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Original Research Article

Cadaveric Morphometric Study of the First Cervical Vertebra

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Abstract:

Background: The atlas (first cervical vertebra) has undergone many structural modifications. It is critically located and close to the 'life centres'. For this study, one hundred dried intact human atlas vertebrae from the Indian population were measured using a digital Vernier calliper that provides accurate resolution up to 0.01 mm. The distance between the tips of the transverse process, the outer and the inner distance between the foramen transversaria and various diameters of vertebral foramen were measured. The mean width of the measured atlases was 69.37 mm. The mean distance between the lateral margins of foramen transversaria was 55.66 mm and the inner distance was 45.93 mm. The mean thickness of vertebral artery grooves was 3.72 ± 1.06 mm. The observations made in the present study may help in improving understanding of various bony dimensions while operating close to important structures like nerve roots and the vertebral artery.

Material and Methods: One hundred dried human atlases of unknown sex, obtained from the Department of Anatomy PMCH Patna. and Included Other medical colleges were studied. All samples were drawn from the Indian population. Atlases with pathological features were excluded from the study. The following parameters were measured for each atlas using a vermier caliper. Conclusion- studied one hundred dried first cervical vertebra deriving from the Indian population to give us the opportunity to analyse metrical data.

Keywords: Atlas, atypical cervical vertebra, morphology C1.

Introduction

The first cervical vertebra has many unique features. It is located at a critical point close to the vital centres of the medulla oblongata, which can get compressed by a dislocation of the atlantoaxial complex or instability of the atlanto-occipital joint. Therefore, reduction and rebuilding of the stability of this complex is important [1]. A short segment posterior fixation technique is often adopted to preserve the motion of the atlanto-occipital joint. Hence the aim of the present study was to evaluate the metrical details of the atlas in the Indian population. The first cervical vertebra, or atlas, articulates with the occiput rostrally and the axis caudally. It consists of two articulating lateral masses that are connected anteriorly and posteriorly by neural arches. The lateral masses are also connected coronally by the transverse atlantal ligament. The superior articulation with the occiput is biconcave and provides flexion and extension. The inferior articulating surface of the atlas articulates with the rostral joint surfaces of the axis in a noncongruent manner. The atlas has been described as acting as an intercalated segment, in that its movements are a reaction to the motion of the occiput versus the axis and examples. Its rotating and translating with lateral bending.

Materials and Methods

One hundred dried human atlases of unknown sex, obtained from the Department of Anatomy, Patna Medical College and Hospital Patna, Bihar. and periphery medical colleges were studied. All samples were drawn from the Indian population. Atlases with pathological features were excluded from the study. The following parameters were measured for each atlas using a vermier caliper.

That provides accurate resolution up to 0.01mm. as the maximum vertical distance at midline, and the maximum transverse width of the facet of the dens was measured as the maximum transverse distance. The mean, range and standard deviation were calculated for all measurements for the 100 vertebrae. The significant difference was calculated using the Z test and $p <= 0.05$.

Results

Fifteen parameters were studied for the hundred atlases. Measurement results were analysed and are shown in Tables I, II and III. The mean width of the atlases was 69.37 mm (Table I), and the mean thickness

of the vertebral artery groove each atlas using a digital Vernier calliper that provides accurate resolution up to 0.01mm. Each measurement was taken three times to minimize error. All measurements were performed by the first author for the sake of consistency. The distance between the tips of the transverse processes of the atlas (atlas width, TD), the distance between the most lateral margins of the two foramina transversaria (outer distance, OD), and the distance between the medial margins of the two foramina transversaria (inner distance, ID) were all measured. The maximum anteroposterior (A-P) diameter of the vertebral foramen was measured in the sagittal plane and the minimum A-P diameter was measured in the parasagittal plane. The maximum transverse diameter of the vertebral foramen was measured and the shape, anteroposterior and transverse diameters of the superior articular facet as well as of the inferior articular facet were noted bilaterally. We also measured the thickness of the posterior arch at the groove for the vertebral artery on both sides. The height of the anterior, as well as posterior arches in the midline, was measured from its superior border to its inferior border. The vertical height of the facet of the dens was measured was 3.72 mm on the right side and 3.70 mm on the left side (Table III) The superior articular facet was oval in 74% of the atlases with the anteroposterior diameter larger than the transverse diameter in the majority of samples, whereas the facets of

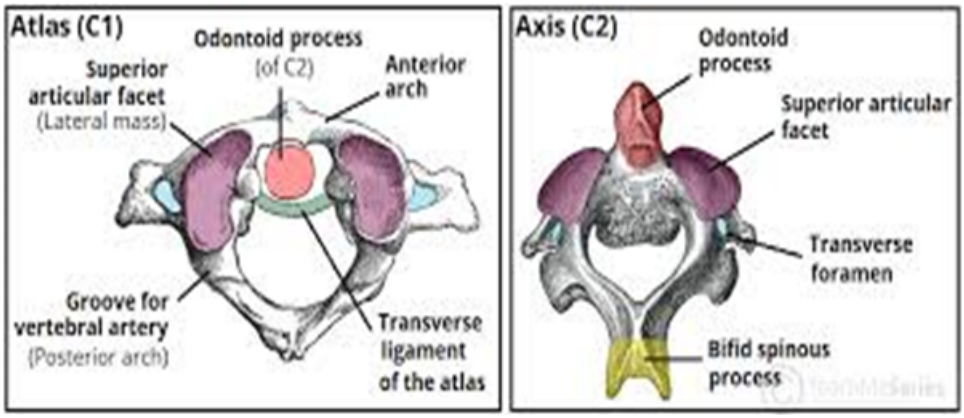

Table I: Anatomical parameters of atlas

No.	Parameter	Range (mm) Mean±SD(n=100) (mm)						
1	Width of Atlas	margins of foramina Trans∗. diameter			56.36	85.02	69.37	6.47
2	Outer distance b/w lateral		transversaria	(OD)	45.36	69.35	55.66	5.01
3	Inner distance b/w medial	margins of foramina	transversaria	(ID)	36.25	55.29	45.93	4.22
4	Vertebral foramen	A-P maximum A-P minimum			22.81	32.76	26.89	1.93
∗					22.62 20.14	36.56 35.1	27.89 25.66	2.59 2.59

Table III: Dimensions of some parameters of atlas

S.No.	Parameter		Range (mm) Mean ± SD (n=100) 1 Rt∗ (mm)		
1	Thickness of groove		2.0 – 6.42	3.72	1.06
2	for Vertebral artery	Lt†	1.18 – 7.28	3.70	1.06
3	Anterior arch height		6.88 – 16.19	10.33	1.67
4	Posterior arch height		4.88 – 14.11	8.61	1.77
5	Height of facet for dens		2.1 – 14.11	8.91	2.34
6	Width of facet for dens		5.21 – 15.34	9.37	2.19

- Right, † - Left

Parameter	Diameter Rt.∗	Range (mm)		Lt.† Me Rt.		SD (n=100) Lt. m) an ±		(m	
Superior articular facet	A -P	14.03	27.26	15.57	– 27.3	21.24	2.39	21.02	2.52
	Transverse	6.75	14.5	6.87 –	14.21	10.36	1.72	10.47	1.61
Inferior articular facet	A-P	10.62	20.62	9.89 –	21.82	16.57	1.91	16.50	1.67
∗	Transverse	7.13	17.56	7.4 –	17.53	14.01	1.93	14.42	1.67

- Right, † - Left

Table IV: Diameters of articular facets of atlas

Parameter	Parameter	Previous studies		Present study	Senegul & Lang7	Heggeness & Cacciola
		Kodiglu2	Doherty5	et al. 6		
1	Width of Atlas	74.6	78.2			69.37
2	Outer distance b/w outer margins of f. transversarium Inner distance b/w					
		59.5	64			55.66
3	inner margins Vertebral foramen					
	Trans. dia. ∗ of f. transversarium A-P	48.6	52.3			45.93
4	max. †	28.7	30.2	32		26.89
	Superior A-P articular facet Trans-	46.2	34.5	29		27.89
5	verse Inferior articular A-P	19.2			19.73	21.02
	facet Transverse	9.7			11.12	10.47
6		17.3			15.76	16.50
∗		14.6			15.22	14.42

Transverse diameter, † - maximum

26% were kidney shaped. The anterior edge of these facets was nearer to the midline than to their posterior edge. Their diameters are posted in Table II. There was not a statistically significant difference when comparing diameters. The shape of the inferior articular facet was circular in 71% and oval in 29% of atlases. The mean anterior arch height was 10.33 ±1.67 mm and the mean height of the posterior arch was 8.61 ± 1.77 mm. (Table III)

Discussion

The atlas supports the skull and is uniquely positioned in the atlantoaxial complex. As new surgical techniques and instruments for the treatment of unstable cervical spine continue to evolve, detailed knowledge about this bone becomes even more essential [2]. Table IV gives a comparison of certain atlas parameters in previously published studies to the present study. From Table IV, it is clear that there is some difference in such values for various parameters. This variation is perhaps due to the difference in the races to which the atlases belonged. [3]Textbooks of anatomy describe racial differences in bones, particularly the skull. It is therefore, not illogical to say that the differences noted above are due to racial differences in the atlas. Cacciola et al. reported that in 76% of the vertebrae studied, the superior articular facet was oval in shape and kidney-shaped in 24%. Senegul and Kodiglu observed oval superior articular facets in 72% and kidney-shaped in 28%. As noted above, our measurements were similar regarding facet shape. [4] Lang found that facets were sometimes completely divided into a larger anterior and a smaller posterior section; we found a similar variation in the two facets of the vertebrae bilaterally. The inferior articular facets were flat or slightly concave facing medially and slightly backwards. In our study, 71% were circular with similar A-P and transverse diameters and 29% were oval. Cacciola et al [5] . observed circular inferior articular facets in most vertebrae, and Senegul [2] and Kodiglu also noted circular or slightly droplet-shaped facets. The groove on the superior surface of the posterior arch of atlas represents the exact location of the vertebral artery . [6] The mean thickness of this groove was 3.72 + 1.06 mm in the present study, whereas Senegul and Kodiglu eported thickness 5.05 mm and Ebraheim et al [7]. as 4.1 + 1.2 mm. Senegul and Kodiglu explained that this thickness is sufficient for some fixation techniques such as clamp and hook plating and atlanto-axial wiring. Tan et al [8]. reported groove thickness of 4.65 mm in their study on manual and radiological measurements of fifty isolated atlases. In four of their cases (8%), the groove was less than 4 mm in thickness. In the present study, there were 65 cases in which the thickness was <4 mm. In their study on cadaveric specimens and dry bones Cacciola et al. observed that the groove for the vertebral artery was completely converted into a foramen only in one out of twenty sides. In our study on hundred atlases such a foramen was observed on the right side in two and bilaterally in one.

Conclusion

We studied one hundred dried atlas vertebrae deriving from the Indian population to give us the opportunity to analyse metrical data. The mean width of the atlas was 69.37 mm in the present study. The thickness of the vertebral artery groove was 3.72 mm on the right side and 3.70 mm on the left side. The observations made in the present study may be helpful to neurosurgeons who routinely operate close to important structures such as nerve roots and vertebral artery in the atlanto-occipital area.

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