Section: Anatomy

Research

MORPHOMETRIC ANALYSIS OF ATLAS VERTEBRA IN NOTHERN POPULATION IN INDIA

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Abstract

Background: Morphometric parameter of atlas vertebra is important for orthopaedic surgeons, neurosurgeon who deal with traumatic and nontraumatic conditions which may lead to atlanto occipital and atlantoaxial instability. So, before any spinal surgery like interspinous wiring, plate, and screw fixation, interlaminar clamp, transpedicular screw fixation these anatomical parameters of atlas vertebra knowledge are very important. **Materials and Methods:** Study was carried out on 30 dry adult human atlas vertebra of unknown sex were examined. Anatomical parameters of the vertebra measured, by using digital vernier calliper. Statistical analysis of the measurements was done. **Result:** The anteroposterior & transverse dimension of vertebral canal 28.45± 3.14mm and 24.14±3.14mm respectively. The outer distance of vertebral artery groove 24.24±3.95mm on right side & 23.22± 4.16mm on left side. The inner distance of vertebral artery groove 14.12±2.13mm on right side & 13.93±2.65mm on left side. **Conclusion:** Present study information helpful in avoiding and reducing complication such as vertebral artery injury, spinal cord injury during atlantooccipital and atlantoaxial instability correction.

INTRODUCTION

Atlas vertebra located at critical area close to vital centres of medulla oblongata that can get compressed by dislocation of atlantoaxial and atlanto occipital complex. So, reduction of the stability of this complex is very important.[1]

Atlas lacks a centrum (body of vertebra). The vertebral arch has become modified to form a thick lateral mass on each side, joined at front by short anterior arch and with longer posterior arch. Upper articular surface is kidney shaped and concave while lower is rounded or oval and nearly flat.[2]

The anterior and posterior arch of atlas, superior and lateral mass of atlas on each side forms atlantal ring. The posterior arch forms 3/5th of circumference of atlantal ring. Superior surface of posterior arch bears a wide groove for vertebral artery and venous plexus immediately behind. Superior border gives attachment to posterior atlanto occipital membrane and inferior border to the ligamentum flava. Posterior tubercle is a rudimentary spinous process roughened for attachment of ligamentum nuchae.[3]

Many different surgical procedures like interspinous wiring, plate, and screw fixation, interlaminar clamp, transpedicular screw fixation have been widely used in stabilizing the cervical column. Care should be taken to avoid injury to vertebral artery in its groove. The parameters measured in the present study are useful for the orthopaedic surgeon & neurosurgeons while performing various procedures in atlantoaxial and atlanto occipital fixation.

Aim & Objectives

This study was done to measure important anatomical parameters of atlas vertebra: anteroposterior & transverse dimension of vertebral canal, outer & inner distance of vertebral artery groove, length and width of superior & inferior articular facet, outer & inner distance of foramen transversarium, width of atlas. The aim of study is to compare the results of present study with the results of other studies conducted by different authors in different population, and to analyse their relationship with vertebral artery foramen in determining the safe site for different surgical procedures.

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MATERIALS AND METHODS

The study was carried out as cross-sectional observational study on 30 dry adult human atlas vertebrae of unknown age and sex were obtained from department of anatomy F.H. Medical College, Etmadhpur Agra. Vertebrae were intact and free from any other bony abnormality before measurement were made. All parameters were measured on digital vernier calliper with .01 mm accuracy.

Anatomical Parameter of Atlas Vertebra

A. Anteroposterior diameter of vertebral canal
B. Transverse diameter of vertebral canal
C. Outer distance of vertebral artery groove (distance from midpoint on posterior tubercle to lateral most edge of vertebral artery groove)
D. Inner distance of vertebral artery groove (distance from midpoint on posterior tubercle to medial most edge of vertebral artery groove)
E. Length of superior articular facet.
F. Width of superior articular facet.
G. Length of inferior articular facet.
H. Width of inferior articular facet.
I. Outer distance of foramen transversarium
J. Inner distance of foramen transversarium
K. Width of atlas.

[Figure 1] (A) demonstrates the anatomical parameter measured on atlas vertebra its superior view. Fig:1(B) demonstrates its inferior view of atlas vertebra. Three readings were taken for each bone and their average was recorded as final reading. Statistical evaluation was performed for each parameter. The mean, standard deviation, a paired comparison t- test and P value were performed.

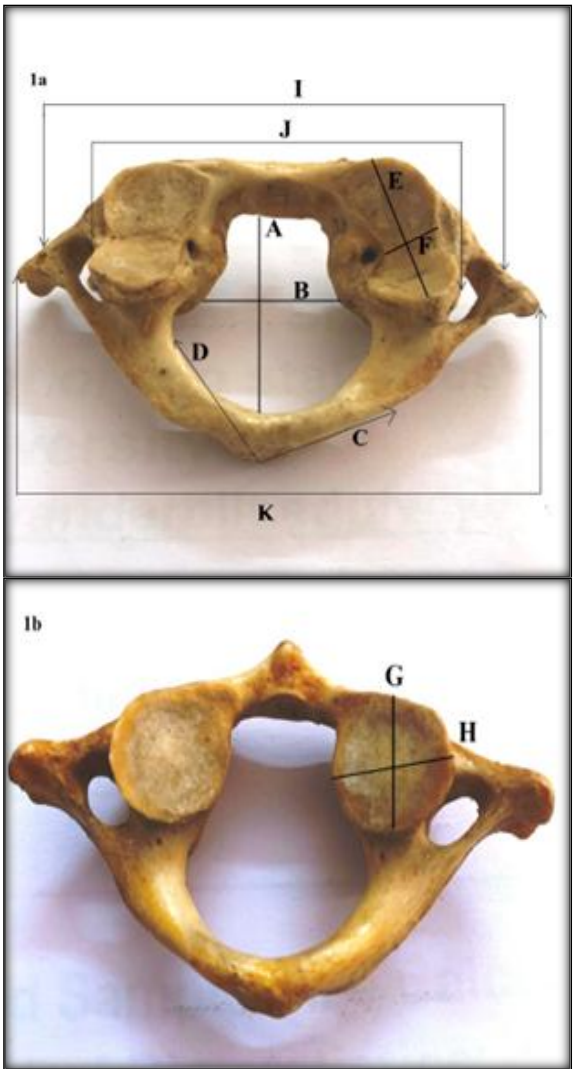

Figure 1: Showing the measuring Parameters Superior aspect (1A) inferior aspect (1B)

RESULTS

The observations and results have been recorded in [Table 1].

Table 1: Showing the result of measured parameters

Sr. No	Description of parameter	Mean(mm)± SD	Range(mm)
A	Vertebral canal AP Dimension	28.25 ± 3.14	21.03 – 36.3
B	Vertebral canal transverse dimension	24.14 ± 3.41	17.03 – 35.23
C_R	Outer distance vertebral artery groove (Rt)	24.24 ± 3.95	16.88 – 33.49
C_L	Outer distance vertebral artery groove (Lt)	23.22 ± 4.16	17.25 – 33.97
D_R	Inner distance vertebral artery groove (Rt)	14.12± 2.13	8.7 – 16.77
D_L	Inner distance vertebral artery groove (Lt)	13.93 ± 2.65	7.49 – 19.9
E_R	Superior articular facet length (Rt)	19.52 ± 2.38	14.11 – 24.28
E_L	Superior articular facet length (Lt)	19.55 ± 2.43	22.47 – 3.4
F_R	Superior articular facet width (Rt)	11.37 ± 3.41	7.18 – 19.8
F_L	Superior articular facet width (Lt)	10.96 ± 2.86	6.12 – 18.69
G_R	Inferior articular facet length (Rt)	16.64 ± 2.42	13.14 – 22.9
G_L	Inferior articular facet length (Lt)	16.04 ± 2.56	11.05 – 21.28
H_R	Inferior articular facet width (Rt)	14.36 ± 1.59	12.4 – 19.99
H_L	Inferior articular facet width (Lt)	14.17 ± 1.39	11.48 – 17.67
I	Outer distance foramen transversarium	56.58 ± 4.89	47 – 66.52
J	Inner distance foramen transversarium	44.02 ± 3.74	36.5 – 54.04
K	Width of atlas	69.53 ± 4.48	61.62 – 79.9

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Table 2: Showing the comparison of present study with other studies

Sr no	Parameters	Lalitha B et al., South India	Ansari MS et al., India	Sengul G et al., Turki	Gupta C et al., India	Present Study India
A	Vertebral canal AP Dimension	28.71±2.43	29.44±2.54	46.2±6	30.4	28.85±3.14
B	Vertebral canal transverse dimension	25.51±2.93	27.31±2.74	28.7±1.8	27.7	24.14±3.41
C_R	Outer distance vertebral artery groove (Rt)	24.42±1.99	24.85±2.78	16.2±2.5	23	24.24±3.95
C_L	Outer distance vertebral artery groove (Lt)	25.3±2.09	24.39±2.06	15.8±2.8	22	23.22±4.16
D_R	Inner distance vertebral artery groove (Rt)	12.01±3.4	10.73±2.92	10.3±1.6	12.8	14.12±2.13
D_L	Inner distance vertebral artery groove (Lt)	12.69±3.03	9.72±2.56	10.4±2	13.8	13.93±2.65
E_R	Superior articular facet length (Rt)	22.47±2.4	22.13±2.26	19.9±3.4	21.5	19.52±2.38
E_L	Superior articular facet length (Lt)	22.81±2.44	21.84±2.11	18.6±3.2	21.8	19.55±2.43
F_R	Superior articular facet width (Rt)	10.10±1.7	11.82±1.79	9.6±1.9	11.8	11.37±3.41
F_L	Superior articular facet width (Lt)	9.95±3.17	12.19±1.58	9.8±1.5	11.5	10.96±2.86
G_R	Inferior articular facet length (Rt)	17.99±1.55	16.24±1.44	17.1±2.6	18	16.64±2.42
G_L	Inferior articular facet length (Lt)	17.75±2.07	16.39±1.93	17.5±2.4	17.9	16.04±2.56
H_R	Inferior articular facet width (Rt)	15.15±1.48	15.84±1.83	8.8±1.5	14.6	14.36±1.59
H_L	Inferior articular facet width (Lt)	15.01±1.43	16.39±1.93	8.5±1.5	15.2	14.17±1.39
I	Outer distance foramen transversarium	54.39±4.73	58.18±4.26	59.5±3.7	57.6	56.58±4.89
J	Inner distance foramen transversarium	44.5±4.57	45.38±3.25	48.6±2.4	45.2	44.02±3.74
K	Width of atlas	78.25±6.86	71.98±4.6	74.6±9.7	72.5	69.53±4.48

DISCUSSION

Many different types of posterior approaches have been adopted for stabilization and fusion of atlantoaxial complex. Gallie in 1939 gave a posterior wiring technique where wire is passed under arch of atlas over a corticocancellous bone graft through which posterior process of C1 and C2 attached to the spinous process of axis. This method is least stable and needs to be external rigid support.[4]

Magerl and Seeman in 1987 introduced trans articular screw fixation technique, C1 lateral mass screw fixation was described by Harms in 2001.[5]

Posterior transarticular screws are widely used for atlantoaxial fixation with good results. Lateral mass screws in C1 and pedicle screws in C2 connected by rod. Assessing the C1 lateral mass can be difficult because of excessive bleeding from venous plexus surrounding C1-C2 joint also a possibility of internal carotid artery and hypoglossal nerve injuries due to bicortical screw placement.[6]

Neurovascular structure anterior to atlas lateral mass is at risk. Internal carotid artery is at risk during bicortical screw fixation of the atlas. So, contrast enhanced computed tomography to assess the location of internal carotid artery before screw fixation.[7]

The measurements done in this study may be helpful in avoiding and reducing complications like vertebral artery injury, spinal cord injury and cranial nerve injury during C1 stabilizing surgeries. Surgeon should carefully study 3D- CT imaging prior to surgery any bony outgrowth (atlas bridges) in combination with vertebral artery groove morphology and vertebral artery course before screw insertion.[8]

The results of this study similar with Lalitha B et al,[9] Ansari MS et al,[10] Gupta C et al,[11] but differ with Sengul G and Kadioglu HH.[12] The present study results were compared with previous studies in [Table 2].

The anteroposterior diameter of vertebral canal was 28.25± 3.14mm with range of 21.02-36.3mm and transverse diameter was 24.14±3.14 with range of 17.03-35.23. In Turkish population vertebral canal anteroposterior dimension significantly larger than Indian population.[12]

Sengul G et al,[12] showed that the range from midline to inner most edge of vertebral artery was 7.2-17.7mm for left side with minimum of 9mm for both the sides and suggested that dissection on the posterior arch of C1 should be limited to 10 mm to prevent injury to vertebral artery during dissection through posterior side. According to present study range from midline to the inner most edge of vertebral artery groove is found to be from 8.7 to 16.77 mm with mean of 14.12±2.13mm right side and from 7.49 to 19.9mm with a mean of 13.93±2.65mm on left side. So, our study we can say that dissection on posterior arch of C1 can be extended to 12mm from the midline through the posterior approach. Anatomically, bony groove on upper surface of the posterior arch of C1 represent the exact location of vertebral artery. Damage to vertebral artery can be avoided, if exposure of posterior arch of C1 remains medial to the groove.[13]

CONCLUSION

Present study found range from midline to innermost edge of vertebral artery groove to be from 8.7 to 16.77 mm with mean of 14.12±2.13mm right side and from 7.49 to 19.9mm with a mean of 13.93±2.65mm on left side. According to our study we can say that dissection on posterior arch of C1 can be extended to 12 mm from midline through posterior approach. Different anatomical parameter measured in the present study may be helpful for orthopaedic surgery and neurosurgery to determine role in planning an operative approach in different surgical procedures like transarticular screw fixation, lateral mass screw fixation, interlaminar clamp, interspinous wiring.

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