Associação Radiográfica entre Ponticulus Posticus e as alterações Morfológicas Condilares

Radiographic Association between Ponticulus Posticus and Changes in condylar Morphology

Delise Pellizzaro[a]*; Marcelo Gonçalves[a]; Guilherme Monteiro Tosoni[a];
Edwin Fernando Ruiz Contreras[b]; Andrea Gonçalves[a]

[a]Universidade Estadual Paulista Júlio de Mesquita Filho, Programa de Pós-Graduação Stricto Sensu em Odontologia.
[b]Universidade Estadual de Londrina.
*E-mail: delisepellizzaro@yahoo.com.br

Resumo

O ponticulus posticus (PP) é definido como uma pequena ponte óssea formada entre a porção posterior do processo articular superior e a porção posterolateral da margem superior do arco posterior da vértebra atlas. A fisiopatologia do PP pode ser relatada pela compressão vascular da artéria vertebral e nervo suboccipital, levando a isquemia circulatória e dor de cabeça cervicogênica, ou por disfunção mecânica da articulação atlanto-occiptal, resultando no tracionamento da dura máter ou iniciando um processo neurodinâmico. O objetivo deste estudo foi avaliar a associação entre PP e alterações morfológicas condilares, por meio das radiografias panorâmicas e teleradiografia lateral. Foram selecionados 1200 pacientes que realizaram documentação ortodôntica em uma clínica de radiologia. O PP foi avaliado e classificado em parcial ou completo. Os dados foram tabulados no SPSS e analisados por regressão logística multinomial. Houve diferença estatística significativa na prevalência do PP parcial entre homens e mulheres (P< 0,001), com odds ratio de 1,91 (95% IC 1,34-2,71), e na prevalência do PP complete (P = 0,002), com odds ratio de 1,72 (95% IC 1,21-2,43). Diferença estatística também foi encontrada na associação entre alteração morfológica condilar e PP complete (P = 0,004). Concluiu-se que o PP é mais prevalente em homens e que existe correlação entre a presença do PP completa e alterações morfológicas condilares.

Palavras-chave: Radiografia. Atlas cervical. Côndilo Mandibular.

Abstract

The ponticulus posticus (PP) is 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. The pathophysiology may be related to pressure applied on the vertebral artery and the suboccipital nerve root, and may be a possible cause of posterior circulation ischaemia and cervicogenic headache, or mechanical dysfunction at the atlanto-occipital joint resulting in traction of the dura mater or initiation of neurodynamic processes. The objective was to determine the prevalence of PP and to assess whether there is an association between this condition and changes in condylar morphology, evaluated using digital panoramic and lateral cephalometric radiographs. A sample of 1200 patients was selected. The patients were referred to a radiology clinic for orthodontic evaluation. PP was classified as either partial or complete PP. Data were entered into an SPSS spreadsheet and analysed by multinomial logistic regression. There was a significant difference in the prevalence of partial PP between males and females (P< 0.001), with an odds ratio of 1.91 (95% CI 1.34-2.71), and in the prevalence of complete PP (P = 0.002), with an odds ratio of 1.72 (95% CI 1.21-2.43). A significant difference was found for the association between condylar morphological changes and complete PP (P = 0.004). It was concluded that PP is more prevalent in men, and there is a correlation between the presence of complete PP and changes in condylar morphology.

Keywords: *Radiography. Cervical atlas. Mandibular condyle.*

1 Introduction

In Latin, ponticulus posticus - PP means “little posterior bridge”. It is defined as an abnormal small bony bridge that 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.[1-3] Historically, the PP has been referred to by many names including Kimmerle anomaly, foramen sagitale, atlantal posterior foramen, arcuate foramen and upper retroauricular foramen.[4,5] Its prevalence has been reported to be between 5-38%, depending on the population and age group studied.[1,6,7] A range of factors including genetic factors,[8] ossification caused by age[1,9] or external mechanical factors, such as carrying heavy objects on the head,[10] have been suggested to be possible causes of PP formation.

Various techniques have been used to evaluate the prevalence of PP in different populations, but most are diagnosed by plain radiographs.[11]. The lateral cephalogram is the most common diagnostic radiograph used in orthodontics, and allows visualisation of the presence of PP.[12] Radiographically, PP can be classified into two types: complete form, defined as a clear bony bridge between the superior articular process and the posterior arch of the atlas (forms a complete bone ring); and partial form, defined as a distinct bone spicule that extends from the superior articular facet overhanging the dorsal arch (some portions of the bone ring are defective).[1,2,13] Although radiologists and orthodontists are not responsible for treatment of cervical spine anomalies, they should carefully evaluate lateral cephalograms for cervical spine anomalies as these may be indicators for underlying

disease processes.[3,12]

The pathophysiology of PP may be related to the pressure applied on the vertebral artery and the suboccipital nerve root.[11] The presence of PP is a possible cause of posterior circulation ischaemia and cervicogenic headache,[1] or mechanical dysfunction at the atlanto-occipital joint resulting in traction of the dura mater or initiation of neurodynamic processes.[3]

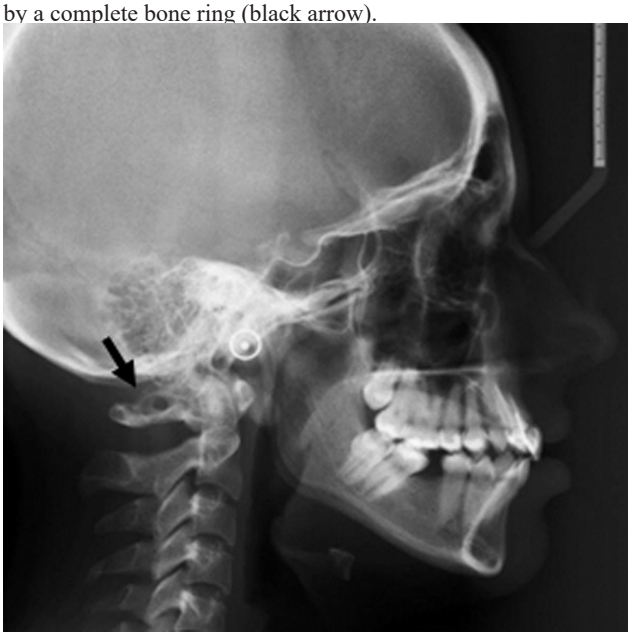
In regard to clinical significance, patients with PP can be either symptomatic or asymptomatic.[5] The presence of PP has been associated with symptoms such as headaches (migraine and chronic tension-type), neck and cervical pain, acute hearing loss and vertigo.[14] Patients often report headaches and neck pain[4] without any apparent dental causes. This pain may be related to the presence of PP, which can be easily identified on lateral cephalograms. The symptoms of PP are similar to patients with changes in condylar morphology;[15] however, no studies in the literature have investigated whether there is an association. Thus, the aim of this study was to determine the prevalence of PP in patients with orthodontic indications, and to assess whether there is an association between this condition and changes in condylar morphology.

2 Material and Methods

This cross sectional, observational retrospective study was approved by Ethics Committee of Araraquara Dental School - Universidade Estadual Paulista (CAAE 41353214.6.0000.5416). A radiographic exams of 1200 patients (including 480 male and 720 female), ranging from 4 to 74 years, was randomly selected from clinical records of the private Radiology clinic. These patients performed on standard orthodontic documentation between January and July 2015. Digital panoramic and lateral cephalometric radiographs were obtained using Planmeca ProMax (Planmeca Inc., Helsinki, Finland). Only radiographic images that presented congenital anomalies were excluded from the study. No clinical analysis was performed, only image analysis by the same radiologist with 5 years' experience. The lateral cephalometric radiographs were carefully analysed for the presence or absence of PP, and where present, PP was further defined as either the partial (Figure 1) or complete (Figure 2) form. The complete form was defined as a clear bone bridge between the superior articular process and the posterior arch of the atlas. The partial form was considered a distinct bony spicule extending from the superior articular facet overhanging the dorsal arch. The presence of condylar morphological changes (flattening, osteophyte formation, cortical erosions and irregularities) on the left side, right side or both sides was evaluated using digital panoramic radiography. A single oral and maxillofacial radiologist read all the images to ensure consistency.

Figure 1 - Partial form of ponticulus posticus (black arrow) showing an incomplete bony ring.

Figure 2 - The complete form of ponticulus posticus characterised by a complete bone ring (black arrow).



The complete form was defined as a clear bone bridge between the superior a

Statistical analysis was conducted using Statistical Package for the Social Sciences (SPSS) 15.0 for Windows (SPSS, Chicago, IL, USA). Data were entered into an SPSS spreadsheet and analysed by multinomial logistic regression.

3 Results and Discussion

The assessment of 1200 lateral cephalograms revealed PP in 308 patients. Out of these patients, 150 were partial and 158 were complete (Table 1).

Table 1 - Distribution of ponticulus posticus prevalence according to gender.

Ponticulus Posticus	Gender		Total
	Male	Female	
Absence	**322** (67.1%)	**570** (79.2%)	**892** (72.3%)
Present	**158** (32.9%)	**150** (20.8%)	**308** (25.7%)
	Partial 80 (16.7%) Complete 78 (16.2%)	Partial 70 (9.7%) Complete 80 (11.1%)	
Total	**480** (100.0%)	**720** (100.0%)	**1200** (100.0%)

Fonte: Dados das pesquisa.

From cases with partial PP, 80 were identified in males and 70 in females and from those with complete PP, 78 were males and 80 were females (Table 1). There was a significant difference between males and females for the prevalence of partial PP ($P < 0.001$), with an odds ratio of 1.91 (95% CI 1.34, 2.71), and for the prevalence of complete PP ($P = 0.002$), with an odds ratio of 1.72 (95% CI 1.21, 2.43; Table 3).

Condylar morphological changes were found in 274 patients, of which 38 had partial PP, 52 had complete PP and 184 did not have PP (Table 2).

Table 2 - Distribution of the prevalence of ponticulus posticus and condylar morphological changes.

Ponticulus posticus	Condylar morphological changes		Total
	Absence	Present	
Absence	**708** (79.4%)	**184** (20.6%)	**892** (100.0%)
Present	**218** (70.8%)	**90** (29.2%)	**308** (100.0%)
	Partial 112 (36.4%) Complete 106 (34.4%)	Partial 38 (12.3%) Complete 52 (16.9%)	
Total	**926** (77.1%)	**274** (22.9%)	**1200** (100.0%)

Fonte: Dados das pesquisa.

There was a significant difference for the association between condylar morphological changes and complete PP ($P = 0.004$; Table 3).

Table 3 - Regression analyses** for the association between ponticulus posticus and condylar morphological changes according to gender.

Ponticulus posticus		P	Odds ratio (OR)	95% confidence interval	
Partial	Gender (M/F)	**<0.001***	1.91	1.34	2.71
	Condylar morphological changes (No/Yes)	0.113			
Complete	Gender (M/F)	**0.002***	1.72	1.21	2.43
	Condylar morphological changes (No/Yes)	**0.004***			

* Statistically significant difference detected by regression analysis.
** Model fitting for age

Fonte: Dados das pesquisa.

Over the past 50 years, there has been greater awareness for how minor anomalies of the atlanto-occipital region, such as PP, can cause pathophysiological conditions of clinical significance.[9]

The prevalence of PP has been reported to range from 5–38% depending on the population and age group studied.[1,6,16-18] Our results corroborate the findings from others studies in the literature,[1,16,18] with an observed prevalence of 25.7% PP in our studied sample. Previous authors[7] investigated the presence of PP from cone beam computed tomography (CBCT) and reported that the distribution of PP was higher in males (42.5%) than in females (36.6%). Consistent with this, we found a higher prevalence of PP in males (32.9%) than females (20.8%) for both the complete and partial forms. On the other hand, few previous studies did not identify a significant difference in prevalence between genders.[11,17]

The origin of PP is not yet well known.[18] Among the hypotheses proposed in the literature, an embryonic origin seems to be the most supported.[12] The presence of lamellar patterns within the bone matrix and a cortex indicating endochondral ossification suggests that PP may originate from the dorsal arch of the proatlas.[4,12] We believe that the higher prevalence observed in males may also be related to genetic factors, as the bone mass is higher in males than in females. This gender disparity is present early in life, and is considered an important factor during growth, regulating the size and/or density of the bone.[19]

To our knowledge, the present study is the first to investigate the association between PP and condylar morphological changes. These changes were found in 20.6% of the patients with an absence of PP and in 29.2% of the patients with PP. Condylar bone changes, such as flattening and osteophyte formation, are more common in patients with an altered mandibular position (condyle located more anteroinferior within the glenoid fossa),[15] and cervical vertebrae anomalies can also influence the position of the mandible.[18,20,21] Therefore, it is reasonable to conclude from our results that the higher prevalence of condylar morphological changes in patients with PP might be due to an alteration in jaw position; however, this hypothesis could not be confirmed in the current study.

Ponticulus is not a rare finding and its association with unexplainable headache, neck pain, and other symptoms in craniocervical junction, imply that radiologists and dentists in general should closely inspect the vertebral region on a lateral cephalogram[22]. In the presence of PP and signs and symptoms of pain in these regions, the dentist should refer this patient to the medical specialist to confirm the diagnosis and perform its clinical or surgical treatment.

Given our studied sample, comprising a dataset based on images, clinical information such as the signs, symptoms and occlusion status of both jaws could not be assessed, and this represents a limitation of this study. Further studies that address these issues should be carried out in order to better

understand this association.

4 Conclusion

In conclusion, the results of the current study showed that PP is more prevalent in men, and there is a correlation between the presence of complete PP and changes in condylar morphology. This association might be related to a change in jaw position, and further studies are required to investigate this proposed association.

References

1. Chitroda PK, Katti G, Baba IA, Najmudin M, Ghali SR, Kalmath BGV. Ponticulus posticus on the posterior arch of atlas, prevalence analysis in symptomatic and asymptomatic patients of gulbarga population. J Clin Diagn Res 2013;7(12):3044-7.doi: 10.7860/JCDR/2013/6795.3847.
2. Cho YJ. Radiological analysis of ponticulus posticus in Koreans. Yonsei Med J 2009;50(1):45-9.
3. Sabir H, Kumbhare S, Rout P. Evaluation of ponticulus posticus on digital lateral cephalograms and cone beam computed tomography in patients with migraine and healthy individuals: a comparative study. Oral Surg Oral Med Oral Pathol Oral Radiol 2014;118(3):348-54.
4. Gibelli D, Cappella A, Cerutti E, Spagnoli L, Dolci C, Sforza C. Prevalence of ponticulus posticus in a Northern Italian orthodontic population: a lateral cephalometric study. Surg Radiol Anat 2016;38(3):309-12.
5. Kuhta P, Hart J, Greene-Orndorff L, McDowell-Reizer B, Rush P. The prevalence of Posticus ponticus: retrospective analysis of radiographs from a chiropractic health center. J Chiropr Med 2010;9:162-5.
6. Huang DG, Hao DJ, Fang XY, Zhang XL, He BR, Liu TJ. Ponticulus posticus. Spine J 2015;15(11):17-9.
7. Sekerci AE, Soylu E, Arikan MP, Aglarci OS. Is there a relationship between the presence of ponticulus posticus and elongated styloid process? Clin Imaging 2015;39(2):220-4.
8. Selby S, Garn SM, Kanareff V. The incidence and familial nature of a bony bridge on the first cervical vertebra. Am J Phys Anthropol 1955;13(1):129-41.
9. Wight S, Osborne N, Breen AC. Incidence of ponticulus posterior of the atlas in migraine and cervicogenic headache. J Manipulative Physiol Ther 1999;22(1):15-20.
10. Paraskevas G, Papaziogas B, Tsonidis C, Kapetanos G. Gross morphology of the bridges over the vertebral artery groove on the atlas. Surg Radiol Anat 2005;27(2):129-36.
11. Chen CH, Chen YK, Wang CK. Prevalence of ponticuli posticus among patients referred for dental examinations by cone-beam CT. Spine J 2015;15(6):1270-6.
12. Sharma V, Chaudhary D, Mitra R. Prevalence of ponticulus posticus in Indian orthodontic patients. Dentomaxillofac Radiol 2010;39:277-83.
13. Stubbs DM. The arcuate foramen: variability in distribution related to race and sex. Spine 1992;17:1502-14.
14. Bayrakdar IS, Miloglu O, Altun O, Gumussoy I, Durna D, Yilmaz AB. Cone beam computed tomography imaging of ponticulus posticus: prevalence, characteristics, and a review of the literature. Oral Surg Oral Med Oral Pathol Oral Radiol 2014;118(6):210-9.
15. Tsuruta A, Yamada K, Hanada K, Hosogai A, Kohno S, Koyama J *et al.* The relationship between morphological changes of the condyle and condylar position in the glenoid fossa. J Orofac Pain 2004;18(2):148-55.
16. Sekerci AE, Soylu E, Arikan MP, Ozcan G, Amuk M, Kocoglu F. Prevalence and morphologic characteristics of ponticulus posticus: analysis using cone-beam computed tomography. J Chiropr Med 2015;14(3):153-61.
17. Elliott RE, Tanweer O. The prevalence of the ponticulus posticus (arcuate foramen) and its importance in the Goel-Harms procedure: meta-analysis and review of the literature. World Neurosurg 2014;82(1-2):335-43.
18. Adisen MZ, Misirlioglu M. Prevalence of ponticulus posticus among patients with different dental malocclusions by digital lateral cephalogram: a comparative study. Surg Radiol Anat 2017;39(3):293-297. doi: 10.1007/s00276-016-1728-4.
19. Gilsanz V, Kovanlikaya A, Costin G, Roe TF, Sayre J, Kaufman F. Different effect of gender on the sizes of the bones in the axial and appendicular skeletons. J Clin Endocrinol Metab 1997;82(5):1603-7.
20. D'Attilio M, Epifania E, Ciuffolo F, Salini V, Filippi MR, Dolci M *et al.* Cervical lordosis angle measured on lateral cephalograms. Findings in skeletal class II female subjects with and without TMD: a cross sectional study. Cranio 2004;22:27-44. doi: 10.1179/crn.2004.005
21. Festa F, Tecco S, Dolci M, Ciufolo F, Di Meo S, Filippi MR *et al.* Relationship between cervical lordosis and facial morphology in Caucasian women with a skeletal class II malocclusion: a cross-sectional study. Cranio 2003;21:121-9.
22. Tambawala SS, Karjodkar FR, Sansare K, Motghare D, Mishra I, Gaikwad S, Dora AC. Prevalence of Ponticulus Posticus on Lateral Cephalometric Radiographs, its Association with Cervicogenic Headache and a Review of Literature. World Neurosurg 2017;103:566-575.

Legend of the figures:

Figure 1. Partial form of ponticulus posticus (black arrow) showing an incomplete bony ring.

Figure 2. The complete form of ponticulus posticus characterised by a complete bone ring (black arrow).