Morphometric Analysis Of Dry Atlas Vertebrae In The Population Of Northern India

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Abstract: Background: The atlas is atypical first cervical vertebra. It is located near the vital structures of life. It has many structural variations and many dimensional variations. The aim of this study was to understand various dimensions of the Atlas vertebra and its variations with effect on the related structures. Material And Methods: 50dryhuman Atlas vertebrae were studied from various colleges in Northern India. A digital vernier calliper with a resolution of 0.01mm was used for carrying out these measurements. Result: The mean inner and outer groove length observed in 100 vertebral artery grooves was 6.94mm ± 1.195mm and 11.40mm ± 1.905mm respectively. The observed anteroposterior diameter had a mean of 7.52mm±1.27mm on the right side and 7.59mm±1.49mm on the left side of the foramen transversarium. The mean width of the vertebral artery groove was 8.43±1.22mm and 8.68±1.35mm on the left and right respectively. Conclusion: This information for clinicians can help in preventing any damage while performing invasive procedures in this region. The variations in the atlas vertebra and its relations with other structuresfor example nerve roots and vertebral arteries become easy with the understanding of its morphometric and morphological analysis in this study. [Bharti A Natl J Integr Res Med, 2023; 14(3): 44-50, Published on Dated: 18/05/2023]

Key Words: Atlas, C1 Cervical Vertebra, Vertebral Artery, Atypical Vertebra

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Introduction: Atlas, an atypical cervical vertebra, is the vertebral column's first vertebra. It supports the Globe of the Human skull and hence derives its name 'Atlas' because of its similarity with the Greek God who held up the celestial sphere as per Greek mythology. It is a ring-shaped vertebra lacking the vertebral body and spinous process. Its structure consists of two arches - anterior and posterior, two small transverse processes with a foramen in it on either side, two lateral masses and a pair each, of superior articulating facets and inferior articulating facets[1].

The cervical vertebra has the foramen transversarium as its characteristic feature through which the second part of the vertebral artery passes along with the vertebral vein and sympathetic nerves. The anterior arch has the longus coli muscle attached to its anterior surface and the anterior atlantooccipital membraneis attached to its upper border[1].

The posterior arch is broader than the anterior arch and has a vertebral artery groove on either side of the upper surface. It is arched above the posterior atlantooccipital membrane. It also has a vertebral artery passing through its superior surface before entering through the foramen magnum into the cranial cavity. This is known as the vertebral artery groove. The atlas is formed by three ossification centers[3].

Many factors such as degenerative bone disease, surgical complications arising after cervical laminectomy, dislocations caused by trauma, or even congenitalanomalies can cause atlantooccipital junction instability. Nerve and arterial compression can be of concern in this region for clinicians. A detailed study of its morphological and morphometric features is a requirement of Head and Neck surgeons and clinicians

Aim And Objectives: Aim: The aim of the analysisis a morphometric and morphological study of dry atlas vertebrain the North Indian population.

Objectives: To perform the morphometrical measurements of vertebral artery groove in the dry atlas vertebra. To observe the morphological changes and morphometric measurements of the foramen transversarium in the dry atlas vertebra.

Material & Methods: The study of morphometric and morphological analysis of dry atlas vertebra is of observational descriptive type. It was carried out using50complete and unbroken dry human atlas vertebrae collected from various colleges in Northern India. Any broken, degenerated, or artificially repaired bones were not included in the study. The number of observations taken was100 (50 on either side of dry atlas vertebrae) irrespective of age and sex. The measurement was carried out using a digital vernier caliper with a minimum resolution of 0.01mm (Figure 1).

Results And Discussion: Results are as follows.

Figure 1: Digital Vernier Caliper And Atlas Vertebra

The following parameters were measured for the Vertebral artery Groove using a vernier caliper. Innerlength of vertebral artery groove- The distanceonthe medial side of the vertebral artery groove anteroposteriorly 4 (Figure 2).

Figure2: Measurement Of Inner Length Of Vertebral Artery Groove

Outer length of vertebral artery groove – The distance of the lateral side of vertebral artery groove anteroposteriorly[4] (Figure 3).

Figure 3: Measurement Of Outer Length Of Vertebral Artery Groove

Width of the vertebral artery groove – The distance between the inner border and the outerborders of the groove of the vertebral artery[4] (Figure 4).

Figure 4 : Measurement Of The Width Of Vertebral Artery Groove

The thickness of the groove – The distance between the superior and inferior surfaces of the atlas measured at the thinnest part laterally6 (Fig 5).

Figure 5: Measurement Of Thickness Of Vertebral Artery Groove

L1: The distance from the midline to the proximal end of the inner border of the groove of vertebral artery [5](Figure 6).

Figure 6: Measurement Of L1 Of Vertebral Artery Groove

L2: The distance from the midline to the proximal end of the outer border of the groove of vertebral artery[5] (Figure 7).

Figure 7: Measurement Of L2 Of Vertebral Artery Groove

L3: The distance from the midline to the distal end of the inner border of thegroove for vertebral artery[5] (Figure 8).

Figure 8: Measurement Of L3 Of Vertebral Artery Groove

L4: The distance from the midline to the distal end of the outer border of the vertebral artery groove[5] (Figure 9).

Figure 9: Measurement Of L4 Of Vertebral Artery Groove

The measurements of foramen transversarium weretaken to study its morphometry and morphology.

The foramen transversarium was studied for its morphology. They were classified into five types based on their shape6.

- Type A: Circular.
- Type B: Oval (Anteroposterior Direction).
- Type C: Oval (Transverse Direction).
- Type D: Oval (Axis From Right To Left).
- Type E: Oval (Axis From Left To Right).

The following dimensions were measured[6]: Anteroposterior Diameter (AP) – It is the distance of the foramen transversarium measured anteroposteriorly (Figure 10).

Figure 10: Measurement Of Anteroposterior Diameter Of Foramen Transversarium

Transverse dimension (W)– It is the distance of the foramen transversarium in the transverse plane (Figure 11).

Figure 11: Measurement Of Transverse Diameter Of Foramen Transversarium

A dry atlas vertebra was observed for the morphological features and morphometric diameters were measured and recorded.50 dry human atlas vertebrae were studied. These were recorded and their mean value was recorded.

The Groove of the Vertebral Artery: The observations of significant morphometric diameters of the groove for the vertebral artery were recorded. It included the inner length and the outer length of the groove as well as the width and thickness of the groove, L1, L2, L3, and L4. The values were tabulated in Microsoft Excel to find the mean values.

The mean of inner and outer groove length as observed in 100 vertebral artery grooves was 6.94mm ± 1.195mm and 11.40mm ± 1.905mm respectively. The mean width and thickness were 8.56mm ± 1.28mm and 3.88mm ± 0.94mm respectively. L1, L2, L3, and L4 had a mean of 12.15mm ± 1.77mm, 16.62mm ± 2.73mm, 19.17mm ±2.455mm, and 26.01mm ± 2.40mm respectively.

The inner groove length had a mean of 6.73mm ± 1.24 mm and 7.15 mm ± 1.15mm on the right and left sides. Similarly, the mean outer groove length was 11.71±2.10mm and 11.09±1.71mm on the right and left sides respectively. The mean width of the vertebral artery groove was 8.43±1.22mm and 8.68±1.35mm on the left and right respectively whereas the mean of the thickness of the right and left side was 3.91±0.91mm and 3.84±0.97mm respectively.

The mean of the right and left sides of L1 was 11.57±1.96mm and 12.72±1.58mm, L2 at 16.41±3.12mm and 16.83±2.34mm, L3 at 18.58±2.48mm and 19.75±2.43mm and L4 at 25.6±2.7 mm and 26.43±2.1 mm respectively (Table 1).

Table 1: Morphometric Parameters Of Vertebral Artery Groove

Parameters	N	Mean	Mean Right & Left	SD	Mean Of SD - Right & Left
Inner Groove Length					
Right	50	6.73	6.94	1.24	1.195
Left	50	7.15		1.15	
Outer Groove Length					
Right	50	11.71	11.4	2.1	1.905
Left	50	11.09		1.71	
Width					
Right	50	8.43	8.555	1.22	1.285
Left	50	8.68		1.35	
Thickness					
Right	50	3.91	3.875	0.91	0.94
Left	50	3.84		0.97	
L1					
Right	50	11.57	12.145	1.96	1.77
Left	50	12.72		1.58	
L2					
Right	50	16.41	16.62	3.12	2.73
Left	50	16.83		2.34	
L3					
Right	50	18.58	19.165	2.48	2.455
Left	50	19.75		2.43	
L4					
Right	50	25.6	26.015	2.7	2.4
Left	50	26.43		2.1	

From the above calculations, it can be seen that the vertebral artery groove had greater width on the left side than the right side whereas the thickness was greater on the right side than the left side though the difference was not significant.

L1, L2, L3, and L4 had greater mean on the left side than the right side.

L1 and L3 were observed to have significant differences between the right and left sides with p-values of 0.028 and 0.008 respectively.

However, L2 and L4 were similar with insignificant differences on the two sides. L1 has a positive correlation with L2, L3, and L4 (r-value of 0.48, 0.65, and 0.53; significance with p value less than 0.003 but negative correlation with the outer length of the vertebral artery groove (r value of 0.31; significance with a p-value of 0.027).

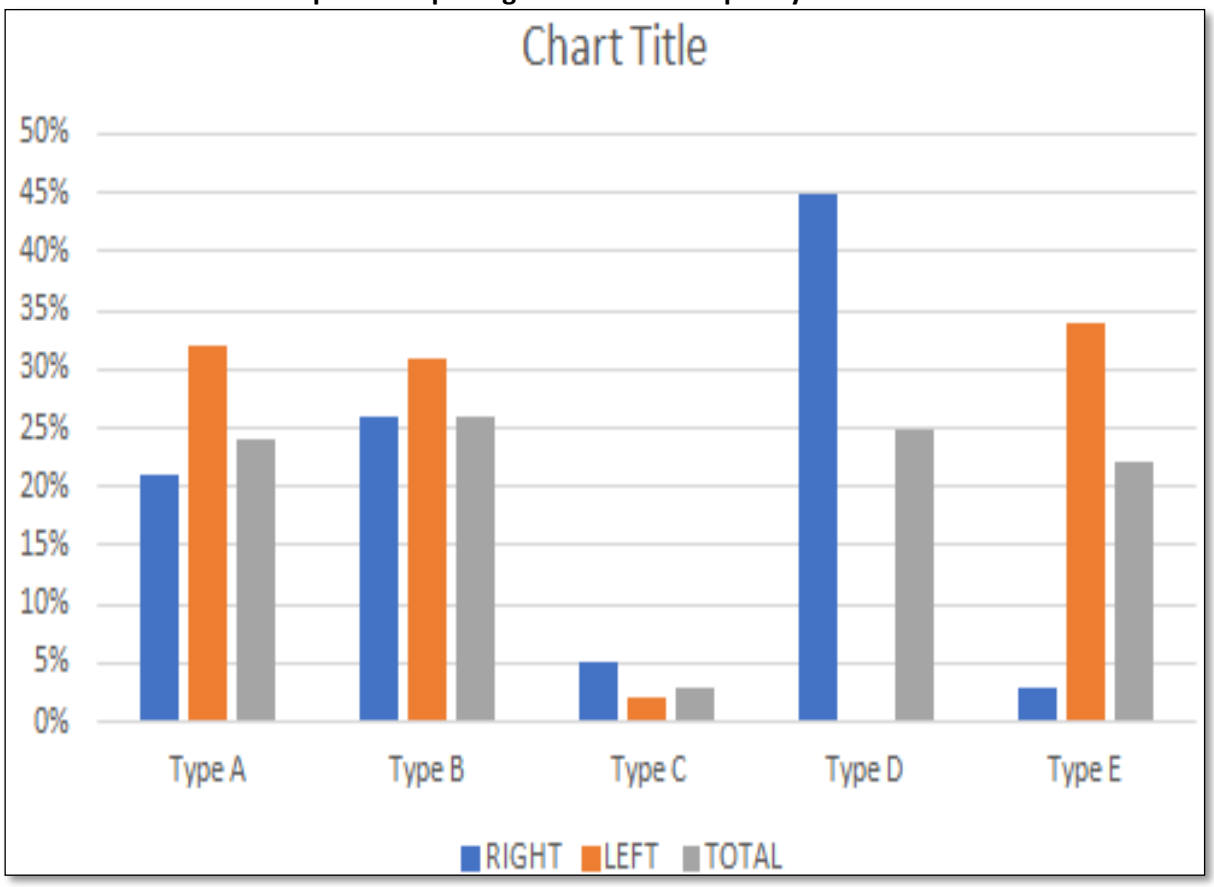
Foramen Transversarium: Based on the observed morphology, foramen transversarium has been classified into five distinct types:

- Type A: Circular.
- Type B: Oval (Anteroposterior Direction).
- Type C: Oval (Transverse Direction).
- Type D: Oval (Axis From Right To Left).
- Type E: Oval (Axis from Left To Right).

Table 2: Observation Of Morphological Features

Parameters	N	Right	Left
Anteroposterior Diameter (AP)	50	7.52mm±1.27mm	7.59mm±1.49mm
Transverse Diameter(W)	50	5.45mm±1.25mm	5.51mm±1.23mm

Graph 1: Morphological Features Frequency Distribution



The observation of the morphology of 100 foramen transversarium (50 right and 50 left sides) gave the percentage distribution in five types, type A - 24%, type B - 26%, type C - 3%, type D - 25%, and type E - 22% (Table 2) (Graph 1).

Further, the distribution of observation only on the right side was type A - 21%, type B - 26% type C - 5%, type D - 45%, and type E - 3% (Table 2). On the left side, the observation was a type - 32%, type B - 31%, type C - 2%, type D - 1%, and type E - 34% (Table 2).

From the total 100 observations taken of foramen transversarium (50 on left and 50 on right), the overall highest percentage was of type B at 26%.

The identical observation was seen on the right side with Type B having highest frequency at 26%.

For only left side observations, type A and Type B were almost equal at 32% and 31% respectively. Type C was slightly higher on right side at 5% as compared to 2% on left side.

For Type D & E types, observations were substantially skewed on the right and left sides in both cased with type D being more common on the right side at 45% as compared to left side at nil and type E more common on the left side at 34% as against 3% on the right side.

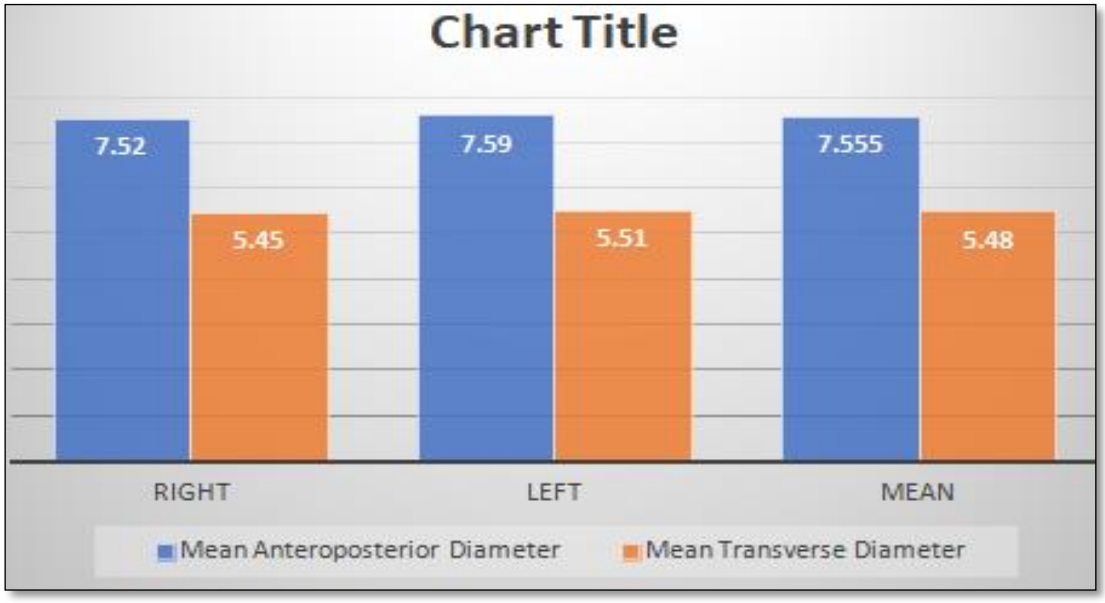
The diameters of foramen transversarium was measured anteroposteriorly andtransversely. The observations were recorded and tabulated for statistical analysis using Microsoft Excel (Table 3).

Table 3: The Mean Value Of Morphometric Measurements Of Foramen Transversarium Of Right And Left Side Of The Atlas Vertebra

Type A	21%	32%	24%
Type B	26%	31%	26%
Type C	5%	2%	3%
Type D	45%	0%	25%
Type E	3%	34%	22%

The observed anteroposterior diameter had a mean of 7.52mm±1.27mm on the right side and 7.59mm±1.49mm on the left side of the foramen transversarium as shown in Table 3. Similarly, the observations of transverse diameter gave a mean of 5.45mm±1.25mm on the right side and 5.51mm±1.23mm on the left side of the foramen transversarium (Table 3). The means of the diameter of both, anteroposterior and transverse were almost similar on the right and left sides with the difference being not significant. Also, though the difference was insignificant, it was observed that the means of anteroposterior diameter as well as the transverse diameter of the foramen transversarium were slightly more on the left side than the right side(Graph 2).

Graph 2: Depicts Mean Values Of Anteroposterior And Transverse Diameters Of Foramen In The Transverse Process Of Both, Right And Left Side



Conclusion: Many research workers discussed the morphometric measurements and morphological features of the cervical vertebra.

The atlas vertebra being the first cervical on which the head rests and moves, it was realized that a detailed study was required for this vertebra. The morphometric measurements and morphological observations of the anatomy of the atlas are necessary for neurosurgeons and orthopedics. The study was performed in 50 dry atlas vertebrae, foramen transversarium, and the vertebral artery groove was studied for its shapes, sizes, and dimensions so that the related structure, the vertebral artery that passes through foramen transversarium, and the vertebral arteries and nerve roots that rests on vertebral groove can be skilfully approached by the clinicians based on above knowledge provided in this study.

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