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MORPHOMETRIC ANALYSIS OF ATLAS AND IT'S CLINICAL SIGNIFICANCE: AN ANATOMICAL STUDY OF INDIAN HUMAN ATLAS VERTEBRA.

Anatomy

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ABSTRACT

The atlas and axis are unique in their morphology and also have a complex vertebral artery relationship.The atlas consists of a neurovascular groove for the vertebral artery located behind each lateral mass at the posterior arch of the atlas. Superiorly the vertebral groove is arched by the posterior atlanto-occipitalmembrane, leaving an opening for the upwards passage of the vertebral artery and the outwards passage of the first cervical spinal nerve. This prospective observational study was conducted in the Department of Anatomy, Government Medical College, Jammu, a total of 40 dry adult atlas vertebrae were measured with the aim to study the morphology of Indian human atlas vertebra and it's clinical significance. The mean±SD and range of various parameters of atlas were recorded. It was observed that there was no significant difference between right and left sides which shows bilateral symmetry. The study concluded that various parameters of atlas are helpful for the different neurosurgeries mainly in the surgical procedures of traumatic neck condition to prevent further injuries to vertebral artery and spinal cord.

KEYWORDS

Atlas, Morphology, Artery, Vertebrae, Neurosurgery and clinical significance.

INTRODUCTION

The cervical spine is made up of 7 vertebrae and among them Atlas is the first cervical vertebrae (C1) which comprises of two bony arches with two bony masses laterally and articulate with occiput superiorly and with C2(Axis) inferiorly.[1]

The atlas and axis are unique in their morphology and also have a complex vertebral artery relationship.[2]

It plays an important role in movement of neck and head.The atlas consists of a neurovascular groove for the vertebral artery located behind each lateral mass at the posterior arch of the atlas. Superiorly the vertebral groove is arched by the posterior atlanto-occipitalmembrane, leaving an opening for the upwards passage of the vertebral artery and the outwards passage of the first cervical spinal nerve.[3]

The common reasons of morphological alteration in atlas are traumatic injuries, congenital, chronic inflammatory disorders, degenerative disorders, etc. which results in instability of craniovertebral junction (CVJ) and increases the surgical compliactions.[4]

It is very much important to study the relationship between the atlas, vertebral arteries and axis vertebrae in various operative approaches in the occipitocervical region. Various researchers found the occurrence of vertebral artery injury during transoral surgery, lateral mass and trans articular screw implantation for atlanto-axial fixation and during lateral approaches to the foramen magnum region. The arterial injury results in bleeding and neurologic deficits.[5]

As the literature suggests that surgeries of this region are high risk injuries. The reported incidence of vertebral artery injuries was 2% to 8%.[2]These arterial injuries affect the brain stem and cerebellum resulting in neurological impairments and neurological problems likeunconsciousness, respiratory and cardiovascular impairments. The post - operative compression of vertebral artery can lead to common clinical manifestations like migraine, vertigo, diplopia, shoulder pain, neck pain or severe incidents of cerebrovascular incidents. A study reported the cerebellar haemorrhage complications during supratentorial craniotomy operations which is the result of obstruction of the blood flow in the internal jugular vein which lies anteriorly to the transverse process of the atlas.[6,7]

AIMS AND OBJECTIVES

The present study aimed to study the morphology of Indian human atlas vertebra and it's clinical significance.

MATERIAL AND METHODS

This prospective observational study was conducted in the Department of Anatomy, Government Medical College, Jammu. A total of 40 dry adult atlas vertebrae of unknown gender were studied. All the atlas were examined and measured. The length and width was measured by using caliper.

Figure 1. Measurement Of Atlas By Using Caliper

Inclusion Criteria:
1. Adult atlas vertebrae of Indian origin.

Exclusion Criteria:
1. Broken atlas vertebrae.

All the measurements were taken two times to prevent the measuring errors. The data was recorded and analysed through descriptive statistics. The following parameters were measured in the study:
1. Distance between both tips of transverse processes (width of the atlas).
2. Distance between both lateral most edge of the transverse foramen (outer distance of foramen transversarium).
3. Distance between both medial most edge of the transverse foramen (inner distance of foramen transversarium)
4. Antero-posterior diameter of vertebral canal.
5. Transverse diameter of vertebral canal.
6. Distance from mid-point on posterior tubercle to lateral most edge of vertebral artery groove (outer distance of vertebral artery groove).
7. Distance from mid-point on posterior tubercle to medial most edge of vertebral artery groove (Inner distance of vertebral artery groove).
8. Length and width superior articular facet.
9. Length and width of inferior articular facet.

Table 1 Distribution Of Parameters

Parameters	Mean ± SD (mm)	Range (mm)
Distance between both tips of transverse processes	70.45±5.76	61.38-84.71
Distance between both lateral most edge of the transverse foramen	52.70±4.37	48.87-64.97

Distance between both medial most edge of the transverse foramen	45.44±4.25	38.95-55.78
Antero-posterior diameter of vertebral canal	28.44±2.51	23.22-34.83
Transverse diameter of vertebral canal	26.23±2.83	20.62-33.64
Right vertebral artery groove- outer distance	23.24±2.01	19.62-28.83
Left vertebral artery groove- outer distance	24.09±1.99	20.89-28.62
Right vertebral artery groove- inner distance	12.2±3.57	6.98-21.87
Left vertebral artery groove- inner distance	12.72±3.01	7.9-28.01
Length of right superior articular facet	21.47 ± 2.39	16.75–28.03
Length of left superior articular facet	22.19±2.57	17.04-27.28
Width of right superior articular facet	10.82±2.02	7.9-16.17
Width of left superior articular facet	10.10±1.9	6.1-12.97
Length of right inferior articular facet	15.99±2.1	14.68-22.03
Length of left inferior articular facet	16.75±1.98	13.67–21.16
Width of right inferior articular facet	15.75±1.87	12.69–18.95
Width of left inferior articular facet	16.41±1.39	13.04-19.68

Observations

In the present study a total of 40dry adult atlas vertebrae were studied. Data was analysed and range, mean±standard deviations of all the parameters were recorded.

Table 1, showed the mean±SD and range of various parameters of atlas. It was observed that there was no significant difference between right and left sides which shows bilateral symmetry.

DISCUSSION

The literature suggests that occipito-cervical instability results in disabling pain, cranial nerve dysfunction, paralysis, or sudden death. The anatomy of atlas and vertebral arteries plays an important role in surgical procedures. A study conducted by Gupta S, et al. (2013) reported the incidence of vertebral injury (2%).[8]Similarly, Madawi AA, et al. (1997) found 8% incidence of vertebral injury among the patients with neurological deficit.[9]

In the present study the mean distance between both tips of transverse processes was 70.45±5.76, mean distance between both lateral most edge of the transverse foramen was 52.70±4.37, mean distance between both medial most edge of the transverse foramen was 45.44±4.25, mean AP diameter of vertebral canal was 28.44±2.51, mean transverse diameter of vertebral canal was 26.23±2.83, mean outer distance of right and left vertebral artery groove was 23.24±2.01&24.09±1.99 respectively, mean inner distance of right & left vertebral artery groove was 12.2±3.57&12.72±3.01 respectively, mean length of right and left superior articular facet was 21.47 ± 2.39&22.19±2.57 respectively, mean Width of right& left superior articular facet was 10.82±2.02&10.10±1.9 respectively, mean length of right & left inferior articular facet was 15.99±2.1&16.75±1.98 respectively and the mean width of right & left inferior articular facet was 15.75±1.87&16.41±1.39 respectively.

The findings are in accordance with the study conducted by Patel NP, et al. (2016), observed that the mean width of atlas was 71.19 mm, mean distance between lateral margins of both transverse foramina was 55.48 mm and the inner distance was 44.77 mm. The mean for anteroposterior diameter of vertebral canal of atlas was 28.16 mm and transverse diameter was 26.63 mm. The height of anterior arch was 10.21 mm and posterior arch was 8.68mm. The mean for height of facet for dens was 8.96mm and width was 9.18 mm. The mean of anteroposterior diameter of right and left superior articular facet was 20.73 mm and 20.86 mm and transverse diameter was 11.34mm and 11.39mm. The mean of anteroposterior diameter of right and left inferior articular facet was 17.89mm and 17.77mm and transverse diameter was 14.97mm and 15 mm. The mean thickness of vertebral artery groove (VAG) for right and left side was 4.15mm and 3.99mm and width was 8.26 and 8.1 mm. The length of VAG-inner edge (D1) for right and left side was 10.34mm and 10.3mm and length for outer edge (D2) was 14.93mm and 15.1mm.[10]

In similar another study conducted by Ansari MS, et al. (2015) found that the mean transverse diameter and maximum anteroposterior dimension of vertebral canal of atlas was 27.31±2.74 and 29.44±2.54mm, respectively. The vertebral artery groove thickness on atlas is 3.79±1.08mm on right and 4.05±00.86mm on left, respectively. The mean distance from sagittal midline to the innermost edge of the vertebral artery groove is 10.73±2.92mm on right side and 09.72±2.56mm on left side. Overall, 74% of superior articular facets were found to be oval in shape and 26% in kidney shape.[11]

CONCLUSION

The present study concluded that various parameters of atlas are helpful for the different neurosurgeriesmainly in the surgical procedures of traumatic neck condition to prevent further injuries to vertebral artery and spinal cord.

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