

Correlation of Ponticulus Posticus with Dentofacial Skeletal Patterns

Abstract

Background: This study aimed to assess the correlation of ponticulus posticus (PP) with dentofacial skeletal patterns on lateral cephalograms of an Iranian population. **Methods:** This retrospective study evaluated 1000 lateral cephalograms of 690 females and 310 males. Demographic information of patients was recorded, and two observers evaluated all radiographs for the presence of PP. The dentofacial skeletal pattern was also determined as Class I, II, or III. Disagreements were resolved by discussion with a third observer. Data were analyzed using the Chi-square test. **Results:** The mean age of patients was 19.47 ± 8.37 years (range 7–64 years). The prevalence of PP was 38.3%. PP had a significant correlation with gender ($P = 0.022$) such that PP was more common in males (43.5%). No significant correlation was noted between PP and age or dentofacial skeletal pattern ($P > 0.05$). **Conclusions:** PP was relatively common in our study population. PP had no correlation with age or dentofacial skeletal pattern of patients.

Keywords: Arcuate foramen, atlas, dentofacial skeletal pattern, lateral cephalometry, ponticulus posticus

Introduction

The atlas is the first (most superior) cervical vertebra of the spine, which can have morphological variations and characteristics that distinguish it from the other vertebrae.^[1] Ponticulus posticus (PP) is a small abnormal posterior bridge, which forms between the posterior segment of the superior articular eminence and the posterolateral part of the superior margin of the posterior arch of the atlas. PP is also known as the arcuate foramen, foramen arcuate atlantis, posterior ponticle, or Kimerle anomaly.^[2] It can completely or partially surround the vertebral artery and the first cervical nerve root.^[1,3] It reportedly has a prevalence of 1.3%–45.9%, and its prevalence is not significantly different between males and females. This anomaly is bilateral in 5.4% and unilateral in 7.5% of the patients.^[1-9]

It has been reported that some conditions such as headache, neck pain, migraine without aura, initiation of hearing loss, photophobia, and tension-type chronic headaches are related to the presence of PP.^[2-4,10] Furthermore, it is important to identify PP to determine the site of entry of

screw to the lateral masses of atlas because some surgeons have pointed to the risk of acute complications such as traumatization of the vertebral artery in surgical procedures of this region.^[7]

Lateral cephalometry is highly popular in orthodontics. Cephalometric radiographs are requested to evaluate the stage of skeletal maturation and dentofacial skeletal pattern. However, they can also provide other diagnostic information about the cranium and cervical vertebra and the craniofacial and dental variations.^[2,11-15] Such information may be valuable for early detection of developmental problems.^[11,14,16] The variations in shape, size, form, and contour of anatomical landmarks are multiple and confusing. Thus, care must be taken to precisely assess these anatomical variations in different populations.^[17]

Correlations have been reported between the morphology of the vertebral column and position of the mandible.^[18,19] This relationship may be based on the involvement of neural crest cells and/or homeobox or hox genes during growth and development stage, affecting tooth formation and eruption, cervical vertebra, and jaws development.^[20,21]

There is a gap of information regarding the prevalence of PP in Iran and its correlation

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with dentofacial skeletal patterns.^[2,5,6] Thus, this study aimed to assess the correlation of PP with dentofacial skeletal patterns on lateral cephalograms of an Iranian population.

Methods

This descriptive, cross-sectional study evaluated the lateral cephalograms of patients retrieved from the archives of three private orthodontic offices in Kermanshah city. The study protocol was approved by the institutional review board of Kermanshah University of Medical Sciences (IR. KUMS.REC.1397.049).

Sample size was calculated to be 1000 according to a study by Adisen and Misirlioglu^[2] that reported the prevalence of PP to be 22.8% and 15.9% in males and females, respectively, assuming $\alpha = 0.05$, power of 90%, and accuracy (d) of 0.085. Lateral cephalograms were selected using convenience sampling.

Lateral cephalograms had been taken from January 2016 to July 2018 for orthodontic treatment planning and diagnostic purposes. The pretreatment radiographs of three private orthodontic offices were searched randomly until the desired number of eligible cephalograms was reached.

All 1136 lateral cephalograms of patients between 18 and 25 years were first retrieved. Of all, 136 lateral cephalograms were excluded due to the invisibility of PP or other cephalometric points, wrong head posture, and blurring.

All cephalograms had been taken with teeth in occlusion, lips at rest, and head in standard position (Frankfurt plane parallel to the horizontal plane) by an experienced technician using Soredex (Helsinki, Finland) cone-beam computed tomography (CBCT) scanner with the exposure settings of 73 kVp, 10 mA, and 11 s. The lateral cephalograms were saved in JPEG format and displayed on a 14-inch laptop monitor with 300 dpi resolution in a semi-dark room.

For each lateral cephalogram, demographic information of patient (age and gender), presence/absence of PP, its level of development if PP was present (complete or partial), and dentofacial skeletal pattern were all recorded.

Development of PP on the atlas was classified as (I) absence of any bony process, (II) incomplete formation of PP, or (III) complete formation of a bony bridge [Figure 1].

The dentofacial skeletal pattern [Figure 2] was determined by an orthodontist based on the ANB angle and the Wits appraisal. The skeletal pattern was categorized as Class I when the ANB angle was $0^\circ \pm 2^\circ$ and the Wits appraisal was 4 mm, Class II when the ANB angle was $>4^\circ$ and the Wits appraisal was >4 mm, and Class III when the ANB angle was $<0^\circ$ and the Wits appraisal was <0 mm.^[22,23]

All cephalograms were evaluated for the presence of PP by an expert oral and maxillofacial radiologist and an expert orthodontist. Disagreements were resolved by discussion

with a third observer. Furthermore, 20% of cephalograms were evaluated again by one of the observers. To assess the intraobserver agreement, all cephalograms were assessed again for the presence of PP and its development, and other measurements were repeated again after 2 weeks by the same observers, and the results of the first and second observations were compared.

Data were analyzed using SPSS version 25 (SPSS Inc., IL, USA). The Chi-square test was used to compare the presence of PP between males and females, age groups, and dentofacial skeletal patterns. Level of significance was set at 0.05.

Results

This study evaluated the lateral cephalograms of 690 females (69%) and 310 males (31%) with a mean age of 21.61 ± 2.21 years. Table 1 shows the prevalence of PP and dentofacial skeletal pattern of subjects.

No significant correlation was noted between the prevalence of PP and dentofacial skeletal pattern ($P = 0.571$). No significant correlation was noted between the type of PP and dentofacial skeletal pattern either [$P = 0.565$, Table 2].

A significant correlation was noted between gender and PP ($P = 0.022$) such that the prevalence of PP was higher



Figure 1: Development of ponticulus posticus. (a) Complete ponticulus posticus, (b) incomplete ponticulus posticus

Table 1: Prevalence and type of ponticulus posticus and dentofacial skeletal pattern

	Frequency (%)
Ponticulus posticus	
Absence	617 (61.7)
Presence	383 (38.3)
Type of ponticulus posticus	
Incomplete	229 (59.8)
Complete	154 (40.2)
Dental occlusion	
Class I	278 (27.8)
Class II	582 (58.2)
Class III	140 (14.0)

Table 2: Prevalence and type of ponticulus posticus based on dentofacial skeletal pattern

Dental occlusion	Ponticulus posticus		Type of ponticulus posticus	
	Absence, n (%)	Presence, n (%)	Incomplete, n (%)	Complete, n (%)
Class I	169 (60.8)	109 (39.2)	61 (56.0)	48 (44.0)
Class II	356 (61.2)	226 (38.8)	140 (61.9)	86 (38.1)
Class III	92 (65.7)	48 (34.3)	28 (58.3)	20 (41.7)
<i>P</i>	0.571		0.565	

Table 3: Prevalence of ponticulus posticus based on gender

Gender	Ponticulus posticus		Type of ponticulus posticus	
	Absence, n (%)	Presence, n (%)	Incomplete, n (%)	Complete, n (%)
Female	442 (64.1)	248 (35.9)	157 (63.3)	91 (36.7)
Male	175 (56.5)	135 (43.5)	72 (53.3)	63 (46.7)
<i>P</i>	0.022		0.057	

Table 4: Prevalence of ponticulus posticus based on gender and dentofacial skeletal pattern

Gender	Ponticulus posticus		Type of ponticulus posticus	
	Absence, n (%)	Presence, n (%)	Incomplete, n (%)	Complete, n (%)
Female, dental occlusion				
Class I	112 (65.9)	58 (34.1)	33 (56.9)	25 (43.1)
Class II	274 (62.6)	164 (37.4)	108 (65.9)	56 (34.1)
Class III	56 (68.3)	26 (31.7)	16 (61.5)	10 (38.5)
Male, dental occlusion				
Class I	57 (52.8)	51 (47.2)	28 (54.9)	23 (45.1)
Class II	82 (56.9)	62 (43.1)	32 (51.6)	30 (48.4)
Class III	36 (62.1)	22 (37.9)	12 (54.5)	10 (45.5)

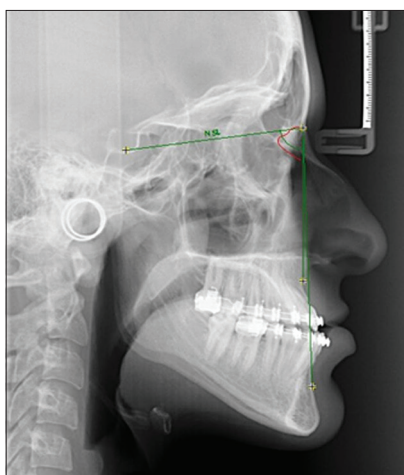


Figure 2: Skeletal relationship in the sagittal plane to determine the dentofacial skeletal pattern according to the Angle's classification

in males. The prevalence of complete PP was also higher in males; although the correlation between the type of PP and gender was not significant [$P = 0.057$, Table 3].

The maximum prevalence of PP in females was in Class II patients, while the maximum prevalence of PP in males was in Class I patients. The highest prevalence of complete PP in females was recorded in Class I patients, while the highest prevalence of complete PP in males was recorded in Class II patients [Table 4].

Discussion

This study assessed the correlation of PP with dentofacial skeletal patterns on lateral cephalograms of an Iranian population.

Development of PP was classified as absence of PP, complete PP, and partial PP. The prevalence of PP was found to be 38.3%. No significant correlation was noted between PP and dentofacial skeletal pattern or age, but PP and gender were significantly correlated, and its prevalence was 43% in males and 35.9% in females. Previous studies have reported the prevalence of PP to be 4.3%–46%.^[1,2,7,9,24-28] Such differences can be due to the methodology, type and number of samples, and different inclusion and exclusion criteria. Higher prevalence of PP in our study compared with the studies by Sharma *et al.*,^[24] and Mudit *et al.*^[9] were due to larger sample size, wide age range, and racial differences among patients. In a meta-analysis, Elliott and Tanweer^[26] indicated that the accuracy of assessment of corpse was higher than that of computed tomography (CT), and the accuracy of CT was higher than that of lateral cephalometry for this purpose. This finding can also explain the difference in prevalence values of PP in different studies.

In our study, the prevalence of complete and partial PP was 40.2% and 59.8%, respectively, and PP was significantly

more common in males than females (43.5% vs. 35.9%, respectively). No significant correlation was noted between the type of PP (partial/complete) and gender, age, or dentofacial skeletal pattern. However, the complete type was more common in male Class II patients, while the partial type was more common in female Class II patients. Adisen and Misirlioglu^[2] in a similar study found no significant difference between the prevalence of partial and complete types based on gender or dentofacial skeletal pattern of patients.

Some studies have demonstrated a correlation between anomalies of the cervical vertebrae and mandibular position.^[2,29,30] We found no significant correlation between PP and dentofacial skeletal pattern. Adisen and Misirlioglu^[2] reported that PP was more common in Class III patients, followed by Class I and Class II patients; however, this difference was not significant, and this finding was in line with our results. Kamak and Yildirim^[31] evaluated anomalies of the cervical vertebrae among different classes of occlusion and found no significant association in this respect. Haji Ghadimi *et al.*^[32] showed that PP was not correlated with Class I or Class II malocclusion. However, they failed to find a significant correlation between Class III malocclusion and PP. They explained that not finding a significant correlation was due to small number of Class III patients in their study. We found the same results despite the fact that we had a larger sample size than theirs.

Considering the significance of PP and its relatively high prevalence in the Iranian population residing in the West of Iran (38.3%), it is recommended to evaluate PP on lateral cephalograms before surgical procedures of the first cervical vertebra. In case of visualization of PP, three-dimensional (3D) imaging can be requested to determine its exact size and shape.

This study had some limitations with regard to the use of lateral cephalometry. Although lateral cephalometry is an efficient tool for the detection of PP, previous studies using both lateral cephalometry and CT scan have reported significantly higher prevalence of PP and partial bridges on 3D CT scans.^[7,33] These findings suggest that one-dimensional radiography may underestimate the prevalence of PP. Moreover, lateral cephalometry cannot help in determination of unilateral or bilateral presence of PP, and the 3D morphology of PP cannot be reconstructed. Future multicenter studies using CBCT or CT are required to confirm and validate the findings of this study.

Last but not least, this study had a retrospective design and we had no information about pain in patients to assess the relationship of the presence of PP and facial pain.

Conclusions

Based on the results of this study, there is no significant correlation between the occurrence or type (partial/complete) of PP and gender or dentofacial skeletal pattern of patients.

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Conflicts of interest

There are no conflicts of interest.

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