

Original Research Article

Morphometric study of dens and its clinical importance

Syed Mubashir Yousuf¹, Shameema Gulzar², Mohd Saleem Itoo¹, G. Mohammad Bhat¹,
Mudasir Ahmad Khan^{3*}

¹Department of Anatomy, Government Medical College, Srinagar, Jammu & Kashmir, India

²Department of Anatomy, Government Medical College, Baramulla, Jammu & Kashmir, India

³Department of Anatomy, Government Medical College, Anantnag, Jammu & Kashmir, India

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*Correspondence:

Dr. Mudasir Ahmad Khan,

E-mail: doctorkhan97@gmail.com

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ABSTRACT

Background: The axis vertebra's distinguishing characteristic is the existence of the odontoid process. The axis vertebra's morphology is very different from the morphologies of the other cervical vertebrae. Surgery on the axis vertebrae is exceedingly risky, and dens of axis vertebrae fractures are fairly common. As a result, it is essential to have a good grasp of the anatomical variance before performing the procedure. The study aimed to evaluate the morphometric parameters of the odontoid process of the axis vertebra. The different anatomical parameters of the odontoid process of the vertebra will be measured and compared with the previously studied parameters.

Methods: Thirty dried human axis vertebrae of unknown sex will be taken. The linear and angular morphometric measurements of odontoid process will be recorded by using vernier caliper and goniometer.

Results: The mean height, a-p diameter, and minimum and maximum width were 15.8mm, 10.7mm, 10.3mm and 8.5mm respectively. The total height and vertical angle were 38.1mm and 52.2 degrees respectively.

Conclusions: To prevent damage to vital components and to help treat dens fractures, the information gleaned from this study may be helpful to surgeons working around the dens of the axis vertebra.

Keywords: Axis vertebrae, Odontoid process, Vernier caliper

INTRODUCTION

The adult human contains 33 vertebrae in his vertebral column, which is divided into five regions: cervical 7, thoracic 12, lumbar 5, sacral 5, and 4 coccygeal vertebrae.¹ The axis is an atypical second cervical vertebra with the characteristic feature of possessing the odontoid process and superior articular facets with specialized properties. It forms a pivotal type of joint with the atlas, the atlantoaxial joint, on which the atlas rotates, permitting the head a greater range of motion.^{2,3}

Phylogenetically, the tip, body, neck, and base make up the densities of the axis. It is a crucial component of the

craniocervical junction.⁴ Clinicians undertaking diagnostic, treatment, and operation in the area should therefore be aware of the specifics of its structural variances.⁵

The cervical area is the most versatile part of the vertebral column. The cylindrical neck contains a number of vital structures and connects the body with the head. Dense axis fractures occur frequently and are treated conservatively, surgically, or both. Surgical treatment is done by using a fusion of the first and second vertebrae (C1-C2 fusion), by osteosynthesis using plates and screws, or by fixing the fracture of the dens of the axis with the help of one or two screws.⁴ The indication for

screw application depends on the feature of the odontoid process and the type of fracture.⁷ Among all the fractures of the cervical part, the fracture of the dens of the axis accounts for approximately about 10-14%.⁸

The importance of understanding the unique anatomy and architecture of dens of the axis, the pattern of specific fractures, and the mechanism and biomechanics of dens leads to the proper diagnosis and outcome. Its anatomical structure, especially for anterior and posterior surgical fixation, must be known in advance.^{9,10}

METHODS

This observational study was carried out on 30 dried human axis vertebrae of unknown sex used for teaching in the Department of Anatomy at the Government Medical College Srinagar, Jammu and Kashmir, India, over a period of 3 months from October to December 2022.

Exclusion criteria

Only intact axis vertebrae that were devoid of osteophytes, congenital anomalies, or any other physical damage were used in the study. An accurate vernier calliper was used to measure all linear parameters, and a conventional goniometer was used to measure all angular parameters. One observer performed each measurement. The data were statistically analysed.

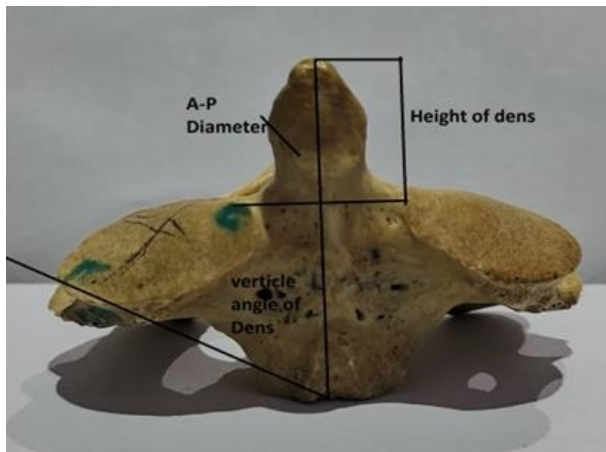


Figure 1: Height of dens, A-P diameter, vertical angle of dens.

The height of dens was measured from the superior border of the superior articular surface to the tip of dens, and the vertical angle of dens was taken as an angle between the inferior surface of the vertebral body shown in Figure 1 and the vertical axis of the dens shown in Figure 2. The maximum and minimum transverse diameters and antero-posterior diameters were measured, as shown in Figure 2.

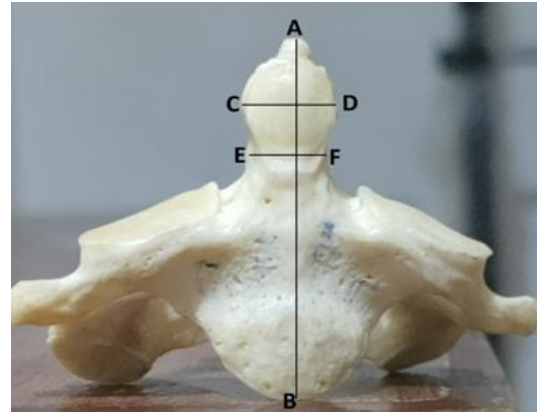


Figure 2: (A, B) Total height of dens, (C, D) maximum width and (E, F) minimum width.

Statistical method

The collected data was put into a Microsoft Excel spreadsheet, which was afterwards exported to the data editor in SPSS version 20.0.

RESULTS

The linear and angular parameters of dens were measured and statistically analyzed, and the range, mean value, and standard deviations were calculated and summarized in Table 1 and shown in Figure 3. The obtained results were then compared to the previous studies and shown in Table 2.

Table 1: Measurement of different variables of dens.

Variable	Min	Max	Mean	Std. Deviation
Height	13.0	19.0	15.8	1.77
A-P diameter	9.0	12.0	10.7	0.99
Maximum width	9.0	12.0	10.3	0.91
Minimum width	6.0	10.0	8.5	1.01
Vertical angle of dens	35.0	65.0	52.2	8.51
Total height	33.0	43.0	38.1	2.57

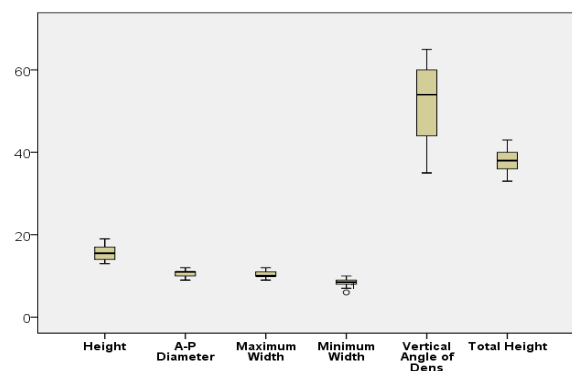


Figure 3: The distribution of various variables of dens.

Table 2: Comparison of some dens parameters in different studies.

	Xu et al (1995)	Doherty and Heggenes(1995).	Senegul and Kodiglu (2006)	Gosavi et al ¹⁴	Singla et al ¹²	Teo et al ¹⁵	Present study
Height	15	-	14.5	14.86	14.66	17.8	15.8
A-P diameter	10.3	11.2	-	9.92	10.1	9.4	10.7
Max. width	10	10.8	11.2	9.28	9.32	12.4	10.3
Vertical angle	64.1	-	-	53.6	—	59.7	52.2

The mean height of the odontoid process from the superior articular facet to the tip was 15.8 mm. The mean anteroposterior diameter was 10.7 mm. The mean maximum width and the mean minimum width of dens were 10.3 mm and 8.5 mm, respectively, and the mean vertical angle was 52.2 mm.

DISCUSSION

The length and diameter of the odontoid process are important to determining the application of one or two screws in case of fracture. To perform an anterior or posterior surgical fixation of the fracture line, the quality of the bone and the parameters related to technical factors should be thoroughly known.

Knowledge about the length and diameter of the odontoid process are important to deciding whether to apply one or two screws in case of fracture. Anterior or posterior surgical treatment is based on the fracture line, the quality of the patient's bone, and technical factors.¹¹

The best approach for the treatment of the odontoid process is controversial when the fracture is at the base of the odontoid process at its junction with the body of the axis. The routinely performed procedure involves posterior fusion arches of the atlas and axis. But this procedure may require an extra period of external immobilization for stabilization to be successful. Although this approach provides better stabilization of the spine, it has important limitations of restricting the normal rotation between the axis and atlas, which usually accounts for more than one-half of the normal axial rotation of the cervical spine.¹²

In the present study, the various dimensions of dens, such as length, anteroposterior diameter, vertical angle, and minimum and maximum width, were compared to those reported in previous studies (Table 2). Nucci et al found that the crucial transverse diameter for the emplacement of two 3.5 mm cortical screws with tapping in the dens was 9 mm.¹³ They observed that in 95% of cases, the diameter was greater than 9 mm.¹³ Gosavi et al found 58% had a diameter of more than 9mm.¹⁴ whereas in the present study, 86.6% had a diameter of dens greater than 9 mm. The vertical angle was measured by Xu et al, as 64.1 degrees, Gosavi et al, measured it as 53.6 degrees, and Teo et al measured it as 59.7 degrees, whereas in our

present study, it measured as 52.2 degrees, which is close to the measurements of Gosavi et al.¹⁵ The height of dens measured by Teo et al was found to be 17.8 mm, and Gosavi et al measured it as 14.77 1.73 mm, whereas in our present study, it was found to be 15.8 mm, which is close to the result obtained by et al.¹⁴

CONCLUSION

To prevent damage to vital components and to help treat dens fractures, the information gleaned from this study may be helpful to surgeons working around the dens of the axis vertebra.

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

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