Morphometric Analysis of Human Axis (C2) Vertebra in Population of Assam

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ABSTRACT

Background: Axis vertebra (C2) is involved in various pathologies that lead to instability at the craniovertebral junction. Pre-operative morphometric analysis of the axis vertebra is important since various surgical innervations rely on different anatomical details which vary widely in the population and races.

Objectives: To study the various morphometric parameters of the human axis vertebrae(C2) in dry bone specimens.

Methods: A total of 30 dry bone specimens of axis vertebrae were collected and their morphometric analysis was done using VernierCalliper. The results were analyzed using appropriate statistical tools and represented using appropriate tables and diagrams.

Results: The mean of the maximum anteroposterior diameter and maximum transverse diameter of the superior articular facet was measured as 16.73mm and 15.98mm on the right side,17.05mm and 16.25mm on the left side. The mean distance from the tip of the Transverse Process to the Midline was 29.76mm on the right and 26.46mm on the left side.

Conclusion: The vertebral dimensions that were measured in our study can be used to develop instrumentation as well as the reference values for the evaluation and diagnosis of various clinical conditions.

Keywords: Anthropometry, C2 Vertebra, morphometry Axis.
DOI Number: 10.48047/nq.2024.22.2.NQ24010 NeuroQuantology 2024; 22(2):97-107

INTRODUCTION

The axis vertebra is characterized by the presence of specialized superior articulating facets and dens, or odontoid processes, projecting superiorly from its body.[1]The morphology of the atlas and axis vertebrae is distinct, and their relationship to the vertebral artery is intricate. 7–27% of cervical spine fractures are dens of axis fractures, although due to the high risk of vertebral artery injury, these locations are not recommended for surgery.[2]The second cervical vertebra forms a pivot on which the atlas rotates carrying the head. This region is very small but can cause serious complications due to the complex anatomy of the cranio-cervical junction.[1]Anterior screw fixation is the preferred treatment for odontoid fracture. Thus,a thorough understanding of the anatomy of the axis vertebra is required in surgical interventionssuch screw fixation.[3]The purpose of this study was to measure significant axis vertebral anatomical parameters to determine the various axis vertebral parameters of human dry bone specimens from Assam and to compare the current study's findings with those of other studies carried out by various authors in various populations. Understanding these factors will enable safe surgical procedures to be carried out in this area.

AIMS AND OBJECTIVE

- To study the various morphometric parameters of the human axis vertebrae(C2) in dry bone specimens.
- Obtain enough data for future studies for preoperative planning.

MATERIAL AND METHODS

A total of 30 dry bone specimens of axis vertebrae were collected irrespective of age and sex from the Department of Anatomy, GMCH and from First-year students of GMCH and their morphometric analysis was done using Vernier Caliper. Regarding the specifics of the vertebrae that were acquired, no identifying information was given. The study included only unaltered Indian axis vertebrae that were devoid of any bone anomalies. With a digital calliper that was accurate to 0.01 mm for linear measurements, all linear parameters were measured.Statistics were used to analyse the collected data. Calculations were made for the mean, standard deviation, and range of several parameters. Parameters were calculated using Microsoft Office Excel.

In the present study, 30(thirty) human dry bone specimens were morphologically studied under the following headings**(Table 1).**

Fig 1: The anterior height of the axis was measured as the distance from the inferior edge of the body in the anterior midline to the tip to the odontoid process.

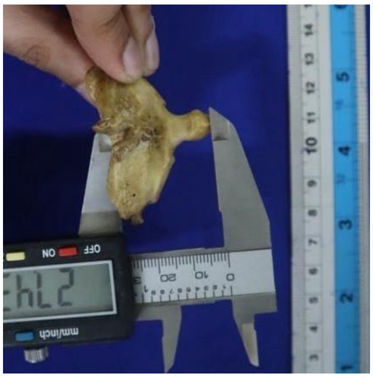

Fig 2: The posterior height of the axis was measured as the distance from the inferior edge of the body in the posterior midline to the tip to the odontoid process.

Fig 3: Anterior height of the body of the axis was measured from the midpoint of the imaginary line joining the superior articular facets to the inferior edge of the body.

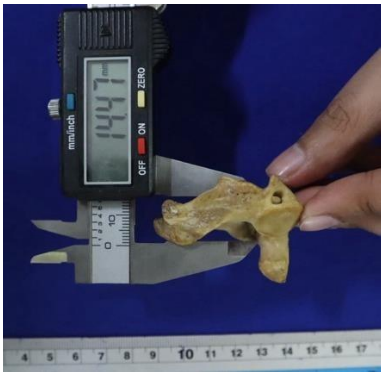

Fig 4: The posterior height of the body of the axis was measured from the midpoint of the imaginary line joining the two superior articular facets to the inferior edge of the body.

Fig 5: Measurement of anterior height of dens from the tip of dens to the midpoint of imaginary line joint the two superior articular facets of axis.

Fig 6: Measurement of posterior height of dens from the tip of dens to the midpoint of the imaginary line joining the two superior articular facets of the axis.

Fig 7: Measurement of the maximum anteroposterior diameter of dens.

Fig 8: Measurement of the maximum transverse diameter of dens.

Fig 9: Measurement of anteroposterior diameter of superior articular facet on the superior aspect both left and right side.

Fig 10: Measurement of the transverse diameter of superior articular facet on the superior aspect both left and right side.

Fig 11: Measurement of anteroposterior diameter of inferior articular facet on the superior aspect both left and right side.

Fig 12: Measurement of transverse diameter of inferior articular facet on the superior aspect both left and right side as shown in the figure.

Fig 13: Measurement of the pedicle of axis for both left and right.

RESULTS AND OBSERVATIONS

The results of this study are shown in Table 1, the mean value and standard deviation and range of the measured value are also mentioned in the table.The mean values of the anterior and posterior height of the axis were 32.07±2.36 and 29.90±2.10 respectively. The mean value of the anterior and posterior height of the body of axis is 19.62±2.19 and 16.86±1.73 respectively. The mean value of the antero-posterior diameter of the inferior surface of the body of the axis is 15.67±1.56 and the transverse diameter if the inferior surface is 14.52±3.10. The mean anterior and posterior heights of the dens of the axis are 12.41±2.90 and 12.91±2.46 respectively. And antero-posterior diameter of the dens of axis is 10.25±1.42. The mean anteroposterior diameter of the superior articular facet of the left and right side are 17.05±1.27 and 16.73±1.85 respectively. The mean of the transverse diameter of superior articular facet of left and right side are 16.25±1.39 and 15.48±1.71 respectively. The mean anteroposterior diameter of the inferior articular facet of the left and right side are 12.42±2.93 and 10.42±2.20 respectively. The mean of the transverse diameter of inferior articular facet of left and right side are 10.83±1.37 and 10.29±2.26 respectively. Mean pedicle width was 9.02±2.56 on left side and 9.46±2.49 on right side.

Table1: Figure showing the different parameters and measured results with mean, standard deviation and range.

Sl no.		Parameters	Mean(mm)± SD	Range(mm)
1	Height of axis	Anterior height	32.07±2.36	28.55-37.96
		Posterior height	29.90±2.10	26.18-33.46
2	Body	Anterior body height	19.62±2.19	16.24-22.89
		Posterior body height	16.86±1.73	14.23-19.88
		Antero-posterior Diameter inferior surface	15.67±1.56	13.29-19.56
		Transverse Diameter of inferior surface	14.52±3.10	9.33-18.93
3	Dens	Anterior height	12.41±2.90	6.67-17.21
		Posterior height	12.91±2.46	8.01-16.76
		Antero-posterior diameter	10.25±1.42	8.21-14.88
4	**Superior Articular facet**	**Antero-posterior Diameter of Left side**	**17.05±1.27**	**12.56-19.29**
		Antero-posterior Diameter of Right side	16.73±1.85	12.56-18.96
		Transverse Diameter of Left side	16.25±1.39	13.56-17.89
		Transverse Diameter of Right side	15.48±1.71	10.78-17.84
5	Inferior Articular facet	Antero-posterior Diameter of Left side	12.42±2.93	8.30-18.16
		Antero-posterior Diameter of Right side	10.42±2.20	7.33-15.01
		Transverse Diameter of Left side	10.83±1.37	8.56-13.17
		Transverse Diameter of Right side	10.29±2.26	6.33-14.41
6	Pedical Width	Left	9.02±2.56	5.32-14.34
		Right	9.46±2.49	4.53-14.25

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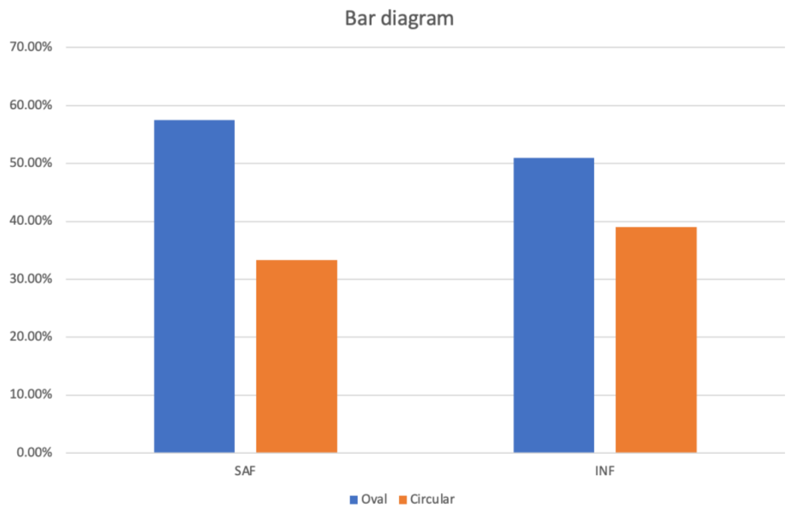

Fig 14: Bar diagram showing the percentage of oval and circular Superior and inferior facets.

Table 2: Showing the different parameters and their comparison with other researchers.

Parameter		Senegul & Kodiglu	Naderi et al	Gosavi S, Swamy	Singla, Mukesh et al	Present study
Height of axis	Anterior height		38.7	34.17	34.33	32.07±2.36
	Posterior height		33.2		30.56	29.90±2.10
Body	Anterior Height	22.1	23.2	20.49	20.49	19.62±2.19
	Posterior Height		17.2	16.07	16.07	16.86±1.73
Dens	Anterior height	14.5	15.5	14.86	14.66	12.41±2.90
	Posterior height		15.4		13.89	12.91±2.46
	AP diameter		11.3	9.92	10.1	10.25±1.42
Pedicle width	Left	9.5	4.29	7.19	10.07	9.02±2.56
	RIght		7.19	7.73	10.52	9.46±2.49

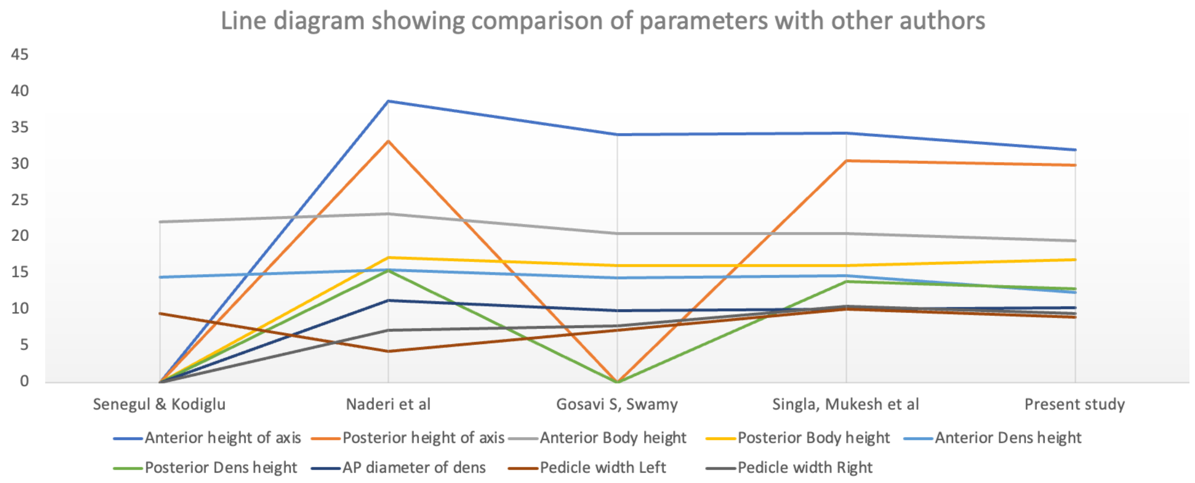

Fig 15: Figure showing line diagram showing the different parameters and their comparison with other researchers.

Parameter		Gosavi S, Swamy	Senegul & Kodiglu	Singla, Mukesh et al	Present study
Superior articulating facet(SAF)	A-P diameter(mm) right	16.4		16.61	16.73±1.85
	A-P diameter(mm) left	16.66		16.7	17.05±1.27
	Transverse diameter(mm) Right	14.44		14.92	15.48±1.71
	Transverse diameter(mm) Left	14.64		14.79	16.25±1.39
	Shape-Oval	63% AP>Transverse	86%	84%	57.5%
	Circular	37%	14%	16%	33.3%
Inferior Articular facet(IAF)	A-P diameter(mm) right	9.74		11.75	16.73±1.85
	A-P diameter(mm) left	9.61		12.02	17.05±1.27
	Transverse diameter(mm) Right	9.92		11.40	15.48±1.71
	Transverse diameter(mm) Left	6.59		11.42	16.25±1.39
	Shape-Oval		4%	10%	51%
	Circular		96%	90%	39%

Table 3: Showing the different parameters and their comparison with other researchers.

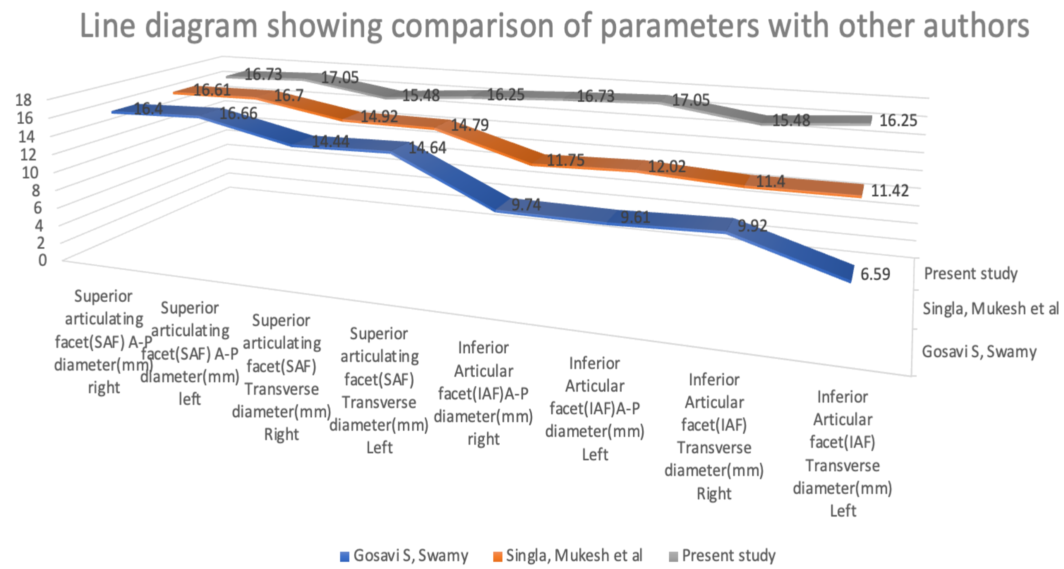

Fig 16: Figure showing line diagram showing the different parameters and their comparison with other researchers.

Discussion:

The characteristic feature of the axis is the presence of dens or odontoid process projecting superiorly from its body and specialized superior articulating facets[1].The knowledge of the exact dimensions and shape of this bone is required for the evaluation of many clinical problems.[4]Several surgical procedures, including interlaminal clamping, interspinous wire, and plate and screw fixation, are needed to treat the instability of the atlantoaxial complex or occipital-cervical junction caused by a variety of traumatic and non-traumatic disorders.For certain surgical treatments, the axis vertebra's morphometric anatomy is crucial.For anterior cranio-vertebral fixation, the anterior C2 body may be utilized.In the present study, the mean value of the anterior height of the C2 vertebral body was 32.07 mm. Naderi et al measured this parameter to be 38.7 mm[5].Gosavi S swami found the value to be 34.17mm[6].Singla, Mukesh et al measured the value to be 34.33mm[7].

When an odontoid process fracture occurs at the base of the process at the point where it joins the body of the axis, there is controversy on the optimal course of therapy. The surgeon typically conducts a surgical procedure called posterior fusion of the atlas and axis arches. However, for the stabilization to be effective with this approach, there might need to be an extra period of external immobility. This method improves spine stability, but it has a significant drawback. This approach restricts the normal rotation between the atlas and the axis, which usually accounts for more than one-half of the normal axial rotation of the cervical spine.The anterior trans-oral technique is an alternative method for treating the odontoid process fracture[8].The trajectory of the screw for anterior screw fixation of the odontoid is parallel to the vertical axes of the odontoid process.Consequently, knowledge of the C2 body and the odontoid process is necessary for surgery in this area[8]. The mean of the odontoid process's anteroposterior diameter in the current investigation was 10.25 mm.

Gupta & Goel reported that the mean screwable thickness of the C2 pedicle was 7.8 mm, and that the mean height of the pedicle was 8 mm.[9]Karaikovic et al in their study, pedicle width was equal to or smaller than 4 mm in 8.5% of 53 C2specimens.[3]In the present study, 3.3% of specimens had pedicle width less than 5mm.Cacciola et al worked on the vertebral artery in relation to C1-C2 vertebrae and studied the detailed anatomy of the vertebral artery.

SAF of the axis are present near the body and medial aspect of the pedicle as compared with other vertebrae and the foramen transversarium of the axis is present partially or completely on the inferior surface of superior articulating facets as compared to other cervical vertebrae, where this foramen is located entirely about the transverse process.[10]

Singla, Mukesh et al. in their study, 84% of SAF were oval and 16% were circular. Further in the oval facet, the AP diameter was more than the transverse diameter in 60% of cases and in the other 24% of cases transverse diameter was more than the AP diameter[7].In the present study, 57.5% of SAF were oval and 33.3% were circular.In the present study, 51% of IAF were oval and 39% were circular.The variations observed in the parameters between research could potentially be due to the different ethnic backgrounds of the vertebrae included in each study.

Although transpedicular screw fixation in the cervical column has several advantages, there remains debate over possible risks. Damage to nearby critical structures, including the spinal cord, nerve roots, cranial nerves, and vertebral arteries, can result from improper pedicle screw insertion.[11]

CONCLUSION

The axis is characterized by the presence of specialized superior articulating facets andens, an odontoid process, projecting superiorly from its body.For the assessment of numerous clinical issues, knowledge of this bone's precise dimensions and shape is necessary.Several surgical procedures, including interlaminal clamping, interspinous wire, and plate and screw fixation, are needed to treat the instability of the atlantoaxial complex or occipital-cervical junction caused by a variety of traumatic and non-traumatic disorders. From the present study, the vital anatomical data on different parameters of the axis in the population of Assam were obtained which may be helpful for the surgeons in minimising chances of damage to vertebral artery, cranial nerve damage and injury to other vital structures.

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