

## Study Of Radiological Evaluation Of Cervical Spine In Marathwada Region

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**Abstract:**Background:Cervical vertebrae are the most crucially located and play a dynamic role in the mobility and protection of the vital parts of the central nervous system, they are prone to undergo degenerative diseases like spinal stenosis, cervical spondylosis etc. Hence it is important to know the exact dimensions of cervical vertebral body and spinal canal in the diagnosis, prognosis and treatment of diseases related to cervical spine and spinal cord.Material And Methods:Normal plain radiographs of cervical spine of two hundred adult subjects of known sex (one hundred males and one hundred females) and of known age group (between 18 to 50 years) studied for Antero-posterior diameter of vertebral body (AP-VB), Height of vertebral body (HT-VB) and Canal body ratio (CBR) in C3 to C7 cervical vertebrae. Data tabulated and analysed by using software statistical Package for Social Sciences(SPSS).Result:Higher mean AP – VB diameter and mean Ht - VB values are recorded in males as compared to females. Higher mean Canal body ratio (CBR) was recorded in females as compared to males.Conclusion: Present study showed, higher mean value of (AP-VB), (HT-VB) in males as compared to females and found to be statistically significant indicating sexual dimorphism. Canal body ratio (CBR) showed slightly higher values in females as compared to males and found statistically significant at C6 and C7 Levels. [Fulari S Natl J Integr Res Med, 2021; 12(3):1-6]

**Key Words:** Cervical spine, Spinal canal, Antero-posterior diameter of vertebral body (AP-VB), Height of vertebral body (HT-VB), Canal body ratio (CBR).

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**Introduction:** The spine is a complex and vital structure. Its function includes not only structural support of the body as whole, but it also serve as a conduit for safe passage of the neural elements while allowing proper interaction with the brain<sup>1</sup>.

The spine is made up of 33 individual bony vertebrae. The number and specific characteristics of the vertebrae vary depending on the body region with which they are associated. There are seven cervical, twelve thoracic, five lumbar, five sacral, and three to four coccygeal vertebrae. The sacral vertebrae fuse into a single bony element, the sacrum<sup>2</sup>. Among all these vertebrae, cervical vertebrae are the most crucially located and play a dynamic role in the mobility and protection of the vital parts of the central nervous system.

The word 'cervix' in Latin means 'neck'. The word "cervical" means "related to or pertaining to neck". "Stenosis" means abnormal narrowing of cervical spinal canal<sup>3</sup>.

As the cervical vertebrae carry most of the weight of the head and suffer the greatest strains during extreme ranges of motion and stress, they are prone to undergo degenerative diseases like

spinal stenosis, cervical spondylosis etc. It is a known fact that the vertebral column morphology is influenced externally by mechanical and environmental factors and internally by genetic, metabolic and hormonal factors<sup>3</sup>. Hence it is important to know the exact dimensions of cervical vertebra body and spinal canal in the diagnosis, prognosis and treatment of diseases related to cervical spine and spinal cord, such as spinal stenosis and intra spinal tumours etc.

A careful study of plain radiographs (x-ray) of cervical spine can accurately estimate dimensions of vertebral body and spinal canal. Furthermore, plain radiographs are easily available and more economical from a patient's point of view.

The anteroposterior (AP) diameter of the normal adult male cervical spinal canal has a mean value of 17-18 mm from 3rd cervical vertebra level to 7th cervical vertebra level. Cervical spinal canal stenosis is associated with an anteroposterior diameter of less than 12 mm.<sup>4</sup>. The canal-to-body ratio also known as Torg's ratio or Pavlov's ratio has been described as a reliable means for assessing the stenosis of the spinal canal and detecting those who are at risk of cervical neuro-

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praxia. It is determined by dividing the sagittal spinal canal diameter by the corresponding sagittal vertebral body diameter. A ratio of 0.82 or less indicates cervical Spinal canal stenosis<sup>5</sup>. The canal-to-body ratio is also useful to screen athletes who are at risk of certain cervical injuries. From this it is comprehensively proved that the dimensions and other parameters of the cervical vertebra should be a vital part of study in event of investigating an individual with cervical vertebral diseases.

To understand and correlate the parameters of cervical vertebra a dire need is felt to study the normal values of these bones first with proper method and utmost accuracy. Several studies describing the dimensions of cervical spine have been done in western countries. But, significant statistical differences have been found to exist between different population groups and, also it is observed that there is racial variation in these dimensions.

The correlations between cervical spinal canal and vertebral body dimensions have been seldom analysed in Indian population. Few studies have been done on Indian population to evaluate the discrepancies that are believed to exist in canal dimensions in males and females. Since no such data is available for population in the Marathwada region of Maharashtra.

In this radiological study an attempt is made to record the normal values of mid-sagittal vertebral body diameter, mid-sagittal canal diameter and canal-body ratio in adult population of Marathwada region to establish the normal dimension of cervical vertebra and spinal canal in Marathwada region and to establish canal body ratio (Torg's Ratio / Pavlov's ratio)<sup>5</sup>.

**Material & Methods:** Normal plain radiographs of cervical spine of two hundred adult subjects of known sex (one hundred males and one hundred females) and of known age group (between 18 to 50 years) 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 about 2.5cm behind the mastoid process.<sup>6</sup>

These radiographs were diagnosed as "normal" by experienced radiologists. Measurement were made directly on the radiograph after marking points or lines with a graphite film marker which provided a very small well defined point or line necessary for accurate measurement.<sup>7</sup>

The measurements were made with a standard metallic ruler (precision ±0.5mm). Same ruler was used throughout study.

Each measurement of distance was rounded off to the nearest milli meter. The data was recorded and entered in a Microsoft excel file. The dimensions of only C3 to C7 cervical vertebrae were studied.

The Following Parameters Were Studied On:

i. Antero-Posterior Diameter Of The Vertebral Body (AP-VB): This is the mid vertebral distance between the mid-points on anterior border and posterior border of vertebra body shadow.

ii. Height- Vertebral Body (Ht- VB): The shortest vertical distance passing through the center of the vertebral body.

iii. The 'Canal Body Ratio' (Torg's Ratio, Pavlov's Ratio)<sup>5</sup>: This is a ratio of an teroposterior diameter of spinal canal and an teroposterior diameter of corresponding vertebral body.

Statistical Analysis<sup>8</sup>: Analysis was done using the software Statistical Package for Social Sciences (SPSS) software. Microsoft word and excel have been used to generate graphs and tables.

Type Of Study: Cross Sectional Study.

**Results:** Results are as follows:

**Table 1: Sample Distribution According To Gender And Age Group**

Age Group	Male		Female	
	n	%	n	%
18-25 years	22	22 %	22	22 %
25-35 years	48	48 %	48	48 %
35-45 years	25	25 %	25	25 %
>45	5	5 %	5	5 %
Total	100	100 %	100	100 %

n= (Number of subjects)

Table 1 shows distribution of 200 normal subjects falling in an age group of 18-50 years, which comprised of 100 males and 100 females.

**Table 2: Comparison Of AP– VB Diameter Between Males And Females**

Vertebral Level	Gender	Mean (mm)	Standard Deviation S.D.	Mean Difference	Z test	p value
C3	Male	17.77	1.54	2.94	13.76	<0.001*
	Female	14.83	1.48			
C4	Male	18.00	1.54	2.80	13.29	<0.001*
	Female	15.16	1.48			
C5	Male	18.30	1.61	2.74	12.80	<0.001*
	Female	15.56	1.41			
C6	Male	18.92	1.59	2.94	13.92	<0.001*
	Female	15.98	1.39			
C7	Male	19.27	1.62	2.8	12.48	<0.001*
	Female	16.47	1.55			

Table 2 shows that mean values of AP – VB diameter in males were increases from C3 to C7 levels with an increase in standard deviation (SD) from C3-C7. Similarly there was an increase in mean values of AP–VB diameter in females from C3 to C7 levels with an increase in standard deviation (SD) from C3 - C7 level. At all vertebral

levels, higher mean AP – VB diameter values are recorded in males compared to females. The mean difference between males and females ranges from 2.74 mm to 2.94 mm. So the mean difference between AP –VB diameter of males and females is found to be statistically significant at all vertebral levels (P<0.001).

**Table 3: Comparison Of Height Of Vertebral Body (Ht- VB) Between Males And Females**

VL	Gender	Mean (mm)	Standard Deviation S.D.	Mean Difference	Z test	p value
C3	Male	13.78	1.06	1.42	9.36	<0.001*
	Female	12.37	1.07			
C4	Male	13.94	0.97	1.3	9.18	<0.001*
	Female	12.62	1.03			
C5	Male	14.41	1.12	1.58	9.84	<0.001*
	Female	12.83	1.15			
C6	Male	14.80	1.11	1.72	10.80	<0.001*
	Female	13.08	1.14			
C7	Male	15.28	1.16	1.21	7.73	<0.001*
	Female	14.07	1.05			

The present study showed that, mean values of Ht - VB in males were increases from C3 to C7 levels and also standard deviation (SD) changes from C3-C7. Similarly the mean values of Ht - VB in females were increases from C3 to C7 levels and also standard deviation (SD) changes from C3-C7. At all vertebral levels, higher mean Ht - VB

values were recorded in males compared to females. The mean difference between males and females ranges from 1.21 mm to 1.72 mm. So the difference of mean value of Ht - VB between males and females is found to be statistically significant at all vertebral levels (P<0.001).

**Table 4: Comparison Of Mean Value Of Canal-Body Ratio (CBR) Between Males And Females**

Vertebral level	Gender	Mean (mm)	Standard Deviation S.D.	Mean Difference	Z test	p value
C3	Male	0.95	0.12	-0.02	-1.43	0.15
	Female	0.97	0.07			
C4	Male	0.96	0.12	-0.02	-1.49	0.13
	Female	0.98	0.06			
C5	Male	0.96	0.12	-0.02	-1.49	0.13
	Female	0.98	0.06			
C6	Male	0.94	0.12	-0.04	-2.98	0.002
	Female	0.98	0.06			
C7	Male	0.94	0.11	-0.03	-2.30	0.02
	Female	0.97	0.07			

The present study showed that there was an increase in mean values of CBR in males, from C3 to C5 and then decreases with changes in standard deviation (SD) from C6-C7. Similarly the mean values of CBR in females were increases from C3 to C7 levels with changes in standard deviation (SD) from C3-C7. At all vertebral levels, slightly higher mean C/B ratio was recorded in females compared to males and the difference between them was found to be statistically significant at C6 level (P<0.01) and C7 level (P<0.01) only.

**Discussion:** The present study was done on normal plain radiographs (x-ray) of adult subjects (males, females) of age between 18 years to 50

years, by excluding various disorder like, skeletal deformity, fractures, cervical spondylosis, dislocations etc. The observations on the cervical spinal canal dimensions in males and females were compared and the differences between them were evaluated for statistical significance.

The correlation between the various parameters was assessed. The results obtained in present study were compared with the result from the Previous studies and discussed under the following headings: 1) Anteroposterior diameter of the vertebral body (AP- VB). 2) Height of the vertebral Body (Ht- VB).3)Torg’s ratio or Pavlov’s ratio or canal body ratio (CBR).

**Table5: Comparison Of The Vertebral Level With The Least AP- VB Diameter In Different Studies**

Study	Vertebral level (Mean value of AP- VB in mm)	
	Male	Female
Hukuda (2002)	C5 (17.4)	C5 (15.3)
Athar Maqbool (2003)	C4 (1.56)	C4 (1.31)
Karabulut (2007)	C3, (17.92)	C4 (15.31)
Kathole (2012)	C5 (16.87)	C5 (14.06)
<b>Present Study</b>	<b>C3 (17.77)</b>	<b>C3 (14.83)</b>

In this study, least anteroposterior (AP-VB) diameter of vertebral body was found at C3 level in both genders. Which approximately coincides with the findings of Karabulut<sup>9</sup>, whereas Hukuda<sup>10</sup>, and Kathole<sup>11</sup> noted least antero-

posterior (AP-VB) diameter of vertebral body at C5 level in both genders. Athar Maqbool<sup>12</sup> was found least (AP-VB) diameter of vertebral body at C4 level.

**Table 6: Comparison Of Height VB (Mm) In Different Studies**

Vertebral level	Male		Female	
	Hukuda (2002)	Present Study	Hukuda (2002)	Present Study
C3	14.6	13.78	13.0	12.37
C4	14.2	13.94	12.7	12.64
C5	13.9	14.41	12.7	12.83
C6	13.7	14.80	12.8	13.08
C7	15.6	15.28	14.1	14.07

The Present study shows a gradual increase in height of vertebral body (Ht-VB) from C3 to C7 in both genders. The values (Ht-VB) in present study in males are on higher side than females. The similar findings were noted in a study on Japanese subjects by Hukuda et al 2002.<sup>10</sup> with a slight marginal difference.

The higher mean value of height of vertebral body (Ht-VB) was more in males as compared to females, at all vertebral levels; with a statistically significant difference (P<0.001). This is similar to the findings of Hukuda<sup>10</sup>. Present study height of

vertebral body (Ht-VB), at C7 was noted to be the longest vertebra and C3, the shortest Vertebra. Kosif et al (2007)<sup>13</sup> in his study observed that the height of the cervical vertebrae was low in women with a statistically significant difference. Loss of height of vertebra is known to cause flattening of cervical lordosis which results in kyphosis with advancing age.

Kosif suggested those women are at a higher risk of developing kyphosis due to loss of cervicallordosis. Minor osteoporosis in the vertebral bodies leads to a decrease in height of

cervical spine in the older age group. Also, weakening of the fibrous tissue that supports the vertebral spine and atrophy in the muscle tissue

increases the load of the vertebral spine and causes instability<sup>10</sup>.

**Table 7: Comparison Of The Vertebral Level With The Least Canal Body Ratio (CBR) In Different Studies**

Study	Vertebral level (Mean value of AP VC in mm)	
	Male	Female
Hwan Mo Lee (1994)	C4 (0.90)	C3 (0.97)
Hukuda (2002)	C7 (0.84)	C7 (0.94)
Athar Maqbool (2003)	C3, C4 (0.94)	C3 (1.06)
Asthik (2007)	C7 (0.74)	C6, C7 (0.74)
Karabulut (2007)	C4 (0.73)	C4 (0.79)
Kathole (2012)	C3, C4, C5 (0.95)	C3 (1.06)
Present Study	C3 (0.94)	C3, C7 (0.97)

In the present study least canal body ratio was found at C3 in both genders. Kathole<sup>11</sup>, and Athar Maqbool<sup>12</sup> reported the similar finding with present study, whereas Karabulut<sup>9</sup> find at C4 level. Study conducted by Asthik<sup>14</sup> and Hukuda<sup>10</sup> shows similar pattern at C7 level. Torg et al<sup>5</sup> in his study reported that measurement of canal body ratio less than 0.82 denotes spinal canal stenosis. The values of canal body ratio in present study were not below 0.82 stated by Torg, so there is no evidence suggestive of spinal canal stenosis.

**Conclusion:** The present study was undertaken with an aim to establish the normal dimensions of the cervical vertebrae and cervical spinal canal in normal adult Maharashtra population of Marathwada region. The study consist of 200 plain radiographs (100 males, 100 females) with an age ranging from 18-50 years, obtained from various departments of radiodiagnosis in Marathwada region. The parameters were measured and the values tabulated and analysed for statistical significance.

At all vertebral levels, higher mean value of anteroposterior diameter of vertebral body (AP-VB), height of vertebral body (Ht-VB) in males. The difference between them was found to be statistically significant at all vertebral levels in males. ( $P < 0.001$ ), indicating sexual dimorphism. The mean anteroposterior diameter of vertebral body (AP-VB), was higher in both genders at C7 level (M-19.27mm; F- 16.47mm) and lower at C3 level (M-17.77mm; F14.83mm).

The mean height of vertebral body (Ht-VB) was higher in both genders at C7 level (M-15.28mm; F-14.07mm) and lower at C3 level (M-13.78mm; F12.37 mm).

Canal body ratio or Torg's ratio in males was higher at C4 (0.96) and lower at C6; C7 (0.94) and in females canal body ratio (CBR) was higher at C4; C5; C6 level (0.98) and lower at C3; C7 (0.97).

The canal body ratio shows a slightly higher value in females when compared to males and the difference between them was found statistically significant at C6 and C7 level only. There exists a definite sexual dimorphism between the spinal canal dimensions in males and females. The canal body ratio (CBR) showed significant difference in the lower cervical spine in males and females, the values in females were higher than males.

Such difference may be attributed to the large stature of males which inversely affects the canal body ratio. The presence of definite sex discrepancy in the Torg's ratio or canal body ratio (CBR) of the lower cervical spine may explain the increased predisposition of males to the development of cervical myelopathy.

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