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Original Research Article

POSTICUS PONTICUS: ITS INCIDENCE AND DIMENSIONS IN NORTH INDIAN POPULATION

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ABSTRACT

Background: Atlas the first cervical vertebra, shows great morphological variations. Frequently bony spurs arise from the anterior and posterior margin margins of the groove for vertebral artery and sometimes convert the groove into a foramen termed as Posticus Ponticus or arcuate foramen or retroarticular foramen. This type of foramen is reported by different workers to be present in 2.25% to 45.9% of the population depending upon the age, gender, side and race.

Aim: to find out the incidence and type of Retroarticular foramina, their relation with side and their different diameter and cross sectional area.

Materials and Method: the present study was conducted on 40 complete (80 sides) undamaged dry human atlas vertebra of unknown age and gender obtained from the Department of Anatomy, Government Medical College, Patiala, Punjab.

Results: complete foramen was found bilaterally in one vertebra (2.5%) and unilaterally on left side in 2(5%) & on right side in 1 (2.5%) vertebra. Thus it was more on the left side as far as side is concerned. If taken unilaterally in toto, out of 80 sides of 40 vertebra it was seen in 5 (6.25%) sides. However partial bridging or incomplete foramen was seen bilaterally in 33 (82.5%) and on right side only in 2 (5%) & on left side only in 1 (2.5%) vertebra.

Conclusion: neurologists, neurosurgeons and medical community in general should have knowledge about the variation and try to look for it when dealing with patients complaining of symptoms of vertebro-basilar insufficiency like headache, vertigo, shoulder and arm pain.

KEY WORDS: Arcuate foramen, Retroarticular foramen, Vertebro-basilar insufficiency.

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INTRODUCTION

Atlas is the first cervical vertebra and supports the head. It is unique in that it fails to incorporate a centrum, whose expected position is occupied by the Dens, a cranial protuberance from the Axis. The Atlas consists of two lateral masses connected by a short anterior and a long posterior arch. The posterior arch forms 3/5th of the circumference of the atlantal ring. Its superior surface bears a wide groove for the

vertebral artery and venous plexus immediately behind, and variably overhung by the lateral mass. Frequently, bony spurs arise from the anterior and posterior margins of the groove for the vertebral artery. These are sometimes referred to as Ponticles; they occasionally convert the groove into a foramen, the arcuate foramen or Posticus ponticus. It may increase the risk of injury to the vertebral artery in surgical procedures involving the C1 Arch. More often the foramen is incomplete superiorly [1].

Osseofibrous ring on vertebral artery groove of atlas is named as foramen Alantantodeum posterius/ vertebrale, ponticulus posticus, posterior glenoid process, retroarticular canal, kimmerle anomaly/variant/deformity, canalis arteriae vertebralis, ponticulus posterior (ponticulus posticus) of the atlas, pons posticus, foramen sagitale, atlas bridging, foramen retroarticular superior, retrocondylar bony foramen, posterior atlantoid foramen and speculum [2].

This type of foramen is reported by different workers to be present in 2.25% to 45.9% of the population depending upon the age, gender, side and race [2-26]. Since no such data is available from this region so this study was conducted to find out the incidence and type of Retroarticular foramina, their relation with side and their different diameter and cross sectional area.

MATERIALS AND METHODS

A total of 40 complete (80 sides) , undamaged dry human atlas vertebrae of unknown age and gender were obtained from the Department of Anatomy, Government Medical College, Patiala, Punjab and studied for the presence of Arcuate foramen. All specimens were numbered from 1 to 40. The specimens were classified according to the following classifications on both sides:

a) Lamberty and Zivanovic [3]
b) Taitz and Nathan [4]
c) Mitchell [5]
d) Hasan et al [6]

a) According to Lamberty and Zivanovic [3] the retroarticular canals may be complete, incomplete or with no tendency to form canal or foramen.

b) Similarly Taitz and Nathan [4] classified retroarticular canals as having partial bridging, complete bridging and no bridge at all

c) Mitchell [5] classified the formation of arcuate foramen into following three classes:

Class I : no foramen

Class II : retroarticular sulcus with bony lipping or exostosis of posterior arch

ClassIII : complete bony ring.

So virtually all the above three classifications are the same.

However Hasan et al [6] classified the posterior and lateral foramen in 6 classes:

Class I: where only an impression for the vertebral artery was noticeable on the posterior arch

Class II: where the impression for the artery was deeper than the former class

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

Class IV: where a complete posterior ponticulus could be detected

Class V: where a lateral bridge extended from the lateral mass to the transverse process

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

After classifying the numbered vertebrae as per all the above mentioned classifications the data were recorded separately for both sides. Wherever a complete retroarticular foramen was found its maximum superoinferior and anteroposterior diameters were taken using a Digital vernier calliper with least count 0.02 mm .The cross sectional area of the foramen was calculated using the formula

Area (A) = π × D1 × D2 × ¼ (Mitchell, 1988a) [5]

OBSERVATIONS

Table 1: Showing incidence of arcuate foramen in present study.

Classification			Unilateral		Bilateral
Lamberty and Zivanovic [3]	Taitz and Nathan [2]	Mitchell [5]	Right	Left	
No tendency	No Bridge	Class 1	-	-	3(7.5%)
Incomplete	Partial Bridge	Class 2	2(5%)	1 (2.5%)	33 (82.5%)
Complete	Complete Foramen	Class 3	1 (2.5%)	2(5%)	1 (2.5%)
Total			3		37

Table 2: Showing incidence of Arcuate foramen in the present study as per Hasan et al classification.

Class	Unilateral		Bilateral
	Right	Left	
Class I	-	-	2(5%)
Class II	-	-	1 (2.5%)
Class III	2 (5%)	1 (2.5%)	33 (82.5%)
Class IV	1 (2.5%)	2 (5%)	1 (2.5%)
Total	3		37

Table 3: Showing dimensions of complete arcuate foramina.

Sr no.	Specimen no.	Antero- posterior diameter (mm)	Supero- inferior diameter (mm)	Cross sectional Area (mm^2)
1	30 R	4.79	4.24	15.95
2	31 L	5.76	4.42	19.99
3	33 L	4.66	5.59	20.45
4a.	36 L	6.61	4.65	24.14
4b.	36R	5.25	4.36	17.97

Mean area = Rt. Side 16.96 mm^2
Lt Side 21.52 mm^2

Table 1 shows incidence of arcuate foramen as observed in the present study as per three classifications which overlap each other.

Fig. 1: Showing bilateral arcuate foramen.

Fig. 2: Showing arcuate foramen on left side.

Fig. 3: Showing arcuate foramen on right side.

Fig. 4: Showing retroarticular sulcus with bony lipping.

DISCUSSION

Table 4: Incidence of Arcuate foramen.

s.no.	Authors	Year	Incidence of arcuate foramen	
			Complete	Incomplete
1	Lamberty and Zivanovic [3]	1973	15%	21.66%
2	Taitz and Nathan [4]	1986	7.90%	25.90%
3	Mitchell [5]	1998	9.80%	-
4	Hasan et al [6]	2001	6.57%	-
5	Manjunath [7]	2001	11.70%	-
6	Unur et al [8]	2004	5.10%	-
7	Cakmak et al [9]	2005	11.70%	3.30%
8	Parasekavas & Papaziogas [10]	2005	10.23%	24.43%
9	Krishnamurthy et al [11]	2007	8.33%	5.50%
10	Tubbs et al [2]	2007	5%	-
11	Simsek et al [12]	2008	3.80%	5.60%
12	Shilling et al [13]	2010	19.20%	10.10%
13	Sharma et al [14]	2010	4.30%	-
14	Kuhta et al [15]	2010	45.90%	-
15	Zambare & Reddy [16]	2011	4%	12%
16	Aggarwal et al [17]	2012	10.71%	-
17	Baesa et al [18]	2012	16.10%	31.80%
18	Shinde & Mallikarjun [19]	2012	2.98%	-
19	Chitroda et al [20]	2013	8%	60%
20	Lalit et al [21]	2014	10%	13.33%
21	Akhtar et al [22]	2015	7.62%	13.55%
22	Patel et al [23]	2015	8%	12%
23	Bharathi et al [24]	2016	5%	15%
24	Kumar & Selvi [25]	2016	2.25%	1.50%
25	Seema et al [26]	2016	16%	-
26	Present study	2017	6.25%	86.25%

As evident from table no. 1 a complete foramen was found bilaterally in one vertebra (2.5%) as seen in Fig.1 and unilaterally on left side in 2 (5%) as shown in Fig.2 & on right side in 1 (2.5%) vertebra as seen in Fig.3. Thus it was more on the left side as far as side is concerned. If taken unilaterally in toto, out of 80 sides of 40 vertebra it was seen in 5 (6.25%) sides. However partial bridging or incomplete foramen was seen bilaterally in 33 (82.5%) and on right side only

in 2 (5%) & on left side only in 1 (2.5%) vertebra. Thus it can be deduced that partial bridging or incomplete foramen i.e. a tendency to form spurs or bony lipping as seen in Fig.4 is much more common than anticipated though its progression to a complete foramen formation is much less.

Table 4 shows the incidence of complete and incomplete arcuate foramen as observed by the earlier workers. It is evident that there is a wide variation in incidence of both these type ranging from 2.25% to 45.9% & from 1.5% to 60% respectively. However some studies have given incidence of complete foramen only, like Kuhta et al who found it in 45.9% but they are silent about incomplete foramina.

Thus our incidence of complete foramen is in consonance with Hasan et al (2001) (6.57%), Taitz and Nathan (1986) (7.9%) and Akhtar et al (2015) (7.62%). However incidence of incomplete foramen is 86.25% in our study which is much more than earlier studies (maximum being reported to be 60% by Chitroda et al, 2013).

Table 5: Shows a comparison of mean cross sectional area of the complete arcuate foramen as observed by earlier authors and the present study.

S. no.	Author	Year	Mean cross- sectional area	
			Right	Left
1	Hasan et al [6]	2001	46.75mm2	50.28mm2
2	Tubbs [2]	2007	14.2mm2	
3	Kumar & Selvi [25]	2016	0.53cm2	0.59cm2
4	Present Study	2017	16.96 mm2	21.52 mm2

As evident from Table no.5, the mean cross sectional area is more on the left side in all the studies including the present study. Our values of 16.96mm^2 and 21.52mm^2 on right and left side respectively are comparable to Tubbs (2007) who found it to be 14.2mm^2. But the other two studies have found it in the range of 46-59mm^2. Such a huge difference is unexplainable.

Etiopathogenesis of Arcuate foramen: Piplani et al [21] threw a flood of light on various theories quoted by earlier workers leading to formation of arcuate foramen.

Le double [27] attributed the formation of this ring to the ossification of ligaments induced by vertebral artery pulsations.

Frazer [28] associated the bridging leading to formation of the foramen with ossification of the oblique ligament of atlas.

Lamberty and Zivanovic [3] proposed that ossification of ligament does not occur in the in young persons (2 and 4 years).

Taitz and Nathan [4] concluded that aging could be a factor predisposing to complete bridge formation.

Paraskevas and Papiziogas [10] found higher incidence of complete foramen in labourers than non labourers.

Cakmak [9] found increased frequency of incomplete foramen in females whereas Stubbs [29] found complete foramen more in males and partial foramen more in females.

Mitchell [5] found the incidence of the foramen was more in blacks as compared to whites.

Phylogeny and Ontogeny: It seems to be a principle in morphology that the greater the amount of specialization of function manifested by any organ, the farther does the structure so specialized depart from the form of the primordial type to which it belongs. This principle is particularly exemplified in the case of the upper two cervical vertebrae, on account of the special varieties of motion in this region. It is stated that the hinder part of atlantic condyle can be seen to surmount a lateral offshoot from the neural arch, or in other words a true oblique process. It indicates that the posterior part of the atlantic condyle is in reality the summit of an oblique process, whose base usually has become absorbed. This process is present in some monkeys and in the lemur among quadrumana, in the bear, lion, leopard, civet, otter and most carnivores, in sheep, deer, goat, llama and other ruminants, and in pig, horse among pachyderms [30].

Le Minor described this foramen as a uniquely derived trait within primates which is restricted to some individuals in homo sapiens. Appearance of this foramen in human evolution can be related to the erect posture and bipedal locomotion, and consecutive modifications of the regional venous circulation [31].

Clinical Importance: Cakmak et al [9] showed that patients with complete arcuate foramen had significant complaints of shoulder – arm pain, neck pain, and vertigo compared to patients with incomplete arcuate foramen. They further added

that cervical spine radiography is a simple and useful technique to diagnose arcuate foramen and must be considered in patients complaining of pain in temporal or occipital region, vertigo, photophobia or paraesthesia of hands.

Krishnamurthy et al [11] concluded that neurologists, neurosurgeons and medical community in general should have knowledge about the variation and try to look for it when dealing with patients complaining of symptoms of vertebrobasilar insufficiency like headache, vertigo, shoulder and arm pain.

Patel et al [23] concluded that presence of ponticles may reduce the cross sectional area of vertebral artery, compromising its blood flow resulting in vertebra basilar insufficiency which may lead to various types of neurological symptoms like dizziness, fainting, transient diplopia and vertigo.

Cushing et al [32] showed the tethering of vertebral artery in the congenital arcuate foramen of the Atlas vertebra as a possible cause of vertebral artery dissection in children.

Limousin's [33] study showed that the normal mobility of the vessel during flexion and extension of the neck may cause disturbances of arterial flow and of peri-arterial sympathetic plexus giving rise to symptoms similar to those found in Barre-lieou syndrome.

Conflicts of Interests: None

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