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Original Research Article

MORPHOMETRIC ANALYSIS OF TYPICAL CERVICAL VERTEBRAE AND THEIR CLINICAL IMPLICATIONS: A CROSS SECTIONAL STUDY

Ephraim Vikram Rao. K *[1], B Sadananda Rao [2], B H Shiny Vinila [3].

[*1] Assistant Professor, Department of Anatomy, Deccan College of Medical Sciences, Hyderabad, Telangana, India.

[2] Associate Professor, Department of Anatomy, Kamineni Academy of Medical Sciences and Research Center, Hyderabad, Telangana, India.

[3] Senior lecturer, Department of Anatomy, Panineeya Mahavidyalaya Institute of Dental Sciences and Research Center, Hyderabad, Telangana, India.

ABSTRACT

Introduction: Knowledge on the dimensions of morphological features of typical cervical vertebrae is of importance to improve the surgical outcome while performing cervical pedicle screw insertion, cervical laminectomy, hook plating, lateral mass screw fixation, inter spinous wiring and the cervical transpedicular screw fixation. The aim of the present study on the morphometric analysis of the typical cervical vertebrae (C3-C6) is to provide knowledge for the surgeons to improve the surgical techniques and to minimize the post operative complications.

Materials and Methods: The present study consisting of 50 dry typical cervical vertebrae. Height, transverse diameter, antero-posterior diameter of vertebral bodies, height and length of laminae, length and width of pedicles, length of spine, length and width of superior and inferior articular facets were measured using digital Vernier caliper with 0.01mm precision.

Results: The mean and standard deviations of height, transverse diameter, antero-posterior diameter of vertebral bodies were 12.31±1.58 mm, 21.49±2.13 mm and 15.69±1.42 mm respectively. The mean & SD of the height and length of laminae were 10.60±1.21 mm and 15.13±1.38 mm respectively. The mean & SD of length and width of pedicles were 5.62±1.53 mm and 4.64±0.72 mm respectively. The mean & SD of length of spines were 16.23±2.23mm. The mean & SD of length and width of superior and inferior articular facets were 12.75±2.47mm, 9.69±1.54 mm, 13.55±2.16 mm and 6.37±0.82 mm respectively. The mean antero-posterior diameter of bodies was measured on superior and inferior surfaces and it was found that the mean antero-posterior diameters on inferior surface of bodies were higher than superior surface. Student t test was performed between the right and left sides of all the parameters and found bilateral symmetry.

Conclusion: The knowledge on the morphometric dimensions of the typical cervical vertebrae (C3-C6) provides essential guidance to the surgeons to improve the surgical techniques which can minimize the intra operative and/or post operative complications.

KEY WORDS: Typical Cervical Vertebrae, Transverse Diameter, Antero-Posterior Diameter, Transpedicular Screw Fixation, Cervical Laminectomy.

Address for Correspondence: Dr. Ephraim Vikram Rao. K, Assistant Professor, Department of Anatomy, Deccan College Of Medical Sciences,Santhosh Nagar, Hyderabad, 500058. , Telangana, India. Ph. No.: +919949353025 **E-Mail:** dr.ephraimvikram@gmail.com

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INTRODUCTION

The cervical vertebrae present foramina transversaria in their transverse processes. They are the smallest and exhibit the greatest range and variety of movements that makes them prone to a diverse array of traumatic and degenerative conditions [1]. The other causes of cervical spine instability are neoplasm and infection [2]. Cervical spine instability can be corrected surgically by clamps, hook plating, lateral mass screw fixation, inter spinous wiring and the cervical transpedicular screw fixation [3-6]. In many conditions, the cervical spine stabilization is needed to maintain spinal alignment which is frequently managed by arthrodesis that involves surgical fusion of adjacent degenerated vertebrae with plates and screws, accurate placement of screws is very important as there is a risk of damage to the vertebral artery, spinal medulla or nerve roots[7].

The exact dimensions of bodies of cervical vertebrae are an important tool in the planning of management and treatment of diseases related to the cervical spine [8]. The anteroposterior diameter of a cervical vertebral body is an important parameter for the anterior fixation of bicortical screws [9]. Knowledge on the dimensions of laminae of cervical vertebrae is very much essential while performing cervical laminectomy. Cervical laminectomy is a surgical procedure where the posterior bony elements or laminae of the cervical vertebrae are removed which allows the spinal cord to migrate dorsally away from anteriorly situated compressive pathology, while also affording direct relief from dorsal stenosis or spondyloar throsis [10].

Knowledge of the dimensions of pedicles is essential while performing cervical pedicle screw insertion and also to minimize the risk of catastrophic damage to surrounding neurovascular structures and improve surgical outcome[11].

The present study on the morphometric analysis of the typical cervical vertebrae (C3-C6) provides knowledge for the surgeons to improve the surgical techniques and to minimize the post operative complications.

The present study was a cross sectional study consisting of 50 typical cervical vertebrae which were collected from the department of Anatomy, Deccan college of medical sciences. Damaged vertebrae and the vertebrae with deformities/ spurs were excluded from the study. Only intact vertebrae, in good condition were included in the study and photographed. All the parameters were measured using digital Vernier caliper with 0.01mm precision. Mean and standard deviations of the following parameters were calculated:

Vertebral Body: Height, transverse diameter, antero-posterior diameter from superior surface and antero-posterior diameter from inferior surface were measured. The midline vertical distance between superior and inferior border of the anterior surface of the vertebral body was taken as height of the vertebral body (Figure 1). The maximum transverse distance of superior surface of the vertebral body was taken as transverse diameter of vertebral body. Antero-posterior distance between the anterior and posterior borders of superior surface of the vertebral body measured in the midline was taken as antero-posterior diameter of superior surface of the body (Figure 2).

Laminae: Midline distance between superior and inferior border of laminae was considered as height of the laminae and the distance between spine and lateral border of superior articular facet along superior border of lamina was taken as transverse length of the laminae (Figure 3).

Pedicles: The length of the pedicle was measured from the anterior margin of superior articular facet to posterior margin of vertebral body. The width was determined by the distance between the medial and lateral border of pedicle (Figure 4).

Length of the spine: The distance from anterior end of the spine to the longest tip of the bifurcated spine (Figure 5).

Superior articular process: The maximum distance between superior and inferior border of the superior articular process was considered as length and the maximum transverse diameter of superior articular process as width (Figure 6).

Inferior articular process: Maximum distance

Fig. 1: Showing the height (A) of typical cervical vertebral body.

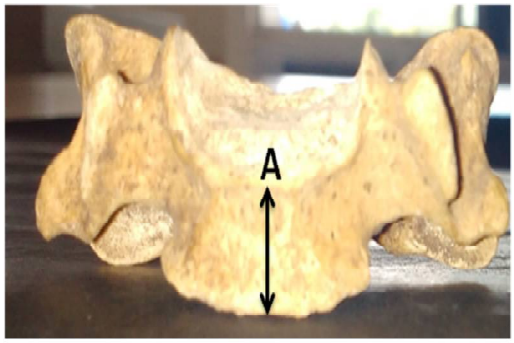

Fig. 2: Showing the transverse diameter (B) and antero-posterior diameter (C) of typical cervical vertebral body.

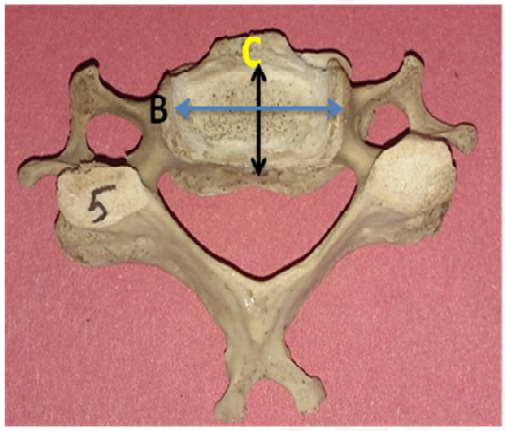

Fig. 3: Showing height (D) and length (E) of the lamina of typical cervical vertebra.

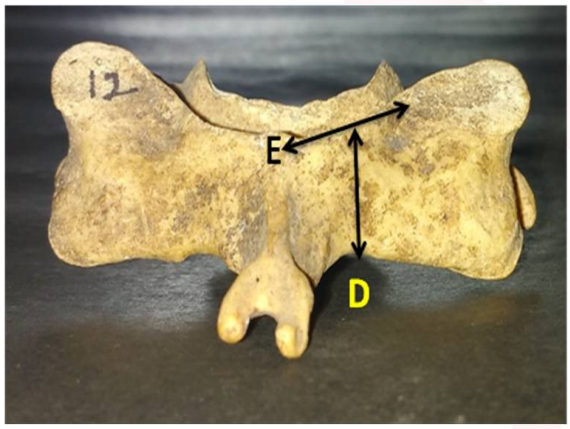

Fig. 4: Showing the length (F) and the width (G) of the pedicle of typical cervical vertebra.

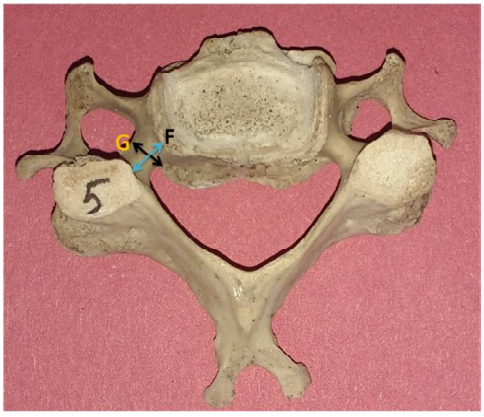

Fig. 5: Showing the length of spinous (H) process of typical cervical vertebra.

Fig. 6: Showing the length (I) and width (J) of superior articular facet of typical cervical vertebra.

Fig. 7: Showing the length (K) and width (L) of inferior articular facet of typical cervical vertebra.

between superior and inferior border of the inferior articular process considered as length and the maximum transverse diameter of inferior articular process as width (Figure 7).

Statistical analysis: The mean and standard deviations of all the parameters were calculated. The comparison of morphometric dimensions of the right and left sides was performed using Student's t-test and p-value was calculated.

RESULTS

The mean and standard deviations of height, transverse diameter, antero-posterior diameter of vertebral bodies, height and length of laminae, length and width of pedicles, length of spine, length and width of superior and inferior articular facets were measured on all 50 typical cervical vertebrae. The mean and standard deviations of height, transverse diameter, antero-posterior diameter of vertebral bodies are presented in Table 1.

Table 1: Showing the mean and standard deviations of various parameters measured on bodies of typical cervical vertebrae.

Parameter	Mean & SD
Body height	12.31 ± 1.58mm
Body transverse diameter	21.49 ± 2.13mm
Body Anteroposterior diameter of Superior surface	15.69 ± 1.42mm
Body Anteroposterior diameter Inferior surface	17.24 ± 1.58mm

The mean and standard deviations of height and length of laminae, length and width of pedicles, length of spine, length and width of superior and inferior articular facets are presented in Table 2. Student t test was performed between the right and left sides of all the parameters and they were found to have bilateral symmetry as there was no statistically significant difference between them (P> 0.05).

Table 2: Showing the mean and standard deviations of various parameters measured on neural arches of typical cervical vertebrae.

Parameters	Right (mm)	Left (mm)
Laminae height	10.54±1.27	10.66±1.15
Laminae length	14.99±1.53	15.28±1.23
Pedicil length	5.45±1.60	5.80±1.44
Pedicil width	4.65±0.71	4.64±0.74
Spine length	16.13±2.13	16.20±2.21
Superior articular facet max	13.11±3.15	12.39±1.80
Superior articular facet min	9.73±1.93	9.65±1.16
Inferior articular facet max	13.83±3.02	13.28±1.3
Inferior articular facet min	9.75±2.47	9.19±1.58

DISCUSSION

Cervical spine surgery requires a thorough anatomical knowledge of all the parameters of cervical vertebrae for proper selection of sizes of the plates, screws and other surgical instruments leading to a successful surgical outcome. Instrumentation of the cervical spine is often done for the orthopedic management of pathologies resulting in cervical instability as well as for the decompression of neural structures. Previous studies reported that the vertebral dimensions are race specific [8]. The present study gives morphometric dimensions of dry typical cervical vertebrae in south Indian population.

As all the vertebrae, cervical vertebrae also have body and neural arch. The dimensions of the body of typical cervical vertebrae are important in anterior cervical reconstruction using plate fixation. Antero-posterior diameter of vertebral bodies is important in bicortical screw fixation.[9] In the present study the mean height, transverse diameter, antero-posterior diameter of vertebral bodies was 12.31mm, 21.49 mm and 15.69 mm respectively. A study by Tan et al., conducted on Singapore population reported that the vertebral body height, transverse diameter and antero-posterior diameter were 10.2mm, 14.8mm and 14.1mm respectively which were smaller than the values of the present study [12]. In Mexican population Bazaldua CJJ et al reported the transverse diameter and antero-posterior diameters as 21.31mm and 16.08mm respectively, in Turkish population Abu zayed et al reported the antero-posterior diameter as 15.6 to 17.6mm [9]. Another Indian study by Sandeep Saluja et al., reported the height, transverse diameter and antero-posterior diameters as 11.39mm, 22.18mm and 14.84mm respectively which were similar to the present study [13]. This confirms that the Indians have larger cervical bodies when compared to Singaporeans. The antero-posterior diameter of Turkish population was smaller than Indians and the dimensions of Mexicans were nearer to Indians [9,14].

The dimensions of the parts of neural arch especially pedicles and laminae have an important role in cervical transpedicular screw

fixation and cervical laminectomy. The mean length and width of the pedicles were 5.62±1.53 mm and 4.64±0.72 mm respectively which coincides with the results of Kayalioglu et al., (5.83mm and 4.72mm) and Bozbuga et al., (5.75mm & 4.65mm) [15,16]. The Edlin et al., higher values than the present study [17]. The mean height and lengths of lamina were 10.60±1.21 mm and 15.13±1.38 mm respectively which were similar to the results of Sandeep Saluja et al., another Indian study [13]. The length of spinous process assumes importance during screw placement in traumatic or degenerative lesions. The mean length of spinous process was similar with Sandeep Saluja et al., and smaller when compared to Bazaldua CJJ et al., a Mexican study [9,13]. Lateral mass screw fixation is a technique of choice in stabilizing sub-axial cervical spine as it maintains rotational stability. Injury to adjacent neurovascular structures or facet joints, weak screw grip due to less cortical bone in the lateral mass and a smaller area left for bony fusion after plate insertion were reported as complications of lateral mass screw fixation. The dimensions of superior and inferior articular process form the basis for lateral mass screw fixation [18].

CONCLUSION

The present study on the morphometric analysis of the typical cervical vertebrae (C3-C6) provides knowledge on the dimensions of various parts of typical cervical vertebrae for the surgeons to improve the surgical techniques and minimize post operative complications.

Conflicts of Interests: None

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