# Incidence of Ponticles in Human Atlas Vertebrae - A Study from South Gujarat Population

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## ABSTRACT

**Background**: *Atlas, an atypical 1st cervical vertebra bears anterior and posterior arch. The superior surface of posterior arch presents groove for vertebral artery. Sometimes bony out growth extending from superior articular process to the posterior arch is known as ponticle which may cause external pressure on the vertebral artery when latter passes from foramen transversarium to foramen magnum of the skull.*

**Aim:** *The study was to find out an incidence of atlas ponticles (bridges) for its clinical and surgical significance.*

**Materials and Methods**: *In this study, 50 dried macerated atlas vertebrae of unknown age and sex were collected from department of anatomy of medical colleges of South Gujarat and examined for presence of ponticles.*

**Results**: *Out of 50 atlas vertebrae, total 11 (22%) bones presented with ponticles of which incidence of posterior ponticle was seen in 10 (20%) cases and lateral ponticle in 1 (2%) case. Total incidence of complete and incomplete variety was noted in 5 (10%) and 6 (12%) cases respectively. Incidence of bilateral ponticle was observed in 2 (4%) while unilateral in 9 (18%) vertebrae of which 5 (10%) right sided and 4 (8%) left sided.*

**Conclusion:** *The presence of ponticles may reduce the cross sectional area of vertebral artery, compromising its blood flow resulting in vertebro-basilar insufficiency which may lead to various types of neurological symptoms like dizziness, fainting, transient diplopia and vertigo.*

**Key Words**: *Atlas vertebra, Ponticle, Vertebral artery groove*

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## INTRODUCTION

In human atlas vertebra, the superior surface of posterior arch bears a groove known as sulcus arteriae vertebralis for the third part of vertebral artery, dorsal rami of first cervical nerve and vertebral venous plexus. The posterior atlanto-occipital membrane is attached to superior border of posterior arch. The third part of vertebral artery after emerging from foramen transversarium of the atlas runs backwards and medially behind the lateral mass and lies in the groove on posterior arch of atlas and then runs upwards to form basilar artery in cranial cavity. During this course it is vulnerable to damage from external factors like bony or ligament us structures. Sometimes groove may present a bony outgrowth over it known as ponticle (bridge) either in posterior/ lateral/ posterolateral ponticle. The posterior ponticle is a bony spur extending from dorsal side of lateral mass to the postero-medial margin of the groove,[1] may present as partial or complete form. When it is partial, it is described as Kimmerley' anomaly/ variant/ deformity/ posterior bridge or ponticulus posticus. When it is complete, it converts the groove into foramen described as foramen sagittale/ retroarticular or arcuate foramen.[2] The lateral ponticle extends from lateral margin of the lateral mass to the posterior root of transverse process, may present as partial or complete form.[3] Its complete variety forms a foramen known as lateral vertebral foramen or supra transverse foramen.[4,5] Sometimes, a bony fragment extends from the lateral margin of posterior one third of lateral mass to transverse process and dorsal edge of the posterior arch of atlas known as posterolateral ponticle.[4-6] All types of bony ponticles (bridges) are common structure in lower vertebrates[7] but their presence in the human beings are not common. Physicians, neurologists and surgeons operating in this area of atlas vertebra should be aware of this variation as a cause of vertebro-basilar insufficiency.[8]

## MATERIALS AND METHODS

In this study, 50 dried macerated atlas vertebrae of unknown age and sex were collected from department of anatomy of medical colleges of South Gujarat region and examined for presence of ponticles. Incidences and the morphology of atlas ponticles were studied and observations were noted following the criteria used by Mitchell (1998)[4, 5] for

posterior and lateral ponticles. According to Mitchell[4,5]

There are 3 classes of posterior ponticles:
Class I: Retro articular groove.
Class II: Incomplete ring with missing middle part.
Class III: Complete retro articular ring.
For lateral bridge, it was evaluated as complete or incomplete form.

The objective of the present study was to find out an incidence of posterior, lateral or posterolateral ponticles in South Gujarat population.

**RESULTS**

Out of 50 atlas vertebrae, total 11(22%) vertebrae presented with bony ponticles. Among them, the posterior ponticle was observed in 10(20%) cases and lateral ponticle in 1(2%) case. Out of 10(20%) cases of posterior ponticle; 4(8%) cases were complete and 6(12%) cases were incomplete type. In 4(8%) cases of complete posterior ponticle; 1(2%) case was bilateral and 3(6%) cases were of unilateral variety (Fig.1a & b). Whereas in 6(12%) cases of incomplete posterior ponticle; 1(2%) case was bilateral and 5(10%) cases were unilateral i.e. 2(4%) right and 3(6%) left sided (Fig.2a & b). Lateral ponticle was noted only in 1(2%) bone which was of right sided unilateral complete type (Fig. 3). Posterolateral ponticle was not found in any atlas vertebra (Table 1).

**Table 1: Incidence of various Types of Ponticles in Atlas Vertebrae**

| **Posterior Ponticle (20%)** | **Unilateral (18%)** | | **Bilateral (4%)** |
|---|---|---|---|
| | **Right** | **Left** | |
| Complete | 2 (4%) | 1 (2%) | 1 (2%) |
| Incomplete | 2 (4%) | 3 (6%) | 1 (2%) |
| Total | 4 (8%) | 4 (8%) | 2 (4%) |
| **Lateral Ponticle (2%)** | **Unilateral** | | **Bilateral** |
| | **Right** | **Left** | |
| Complete | 1 (2%) | - | - |
| Incomplete | - | - | - |
| Total | 1 (2%) | - | - |
| **Postero Lateral Ponticle** | Not found | | |
| **Gross Total** | 5 (10%) | 4 (8%) | 2 (4%) |

**Table 2: Comparative Incidence of Various Atlas Ponticles (Bridge) as reported by previous Authors**

| **Sr. No.** | **Researchers** | **Year** | **Incidence** | | | |
|---|---|---|---|---|---|---|
| | | | **Number of study** | **Complete posterior bridge** | **Incomplete posterior bridge** | **Lateral bridge** |
| 1 | Le Double | 1912 | - | 11.70% | - | 1.80% |
| 2 | Radojevic & Negtovanic | 1963 | 280 | 21.00% | 2.00% | 2.50% |
| 3 | Lamberty & Zivanovic | 1973 | 60 | 15.00% | 21.66% | - |
| 4 | Taitz & Nathan | 1986 | 672 | 7.80% | 25.90% | 3.80% |
| 5 | Usha Dhall et al | 1993 | 148 | 37.83% | - | 13.50% |
| 6 | Mitchell J | 1998a,b | 1354 | 9.80% | 29.60% | 12.24% |
| 7 | Hasan et al | 2001 | 350 | 6.57% | - | 2.00% |
| 8 | Paraskevas & Papaziogas | 2005 | 176 | 10.23% | 24.43% | 11.36% |
| 9 | Krishnamurthy A et al | 2007 | 1044 | 13.80% | 8.33% | 5.50% |
| 10 | Tubbs RS et al | 2007 | 60 | 5.00% | - | - |
| 11 | Zambare & Reddy | 2011 | 50 | 4.00% | 12.00% | - |
| 12 | Present Study | 2015 | 50 | 8.00% | 12.00% | 2.00% |

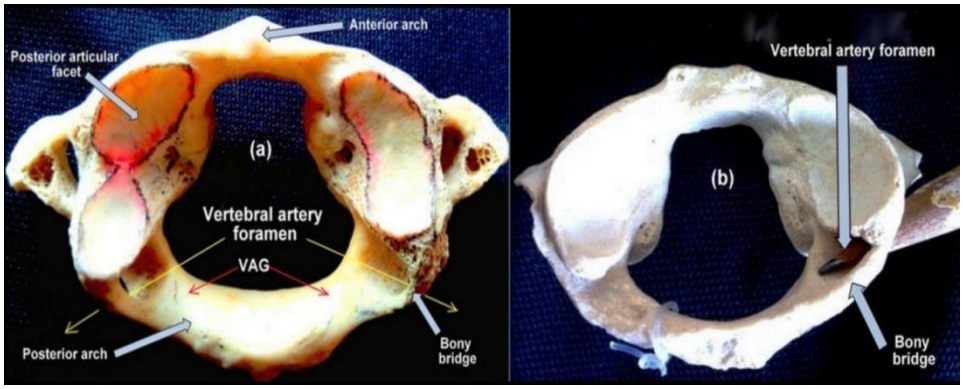


**Fig.1: complete posterior ponticle in atlas vertebra**
**(a) Bilateral (b) Unilateral (right side)**

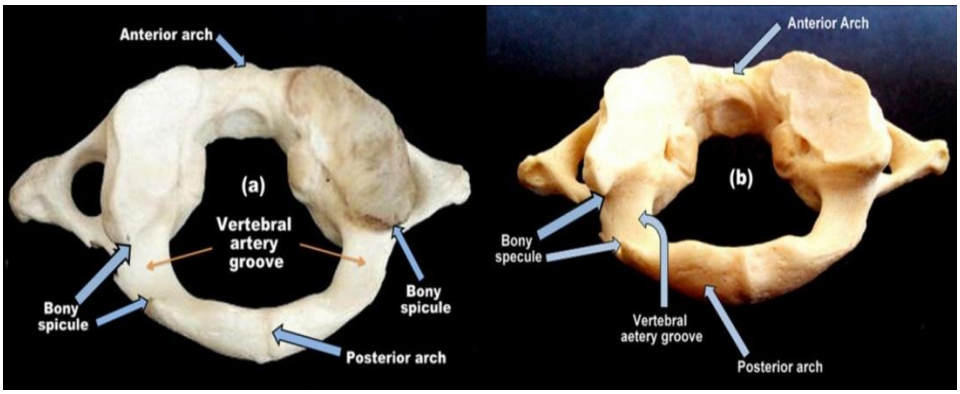


**Fig.2: Incomplete Posterior ponticlein atlas vertebra**
**(a) Bilateral (b) Unilateral (left side)**

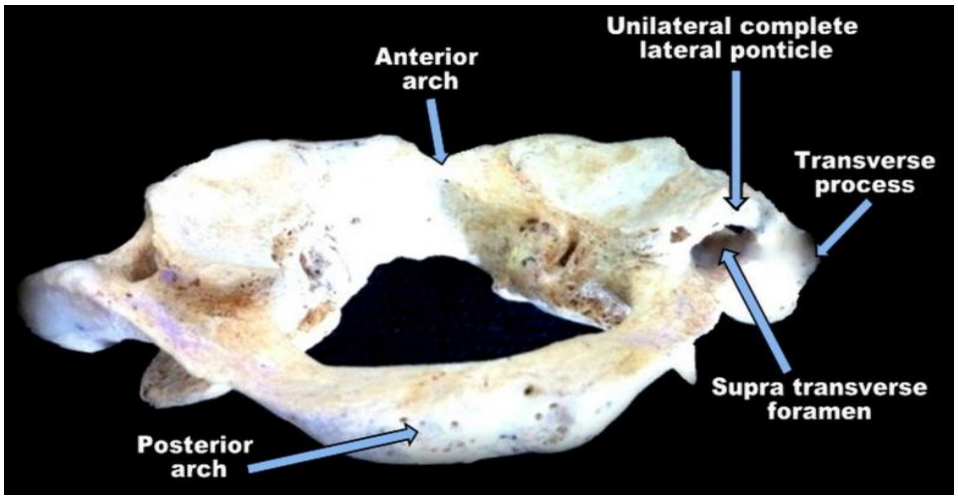


**Fig.3 Unilateral complete lateral ponticle (Right Side)**

**DISCUSSION**

The atlas vertebra shows the highest variability amongst all cervical vertebrae. The atlas bridges (ponticle) are a shared structure between human and non-human primates.[4, 5] This regressive and disappearing phenomenon of atlas ponticles could be related to acquisition of erect posture and bipedalism.[9] A plethora of literature is available on atlas ponticles regarding incidence of ponticles, unilateral v/s bilateral presence, measurement of the arcuate for a men, incidence of complete v/s incomplete ponticles, correlation with age or sex, genetic predisposition of ponticles amongst family members, prevalence of ponticles within specific human populations in many countries but limited study has been carried out in South Gujarat population till date.

Origin of these ponticles (bridges) is a matter of much debate and number of theories has been explained. The posterior and lateral ponticles (bridge) was first reported by Macalister (1869).[3] The formation of posterior bridge is simply a congenital phenomenon, due to persistence of the superior oblique process of other mammals.[3,10] Various authors have postulated that the posterior bridge develops from the dorsal arch of proatlas and belongs to occipital vertebra[2] or as a regressive and morphological phenomenon.[7] It may occur as genetical basis or familiar in nature.[11] It may be due to ossification of the lateral fibres of posterior atlanto-occipital membrane or acquired ossification of oblique ligament, due to the pulsation of vertebral artery[9] or by external mechanical factor like carrying heavy objects on the head.[12] The presence of lateral ponticle may be due to lateral extension of proatlas and belongs to manifestations of the occipital vertebra.[2,10,13] The presence of ponticles in atlas vertebra was compared with the studies of previous authors. Mitchell (1998) gave 3 classes of atlas vertebrae based upon degree of formation of posterior and lateral bridges for the passage of third part of vertebral artery.[4,5] Incidence of posterior ponticles (complete & incomplete) were 20% in our study which was comparable to 19.3% reported by Schilling et al,[14] but differ with findings of others researchers. It was reported 5% by Tubbs et al,[15] 36.6% by Lamberty & Zivancovic[7] and a very high incidence was noted by Taitz & Nathan in Middle Eastern population.[12] In present study, incidence of complete posterior ponticles was 8%, which was nearly similar to 7.8% reported by Taitz & Nathan[12] in Middle Eastern population. In present study, incidence of incomplete posterior ponticles was 12% of which right side 4%, left side 6% & bilateral 2%. This finding is similar as reported by Zambare & Reddy.[17]

Formation of incomplete posterior ponticle can be explained by disappearance of middle part of posterior bridge first and it may be precursor of a complete bridge.[6,11] So incomplete ponticle is a characteristic feature of younger age group (10-30 years) and complete bridges predominate in 30 to 80 years. Taitz and Nathan[12] observed partial posterior bridge in 174 (25.9%) cases and complete bridge/ring in 53 (7.8%) cases, in 672 atlas vertebrae of 6 population groups. Lamberty and Zivancovic[7] found bony rings in 135 (13.64%) cases, of which complete ring in 75(7.58%) cases and incomplete rings in 60(6.06%) cases out of 990 x-ray studies. In present study, incidence of lateral ponticle was 2%, this finding runs parallel to 1.8% reported by Le Double[9] and 2% by Hasan et al.[6] Incidence of lateral ponticle (2%) is lower than posterior (8%) can be explained by loss of lateral ponticle early in development resulting in higher incidence of posterior ponticles than lateral.[4,5,12] In present study we did not find any posterolateral ponticles. During rotatory movement of head, atlantoaxial joint plays crucial role by contributing 50% rotation but this makes the vertebral artery vulnerable to compression and stretching at this level.[17] Individual with a lateral ponticle of atlas and associated retroarticular canal may lead to further compression of vertebral artery and compromise its blood flow.[18] 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 and parasthesia of hand.[19] So knowledge of variation in atlas vertebra helps in interpretation of radiological findings, provide guidance for neurosurgical intervention in relation to atlas vertebrae and aid in diagnosis of cranio-vertebral manifestations.

## CONCLUSION

The presence of bony ponticles may reduce the cross sectional area for vertebral artery and compromising its blood flow resulting in vertebro-basilar insufficiency. Knowledge of bony ponticles of atlas will prove useful for orthopaedicians, neurosurgeons and anthropologists and should be considered during surgical and therapeutic manipulation of the cervical spine or screw fixation in the lateral mass.

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