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Original Research Article

STUDY OF DIMENSIONS OF RETROARTICULAR BONY RINGS IN HUMAN ATLAS VERTEBRAE

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ABSTRACT

Background: The third part of vertebral artery on its exit from the FT of atlas is vulnerable for compression by External factors like bony outgrowths which may be complete to form the retroarticular bony rings. Such rings may predispose to vertebrobasilar insufficiency, Barre- lieou and cervicogenic syndrome especially in neck movements. The aim of this study is to know the dimensions of Retroarticular Bony Ring as the knowledge about such dimensions can improve the success rate of surgeries.

Materials and Methods: 120 sides on sixty dry adult human atlas vertebrae were obtained in the Department of Anatomy, Government Medical College, Amritsar, Punjab, India. The Retroarticular Bony Rings (RBR) were identified following the criteria used by Mitchell J and Hasan et al. Linear dimensions of Retroarticular Bony Ring (RB Rings) like Antero-posterior (Length) Supero-inferior (Height) and Medio-lateral (Width) were measured with the help of digital vernier caliper.

Results: The complete ponticuli were seen in 10 vertebrae (16.66%). Bilateral retroarticular bony rings have the lowest incidence of 3.33%, 5% on right side and 8.33% on left side. The mean anteroposterior diameter of the right retroarticular canal was 8.79mm and left side was 8.47mm, superoinferior diameter was 5.98mm on right side and 5.47mm on left side and mediolateral diameter was 4.76mm on right side and 4.42mm on left side.

Conclusions: The Knowledge about the dimensions of Bony ring of atlas is important for radiologists, otolaryngologists, neurologists and orthopaedicians as this information may be helpful in avoiding and reducing complications such as vertebral artery injury and spinal cord injury during spine surgeries.

KEY WORDS: Retroarticular Bony ring, Vertebral artery, Ponticuli, Bony Canal, Atlas vertebrae

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INTRODUCTION

Superior aspect of posterior arch of atlas is characterized by a groove known as sulcus arteriae vertebralis for the passage of third part of vertebral artery. Bony outgrowths may occur and convert this groove into a complete or incomplete ring forming retroarticular bony rings [1]. The bony rings may indicate anomalous ossification of the groove by oblique ligament of atlas; a fibrous tissue present at the lower border of posterior atlanto-occipital membrane [1,2], regression [3] or remnants of the proatlas [4]. The Ponticulus Posticus is the posterior osseous bridge that is formed between the posterior margin of superior articular facets and the posterior arch of the atlas and when complete forms the retroarticular bony ring [5-7] and has been variously described by many

authors in literature as Kimmerle variant, Canalis arteriae vertebralis, Arcuate foramen, Retrocondylar vertebral artery ring, Retroarticular canal, Atlas bridges and Ponticuli [8-10]. Whereas the Ponticulus lateralis are the lateral bridges formed as a lateral outgrowth from lateral margin of the superior articular facets to posterior root of transverse process of the atlas [11,7]. Lateral bridges are reported to be less common than the posterior bridge and sometimes may exist as a complete foramen called as supratransverse foramen [12,7]. These bridges predispose to vertebrobasilar insufficiency, Barre-Lieou and cervicogenic syndromes especially in severe neck movements [3]. The left VA on the left side has a larger diameter than the right [13] while the left bony canal or posterior bridge being smaller than the right [14] and thus makes the left bony ring more vulnerable than the right one. Reduction in the foramen size from the transverse to the arcuate foramen may cause further compression of the VA [15]. The aim of this study was to know the dimensions of Retroarticular Bony Ring as the knowledge about such dimensions can improve the success rate of surgeries hence preventing damage to the adjoining vital structures like spinal cord, nerve roots, cranial nerves and the vertebral arteries.

MATERIALS AND METHODS

120 sides on sixty dry adult human atlas vertebrae belonging to North Indian individuals were obtained by maceration from the cadavers made available for the purpose of dissection, in the Department of Anatomy, Government Medical College, Amritsar, Punjab, India. All the atlas vertebrae were thoroughly cleaned and numbered from 1-60. Damaged and pathological Atlas vertebrae were excluded from study.

The Retroarticular Bony Rings (RBR) were identified following the criteria used by Chevrel et al and Mitchell (1998a, 1998b).

Linear dimensions of Retroarticular Bony Ring (RB Rings) (Figure 1,2) were measured with the help of digital vernier caliper with a least count of 0.02 mm. All the measurements were taken directly from the bones and then the data was stored on the computer sheet. For the retroarticular Bony Rings Antero-posterior (Length) Supero-inferior (Height) and Medio-lateral (Width) diameters were measured

Retroarticular Bony Ring Length: It is the maximum antero-posterior Diameter of the Bony Canal, taken from the posterior part of the groove on the posterior arch to the root of the superior articulating surface and marked as AB. Figure 1.

Retroarticular Bony Ring Height: It is the maximum supero-inferior diameter of Bony canal, taken from the floor of the groove to the inner part of the overlying bony strut and marked as EF. Figure 1.

Retroarticular Bony Ring Width: It is the maximum Medio-lateral or transverse diameter of the Bony Canal marked as CD. Figure 1.

Fig. 1: Showing Measuring Of A Complete Retroarticular Ring- Antero-Posterior Diameter - AB, Vertcical Height- EF, Transeverse Width- CD Also Showing Osteophyte Encroachments.

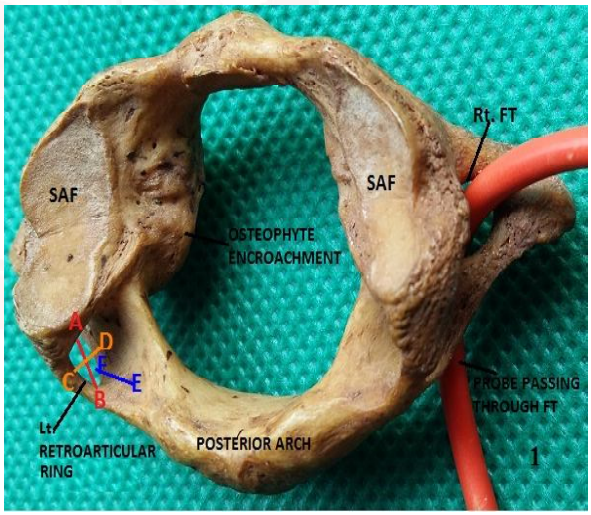
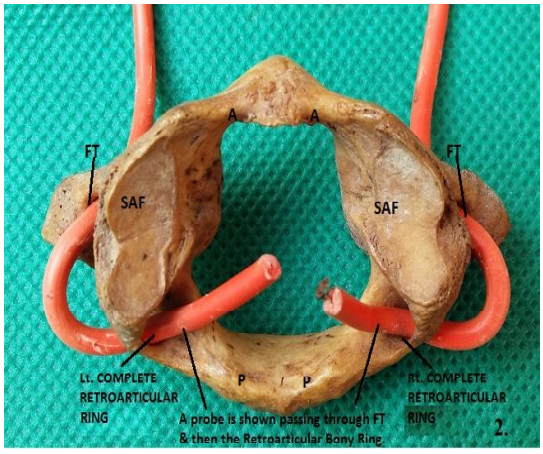


Fig. 2: Showing bilateral complete retroarticular bony ring V.A- vertebral artery, SAF- Superior Articular Facet, P- posterior arch, AA- Anterior Arch and a probe passing through ft and then bony retroarticular bony ring.



RESULTS

Table 1: Showing Comparision Of Incidence Of Retroarticular Bony Rings In Different Population.

Author & Year	Population	Posterior Bridge Complete Bony Ring	Lateral Bridge
Mitchell (1998a,b)	South African Population	9.8% - 11.7% (Rt.) - 24.6% (Lt.) - 31.8% (Bl)	12.24% (18)- Complete
Karau Bundi (2010)	Kenyan population	14.90%	3.9% Rt. – Complete
Present Study (2016)	North Indian Punjabi Population	16.66% (10 vertebrae out of 60) - - 5% (3) Rt. - 8.33% (5)Lt. - 3.33% (2) Bl. 10% (12sidesof vertebrae out of 120 sides) – 4.16% (5) Rt. - 5.83% (7) Lt.	No- Complete Incomplete - 3.33% (2) Rt. - 5% (3) Lt.

Table 2: Showing Comparison Of The Diameters Of Retroarticular Canal In Different Populations.

Author	Year	Population	Antero posterior Diameter (PoLength) mm Mean±SD Range		Superoinferior Diameter(PoHeight) mm		Mediolateral Diameter (PoWidht) mm	
Pyo & Lowman [8]	1959	American whites	8.5mm****		--		-	
Mitchell [11]	1998a	mixed South Africans	Right	6.4	5.3	5.1	-	
			Left	6.6				
Unur et al. [9]	2004	Turkish	8.1mm***		5.7mm****		-	
Paraskevas et al. [14]	2005	Northern Greeks	Right	6.4	Right	5.4	-	
			Left	6.7	Left	5.4		
Krishnamurthy et al [21]	2007	South Indian	Right	9.26±0.464 8.63–9.92	Right	5.38±0.2285.04–5.68	-	
			Left	8.14±1.01 6.73–9.43	Left	4.91±0.670 3.75–5.93		
Karau Bundi et al [30]	2010	Kenyan	6.29	6	5.11	5.16	-	
Present study	2016	North Indian	Right	8.79±0.31 8.21–9.11	Right	5.98±0.78 5.56–6.25	Right	4.76±0.56 4.02–5.98
			Left	8.47±1.21 7.65–9.87	Left	5.47±0.98 4.86–6.23	Left	4.42±0.65 4.21–6.67
			Bilateral (Mean)	**8.63±1.19 5.21-9.32**	Bilateral (Mean)	**5.72±0.78 4.0-7.0**	Bilateral (Mean)	**4.44±0.61 3.21-5.50**

Out of 120 sides (60 vertebrae) observed the complete ponticuli were seen on 12 sides (10%) or 10 vertebrae (16.66%). i.e. 5 cases on right side, 7 cases on left side and among them 2 were bilateral.

Bilateral retroarticular bony rings have the lowest incidence 3.33%, on right side was 5 % and on left side was 8.33%

In terms of sides 12 sides out of 120 sides (10%) of the vertebrae showing bony ring 4.16% (5) on right side and 5.83% (7) on the left side.

The mean anteroposterior diameter of the right retroarticular canal was 8.79mm and left side was 8.47 mm

The superoinferior diameter was 5.98mm on right side and 5.47 mm on left side. The mediolateral diameter was 4.76mm on right side and 4.42mm on left side. On the right side, the anteroposterior diameter was significantly larger than the superoinferior (p=0.001).

DISCUSSION

The present study has identified retroarticular bony rings (RB Rings) in 16.66% (10 vertebrae out of 60) or 10% (12 sides of vertebrae out of 120 sides) of the North Indian population. Our findings that bilateral retroarticular bony rings have the lowest incidence 3.33%, the right type of retroarticular canal having an incidence of 5 % and left type having higher incidence of 8.33% in north Indian samples. or in terms of sides there were 10% (12 sides of vertebrae out of 120 sides) of the vertebrae showing bony ring 4.16% [5] on right side and 5.83% [7] on the left side. This is within the range described by Mitchell in 1998 [5,16]and Karau Bundi et al 2010 [16].

These findings also support the findings of lamberty et al3 who found bilateral type having the lowest incidence of 3.3% and the left only type the highest incidence in a skeletal sample of 60 american whites. Our findings also concurs with the paraskevas 2005 [14] who also found that bilateral bony rings has the lowest incidence 1.13%, the right only type of bony ring having an incidence of 2.84% and the left only type the higher incidence 5.11% in northern greek skeletal sample [14]. The phenomenon of higher occurrence of bony ring on left side than the right can be attributed to the explanation due in part to unequal weight bearing as a result of more commonly left tilted head posture [17]. Owing to the right sided dominance of muscles of the body in right handers, the larger and consequently stronger sternocleidomastoid muscle would tend to tilt the head towards opposite side [18]. It is also believed that atlas bridges are more common in individuals who sustain greater stress in the region of craniocervical junction [4].

In the present study no complete lateral bridges were found and incomplete lateral bridge was more commonly observed on the left side. These findings support the findings of Dhall et al Who also observed an increased incidence of lateral bridges on the left side and correlated with the larger superior articular facets on that side

[19,17]. Whereas Complete lateral bridges, forming supratransverse foramina were found on right side in 3.9% of the cases in the work done by Karaubundi et al in 2010 in Kenyan population [16]. The findings of the present study also support those of previous research that lateral bridges are less common compared to the posterior bridges [4,5,11].

For the retroarticular canal, the mean anteroposterior diameter was 8.79mm on the right and 8.47mm on the left. The mean superoinferior diameter was 5.98mm on the right and 5.47mm on the left. The mean mediolateral diameter was 4.76mm on the right and 4.42mm on the left. These measurements concur with those of the previous research as shown in Table II. Our results support those of previous workers [5,11,14] that the anteroposterior diameter is significantly larger than the superoinferior in the retroarticular canal and it has been seen that the left vertebral artery was found to be larger than the right20. Therefore, possible that the vertebral artery is compressed superoinferiorly [5,11].

The presence of more bridges on the left side with small diameter as compared to right side are observed in the present study would mean that VA is more liable for compression [21]. It is possible that the third segment of the VA may be a reserve length to allow for neck rotation without injury or compression to the artery. Presence of these ponticles may limit this reserve length, predisposing to entrapment of the artery [16].

Furthermore, the ossification of ligamentous structures in various parts of the body may result in clinical problems such as compression to neighboring structures and complications in regional surgery [22]. Maintaining the vertebral artery intact constitutes an important concern as presence of Retroarticular bony rings can lead to compression of the vertebral artery in the absence of arterial disease or may be an aggravating factor in case of disease [5,11,14]. High incidence of this bony rings is associated with vertebro-basilar insufficiency presenting with dizziness, fainting and transient diplopia. There are 8 reported cases where surgical removal of bony bridges alleviate the symptoms of vertebrobasilar insufficiency [23]. It is also revealed that the vertebral artery occupies 57% of the vertebral artery groove and when a foramen is formed over here, it produces a relatively tight situation of vertebral artery leading to giddiness on external neck movements due to vertebrabasilar insufficiency [24]. Association between the arcuate foramen and tethering of vertebral artery in it may lead to its dissection from repetitive trauma with movement of neck has also been reported [25]. This compression becomes evidently symptomatic in extreme manipulations of the neck [26]. Cakmak et al (2005) [27] 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.

In an individual with a lateral bridge of atlas and an associated retroarticular canal may further results in increased compression of the vertebral artery [28] and compromised blood flow during extreme rotation of head and neck as occurs in manipulation of cervical spine [29,30].

CONCLUSION

The prevalence of retroarticular bony rings in the atlas among North Indians are comparable to that in other populations. Thus Knowledge about the dimensions of Bony ring of atlas is important for radiologists, otolaryngologists, neurologists and orthopaedicians as this information may be helpful in avoiding and reducing complications such as vertebral artery injury and spinal cord injury during spine surgeries.

Conflicts of Interests: None

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