Original Article

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Clinico-anatomical Approach for Instrumentation of the Cervical Spine: A Morphometric Study on Typical Cervical Vertebrae

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Abstract

Introduction: Seven cervical vertebrae form the skeleton of the neck. These bones are the part of the axial skeleton. Four out of seven cervical vertebrae are typical on the basis of commonly prevailing characteristics. These centrally positioned and well-stacked bones support and position the head. The craniovertebral and intervertebral articulations provide the necessary flexibility.

Aim: The aim of the present study was to observe the morphology and morphometry of typical cervical vertebral body.

Materials and Methods: The present study was carried out on 240 adult dry human typical cervical vertebrae obtained from the Department of Anatomy of four medical colleges in Bihar to observe the dimensions of the vertebral bodies.

Result: Height of the vertebral bodies was observed to be larger at lower levels. Maximum anteroposterior length and transverse length were observed at C_6 and C_5, respectively.

Conclusion: Knowledge of both morphology and morphometry of typical cervical vertebrae is imperative for developing instrumentation related to the cervical spine. Ethnic variations have been reported in these dimensions.

Key words: Cervical vertebrae, Instrumentation, Morphology, Morphometry, Variations

INTRODUCTION

Cervical curvature plays an integral role in the proper functioning of the cervical spine. The summation of small movements occurring at the cervical intervertebral joints accounts for the high mobility and flexibility of the neck as an entity. The skeleton of the neck comprises seven small cervical vertebrae out of which four (C_3-C_6) are typical. Each vertebra consists of an anterior vertebral body and a posterior neural arch. The vertebral body has a central part of cancellous bone and a peripheral cortex of compact bone. The margins of upper and lower surfaces of the vertebral body are thickened to form vertebral rings. The neural arch is constituted by pedicles, laminae, spinous process, and articulating facets. The vertebral bodies are connected anteriorly by a long strong strap like anterior longitudinal ligament and a similar posterior longitudinal ligament. Fractures and dislocations of the spine are serious injuries as they may be associated with damage to the spinal cord or cauda equina. Instrumentation of the cervical spine is often used for the orthopedic management of pathologies resulting in cervical instability as well as for the decompression of neural structures. One of the most frequent and complex procedures for this is the placement of transpedicular screws.[1-4] The neural arches of adjacent vertebrae articulate with each other though facet joints which form synovial joints. Remaining portions of the neural arch of consecutive vertebrae are joined together by ligamentum flavum and other ligaments which are collectively termed as posterior ligament complex. Size of the vertebral bodies and both direction and size of the articular facets are different in different regions of the vertebral column. Previously morphometric studies of the cervical, thoracic, and lumbar vertebrae have been undertaken, and they have highlighted the importance of such studies in the development of vertebral

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column instrumentation.[5-8] Majority of these studies focus exclusively on the pedicle as this is the site where vertebral column fixation surgeries are most frequently implemented. Only a few studies describe the characteristics of the remaining elements that comprise the vertebra.[9,10] Most spinal surgeons agree to have adequate knowledge of spinal column morphology to avoid damage to the vertebral artery, spinal medulla, or nerve roots during fixation interventions involving posterior cervical spine.[11] Ethnic differences in dimensions of cervical spine have been reported across various populations. This study was taken up as no such citable previous study was performed in the state of Bihar.

MATERIALS AND METHODS

Two hundred and forty adult dry human typical cervical vertebrae were obtained from the Department of Anatomy of four medical colleges in Bihar to observe the dimensions of the vertebral bodies. Sex of the bone was not considered in the study. Only those vertebrae which were intact in all aspects were included in the study. Damaged, malformed, and vertebrae with signs of previous fractures were excluded from the study. All the measurements were conducted by using a sliding Vernier Calliper with 0.1 mm accuracy. Dimensions of the body were recorded in the following manner:

(a) Height: Distance between superior and inferior borders of the vertebral bodies at the midline
(b) Anterior-posterior length (APL): Distance between the anterior surface and posterior surface of the body at the midline
(c) Transverse length (TL): Distance between two lateral surfaces of the vertebral body (Figures 1-4).

RESULTS

Out of 240 cervical vertebral bodies studied, the maximum and minimum APL were observed at C_6 and C_3 respectively. TL was greatest at C_5 and smallest at C_3. The maximum body height was recorded at C_6 and lowest at C_4 (Tables 1 and 2).

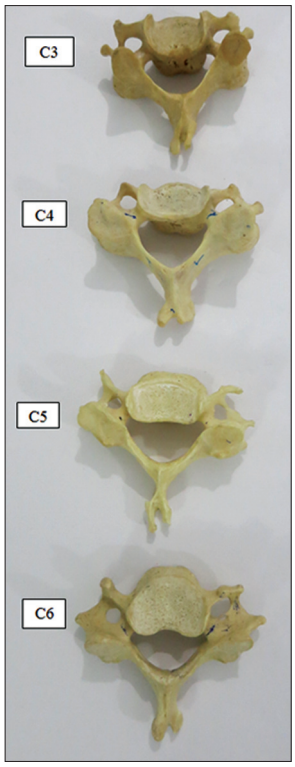

Figure 1: Vertebrae C_3-C_6

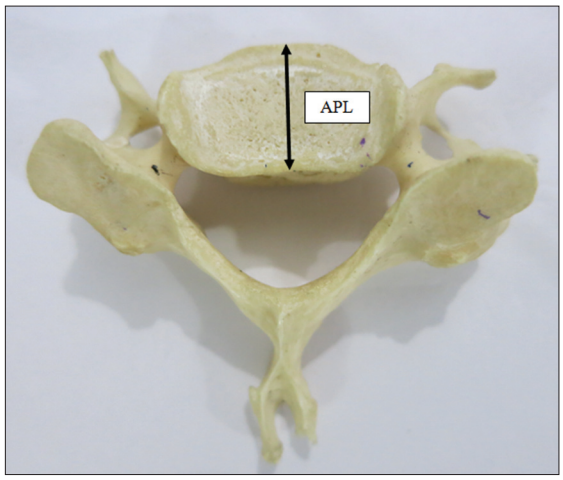

Figure 2: Recording of anteroposterior length (mm)

DISCUSSION

Cervical spine instrumentation requires minute precision and thorough anatomical knowledge for a successful outcome. The management of spinal trauma either in isolation or a part of the polytraumatized patient is a difficult venture. Several authors have described the various parameters of the vertebral column in general by methods such as computed tomography scans and three-dimensional (3D) reconstructions. It has also been previously demonstrated that vertebral dimensional differences exist among different races,[12] and in this study, we have observed vertebral dimensions in Bihar region. The APD of a cervical vertebral body is an important parameter for the anterior fixation of bicortical screws.[9] In this study, we have observed that body height of typical cervical vertebra was minimum in C_4 and maximum in C_6. The APL was maximum and minimum at C_6 and C_3, respectively. The TL was greatest and least at C_5 and C_3, respectively. 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. Knowledge of normal dimensions of vertebral bodies helps us to understand various clinical conditions such as stenosis and other space occupying

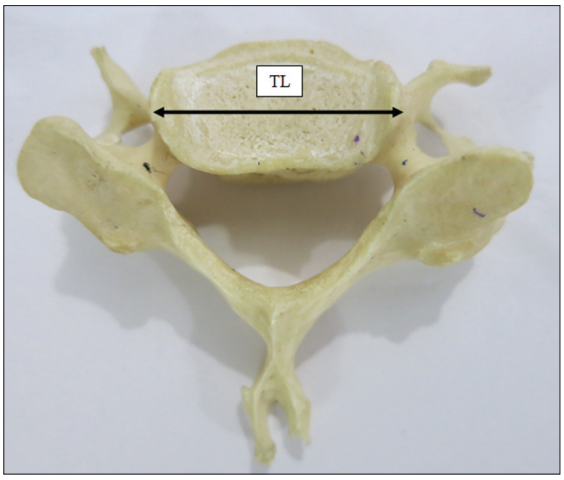

Figure 3: Recording of transverse length (mm)

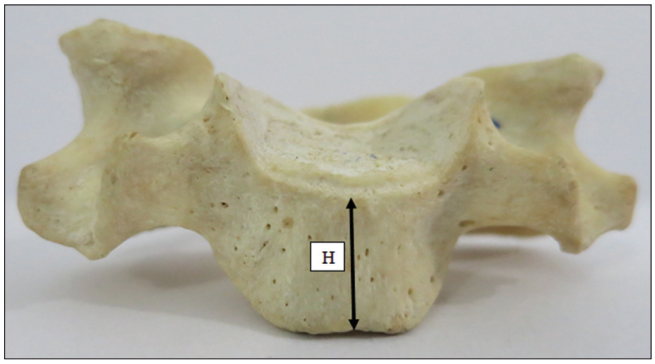

Figure 4: Recording of height of vertebral body (mm)

lesions. Growth of the vertebral body may be related to genetic, racial, postural, and occupational factors. Body of cervical vertebrae from C_3-C_6 is somewhat box-shaped. Vertebral bodies appear to grow more in height than in depth and APL of a vertebral body is always greater than height. Variations in the components of the spine are so great that this subject has interested specialists from several fields. Spinal posture depends upon the anatomical and functional integrity of the vertebrae and if this integrity is lost clinical symptoms may develop.

CONCLUSION

Morphometry of vertebral bodies is useful for surgeons and orthopedicians who perform plate fixation during anterior cervical spine surgery. Variations in racial data must be taken into consideration during surgical procedures. Morphologic characteristics of the cervical vertebrae are responsible for the natural cervical lordosis curvature and the mobility of the cervical column. However prior to instrumentation, the orthopedic assessment of the spine should include evaluation of both skeletal and neurological injuries and a careful examination of both spinal and non-spinal injuries.

Table 1: Comparison of the values of the typical cervical vertebrae observed in this study

Parameter	*n*	Maximum	Minimum
Height	240	C_6	C_4
APL	240	C_6	C_3
TL	240	C_5	C_3

C=Cervical vertebra, APL: Anterior-posterior length, TL: Transverse length

Table 2: Morphometric characteristics of the typical cervical vertebral bodies

Cervical vertebra	Mean±SD (mm)		
	APL	TL	Height
C_3 (*n*=60)	13.6±0.18	22.8±0.21	8.9±0.11
C_4 (*n*=60)	14.4±0.15	23.6±0.28	8.1±0.10
C_5 (*n*=60)	15.2±0.21	26.4±0.30	10.1±0.17
C_6 (*n*=60)	15.8±0.19	25.2±0.23	11.3±0.16

C: Cervical vertebra, APL: Anterior posterior length, TL: Transverse length, SD: Standard deviation

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