This is in contrast to previous observers[12,13] who reported a smaller disc at L5-S1; it may be peculiar to the age group and demography of our sample. In our observations the statistical difference between two sexes was highly significant ($p < 0.0001$). Wedging index of the discs had clearly shown a cranio-caudal gradient; increasing gradually both in the male and female group. Females having more wedging than the males. These results are consistent with previous studies [2,4,5].

A cranio-caudal increasing trend of anterior and central heights and anteroposterior diameter of lumbar vertebrae was observed both in the male and female subjects. The anterior height (Va) from L2 to L5 was significantly more in the female ($p < 0.0001$) leading to a lower value of convexity index. Change in concavity index of the vertebrae was slight and with a gradual decrease in a cranio-caudal pattern in both sexes. This is in agreement with observations by Gocmen-Mas et al[14]. The study has shown a clear gender influence on lumbar spine morphology. Previous studies have also shown similar observations [5,15,16].

This is a first report on morphometric data of lumbar spine in Southern Punjab. However it has its weaknesses. The cross sectional population sample had a broad range of 42 to 26 years for males and 37 to 22 years for females limiting its applicability to general population in the region. A relationship of lumbar spine geometry with gross anthropometry has been reported[17] and since the subjects in both groups in this study had different individual height and weight these confounding factors may have influenced the results.

Nonetheless the study has provided some vital reference values of measurements of lumbar spine in adult male and female population of Southern Punjab which may be of academic interest not only for the anatomist and radiologist but also useful for the practicing physician to help make better assessment of morphological changes by comparison. We hope that the information may also be valuable in designing population specific intervertebral disc implants. Nevertheless a study with a larger sample segmented in different age groups of male and female subjects and with due consideration of any confounding factors would be desirable. A longitudinal study in this regard could be even more promising.

CONCLUSION

The study has provided some vital reference values of measurements of lumbar spine in adult male and female population of Punjab which may be useful for the practicing clinician to help make better assessment of morphological changes

by comparison and also for the anatomist and radiologist for further research in this area.

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