ISSN: 0975-3583, 0976-2833 VOL15, ISSUE 6, 2024

Morphometric evaluation of first cervical vertebra (C1) and its clinical implications – a cross sectional study.

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Abstract

Introduction: The atlas vertebra is an atypical cervical vertebra thereby having certain important features to accommodate the widest diameter of spinal cord. Its position is vital as it is closely related to medulla oblongata containing respiratory, cardiac and vascular centers. These centers can get compromised by varying degree of traumatic conditions involving atlanto-axial complex or atlanto-occipital joint pathologies. Therefore, maintaining the stability of this complex is pivotal. Among the various surgical procedures posterior fixation is often adopted to maintain the stability of atlanto occipital joint**.** The **Aim** of present study was to perform the morphometrical analysis in dry adult atlas vertebra. **Material and methods**: This cross-sectional study was conducted on 43 dry, undamaged human Atlas vertebra (C1) of unknown sex, age and race obtained from the bone bank of department of Anatomy, Government medical college Srinagar. **Results:** The transverse and the anteroposterior diameter of atlas in millimeters (mm) were 79.83 ± 6.59 and 45.52 ± 4.23 respectively, the anteroposterior and the transverse diameter of vertebral canal in millimeters were 32.63 ± 3.07 and 30.21 ± 2.89 respectively. The Length of right and the left vertebral artery groove in millimeters were 15.31 ± 3.81 and 15.91 ± 2.63 respectively. Length and width of right superior articular facet was 21.3 ± 2.46 and 14.73 ± 1.83 respectively and the length and width of right inferior articular facet was 17.14 ± 2.03 and 11.84 ± 2.13 respectively. Length and width of left superior articular facet was 21.03 ± 2.36 and 14.43 ± 2.03 respectively and the length and width of left inferior articular facet was 16.83 ± 2.36 and 10.05 ± 2.31 respectively. **Conclusion:** The precise knowledge of various morphometric parameters of atlas and their comparison with the studies conducted by other researcher's will be very benevolent in the manufacturing of instruments related to atlas vertebrae. The current study will contribute to a better knowledge of diverse bone dimensions, which may aid with preoperative planning and diagnostics when operating near vital structures like the vertebral artery and nerve roots.

Key words: Atlas, morphometry. Atlanto-axial complex, Atlanto-occipital joint.

Introduction

According to the Greek mythology Atlas was commanded to hold the weight of heavens and likewise Atlas vertebra supports the weight of whole head, hence this name was given to atlas vertebra**.**[1] The location of atlas vertebra is very pivotal as various vital centres of brain stem are located very close to it**.**[2] The absence of a body or spinous process distinguishes the Atlas, the first cervical vertebra (C1), from the other cervical vertebrae. It articulates with the Axis vertebra below and with the Occipital bone above. The first cervical vertebra is the crucial component that connects the skull to the vertebral column. It contains a transitional region that separates the flexible skull from the stiff vertebral column**.**[3] Craniovertebral junction (CVJ) is an anatomical zone where the skull meets the cervical spine. This zone is of utmost importance for performing various spinal surgeries. There are various important structures present in craniovertebral junction and prior to performing surgery at CJV the knowledge of morphometry and morphology of these structures is of utmost importance.[4,5], Moreover there are lots of surgical techniques performed to address the instability of the atlantoaxial complex brought on by a variety of traumatic and non-traumatic disorders such as, interspinous wiring, plates and screw fixation.[6,7] Pedicle screw insertion errors can harm nearby critical structures

ISSN: 0975-3583, 0976-2833 VOL15, ISSUE 6, 2024

like the spinal cord, cranial nerves and various structures associated with atlas vertebra and such therapeutic misadventures have been happening from time to time in such procedures. In order to minimize such events from happening, morphometric study of atlas vertebra is of great importance.[8]

Material and methods

This cross-sectional study was conducted on 43 dry, undamaged human Atlas vertebra (C1) of unknown sex, age and race obtained from the bone bank of department of Anatomy, Government medical college Srinagar. All the atlas vertebra were thoroughly inspected and examined to ensure excluding the vertebrae with any bony abnormalities before going through the measurements. The following parameters were measured for each atlas using a digital Vernier caliper as shown in figure 1 and 2.

1. Transverse diameter of atlas (M1)
2. Anterio posterior diameter of atlas (M2)
3. Transverse diameter of vertebral canal (M3)
4. Antero-posterior diameter of vertebral canal (M4)
5. Length of Right vertebral artery groove (M5)
6. Length of Left vertebral artery groove (M6)
7. Length of right superior articular facet (M7)
8. Width of right superior articular facet (M8)
9. Length of right inferior articular facet (M9)
10. Width of right inferior articular facet (M10)
11. Length of left superior articular facet (M11)
12. Width of left superior articular facet (M12)
13. Length of left inferior articular facet (M13)
14. Width of left inferior articular facet (M14)

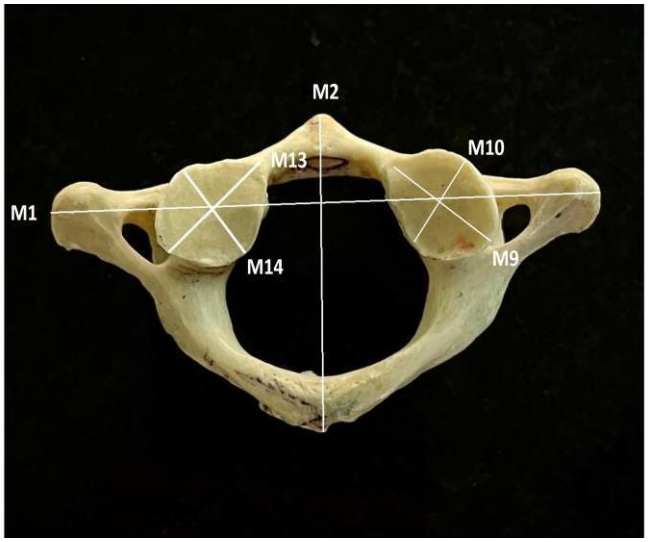

Figure 1: showing the measured parameters on inferior surface of Atlas: M1- transverse diameter of atlas, M2- Anteroposterior diameter of Atlas, M9-Length of right inferior articular facet, M10- Width of right inferior articular facet, M-13 -Length of left inferior articular facet and M14- Width of left inferior articular facet.

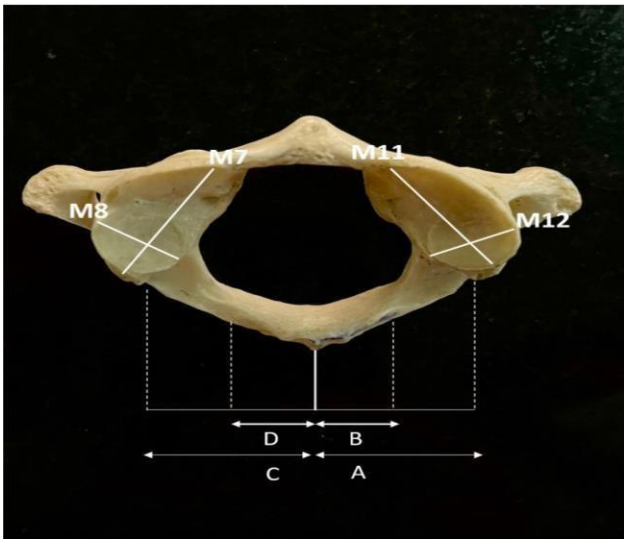

Figure 2: showing the measured parameters on the superior surface of Atlas: M7- Length of right superior articular facet, M8- Width of right superior articular facet, M11- Length of left superior articular facet, M12- Width of left superior articular facet, M5- Length of right vertebral artery groove (C minus D) and M6- Length of left vertebral artery Groove (A minus B).

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Results and observation.

In the current study 14 parameters were recorded and the results of the parameters have been shown in tabulated form in the below tables:

Table 1: Dimensions of atlas and its vertebral canal

Parameter no	Parameters	Value in Millimetres (mm)
M1	Transverse diameter of atlas	79.83 ± 6.59
M2	Anterio posterior diameter of atlas	45.52 ± 4.23
M3	Transverse diameter of vertebral canal	30.21 ± 2.89
M4	Anterio-posterior diameter of Vertebral canal	32.63 ± 3.07

Table no 2: Length of vertebral artery grooves.

Parameter No	Parameters	Value in millimetres (mm)
M5	Length of right vertebral artery groove	15.31 ± 3.81
M6	Length of left vertebral artery groove	15.91 ± 2.63

Table 4: Dimensions of Right superior and inferior articular facets.

Parameter No	Parameters	Value in millilitres (mm)
M7	Length of superior articular facet	21.3 ± 2.46
M8	Width of superior articular facet	14.73 ± 1.83
M9	Length of inferior articular facet	17.14 ± 2.03
M10	Width of inferior articular facet	11.84 ± 2.13

Table 5: Dimensions of Left superior and inferior articular facets.

Parameter No	Parameters	Value in millilitres (mm)
M11	Length of superior articular facet	21.03 ± 2.36
M12	Width of superior articular facet	14.43 ± 2.03
M13	Length of inferior articular facet	16.83 ± 2.36
M14	Width of inferior articular facet	10.05 ± 2.31

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Discussion

The most complex area of the spine is cranio-vertebral junction which is formed by occipital bone, atlas and axis.[5,9] As the atlas vertebra supports the skull, the atlantoaxial complex is positioned uniquely.[2] The detailed knowledge of anatomy of bones in the cranio-vertebral junction and surrounding structures is important as new surgical techniques and instrumentation continue to evolve for the treatment of unstable cervical spine.[10,11] The transverse (M1) and Anterio posterior (M2) diameters of atlas in our study were measured as 79.83 ± 6.59 mm and 45.52 ± 4.23 mm respectively which is consistent with the study conducted by Rocha et al[12] and Naderi et al [13]. The transverse (M3) and Anterio-posterior(M4) diameters of vertebral canal of atlas measured in our study where 30.21± 2.89mm and 32.63 ± 3.07 mm respectively. The present values were slightly more than the studies conducted by Lalitha B et al [14] and Ansari MS et al [15] and less than the values in the study conducted by Sengul G et al[16]. Length of right (M5) and left (M6) vertebral artery grooves were measured to be 15.31 ± 3.81mm and 15.91 ± 2.63 mm respectively. The present values were found to be higher than the study conducted by Akram M and Fathy A[17] and the study conducted by Ansari MS et al [15]. The values of Length (M7) and width (M8) of superior articular facet on the right side were found to be 21.30 ± 2.46 mm and 14.73 ± 1.83 mm, while as the length (M9) and the width (M10) of inferior articular facet on the right side was found to be 17.14 ± 2.03 mm and 11.84 ± 2.13 mm respectively. The present values were found to be slightly less than the study conducted by Ansari MS et al [15]. Similarly, the values of length (M11) and Width (M12) in our study of superior articular facet on left side were found to be 21.03 ± 2.36 mm and 14.43 ± 2.03 mm respectively. The values of the length (M13) and the width(M14) of the inferior articular facet on the left side were found to be 16.83 ±n 2.36 mm and 10 .04 ± 2.31 mm respectively. The values were found to be consistent with the study conducted by Ansari M et al[15].

Conclusion

The precise knowledge of various morphometric parameters of atlas and their comparison with the studies conducted by other researcher's will be very benevolent in the manufacturing of instruments related to atlas vertebrae. The current study will contribute to a better knowledge of diverse bone dimensions, which may aid with preoperative planning and diagnostics when operating near vital structures like the vertebral artery and nerve roots. The current study's measurement of several anatomical parameters may be useful for neurosurgery and in orthopedics to ascertain their roles in organizing an operating strategy in various surgical procedures.

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