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Morphometric Study of Cervical Intervertebral Disc

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Abstract:

CONTEXT- Any pathology in intervertebral discs may also affect the intervertebral foramen and spinal canal at that level.The height of intervertebral disc directly affects the size of the intervertebral foramen. So, normal dimensions of intervertebral discs are very important.
OBJECTIVE- The present study was carried out to determine the normal height of cervical intervertebral discs in Western Maharashtra Population. The study was carried out in 2011.
MATERIAL & METHOD- Normal lateral radiographs of cervical spine of three hundred adult subjects of known age and sex from Western Maharashtra were utilized. These radiographs were obtained from Radiology Department, P. V. P. Government Hospital, Sangli, Radiology Department, Government Medical College, Miraj and other colleges and private practitioners in the region of Western Maharashtra.
RESULT- The study showed that, the height of intervertebral discs goes on increasing from C2-C3 to C5-C6; thereafter it decreases from C5-C6 to C6-C7, in both sexes. Thus, the mean height of intervertebral disc at the level of C5-C6 was greater than the other interverbral discs of cervical spine, in both sexes. It also showed statistically significant difference in their mean values of males and females, indicating the sexual dimorphism as well as evidence of racial variation.
CONCLUSION- Careful study of this parameter can be used in radiological detection of clinical conditions like prolapsed intervertebral disc, etc. The value of mean heights of intervertebral disc less than lower limit of calculated range, suggests some pathology at that particular intervertebral disc level such as prolapsed intervertebral disc, etc. Such cases need further investigations and clinical evaluation. Thus, the normal dimensions of intervertebral discs of cervical spine, determined from present study, can be used as reference values for evaluating various clinical conditions in the cervical spine in Western Maharashtra population.
KEY WORDS- Intervertebral discs, Intervertebral foramen, Spinal canal

Introduction:

Intervertebral disc is an integral part of the spine. Various aspects of intervertebral discs have been studied by various authors. Vesalius A. (1543)[1] first referred to the disc in situ. Normal dimensions of intervertebral discs are very important. Any pathology in the intervertebral discs may also affect the intervertebral foramen and spinal canal at that

level. The height of intervertebral disc directly affects the size of the intervertebral foramen. (Lu J. *et al*,1999)[2].. So, it is important to know the normal height of intervertebral disc. Many workers have studied the dimensions of cervical intervertabral discs in various ethnic groups but so far no work was found to be done in people of Western Maharashtra region. Therefore this study has been undertaken to determine the normal dimensions of cervical intervertebral discs in Western Maharashtra population.

Materials & Method:

For present study, normal lateral radiographs of cervical spine of three hundred adult subjects from Western Maharashtra were utilized. These radiographs were of known sex (one hundred and fifty males and one hundred and fifty females) and of known age group (between twenty five to forty years of age).

These radiographs were obtained from Radiology Department, P. V. P. Government Hospital, Sangli; Radiology Department, Government Medical College, Miraj and other colleges and private practitioners in the region of Western Maharashtra.

The radiographs of both sexes were taken with subjects standing straight in neutral relaxed position, forward facing to a defined point to prevent rotation of the neck, with shoulders relaxed and arms down. The distance between X-ray tube and film plate was 1.5 meter. The X-ray tube was focused on the fourth cervical vertebra.These radiographs were diagnosed as 'normal' by experienced radiologists. The radiographs showing any obvious abnormality were excluded from the study.

The measurements were made by using scale calibrated to 0.5 mm. The dimensions of C3 to C7 cervical intervertebral discs were studied. (Figure 1)

The heights of intervertebral disc:

a) The maximum height of intervertebral disc:

This is the maximum vertical distance between the points, one on inferior border of vertebral body shadow and the other on superior border of the successive vertebral body shadow.

b) The minimum height of intervertebral disc:

This is the minimum vertical distance between the points, one on inferior border of vertebral body shadow and the other on superior border of the successive vertebral body shadow.

After obtaining these dimensions the average height of intervertebral disc was calculated by taking mean of maximum and minimum heights of intervertebral disc.

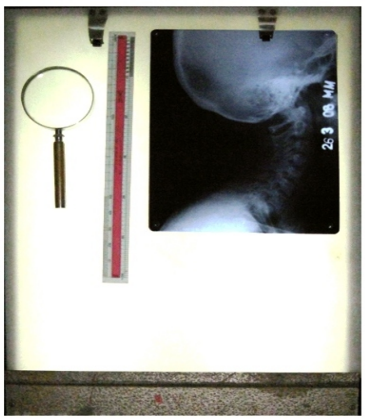
The data collected was subjected to statistical tests. Using statistical tests, conditions like prolapsed intervertebral disc were evaluated and discussed.

X-Ray Cervical Spine Lateral View

e = Maximum height of intervertebral disc

f = Minimum height of intervertebral disc

Mean height = (e+f)/2



Material Used

1. Cervical spine X-ray (Lateral view)
2. X-ray view box
3. Measuring Scale
4. Magnifying lens.

Figure 1. Method for measurement of cervical intervertibral disc.

Observations & Results:

Range, mean and standard deviation (S.D.) of each measurement was calculated. By using the formula "mean ± 3 S.D." calculated range was derived. This calculated range will cover 99.75% of sample population of this study. Any value lying outside the calculated range, suggest pathological condition of the intervertebral disc and require further investigations and clinical evaluation.

From the Table 1, it was observed that, the value of mean height of intervertebral disc, gradually goes on increasing from above downwards i.e., from C2-C3 level to C5-C6 level. Thereafter it decreases from C5-C6 level to C6-C7 level, in both sexes. The mean height of intervertebral disc at the level of C5-C6 was greater, than other intervertebral discs of cervical spine, in both sexes. The values of mean heights of intervertebral discs were greater in males than in females. The difference in the mean value of males and females was statistically significant ($P < 0.01$ at each intervertebral disc level).

From the Table 2, it was observed that the mean height of intervertebral disc of whole population group under present study, goes on increasing from above downwards in the upper segment of cervical spine i.e. from C2-C3 level (3.51 mm) to C5-C6 level (4.45 mm), thereafter it goes on decreasing from C5-C6 level (4.45 mm) to C6-C7 level (4.11 mm). Thus, maximum height of intervertebral disc was found at C5-C6 level (4.45 mm).

Table 1: Showing mean height (in mm) of intervertebral discs in both sexes.

Level	Sex	Range	Mean ±SD	Calculated range (Mean±3SD)	Z-value	P-value
C2-C3	M	3-5.5	3.7 ±0.51	2.17-5.23	7.91	<0.01
	F	2.5-4.75	3.32 ±0.32	2.36-4.28		
C3-C4	M	3-5.5	3.92 ±0.45	2.57-5.27	7.5	<0.01
	F	3-4.75	3.56 ±0.39	2.39-4.73		
C4-C5	M	3.25-6.25	4.18 ±0.51	2.65-5.71	4.1	<0.01
	F	3.25-5.25	3.97 ±0.37	2.86-5.08		
C5-C6	M	3-6.25	4.55 ±0.52	2.99-6.11	3.78	<0.01
	F	3.5-5.5	4.35 ±0.39	3.18-5.52		
C6-C7	M	3-6	4.19 ±0.54	2.57-5.81	2.97	<0.01
	F	3.25-5.25	4.03 ±0.4	2.83-5		

Table 2: Showing mean height of intervertbral discs (in mm) for whole population group under present study.

Vertebral level	Range	Mean	S. D.
C2-C3	2.50 – 5.50	3.51	±0.47
C3-C4	3.00 – 5.50	3.74	±0.46
C4-C5	3.25 – 6.25	4.07	±0.46
C5-C6	3.00 – 6.25	4.45	±0.47
C6-C7	3.00 – 6.00	4.11	±0.48

Table 3: Showing the lower limits (calculated range) of mean height (in mms) of intervertebral discs.

Vertebral level	Values suggestive of abnormally reduced heighti.e., Values < (Mean-3 S.D.)	
	Male	Female
C2-C3	<2.17mm	<2.36mm
C3-C4	<2.57mm	<2.39mm
C4-C5	<2.65mm	<2.86mm
C5-C6	<2.99mm	<3.18mm
C6-C7	<2.57mm	<2.83mm

Discussion:

Normal dimensions of intervertebral discs are very important. Any pathology in intervertebral discs may also affect the intervertebral foramen and spinal canal at that level.The height of intervertebral

disc directly affects the size of the intervertebral foramen. The reduction in the height of intervertebral disc by 3 mm is associated more frequently with severe narrowing of the neuroforamen. (Lu J. *et al*,1999).[2]

In adults, maximum movement of flexion and extension occurs around the level of the disc between C5-C6 cervical vertebral body and it is here that the earliest and also the most severe degenerative changes are to be found. The next common site of change is at the C6-C7 disc**(**David Sutton).[3]

The findings of height of intervertebral disc in present study were compared with the findings of other workers.

Lu J et al (1999)[2] found the maximum value (3.56 mm) of mean height of intervertebral disc at the level of C3-C4, whereas in the present study the mean height of intervertebral disc was maximum (4.45 mm) at the level of C5-C6, and minimum (3.51 mm) at C2-C3 level. Thus the findings of present study do not correlate with the findings of Lu J et al (1999)[47].

Bhalla et al (1977)[4]observed that intervertebral disc space at the level of C2-C3 was of the smallest width, thereafter it increases in size until the level of C5-C6. Measurements of intervertebral disc showed that the disc space was maximum at C5-C6 level (4.4mm), and minimum at C2-C3 level (2.58mm). Thus the findings of present study correlate well with the findings of Bhalla et al (1977).[4]Bhalla et al have used anteroposterior radiographs of cervical spine.

Study done by Debois V et al (1999)[5] strongly suggest that the degree and severity of neurologic symptoms accompanying cervical soft disc herniation are inversely related to the sagittal diameter and the area of the bony cervical spinal canal. The area of bony cervical spinal canal is reduced in cases of developmental stenosis or because of soft disc herniation. Moreover, patients with soft cervical disc herniation have a significantly smaller sagittal diameter of the bony spinal canal, a significantly smaller minimal bony intervertebral foramen diameter, and a significantly smaller cross-sectional area of bony cervical canal than do healthy matched individuals.

In present study, the maximum height of intervertebral discs was observed in the anterior part of the disc, and minimum height was observed in posterior part of the discs, on lateral radiograph of cervical spine. The same pattern was also observed by Lu J. et al (1999).[2]This pattern in the height of intervertebral disc is responsible for giving the anterior convexity to the cervical spinal curvature, as mentioned in various standard text books of Anatomy.

From the Table 3 it was observed that, the value of mean heights of intervertebral disc less than lower limit of calculated range, suggests some pathology at that particular intervertebral disc level. The abnormally reduced height may be due to various clinical conditions such as prolapsed intervertebral disc, etc. Such cases need further investigations and clinical evaluation.

Summary:

The dimensions of cervical vertebral body, spinal canal and intervertebral discs are an important consideration in the diagnosis, prognosis and treatment of diseases related to cervical spine and spinal cord.

In the present study, normal lateral radiographs of cervical spine of three hundred Western Maharashtra adult subjects with known age (between 25 to 40 years) and known sex (hundred and fifty males and hundred and fifty females) were studied.

The height of third to seventh cervical intervertebral disc was studied in the present study. The height of intervertebral discs goes on increasing from C2-C3 to C5-C6; thereafter it decreases from C5-C6 to C6-

C7, in both sexes. Thus, the mean height of intervertebral disc at the level of C5-C6 was greater than the other interveterbral discs of cervical spine, in both sexes.

Height of intervertebral discs showed statistically significant difference in their mean values of males and females, indicating the sexual dimorphism. Comparison of these dimensions with corresponding dimensions from other ethnic groups showed evidence of racial variation. Furthermore, careful study of these parameters and ratio, can be used in radiological detection of clinical conditions like prolapsed intervertebral disc, etc. These parameters can be helpful in clinical correlation of above mentioned conditions.

Thus, this study presents comprehensive data about morphometry of cervical vertebrae. The normal dimensions of intervertebral discs of cervical spine, drawn from present study, can be used as reference values for evaluating various clinical conditions in the cervical spine in Western Maharashtra population.

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