

**Original Article****Morphometric Study of Adult Human Atlas Vertebra in Bangladesh**

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**Abstract**

**Context:** The atlas has undergone many structural modification and located at critical point close to the vital centres of medulla oblongata which can get compressed by a dislocation of atlanto axial instability of atlanto axial joint. The observations of this study may provide some baseline data and development of instrumentation related to atlas vertebra for future studies in this regard.

**Objective:** knowing of various dimensions of atlas vertebra are very important in improving understanding of various bony dimensions while operating close to important structures like nerve roots and vertebral artery and development of instrumentation related to atlas vertebra.

**Materials and methods:** In this study total 103 dried, unbroken atlas vertebra of unknown age and sex were collected from 1<sup>st</sup> and 2<sup>nd</sup> year students of Jahurul Islam Medical College, 2022 in Kishoreganj. All dimensions are measured using Digital Vernier Calipers with 0.01 resolution.

**Conclusions:** The observations of present study helps in improving understanding of various dimensions which could facilitate diagnosis and preoperative planning while operating close to nerve roots and vertebral artery and allow for more accurate modelling in Bangladesh.

**Keywords:** Foramina transversarium, anterior arch and posterior arch and atlas

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**Introduction**

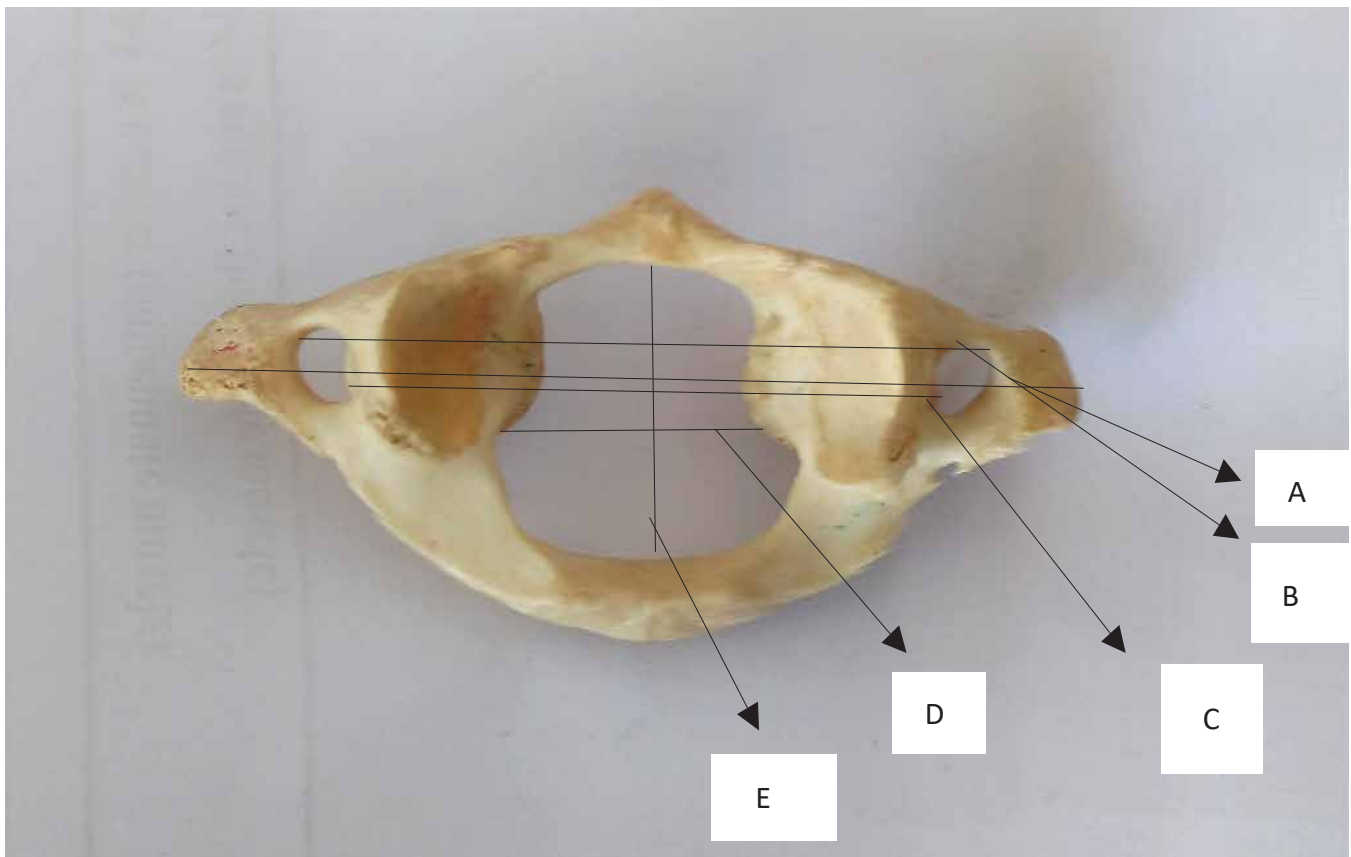
The first cervical vertebra, Atlas (C1) has different anatomical features from the other cervical vertebrae. The atlas holds the globe of the skull and is devoid of body and spine and is composed of an anterior arch and posterior arch with laterally projecting transverse processes which resemble an irregular ring. A short segment posterior fixation technique is often adopted to preserve the motion of the atlanto-occipital joint. It is located at critical point close to the vital centres of medulla oblongata which can get compressed by a dislocation of the atlanto axial complex. C1 vertebra is an important part of bony anatomy of Cranio-vertebral Junction<sup>1</sup>.

The vertebral artery groove is situated on the superior surface of posterior arch behind lateral mass lodging the third part of vertebral artery. The stabilization procedures including wiring, transarticular screw fixation, iatrogenic injuries to vertebral artery is the most frequent preoperative complication which lead to catastrophic intraoperative bleeding<sup>2</sup>.

So knowing the dimensions of atlas vertebra is very important for development of instrumentation related to cervical spine. Ethnic variation have been reported in these dimensions. Aim of present study was to evaluate the various dimensions of atlas quantitatively and analyze their relationship with the vertebral artery foramen to determine the safe sites for different surgical approaches.

**Materials and methods**

The present study was cross sectional. In this study 103 dried atlas vertebra of unknown age and sex without any obvious pathology were collected from 1<sup>st</sup> and 2<sup>nd</sup> year students of Jahurul Islam Medical College in Bangladesh. The specimens were measured by using vernier caliper provides accurate resolution up to 0.01 mm. Each measurement was taken two times to minimize error. The data were evaluated by the descriptive statistics and the mean, range and standard deviation were calculated for all vertebra



**Figure 1:** Depicts description of atlas measurements taken from superior aspect.



**Figure 2:** Depicts description of atlas measurements taken from superior aspect.

The width of atlas was measured as the distance between both tips of transvers process (A)

Outer distance of vertebral artery foramen was measured as the distance between both lateral most edges of transvers foramen (B)

Inner distance of vertebral artery foramen was measured as the distance between both medial most edges of transvers foramen(C)

The maximum transvers diameter of vertebral canal was measured along the frontal plane passing through the canal’s midpoint (D)

The maximum A-P diameter of vertebral canal was measured along the mid-sagittal plane passing through the canal’s midpoint (E)

The height of anterior arch was measured between superior borders to inferior border at midline (F)

The height of posterior arch was measured between superior borders to inferior border at midline (G)

Protocol of study: the following parameters were worked out in the present study on atlas vertebra.

- The width of atlas: distance between the tips of the two transvers processes of the atlas.
- The outer distance of vertebral artery foramen: distance between lateral most margins of both the foramina transversaria.
- The inner distance of vertebral artery foramen: distance between medial most margins of both foramina transversaria.
- The height of anterior arch: measured between superior border to inferior border at midline
- The height of posterior arch: measured between superior border to inferior border at midline
- Transvers diameter of vertebral canal: the maximum transvers diameter of vertebral canal was

measured along frontal plane passing through the canal's midpoint

- Antero-posterior diameter of vertebral canal: diameter of vertebral canal measured in sagittal plane

**Results**

Hundred three atlas vertebra were measured. Measurement's results were analyzed, tabulated in Table I and standard statistical analysis was done.

**Table I: Different measurement of Atlas vertebra**

Parameter	Mean(mm)	SD	Range(mm)
Width of atlas	68.4	9.6	51.2-82.96
Outer distance b/w lateral margin of both transvers foramina	56.11	5.94	46.23-66.99
inner distance b/w lateral margin of both transvers foramina	47.2	5.3	38-56.78
Vertebral canal(TD)	25.72	3.11	20.12-31.78
Vertebra canal(AP)	31.51	3.18	26.55-38
Height of Anterior arch	16.98	3.97	9.5-23.87
Height of Posterior arch	12.43	2.42	8-17.34

(Max: Maximum, AP: Anteroposterior, TD: Transvers Diameter)

The mean width of atlas was 68.4 mm. The maximum and minimum value was 82.98 mm and 51.2 mm respectively. The mean value for outer distance between lateral margins of both transvers foramina was 56.11 mm and maximum and minimum value was 66.99 mm and 46.23 mm. The mean value for inner distance between medial margins of both transvers foramina was 47.2 mm with maximum and minimum value observed as 56.78 mm and 38 mm respectively. The mean for maximum transvers diameter of vertebral

canal was 25.72 mm with maximum and minimum value was 31.78 mm and 20.12 mm respectively. The calculated mean for anteroposterior diameter of vertebral canal of atlas was 31.51 mm and maximum and minimum values were 38 mm and 26.55 mm.

In present study the mean for height of anterior arch was 16.98 mm and for posterior arch was 12.43 mm. The maximum and minimum values for height of anterior arch were 23.87 mm and 9.5 mm for posterior arch were 17.34 mm and 8 mm.

**Table II: Comparison of different parameters with different authors**

Parameter	Segul and Kodiglu 2006	Lang 1995	Shilpa N Gosavi 2012	Ansari et al	Present study
Width of Atlas	74.6	78.2	69.37	72.44	68.4
Outer distance b/w outer margin of transversarium	59.5	64	55.66	56.31	56
Inner distance b/w outer margin of transversarium	48.6	52.3	45.93	43.88	47.2
Vertebral canal (transverse diameter)	28.7	30.2	21.24	22.33	25.72
V.canal (AP.diameter)	46.2	34.5	10.36	8.74	31.51
Height of anterior arch			10.33		16.98
Height of posterior arch			8.61		12.43

### Discussion

The atlas supports the skull and uniquely positioned in 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<sup>1</sup>.

Various techniques such as interlaminar clamp and hook plating, lateral screw and plate fixation and interspinous wiring have been described for treating cervical instability<sup>2</sup>.

Table II gives comparison of certain atlas parameters in previously published studies to the present study. From Table II, it is clear that there is some difference in such values for various parameters. This variation is due to

the difference in the races to which the atlases belonged. Textbooks of anatomy describes 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

In present study, the mean for width of atlas was  $68.4 \pm 9.6$  mm. In previous studies sengul and Kodiglu et al calculated as 74.6 mm, Gosavi SN in 2012 calculated as 69.37 mm and Sharma T observed as 77 and 68mm for male and female Punjabi population<sup>2,3,4</sup>. The mean of outer distance of vertebral artery foramen was 56.11 mm with range from 46.23 to 66.99 mm. However observation is differed from other author's observation<sup>1</sup>. The mean of inner distance of vertebral artery foramen was  $47.2 \pm 5.3$  mm and matched with observation of Gosavi SN<sup>1</sup> and Gupta C<sup>5</sup> which was

reported as 45.93 mm and 45.2 mm .It is also matched with other's study reported as 48.6 mm by Sengul G and Kodiglu HH and 52 mm by Lang J et al<sup>6,7</sup>. The mean value for transvers diameter of vertebral canal of atlas was  $25.72\pm 3.11$  and anteroposterior diameter was  $31.51\pm 3.18$  mm. Gosavi SN in 2012 measured as 27.89mm and 26.89 mm. The height of anterior arch was  $16.98\pm 3.97$  mm and posterior arch was  $12.43\pm 2.42$  mm and these observation were not close to the study done by Gosavi SN who observed as  $10.33\pm 1.67$  mm and  $8.61\pm 1.77$  mm. Damage to vertebral artery can be avoided if the exposure of the posterior arch of atlas should remain within 12 mm lateral to midline and dissection on superior aspect of posterior ring should remain within 8mm from the midline<sup>8,9</sup>.

### Conclusion

We studied hundred three atlas vertebra to give us opportunity to analyse metrical data. The observations of the present study will be important to understand the ergonomics of craniovertebral joint. They will be helpful for neurosurgeon, clinicians and radiologists in clinical practice. Instruments for treatment of unstable cervical spine continue to evolve and detailed knowledge about atlas vertebra becomes even more essentials.

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