RESEARCH ARTICLE

# A STUDY OF FORMATION OF ABNORMAL FORAMINA AND CANAL ON POSTERIOR ARCH OF ATLAS VERTEBRAE

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**ABSTRACT**
**Background:** Atlas vertebra is the first and atypical cervical vertebra. It has anterior and posterior arches and is devoid of body. The posterior arch has a neurovascular groove on the lateral part of superior surface. This groove is sometimes converted into a ring or canal. Atlas vertebra has high degree of variation in morphology. Its knowledge is essential for orthopedic surgeons, neurosurgeons, radiologists, and anthropologists.
**Aims and Objectives**: To study the formation of abnormal foramina and canal on posterior arch of atlas vertebrae.
**Materials and Methods:** The present study was carried out in Shyam Shah Medical College and SGM Hospital, Rewa, Madhya Pradesh, India. During routine demonstration classes in the Department of Anatomy, we found atlas vertebrae with unilateral complete retroarticular ring. There are collections of 34 atlas vertebrae. These vertebrae were examined for evidence of exoostosis from the posterior margin of superior articular facet.
**Results:** On the basis of observations, we found that the formation of retroarticular ring and canal occurs in six stages.
**Conclusion:** Retroarticular groove may convert into ring and canal, knowledge of it is beneficial for neurosurgeons and orthopedicians in the treatment of vertebrobasilar insufficiency. It is also beneficial for an anthropologist in correlating the morphological changes from primate to human species.
**Key Words:** Atlas Vertebra; Retroarticular Ring; Retroarticular Canal

## Introduction

According to Greek mythology, the Earth is supported on shoulders of Atlas. As we know that Atlas vertebra is the first cervical vertebra and it supports the globe of the head, which is why it is named after Atlas. This vertebra is devoid of body. It has two arches, anterior and posterior. The anterior arch is shorter than the posterior arch. Posterior arch has a groove on its lateral part of superior surface. The third part of vertebral artery with dorsal ramus of first cervical nerve passes through this groove. It has two transverse processes, each of which bears single foramen transversarium. The atlas vertebra has two lateral masses, which articulate superiorly with occipital condyles to form atlanto-occipital joints. According to RJ Last, the lateral part of atlanto-occipital membrane sometimes ossifies, converting the neurovascular groove into a canal.[1] According to *Gray's Anatomy*, the retroarticular ring is formed by spurs or ponticles arising from posterior surface of lateral mass and superior surface of posterior arch of atlas vertebra.[2]

## Materials and Methods

During routine demonstration classes in the Department of Anatomy, SS Medical College, Rewa, MP, India, we found atlas vertebrae with unilateral complete retroarticular ring. There are collections of 34 atlas vertebrae. These vertebrae were examined for evidence of exoostosis from the posterior margin of superior articular facet and for formation of retroarticular ring and canal.

## Results

We have seen following observations in atlas vertebrae. On the basis of the observations, we categorized the vertebrae in following six groups:
**Group 1:** Vertebrae showing shallow ill-defined groove on superior surface of lateral part of posterior arch [Figure 1].
**Group 2:** Vertebrae showing a deep well-defined groove [Figure 2].

**Figure-1: Vertebrae showing shallow ill-defined groove on superior surface of lateral part of posterior arch**

Figure-2: Vertebrae showing a deep well-defined groove

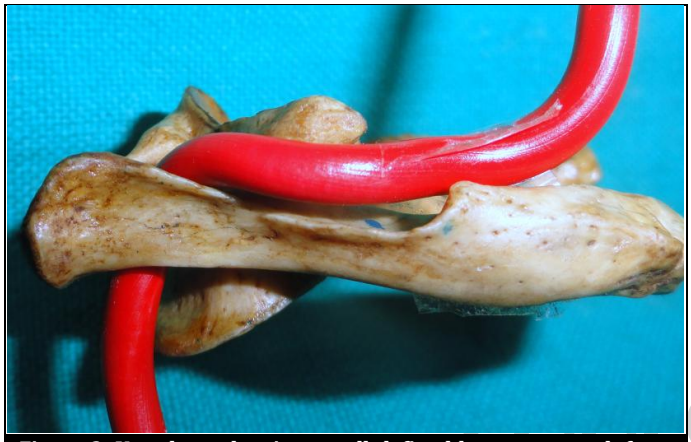

Figure-3: Vertebrae showing a well-defined bony outgrowth from the posterior margin of lateral mass

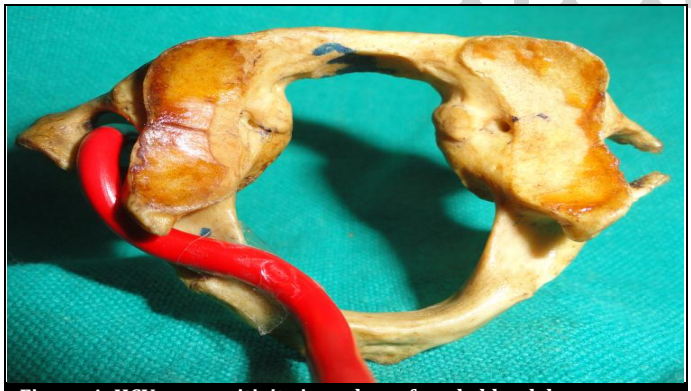

Figure-4: HCV seropositivity in male vs. female blood donors

Figure-5: Vertebrae showing the above-described bony outgrowth fuses with bony spicule

Figure-6: Vertebrae showing a well-defined posterior bridge and a bony ridge appearing from the posterior border of transverse process

Figure-7: Vertebrae showing appearance of a posterolateral tunnel due to fusion of posterior and lateral bridge

**Group 3:** Vertebrae showing a small bony outgrowth that arises from the posterior margin of lateral mass [Figure 3].

**Group 4:** Vertebrae showing a well-defined bony outgrowth from the posterior margin of lateral mass and another small spicule situated on the posterior arch [Figure 4].

**Group 5:** Vertebrae showing the above-described bony outgrowth fuses with bony spicule, thus a posterior bridge appears, joining the posterior margin of lateral mass and the posterior arch [Figure 5].

**Group 6:** Vertebrae showing a well-defined posterior bridge and a bony ridge appearing from the posterior border of transverse process, which is lateral bridge [Figure 6].

**Group 7:** Vertebrae showing appearance of a posterolateral tunnel due to fusion of posterior and lateral bridge. We have observed that this fusion is not complete. A large gap persists in between the lateral and posterior bridge [Figure 7].

## Discussion

Vertebral artery emerges from foramen transversarium. It passes on the superior surface lateral part of posterior arch. It is accompanied by dorsal ramus of first cervical

nerve. This passage varies in morphology from shallow groove to complete canal. In this study, we have categorized the vertebrae on the basis of morphology of this passage. Above description shows the various stages of development of retroarticular ring and canal.

Mitchell[3] categorized retroarticular ring into three classes:
Class I: Retroarticular groove
Class II: Incomplete ring with its middle part missing
Class III: Complete retroarticular ring to retroarticular canal

Miki *et al*.[4] radiographically classified the ponticulus posticus (bony outgrowth) into three types:

I. Full type: It forms a complete bony ring.
II. Incomplete type: Some portions of the bony ring are defective.
III. Calcified type: There is a linear or amorphous calcification.

Krishnamurthy *et al*.[5] observed 1044 complete/undamaged dry human atlas vertebrae of unknown sex and age. These vertebrae were examined for evidence of exoostosis from the posterior margin of superior articular facet. The specimens showing such bony outgrowths were classified as having either a partial or a complete left and/or right arcuate foramen.

Hasan *et al*. [6] have classified the arcuate foramen into following six groups:
Class I: Impression or the vertebral artery is noticeable.
Class II: Impression is seen as a distinct groove or sulcus.
Class III: Partial posterior ponticulus is noted as a bony spicule.
Class IV: Complete posterior ponticulus could be detected.
Class V: Lateral bridge extends from the lateral mass to the transverse process.
Class VI: Posterolateral tunnel appears as a combination of complete posterior (class IV) and lateral class (V) bridges.

According to Hasan *et al*.,[6] in human species the ring is regressing and morphological features are disappearing.
We have observed all type of vertebrae described above. We conclude that these vertebrae show various stages of development of retroarticular canal from shallow groove.

The retroarticular ring is protective for neurovascular bundle. De Double (1912) described that bony ring is normal and permanent feature of atlas vertebrae in vertebrate including primates. Paraskevas *et al*.[7] described the possibility of calcification of the bony bridge progresses over time from incomplete bony arch to complete ossification.

Schilling *et al*.[8] suggested that the presence of the ponticulus posticus (bony outgrowth) is independent from age and should not be considered as calcification or an ossification of lateral segment of the posterior atlanto-occipital ligament, rather an ossification with functional significance. It develops in primates to protect the passage of vertebral artery by its sinuosity, where it is susceptible to damage or compression as a result of craniocervical dynamics.

## Conclusion

The knowledge of retroarticular ring is essential for surgeons, especially neurosurgeons and orthopedicians in treatment of vertebrobasilar insufficiency due to compression of vertebral artery in bony ring. This study is also beneficial for anthropologist to correlate the morphological changes observed in vertebrate, especially from primate to human species.



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