Chattagram Maa-O-Shishu Hospital Medical College Journal
Volume 23, Issue 2, July 2024

Original Article

Gender Related Change in Morphometry of Normal Lumbar Intervertebral Disc by MRI in a Tertiary Level Hospital of Bangladesh

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Date of Submission : 24.02.2024
Date of Acceptance : 20.03.2024

www.banglajol.info/index.php/CMOSHMCJ

Abstract

Background: *Morphometry of lumbar intervertebral disc is valuable for the diagnostics and therapeutic purposes and also for adequate planning, preparation and preoperative selection of prosthetic implants. This study was aimed to measure the morphometry of all lumbar intervertebral discs in relation to sex.*

Materials and methods: *This cross-sectional analytical study was conducted in the Department of Anatomy, Chittagong Medical College, Chattogram, upon 50 male and 50 female from April 2021 to March 2022. All participants with normal lumber MRI scan as certified by expert radiologist were recruited from Radiology and Imaging department of Chittagong Medical College Hospital (CMCH) as per inclusion criteria. T2 weighted sagittal lumbar normal MRI scans were included in this study. All measurements such as Superior Length of the disc (SL) and Inferior Length of the disc (IL) Anterior Disc Height (ADH) midpoint disc height (MDH) and Posterior Disc Height (PDH) were taken and recorded in a predesigned case-record form. Measurements were presented as mean±SD and were compared by unpaired student's t test. Data were analyzed by SPSS (Version 26.0). Finally the results were presenters using tables and figures.*

Results: *In this study mean SL and IL of male were greater than female and showed an increase from L1-L2 to L4L5 but unpaired student's t-test revealed that the difference in SL and IL were not statistically significant in any sex (p>0.05). For ADH, MDH and PDH all mean values were found to be higher in males than in females except for the MDH in the L1-L2 level and for ADH in the level of L5-S1.Also the mean of ADH, MDH and PDH were not statistically significant in relation to sex (p>0.05).*

Conclusion: *The result of the present study provides some baseline information about morphology of lumbar intervertebral disc of normal Bangladeshi population and encourages further research in this field.*

Key words: Lumbar intervertebral disc; MRI; Sex.

INTRODUCTION

The vertebral column possesses a considerable degree of flexibility due to presence of intervertebral disc.[1] The intervertebral disc (IVD), which is made up of the annulus fibrosus, nucleus pulposus, and end plates, is a crucial and dynamic tissue that resides between the vertebrae.[2] The intervertebral disc is responsible for transmission and stabilizing a combination of compression, torsion and bending forces subjected to the trunk of the body.[3] The most prone place to the common backache ailment is the lumbar region.[4] Back pain and intervertebral disc degeneration are closely associated.[5] The most popular technique for determining intervertebral disc degeneration specifically is Magnetic Resonance Imaging (MRI).[6] MRI is non invasive and provides diverse information about soft tissues of lumbar area in sagittal and axial planes.[7] From a clinical point of view, low back pain and

disc herniation represent a major health problem and are influenced by multiple factors including age and gender.[8] Artificial Disc Replacement (ADR) is an example of operative methods that have been recently introduced to restore the intervertebral disc space so that the segmental movement maintains.[9] For the development of an artificial intervertebral disc the morphometry of the ADR is very important.[10] Morphometry of lumbar intervertebral disc is valuable for the diagnostics and therapeutic purposes. It is also essential for the design of artificial lumbar intervertebral discs to ensure good prosthesis-vertebra contact and better load distribution and can improve spinal biomechanics. Keeping the above background knowledge this study is aimed to evaluate the morphometry of intervertebral disc in both genders in different lumbar vertebral level by MRI among normal Bangladeshi population of Chattogram.

MATERIALS AND METHODS

This cross sectional analytical study was carried out with 50 male and 50 female of age 30 years and above, from April 2021 to March 2022 in the Department of Anatomy, Chittagong Medical College. After getting approval from the ethical review committee of Chittagong Medical College, the study subjects were selected from patients attending in Radiology and Imaging Department of CMCH according to enrollment criteria. Subjects having bone deformity such as, acromegaly, dwarfism etc. and tribal people were excluded. MRI scans were performed with high field 1.5 Tesla Magnetic resonance system (Hitachi, Japan) with HMS Spine Coil. After reporting the MRI as normal scan by the expert radiologist the subjects were contacted.

All the subjects were informed and explained about the aim and objective of the study along with its procedure in detail before taking their written consent for voluntary participation in the study. Age was recorded according to birth certificate or vaccination card of the subjects. A data sheet was designed to record the demographic information along with thedifferent morphometric measurements which involves It involves the measurement of Superior Length of Intervertebral Disc (SL) Inferior Length of Intervertebral Disc (IL) Anterior Disc Height (ADH) Midpoint Disc Height (MDH) and Posterior Disc Height (PDH). Superior length of the disc was measured as the distance between anterior end and posterior end of the inferior border of corresponding upper vertebrae of the relevant intervertebral disc, measured in mm. Inferior length of the disc was measured as the distance between anterior end and posterior end of the superior border of corresponding lower vertebrae of the relevant intervertebral disc measured in mm.[11] Anterior Disc Height (ADH) was taken as the distance between the extreme anterior margins of the two adjacent vertebral endplates of the relevant intervertebral disc, measured in mm. Midpoint Disc Height (MDH) was taken as the distance between the midpoints of the two adjacent vertebral endplates of the relevant intervertebral disc measured in mm. Posterior Disc Height (PDH) was measured as the distance between the extreme posterior margins of the two adjacent vertebral endplates of relevant intervertebral disc, measured in mm (Figure 1).[12]

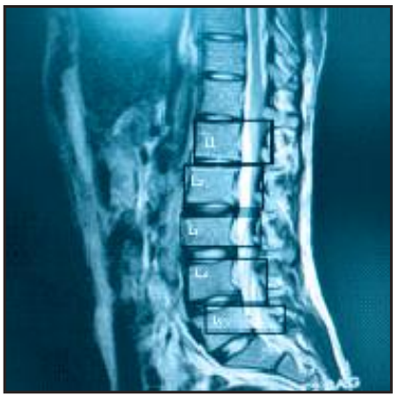

Figure 1 T2 Sagittal image of MRI of Lumbar vertebrae and intervertebral disc

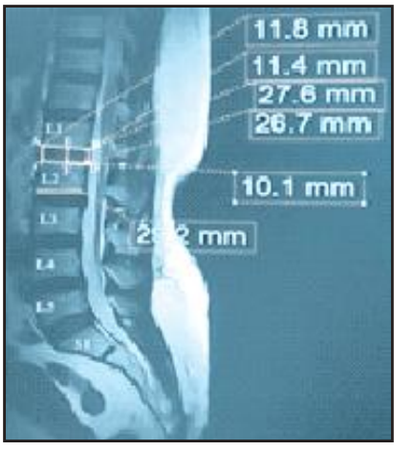

Figure 2 Lumbar MRI showing measurement of SL, IL, ADH, MDH and PDH.SL (A -B) IL (C-D) ADH (A-C) MDH (E-F) PDH (B-D).

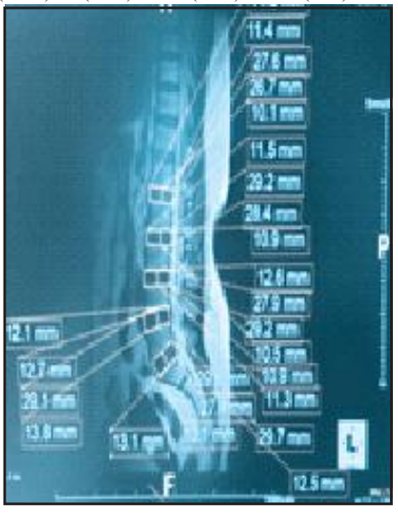

Figure 3 Showing measurement of all lumbar intervertebral discs (L1/L2 to L5/S1) in normal MRI scan

RESULTS

A total of 100 participants fulfilling the inclusion and exclusion criteria were enrolled in the study with male: female of 1:1. The age of the respondents ranged from 30-79 years with the mean ± SD age of 43.50±12.61 years. The mean age ± SD of males was 43.56±12.34 year whereas 43.44±13.01 year was in females.

There were 46 (46%) participants in age group of 30-39 years, 21 (21%) participants in the age group of 40-49 years, 18 (18%) participants in the age group of 50-59 years, 8 (8%) participants in the age group of 60-69 years and 7 (7%) participants in the age group of 70-79 years (Figure 4).

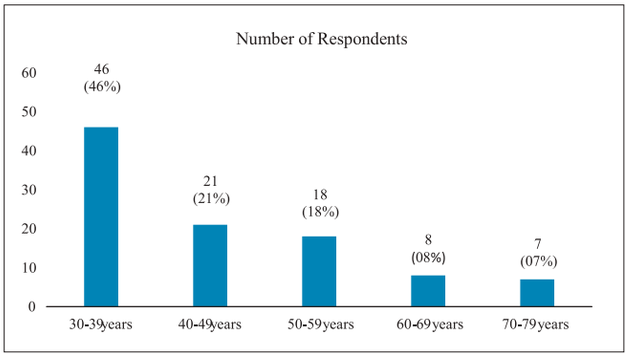

Figure 4 Distribution of the respondents according to age (n=100)

Table I Comparison of the mean values and standard deviations of Superior Length (SL) and Inferior Length (IL) of lumbar intervertebral disc at different lumbar vertebral level in relation to both sexes (n=100)

Vertebral level	Length of IVD	Males (n=50)	Females (n=50)	p-value	p – value
L1-L2	SL	29.77±2.74	28.87±3.63	0.165	p>0.05
	IL	30.00±3.63	29.00±3.63	0.141	p>0.05
L2-L3	SL	30.64±2.42	29.79±3.73	0.181	p>0.05
	IL	30.96±3.62	30.38±3.65	0.357	p>0.05
L3-L4	SL	31.63±2.35	31.17±3.50	0.443	p>0.05
	IL	31.82±2.26	31.53±3.62	0.630	p>0.05
L4-L5	SL	32.45±2.21	31.94±3.39	0.381	p>0.05
	IL	32.83±2.68	32.51±3.58	0.612	p>0.05
L5-S1	SL	32.23±2.42	31.72±3.17	0.367	p>0.05
	IL	32.13±2.80	31.44±3.13	0.251	p>0.05

p> 0.05 = not significant.

Table I shows the mean SL and IL has cephalo-caudal gradient of increase from L1-L2 to L4L5 but there was decrease in SL and IL at the level of L5-S1 than the L4-L5 among both genders. Unpaired student's t-test was performed to compare the means of male and female but there was no statistically significant difference in SL and IL among male and female (p>0.05).

Table II Comparison of the mean values and standard deviations of the Anterior Disc Height (ADH) Midpoint Disc Height (MDH) and Posterior Disc Height (PDH) of lumbar intervertebral disc at different lumbar vertebral level in relation to both sex (n=100)

Vertebral level	Height of IVD	Males (n=50)	Females (n=50)	p-value	p– value
L1-L2	ADH	8.29±1.26	8.16±1.17	0.612	p>0.05
	MDH	7.35±0.91	7.39±1.25	0.848	p>0.05
	PDH	7.85±1.20	7.54±1.18	0.195	p>0.05
L2-L3	ADH	9.15±1.15	8.85±1.03	0.166	p>0.05
	MDH	8.20±1.10	8.07±0.90	0.510	p>0.05
	PDH	8.07±1.09	7.92±0.97	0.477	p>0.05
L3-L4	ADH	10.07±1.34	10.02±1.26	0.835	p>0.05
	MDH	9.12±1.10	8.77±1.15	0.123	p>0.05
	PDH	8.87±0.99	8.67±1.18	0.364	p>0.05
L4-L5	ADH	11.64±2.08	11.05±1.44	0.098	p>0.05
	MDH	9.86±1.55	9.59±1.28	0.343	p>0.05
	PDH	9.25±1.35	9.15±1.20	0.694	p>0.05
L5-S1	ADH	12.24±2.58	12.31±2.19	0.895	p>0.05
	MDH	10.13±2.06	9.94±1.83	0.624	p>0.05
	PDH	8.91±1.25	8.76±1.35	0.575	p>0.05

p> 0.05 = not significant

Table II shows all mean values were found to be higher in males than in females except for the MDH in the L1-L2 level and for ADH in the level of L5-S1. The mean ADH and MDH has cephalo-caudal gradient of increase from L1-L2 to L5-S1 both in male and female. There was increase in mean PDH from L1-L2 to L4-L5 but there was decrease in height at the level of L5-S1 than the L4-L5 among both sexes. Unpaired student's t-test was performed to compare the means of male and female but there was no statistically significant difference among ADH, MDH and PDH of male and female (p>0.05).

DISCUSSION

In this study mean SL and IL of male were greater than female and showed an increase from L1-L2 to L4-L5 that means SL AND IL are highest in L4-L5 level both in males females. But unpaired student's t-test revealed that the mean of SL and IL were not statistically significant in any sex (p>0.05). Bepat et al. (2015) in their study found that there was highly significant between mean values of SL from LD1 to LD5 among males and females (p<0.01).The inferior length of the disc height is more in LD3 in males and in LD4 in females. All the mean values of IL from LD1 to LD5 showed statistical difference in sex in males and females (p< 0.01).[11] This dissimilarity may be due to their different methods. In their study they used T1 weighted MRI images.

In this study all mean values were found to be higher in males than in females except for the ADH in the level of L5-S1. The

mean ADH has cephalo-caudal gradient of increase from L1-L2 to L5-S1 both in male and female. This result is consistent with earlier investigations.[11,12,13] But the results of Mirab et al. indicated that the mean value of measured ADH of lumbar intervertebral discs in the male populations showed an increase from L1/L2 level to L4/L5 level, whereas these dimensions decreased at L5/S1 level. On the other hand, in the group of healthy females, anterior intervertebral disc height increased from L1/L2 to L5/S1.[14] Fetouh in Egypt showed that there was a cephalocaudal gradient of increase from L1/L2 to L5/S1 discs nearly in all decades studied except L5/S1 disc in 3rd and 4th decades at which it decreased. These findings are partially dissimilar with the present study and may be due to racial difference.[15] The trend of higher mean values in males than in females coincides with the studies by Onishi et al. (2019) and Fetouh et al.[15,16] Konrad Bach et al. (2019) conducted a study on 240 lumbar CT They found ADH significantly smaller for women than men ($p < 0.001$) except L5/S1, in which it was approximately the same height. It is may be due to different method and large sample size.[17] In the current study unpaired student's t-test was performed to compare the means of male and female but there was no statistically significant difference in ADH of male and female ($p>0.05$) . This finding coincides with other studies of Malkoc et al. and Gocmen et al. (2010). ($p>0.05$).[13,18]

In the current study all mean values were found to be higher in males than in females except for the MDH in the L1-L2 level. The mean MDH has cephalo-caudal gradient of increase from L1-L2 to L5-S1 both in male and female. This difference of MDH is similar to that of Bepat et al. and Onishi et al.[11,16] But dissimilar with the findings from Mansur et al. Mirab et al. Fetouh et al. and Al-Hadidi et al.[8,12,14,15] Anna et al. in Poland assessed 557 abdominal computed tomography scans. In their study midpoint height of the intervertebral discs increased from Th12/L1 to L3/L4 level (mean maximal height (mm)±SD 9.53±2.35). The mean height of IVD at the L4/L5 level was smaller than at L3/L4 which is dissimilar with current study.[19]. This difference may be due to different method and large sample size. Statistical analysis revealed by unpaired t test in this study that there was no statistically significant difference in MDH of male and female ($p>0.05$). Also the findings of Mansur et al. showed no statistical sex difference in mean values of MDH at any level which is similar to the findings of present study.[12] But Selcuk et al. also found in CT of Lumbar intervertebral disc the L1-L2 intervertebral disc heights were significantly higher in females ($p=0.006$). However, L3-L4, L4-L5, and L5-S1 intervertebral disc heights were significantly higher in males, when compared to females. These values and comparisons between groups reveals a statistical significance of $p<0.001$ in all comparisons. This is dissimilar with present study.[20] This dissimilarity may be due to racial difference and different method.

In the present study there was increase in mean PDH from L1-L2 to L4-L5 but there was decrease in height at the level of L5-S1 among both sex groups which is similar with Mansur et al. and Mirab et al. and Fetouh.[12,14,15] Again, here all mean values were found to be higher in males than in females. This result is similar with Onishi et al.[16] In current study the highest difference between the anterior and posterior disc height is recorded at the L5-S1 level, being the mean difference of 3.3 mm in the male and 3.55 mm in the female. In contrast, Onishi et al. found that there was a significant difference in the segment L5-S1's height between measurements of the anterior and posterior heights, with a mean difference of 5.1 mm for females and 5.42 mm for males, which is different from the findings of the current study.[16] This dissimilarity may be due to racial difference. In this study unpaired student's t-test was performed to compare the means of male and female but there was no statistically significant difference in PDH of male and female ($p>0.05$) . Both the study of Mansur et al. and Fetouh also showed no statistical sex difference in mean values of PDH at any level ($p>0.05$).[12,15] Bepat et al. showed the mean values of posterior disc height are showing the statistical sex difference in LD3 and LD5 in males and females. ($p<0.001$).[11]

LIMITATIONS

The present study may not be accurately representative of the population of Bangladesh because the sample size was very small and it was solely drawn from Chattogram.

CONCLUSION

In the normal population of Chattogram, Bangladesh, the study reported a difference between the superior and inferior length of the disc in relation to sex, however this difference was not statistically significant. There was no discernible difference between males and females in terms of anterior disc height, midpoint disc height or posterior disc height.

For accurate diagnostic interpretation and surgical procedures on the lumbar intervertebral disc, orthopedic surgeons and radiologists must have this basic knowledge of the shape of the lumbar intervertebral disc in the normal Bangladeshi population among both sexes. This will contribute to the creation of a standard for information on various populations as a whole and stimulate additional study in the area.

RECOMMENDATION

To create a larger sample size and acquire more reliable data, a multicenter, nationwide study that includes the indigenous people of the nation should be taken into consideration.

ACKNOWLEDGEMENT

We thank all of the teachers and staff members of the Department of Anatomy at Chittagong Medical College for their sincere support as well as Consultant, Department of Radiology, CMCH and other staff members under the MRI unit of the Radiology Department.

DISCLOSURE

All the authors declared no competing interest.

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