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Original Research Paper

Morphometric Analysis of Spinal Canal Diameter of Cervical Spine in Indian Population Using Radiographs and Computerised Tomography

Medical Science

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INTRODUCTION

The cervical spine protects the spinal cord. It functions as a mechanical structure, which helps in transmission of load allowing motion at the same time. Multiple authors have reported the association of neurologic symptoms with spinal canal stenosis. There are several radiological and morphological anatomic studies [9,10,11,12] on assessment of size of spinal canal in different populations in the world. The most frequently applied radiologic parameters on standard radiographs include midsagital antero – posterior diameter, canal-to-corpus ratio (ie, the Torg ratio or Pavlov ratio) measured on a lateral view, interpedicular distance measured on a frontal view, and cross-sectional area measured on a transverse plane at computed tomography. There are various studies, which are conducted on western population [9,10,11,12] but to our knowledge, until recently, there have been no report or study mentioning the cervical spinal canal morphometry for Indian population has been done. Our study is designed to radiologicaly evaluate normal values of the cervical spinal canal dimensions in several planes with respect to spinal level, age, sex, and body height of the Indians and to compare them with the western population.

MATERIALS AND METHODS:

One hundred consecutive adult patients with history of head injury to our institute requiring CT scan and cervical radiographs were prospectively included in the study. Patients with history of previous cervical spine fracture, cervical myelopathy, previous surgery of cervical spine, rheumatoid arthritis and those with improper radiographs were excluded from analysis. Demographic data was collected for all patients.

For analyzing X-ray a spherical marker of known dimensions was kept above the thyroid

cartilage in the midline in the field for comparison. The sagittal spinal canal diameter was measured as the shortest distance from the midpoint between the vertebral body's superior and inferior endplates to the spinolaminar line. CT scan was done with 1 mm thickness cuts and images were analysed by Phillips Extended workspace Brilliance. Axial cut was taken through the midpoint of the Superior and Inferior endplates as defined on the sagital cut, in a plane parallel to both the end plates. In this axial cut, anteroposterior and transverse diameter of the cervical vertebrae are measured. The data is compiled to SPSS version 20 and statistical analysis was done.

Staistical analysis:

Samples were divided into male and female. Mean, range and standard deviation were calculated for each dimension that was measured. The unpaired t test was used for comparison between X Ray, CT anterior-posterior and CT transverse diameter of each vertebrae for both male and female. Pearson correlation was used to find out the correlation between age and height with the canal diameter at each vertebral level.

Results:

Out of 100 patients, 35 were female and 65 were male. The mean age of study group was 51.23 yrs and mean height was 160.21cms.

	Mean Sagital diameter (Xray)	Mean Sagital Diameter (CT scan)	Mean Transverse diameter (CT scan)
C1	20.35	17.05	22.61
C2	20.10	16.08	21.78
C3	16.37	12.64	23.66
C4	15.93	12.68	23.89
C5	16.09	12.85	23.99
C6	16.40	13.06	23.99
C7	16.69	13.48	23.74

On comparison between males and females, males showed a higher sagital diameter on radiograph, sagital diameter and anteroposterior diameter on CT scan at each vertebral level.

We also found no co-relation between age and height of the subjects with canal diameter.

Discussion:

In general the diagnosis of cervical spondylosis is made by the findings in plain radiograph, which show narrowing of the disc spaces and osteophyte formation on the vertebral bodies. If neurological symptoms occur in addition, they may be attributed to the spondylotic lesion. On the other hand, as has already been related, such symptoms when associated with minimal radiological changes of cervical spondylosis may be mistaken for the space-occupying lesion or for motor neuron disease. The size of the cervical canal must be measured, in order to avoid such wrong diagnosis.

There is a mutual relationship between the size of the canal and the amount of encroachment[8]. Whether the cord is compressed or not depends on the encroachment of this space by the disc protrusion or osteophyte. We can obtain various measurements by using radiographic images and use them as a part of diagnostic evaluation of cervical spine, however for this procedure to be clinically useful it is necessary to establish normal parameters.

In our study, we established normal values for cervical canal diameter in adult Indian population. We found that the diamter is the highest at C1 level. Also, males showed higher values at all vertebral levels in both x ray and CT scan as compared to females.

Average sagittal diameter using lateral cervical spine X

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ray:

Level of Vertebra	Investigator	Average value
C1 to C7	Our Study	17.41 mm
C4 to C6	Boijsen [14]	18.5mm
C3 to C5	Hinck [15]	17mm
C3 to C5	Moiel et al [4], Payne and Spillane[9]	17mm
C3 to C7	Wolf et al [18]	17mm
C3 to C5	Epstein et al [19] and Countee[3] Vijaynathan [3]	14mm
C3 to C5	Wilkinson et al[18]	16.6mm
C1 to C7	Zhang Ling et al [25]	15.33mm to 20.46mm

From the above, we can suggest that our values were on the lower side as compared to western population and similar to chinese population.

Average saggital diameters using specific CT axial cuts.

Level of vertebra	Our study	Inoue et al (Japanese)	Zeng et al (Chinese)	Debois et al (Belgian)	Stanley et al (American)	Matsuura et al (American)
C3	12.64	13.2	13.2	14	14.8	14.2
C4	12.68	12.8	12.4	14.4	14.4	14.2
C5	12.85	12	12.4	14.8	14	14.4
C6	13.06	12.8	12.4	14.2	14	14.2
C7	13.48	13.8	13.4	14.2	14	14

Our study suggested that Indians have a slightly lower sagital canal diameter on CT scans as compared to americans and similar to chinese and japanese population.

Average transverse canal diameter using the specific CT axial cuts.

Level of vertebra	Our study	Debois et al (Belgian)	Stanley et al (American)	Matsuura et al (American)
C3	21.78	25	23	25
C4	23.66	26	24	25.2
C5	23.89	26	24	25
C6	23.99	26	24	25.2
C7	23.74	25	23	24

Our study showed that Indians have a slightly lower transverse canal diameter on CT scans at all levels as compared to their western counterparts.

In the study conducted by T. A. COUGHLIN, Z. KLEZL31 on British population which was published in JBJS 2012 they found that normal cervical spinal canal diameter was between 17mm to 18mm and those with canal diameter less than 12mm to 14mm due to any reason showed the signs of cervical myelopathy. In our study out of 100 subjects about 30% showed values lower than 12 mm at various levels and all of these were NORMAL subjects. So, we can conclude that the values which are designed for western population might not be applicable for Indians. As this was a pilot study, a larger study is needed to find out the minimum sagittal canal diameter for Indian population below which a patient can present with signs of cord compression.

Conclusion : In conclusion, our study showed that CT scan is more accurate for measurement of spinal canal diameter as compared to X Ray. Males have higher canal diameter at all levels compared to female. Normal Indian Population have smaller canal diameter as compared to their western conterparts. Age and height has no correlation with canal diameter. However, a larger study is needed to find out the normal cervical spinal canal diameter in Indian population.