

Study of Ponticulus Posticus in Dry Atlas Vertebrae in Central Gujarat Region and its Clinical Significance

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ABSTRACT

Introduction: Atlas is the first cervical vertebra which supports skull through atlanto-occipital joint. It has an anterior and a posterior arch with a groove on superior surface for the third part of the vertebral artery. The groove has anterior and posterior margin onto which lateral margin of atlanto-occipital membrane is attached. From these anterior and posterior margins of groove, sometimes bony projections occur and convert the groove into a foramen which may be incomplete or complete and known as ponticulus posticus. This may compress the vertebral artery passes through it and may cause vertebrobasilar insufficiency and produce symptoms like vertigo, dizziness, nausea, headache etc.

Aim: To find out occurrence rate of ponticulus posticus in atlas vertebrae with their measurements and its clinical significance.

Materials and Methods: Total 100 atlas vertebrae were examined for incomplete and complete ponticulus posticus. Their anteroposterior length and vertical height

were also measured with the help of vernier caliper.

Result: Incomplete ponticulus posticus were found in total 33 (33%) of vertebrae and complete ponticulus posticus were found in 4 (4%) vertebrae. Similarly, foramen for vertebral artery on lateral side was found in only 1 (1%) vertebra on right side. Anteroposterior length of foramen was 11.5 ± 2.5 mm on right side and 11.2 ± 2.2 mm on left side. Vertical height of foramen was 6.3 ± 1.2 mm on right side (statistically non-significant) and 6.3 ± 1.1 mm on left side. Anteroposterior length and vertical height does not show any statistical significant difference on right and left side. Data entry and analysis was done by using Microsoft Excel 2016. Data was represented as mean \pm SD.

Conclusion: Neurosurgeons, Orthopedic surgeons, Radiologists and clinicians must be aware about the presence of ponticulus posticus which may compress the third part of vertebral artery and produce neurological symptoms. Measurements of ponticulus posticus help them to understand anatomy of this region better for performing surgeries like internal fixation techniques.

Keywords: Headache, Vertebral artery, Vertebrobasilar insufficiency

INTRODUCTION

The first cervical vertebra which supports the head also known as atlas vertebrae has two lateral masses united by an anterior and a posterior arch. There is a wide groove for the vertebral artery on the superior surface of the posterior arch. Occasionally, the bony projections arise from the anterior and posterior margins of the groove and convert the groove into a foramen which may put the vertebral artery at risk during injury or surgical procedures around the atlas vertebrae. Such bony projections are known as ponticles [1]. The foramen thus formed is known as ponticulus posticus means posterior bridge. In the event of presence of posterior or lateral vertebral artery foramen be it complete or incomplete or be unilateral or bilateral, the vertebral artery becomes unsafe and is liable

to be pressed on [2] [Table/Fig-1]. This pressure causes vertebrobasilar insufficiency and produce symptoms like vertigo, dizziness, nausea, headache etc. Other words used for this foramen are arcuate foramen or Kimmerly's anomaly etc., [3]. With this information in mind, the present study was taken up to find out the occurrence rate of ponticulus posticus in atlas vertebra with its measurements so as to correlate with its clinical significance.

MATERIALS AND METHODS

This was an analytical cross-sectional study conducted in the Department of Anatomy of various Medical Colleges of Central Gujarat, India, after taking institutional approval. Analysis of study was conducted for the duration of about three months



[Table/Fig-1]: Ponticulus Posticus (Incomplete on right side and complete on left side). **[Table/Fig-2]:** Measurement of anteroposterior length of ponticulus posticus. **[Table/Fig-3]:** Measurement of vertical height of ponticulus posticus.

between the April 17 and June 17 after collecting the data. Total 100 dry, adult, atlas vertebrae were examined. Age and sex of the specimens were unknown. The vertebrae with distorted morphology were removed from the study.

The following observations were made with naked eye. Morphometric measurements were taken with the help of Vernier caliper in nearest to millimetre of length. Measurements were taken solely by the main author at two separate points of time and then average of them considered as a final result and data recorded by corresponding author. Both are faculty members of Anatomy Department. Occurrence rate of ponticulus posticus on the groove for the vertebral artery on superior surface of posterior arch of atlas vertebrae were sought out and noted. Morphometric measurements like anteroposterior and vertical height of the groove for vertebral artery were measured with the help of Vernier caliper [Table/Fig-2 and 3]. Occurrence rate of similar lateral canal for the vertebral artery were also sought out and noted.

STATISTICAL ANALYSIS

Data entry and analysis was done by using Microsoft excel 2016. Data was represented as mean \pm SD. Z-test was applied to both the parameters.

RESULTS

Total 100 atlas vertebrae were examined to find incidence of ponticulus posticus on superior surface of posterior arch of atlas vertebrae. Incomplete ponticulus posticus were found in total 33 (33%) of vertebrae [Table/Fig-4] Out of these in 7 (7%) vertebrae, the incomplete ponticulus posticus was seen on right side only and in 3 (3%) vertebrae on left side only. In the remaining 23 (23%) vertebrae the incomplete ponticulus posticus was seen on both the sides. Complete ponticulus posticus were found in 4 (4%) vertebrae [Table/Fig-5]. Out of these, right side showed complete ponticulus posticus in 1 (1%) vertebrae only and left side showed complete ponticulus posticus in 3 (3%) vertebrae only.

Similar foramen for the vertebral artery on the lateral side was found in only 1 (1%) vertebra on right side.

	Right	Left	Both	Absent	Total
Occurance rate	7	3	23	67	100
Percentage (%)	7	3	23	67	100

[Table/Fig-4]: The occurrence rate of incomplete ponticulus posticus on the groove for the vertebral artery.

	Right	Left	Both	Absent	Total
Occurance	1	3	0	96	100
Percentage (%)	1	3	0	96	100

[Table/Fig-5]: The occurrence rate of complete ponticulus posticus on the groove for the vertebral artery.

Anteroposterior length of foramen was 11.5 ± 2.5 mm on right side and 11.2 ± 2.2 mm on left side Vertical height of foramen was 6.3 ± 1.2 mm on right side and 6.3 ± 1.1 mm on left side [Table/Fig-6]. Data entry and analysis was done using Microsoft excel 2016. Z-test was applied to both the parameters and observed difference between two mean is less than 1.96 times than standard error of difference. It is not significant at 5% level of significance.

	Depth (in mm)		Anteroposterior Length (in mm)	
	Right	Left	Right	Left
Mean	6.3 mm	6.3 mm	11.5 mm	11.2 mm
SD	± 1.2 mm	± 1.1 mm	± 2.5 mm	± 2.2 mm
Range	2.8 to 9.2 mm	3.2 to 9.0 mm	6.0 to 18.2 mm	7.4 to 17 mm
95% Confidence interval	7.5 mm-5.1 mm	7.4 mm-5.2 mm	14.0 mm-9.0 mm	13.4 mm-9.00 mm
SE	0.16		0.33	
z	1		0.63	

[Table/Fig-6]: Measurements of anteroposterior length and depth of ponticulus posticus.

DISCUSSION

The aim of the present study was to find out occurrence rate of ponticulus posticus and to take their morphometric measurements in dry atlas vertebrae of unknown age and

sex in Central Gujarat region. Variations of groove for the vertebral artery on the superior surface of posterior arch from incomplete to complete foramen are common. When present, this foramen may compress the vertebral artery and produce symptoms related vascular compromise like headache, syncope, altered consciousness etc., surgical management in such kind of patients if required, demands proper identification of pathology. So, neurosurgeons or orthopaedic surgeons who operate in this area should have a detailed knowledge of variations of groove for the vertebral artery. Occurrence rate of this foramen were studied by various authors whose comparison has been given in the [Table/Fig-7].

S. No	Authors	No. of Specimens	Partial		Complete	
			Total	%	Total	%
1	Gopal K et al., [2] 2013	300	28	9.33	24	8
2	Santhi B et al., [3] 2017	58	2	3.45	5	8.6
3	Patel NB et al., [4] 2015	50	6	12	4	8
4	Mohanti SR et al., [5] 2015	25	9	36	2	8
5	Rekha BS et al., [6] 2013	200	69	34.5	9	4.5
6	Krishnamurthy A et al., [7] 2007	1044	57	5.5	87	8.3
7	Present Study	100	33	33	4	4

[Table/Fig-7]: comparison of studies of occurrence rate of ponticulus posticus by various authors.

The present study shows the occurrence rate of incomplete ponticulus posticus in 33 (33%) of vertebrae which matches with the study of Mohanty SR et al., in 9 (36%) [5] and Rekha BS et al., in 69 (34.5%) [6] but was less than that of the studies done by Gopal K et al., in 28 (9.33%) [2], Santhi B et al., in 2 (3.45%) [3], Patel NB et al., in 6 (12%) [4] and Krishnamurthy A et al., in 57 (5.5%) [7]. Santhi B et al., had found projection from superior articular facet posteriorly in 31.03% may be responsible for less occurrence rate of incomplete ponticulus posticus 2 (3.45%) [3].

Occurrence rate of complete ponticulus posticus in this present study was 4 (4%), similar to study of Rekha BS et al., in 9 (4.5%) [6] but was less than the study of Gopal K et al., 24(8%) [2] Santhi B et al., in 5 (8.6%) [3], Patel NB et al., in 4 (8%) [4], Mohanty SR et al., in 2 (8%) [5] and Krishnamurthy A et al., 87 (8.3%) [7].

The present study has found lateral canal for the vertebral artery on right side of only 1 vertebra (1%). Similar lateral canal had been found by Gopal K et al., in 2 vertebrae (0.67%) [2],

Patel NB et al., in 1 vertebra (2%) [4] and Rekha BS et al., in 13 vertebrae (6.50%) [6]. The factors for the development of this ponticulus posticus is not defined clearly.

Hasan M et al., had described that the occurrence rate of posterior ponticuli in large number in compare to lateral ponticuli was may be because later lost early in the development. He also mentioned about the disappearance of the middle part of the posterior bridge which results into a partial bridging. The superior articular process of atlas of the head in man may be responsible for the disappearance of roof the tunnel [8]. Hasan M et al., had found a posterolateral periarticular bony tunnel on the superior surface of 4 of 350 atlas vertebrae and suggested that the presence of bony tunnel cannot be accounted for by any of the explanations so far proposed [8].

Paraskevas G et al., had found that incidence of canal for vertebral artery is more common in labourers then in non-labourers and suggested that carrying heavy objects may be the factor for the development of the canal for the vertebral artery [9].

Shaikh JV et al., observed only one ponticulus posticus (0.5%) in 200 examined atlas vertebrae in Western Maharashtra region and compared it with the studies of North India and Bihar and mentioned that this very low incidence in Western Maharashtra region, compared to North India is because of North Indians have to carry heavy loads for long distance then the people of Western Maharashtra [10].

Kumar S B et al., proposed that high incidence of posticulus ponticulus compared to vertebral artery compression syndrome indicates multiple factors for the development of the syndrome [11].

Anteroposterior length and vertical height of the ponticulus posticus were measured and compared. Anteroposterior length of present study (right=11.5 mm, left=11.2 mm) was greater than the study of Santhi B et al., (6.09 mm) [3] and Krishnamurthy A et al., (right=9.99 mm, left=7.16 mm-bilateral), (right=9.26 mm, left=8.14 mm-unilateral) [7]. Mean vertical height of the present study (right=6.3 mm, left=6.3 mm) was less than the study of Krishnamurthy A et al., (right 6.52 mm, left 6.57 mm-bilateral), (right=5.30 mm, left=4.91 mm, unilateral) [7] but greater than the study of Santhi B et al., (5.44 mm) [3]. Difference between the results of present study and the study of Krishnamurthy A et al., was may be because Krishnamurthy A et al., had taken measurements of only complete foramen [7] while in present study measurements were taken, both on incomplete and complete foramen. Knowledge of measurements is important in understanding the level of compression and for various surgeries done in this region.

LIMITATION

The limitations of present study are that study has been done on the dry bones of unknown age and sex in central Gujarat region. Large radiological, clinical and anatomical studies from other regions are required for better support.

CONCLUSION

Variations in the groove for the vertebral artery on the superior surface of posterior arch of atlas vertebrae in the form of incomplete or complete foramen are common. This anatomical knowledge is important for neurosurgeons, orthopedic surgeons, radiologists and clinicians while dealing with this region. The measurements can also be helpful while operating on posterior and superior aspect of posterior ring during various surgeries like internal fixation technique.

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