

Original Research Article

Morphological study of cervical spinal body and vertebral body anatomy: CT scan based

A. K. Chaurasiya, Anil Dawar, Rajneesh Gour, Kunal Vaidya*

Department of General Surgery, Gandhi Medical College and Associated Hamidia Hospital, Bhopal, Madhya Pradesh, India

Received: 24 February 2021

Revised: 04 April 2021

Accepted: 06 April 2021

***Correspondence:**

Dr. Kunal Vaidya,

E-mail: drkunalvaidya@gmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: The morphometry of the cervical spine vertebra is of clinical importance in traumatic, degenerative and inflammatory condition requiring surgery and instrumentation. The aim of this study was to determine the mid-sagittal, AP Transverse diameter, AP diameter of cervical vertebral body, surface area of canal and torg ratio at level C2 –C7.

Methods: Study was performed in the department of general surgery, GMC and Hamidia Hospital Bhopal from January 2016 - June 2020 in 300 patients with clinically apparent cervical spondylosis and cervical spine injury belongs to central India of age group 20- 88 years including males and females by gathering their parameters (height and weight) and CT of cervical region from C1 to D1 spine.

Results: In our study maximum sagittal canal diameter in males was found at C2 vertebral level (14.14 mm) and minimum at C4 vertebral level (14.00 mm) whereas the maximum sagittal canal diameter in females was found at C2 and C7 vertebral level (14.00 mm) and minimum at C4 vertebral level (13.82 mm) while mean sagittal canal diameter was greater in males than females. The maximum transverse canal diameter in both males and female was found at C7 level, it measures 21.09 mm in males and 21.38 mm in females.

Conclusions: The CT scan can provide accurate cervical canal measurement that could serve as useful guide in preoperative surgical planning, instrumentation and size of prosthesis.

Keywords: Cervical spine, CT scan, Morphometry

INTRODUCTION

The morphometry of the cervical spine is of clinical importance in traumatic, degenerative and inflammatory condition. Detailed knowledge of cervical spine morphometry is critical for understanding the pathology of certain diseases and for proper planning.¹⁻⁵ Lateral X rays do not provide the necessary accuracy.⁶⁻⁸ The measurements can be used as a reference and diagnostic tool for various spine pathology.⁹⁻¹¹ In the past, several efforts have been conducted to accurately measure

cervical spine canal's diameter, in patients with degenerative canal stenosis.⁷⁻¹⁰ Nevertheless, plain x-ray measurements lacked compatibility due to differences in magnification and lack of axial view.¹² CT scan can replace older conventional radiography techniques by providing more accurate measurements on anatomical elements of the cervical spine and instrument application.¹³ The aims of this study was to a prospective CT morphometric analysis of cervical spine canal to determine the mid-sagittal, AP Transverse diameter, AP diameter of vertebral body, surface area of canal and

torgs ratio at level C2 - C7 in various subgroups of Indian population.

METHODS

Cross sectional and observational study was performed to collect images of cervical spine in the department of General Surgery, GMC and Hamidia Hospital Bhopal from January 2016 to June 2020 in 300 patients with clinically apparent cervical spondylosis and cervical spine injury belongs to central India of age group 14-88 years including males and females with proper explanation of procedure and written informed consent to participate in study by gathering their parameters (height and weight) and CT of cervical region from C1 to D1 spine. CT morphometric analysis of cervical spine canal was done by the mid-sagittal, AP Transverse diameter, AP diameter of vertebral body, surface area of canal and torgs ratio at level C2 - C7 in various subgroups of Indian population. The torg ratio is an indicator of cervical canal stenosis determined by dividing the saggital spinal canal diameter (SCD) by the corresponding saggital vertebral body diameter. Height is calculated in cm and images from C2 - C7 were selected and parameters will determine using the measuring tools of the imaging software.

Inclusion criteria

Patient with clinically apparent cervical spondylosis, with cervical spine injury, patient of 14 years and above who gave prior informed consent were included in the study.

Exclusion criteria

Patients not giving prior informed consent, having age less than 14 years were excluded from the study.

Statistical analysis

The data will be collected and recorded on a printed proforma. Data were coded and recorded in MS Excel spreadsheet program. SPSS v23 (IBM Corp.) was used for data analysis.

RESULTS

In our study maximum sagittal canal diameter in males was found at C2 vertebral level (14.14 mm) and Minimum sagittal canal diameter in males was found at C4 vertebral level (14.00 mm) whereas the maximum sagittal canal diameter in females was found at C2 and C7 vertebral level (14.00 mm) and minimum sagittal canal diameter in females was found at C4 vertebral level (13.82 mm) while mean sagittal canal diameter was greater in males than females. The maximum transverse canal diameter in both males and female was found at C7 level, it measures 21.09 mm in males and 21.38mm in females whereas the minimum diameter in males was at C2 (20.80 mm) and in female at C2 and C3 (20.80).

The maximum vertebral body antero-posterior diameter was found at C7 vertebral level in both male (15.80mm) and female (15.54 mm) whereas the minimum vertebral body antero-posterior diameter was found at C2 in both males (15.63) and females (15.29mm). The maximum vertebral canal surface area in males was found at C7 vertebral level (148.87 mm²) and minimum canal surface area in males was found at C5 vertebral level (146.87 mm²) whereas the maximum canal surface area in females was found at C7 vertebral level (148.2 mm²) and minimum vertebral body canal surface area in females was found at C4 vertebral level (144.4 mm²). The torg ratio was almost equal at all cervical vertebra levels (C2-C7) in both males and females.

Table 1: Sagittal canal diameter (SCD), Transverse canal diameter (TCD), Vertebral body antero-posterior diameter (VBD), Canal surface area (CSA) and torg ratio (t/r) at C2, C3, C4, C5, C6, and C7 spine levels.

Level	Male (n=195)					Female (n=105)				
	Mean± SD					Mean± SD				
	SCD	TCD	VBD	CSA	T/R	SCD	TCD	VBD	CSA	T/R
C2	14.14± 0.82	20.8± 0.78	15.63± 0.74	147.4± 12.3	0.9± 0.04	14± 0.92	20.8± 0.59	15.29± 0.84	145.66± 11.59	0.92± 0.04
C3	14.11± 0.8	20.9± 0.76	15.7± 0.7	147.56± 12.09	0.88± 0.12	13.9± 0.93	20.8± 0.57	15.35± 0.77	145.9± 12.2	0.91± 0.05
C4	14± 0.86	21.05± 1.3	15.77± 0.72	147.58± 14.8	0.89± 0.04	13.82± 0.9	21.37± 2.07	15.4± 0.74	146.2± 11.5	0.92± 0.03
C5	14.02± 0.86	20.9± 0.76	15.8± 0.75	146.87± 12.6	0.89± 0.04	13.84± 0.85	20.9± 0.58	15.46± 0.77	146± 12.09	0.91± 0.04
C6	14.06± 0.83	20.92± 0.76	15.76± 0.75	147.31± 12.46	0.89± 0.04	13.9± 0.82	20.96± 0.6	15.52± 0.77	145.7± 11.6	0.92± 0.04
C7	14.1± 0.84	21.09± 1.35	15.76± 0.8	148.87± 15.38	0.89± 0.04	14± 0.77	21.23± 2.63	15.54± 0.82	146.44± 12.44	0.91± 0.08

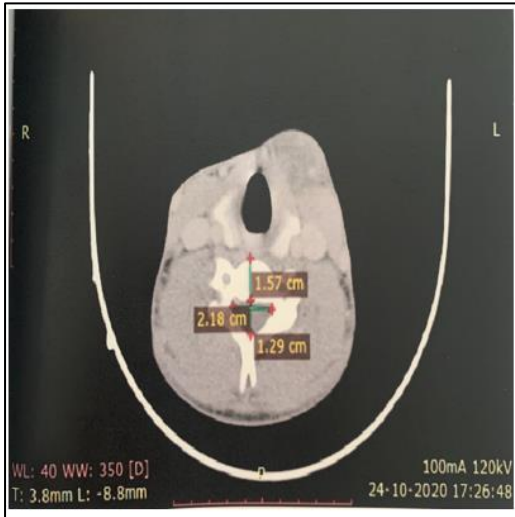


Figure 1: Sagittal canal diameter of 12.9 mm and transverse canal diameter of 21.8 mm and vertebral body antero-posterior length of 15.7 mm.

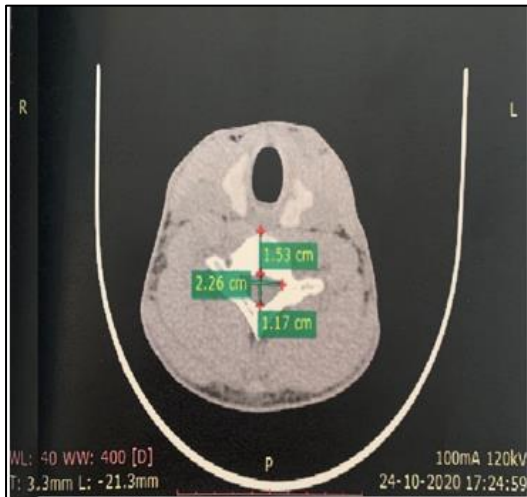


Figure 2: Sagittal canal diameter of 11.7 mm and transverse canal diameter of 22.6 mm and vertebral body antero-posterior length of 15.3 mm.

DISCUSSION

The study was conducted on 300 patients of age group 14 year and above with clinically apparent cervical spondylosis and cervical spine injury who presented Department of surgery of Gandhi Medical College And Hamidia Hospital, Bhopal during the time period extending from January 2016 to June 2020. The patients who were less than 14 years of age and who were not giving consent were excluded from our study group. Pathologies in cervical spine are very common. Knowledge of anatomy of this region and the normal range is important in the proper planning of the management. We all know that there are normal variations amongst various races, regions and gender.

Mid sagittal anteroposterior canal diameter (SCD)

In our study sagittal canal diameter (antero-posterior diameter of canal) cervical canal from C2 to C7, is found to be maximum at level of C2 in male (14.40 mm) and C2 and C7 in females (14.00 mm) compare to all other cervical vertebra, it was almost equal to the study of cervical canal conducted by Gour et al.¹⁴ On plain X-Ray and dried cervical vertebral bodies. In our study sagittal canal diameter is found to be minimum at level of C4 in males (14.00 mm) and C4 in females (13.82 mm) which was almost equal to the study conducted by Gour et al.¹⁴ Our study revealed similar findings to the study conducted by Poulos et al based on CT scan findings.⁷ Smallest sagittal diameter of the canal was detected at level of C4 for both males and females almost same result found by Poulos et al.⁷

Table 2 shows that our results were almost equal to the findings of the study din, by Gour et al on Indian population while other studies conducted on the Japanese, Korean people revealed smaller sagittal canal diameter as compared to our study which was done on Indian population.^{12,13,14} The White population and African population have a significantly larger sagittal canal diameter when compared to our study.^{15,17}

Torg ratio

The Torg ratio is an indicator of cervical canal stenosis determined by dividing the sagittal spinal canal diameter (SCD) by the corresponding sagittal vertebral body diameter (VBD). The results of the method may help to determine the presence of spinal stenosis and to identify patients at risk for cervical spine cord injuries. In our study the torg ratio was almost equal at all cervical vertebra levels (C2-C7) in both males and females.

In our study the torg ratio was found to be almost equal at all cervical spine vertebrae for both male and female while other studio like Karabulut et al study on Turkish population and Kathole et al study done in Maharashtra, India also reported a similar torg ratio at each cervical vertebrae body.^{18,19}

Canal surface area

In our study maximum vertebral canal surface area in males was found at C7 vertebral level (148.87 mm²) and Minimum canal surface area in males was found at C5 vertebral level (146.87 mm²) while the minimum vertebral body canal surface area in females was found at C4 vertebral level (144.4 mm²) and almost equal at all other cervical vertebra which when compared to study done by Tiemey et al shows that maximum vertebral canal surface area was found at C7 vertebral level in their study population.¹⁰

Table 2: Sagittal canal diameter measurement in comparison with different races.¹⁴⁻¹⁷

Level	Korean ¹⁵		Japanese ¹⁶		White ¹⁵		African ¹⁷		Indian ¹⁴	Our study	
	M	F	M	F	M	F	M	F	M	F	
C3	13.3	13.4	13.3	12.8	16.5	15.5	15.2	15.1	14.38	14.11	13.9
C4	12.8	12.9	12.6	12.4	15.4	14.8	14.8	14.5	14.4	14	13.82
C5	13	13	12.9	12.4	15.4	14.4	15.1	14.6	14.36	14.02	13.84
C6	13.2	12.9	13.3	12.4	15.4	14.1	15.2	14.4	14.55	14.06	13.9
C7	13.4	13.3	13.3	12.7	15.5	14.4	15.5	14.3	NA	14.1	14

Table 3: Comparison of torg ratio with other study.

	Karabulut et al (neck pain) ¹⁸		Kathole et al (dried bone) ¹⁹		Our study	
	M	F	M	F	M	F
C2	0.86 (± 0.20)	0.80 (± 0.14)	-	-	0.9 (± 0.04)	0.92 (± 0.04)
C3	0.85 (± 0.14)	0.87 (± 0.14)	0.95 (± 0.06)	1.06 (± 0.06)	0.88 (± 0.12)	0.91 (± 0.05)
C4	0.73 (± 0.18)	0.79 (± 0.15)	0.95 (± 0.06)	1.07 (± 0.07)	0.89 (± 0.040)	0.92 (± 0.03)
C5	0.82 (± 0.17)	0.84 (± 0.14)	0.95 (± 0.06)	1.08 (± 0.07)	0.89 (± 0.04)	0.91 (± 0.04)
C6	0.81 (± 0.15)	0.84 (± 0.13)	0.96 (± 0.06)	1.08 (± 0.06)	0.89 (± 0.04)	0.92 (± 0.04)
C7	0.79 (± 0.14)	0.83 (± 0.12)	0.96 (± 0.06)	1.07 (± 0.07)	0.89 (± 0.04)	0.91 (± 0.04)

CONCLUSION

The morphometric dimensions show ethnic, racial and geographical variations hence normal reference value of population of particular region is important. CT scan can provide accurate cervical canal measurements that could serve as a useful guide in preoperative management; surgical planning, instrumentation and size of screw.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

- Hukuda S, Kojima Y. Sex discrepancy in the canal/body ratio of the cervical spine implicating the prevalence of cervical myelopathy in men. *Spine*. 2002;27(3):250-3.
- Pavlov H, Torg JS, Robie B, Jahre C. Cervical spinal stenosis: determination with vertebral body ratio method. *Radiology*. 1987;164(3):771-5.
- Song KJ, Choi BW, Kim SJ, Kim GH, Kim YS, Song JH. The relationship between spinal stenosis and neurological outcome in traumatic cervical spine injury: an analysis using Pavlov's ratio, spinal cord area, and spinal canal area. *Clin Orthop Surg*. 2009;1(1):11-8.
- Ladd AL, Scranton PE. Congenital cervical stenosis presenting as transient quadriplegia in athletes. Report of two cases. *J Bone Joint Surg Am*. 1986;68(9):1371-4.
- Yue WM, Tan SB, Tan MH, Koh DC, Tan CT. The Torg--Pavlov ratio in cervical spondylotic myelopathy: a comparative study between patients with cervical spondylotic myelopathy and a nonspondylotic, nonmyelopathic population. *Spine*. 2001;26(16):1760-4.
- Song KJ, Choi BW, Kim SJ, Kim GH, Kim YS, Song JH. The relationship between spinal stenosis and neurological outcome in traumatic cervical spine injury: an analysis using Pavlov's ratio, spinal cord area, and spinal canal area. *Clin Orthop Surg*. 2009;1(1):11-8.
- Evangelopoulos D, Kontovazenitis P, Kouris S, Zlatidou X, Benneker L, Vlamis J, et al. Computerized tomographic morphometric analysis of the cervical spine. *Open Orthop J*. 2012;6:250-4.
- Herzog RJ, Wiens JJ, Dillingham MF, Sontag MJ. Plain film radiography, multiplanar computed tomography, and magnetic resonance imaging. *Spine*. 1991;16(6):178-86.
- Sasaki T, Kadoya S, Iizuka H. Roentgenological study of the sagittal diameter of the cervical spinal canal in normal adult Japanese. *Neurol Med Chir*. 1998;38(2):83-8.
- Ryan T, Maldjian C, Mattacola CG, Stephen SJ. Cervical spine stenosis measures in normal subjects. *Physical therapy faculty publications*. 2019;16.
- Lim JK, Wong HK. Variation of the cervical spinal Torg ratio with gender and ethnicity. *Spine J*. 2004;4(4):396-401.
- Gupta SK, Roy RC, Srivastava A. Sagittal diameter of the cervical canal in normal Indian adults. *Clin Radiol*. 1982;33(6):681-5.
- Prasad SS, O'Malley M, Caplan M, Shackelford IM, Pydisetty RK. MRI measurements of the cervical spine and their correlation to Pavlov's ratio. *Spine*. 2003;28(12):1263-8.

14. Gour KK, Shrivastava SK, Thakare AE. Size of cervical vertebral canal measurements in lateral cervical radiographs and dried bones. *Int J Biol Med Res.* 2011;2(3):778-80.
15. Lee HM, Kim NH, Kim HJ, Chung IH. Mid-sagittal canal diameter and vertebral body/canal ratio of the cervical spine in Koreans. *Yonsei Med J.* 1994;35(4):446-52.
16. Castro FP. Stingers, cervical cord neuropraxia and stenosis. *Clin Sports Med.* 2003;22:483-92.
17. Hershman EB. Brachial plexus injuries. *Clin Sports Med.* 1990;9(2):311-29.
18. Dicle L. The variation of torg ratio with gender in patients with neck pain. *Med J.* 2007;34:154-8.
19. Kathole D. Normal cervical spine morphometry and cervical spinal stenosis in asymptomatic professional football players. *Int J Recent Trends Sci Technol.* 2012;3(2):54-8.

Cite this article as: Chaurasiya AK, Dawar A, Gour R, Vaidya K. Morphological study of cervical spinal body and vertebral body anatomy: CT scan based. *Int Surg J* 2021;8:1540-4.