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Original Research Article

PONTICULUS POSTICUS: ITS INCIDENCE AND IMPLICATIONS FOR SCREW INSERTION INTO LATERAL MASS OF ATLAS: USING PLAIN CERVICAL RADIOGRAPH

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ABSTRACT

Introduction: Ponticulus posticus a bony ridge arising from the superior articular process of the atlas that completely or partially encircles the vertebral artery. We retrospectively reviewed cervical plain radiograph which had been ordered by neurosuregeon and orthopaedic surgeon for evaluation of cervical spine problems, to investigate the prevalence of ponticulus posticus in Solapur population.

Materials and Methods: 960 lateral cervical spine radiographs were obtained from radiology department, ARMCH, Kumbhari and Ashwini Sahkari Rugnalaya, Solapur. The patient of which 504 (58.33%) were males and 456(41.67%) were females. Cases were classified into incomplete and complete bony ridge.

Results: Overall incidence of Ponticulus posticus was 14.3%, with complete lesions in 6.8% and incomplete lesion in 8.02%. We found increasing percentages of patients with Ponticulus posticus from the youngest to the adolescent age group, with significantly greater prevalence in patients aged 15-30 years compared with the younger groups. Lesions were more common in males (69.7%) compared with females (30.3%), but no statistically significant difference between genders was detected for complete as well as incomplete ponticulus posticus ($\div^2$=*0.003*, p=0.95).

Conclusion: The ponticulus posticus is a relatively common anomaly therefore proper identification of this anomaly on preoperative lateral radiograph should alerts surgeon to avoid using ponticulus posticus as a starting point for C1 lateral mass screw for atlantoaxial instability. If ponticulus posticus suspected or confirmed on radiograph, 3D CT scanning should be considered for variations in size and shape of ponticulus posticus and possibility of injury to vertebral artery.

KEY WORDS: Ponticulus Posticus, Atlas, Atlantoaxial instability, Lateral cervical radiograph, Lateral mass screw.

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INTRODUCTION

The evaluation of anatomical landmarks is important task for radiologist because significant changes in these structures may be index to underlying disease processes. The variations of such landmarks are common and often confus-

ing. There occur extensive variations in the craniocervical junctions [1]. For these reasons they must be studied with care to ensure adequate differentiation from disease processes.

The ponticulus posticus means "little posterior bridge" in Latin [2]. It was defined as an abnormal small bony bridge formed between the posterior portion of the superior articular process and the posterolateral portion of the superior margin of the posterior arch of the atlas. This condition had not been a matter of concern for spine surgeons until its surgical significance in the insertion of screws into the lateral mass of the atlas was recently reported. Young et al reported that mistaking the ponticulus posticus for a broad posterior arch of the atlas during C1 lateral mass screw placement could cause injury to the vertebral artery [3].

The normal atlas is a ring-like structure consisting of two lateral masses connected by a short anterior arc and a longer posterior arch. It is the widest cervical vertebra, with its anterior arch approximately half as long as the posterior arch. The posterior arch corresponds to the laminae of other vertebrae. On its upper surface is a wide groove for the vertebral artery and the first cervical nerve. In 1–15% of the population, a bony arch may form thereby converting this groove into a foramen through which these structures pass. This bony arch is known as the ponticulus posticus [4]. Historically, ponticulus posticus has been referred to by many names including pons posticus, arcuate foramen, foramen arcuale, retroarticular vertebral artery ring, Kimmerle anomaly, foramen atlantoideum, foramen sagitale, canalis arteriae vertebralis, and retroarticular canal of the atlas [5-8].

Although we are not directly concerned with the management of cervical spine anomalies, we do have an obligation, as healthcare professionals, to record any such findings that may hold importance for the patients 'overall health. Considering the growing clinical importance of this entity, we need to understand the morphological features and the prevalence of this anomaly. We retrospectively reviewed cervical plain radiograph which had been ordered by neurosuregeon and orthopaedic surgeon for evaluation of cervical spine problems, to investigate the incidence of ponticulus posticus in Solapur population.

MATERIALS AND METHODS

This study was approved by the institutional review board of our institution. We retrospectively reviewed 1060 cervical plain radiograph images of 1060 consecutive patients over eight years of age who had visited our hospital due to cervical problem from April 2012 to August 2016. There were 504 men and 456 women, and the overall mean age was 26.63 ± 14.33 years (range; 8 - 56). The age of male patients ranged from 8 to 51 years (mean age ± standard deviation; 27.58 years ± 14.54) and from 9 to 56 years in females (25.59 years ± 14.04).

The study was carried out at the Department of Radiology, Ashwini Rural Medical College and research centre, Kumbhari and Ashwini Sahkari Rugalaya, solapur. Lateral cervical radiographs were retrieved from the archives of the division and examined for cervical spine anomalies, in particular ponticulus posticus. In Lateral cervical radiographs, 100 images with poor visualization of the posterior arch of the atlas due to overlapping of the mastoid process or the occiput and radiograph with lateral inclination of posterior arch of the atlas were excluded. Patients reporting with congenital anomalies such as cleft lip and palate were not included in the study. Patients with a history of trauma or surgery in the cervical spine were also excluded from the study. Cases were classified into two categories incomplete and complete bony ridge and the incidence of lesion for age and sex group were determined.

Statistical analysis: Data were collected regarding the patients' gender and age grouping as determined in the patients' electronic records.

Descriptive statistics such as mean, standard deviation and percentage was used to present the data. $\div^2$ tests was used for determining significance of differences in incidence of complete and incomplete ponticulus posticus between age groups and gender grouping as determined from the patients' electronic records and lesion location. A p- value less than 0.05 were considered as significant.

RESULTS

Among the 960 lateral cervical plain radiograph

examined, 66 (6.8%) had complete (Figure. 2) and 77 (8.02%) had incomplete (Figure.3) bony ridge formation. Of the 66 complete bony ridge 46 (69.70%) were males and 20 (30.30%) were females. Further, of the 77 incomplete bony ridge 54 (70.13%) were males and 23 (29.87%) were females. A significant difference was found between age groups (x^2 =26.71, p<0.0001), as listed in Table 1.

Fig. 1: Lateral cervical spine radiograph- Lateral cervical spine radiograph- Showing normal spine with vertebrae C1-5.

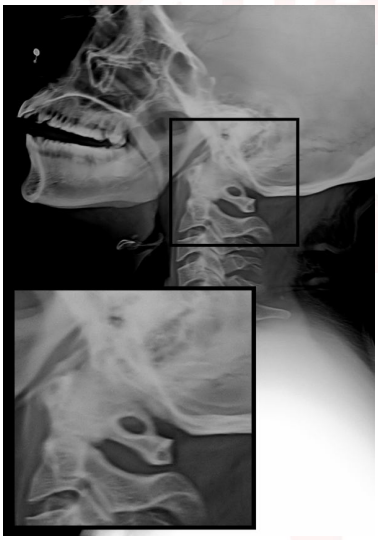

Fig. 2: Lateral cervical spine radiograph-Complete ponticulus posticus.

Fig. 3: Lateral cervical spine radiograph- Incomplete ponticulus posticus.

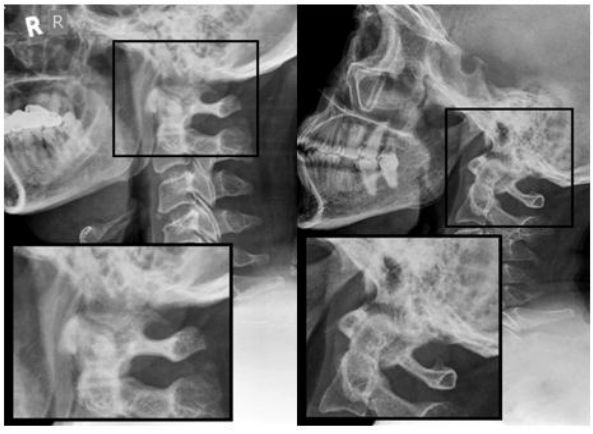

Table 1: Incidence of lesion by age group.

Age groups (Years)	Total	Complete ponticulus posticus	Percentage (%)	Incomplete ponticulus posticus	Percentage (%)
< 15	302	14	4.6	19	7.1
16-30	266	38	14.3	30	9.9
31-45	252	9	3.6	16	6.3
45-60	140	5	3.6	12	8.6

Significantly more male (69.7%) patients were identified with Ponticulus posticus (30.3%) than females (p=0.014) but no statistically significant difference between genders was detected for complete as well as incomplete ponticulus posticus (x^2=*0.003,* p=0.95), as shown in Table 2. Also age and sexwise distribution of Complete and incomplete ponticulus posticus is summarized in table 3 and Table 4.

Table 2: Incidence of lesion in males vs females.

Gender	Total sample	Complete ponticulus posticus	Incomplete ponticulus posticus	Total
Females	456	20	23	43
Males	504	46	54	100
Total	960	66	77	143

Table 3: Age and sex distribution of complete ponticulus posticus.

Age groups (Years)	Total sample	Males	Females	Total
< 15	302	10 (3.3%)	4 (1.3%)	14
16-30	266	26 (9.8%)	12 (4.5%)	38
31-45	252	6 (2.4%)	3 (1.2%)	9
45-60	140	4 (2.9%)	1 (0.7%)	5

Table 4: Age and sex distribution of incomplete ponticulus posticus.

Age groups (Years)	Total sample	Males	Females	Total
< 15	302	15 (9.8%)	4 (4.5%)	19
16-30	266	20 (3.3%)	10 (1.3%)	30
31-45	252	10 (2.4%)	6 (1.2%)	16
45-60	140	9 (2.9%)	3 (0.7%)	12

DISCUSSION

The presence of complete or incomplete bony bridge over the vertebral groove of the atlas has been mentioned briefly in anatomy textbooks, the detailed anatomy and its clinical significance have received less attention. Earlier studies on dry atlas and plain cervical radiographs showed inconstant data on the ponticulus posticus [9-11].

However, Ponticulus posticus has become an

important anomaly of the atlas, as the use of lateral mass screws for the fixation of the atlas has become common for the treatment of atlantoaxial instability. However, it can sometimes be a difficult procedure, as the region contains venous plexuses as well as the greater occipital nerve. To avoid these difficulties, some surgeons have recommended that, in the presence of a broad posterior arch of the atlas, the insertion of the screw be started in the dorsal aspect of the posterior arch instead of at the base of the lateral mass or at the junction of the posterior arch and the lateral mass. A broad dorsal arch of the atlas is the best indication for this modified screw trajectory. However, in patients with ponticulus posticus, and resulting arcuate foramen carrying vertebral artery, it can be mistaken for a broad dorsal arch and the surgeon may insert the screw into the ponticulus posticus. This can result in an injury to the vertebral artery, and lead to stroke or even death by thrombosis, embolism, or arterial dissection [3].

In the western population, the prevalence of ponticulus posticus has been reported to be between 5.1% and 37.8% [2-3]. Our cervical spine radiographs results (complete 6.8% + Incomplete 8.02%) were in accordance with Kendrick and Biggs [10] (complete + incomplete 15.8%), Pyo and Lowman [11] (complete + incomplete 12.7%) studies. Dugdale [12] observed both complete (14.8%) and incomplete (11.7%) ponticulus posticus in high frequency compared to present and former studies. The low occurrence of the complete ponticulus posticus in cervical spine radiographs may be due to difficulties in visualization.

Cederberg et al [13] studied Ponticulus posticus in 255 subjects using lateral cephalographs. Ponticulus posticus partial and complete was found in 11% of the cases. No gender difference was reported and congenital origin of the anomaly was cited. Complete ponticulus posticus has been found to be between 2.6% and 14.3% in radiological and between 3.4% and 15% in osteological studies [14].

In a study done by V Sharma et al [15] on Indian Orthodontic patients, the authors found prevalence of complete ponticulus posticus as 4.3%, which is lower than ours (6.87%) and they also found male (5.33%) predominance over female (3.76%) in the population studies. In our study, complete ponticulus posticus is seen in 9.12% of males and 4.38% of females. The difference could be attributed to the different origin of population in both the studies.

Our results are within the reported range of incidence for children and adolescents. We found increasing percentages of patients with Ponticulus posticus from the youngest to the adolescent age group, with significantly greater incidence in patients aged 15-30 years compared with the younger groups. This suggests that ponticulus posticus bridges can form early in childhood (the youngest patient with a lesion in our series was 8 years of age) but they may form more frequently after puberty. Similar trends have been reported among patients in the first two decades [10,16].

There are a significantly greater number of complete bridges compared with partial Ponticulus posticus in children older than 15 years of age. This suggests that partial bridges progress to complete lesions as children age, a finding that has been reported previously in children [16, 17] and adults. Other authors [17, 18] have proposed that partial lesions result from a regressive loss of the middle part of the complete bridge [9, 18, 19] and that the lesions themselves regress with age [9, 10]. But the finding of a greater percentage of complete lesions in the older cohort suggests that this does not happen, at least in the first two decades.

Our results suggest that the presence of the Ponticulus posticus is a condition independent of age, as there is no statistical significant association between age and ponticulus posticus and therefore should not be considered a calcification or an ossification of the lateral segment of the posterior atlantooccipital ligament, but rather an ossification with functional significance, developed in other primates (Krishnamurthy et al., 2007) [20] in order to protect the passage of the vertebral artery in a region which, by its sinuosity, is susceptible to being damaged or compressed as a result of craniocervical dynamics.

This study found a slightly higher incidence as described in the literature (Young et al [3]. Simsek et al [21]. Cakmak et al [22]) and striking

difference in gender distribution, having a higher incidence in male patients (69.7%) than females (30.3%), which is consistent with from that described by Paraskevas et al [18].

CONCLUSION

In conclusion, the finding of ponticulus posticus is not a rare finding in childhood and adolescence, even in the first decade, and seems to become more common after the age of 13 years. It appears that incomplete ponticulus posticus lesions progress to complete bridges early in adolescence. It can be of great importance for patients, in whom these anomalies assume clinical significance during management of cervical spine surgical intervention, especially those requiring screw placements in the lateral mass region of atlas. As indicated by this study, it is a not an uncommon anomaly in the Indian population. Thus, care must be taken to account for it on lateral cephalograms of orthodontic patients. If any such anomaly is detected or suspected, it must be documented in the patient's health record and specialist consultation must be sought. A CT scan can be used to substantiate the size and morphology of the ponticulus, if required. Apart from this surgical aspect, it may assume significance in certain cases of headache and migraine. The lateral cervical lateral radiograph must thus be looked upon as a baseline screening tool for detecting anomalies and pathology in the cervical spine region.

Conflicts of Interests: None

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