



Original Research Article

## Ponticuli in Human Atlas Vertebrae and Its Significance

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### ABSTRACT

**Background:** Atlas, the first cervical vertebra presents with bony spurs frequently from the anterior and posterior margins of the groove for the vertebral artery, which may convert the groove into a foramen known as foramen arcuale. It is otherwise called ponticuli.

**Objectives:** To study the presence of Ponticuli in the atlas vertebra.

**Materials & Methods:** A total of 100 dry and macerated human atlas vertebrae of unknown sex were collected from Department of Anatomy, BMCRI, Bangalore. Observations were made on the presence of complete or incomplete ponticuli.

**Results:** Presence of ponticuli was noted in 12%. It was more commonly found incomplete and unilateral.

**Conclusion:** Foramen arcuale may compress third segment of vertebral artery and cause vertebrobasilar insufficiency which may produce headache, cerebrovascular accidents etc. Knowledge of this study may be helpful for radiologists, orthopedicians and neurosurgeons.

**Key Words:** Atlas, Ponticuli, Foramen arcuale, Retroarticular ring, Vertebra

### INTRODUCTION

The first cervical vertebra is an atypical vertebra known as Atlas. It is named after 'ATLAS' who, according to Greek Mythology supported the Earth on his shoulders. <sup>[1]</sup> Unlike other cervical vertebrae the atlas vertebra is ring shaped, does not have body and spine. It holds the globe of head. There are two lateral masses in the atlas vertebra connected by an anterior and posterior arch. The posterior arch of the atlas forms about three fifth of the atlantal ring. The superior surface of the posterior arch presents a wide groove immediately behind the lateral mass for third part of vertebral artery, dorsal ramus of first cervical nerve and venous plexus. <sup>[2]</sup>

Posterior atlantooccipital membrane is attached to the upper border of the posterior arch of atlas. The vertebral artery and first cervical nerve passes through the deficient membrane at each lateral extremity. Sometimes the lateral margin of the membrane ossifies, converting the groove into a bony canal. The retroarticular canal or retro-articular vertebral artery ring is the conversion of neurovascular groove into a bony ring or a bony canal, which occurs rarely. It can predispose the occurrence of vertebrobasilar insufficiency. The third part of vertebral artery emerges from foramen transversarium of the atlas, runs backwards and medially behind the lateral mass of the atlas, and lies in this

groove on posterior arch of the atlas. It then passes through the gap in anterior part of posterior atlanto-occipital membrane and enters the foramen magnum. [3,4]

Kimmerle anomaly, ponticulus posterior (ponticulus posticus) of the atlas, pons posticus, foramen atlantoideum posterius/vertebrale, canalis arteriae vertebralis, foramen sagitale, retroarticular VA ring, foramen retroarticular superior, retrocondylar bony foramen, posterior atlantoid foramen, atlas bridging, posterior glenoid process and spiculum are the other names given for this foramen. [5]

**Objectives:**

1. To study the incidence of ponticuli in the human atlas vertebra
2. To find the presence of complete or incomplete ponticuli
3. To study if the ponticuli are unilateral or bilateral
4. To determine if the ponticuli are on the right or left side of the human atlas vertebra

**MATERIALS AND METHODS**

Hundred dry and macerated human atlas vertebrae of unknown sex and age with no obvious pathology were collected from Department of Anatomy, Bangalore medical college and research institute, Bangalore. These vertebrae were examined for the presence of bony spiculum from the posterior margin of superior articular facet. The vertebrae with such bony spurs were classified as having either a partial or a complete, unilateral or bilateral foramen arcuale. Observations were recorded on the

presence of ponticuli, to classify its type and to determine its side and photographed.

**RESULTS**

In the present study one hundred human atlas vertebrae were examined, out of which 12 (12%) atlases showed the presence of bony spur / ponticuli. Foramen arcuale was found to be incomplete in 8 (8%) and was complete ring in 4 (4%) specimens. It was mostly unilateral in 10% and bilateral in 2%. Out of 12 ponticuli, 4 were noticed on right side, 6 on left side and 2 found on both the sides. In case of 8 incomplete retroarticular ring 2 occurred on right side, 5 on left side, 1 on both the sides. Likewise in 4 complete retroarticular ring, 2 recorded on right side, one on left side and 1 on both the sides. Results and comparison are tabulated below. (Figure 1-4, Table 1-7)

**Table no: 1 Incidence of Ponticuli**

Total no	Presence %
100	12

**Table no: 2 Percentages of Complete/Incomplete Foramen arcuale**

Total no	Incomplete %	Complete %
12	8	4

**Table no: 3 Percentages of Unilateral /Bilateral Ponticuli**

Total no	Unilateral %	Bilateral %
12	10	2

**Table no: 4 Percentages of Right /Left side of the Ponticuli**

Total no	Right	Left	Bilateral
12	4	6	2

**Table no: 5 Percentages of Incomplete/ partial ring**

Total no	Right	Left	Bilateral
8	2	5	1

**Table no: 6 Percentages of Complete ring**

Total no	Right	Left	bilateral
4	2	1	1

**Table no: 7 Comparison of results of present study with previous studies<sup>7,11,12,13</sup>**

Study	Material	Incomplete%	Complete %	Unilateral/ bilateral	R/L
Lamberty et al, 1973	Osteological	21.66	15	-	-
Hasan et al, 2001	Osteological	6.57 & 2	3.4	-	-
Krishnamurthy et al 2007	Osteological	5.5	8.33	Unilateral	L
Dahiphale et al, 2009	Osteological	18	2	-	-
Schilling et al, 2010 [13]	Radiographic	10.1	9.2	-	-
Present study 2012	Osteological	8	4	Unilateral	L

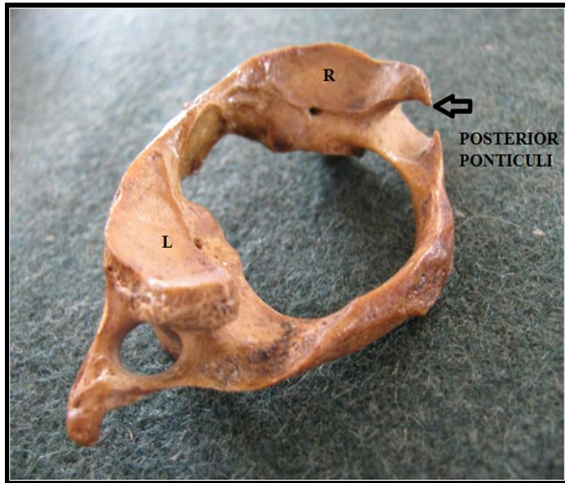


Figure 1: Posterior ponticuli on right side

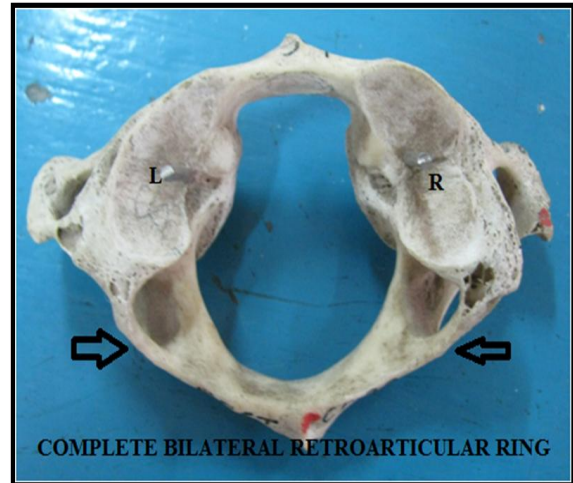


Figure 4: Atlas with complete bilateral Retroarticular ring

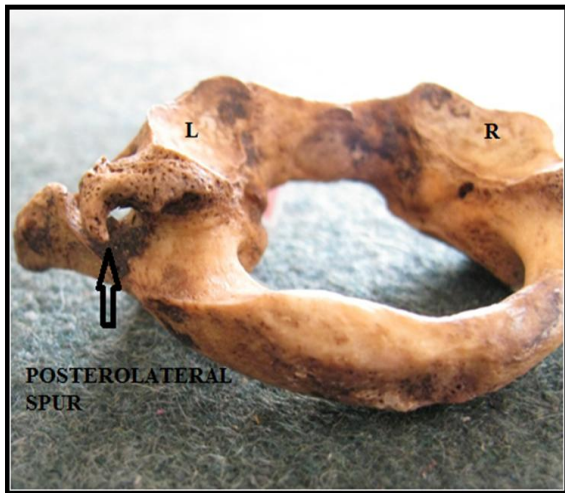


Figure 2: Posterolateral ponticuli on left side



Figure 3: Complete Retroarticular ring on right side

## DISCUSSION

In the atlas vertebra, retroarticular canal and the lateral bridge are formed by osseous outgrowth or exostosis which may cause compression on the vertebral artery as it passes in the vertebral artery groove in the posterior arch of atlas. It traverses from the foramen transversarium of the vertebra to the foramen magnum of the skull. [6]

### Mechanism of bony formation

Various suggestions are given related to the mechanism behind the formation of bony spur or bony canal. It is still not clear it might have congenital or genetic basis.

Few suggest that it is a simple ossification of a ligament or membrane due to ageing. Ligament usually gets ossified is oblique ligament of atlas or the posterior atlanto occipital membrane. Ossification would be due external mechanical factors such as carrying heavy loads or induced by pulsation of vertebral artery. Increased incidence of ponticles on left side may be due to unequal weight bearing in left tilted head posture. But, others believe that in humans it could be a regressive and disappearing morphological phenomenon since it presents in very young age when ossification of ligament is unlikely. Ponticles may be remnants of the proatlas, the so-called occipital vertebra. [5,7,8]

In a cadaveric study by Tubbs (2007) foramen arcuale was found in 5 % cases. [5] According to Mitchell (1998), the incidences of the complete and incomplete lateral bridge of the atlas were 12.24% and 87.76%. [6]

Hasan et al (2001) stated the prevalence of posterolateral ponticuli as 2% and posterior ponticulus as 6.57%.

They also classified the arcuate foramen into six groups.

Class I: Impression for the vertebral artery - noticeable,

Class II: Impression - distinct groove or sulcus,

Class III: Partial posterior ponticulus - bony spicule,

Class IV: Complete posterior ponticulus

Class V: Lateral bridge extended from the lateral mass to the transverse process,

Class VI: Posterolateral tunnel made its appearance as a combination of complete posterior (class IV) and lateral (class V) bridges. [7]

Malukar et al (2011) observed, out of 80 specimens 14 atlas vertebrae (17.5%) had retro articular groove or ring on one or either sides, mostly on left side as in the present study. [9]

Manjunath (2001) studied 60 South Indian atlases and found a complete bony ring in 6 cases unilaterally, 1 case bilaterally and incomplete ring in 4 cases. [10]

Krishnamoorthy et al (2007) stated, out of 1044, 144 (13.8%) showed bony exostosis. Partial bony outgrowth/incomplete ring were found in 57 (5.5%) vertebrae, and 87 (8.33%) vertebrae had a complete arcuate foramen. Bilateral complete foramen was present in 12 (1.14%) of these samples and in the remaining 75 vertebrae (7.18%), the occurrence was on unilateral side. Twenty-seven (2.58%) vertebrae showed complete arcuate foramen on the right side while 48 (4.59%) vertebrae showed it unilaterally on the left. [11] Dahiphale et al (2009) observed

2 % of complete ring and 18 % incomplete ring. [12]

Foramen arcuate is a significant clinical and surgical significant anatomical variant of the atlas because foramen arcuate or ponticulus posticus is associated with Barre-Lieou syndrome, which presents with symptoms of headache, retro-orbital pain, vasomotor disturbance of the face and recurrent disturbances of vision, swallowing and phonation due to alteration of blood flow within the vertebra. [9]

## CONCLUSION

The presence of ponticuli in atlas vertebrae was found in 12%. It was incomplete ring in 8% of cases. It was commonly unilateral and left sided predilection was recorded. Presence of such osseous bridge or ring might cause cervical pain and even cerebrovascular disorders due to pressure on third part of vertebral artery present in the vertebral artery groove. Anatomical variations in the cranio vertebral junction should be considered in surgical procedures in this region.

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