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Short Communication

Morphometric Study of Lumbar Intervertebral Disc by MRI

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ABSTRACT

Introduction: Accurate knowledge of normal lumbar intervertebral discs is of practical importance for the orthopedic surgeons and radiologists
Materials and methods: Morphometric parameters of the intervertebral discs were obtained from MRI of 100 healthy individuals (50 males and 50 females) age between 25 to 70 years
Observations: The different parameters studied; i.e. Midpoint height of the disc, Anterior disc height, Posterior disc height, Superior length of the disc, Inferior length of the disc and Disc depth.
Summary: Changes in discs at different levels in lumbar region were studied and the statistical sex difference was observed in mean values of males and females.

Keywords: Intervertebral disc, lumbar, MRI, Sex difference

INTRODUCTION

The vertebral column possesses a considerable degree of flexibility which is because of the presence of intervertebral discs. [1]

The lumbar spine is designed to provide axial rigidity to the lower trunk to sustain axial compression loads exerted from the trunk and upper limbs and permit movements between the trunk and pelvis.

The intervertebral disc is responsible for transmission and stabilizing a combination of compression, torsion and bending forces subjected to the trunk of the body. [2]

The intervertebral disc consists of a gelatinous nucleus pulposus which is surrounded by an annulus fibrosus. This particular construction can withstand the high loads acting on the spine during everyday life, while giving mobility to the vertebral column. [3]

Humzah and Soomes, Oda et al suggested that irreversible changes of the disc height are associated with the adaptation of the intervertebral discs to alterations in the prevailing functional conditions with the vertebral column during aging. [4]

MATERIALS AND METHODS

Morphometric parameters of the lumbar vertebrae and the intervertebral discs were obtained from 100 healthy individuals

(50 males and 50 females) age between 25 to 70 years

The mid sagittal T1 weighted MR images using image analysis software were taken. The subjects with disc herniation, vertebral fractures, and congenital or acquired bone deformities were excluded in the present study. The limits of intervertebral discs were taken as the anterior and posterior ends of the vertebral end plates.

1. Midpoint height of the disc (MHD)

The distance of line joining the midpoint of AB and midpoint of CD

2. Anterior disc height (AHD

The measurement between A and C

3. Posterior disc height (PHD)

The distance between B and D

4. Superior length of the disc (SLD)

The distance between A and B

5. Inferior length of the disc (ILD)

The distance between C and D

6. Disc depth (D)

The mean of superior and inferior length of the disc (SLD+ILD/2)

OBSERVATIONS

The following different parameters were studied; i.e. Midpoint height of the disc, Anterior disc height, Posterior disc height, Superior length of the disc, Inferior length of the disc and Disc depth

Mean values were obtained in mms. Standard deviation of the parameters was calculated. The difference observed between means of male and female to know whether it is statistically significant, that is value of 'P' is calculated by applying 'Z' test.

Abbreviations used in following tables are:

LD1- Intervertebral disc between L1 and L2
LD2- Intervertebral disc between L2 and L3
LD3 - Intervertebral disc between L3and L4
LD4- Intervertebral disc between L4 and L5
LD5- Intervertebral disc between L5 and S1
P - Probability or The level of significance for difference between two means

Table no 1 Midpoint height of the disc (MHD) (in mm)

MHD		LD1	LD2	LD3	LD4	LD5
Male	Mean	11.28	12.53	13.02	13.07	12.65
	SD	2.58	2.28	2.29	3.4	1.94
Female	Mean	9.56	10.53	11.51	11.89	12.06
	SD	1.59	1.96	1.83	2.52	2.3
P value		0.000	0.000	0.000	0.051	0.169
Statistical significance		Highly Significant	Highly Significant	Highly Significant	Significant	Not Significant

There is gradual increase in height from LD1 to LD5 in males and LD1 to LD5 in females.

There is statistical sex difference in mean values of midpoint height of the disc in males and females.

Table no 2 Anterior disc height (AHD) (in mm)

AHD		LD1	LD2	LD3	LD4	L D5
Male	Mean	8.98	10.33	11.5	13.15	14.04
	SD	2.01	1.91	2.3	2.02	2.24
Female	Mean	8.08	8.92	10.42	12.46	13.31
	SD	1.26	1.53	1.67	2.23	2.66
P value		0.009	0.000	0.000	0.108	0.141
Statistical significance		Highly Significant	Highly Significant	Highly Significant	Not Significant	Not Significant

There is craniocaudal increase in anterior disc height from LD1 to LD5 both in males and females. There is statistical sex difference in mean values of anterior height of the disc in males and females from LD1

to LD3 and no statistical sex difference was found in values of LD4 and LD5

Table no 3 Posterior disc height (PHD) (in mm)

PHD		LD1	LD2	LD3	LD4	LD5
Male	Mean	6.93	7.48	7.96	7.94	7.33
	SD	1.59	1.3	1.33	1.7	1.22
Female	Mean	6.69	7.19	7.39	7.7	6.83
	SD	1.04	1.4	1.38	1.25	1.29
P value		0.374	0.286	0.038	0.423	0.049
Statistical significance		Not Significant	Not Significant	Significant	Not Significant	Significant

There is increase in posterior disc height from LD1 to LD3 in males and LD1 to LD4 in females. The mean values of posterior disc height are showing the statistical sex difference in LD3 and LD5 in males and females.

Table no 4 Superior length of the disc (SLD) (in mm)

SLD		LD1	LD2	LD3	LD4	L D5
Male	Mean	29.87	31.19	32.05	31.79	30.76
	SD	2.35	2.09	2.42	2.76	3.35
Female	Mean	26.43	28.19	29.19	29.38	28.29
	SD	1.89	1.94	2.08	2.42	2.86
P value		0.000	0.000	0.000	0.000	0.000
Statistical significance		Highly Significant	Highly Significant	Highly Significant	Highly Significant	Highly Significant

The mean values of superior length of the disc increase craniocaudally from LD1 to LD4 in males and females. All the mean values from LD1 to LD5 showing statistical difference in sex in males and females.

Table no 5 Inferior length of the disc (ILD) (in mm)

ILD		LD1	LD2	LD3	LD4	LD5
Male	Mean	37.37	32.27	32.64	32.54	30.35
	SD	2.59	2.15	2.68	2.91	3.48
Female	Mean	27.65	29.29	30.05	30.05	27.44
	SD	1.97	2	2.3	2.86	2.4
P value		0.000	0.000	0.000	0.000	0.000
Statistical significance		Highly Significant	Highly Significant	Highly Significant	Highly Significant	Highly Significant

Inferior length of the disc height is more in LD3 in males and in LD4 in females. All the mean values from LD1 to LD5 showing statistical difference in sex in males and females.

Table no 6 Disc depth (D) (in mm)

D		LD1	LD2	LD3	LD4	L D5
Male	Mean	29.95	14.98	22.46	18.72	20.57
	SD	5.13	2.56	3.84	3.2	3.6
Female	Mean	27.04	13.52	20.28	16.9	18.59
	SD	1.84	0.92	1.38	1.15	1.26
P value		0.000	0.000	0.000	0.000	0.000
Statistical significance		Highly Significant	Highly Significant	Highly Significant	Highly Significant	Highly Significant

The disc depth is more in LD1 in both the sexes. All the mean values from LD1 to LD5 showing statistical difference in sex in males and females.

Fig 1: Mid sagittal T1 weighted MR image of lumbar vertebrae
A Anterior end of inferior border of L4
B Posterior end of inferior border of L4
C Anterior end of superior border of L5
D posterior end of superior border of L5

DISCUSSION

Morphometric studies established that vertebrae undergo continuous growth and remodeling throughout the life, in response to the changing needs of the body. [5]
Tomanitsu T investigated that T1 weighted sagittal MR images of the lumbar vertebrae in the vertebral morphometry are useful in comparisons with lateral radiographs. The values of anterior and posterior vertebral height obtained by MRI were greater than by X ray morphomery. The central vertebral height by MRI was smaller than X ray morphometry. [6]

The first sign of the disc degeneration proceeds disc height decrease. As degeneration progresses, disc height decreases. [7]

Hadidi studied the changes in midpoint lumbar disc heights in an asymptomatic Jordanian sample relative to age, sex, lumbar level and midvertebral heights. The result showed that sex independent cephalocaudal increase sequence of midpoint disc heights is evident, where maximum values are recorded at lumbar ¾ level in the younger age groups and at lumbar 5 / sacral level in older ones.The relative height indices were similar in both sexes and remained fairly constant between age groups at all levels.The craniocaudal and age dependent patterns could be termed physiological and interpreted as adaptation of the lumbar spine to changing functional demands. [8]

The mechanical properties of the intervertebral discs largerly determine the mode and amount of transmission of forces from one vertebra to another. [9]

The Amonoo-Kuofi studied morphometric changes in heights and anteroposterior diameters of the lumbar intervertebral disc with age. [10]

The heights of the lumbar disc of men and women within age 20 to 69 years increased with increasing age (4.6- 6.9% in men and 4.7-8.4% in women) The vertebral body endplates became more concave with age. [11]

Clinical part

The high resolution on MR imaging is sensitive in detecting disc disease and in characterizing various subtypes of extradural defects. [12]

From a clinical point of view, low back pain and disc herniation represent major health problem influenced by multiple factors including age and gender. Indeed low back pain ranks high as the most common and expressive health problem.

Accurate knowledge of normal and degenerative lumbar intervertebral discs is of practical importance for the orthopedic surgeons and radiologists alike, for accurate diagnostic interpretation and surgical procedures on the lumbar disc. [9]
The measurements of intervertebral disc help in development of artificial intervertebral disc (AID).

Summary

Changes in the different parameters such as mid height, anterior disc height, posterior disc height, superior length,

inferior length of the disc and disc depth have been studied by the measurements from the MRI.

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