

## Prevalence of Ponticulus Posticus in Different Skeletal Malocclusions and Growth Patterns: A Lateral Cephalometric Study

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### Abstract

**Objectives:** The present study aimed to evaluate the prevalence and type of ponticulus posticus (PP) in patients with different skeletal malocclusions and growth patterns using lateral cephalograms.

**Materials and Methods:** A total of 265 lateral cephalograms were evaluated. Skeletal malocclusions were categorised into Class I, II, and III, and growth patterns into horizontal, average, and vertical. PP was recorded as absent, partial, or complete. The collected data were subjected to descriptive statistical analysis.

**Results:** PP was identified in 59.6% of patients. The prevalence was highest in skeletal Class I subjects (37.7%) and horizontal growth patterns (24.9%). Partial PP was more common than complete PP in all groups. Females showed a slightly higher prevalence than males.

**Conclusion:** PP was a common anatomical variation in the studied population. Routine evaluation of the cervical vertebral region on lateral cephalograms may aid in comprehensive orthodontic diagnosis.

**Keywords:** Anatomy, cervical vertebrae, growth pattern, lateral cephalogram, ponticulus posticus.

### INTRODUCTION:

Lateral cephalograms are routinely used in orthodontics for the evaluation of craniofacial morphology, skeletal relationships, and skeletal maturation. Assessment of cervical vertebral maturation indicators (CVMI) on lateral cephalograms helps orthodontists determine growth potential and appropriate timing of treatment in growing patients.<sup>[1,2]</sup> In addition to growth assessment, these radiographs also provide visualisation of the cervical vertebrae and may help identify anatomical variations as incidental findings that can influence the holistic care of the patient.<sup>[2]</sup> The atlas, the first cervical vertebra, differs structurally from the other cervical vertebrae and contains a groove for the vertebral artery, venous plexus, and suboccipital nerve.<sup>[3]</sup> In some individuals, a bony bridge develops over this groove, forming an anatomical variation known as ponticulus posticus.<sup>[4]</sup> This may occur in complete or partial form and is commonly identified on routine lateral cephalograms. Previous studies have associated PP with headache, vertigo, neck pain, impacted canines, dental agenesis, and skeletal malocclusions.<sup>[5-10]</sup> Because the cervical vertebrae and craniofacial structures share common embryological origins, PP may be associated with skeletal malocclusions and growth patterns.<sup>[11,12]</sup>

### MATERIALS AND METHODS:

The ethical clearance was given by the Institutional Ethical Committee on 24 April 2024 in accordance with the Declaration of Helsinki (1964) (Project No.: IEC-2972). The requirement for informed consent was waived due to the retrospective nature of the study. The minimum sample size was calculated using OpenEpi software version 3.0 based on an expected prevalence of 23.5%, a confidence level of 95%, and confidence limits of 5%. The calculated sample size was 265. Data collection was performed using a convenience sampling method. Lateral cephalograms were obtained from the archives of the Department of Orthodontics and Dentofacial Orthopaedics. The radiographs included in the study were captured by an experienced technician using an Orthophos XG5 cephalometric unit (Dentsply Sirona, Germany) between April 2024 and December 2025. The inclusion criteria of the study specified patients aged 8-45 years, lateral cephalograms with clear visibility of the posterior arch of the atlas, and

radiographs obtained in the natural head position. Radiographs with poor image clarity, facial deforming pathologies, syndromic conditions, and a history of craniofacial trauma or surgery were excluded from the study. Skeletal malocclusions were categorised into Class I, II, or III groups based on ANB angle and Wits appraisal, while growth patterns- horizontal, average, and vertical- were determined using Jarabak's ratio and the SN-GoGn angle. Concurrently, the presence of PP was documented as absent, partial, or complete. The morphology of PP was categorised as partial or complete according to Lo Giudice et al. <sup>[17]</sup>. The complete type was defined as the presence of a complete bony ring over the posterior arch of the atlas [Figure 1], whereas the partial type was defined as a bony bridge extending more than halfway from the articular process toward the posterior arch without complete fusion [Figure 2]. The collected data were entered into Microsoft Excel 2021 and subjected to descriptive statistical analysis. The findings were expressed as frequency and percentage.



**Figure 1: Complete-type ponticulus posticus. Figure 2: Partial-type ponticulus posticus.**

## RESULTS:

A total of 265 lateral cephalograms were evaluated. The mean age of the participants was  $17.7 \pm 4.57$  years, with an age range of 8-45 years. Females constituted 51.7% (n=137) of the study population, while males constituted 48.3% (n=128) [Table 1]. PP was identified in 158 subjects, showing an overall prevalence of 59.6%. Among skeletal malocclusions, PP was most commonly observed in skeletal Class I subjects (37.7%, n=100), followed by Class II (15.8%, n=42) and Class III (6.1%, n=16). Partial PP was more common than complete PP in all skeletal malocclusion groups [Table 2]. Based on growth patterns, PP was most frequently observed in subjects with a horizontal growth pattern (24.9%, n=66), followed by an average growth pattern (18.5%, n=49) and a vertical growth pattern (16.2%, n=43). Partial PP was more prevalent than complete PP across all growth pattern groups [Table 3].

| Growth Pattern | Partial PP n (%) | Complete PP n (%) | Total PP n (%) |
|----------------|------------------|-------------------|----------------|
| Horizontal     | 56 (21.1)        | 10 (3.8)          | 66 (24.9)      |
| Average        | 45 (17.0)        | 4 (1.5)           | 49 (18.5)      |
| Vertical       | 34 (12.8)        | 9 (3.4)           | 43 (16.2)      |
| Total          | 135 (50.9)       | 23 (8.7)          | 158 (59.6)     |

**Table 1: Distribution of Patients According to Gender**

**Table 2: Prevalence of Ponticulus Posticus Among Skeletal Malocclusion Groups**

| Skeletal Class | Partial PP n (%) | Complete PP n (%) | Total PP n (%) |
|----------------|------------------|-------------------|----------------|
| Class I        | 89 (33.6)        | 11 (4.2)          | 100 (37.7)     |
| Class II       | 35 (13.2)        | 7 (2.6)           | 42 (15.8)      |
| Class III      | 11 (4.2)         | 5 (1.9)           | 16 (6.1)       |
| Total          | 135 (50.9)       | 23 (8.7)          | 158 (59.6)     |

| Variable | n   | Percentage (%) |
|----------|-----|----------------|
| Female   | 137 | 51.7           |
| Male     | 128 | 48.3           |
| Total    | 265 | 100            |

**Table 3: Prevalence of Ponticulus Posticus Among Growth Patterns**

## DISCUSSION:

PP is a relatively common anatomical variation of the atlas vertebra that may be identified during routine orthodontic radiographic examination.<sup>[1]</sup> Although it is often considered an incidental finding, increasing evidence suggests that it may have developmental, clinical, and orthodontic significance. In the present study, PP was identified in 59.6% of the subjects. This finding indicates that PP is a common radiographic observation in the studied orthodontic population. Considerable variation in prevalence has been reported in the literature, ranging from low prevalence in certain populations to markedly higher values in others. Such differences may be attributed to ethnic variation, differences in imaging modalities, observer interpretation, diagnostic criteria, and sample characteristics.<sup>[2,4,11]</sup> Despite these variations, most studies agree that PP is a clinically relevant anatomical finding that should not be overlooked during routine radiographic evaluation. Among the skeletal malocclusion groups, PP was most frequently observed in skeletal Class I subjects, followed by skeletal Class II and Class III subjects. Similar observations have been reported by Darwin et al.<sup>[1]</sup> and Adisen and Misirlioglu.<sup>[10]</sup> However, some previous investigations have reported a greater prevalence in skeletal Class III subjects, suggesting that the association between PP and sagittal skeletal relationships may vary among populations.<sup>[16]</sup> Such differences may be related to genetic influences, racial variation, environmental factors, and differences in sample distribution. Nevertheless, the presence of PP across all skeletal malocclusion groups supports the concept that cervical vertebral morphology and craniofacial structures share common developmental pathways. The embryological basis of PP may explain its association with craniofacial morphology. Neural crest cells play a major role in the development of the craniofacial skeleton, cervical vertebrae, and dental structures. Alterations during this developmental process may therefore result in both cervical vertebral anomalies and dentoskeletal variations.<sup>[12,16]</sup> This developmental relationship may explain why PP has been reported in association with several orthodontically relevant conditions, including impacted canines, dental agenesis, cleft lip and palate, and skeletal discrepancies.<sup>[5,9]</sup> In the present study, partial PP was more frequently observed than complete PP in all malocclusion and growth pattern groups. Similar findings have been reported in previous studies evaluating PP morphology.<sup>[13,14]</sup> Partial ossification may represent an early or incomplete stage in the development of the anomaly, whereas complete ossification may indicate more advanced calcification of the atlanto-occipital ligament. The greater prevalence of partial PP observed in the present study supports the view that incomplete ossification is the more common variant. Among the different growth patterns, PP was most commonly observed in subjects with a horizontal growth pattern. This finding further supports the developmental association between cervical vertebral morphology and

craniofacial growth pattern. Since the cervical vertebrae contribute to postural balance and craniofacial development, morphological variations in this region may influence dentofacial growth and skeletal relationships.<sup>[12]</sup> Although the exact mechanism underlying this association remains unclear, the findings of the present study suggest that careful evaluation of cervical vertebral structures may provide additional diagnostic information during orthodontic assessment. The orthodontic significance of PP extends beyond its identification as a simple anatomical variation. Studies have reported associations between PP and neurovascular symptoms such as headache, vertigo, migraine, cervical pain, tinnitus, and vertebrobasilar insufficiency.<sup>[8,9]</sup> Complete forms of PP may allow the vertebral artery and suboccipital nerve to pass through the bony canal, potentially predisposing certain individuals to neurovascular compression. Although clinical symptoms were not assessed in the present study, identification and documentation of PP is important during patient evaluation, particularly in individuals presenting with unexplained cervical or neurological symptoms. The findings of the present study also emphasise the importance of careful radiographic interpretation by orthodontists. Lateral cephalograms are routinely obtained for orthodontic diagnosis and treatment planning and can effectively visualise the cervical vertebrae up to the C5 level while exposing the patient to relatively lower radiation compared with CBCT imaging. Although CBCT provides superior three-dimensional visualisation of PP morphology, lateral cephalograms remain a practical, accessible, and radiation-conscious screening tool during routine orthodontic practice.<sup>[14,15]</sup> The wide variation in the morphology and appearance of PP may not always be fully appreciated on two-dimensional radiographs. However, when interpreted carefully, lateral cephalograms provide valuable opportunities for early recognition of this anatomical variation. Therefore, orthodontists can play an important role not only in identifying dentofacial abnormalities but also in recognising cervical vertebral variations that may have broader clinical significance. Early identification and documentation of PP may contribute to comprehensive diagnosis, interdisciplinary referral when required, and improved overall patient care.

## CONCLUSION:

PP was found to be a relatively common anatomical variation in the studied orthodontic population, with partial PP occurring more frequently than the complete ring form. Since lateral cephalograms are routinely used in orthodontic diagnosis and treatment planning, careful evaluation of the cervical vertebral region may aid early identification of the anatomical variation and contribute to more comprehensive diagnosis and patient care.

## LIMITATIONS:

1. The study was based on lateral cephalograms, which provide a two-dimensional image and may not demonstrate the exact morphology of PP as accurately as CBCT imaging.
2. As the present study was retrospective in nature, correlation of PP with associated clinical symptoms could not be assessed.
3. The study was conducted using archived radiographs from a single institution, which may limit the diversity of the samples.

## FUTURE PROSPECTS:

1. Further studies with a larger sample size are recommended to better evaluate the association of ponticulus posticus with different skeletal malocclusions and growth patterns.
2. Future studies using three-dimensional imaging modalities such as CBCT may provide more accurate assessment of the morphology and clinical significance of PP.
3. Additional research correlating PP with clinical symptoms and other craniofacial anomalies may help in relating its orthodontic implications with clinical relevance.

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