

MORPHOMETRIC ANATOMY OF THE ATLAS (C1) VERTEBRA AMONG KARNATAKA POPULATION IN INDIA

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ABSTRACT

Objective: In this study one hundred dried intact human atlas vertebrae from Karnataka population were examined using direct anatomical measurements.

Materials and Methods: Various dimension of the atlas vertebrae were quantitatively measured using a vernier caliper that provides accurate resolution up to 0.01 mm. The results were analyzed statistically using SPSS 12 version

Results: The distance between the tips of transverse process of the atlas (atlas width TD), 72.45mm. Inner distance between medial margins of foramina transversaria, 43.88mm outer distance between the lateral margins of foramina transversaria 56.31mm..

Distance between the medial margin of the vertebral artery groove from the median plane [right -12.28 mm and left side- 11.54mm]. Distance between the lateral margin of the vertebral artery groove from the median plane [right side -22.80mm and left side- 22.87mm] and Thickness of the groove [right- 3.68mm and left side-3.70mm]

Outer anteroposterior (AP)diameter of vertebral foramen -42mm and inner AP diameter of vertebral foramen 28.51mm and transverse diameter vertebral foramen -27.39mm were noted. Superior articular facet AP diameter [right-22.33mm and left-22.25mm] Superior articular facet transverse diameter [right-8.74 and left 9.57mm] Inferior articular facet AP diameter [right 18mm and left-17.81mm] and inferior articular facet transverse diameter [right 14.83mm and left 14.49mm]. Height of the anterior arch -10.02mm and posterior arch -8.91mm was recorded

Conclusion: The quantitative anatomy of atlas may be helpful for neurosurgeons in avoiding and minimizing the complications such as vertebral artery injury, spinal cord injury and cranial nerve damage during the operation close to atlanto-occipital area.

KEY WORDS: Atlas, Morphometry, Vertebral artery groove.

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INTRODUCTION

The first cervical vertebra supports the skull and is therefore called the atlas (after the mythical Greek god who supported the globe).The atlas

is unique in that it lacks a body and is composed of an anterior and posterior arch with laterally projecting transverse processes [1].

The anatomy of the atlas exhibits complex,

three-dimensional structure showing extensive variability in morphology [2]. It is located at a critical point close to the vital centers of the medulla oblongata which can get compressed by a dislocation of the atlanto-axial complex or instability of atlanto-occipital joint [3]. Various surgical techniques such as interlaminar clamp, interspinous wiring, plate and screw fixation have been currently employed to correct instability of atlanto-axial complex or occipito cervical junction caused by numerous traumatic and non traumatic conditions. Recently, transarticular and transpedicular screw fixation have been widely used in stabilizing the cervical column [2,4,5].

A short segment posterior fixation technique is often adopted to preserve the motion of the atlanto-occipital joint.[3,6]. Incorrect insertion of pedicle screws can cause damage to adjacent vital structures such as the spinal cord, nerve roots, and cranial nerves, vertebral arteries [2]. Clinically, iatrogenic injury to the vertebral artery during an approach to the atlantoaxial region is rare, but has a potential hazard [7]. Since there are few reports on quantitative anatomy of atlas, the aim of the present study was to evaluate the metrical details of atlas in dry bones of Karnataka population in India.

MATERIALS AND METHODS

One hundred dried human atlases of unknown sex of south Indian origin (Karnataka) were studied. All samples were inspected to ensure that the vertebrae were intact and free from osteophytes or pathological features before measurement were made. All parameters were measured using digital Vernier caliper that provides accurate resolution upto 0.01mm. Each measurement was taken twice to minimize the errors. All measurements were performed by first author for the sake of consistency.

The distance between the tips of transverse process of the atlas (atlas width TD), Inner distance between medial margins of foramina transversaria, outer distance between the lateral margins of foramina transversaria were measured.

Distance between the medial margin of the vertebral artery groove from the median plane (right

side and left side). Distance between the lateral margin of the vertebral artery groove from the median plane (right side and left side) and Thickness of the groove [right and left side] were measured.

Outer anteroposterior (AP) diameter of vertebral foramen and inner AP diameter of vertebral foramen and transverse diameter vertebral foramen were noted. Superior articular facet AP diameter (right and left) Superior articular facet transverse diameter (right and left) Inferior articular facet AP diameter (right and left) and inferior articular facet transverse diameter (right and left). Height of the anterior arch and posterior arch was recorded.

The mean, range and standard deviation were calculated for all measurements for 100 vertebrae.

RESULTS

Table 1: Anatomical Parameters of the Atlas (in mm).

Sl.No	Parameters	N	Range	Minimum	Maximum	Mean	Std. Deviation
1	width of atlas	100	27.29	56.39	83.68	72.4477	5.8056
2	Inner distance between medial margins of foramina transversaria	100	17.76	35.17	52.93	43.8785	3.40637
3	outer distance between the lateral margins of foramina transversaria	100	22.89	45.86	68.75	56.3121	4.14336
4 Rt.	Distance between the medial margin of the vertebral artery groove from the median plane right side	100	12.14	7.09	19.23	12.2802	2.61793
Left	Distance between the medial margin of the vertebral artery groove from the median plane left side	100	17.81	5.52	23.33	11.5415	2.79246
5 Rt.	Distance between the lateral margin of the vertebral artery groove from the median plane right side	100	10.9	16.71	27.61	22.8011	2.09841
Left	Distance between the lateral margin of the vertebral artery groove from the median plane left side	100	10.38	17.58	27.96	22.8692	1.94415
6 Rt.	Thickness of the groove right	100	4.72	1.85	6.57	3.6824	0.90239
Left	Thickness of the groove left	100	4.85	1.51	6.36	3.6961	0.93459
7	outer AP diameter vertebral foramen	100	15.56	33.4	48.96	41.9916	3.11912
8	inner AP diameter vertebral foramen	100	10.1	23.16	33.26	28.5138	2.13538
9	Transverse diameter vertebral foramen	100	13.81	21.34	35.15	27.3893	2.45307
10 Rt.	Superior articular facet AP diameter right	100	10.08	16.92	27	22.3338	2.14147
Left	Superior articular facet AP diameter left	100	10.1	17.4	27.5	22.2555	2.19333
11Rt.	Superior articular facet transverse diameter right	100	10.14	3.65	13.79	8.7427	2.04163
Left	Superior articular facet transverse diameter left	100	17.18	5.18	22.36	9.5726	2.32856
12 Rt.	Inferior articular facet AP diameter right	100	8.61	14.2	22.81	17.9928	1.61194
Left	Inferior articular facet AP diameter left	100	20.73	1.36	22.09	17.8176	2.34563
13Rt.	Inferior articular facet transverse diameter right	100	7.03	12.07	19.1	14.8433	1.31118
Left	Inferior articular facet transverse diameter left	100	14.92	4.55	19.47	14.4871	1.79921
14	Height of the anterior arch	100	7.07	6.29	13.36	10.0259	1.28438
15	Height of the posterior arch	100	17.1	4.71	21.81	8.914	2.03873

Table 2: Comparative Study (with previous studies).

Sl. No.	Parameter	Senegul & Kodiglu 2006 [2]	Lang 1995 [8]	Heggness & Doherty 1994 [10]	Cacciola et.al 1994 [9]	Shilpa N Gosavi 2012 [3]	Present Study
1	Width of the Atlas	74.6	78.2			69.37	72.44
2	Outer distance b/w outer margins of f. transversarium	59.5	64			55.66	56.31
3	Inner distance b/w inner margins of f. transversarium	48.6	52.3			45.93	43.88
4	Vertebral foramen trans. Diameter						
4a	Antero – posterior diameter	28.7	30.2	32		26.89	27.39
4b	Antero – posterior diameter	46.2	34.5	29		27.89	28.51
5	Superior articular facet Antero – posterior diameter Right						
5a	Transverse Right	19.9				21.24	22.33
5b		9.6				10.36	8.74
6	Superior articular facet Antero – posterior diameter Left						
6a	Transverse Left	18.6				21.02	22.26
6b		9.8				10.47	9.57
7	Inferior articular facet Antero – posterior diameter Right						
7a	Transverse Right	17.1				16.57	17.99
7b		14.6				14.01	14.84
7	Inferior articular facet Antero – posterior diameter Left Transverse Left						
7a		17.5				16.5	17.82
7b		14.6				14.42	14.49

The parameters studied for the 100 atlas vertebrae, results were analyzed and shown in [Table 1]

DISCUSSION

According to our study, the mean distance between both transverse processes of atlas was 72.45mm. The mean distance between the outermost edges of the transverse foramen was 56.31mm; the mean distance between the inner most edges of the transverse foramen was 43.88mm. [Table 2] gives a comparison of certain parameters of atlas in previously published studies to present study. From the table 2 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].

Immediately behind the superior articular facet is a transverse groove for the vertebral artery. The articular process usually overhangs this groove anteriorly. There is often bony bridge over the course of the vertebral artery [2,8].

In our study the mean distance between the lateral margins of the vertebral artery groove from median plane was 22.80mm on the right side and 22.87 on the left side. The mean distance between the medial margin of the vertebral artery groove to the median plane right side 12.28mm left side 11.54mm.

Damage to vertebral artery can be avoided if the exposure of the posterior arch of C1 remains medial to the groove. Ebrheim et al observed that the dissection on the posterior aspect of the posterior ring should remain within 12mm lateral to midline and dissection on the superior aspect of the posterior ring should remain within 8mm from the midline [7].

The mean thickness of the vertebral artery groove on C1 was 3.68 on the right side and 3.70 on the left side in the present study. Our values were close to the values of Shilpa and Vatsala Swamy [3]. Senegul and Kodiglu [2] reported thickness 5.05mm and Ebraheim et al [7] as 4.1±1.2mm. Senegul and Kodiglu explained that this thickness is sufficient for fixation techniques such as clamp and hook plating and atlantoaxial wiring.

The shape of the superior articular facet of the C1 was generally ovoid. Cacciola et al [9] reported that in 76% of the vertebrae studied the superior articular facet was oval in shape and kidney shaped in 24%. And none of the facet had mirror symmetry. Senegul and Kodiglu [2] observed oval superior articular facet in 72% and kidney shaped in 28%. Lang [8] found that facets were sometimes completely divided into large anterior and smaller posterior section. We also found similar variation.

The inferior articular facets were flat or slightly concave facing medially and slightly backwards. Shilpa and Vatsalaswamy [3] has reported that 71% were circular with similar anteroposterior and transverse diameters and 29% were oval in shape. Cacciola et al [9] observed circular inferior articular facet in most of the vertebrae. In our study also circular inferior articular facet were more frequent.

Parameters of the vertebral foramen, (inner antero-posterior diameter was 28.51mm and transverse diameter was 27.40mm). The height of the anterior arch was 10.03mm and posterior

arch was 8.91mm. more close to the study done by Shilpa & Vatsala Swamy[3].They are ,(inner antero-posterior diameter was 27.89mm and transverse diameter was 26.89mm). The height of the anterior arch was 10.33mm and posterior arch was 8.61mm.

CONCLUSION

Morphometric data provided in the present study may help the surgeons who operate around the craniovertebral junction. But along with dry bone study, cadaveric study and radiological study is also needed to prevent damage to surrounding important structures.

List of Abbreviations

C1 - first cervical vertebra

A-P - Antero-Posterior

Rt - Right

Lt - Left

Conflicts of Interests: None

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