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Case Report

Anatomy Section

Bilateral Arcuate Foramen in a Human Atlas Vertebra - A Case Report

MONIKA LALIT PIPLANI, RAJAN KUMAR SINGLA, KULLAR J.S.

ABSTRACT

The arcuate foramen or retroarticular vertebral artery ring is formed by the bony bridges over groove for vertebral artery on the posterior arch of atlas vertebrae. It is formed by ossification of the oblique ligament of atlas; i.e., the fibrous tissue present at the lower border of posterior atlanto-occipital membrane. A complete ring is reported to be seen in 2% to 14% of the subjects. However, a bilateral complete ring is extremely rare seen only in 1.1% of subjects. We are reporting here one such case where a retroarticular vertebral artery ring was present on both the sides of the same atlas. On the right side its anteroposterior (length) diameter was 6.4 mm and superoinferior diameter (height) was 5.3 mm respectively. The corresponding figures on the left side were 6.2mm & 4.9 mm. A knowledge of such vertebral rings is useful not only for neurophysicians and neurosurgeons but also for radiologists and medical practitioners in general. Its clinical and surgical implications are discussed in detail and a flood of light has been thrown on different theories of its development whether ontogenically, phylogenically or environmentally.

Key Words: Superior articular facet, Vertebral artery, Retroarticular canal, Ponticuli, Arcuate foramen, Posterior arch, Atlas

INTRODUCTION

The posterior arch of the human atlas at its junction with the lateral masses on each side is hollowed out above to form a smooth groove known as sulcus arteriae vertebralis which transmits the vertebral artery and suboccipital nerve (first spinal nerve). The vertebral artery, as it passes through the foramina transversarium of axis vertebra, emerges on lateral side of lateral mass of atlas vertebra, turns posteriorly and medially on this deep groove and finally turns upwards to enter the foramen magnum. This groove is sometimes bridged by oblique ligament of atlas; a fibrous tissue present at the lower border of posterior atlanto-occipital membrane that can ossify completely or incompletely and is converted into a foramen called as arcuate foramen [1]. Alternatively, it has been named as Kimmerle anomaly/ variant/ deformity, ponticulus posterior/ posticus, pons ponticus, foramen atlantoideum posterius/ vertebrale, canalis arteriae vertebralis, foramen sagitale, retroarticular vertebral artery ring, foramen retroarticular superior, retrocondylar bony foramen, posterior atlantoid foramen, atlas bridging, posterior glenoid process and spiculum [2].

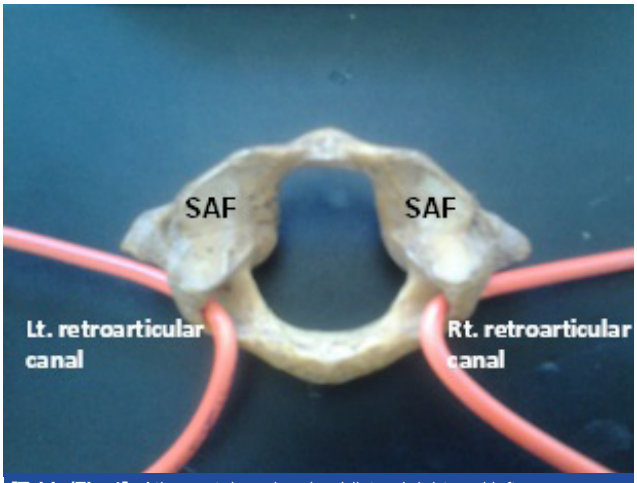
Its importance lies in the fact that, it may cause external pressure on the vertebral artery as the latter passes through it to the foramen magnum [3]. This pressure further increases during extreme rotatory movements carried out during therapeutic manipulations of the cervical spine [4] and results in a compromised blood flow to the brain [5].

It has been reported by different authors to be present in 1.5%-25% of the population depending upon age, sex, race, geographical variations and most important being its completeness and incompleteness. However, all the authors are silent about a complete foramen on both the sides of same atlas vertebra except Krishnamurthy et al., who found it in 1.1% of their specimens.

One such specimen with a bilateral complete arcuate foramen of atlas vertebra was found in the collection of bones in the Department of Anatomy, Government Medical college, Amritsar which is being reported here.

CASE REPORT

The specimen being reported here was of unknown age and sex & was obtained from the Department of Anatomy, Government Medical College, Amritsar, India. It depicted complete arcuate foramina on both the sides [Table/Fig-1]. The ventrodorsal diameter (length) of the foramen was 6.2 mm on left side and 6.4 mm on right side while the rostrocaudal diameter (height) was 4.9 mm on left side and 5.3 mm on right side. The minimum width of the bony bridge converting the groove for vertebral artery into the foramen was 1.9mm on left side and 2.7mm on right side.



[Table/Fig-1]: Atlas vertebra showing bilateral right and left retroarticular canal

DISCUSSION

The ossification of ligamentous structures in different parts of the body may result in clinical problems such as compression of neighbouring structures and complications in regional surgeries. The same is true for this foramen. Ist reported by Macalister [6] it has drawn the attention of many anatomists since then. They have differently classified it as follows:

1. Lamberty and Zivanovic [4] simply classified the retroarticular canal into complete variety found in 15% and incomplete canal found in 21.66%, the rest of the vertebrae having no tendency to canal or foramen formation.
2. Similarly Taitz & Nathan [7] found partial bridge in 25.8%, complete bridge in 7.8% and no bridge in 66.3% of their specimens.
3. Depending upon the formation of arcuate foramen Mitchell [5] classified the vertebrae into class I,II,III whereby class I had no foramen (63.3%), class II had retroarticular sulcus with bony lipping or exostosis of posterior arch (26.9%) and class III represented a complete bony ring enclosing the vertebral artery (9.8%)
4. There was Hasan et al., [8] who worked extensively on the subject and classified posterior as well as lateral foramina in 6 classes:

Class 1: Where an impression for the vertebral artery was noticeable on the posterior arch.

Class 2: Where the impression for the artery was deeper than the former class.

Class 3: Where a partial posterior ponticulus was noted as a bony spicule extending from the superior articular facet overhanging the dorsal arch.

Class 4: Where a complete posterior ponticulus could be detected.

Class 5: Where a lateral bridge extended from the lateral mass to the transverse process.

Class 6: Where a relatively more extensive posterolateral tunnel made its appearance as a combination of complete posterior and lateral bridges.

However none of the above cited authors have commented upon a bilateral presentation of arcuate foramina in their classification as was found in the case being reported. If we consider it separately on the two sides it fits into class III of Mitchell, class IV of Hasan et al., on both the sides. The rarity of this presentation is evident from the fact that Krishnamurthy et al., [2] could find it only in 12 vertebrae out of 1044 i.e., only in 1.14%.

The incidence of a complete ring as reported by earlier authors from time to time is depicted in [Table/Fig-2].

Sr. No.	Authors	Year	Incidence
1.	Lamberty & Zivanovic [4]	1973	15%
2.	Taitz & Nathan [7]	1986	7.8%
3.	Le Minor [9]	1997	18.3%
4.	Mitchell [5]	1998	9.8%
5.	Hasan et al., [8]	2001	3.42%
6.	Manjunath [10]	2001	11.7%
7.	Krishnamurthy et al., [2]	2007	Rt.- 2.5% Lt.- 4.59% B/L- 1.14%
8.	Simsek [11]	2008	3.8%
9.	Dahiphale & Bahotee [12]	2009	2%
10.	Zambare & Reddy [13]	2011	4%

[Table/Fig-2]: Showing incidence of complete arcuate foramen of human atlas vertebra

DEVELOPMENT OF RETROARTICULAR FORAMEN

Whether incomplete or complete many theories have been put forward by different workers for origin of the bridges leading to foramen formation.

- According to Allen [14], Cleland [15], VonTorklus & Gele [16] it is simply a Congenital characteristic.
- Le Double [17] attributed the formation of this ring to the ossification of ligament
- Barge [18] postulated an activation of existing osteogenic potency in the region of craniovertebral junction.
- Selby et al., [19] believed it to be a genetic trait.
- Pyo & Lowman [20] and Breathnach [21] opined it to be a result of ageing.
- Breathnach [21] associated this bridging with ossification of oblique ligament of atlas which could be induced by the pulsation of the vertebral artery.

- Taitz & Nathan [7] blamed external mechanical factors like custom of carrying heavy weights or objects on head for development of bridging on atlas. It was further supported by Paraskevas and Papaziogass [22] who found a higher incidence of complete canal in labourers as compared with non labourers.
- Stubbs [23] encountered a complete foramen more in males and partial foramen in females however on the contrary, Cakmak et al., [24] found a higher incidence of complete foramen in females.
- Mitchell [5] found it more in blacks as compared with whites.
- Paraskevas et al., [22] found a higher incidence of incomplete foramen in 5-44 years of age.

PHYLOGENY

Yamamoto & Kunimatsu [25] mentioned a complete bony ridge to be a normal structure of adult Japanese macaques. Earlier a bony ring in atlas vertebra was described to be a permanent and normal morphological feature in vertebrates including primates which in humans is said to be a regressive and disappearing phenomenon.

CLINICAL IMPORTANCE

A knowledge of arcuate foramen is useful not only for neurophysicians and neurosurgeons but also for radiologists and medical community in general. They should look for it when dealing with patients complaining of symptoms of vertebro-basilar insufficiency like headache, vertigo, shoulder and arm pain [2]. Many cases have been reported where surgical removal of bony bridges allieviated these symptoms [7].

Cushing et al., [26] found an association between the arcuate foramen and tethering of vertebral artery in it leading to its dissection from repetitive trauma with movement of neck. Tubs et al., [3] emphasised that bony bridge forming arcuate foramen may cause external pressure on the vertebral artery as the latter passes through it to the foramen magnum. Cakmak et al., [24] asserted that cervical spine radiography is a simple and useful technique to know the presence of arcuate foramen and should be considered if a patient comes with symptoms like pain in temporal region, pain in back of eye, vertigo, occipital headache, periodic photophobia, paraesthesia of hands or sensation of pressure on hands.

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AUTHOR(S):

1. Dr. Monika Lalit Piplani
2. Dr. Rajan Kumar Singla
3. Dr. Kullar J.S.

PARTICULARS OF CONTRIBUTORS:

1. Assistant Professor, Department of Anatomy, Sri Guru Ram Das Institute of Medical Sciences and Research, Amritsar, Punjab, India.
2. Additional Professor, Department of Anatomy, Government Medical College, Amritsar, Punjab, India.
3. Associate Professor, Department of Anatomy, Government Medical College, Amritsar, Punjab, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Monika Lalit Piplani,
Assistant Professor, Department of Anatomy,
SGRDIMSR, Amritsar, Punjab, India.
Phone: 09814325454
E-mail: monika.lalit@yahoo.com

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