

Arcuate Foramen: An Anatomical Variation in the Atlas Vertebrae

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ABSTRACT

Background: Arcuate foramen is a variation in the posterior arch of atlas vertebrae. It is commonly called as Kimmerle's anomaly, also known as Ponticulus Posticus. It is the product of the complete or incomplete ossification of the posterior atlantooccipital membrane over the vertebral artery groove resulting in the formation of arcuate foramen containing the vertebral artery and the posterior branch of the first cervical spinal nerve.

Aims: The aim of the present study was to identify the percentage of incidence of arcuate foramen in the atlas and its clinical important.

Materials and Methods: The study was conducted in the Department of Anatomy, Katihar Medical College, Katihar, India with 32 adult dried atlas vertebrae.

Results: We found four (12.5%) atlas with arcuate foramen. One atlas having complete arcuate foramen and three having partial complete arcuate foramen.

Conclusion: Awareness of this type of variation is very important for neurosurgeons and radiologist during their clinical practice. The presence of the arcuate foramen would also complicate screw placement during surgery. Clinical prescreening for signs of vertebrobasilar insufficiency is important for chiropractic and manual therapies.

KEYWORDS: Atlas, Variation, Arcuate foramen, Vertebral artery, Atlantooccipital membrane.

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INTRODUCTION

Atlas is the first cervical vertebra which is ring shaped without body and spine. It has small anterior arch and long posterior arch, right and left lateral masses and transverse processes.

The anterior arch presents median anterior tubercle in front for attachment of anterior longitudinal ligament and posteriorly a median facet for articulation with dens of

the axis. Upper margin of anterior arch is connected foramen magnum by anterior atlantooccipital membrane and lower margin with body of axis by atlantoaxial membrane. The anterior arch represents morphologically the ossified hypochordal bow [1]. The upper surface of the posterior arch behind the lateral mass is marked by a groove which lodges the vertebral artery and the 1st cervical nerve. Rest of the upper border of posterior arch is

connected with foramen magnum by posterior atlantooccipital membrane. The lower border of posterior arch is connected with lamina of axis vertebra by ligamenta flava. Upper and lower surface of lateral masses bears superior and inferior articular facets respectively. The transverse processes projects laterally from the lateral masses and consist of foramen transversarium which transmit vertebral artery surrounded by a plexus of sympathetic nerves and vertebral veins [2].

Arcuate foramen also known as ponticulus posticus (latin for "little bridge") or Kimmerle's anomaly. It is a bony bridge on the posterior arch of atlas vertebra that covers the groove for the vertebral artery. This variation is formed due to ossification of the posterior atlantooccipital membrane and it is more common in females than males [3].

The arcuate foramen may be complete or incomplete [4].(Last, 1966). This foramen firstly demonstrated by Kimmerle in the year 1930 in children as young as 2 years. Presence of arcuate foramen may lead to pain in neck or shoulder, diplopia, vertigo, migration and stroke [5,6]. It is thought that arcuate foramen causes Barre Lieou syndrome, which also includes vertebrobasilar insufficiency (VBI) findings, by compressing the structures within arcuate foramen, therefore foramen decompression is performed in its treatment [7,8]. Presence of arcuate foramen in various countries giving an incidence from 8 to 24% by various authors [9]. Limited data were available about these variations therefore, the necessity of this study arose. The main objective of the present study is to investigate the incidence of arcuate foramen in the atlas vertebrae and to discuss its clinical importance.

MATERIALS AND METHODS

The present study carried out on 32 dried fully ossified adult human atlas which were obtained from the Department of Anatomy, Katihar Medical College, Katihar, India. The vertebrae with absence of foramen transversarium, incomplete foramen transversarium, hemi-vertebrae, fused vertebrae, ossified atlantooccipital joints, broken or fractured vertebrae were excluded from this

study. The atlas vertebrae having arcuate foramen were macroscopically observed and classified according to Mitchell J classification [9,10].

RESULTS

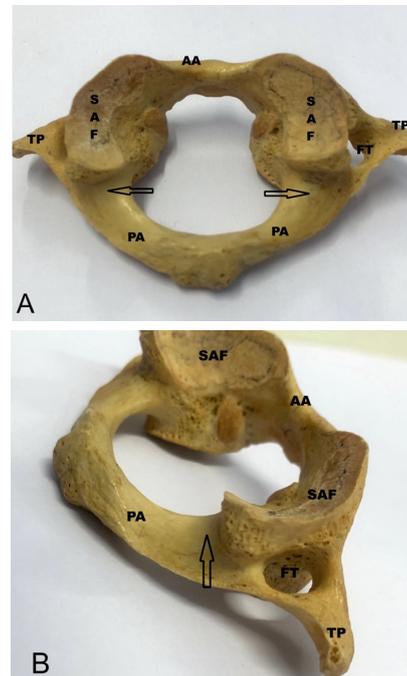


Fig.1: [A: Superior surface of atlas showing type I partial complete arcuate foramen (arrow)]. [B: Lateral surface of atlas showing type I partial complete arcuate foramen (arrow)]. Superior articular facet (SAF), Transverse Process (TP), Foramen transversarium (FT), Anterior arch (AA), Posterior arch (PA).

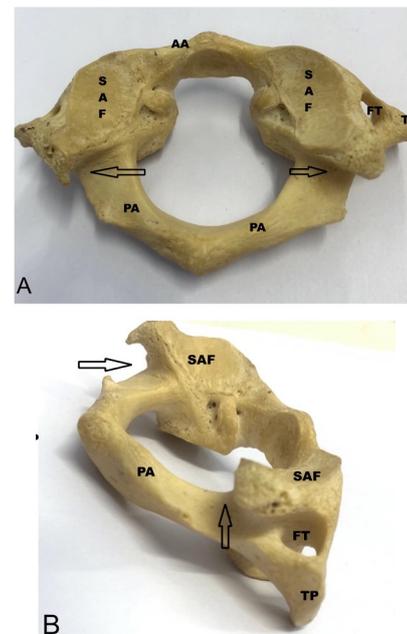


Fig.2: [A: Superior surface of atlas showing type II partial complete arcuate foramen (arrow)]. [B: Lateral surface of atlas showing type II partial complete arcuate foramen (arrow)]. Superior articular facet (SAF), Transverse Process (TP), Foramen transversarium (FT), Anterior arch (AA), Posterior arch (PA).

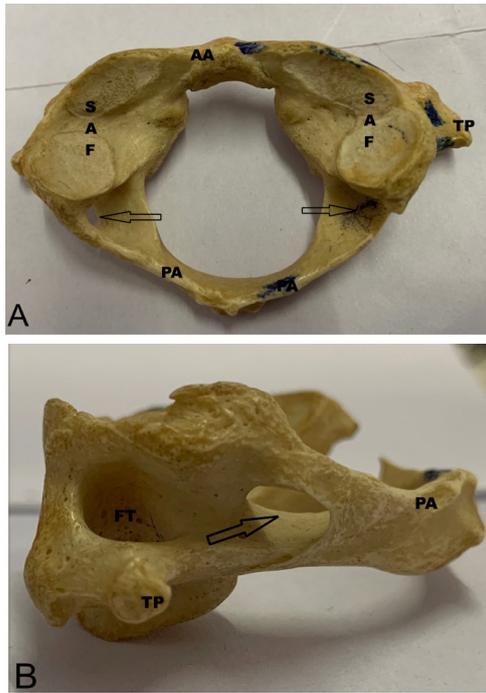


Fig.3: [A: Superior surface of atlas showing type III complete arcuate foramen (arrow)].

[B: Lateral surface of atlas showing type III complete arcuate foramen (arrow)]. Superior articular facet (SAF), Transverse Process (TP), Foramen transversarium (FT), Anterior arch (AA), Posterior arch (PA).

The macroscopic examination for the presence of arcuate foramen was done among the 32 dry atlases. We found 04 atlases (12.5%) with arcuate foramen where 02 (6.25%) vertebrae were belongs to type I, seen Fig.1 and 01 (3.12%) were type II, seen in Fig.2 and 01 (3.12%) were type III, seen in Fig.3 according to Mitchell J classification.

DISCUSSION

In our study we found 12.5% of arcuate foramen variation in the atlas vertebrae. Incidence of arcuate foramen in various countries giving from 8-23% by various authors and tabulated in Table 1. Arcuate foramen is also named as Kimmerle;s foramen or atlas bridging or ponticulus posterior of atlas or canalis vertebralis or speculum or retrocondylar vertebral artery [11].

Embryologically upper four vertebral analgen fuse together and form occipital bone and the caudal parts of it forms occiput and atlas [12]. Similar to arcuate foramen a bony ring of the vertebral artery is a commonly found in other vertebrates. In quadruped’s arcuate foramen is present and its helps in lateral extension by posterior atlantooccipital membrane.

In human, superior articular facet of atlas maintain the weight of head, thus roof of tunnel has disappeared. During placement of lateral mass screw in atlas the clinician must be aware of the arcuate foramen anomaly [13].

Table 1: Incidence of arcuate foramen from previous study

Sl. No.	Authors	Year	Method of study	Incidence of arcuate foramen (%)
1	Malhotra et al., [17]	1979	Dry bone specimens	5.14
2	Krishnamurthy et al., [6]	2007	Dry bone specimens	13.8
3	Lalit et al., [18]	2014	Dry bone specimens	23.33
4	Santhi et al., [19]	2017	Dry bone specimens	12.06
5	Prasad B et al., [9]	2018	Dry bone specimens	17.7
6	Present Study	2022	Dry bone specimens	12.5

Previous study explained that arcuate foramen present as a complete bridge or as a partial bridge which may significantly affects surgical procedure during laminectomy at C1 level [14]. In the present study we also find one complete bridge and three partial bridge arcuate foramen. Arcuate foramen restricts the mobility of vertebral artery flow during flexion and extension of neck and compress the periarterial sympathetic nerve plexus. Its giving rise to a symptom similar like Barre Lieou syndrome [15]. The free border of posterior atlantooccipital membrane which arching over 3rd part of vertebral artery and the surrounding nerve sometime ossified and converted as arcuate foramen [4].

The knowledge of arcuate foramen is very important during neck surgery such as screwing of the lateral mass of the atlas to prevent the injury of vertebral artery. Orthopaedician, radiologist and neurosurgeon should know the presence of arcuate foramen during their clinical investigation at the level of first cervical region [16].

CONCLUSION

In the present study we found 12.5% atlas with arcuate foramen. This variation will help clinician during any head neck surgery at the level of atlas. This complete and partial complete arcuate foramen may damage artery, vein and nerve related to this. The symptoms like Barre Lieou syndrome may be verify with this variation. Clinical prescreening for signs

of vertebrobasilar insufficiency is important for chiropractic and manual therapies.

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