ISSN: 0975-3583, 0976-2833 VOL 12, ISSUE 05, 2021

Normal Values of Cervical Spinal Canal and Cord Dimensions Using MRI in Pakistani Population

Author Information:

Dr. Shumaila Arooj[1], Dr. Samar Hamid[2], Dr.Sanjay Kumar[3], Dr. Syed Imran Haider[4], Dr. Ehsan Sajjad[5], Dr. Haris Ali[6], Dr Arshan Munir[7]

[1]Consultant Neuroradiologist, Department of Radiology,Jinnah Post Graduate Medical Centre, Karachi, Pakistan
[2]Consultant Radiologist,Department of Radiology, Jinnah Post Graduate Medical Centre, Karachi, Pakistan
[3]MBBS, FCPS, Assistant Professor, Makran Medical College,Turbat, Pakistan
[4]Medical officer, Orthopaedic unit 2, King Edward Medical University, Mayo Hospital Lahore
[5]PGR orthopedic surgery, King Edward Medical University Lahore, Mayo Hospital Lahore
[6]PGR orthopedic surgery, King Edward Medical University Lahore, Mayo Hospital Lahore
[7]PGR orthopedic surgery, King Edward Medical University Lahore, Mayo Hospital Lahore

Source of Support:None
Conflict of Interest:None

ABSTRACT

PURPOSE: To determine baseline reference ranges of the cervical cord as well as spinal canal in sagittal plane in relation to spinal vertebral level, age, gender, patient height and weight in Pakistani population.

MATERIALS AND METHODS:

RESULTS: We observed that there were variations for different genders, vertebral levels and patient built, while age was found to have an important but limited impact. We defined normal sagittal diameters, areas of spinal canal and spinal cord at C1, C3, and C6 levels for males and females. Also, we extracted the data by dividing our patients into three different subgroups as per their height. This created a range of the spinal canal dimensions at C1 (from 12.0 to 18.0 mm), C3 (from 10.0 to 16.0 mm), and C6 (from 11.0 to 17.0 mm) levels.

CONCLUSION: In conclusion, the anteroposterior diameter of the cervical spinal canal and the spinal cord in normal population are dependent on spinal level, gender, age groups and height. These reference ranges will enable radiologists and neurosurgeons to describe MR imaging data more accurately and to assess the severity of cervical spinal canal stenosis in Asian population.

KEY WORDS: Cervical spine, Pakistani population, mid sagittal diameter**,** MRI

WORD COUNT:352

ISSN: 0975-3583, 0976-2833 VOL 12, ISSUE 05, 2021

INTRODUCTION:

OBJECTIVE:

The objective of the study was to determine normal reference range of the cervical spinal canal and cord dimensions in sagittal plane with respect to spinal level, age, gender, patient height and weight in Pakistani population.

MATERIALS AND METHODS:

This prospective cross-sectional single center study was carried out at Radiology department, Jinnah Postgraduate Medical Centre, Karachi, Pakistan for the period of two years from April 2019 to April 2021.After institutional review board approval and signed informed consent of all patients, MR scans without intravenous contrast were performed on Phillips 1.5 Tesla MR Scanner including axial and Sagittal T1W and T2W images. A consultant neuroradiologist examined all cervical spine images of patients who presented to our radiology department with complaints of neckache with or without radiation to upper limbs. A total of 796 patients were selected from 1874 examinations performed during the last one year. Patient's ages ranged from 16 to 68 years (average 42 years). Inclusion criteria comprised of an MR examination that was interpreted as normal by the neuroradiologist or if it had only a minor discogenic type abnormality without thecal sac indentation or spinal cord compression. Exclusion criteria were that an MR scan would be rejected if the clinical history indicates possible intrinsic spinal cord disease, a degenerative process or if the MR scan was of substandard quality. Midsagittal T2W images were used to measure the spinal canal diameters at C1, C3 and C6 levels using a line from the midpoint between the superior and inferior endplates of the vertebral bodies, drawn perpendicular to the anterior cord surface. The cervical spinal cord diameters were measured using the same technique at the same cervical levels. The Statistical Package for the Social Sciences, Version 21.0 (IBM, USA) was used for data entry, analysis and interpretation.Few studies have been conducted in this regard but keeping in view the geographical, environmental, ethnic and nutritional factors under consideration, a dedicated study was conducted in Asian population to evaluate the influence of these factors on the cervical spinal canal and cord dimensions and observe any variation from the western population if present.

RESULTS:

At the midvertebral levels of C1, C3, and C6 vertebrae, sagittal/anteroposterior dimensions and areas of spinal canal and cord were estimated (Fig 1). A multivariate general linear model explained the impact of gender, height, age and spinal level on the calculated values for three different height subgroups at 45 years of age were withdrawn. This resulted in a scale of the spinal canal dimensions at C1 (from 12.0 to 18.0 mm), C3 (from 10.0 to 16.0 mm), and C6 (from 11.0 to 17.0 mm) levels considering +-95% confidence interval (Fig 2).The distribution of patients on the basis of gender versus age groups, distribution of patients on the basis of weight and the frequency of patients based on gender were calculated and analyzed (Fig 3,4,5). Estimated diameters were calculated from the fitted parameters using the minimum and maximum diameters for men and women separately at C1, C3 and C6 levels (Fig 6,7).

ISSN: 0975-3583, 0976-2833 VOL 12, ISSUE 05, 2021

FIGURES AND GRAPHS:

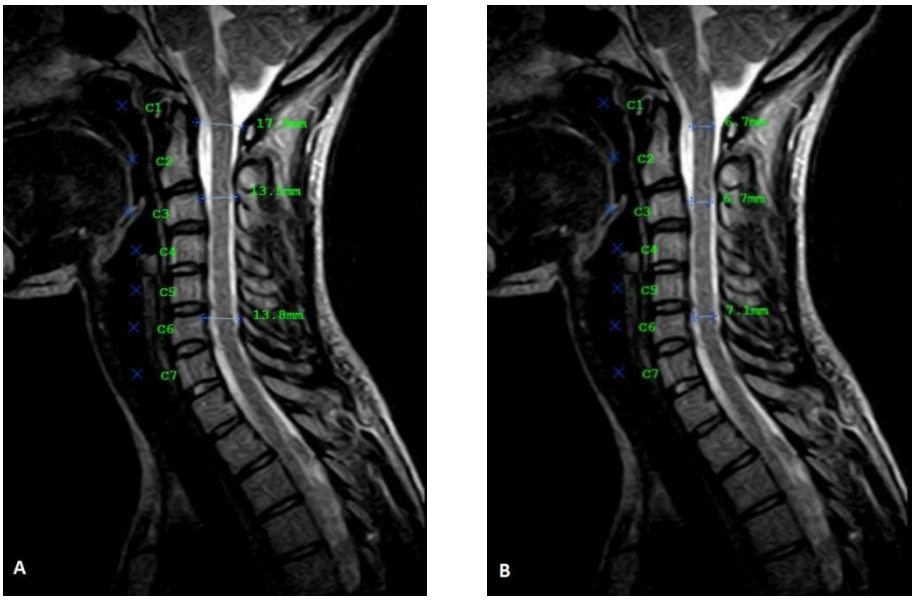


Figure 1: Midsagittal T2W images showing cervical spinal canal and cord diameters measured at C1, C3 and C6 levels. A) The spinal canal diameters measured at C1, C3 and C6 levels on a line from the midpoint between the superior and inferior endplates of the vertebral bodies and drawn perpendicular to the anterior cord surface. B) The sagittal spinal cord diametersmeasured using the same parameters as described in A.

Disc Level	Height (meters)	Spinal Canal Diameter			Spinal Cord Diameter			Difference in Diameters		
		Estimate (mm)	95% Confidence Interval		Estimate (mm)	95% Confidence Interval		Estimate (mm)	95% Confidence Interval	
			(lower)	(upper)		(lower)	(upper)		(lower)	(upper)
Women										
C1	1.4	15.2	14.5	15.9	7.8	7.4	8.2	7.4	6.7	8.1
C1	1.6	15.4	15.2	15.7	8	7.8	8.1	7.4	7.2	7.7
C1	1.7	15.5	15.2	15.8	8.1	7.9	8.3	7.5	7.2	7.7
C3	1.4	12.2	11.6	12.8	7.2	6.8	7.5	5	4.4	5.6
C3	1.6	13.1	12.9	13.3	7.3	7.1	7.4	5.9	5.6	6.1
C3	1.7	13.6	13.3	13.8	7.3	7.1	7.4	6.3	6	6.5
C6	1.4	13.9	13.3	14.4	6.5	6.2	6.8	7.4	6.9	7.9
C6	1.6	13.5	13.3	13.7	6.7	6.6	6.8	6.8	6.6	7
C6	1.7	13.3	13.1	13.5	6.8	6.7	7	6.5	6.2	6.7
Men										
C1	1.5	13.9	13	14.8	8.2	7.7	8.7	5	3.8	6.2
C1	1.7	15.3	15	15.6	8.1	7.9	8.3	6.5	6	6.9
C1	1.8	16	15.4	16.5	8.1	7.8	8.4	7.2	6.9	7.5
C3	1.5	12.2	11.3	13.2	7.1	6.6	7.6	4.8	3.5	6.1
C3	1.7	12.8	12.5	13.2	6.9	6.8	7.1	5.5	5	6
C3	1.8	13.1	12.6	13.7	6.9	6.5	7.2	5.9	5.6	6.2
C6	1.5	12.6	11.9	13.3	7	6.5	7.6	5	3.6	6.4
C6	1.7	13.5	13.3	13.8	6.9	6.7	7.1	6.1	5.5	6.7
C6	1.8	14	13.5	14.4	6.8	6.4	7.1	6.6	6.3	7

Figure 2: Spinal Canal and Spinal Cord diameters and their differences (95% CI)

ISSN: 0975-3583, 0976-2833 VOL 12, ISSUE 05, 2021

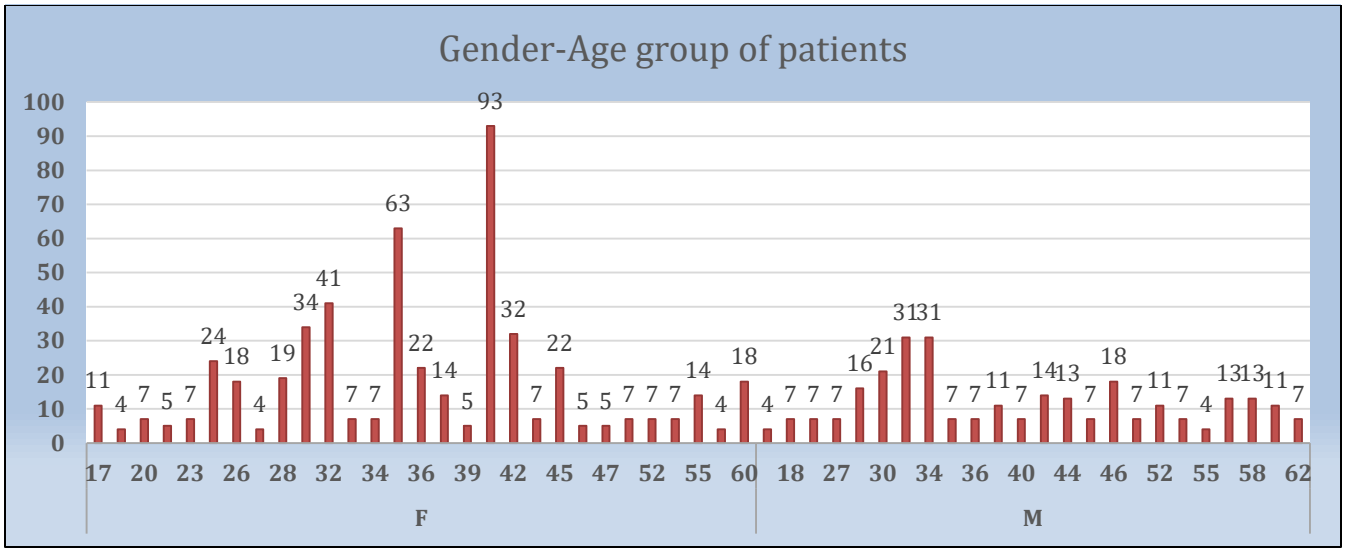


Figure 3: Distribution of patients on the basis of gender and age groups

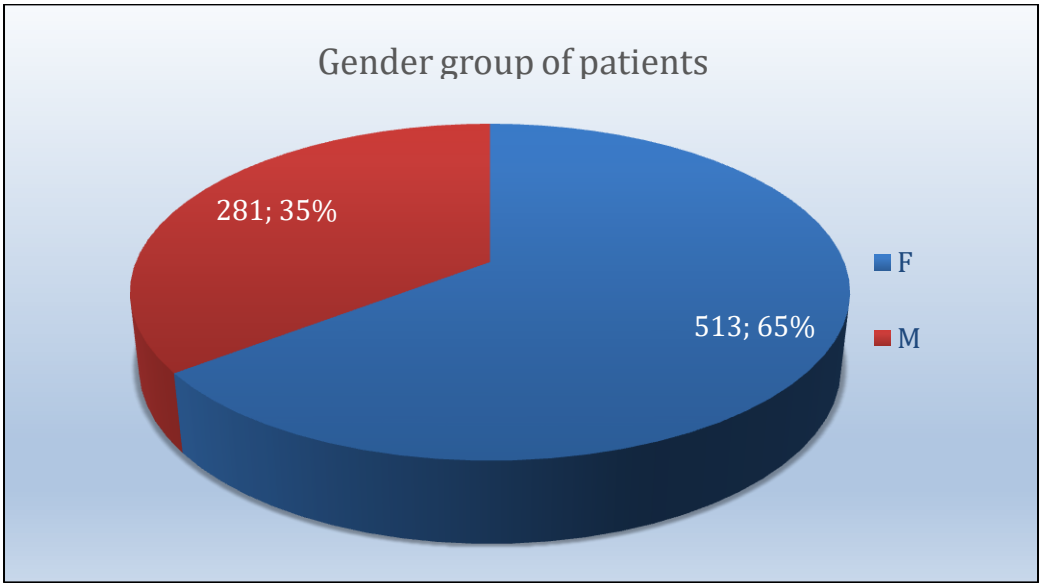


Figure 4: Frequency of patients based on gender

ISSN: 0975-3583, 0976-2833 VOL 12, ISSUE 05, 2021

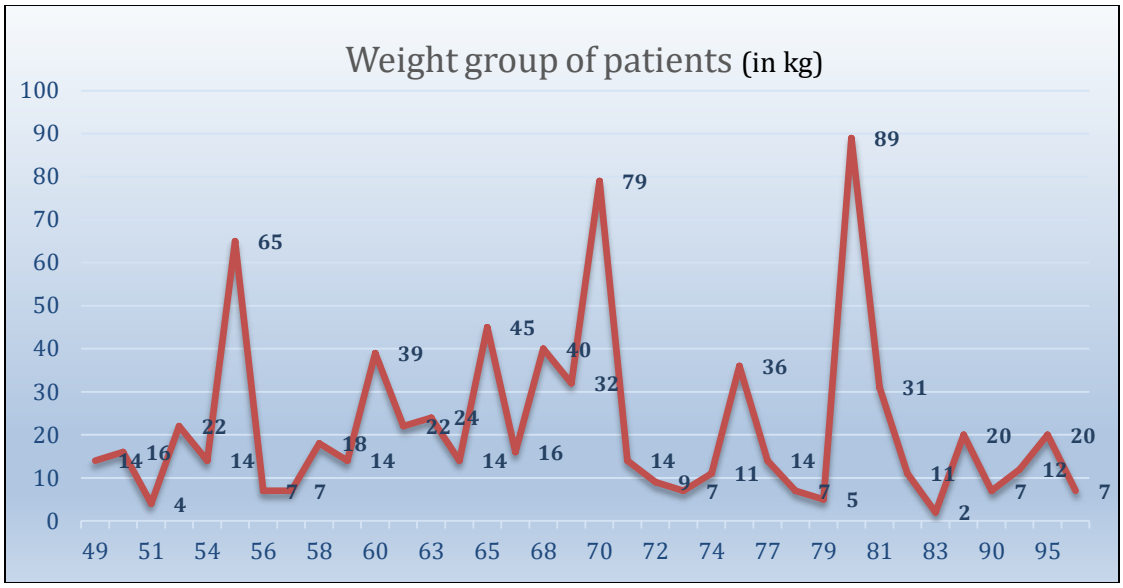
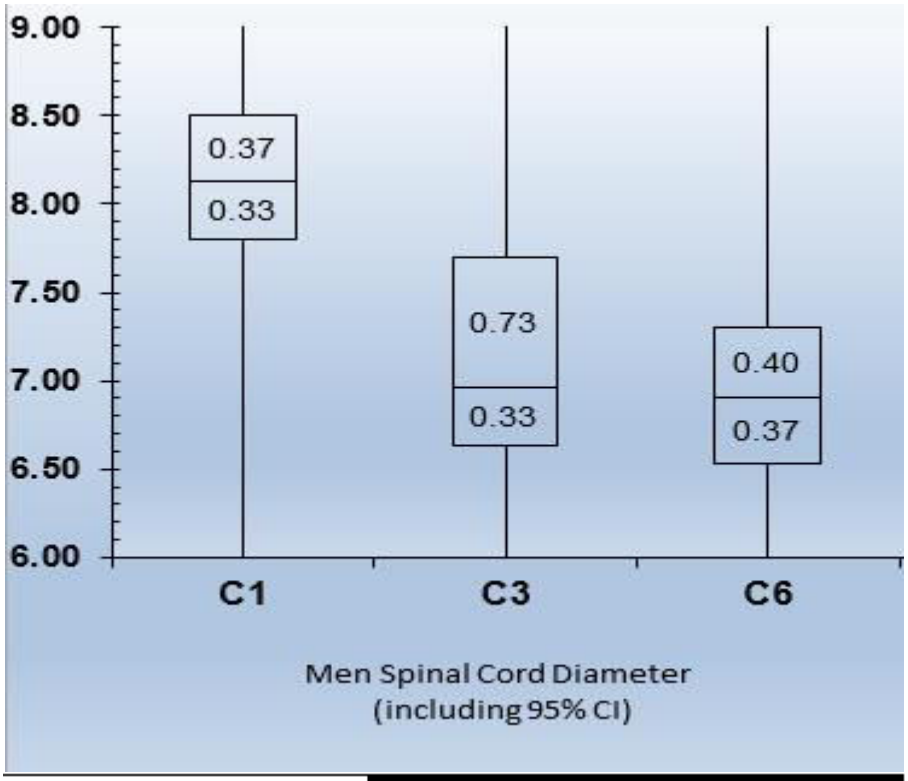


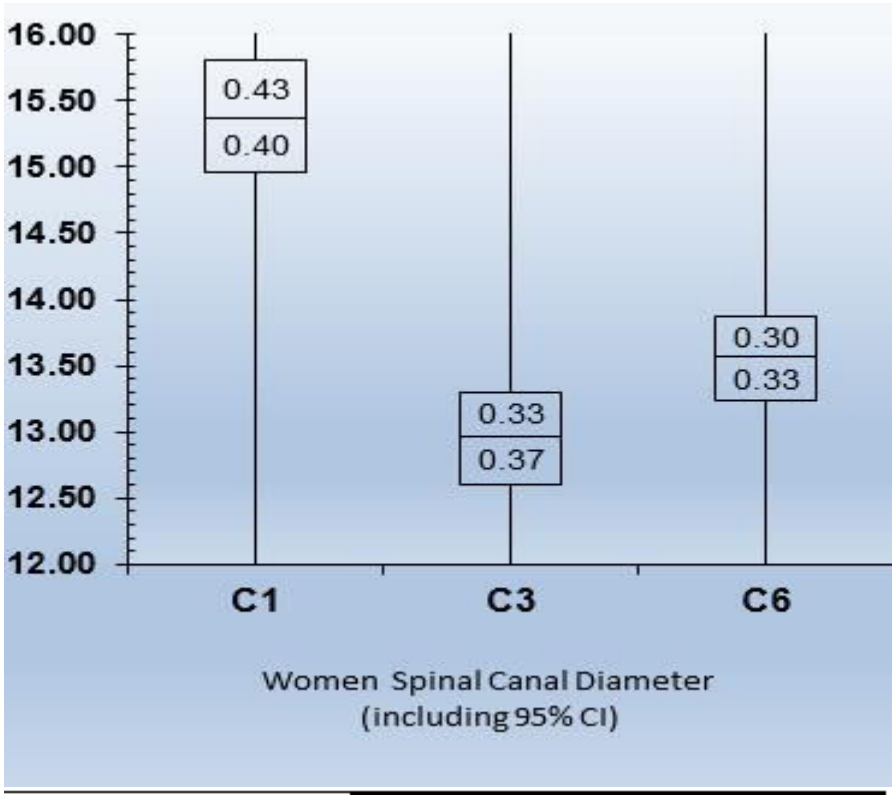
Figure 5: Distribution of patients on the basis of weight (kg)



	C1	C3	C6
Minimum	7.80	6.63	6.53
Estimate Diameter	8.13	6.97	6.90
Maximum	8.47	7.30	7.27

Figure 6: Spinal canal cord diameter at different cervical levels in men

ISSN: 0975-3583, 0976-2833 VOL 12, ISSUE 05, 2021



	C1	C3	C6
Minimum	14.97	12.60	13.23
Estimate Diameter	15.37	12.97	13.57
Maximum	15.80	13.30	13.87

Figure 7: Spinal canal cord diameter at different cervical levels in women

DISCUSSION:

Radiology plays an important role in evaluating and diagnosing various cervical spine-related pathologies. Radiographs of the cervical spine offer limited information due to positioning issues in acute symptomatic individuals as well as due to technical magnification factors. CT and MRI are more reliable and can conduct precise readings, thus avoiding positioning problems and other technical mistakes (1). In association with the incidence and symptoms of spinal cord or nerve root compression, spondylosis or other defects, the significance of the size and shape of the spinal canal has long been recognized (2). While the variation range in the interpedicular width of the cervical spinal canal is also determined, it was also noted that the significance of anteroposterior (sagittal) diameter in the cervical region is important.

In the past, multiple efforts have been made in patients with degenerative canal stenosis (3-5) to correctly assess the diameter of the cervical spinal canal. However, owing to variations in magnification, plain x-ray's measurements lacked compatibility (6). Studies on the length of the

ISSN: 0975-3583, 0976-2833 VOL 12, ISSUE 05, 2021

vertebral bodies, lateral masses, pedicles and foramen of C2 nerve root (7-8) were also conducted using computed tomography. Other anatomical components of the cervical spine (8-9) were evaluated in addition to the osseous structures. Payne and Spillane measured the anteroposterior dimension of 90 adult cervical spinal canals on the cervical spines' lateral radiographs. In instances of cervical spondylosis, they discovered the spinal canal to be smaller (10). Individual variables such as age, gender and height have an important mathematical impact on the measurements at all spinal concentrations. These variables must therefore be taken into account in order to formulate reasonable valid standard values for the cervical spinal canal and cord dimensions, because our readings were more reliable for diameters than for fields.

Due to technical magnification variability or errors, the sagittal diameters on simple x-ray (lateral view) revealed in writings varied but were always higher than CT or MR imaging values (11), hence we opted for MRI for this research. The findings of this research can be contrasted effectively with the outcomes of measurements of Ulbrich et al[12] spinal cervical canal and cord sizes with a reduced population size of 140 patients compared to our research population of 796 patients. The reference study has a constant constriction of the spinal canal from above to downwards level C1 to C6 was observed, these diameters increase with increasing height and is independent of patient age and gender (12). Our results are also similar to the study of Ulbrich et al moreover in this study diameter and spinal canal area decreases from level C1 to C3 and minimally increases at C6 level. Another study was carried out in 2019 by Waheed et al at Karachi, Pakistan which used agreement between Kang's grading system with neurological symptoms (13). In another study reference values of cervical spine and vertebral bodies were calculated in general population residing in West Pomerania (14).Available normal values are mainly from western population. This study was carried out in normal adult population in Pakistan. The dimensions are relatively different from data from other population groups from different countries.

CONCLUSION:

To conclude, the cervical spinal canal and cord in healthy population depends on spinal level, gender, age, and height. These normal values should help Radiologists and Neurosurgeons to describe MR imaging more accurately and to assess the severity of possible cervical spinal stenosis in Asian population.The diameter and spinal canal area decrease from C1 to C3 and then minimally increases to C6 level in cervical spine.These diameters increase with increasing height and is independent of patient age and gender.The dimensions are relatively different from data from other population groups from different countries.

ISSN: 0975-3583, 0976-2833 VOL 12, ISSUE 05, 2021

REFERENCES:

1. Sureka B, Mittal A, Mittal M, Agarwal K, Sinha M, Thukral B. Morphometric analysis of cervical spinal canal diameter, transverse foramen, and pedicle width using computed tomography in Indian population. Neurology India. 2018; 66(2):454.

2. Zahoor Janjua M, Muhammad F. Measurements of the Normal Adult Lumbar Spinal Canal. JPMA. 1989; 39(10).

3. Hashimoto I, Tak Y. The true sagittal diameter of the cervical spinal canal and its diagnostic significance in cervical myelopathy. Journal of Neurosurgery. 1977; 47(6):912-916.

4. Pavlov H, Torg J, Robie B, Jahre C. Cervical spinal stenosis: determination with vertebral body ratio method. Radiology. 1987; 164(3):771-775.

5. Kwon B, Song F, Morrison W, Grauer J, Beiner J, Vaccaro A et al. Morphologic Evaluation of Cervical Spine Anatomy with Computed Tomography. Journal of Spinal Disorders. 2004; 17(2):102-107.

6. Remes V, Heinänen M, Kinnunen J, Marttinen E. Reference values for radiological evaluation of cervical vertebral body shape and spinal canal. Pediatric Radiology. 2000; 30(3):190-195.

7. Wajanavisit W, Lertudomphonwanit T, Fuangfa P, Chanplakorn P, Kraiwattanapong C, Jaovisidha S. Prevalence of High-Riding Vertebral Artery and Morphometry of C2 Pedicles Using a Novel Computed Tomography Reconstruction Technique. Asian Spine Journal. 2016; 10(6):1141.

8. Hong J, Park D, Lee M, Kim S, An H. Anatomical Variations of the Vertebral Artery Segment in the Lower Cervical Spine. Spine. 2008; 33(22):2422-2426.

9. Albayrak R, Fidan F, Unlu M, Sezer M, Degirmenci B, Acar M et al. Extracranial carotid Doppler ultrasound evaluation of cerebral blood flow volume in COPD patients. Respiratory Medicine. 2006; 100(10):1826-1833.

10. Maqbool A, Athar Z, Hussain L. Midsagittal Diameter of Cervical Spinal Canal and Torg's Ratio Of The Cervical Spine In Pakistanis. Pak J Med Sci. 2003; 19(3):203-210.

11. Senol U, Cubuk M, Sindel M, Yildirim F, Yilmaz S, Zkaynak C et al. Anteroposterior diameter of the vertebral canal in cervical region: Comparison of anatomical, computed tomographic, and plain film measurements. Clinical Anatomy. 2001; 14(1):15-18.

12. Ulbrich E, Schraner C, Boesch C, Hodler J, Busato A, Anderson S et al. Normative MR Cervical Spinal Canal Dimensions. Radiology. 2014; 271(1):172-182.

ISSN: 0975-3583, 0976-2833 VOL 12, ISSUE 05, 2021

13. Waheed H, Khan M, Muneeb A, et al. (July 03, 2019) Radiologic Assessment of Cervical Canal Stenosis Using Kang MRI Grading System: Do Clinical Symptoms Correlate with Imaging Findings? Cureus 11(7): e5073. doi:10.7759/cureus.5073

14. Nell C, Bülow R, Hosten N, Schmidt CO, Hegenscheid K (2019) Reference values for the cervical spinal canal and the vertebral bodies by MRI in a general population. PLoS ONE 14(9): e0222682. https://doi.org/10.1371/journal.pone.0222682