

# Ponticulus Posticus: An Important Diagnostic Finding Often Missed in Lateral Cephalograms

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## ABSTRACT

**Aim:** The purpose of the current study was to investigate the presence of the ponticulus posticus (PP) frequently encountered in lateral cephalograms.

**Materials and methods:** About 500 patients of age 12–40 years were selected whose digital lateral cephalogram was recorded and traced to confirm the presence of the PP and categorize as: (A) Absent, as evidenced by lateral cephalograms. (B) Complete PP evidenced by the presence of circumferential bone bridge that connected the upper articular process to the atlas's posterior arch. (C) Partial PP: presented as a bone spike that protruded from the top articular process or the posterior arch of the atlas and extended above the vertebral artery sulcus. Symptoms of migraine, shoulder discomfort, orofacial pain, and headache were also evaluated on interaction with the patients. Using the Chi-square test, the relationship between the patient's gender and the presence of the PP was assessed. A  $p$ -value of 0.05 or less was regarded as statistically significant.

**Results:** About 10% of the patients reported with the presence of complete variant, 70% with partial variant and rest 20% of patients with neither a partial nor a complete form of PP. There was no statistically significant association between the PP and gender, as indicated by the Chi-square values (3.146;  $p = 0.526$ ).

**Conclusion:** On conclusion, according to the findings of the current study, patients with a complete form of PP experience more symptoms than those with a partial form of PP. In both groups, the PP frequency was higher in females.

**Clinical significance:** In lateral cephalograms, the cervical spine region is typically ignored and given little weight. A common variation of atlas vertebrae is the PP, which is located in the posterior arch of the atlas. The PP exacerbates symptoms, such as migraine, tension headaches, shoulder pain, double vision, vertigo, stroke, and pain in the neck and orofacial region. Therefore, orthodontic specialists serve as initial diagnosticians and direct the patients to qualified physicians so that they can experience symptom relief.

**Keywords:** Cervical spine, Diagnostic tool, Lateral cephalograms, Ponticulus posticus.

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## INTRODUCTION

One of the radiographs most frequently used for diagnosing orthodontic problems is the lateral cephalogram. The region of the cervical spine area is generally neglected though it is used to determine the growth status of the patients before doing a growth modification procedure. Although the cervical vertebrae maturation index (CVMI) is used to assess skeletal maturation and predict the growth potential of young patients, less focus is given to the region's radiological anatomy in order to detect severe disease. The lateral cephalogram reveals significant cervical spine pathology. Ponticulus posticus (PP) means "little posterior bridge" in Latin. It is defined as an abnormal small bony bridge which is 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.<sup>1</sup>

Its prevalence in the Western population has been estimated to range from 5.14 to 37.83%. However, there has not been any evidence of a significant variation in occurrence between men and women. In earlier studies about this foramen, investigators noted that it occurred in 9.8–25.9% of the general population.<sup>2</sup>

Because most patients with PP have symptoms, this observation may have clinical value. According to several research, patients with PP do not have a higher risk of suffering negative consequences from cervical modifications because of the presence of a posticulus posticus.<sup>3</sup> However, symptoms such as migraine, vertigo, diplopia, shoulder ache, and neck pain may be related to the PP. These symptoms may be brought on by the compression of the vertebral

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artery as it travels from the foramen transversum of the first cervical vertebra to the foramen magnum of the skull.<sup>4</sup>

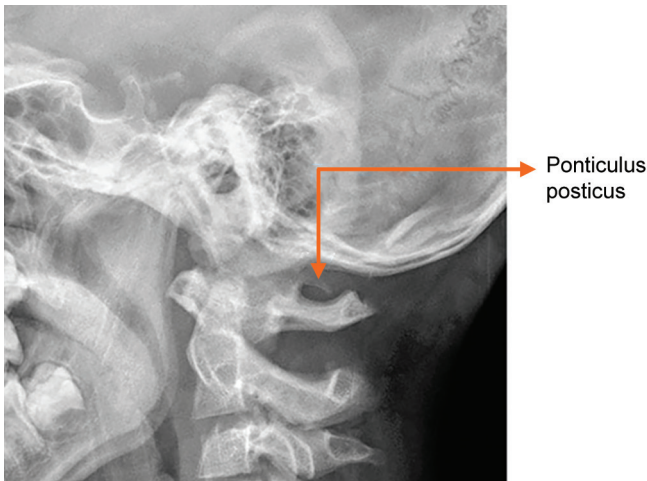


Fig. 1: Presentation of ponticulus posticus in lateral cephalogram

Three deviations of the typical variety can be seen radiographically: (1) complete form, (2) partial form, and (3) absent (calcified form) of PP.<sup>5</sup> A complete form has a fully formed bony ring, whereas a partial form has defects on the bony segments. The third type, absent/calcified type is an amorphous calcification or a linear structure.

Numerous names, including arcuate foramen, retroarticular foramen, Kimerle anomaly, and retrocondylar foramen, have been given to the ponticulus in literature. The PP exacerbates particularly in youngsters, movements like neck flexion and extension or persistent trauma in people with arcuate foramen can compress and impede vertebral artery movement, resulting in stroke also. The literature shows only a small number of studies conducted in an Asian population.<sup>7</sup> Therefore, the aim of the present study was to investigate the presence of the PP frequently encountered in lateral cephalograms.

## MATERIALS AND METHODS

### Patient's Selection Criteria

The present cross-sectional study comprised of 500 patients who were between the age of 12–40 years, and was conducted from the Department of Orthodontics and Dentofacial Orthopedics, Kalinga Institute of Dental Sciences (KIDS), Bhubaneswar, Odisha, India. The present study was conducted from February 2022 till August 2022. Institutional approval was obtained and informed consent was taken from all patients undergoing lateral cephalometric analysis. The current study excluded patients with syndromic disorders, such as cleft lip and palate, craniofacial trauma, poor display of the posterior arch of the first cervical vertebra due to overlapping of the mastoid process, and other congenital anomalies.

### Sample Size Calculation

The sample size was calculated using the following formula:

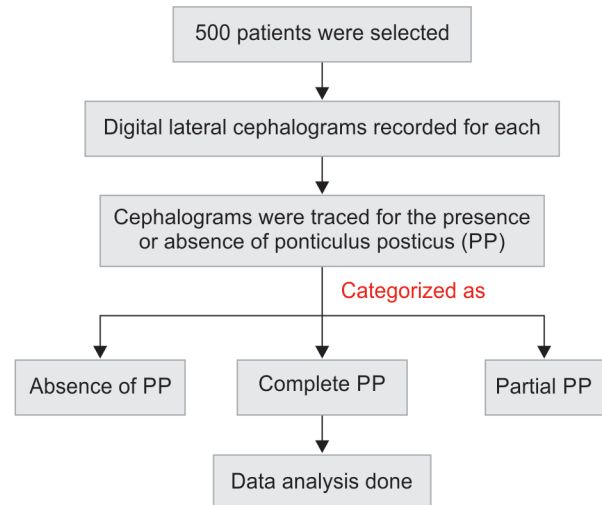
$$n = \frac{N}{1 + Ne^2}$$

where  $n$  – sample size,  $N$  – population size,  $e$  – level of precision is 95%, that is,  $e = 0.05$ .

### Investigators Calibration

The cephalograms (Fig. 1) were traced using a direct visual examination method in good illumination. In a pilot study

### Flowchart 1: Description of the present study



(30 samples), the cephalometric radiographs were performed by two investigators. One month following the initial evaluation, the same two investigators re-examined a random selection of cephalograms to ensure accuracy. Between the two investigators and the two examinations, a total agreement was observed.

### Evaluation of Digital Lateral Cephalograms for Ponticulus Posticus (Flowchart 1)

Digital lateral cephalograms were done by using digital lateral cephalometric system (Kodak). Each cephalogram was traced and looked for abnormalities in the cervical spine. The investigation excluded the lateral cephalometric radiographs with poor visualization of the posterior arch of the atlas caused by the occipital or mastoid process overlapping.

Radiographically, Miki et al.<sup>6–12</sup> have classified PP into three types:

- (A) **Absence of PP:** Ponticulus posticus is missing, as evidenced by lateral cephalograms.
- (B) **Complete PP:** There was a circumferential bone bridge that could be seen that connected the upper articular process to the atlas's posterior arch.
- (C) **Partial PP:** It was a bone spike that protruded from the top articular process or the posterior arch of the atlas and extended above the vertebral artery sulcus.

The two investigators were thoroughly examined for absent, complete, and partial PP. Additionally, Age, gender, and symptoms (migraine, shoulder discomfort, orofacial pain, and headache were verbally recorded) were recorded by the investigator.

### Statistical Analysis

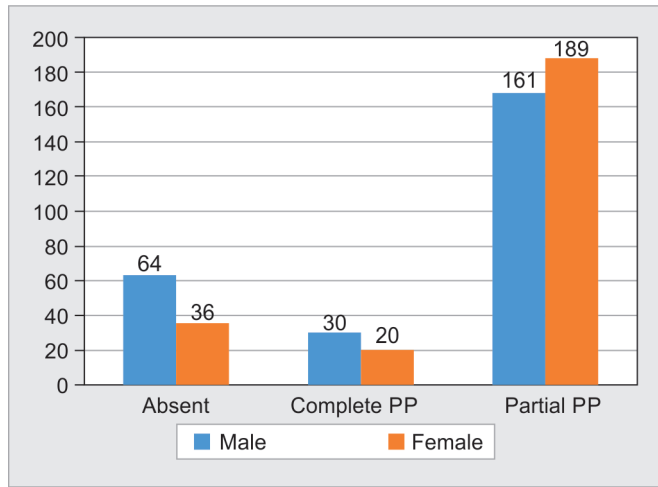
Data analysis was performed using IBM SPSS software version 23, and descriptive statistics were computed for the samples. Using the Chi-square test, the relationship between the patient's gender and the presence of the PP was assessed. A  $p$ -value of 0.05 or less was regarded as statistically significant.

## RESULTS

About 255 (51%) were males and 245 (49%) were females out of 500 cephalograms traced for PP. Complete type of PP was observed in 50 (10%) patients, among which 30 (60%) were males and 20 (40%)

**Table 1:** Prevalence of ponticulus posticus (PP) in the study population

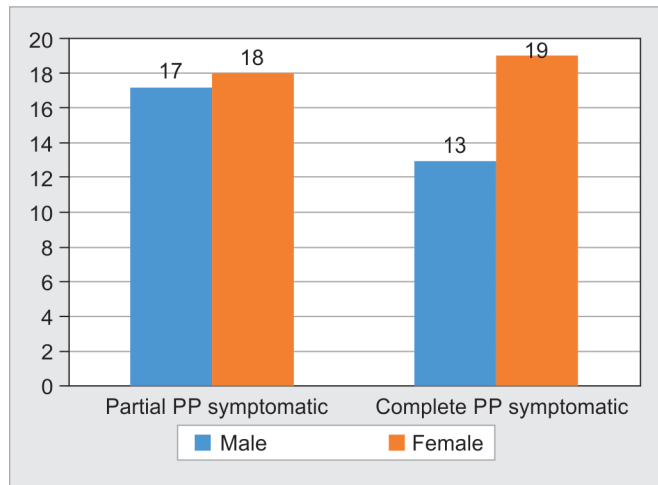
Type of PP	Absent	Complete PP	Partial PP
Male	64 (64%)	30 (60%)	161 (46%)
Female	36 (36%)	20 (40%)	189 (54%)



**Fig. 2:** Prevalence of absent, complete and partial ponticulus posticus (PP)

**Table 2:** Prevalence of symptoms of partial and complete ponticulus posticus (PP)

Type of PP	Partial PP symptomatic	Complete PP symptomatic
Male	17 (49%)	13 (40%)
Female	18 (51%)	19 (60%)



**Fig. 3:** Prevalence of symptoms of partial and complete ponticulus posticus (PP)

were females. The present results demonstrated partial PP in 350 patients (70%). Out of 350, 189 (54%) were females and 161 (46%) were males as depicted in Table 1 and Figure 2. In (20%) 100 cases (64 were males and 36 were females), PP was absent.

Table 2 and Figure 3 show, 32 (76%) patients with complete form of PP reported symptoms, whereas 35 patients (10%) with partial form of PP had symptoms. About 40% were males and

**Table 3:** Association of PP and gender using Chi-square test

	Values	df	p-value
Chi-square	3.146	2	0.526
Likelihood ratio	3.190	2	0.510
Number of valid cases	500		

60% were females who reported with symptoms in the complete variant of PP group. In the partial PP group, symptoms were almost equally present among both the genders. And 49% of the partial PP groups were males and 51% were females who reported with clinical manifestations. Both the groups reported with symptoms such as headache and migraine.

Table 3 depicts the association between PP and Gender using Chi-square test. The Chi-square values (3.146) show that there was no significant association between the PP and Gender ( $p = 0.526$ ).

The inference of the present study indicates the higher prevalence of symptoms in patients having a complete form of PP as compared with that in patients having partial PP. Females had a higher incidence of PP in both forms .

## DISCUSSION

Ponticulus posticus is a common anomaly which can be seen on two-dimensional radiographs such as lateral cephalogram whose anatomical importance is unknown. It has been hypothesized that in quadrupeds (early primates), the anomaly known as the arcuate foramen serves as an additional lateral extension for the attachment of the posterior atlanto-occipital membrane. However, in humans, it has vanished because the superior articular process of the atlas supports the head in a vertical position. Surgery on the cervical spine may become complicated if this abnormality is ignored.<sup>13</sup> As previous literature suggests, this was the first study to be carried out in the state of Odisha, India. Lateral cephalograms are routinely prescribed as a part orthodontic diagnostic process. Therefore, these cephalograms could be used to check for the abnormal cervical vertebra anomaly (ponticulus posticus). In orthodontics, identifying the PP is crucial as this anomaly is implicated in the development of otherwise unexplainable neck pain and headaches, visual disturbances, problems with speech and swallowing, vertigo, and vascular problems.

Previous research recommends that when conducting a similar type of study, the patients' occupation should be taken into account.<sup>9,14,15</sup> The present study could not reveal any relevance in taking this into account as PP was an anatomical variation of the cervical vertebrae.

According to the current study, partial foramen was more common in females (60%) than in males (40%) and complete foramen was significantly more common in males (60%) than in females (40%), respectively. Similar findings were obtained in a study conducted by Stubbs DM<sup>9</sup> from Augusta, the authors discovered a discrepancy in the presence of PP among various racial and sexual groups. About 25.9% of the participants in another study conducted by Taitz and Nathan<sup>16</sup> from Israel had partial PP, whereas 7.9% had total PP. These results were in contrast to those of the current study.

In the current study, when complete PP was analyzed, males had a higher predominance; however, when partial PP was evaluated, females had a larger predominance. The present study was comparable to that of Takaaki et al.,<sup>17</sup> who found that male's predominated more than female's in their study.

In the current investigation, the majority of individuals with complete PP displayed headache or migraine symptoms. In such patients, women were more prevalent. About 10% of the partial PP patients also had some hazy symptoms. In this group of patients as well, more females than males displayed symptoms.

The present study has great clinical relevance as clinicians must educate patients about anatomic bone defects discovered in their regular radiographs. The current study has significant therapeutic importance. If patients present with anatomical changes and related symptoms, they should be referred for additional advanced testing (computed tomography (CT) images and cone-beam computed tomography (CBCT) images). As a result, orthodontists serve as initial diagnostic decision-makers and recommend patients to the proper specialists so that they can get relief from their symptoms as soon as possible, and in some cases, avoid experiencing them altogether.

The study was limited in that the lateral cephalogram could not distinguish between unilateral and bilateral anomalies; hence, future investigations should be conducted prospectively taking into account every clinical aspect and paying particular attention to the specific standardization technique.

## CONCLUSION

On conclusion, according to the findings of the current study, patients with a complete form of PP experience more symptoms than those with a partial form of PP. In both groups, the PP frequency was higher in females.

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