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Original Research Article

Study of Incidence of Ponticulus Posterior In Dry Human Atlas Vertebra and Its Clinical Significance

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ABSTRACT

Background: Atlas is the first cervical vertebra. The vertebral artery lies in the groove on posterior arch of the atlas. The vertebral artery groove may sometimes get converted into a foramen. This is commonly known as ponticulus posterior (ponticulus posticus) or arcuate foramen of the atlas. These foramina may be complete or incomplete. This can lead to compression of the vertebral artery and produce symptoms like headache, syncope, altered consciousness etc. It can also complicate manipulations of the cervical spine by reducing the blood flow during extreme rotations of head and neck. It is also associated with vertebrobasilar artery stroke So, neurosurgeons or orthopaedic surgeons who operate in this area should have a detailed knowledge of variations of groove for the vertebral artery.

Materials and Methods: The present study was conducted on 50 dried and fully ossified adult human atlas of unknown age and sex collected from the department of Anatomy, Government Medical college, Nagpur. Each atlas vertebra was carefully observed for the presence or absence of complete or incomplete ponticuli on superior surface of posterior arch of atlas.

Results: Out of the 50 vertebra studied 7(14%) showed the presence of Ponticuli. Ponticuli were incomplete in all 7 atlas vertebras. Complete ring was not observed in any of the atlas vertebra .Out of the 7 ponticuli 6(12%) were found to be unilateral and in only 1 (2%) case it was found to be bilateral. Out of the 6 ponticuli 4(8%) were noticed on the Left side and 2(4%) were present on the right side.

Conclusion: Presence of incomplete ponticulus posterior might cause cervical pain and even cerebrovascular disorders due to pressure on third part of vertebral artery present in the vertebral artery groove. This anatomical knowledge is important for neurosurgeons, orthopaedic surgeons, radiologists and clinicians while dealing with this region.

KEYWORDS: Ponticulus Posterior, Atlas, Cervical Vertebra, Cerebrovascular disorders, Vertebral artery.

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INTRODUCTION

Atlas is the first cervical vertebra named after the Greek God 'ATLAS' who supported the Earth on his shoulders [1]. Atlas vertebra is ring shaped. It does not have body and spine. There are two lateral masses in the atlas vertebra joined with each other by an anterior and posterior arch. The superior surface of the posterior arch presents a wide groove behind the lateral mass for third part of vertebral artery, dorsal ramus of first cervical nerve [2]. Posterior atlantooccipital membrane is attached to the upper border of the posterior arch of atlas. The vertebral artery and first cervical nerve passes through the deficient membrane at each lateral extremity. The third part of vertebral artery emerges from foramen transversarium of the atlas, runs backwards and medially behind the lateral mass of the atlas, and lies in this groove on posterior arch of the atlas. It then passes through the gap in anterior part of posterior atlanto-occipital membrane and enters the foramen magnum [3,4]. The oblique ligament of atlas which bridges the vertebral artery groove may sometimes ossify convert the groove into a foramen [2,5].

This is commonly known as ponticulus posterior (ponticulus posticus) or arcuate foramen of the atlas. These foramina may be complete or incomplete. The alternative names of this foramen are: retroarticular canal, retroarticular vertebral artery ring, foramen retroarticular superior, retrocondylar bony foramen,atlas bridging, canalis arteriae vertebralis, foramen sagitale, posterior glenoid process and speculum & kimmerle anomaly (or deformity) [6]. These ponticuli may distort the vertebral artery,may cause external pressure on the vertebral artery or may result in vertebrobasilar insufficiency [7,8].

MATERIALS AND METHODS

The present study was conducted on 50 dried and fully ossified adult human atlas of unknown age and sex collected from the department of Anatomy, Government Medical college, Nagpur. The damaged atlas vertebra and the bones with any obvious pathology were removed from the study. Each atlas vertebra was carefully observed for the presence or absence of complete or incomplete ponticuli on superior surface of posterior arch of atlas. The following observations were noted

1. Presence or absence of ponticuli on superior surface of posterior arch of atlas.
2. Whether the ponticuli in atlas are complete or incomplete.
3. Whether the ponticuli are unilateral or bilateral.
4. Whether the ponticuli are on right or left side of atlas vertebra.

RESULTS

Total 50 atlas vertebra were studied to find out the incidence of Ponticuli on superior surface of posterior arch of atlas vertebra. Out of the 50 vertebra studied 7(14%) showed the presence of Ponticuli. Ponticuli were incomplete in all 7 atlas vertebras. Complete ring was not observed in any of the atlas vertebra (Table No. 1). Out of the 7 ponticuli 6(12%) were found to be unilateral and in only 1 (2%) case it was found to be bilateral (Table No.1). Out of the 6 ponticuli 4(8%) were noticed on the Left side and 2(4%) were present on the right side (Table No. 2).All were ponticuli posterior. None of the vertebra showed the presence of lateral ponticulus.

Table 1: Percentage of Complete and Incomplete Ponticuli.

Total No. of Atlas having Ponticuli	% of Incomplete ponticuli		% of Complete Ponticuli
7(14%)	Unilateral	Bilateral	-
	6(12%)	1(2%)	

Table 2: Percentage of Right and Left side of Ponticuli.

Total No. of Atlas having Ponticuli	Right	Left	Bilateral
7(14%)	2(4%)	4(8%)	1 (2%)

Table 3: Occurance rate of Ponticulus Posterior Studies by various authors and comparison with present study.

Study	Incomplete %	Complete %
Hasan et al, 2001 [12]	6.57 & 2	3.4
Cakmak O et al 2005[13]	15	-
Krishnamurthy et al 2007 [14]	13.8	
Dahiphale et al, 2009 [15]	18	2
Zambare & Reddy 2011[16]	16	-
Venkatchalam 2015[17]	8	4
Patel NB et al 2015[18]	12	8
Present study	14	-

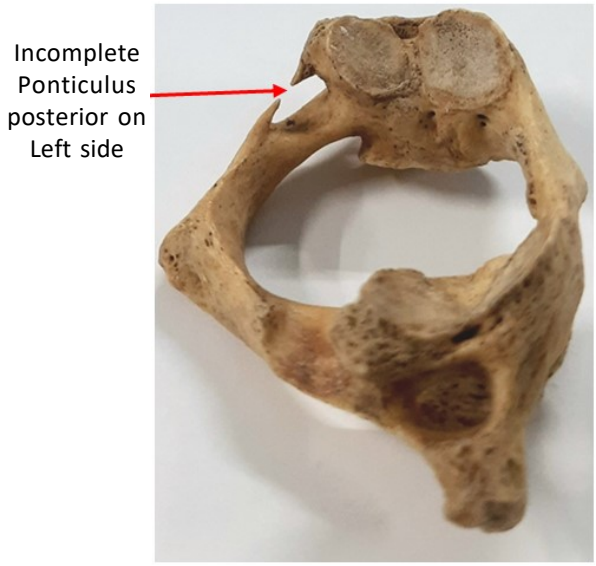

Fig. 1: Showing the presence of Incomplete Ponticulus posterior on Left side.

DISCUSSION

The aim of the present study was to find incidence of Ponticulus posterior in dry atlas vertebra in Vidarbha region. Variations of the groove for vertebral artery on superior surface posterior arch of atlas are common. There may be formation of complete or incomplete osseous bridge between the posterior arch of atlas and posterior margin of superior articular facet [9,10,11]. In the present study we found the incidence of incomplete ponticulus posterior to be 14% with a higher incidence of 8% on the left side as compared to the right side. Occurrence rate of Ponticulus posterior was studied by various authors whose comparison has been given in the table no .3

Hasan M et al [12] classified these posterior bridges into six classes as follow : Class I - included those having only the impression of vertebral artery on the posterior arch of atlas; Class II - included those having deeper impression like groove or sulcus for the vertebral artery; Class III - included those in which partial ponticulus posterior was present as a bony spicule; Class IV - included those having complete ponticulus posterior; Class V - included those having ponticulus lateralis which extended from the lateral mass to the transverse process; Class VI - included those having posterolateral tunnel i.e. combination of complete ponticulus posterior (Class IV) & ponticulus lateralis (Class V).

Various theories have been put forth regarding the formation of ponticuli but it is still not clear whether it has congenital or genetic basis. Some suggest that it is due to ossification of the oblique ligament which bridges the groove for vertebral artery due to ageing [2]. Ossification may be due to external factors such as carrying heavy load. This theory was supported by Paraskevas G et al who found that the incidence of canal for vertebral artery is more common in labourers than in non labourers [19]. LeDouble stated that pulsation of vertebral artery induced the ossification of the ligament. He also stated that ossification cannot be the only causative factor but formation of ponticuli is due to regressive & disappearing morphological phenomenon [11]. Paraskevas G et al [19], Kendrick GA & Biggs NL [20] hypothesized that these incomplete bony ponticuli are precursor of the complete bony ponticuli . the higher incidence of ponticulus posterior on left side rather than on Right side can be explained by unequal weight bearing as a result of more commonly left tilted head posture [21]. Ponticuli may be remnants of proatlas [6,12].

In the present study we found the incidence of incomplete ponticulus posterior to be 14% similar to findings of Zambare & Reddy 2011[16], Krishnamurthy et al 2007 [14], Cakmak O et al 2005[13].

Presence of Ponticulus posterior is a surgically important variation of atlas. This can lead to compression of the vertebral artery and produce symptoms like headache, syncope, altered consciousness etc[9,19,22] . It can also complicate manipulations of the cervical spine by reducing the blood flow during extreme rotations of head and neck [23,24]. It is also associated with vertebrobasilar artery stroke due to its dissection in foramen arcuale due to repeated trauma with the various movements of the head [25]. In any patient complaining about headache, vertigo or pain in temporal region cervical spine radiography should be considered which is a very simple and cost effective technique to know the presence or absence of arcuate foramen [13,26]. So, neurosurgeons or orthopaedic surgeons who operate in this area should have

a detailed knowledge of variations of groove for the vertebral artery.

CONCLUSION

The presence of incomplete ponticulus posterior was 14% in the present study. Presence of incomplete ponticulus posterior might cause cervical pain and even cerebrovascular disorders due to pressure on third part of vertebral artery present in the vertebral artery groove. This anatomical knowledge is important for neurosurgeons, orthopaedic surgeons, radiologists and clinicians while dealing with this region.

Author Contributions

Dr Ashish Kamdi - Contributed to the planning, analysis of the study, helped in preparation of the article

Dr Ashita Kaore - Corresponding author- Contributed to the execution and analysis of the study, correspondence on behalf of all authors.

Dr Hemlata Ambade –Contributed to execution, analysis and preparation of the article

Dr Thakre Gaurav- Contributed to preparation of the article, searching of references.

Dr Namdeo Y Kamdi - Contributed to the planning of the study and overall guidance to all the authors.

Conflicts of Interests: None

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