

Morphometric Study Of Odontoid Process Of Axis Vertebrae In North Gujarat Population.

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Abstract

Introduction: Odontoid process is cone shape process, project cranially from the superior surface of the body of C2. 73% of spinal cord injuries are due to injury to vertebral column. Injury to C1-C 2 complex account for 15-19% of cervical spine injuries. The body of C2 vertebra and odontoid process has been focused in variety of spinal surgery like anterior atlanto-axial, anterior occipito-cervical fixation and anterior odontoid process fixation. This requires knowledge regarding the various parameters of the odontoid process.

Material and Method: Study was conducted on 60 dry axis vertebrae of human origin, in 2020; in 2 medical colleges of North Gujarat University.

Following 9 parameters are measured by manual vernier caliper and goniometer

1. Anterior height of dens body complex
2. Anterior height of body of C2
3. Transverse diameter of body at lower end
4. Antero-posterior diameter of body at lower end
5. Anterior height of dens
6. Posterior height of dens
7. Max. antero-posterior diameter of dens
8. Max. transverse diameter of dens
9. Sagittal angle of dens: angle between coronal plane and axis of dens

Result: Mean anterior height of dens-body complex is 36.73 mm. Mean anterior height of body of C2 is 20.65 mm. Mean transverse diameter and antero-posterior diameter of C2 at base is respectively 15.34 mm and 17.05 mm. Mean anterior and posterior height of dens is respectively 16.07 mm and 14.34 mm. Mean of maximum antero-posterior and transverse diameter of dens is 10.35 mm and 9.69 mm respectively. Sagittal angle shows wide range of variation from - 2 to 15 degree. **Conclusion:** Morphometry of these parameters of body and dens of C2 are useful in various orthopedic and neurological surgeries and also helpful to anthropologists and forensic experts too.

Keywords: Atlas ring, Axis vertebra, Dens, Odontoid process, Os odontoideum, Sagittal angle

Introduction:

Axis is the second cervical vertebra which acts as a pivot for rotation of the first cervical vertebra and head around the strong odontoid process. Odontoid process projects cranially from the superior surface of the body of C2. It is cone shape and slanted little posteriorly. The posterior surface bears a groove for the transverse ligament. Apex is pointed. Its anterior surface bears an ovoid articular facet.

Anterior complex of C2 consist of partially fused centrum of axis, atlas, and rudimentary disc between them; which remain as detectable deep within it. Dens is ossified from 2 centers; appear around 6 month of intra uterine period. They join to each other before birth to form a conical mass. At the upper end, it is deeply cleft by a cuneiform cartilage which forms its apex. This is thought to be a part of the cranio- sclerotomal half of the 1st cervical vertebra or pro-atlas. Ossification may sometimes incomplete. Apical portion may fail to fuse with dens, or dens fails to fuse with body, forming an os odontoideum¹.

Fracture of dens is involved in about 40% fracture of the axis. Most commonly fracture line passes through the base of the dens, at the junction of the dens and body. This is often unstable as transverse ligament interposes between fracture segments². 2nd most common fracture passes through the body, inferior to the base. This fracture heals more rapidly, as it retains blood supply.

There are 3 types of odontoid fracture, by the anatomical location of fracture line. This is called Anderson and D'alonzo classification³.

- Type 1: avulsion fracture of apex. Stable fracture. Less common.
- Type 2: fracture line passing through the base of dens, at the junction of the odontoid base and body. Unstable and Most common fracture.
- Type 3: fracture extends into the body of Axis. Stable fracture.

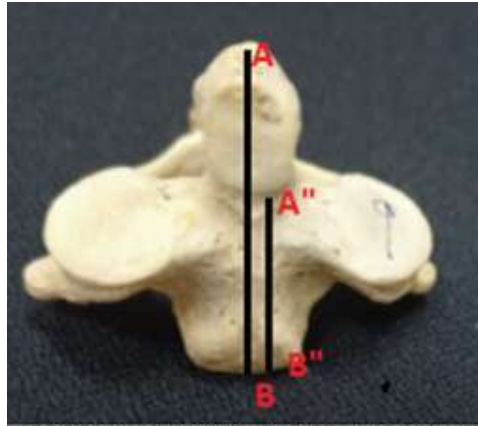
Materials And Method:

This study was conducted on 60 dry axis vertebrae's of human origin, from 2 medical colleges of North Gujarat region, in 2020.

Following 9 parameters were noted by manual vernier caliper and goniometer. Measurements were carried out twice to exclude observers' error. Analysis of data was done to find out Mean, Maximum value, Minimum value and standard error.

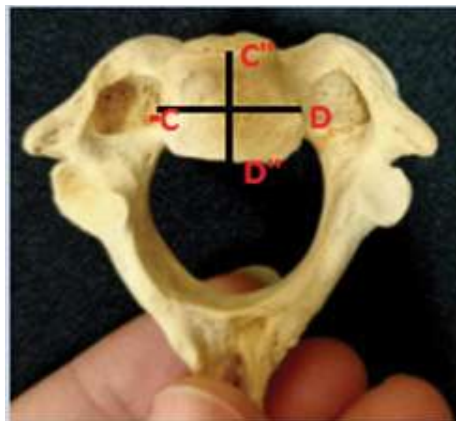
1. Anterior height of dens body complex : from middle of lower end of body to apex of dens
2. Anterior height of body of C2: from middle of lower end of body to middle of constriction between body and dens
3. Transverse diameter of body at lower end
4. Antero-posterior diameter of body at lower end
5. Anterior height of dens from middle of depression between body and dens to apex of dens
6. Posterior height of dens from apex of dens to imaginary line separating dens and body of C2
7. Maximum antero-posterior diameter of dens
8. Maximum transverse diameter of dens
9. Sagittal angle of dens that is angle between coronal plane and axis of dens (angle between IJK)

Figure 1 different measurements from anterior aspect of axis



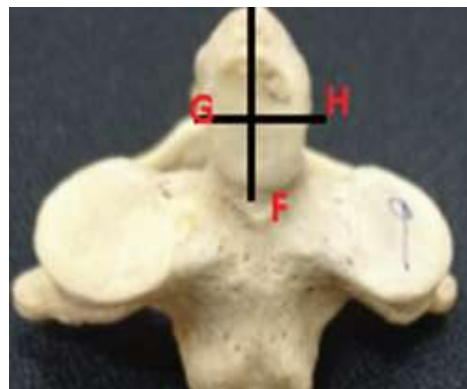
Anterior height of dens body complex (AB), Anterior height of body of C2 (A''B'')

Figure 2 different measurements from Inferior aspect of axis



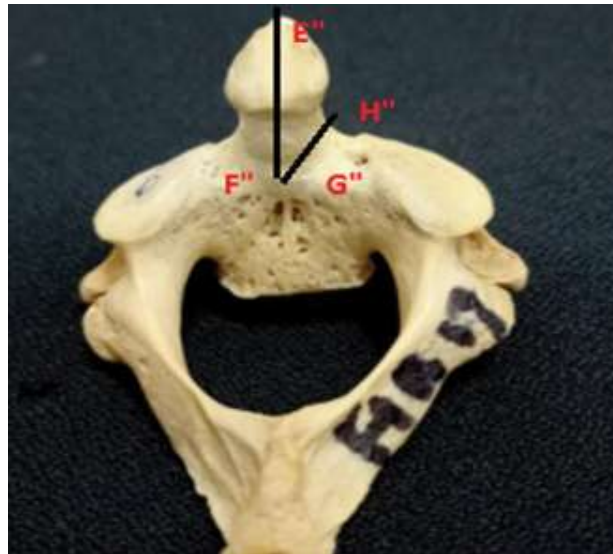
Transverse diameter of body (CD), Antero-posterior diameter of body (C''D'')

Figure 3 different measurements of dens from Anterior aspect of axis



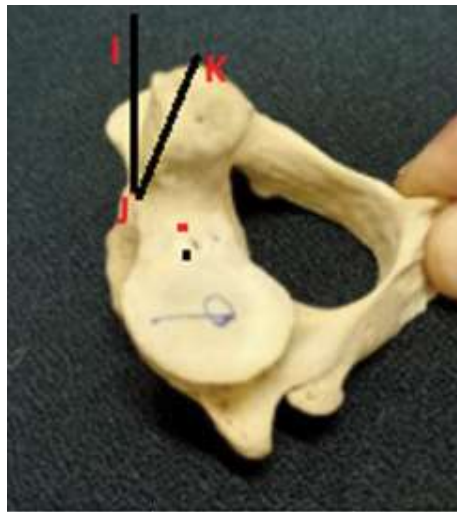
Anterior height of dens (EF), Max. transverse diameter of dens: (GH)

Figure 4 different measurements of dens from Posterior aspect of axis



Posterior height of dens (E''F''), Max. antero-posterior diameter of dens: (G''H'')

Figure 5 measurements from lateral aspect of axis



Sagittal angle of dens (angle between IJK)

Results

Various parameters of axis vertebrae are measured, as shown in figures and tables are prepared. There is a wide range of measurement seen in various parameters that we can see from minimum and maximum value of each data.

Table : 1 Different measurements of Axis

Sr. No.	Parameters	Mean	Max	Min	SD
1	anterior length of dens body complex (mm)	36.73	46.05	31.28	3.08
2	Anterior height of body of C2 (mm)	20.65	27.71	15.78	1.10
3	Antero-posterior diameter of body at lower end (mm)	15.34	18.95	11.58	1.5
4	Transverse diameter of body at lower end (mm)	17.05	22.47	13.62	1.7
5	anterior length of dens (mm)	16.07	18.35	12.81	1.6
6	posterior length of dens (mm)	14.34	16.80	11.09	1.5
7	antero-posterior diameter of dens(mm)	10.35	12.08	8.40	0.83
8	transverse diameter of dens (mm)	9.69	11.38	8.44	0.8
9	sagittal angle	6.82	15	-2	4.36

Mean anterior height of dens-body complex is 36.73 mm. Mean anterior height of body of C2 is 20.65 mm. Mean transverse diameter and antero-posterior diameter of C2 at base is respectively 15.34 mm and 17.05 mm. Mean anterior and posterior height of dens is respectively 16.07 mm and 14.34 mm. Mean of maximum antero-posterior and transverse diameter of dens is 10.35 mm and 9.69 mm respectively. Sagittal angle shows wide range of variation from - 2 to 15 degree.

Discussion

73% of spinal cord injuries are due to injury to vertebral column. Injury to C1, 2 complex, account for 19-15% of cervical spine injuries. Dens is involved in 55% of second cervical vertebrae fracture¹².

Steel's rule of thirds mention that approximately one third of atlas ring is occupied by Dens, one third by spinal cord and one third by fluid filled space and connective tissue around cord².

Congenital anomalies are common in the cervical region of vertebral column, especially associated with dens of C2, due to its complexity in development. Most common congenital anomaly includes os odontoideum and persistent ossiculum terminale. It is necessary to distinguish normal development and developmental anomalies from traumatic injuries¹³.

Table : 2 Comparative parameter of body of axis

Sr. no.	Parameters	Present study	Monika lalit et al ⁴	Shilpa gosa-vi et al ⁵	Naderi et al ⁶	Mukesh single et al ⁷	D S korres et al ⁸
1	Population & Number of Axis studied	North Gujarat, india, 60	Amritsar, india, 60	Maharashtra, india 100	Turkey , 80	Uttarakhand ,india ,30	Greek 105, CT findings
2	anterior length of dens body complex (mm)	36.73±3.08		34.17±3.21	38.7±2.9	34.33±2.69	39.2

3	Anterior height of body of C2 (mm)	20.66	19.28±2.24	20.49±2.25	23.2±2.4	19.67±	
4	Antero-posterior diameter of body at lower end (mm)	15.39±1.5	15.10±1.56	14.77±1.73	15.8±1.7	15.42	
5	Transverse diameter of body at lower end (mm)	17.08±1.7	15.83±2.12	15.99±2.12	18.8±1.8	17.7	

Table: 3 Comparative parameters of dens

Sr. no.	parameters	Present study	Monika lalit et al ⁴	Shilpa gosavi et al ⁵	Naderi et al ⁶	Mukesh single et al ⁷	D S korres et al ⁸	Clayton et al ⁹
1	anterior length of dens (mm)	16.07	16.36±1.68	14.86±1.54	15.5±1.8	14.66±1.37	17.25	15.72±0.49
2	posterior length of dens (mm)	14.34		--	15.4±1.9	13.89±1.81		
3	A-P diameter of dens (mm)	10.35	10.74±1.06	9.92±94	11.3±1.0	10.1±0.91	12.3	10.98±0.10
4	transverse diameter of dens (mm)	9.69	9.85±1.08	9.28±1.07	10.05±0.9	9.32±1.05	13.84	9.46±0.9

The body of C2 vertebra and odontoid process has been focused in variety of spinal surgery like anterior atlanto-axial, anterior occipito-cervical fixation and anterior odontoid process fixation. Type 2 and 3 odontoid fractures may require odontoid screw fixation. This requires knowledge regarding the diameter of the odontoid process. Large odontoid process can be fixed with two screw, whereas narrow odontoid process can be fixed with one screw⁶.

The surgical fracture fixation of the odontoid process of the C2 is a challenging procedure, particularly in elderly patients because of osteoporosis. Screw insertion, near to vital structure like vertebral artery can be damaged².

In present study we have measures various parameters, related to dens and body of axis vertebrae in 60 dry bones. X-ray, CT scan can be used to measure various parameter of the C2 vertebrae.

Mean length of body –dens complex in turkey is around 38.7±/-2.9 mm in naderi et al study and in greek population it is around 39.2 mm., in D.S.korres et al study. In our study we found mean length of body –dens complex is 36.73±3.08 mm, which is comparable to other study done in India and abroad.

Anterior height of body, in greek population it is 23.2±/-2.4 mm. Monika lalit et al⁴ study it was 9.28±2.24 mm, Shilpa gosavi et al study it was 20.49±2.25 mm, Mukesh single et al study it was 19.67 mm, which is comparable to our study.

Antero-posterior and transverse diameter at the base of body is comparatively same in all studies.

Table :4 Comparison of sagittal angle

Sr. no.	Parameter	Present study	B J Doherty et al ¹⁰	J. koebke et al ¹¹
1	Sagittal angle range	-2 to 15	-2 to 42	-3 to 31

Sagittal angle in B J Doherty et al¹⁰ study it was -2 to 42. J. koebke et al¹¹ has found sagittal angle between -3 to 31. In our study sagittal angle is between -2 to 15 degree. All study show wide variation in sagittal angle. Parameters in present study like anterior height of dens, posterior height of dens, maximum transverse diameter of dens, maximum AP diameter of dens are comparative to other studies.

j. lu et al¹⁴, in 1998, in his study, on 15 cadaveric spine, anterior trans articular, atlantoaxial screw of 15-25 mm long can be inserted with a lateral angulation of 5-25 degrees related to sagittal plane and posterior angulation of 10-25 degrees related to coronal plane.

Conclusion

Detailed study of ossification of dens is required for differential diagnosis of developmental anomalies from injury of C2 vertebrae. Various morphometric parameters of body and dens of C2 are of prime importance for various orthopedic and neurological surgeries, because of proximity of spinal cord, medulla oblongata and vertebral artery.

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