



MORPHOLOGICAL VARIATIONS AND MORPHOMETRY OF FORAMEN TRANSVERSARIUM OF HUMAN ATLAS VERTEBRAE

Anatomy

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ABSTRACT

BACKGROUND: Variations of foramen transversarium is a well-known entity of cervical vertebrae (Reos et al 2014) and such variations have been reported to have association with vertebro-basilar insufficiency. Aim of present study is to provide data of morphological variation of transverse foramen of atlas along with its morphometric measurement in Indian population.

MATERIALS AND METHODS: Foramen transversarium of each atlas vertebrae was keenly observed whether it was absent, complete or incomplete, if incomplete foramen transversarium was seen, then it was also examined whether anterior root or posterior root of foramen was missing. Presence of any accessory foramen of transverse process was also noted. Variability of shape of foramen transversarium of atlas was also noted. Viz oval, circular or irregular shape. For measurement of foramen transversarium, diameters were taken in two planes in which foramen diameter has its maximum anteroposterior and maximum transverse value. Foramen transversarium of atlas is normally bounded by anterior and posterior root. The thickness of the anterior and posterior root was also measured by digital vernier calipers for comparison. For measuring thickness of root was tightly hold between jaws of vernier caliper and reading of instrument was noted.

RESULTS: Incomplete foramen transversarium was found in 6.2% vertebrae, out of which 4.8% were bilateral and 1.4% were unilateral and only 7.6% on left side. Out of 250 atlas vertebra, 4% vertebra showed accessory foramen transversarium, out of which 4% were bilateral and 0% were unilateral. Regarding the shape of foramen transversarium most common shape of foramen was circular followed by oval on either side. In the present study out of 250 vertebrae maximum transverse diameter of foramen transversarium was found to be 6.98 ± 0.65 mm on left side while it was 7.13 ± 0.86 mm on right side. Maximum anteroposterior diameter of foramen transversarium was found to be 8.16 ± 0.57 mm on left side and 8.29 ± 0.76 mm on right side.

CONCLUSION: The study reveal statistically significant regional differences. The observations made in the present study may be helpful to anatomists, anthropologists and neurosurgeons.

KEYWORDS

Atlas vertebrae, Foramen transversarium and Transverse process.

INTRODUCTION:

Human first cervical vertebrae, which subserves the function of weight bearing of our head is also called atlas vertebrae. This name to atlas vertebrae has been given on the name of Greek god Atlas, who is supposed to hold the earth on a shoulder. All the cervical vertebrae possess a foramen in their transverse process known as foramen transversarium. Foramen transversarium of atlas allows passing of vertebral artery along with vertebral venous plexus and sympathetic plexus. Then vertebral artery of both side enter the foramen magnum to formed basilar artery. This vertebrobasilar arterial system chiefly supplies our brain stem, occipital lobe and cerebellum.¹

Variations of foramen transversarium is a well-known entity of cervical vertebrae (Reos et al 2014) and such variations have been reported to have association with vertebro-basilar insufficiency. Aim of present study is to provide data of morphological variation of transverse foramen of atlas along with its morphometric measurement in Indian population.²

MATERIALS AND METHODS:

This observational study was carried out on 250 dried adult human atlas vertebrae procured from Department of Anatomy of Rajkiya Medical College, Jalaun; M L N Medical College, Allahabad; Hitech Medical College and Hospital, Bhubaneswar and Index Medical College, Indore from year 2015 to 2020. Any specimen having fracture, gross evidence of congenital or acquired vertebral pathology, or gross osteophytes was excluded from the study. Foramen transversarium of each atlas vertebrae was keenly observed whether it was absent, complete or incomplete, if incomplete foramen transversarium was seen, then it was also examined whether anterior root or posterior root of foramen was missing. (figure-1).



Figure -1 Incomplete Foramen transversarium- anterior root is missing

Presence of any accessory foramen of transverse process was also noted. (figure- 2)



Figure -2 Bilateral accessory foramen of transverse process

Variability of shape of foramen transversarium of atlas was also noted. Viz oval, circular or irregular shape. (figure- 3)



Figure -3 Shape of foramen transversarium

Study tool used for morphometric measurement was a digital Vernier caliper, which was accurate up to 0.1 mm for linear measurement. For measurement of foramen transversarium, diameters were taken in two planes in which foramen diameter has its maximum anteroposterior and maximum transverse value. (figure-4).



Figure-4 Morphometric measurement of foramen transversarium

Foramen transversarium of atlas is normally bounded by anterior and posterior root. The thickness of the anterior and posterior root was also measured by digital vernier calipers for comparison. For measuring thickness of root was tightly hold between jaws of vernier caliper and reading of instrument was noted. Data of morphological variation was represented in percentage, while morphometric data were represented as mean $\pm$ SD in mm, followed by comparison with the data of other available studies using unpaired 't' test. The difference was taken as significant, if the p value was ≤ 0.0 .

OBSERVATION:

Table -1 Absent/ incomplete foramen transversarium

Specimen	Side	Incomplete Foramen Transversarium			Absent Foramen Transversarium		
		left	Right	Total	left	Right	Total
Atlas	Unilateral	7	Nil	7	Nil	Nil	Nil
	Bilateral	12			Nil		

Table 2: Presence of accessory foramen of transverse process

Specimen		Side	Number
Atlas	Unilateral	Right	0
		Left	0
	Bilateral		10

Table - 3: Shape of foramen transversarium

Specimen	Side	Prevalence	Number	%
Atlas	Left	Oval	87	37.7
		Circular	133	57.6
		irregular	11	4.8
	Right	Oval	97	41.9
		Circular	103	44.6
		irregular	38	16.5

Table -4: Measurement of foramen transversarium

Specimen	Maximum transverse diameter of Foramen transversarium (in mm)		Maximum anteroposterior diameter of Foramen transversarium (in mm.)	
	Right	Left	Right	Left
Atlas (n=250)	7.13 $\pm$ 0.86	6.98 $\pm$ 0.65	8.29 $\pm$ 0.76	8.16 $\pm$ 0.57

Table -5: Measurement of anterior and posterior root of foramen transversarium

Specimen	Thickness of anterior root (in mm)		Thickness of posterior root (in mm)	
	Right	Left	Right	Left
Atlas (n=250)	3.11 $\pm$ 0.6	2.98 $\pm$ 0.52	2.84 $\pm$ 0.42	2.8 $\pm$ 0.36

DISCUSSION:

In our study we did not find any Atlas vertebra without foramen transversarium. Incomplete foramen transversarium was found in 6.2% vertebrae, out of which 4.8 % were bilateral and 1.4 % were unilateral and only 7.6% on left side. Out of 250 atlas vertebra, 4 % vertebra showed accessory foramen transversarium, out of which 4% were bilateral and 0 % were unilateral. Regarding the shape of foramen transversarium most common shape of foramen was circular followed

by oval on either side.

In the present study out of 250 vertebrae maximum transverse diameter of foramen transversarium was found to be 6.98 ± 0.65 mm on left side while it was 7.13 ± 0.86 mm on right side. On comparison of measurement of maximum transverse diameter of foramen transversarium with the findings of Awadalla et al (2009)³, Buteera et al (2010)⁴ and Rekha BS et al (2013)⁵, Monika L et al (2015)⁶, Salahuddin et al (2015)⁷ and Monika G. et al (2019)⁸ it was noticed that this parameter showed differences from their study, which was found to be statistically significant ($p < 0.05$). In our study maximum anteroposterior diameter of foramen transversarium was found to be 8.16 ± 0.57 mm on left side and 8.29 ± 0.76 mm on right side. We compared the same parameter with the findings of Taitz et al (1978)¹⁰, Awadalla et al (2009)³, Rekha BS et al (2013)⁵, Monika L et al (2015)⁶, Salahuddinet al (2015)⁷ and Monika. G. et al (2019)⁸ by unpaired t test and it was noticed that this parameter showed differences from their study, which were found to be statistically significant ($p < 0.05$).

CONCLUSION:

Surgical reconstruction of Atlanto axial instability requires a sound anatomical knowledge of creniovertebral region as even minor variation in this region can cause serious complication such as vertebral artery injury, spinal cord injury and cranial nerve damage. The study reveal statistically significant regional differences. The observations made in the present study may be helpful to anatomists, anthropologists and neurosurgeons.

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