



Arcuate foramen of human atlas vertebra – an osteological study of incidence in Jharkhand population and its clinical significance

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ABSTRACT

Aim: To find the incidence and clinical correlation of arcuate foramen and ponticuli in posterior arch of atlas vertebrae.

Objective: To understand the existence of abnormal foramen in posterior arch of atlas vertebrae as an anatomic entity for the knowledge of neurosurgeons and radiologists.

Material and Method: 48 dried human atlas vertebrae of unknown age and sex were taken for the study from the Department of Anatomy, RIMS, Ranchi.

Results: We found the incidence of arcuate foramen in 10.41% of vertebrae with formation of a complete foramen in 4.16% of cases and a spicule of bone in the posterior margin of superior articular facet, leading to the formation of incomplete foramen in 6.25% of cases. Also, the presence of complete foramen was found only on the left side.

Conclusion: This study is of importance to the neurologists, neurosurgeons and radiologists for their clinical implication as to compression of the third part of vertebral artery during its course through the groove in posterior arch of atlas vertebrae.

KEYWORDS : Arcuate foramen, human atlas vertebra, vertebral artery

INTRODUCTION:

The human atlas vertebra consists of two bulky lateral masses, connected in front by a short anterior arch and posteriorly by a longer curved posterior arch. The upper surface of the posterior arch shows a wide groove (sulcus arteriae vertebralis) behind each lateral mass where the third part of the vertebral artery winds. Bony spurs, which may arise from the anterior and posterior margins of the groove for the vertebral artery, are referred to as ponticles and they occasionally convert the groove into a foramen [1]. Gray's anatomy states that the sulcus is converted into a foramen called arcuate foramen in about 14% of the individuals [3].

The groove for vertebral artery may vary in size and depth, from being just an impression, to a clear well defined groove, to the groove being bridged by anomalous ossification, to a notch in posterior margin with projecting ponticulus. Several terms have been coined by different authors for the foramen formed due to anomalous ossification of the groove for vertebral artery. Some of the names that have been used are "Kimmerle's variant" (Kimmerle, 1930), "foramen retroarticulare superior" (Brocher, 1955), "canalis vertebralis" (Wolff-Heidegger, 1961), "retroarticular vertebral artery ring" (Lamberty and Zivanovic, 1973), "retroarticular canal" (Mitchell, 1998a) and "retrocondylar vertebral artery ring" (Mitchell, 1998b). Authors have reported the occurrence of arcuate foramen in 9.8% - 25.9% of the population. The clinical significance lies in the external pressure the bony foramen will create in the course of the third part of the vertebral artery.

MATERIAL AND METHODS:

48 dried human atlas vertebrae of unknown age and sex were obtained from the department of Anatomy, RIMS, Ranchi. These vertebrae were examined for evidence of bony spicule arising from the posterior margin of superior articular facet. They were further examined to see if the bony spicule arched backwards to form a complete foramen or a partial foramen; also, their presence unilaterally or bilaterally.

RESULTS:

In our study, we found 2 vertebrae (4.16%) with a complete arcuate foramen unilaterally and 3 vertebrae (6.25%) with posterior ponticuli leading to the formation of an incomplete foramen. The complete arcuate foramen was found only on the left side.

TABLE 1: Table showing number of vertebrae and percentage of incidence of arcuate foramen

No. of vertebrae studied	No. of vertebrae with complete arcuate foramen	No. of vertebrae with incomplete foramen	Percentage of incidence
48	2 (4.16%)	3 (6.25%)	10.41%



FIGURE 1: Atlas vertebra showing arcuate foramen on left side and a posterior bony spur on right side forming an incomplete foramen (superior view)



FIGURE 2: Atlas vertebra (lateral view) showing arcuate foramen on left side and an incomplete foramen transversarium



FIGURE 3: Atlas vertebra showing bony spur arising from posterior margin of superior articular facet on right side (superior view)

DISCUSSION:

Several authors have studied this foramen and found its occurrence in 9.8-25.9% of the population [5-7]. Taitz and Nathan found the presence of partial posterior bridging of atlas in 25.9% and complete bridging in 7.9% of the population [8]. They proposed a hypothesis that external mechanical factors such as carrying heavy loads on the head, could play a role in the development of these bridges. It has been proposed that the posterior atlantooccipital membrane may be partly or wholly ossified to form a bony bridge over the vertebral sulcus thereby converting it into a foramen called arcuate foramen. Gray's Anatomy states that quite frequently (about 37% of 66 macerated specimens) the groove is wholly or partly converted into a foramen by a spicule of bone arching backwards from the upper surface of the lateral mass (Lamberty and Zivanovic, 1973) [1]. Mahdi Hasan et al reported an incidence of 3.42% of complete foramen and 3.14% of a partial posterior ponticulus [9]. They mentioned the occurrence of posterolateral tunnels to be a normal feature in monkeys and other quadrupeds where the bony roof of the tunnel served for additional lateral extension for the attachment of posterior atlantooccipital membrane because the load of their head is supported by the extensor muscles of the neck, ligaments and posterior atlantooccipital membrane. The roof of the tunnel has disappeared in man because the weight of the head is borne by the superior articular facets. Krishnamurthy et al reported 13.8% of vertebrae showing the presence of a bony exostosis from the posterior margin of superior articular facet out of which incomplete arcuate foramen was found in 5.5% vertebrae and complete arcuate foramen was found in 8.33% of vertebrae [10]. In our study in Jharkhand population, we found the incidence to be 10.41% out of which 4.16% had complete arcuate foramen unilaterally and 6.25% had incomplete arcuate foramen. We found the complete arcuate foramen to be present only on the left side which corroborated with the findings of earlier authors. Dhall et al, who observed an increased incidence of bridges on the left, hypothesised that the asymmetry in the occurrence of bridges may be due to unequal weight bearing as a result of more commonly left-tilted head posture [11].

CONCLUSION:

The presence of arcuate foramen is a clinically significant anatomical entity because it may lead to vascular insufficiency in the course of the third part of the vertebral artery as it passes from the foramen transversarium of atlas vertebra to the foramen magnum. Such a severe arterial compression can occur during rotatory upper cervical manipulation in chiropractic treatment, leading to dangerous consequences. Knowledge of this variation is important for radiologists, neurologists and neurosurgeons while dealing with patients complaining of symptoms of vertebrobasilar insufficiency like headache, vertigo, shoulder pain and arm pain.

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