doi.org/10.46311/2318-0579.60.eUJ4424

REVISTA UNINGÁ
ISSN 2318 0579

Ponticulus posticus: prevalence and association with clinical manifestations in a Brazilian population

Ponticulus posticus: prevalência e associação com manifestações clínicas em população brasileira

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ABSTRACT

Ponticulus posticus (PP) is an anatomical variation found in the Atlas vertebra (C1). This variation may be associated with clinical symptoms. This study aims to contribute more to the respect of PP, through an investigation of its prevalence by Cone-beam computed tomography (CBCT) in a Brazilian population, correlating sex, age and mainly, its correlation with clinical manifestations. 673 scans of Brazilian patients were analyzed. PP´s presence and type of were evaluated and categorized as partial or complete, unilateral or bilateral. The relationship of PP presence with symptomatology was obtained by a questionnaire applied. 167 (24,81%) patients presented PP. Of these, 39 (23,35%) individuals participated in the investigation regarding the information about the presence or absence of any symptoms that could be related to the presence of PP, being 23 (58,98%) women and 16 (41,02%) men. 11 (28,20%) patients presented partial PP in the left side, while eight (20,51%) presented partial PP in the right side. Nine (23,07%) patients presented bilateral manifestation. There was no association of any symptomatology with the types of PP classification (p-value > 0,05). No statistical relationship between sex and age was found. Likewise, it was possible to conclude that there is no proven correlation between the presence of PP and the presence of clinical manifestations.

Keywords: Anatomy. Axis cervical vertebra. Cone-beam computed tomography. Headache.

RESUMO

Ponticulus posticus (PP) é uma variação anatômica caracterizada por ser uma ponte óssea entre a parte posterior do processo articular superior e a parte posterolateral do arco posterior da vértebra Atlas (C1). Essa variação pode estar associada à sintomatologia dolorosa. Este estudo visa a contribuir com mais dados a respeito do PP, investigando sua prevalência e utilizando tomografias computadorizadas de feixe cônico (TCFC) realizadas em população brasileira, correlacionando sexo, idade e, principalmente, manifestações clínicas. Foram analisados 673 TCFC de pacientes brasileiros, em que 167 (24,81%) exames analisados apresentaram o PP. A presença e o tipo de PP foram avaliados e categorizados como parciais ou completos, unilateral ou bilateral. A relação da presença do PP com a sintomatologia foi feita por meio de um questionário. No total 39 (23,35%) indivíduos participaram da pesquisa quanto à etapa de coleta de informações a respeito da presença ou da ausência de sintomatologia que pudesse ser relacionada à presença do PP, sendo 23 (58,98%) do sexo feminino e 16 (41,02%) do sexo masculino. Em 11 (28.20%) pacientes se observou a estrutura anatômica parcialmente no lado esquerdo, enquanto oito (20,51%) apresentaram a estrutura anatômica parcialmente no lado direito. No que diz respeito à presença bilateral, nove (23,07%) pacientes a apresentaram. Não houve associação de nenhuma sintomatologia com os tipos de classificação dos PP (valor-p > 0,05) e nem relação estatística entre sexo e idade. Assim, foi possível concluir que inexiste correlação comprovada entre a presença do PP e a presença de manifestações clínicas.

Palavras-chave: Anatomia. Cefaleia. Tomografia computadorizada de feixe cônico. Vértebra cervical áxis.

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Received: September 29th, 2022.
Accepted: July 31st, 2023.
Published: October 23rd, 2023.

INTRODUCTION

Ponticulus posticus (PP) is the name given to the anatomical variation found in the Atlas vertebra (C1), deriving from the Latin "small posterior bridge." It can also be referred to as the superior reticular foramen, sagittal foramen, Kimmerle's anomaly variant (1930), vertebral canal, and retroarticular canal. It is characterized by being a bony bridge between the posterior part of the superior articular process and the posterolateral part of the posterior arch of the C1 vertebra (Arslan et al., 2018; Tripodi et al., 2019).

In literature, the embryological origin of such anomaly is still controversial. Some theories suggest an ossification of the connective tissue around the vertebral artery, a late ossification of the inferior border of the atlantooccipital membrane (Asvat, 1994; Cirpan et al., 2017; Contreras-Grande & Padilla, 2021) or a primitive structure, due to high prevalence in primates (Pekala et al., 2018).

This anatomical variation is adjacent to some important structures. In the first cervical vertebra, there is a groove just posterior to each superior articular process, through which the vertebral artery, the first spinal nerve (suboccipital nerve), the venous plexus and the peri-arterial sympathetic plexus transit (Cirpan et al., 2017). This proximity becomes a significant concern in orthopedic surgeries, as in the case of C1-C2 vertebrae fusion performed by screw insertion. In this scenario, the PP presents a complicating factor by giving the false impression of being a wide posterior arch, which could lead to surgical error and consequently result in damage to the mentioned structures (Gibelli et al., 2016).

The PP can be found bilaterally or unilaterally (Cho, 2009), in its complete form as a whole bony ring, or in its incomplete form, with parts of the bony ring not fully formed (Miki et al., 1979).

The majority of articles use lateral telerradiography (Giri, Pokharel & Gyawali, 2017) to detect the PP (Young et al., 2005; Schilling, Schilling & Galdames, 2010; Sharma, Chaudhary & Mitra, 2010; Chitroda et al., 2013; Gibelli et al., 2016; Adisen & Misirlioglu, 2017; Joshi et al., 2018). However, with the advancement of technology, cone beam computed tomography (CBCT) can also be used for the same purpose (Geist et al., 2014). The prevalence of anatomical variation is divergent in the literature, ranging from 4.3% (Sharma, et al., 2010; Joshi et al., 2018) to 68,4% in exams of teleradiographies in lateral norm. This discrepancy in values can be explained by the difference in their classification or the imaging examination used. The PP also presents a variation of 9% to 60% in relation to its complete and incomplete forms, respectively (Chitroda et al., 2013).

The clinical consequences of this bone bridge have yet to be elucidated. Some studies suggest a relationship with the appearance of symptoms, such as headaches, diplopia, vertigo, migraine, onset of hearing loss, pain in the shoulders and neck, which could be caused by compression of the vertebral artery (Gibelli et al., 2016; Tambawala et al., 2017).

Therefore, it can be observed in the existing literature that there is still a lack of consensus regarding the prevalence of PP in the general population, with significant variation among the findings (Adisen & Misirlioglu, 2017). Moreover, the number of studies addressing the prevalence in the Brazilian population is limited, and there are few research works that correlate this bony bridge with the presented symptoms (Pekala et al., 2018). Thus, this study aims to contribute with more data through an investigation of the prevalence of PP using cone beam computed tomography in the Brazilian population, correlating it with gender and age, and, most importantly, with clinical manifestations.

MATERIALS AND METHODS

This retrospective longitudinal observational study was approved by the Ethics Committee (CAAE #03629118.4.0000.0104) of the State University of Maringá and developed according to the STROBE initiative (Strengthening the Reporting of Observational Studies in Epidemiology) (Elm et al., 2014) following the guidelines of the Helsinki Declaration.

The samples were collected from an image database of a population from southern Brazil, belonging to the Laboratory of Imaging and Clinical Research (LIPC) at the State University of Maringá (UEM) within the Health Technology Center (CTS) of the Research Support Center Complex (COMCAP) of UEM, which was carried out between the years 2014 and 2019. After meeting the inclusion and exclusion criteria, these amounted to 673 CBCT scans from Brazilian patients.

The inclusion criteria were patients older than 18 years old whose scans allowed visualization up to the C2 vertebra. The exclusion criteria were patients with congenital cranial or vertebral diseases and patients with a history of spinal trauma or surgery. All CBCT scans were performed by the same radiologist using an i-Cat® Next Generation scanner (Imaging Sciences International, Hatfield, PA, USA) with a FOV of 17x23 cm, isotropic voxel size of 250 µm, 120 kVp, 3-8 mA, upon the request of the attending clinician. The images were aligned and processed using the scanner's proprietary software (XoranCatTM software, Xoran Technologies, Ann Arbor, USA). The samples were grouped according to age (18-33 years; 34-38 years; > 48 years), presence (partial or complete), or absence of PP, and gender.

Two radiologists, with more than five years of experience, were calibrated and trained based on the evaluation of 20 CBCT scans over two weeks. The CT scans used for calibration and training were discarded

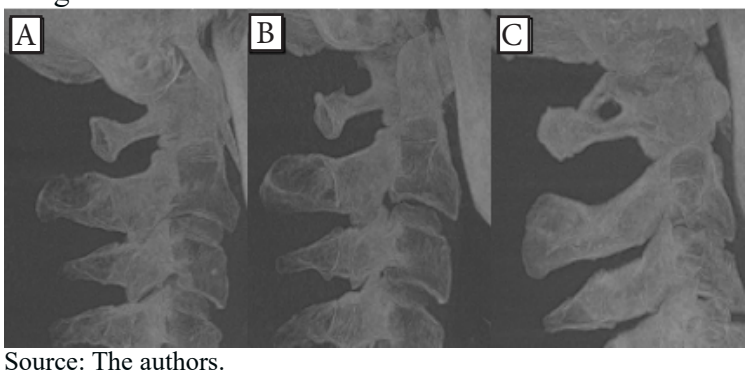
from the sample. All analyzes were performed in a dark and silent room, in duplicate, respecting a two-week interval between them, in order to establish greater intra- and inter-examiner reliability.

Evaluators were free to change brightness and contrast in order to obtain an ideal visual condition. PP was identified using the maximum intensity projection (MIP) volumetric rendering technique and then, when present, multiplanar reconstructions were accessed to confirm the diagnosis (Figure 1). In cases of disagreements between the examiners analysis, a third party was consulted.

The presence and type of PP were assessed and categorized as partial or complete (Figure 1) (Closs et al., 2017), unilateral or bilateral. The study correlating the presence of PP with symptomatology was conducted using a questionnaire developed and adapted based on the work by Pekala et al. (2018). This questionnaire was administered through interviews via telephone calls to individuals with any type of PP. The form was designed to be easily comprehensible, aiming to minimize misinterpretations and ensure accurate responses (Table 1).

Figure 1

Image of cervical vertebra C1.



Source: The authors.

Note. A. normal; B. partial *Ponticulus posticus* (arrow); C. complete *Ponticulus posticus* (arrow).

Table 1

Questionnaire administered to the research participants.

QUESTIONNAIRE
Q1. Do you experience headaches? Yes. ( ) No. ( ) If yes, what is the frequency? _____. How long have you been experiencing this? _____. If the answer to the previous question is yes. During which time of day is the pain most frequent? Morning. ( ) Afternoon. ( ) or Evening. ( ). And what is the average duration? _____.
Q2. Do you experience migraines? Yes. ( ) No. ( ) If yes, what is the frequency? _____. How long have you been experiencing this? _____. If the answer to the previous question is yes. During which time of day is the pain most frequent? Morning. ( ) Afternoon. ( ) or Evening. ( ). And what is the average duration? _____.
Q3. Prior to headaches, did you experience any visual symptoms (such as light flashes, dark spots resembling a mosaic, or zigzagging bright images)? Yes. ( ) No. ( )
Q4. Migraine with aura (numbness or tingling on one side of the body, depending on the severity, it might start with tingling in one hand and spread throughout one side of the body, sometimes causing numbness in half of the tongue). Yes. ( ) No. ( ).
Q5. Migraine without aura (If the patient denies both symptoms mentioned above, classify the migraine and/or headache as without aura). Yes. ( ) No. ( ).
Q6. Do you currently experience or have you experienced dizziness? Yes. ( ) No. ( ) If yes, what is the frequency? _____. How long have you been experiencing this? _____. If the answer to the previous question is yes. During which time of day is the dizziness most frequent? Morning. ( ) Afternoon. ( ) or Evening. ( ). And what is the average duration? _____.
Q7. If the answer to question six is yes. Does any head movement worsen or trigger the dizziness? Yes. ( ) No. ( ) If yes, what type of movement (lowering the head, raising the head, turning right, turning left)? _____.
Q8. Do you currently experience or have you experienced cervical pain with restricted movement? Yes. ( ) No. ( )
Q9. Pain near the nape of the neck? Yes. ( ) No. ( )
Q10. Pain near the shoulders? Yes. ( ) No. ( ) If yes, what is the frequency? _____. How long have you been experiencing this? _____.
Q11. Have you experienced or do you experience pain behind the eyes? Yes. ( ) No. ( ) If yes, what is the frequency? _____. How long have you been experiencing this? _____.
Q12. Do you currently experience or have you experienced vision disturbances? Yes. ( ) No. ( ) (For example, diplopia, the perception of two images in one object). If yes, what is the frequency? _____. How long have you been experiencing this? _____.
Q13. Difficulty swallowing? Yes. ( ) No. ( ) If yes, what is the frequency? _____. How long have you been experiencing this? _____.
Q14. Difficulty speaking? Yes. ( ) No. ( ) If yes, what is the frequency? _____. How long have you been experiencing this? _____.
Q15. Any tearing disturbances? Yes. ( ) No. ( ) If yes, what is the frequency? How long have you been experiencing this? _____.
Q16. Have you experienced episodes of epilepsy? Yes. ( ) No. ( ) If yes, what is the frequency? _____. How long have you been experiencing this? _____.
Q17. Have you noticed any hearing problems? Yes. ( ) No. ( ) (Mainly hearing loss). If yes, how long? _____. If the answer to the previous question is yes. Is the pain Bilateral ( ) Right side ( ) Left side ( ).

Source: The authors.

The questionnaire consisted of objective questions, focused mainly on the absence or presence of the addressed symptoms. If the presence was confirmed by the patient, the questions involved the frequency and how long these manifestations had been going on.

The two main reported clinical manifestations, headache and migraine, can be confused with each other. The present study adopted Wight's definition (1999) for migraine. According to the author, migraine can be defined as a throbbing and recurrent headache, which can differ in intensity, duration and frequency.

The prevalence of PP was compared between genders and age groups using Fisher's exact test. Intra-rater agreements were analyzed using the intraclass correlation coefficient (ICC). In order to identify potential associations of each of the symptomologies with PP classifications, Fisher's exact test was employed, in which a significance level of 5% was adopted. Statistical analyses were conducted using R software version 4.0.2 (R., Auckland, NZL) (R Core Team, 2020).

RESULTS AND DISCUSSION

A total of 673 radiographic examinations were analyzed, in which 167 (24.81%) showed the presence of PP. Of these, 39 (23.35%) individuals found or agreed to participate in the research regarding the information collection stage regarding the presence or absence of any symptomatology that could be related to the presence of PP, with 23 (58.98%) females and 16 (41.02%) males.

The sample size in this study was satisfactory for the requirements necessary for the application of inferential methods, as the sample exceeded 30 individuals (Wackerly et al., 2014). The average age of the sample was 33.69 years (standard deviation ± 12.23), with a minimum age of 21 years and a maximum of 69 years. As for gender, the mean age of male patients was 36.75 years (standard deviation ± 13.17) and 31.56 years (standard deviation ± 11.34) of female patients.

It can be observed (Table 2) that in 11 (28.20%) patients the anatomical structure was partially observed on the left side, while eight (20.51%) exhibited the anatomical structure partially on the right side. Regarding bilateral presence, nine (23.07%) patients had it, the highest frequency was found in females (n=7 - 17.94%) compared to males (n=2 - 5.12%). Furthermore, in Table 2, it's evident that there was no significant difference in prevalence between genders (p-value = 0.67).

Table 2
Prevalence of *Ponticulus posticus* by gender.

Ponticulus posticus	Gender		Total n (%)	p-value
	Male n (%)	Female n (%		
Partial Right Side.	4 (10,25%)	4 (10,25%)	8 (20,51%)	
Partial Left Side.	6 (15,38%)	5 (12,82%)	11 (28,20%)	
Complete Right Side.	2 (5,12%)	3 (7,69%)	5 (12,82%)	0,67[1]
Complete Left Side.	2 (5,12%)	4 (10,25%)	6 (15,38%)	
Bilateral.	2 (5,12%)	7 (17,94%)	9 (23,07%)	

Source: The authors.
Note. *Considered significant if ≤ 0.05; Fisher's exact test.

With regard to age groups, it can be seen in Table 3 that patients aged between 18 and 33 years old had higher prevalence levels, regarding the presence of partial PP on the left side (n=6 - 15.38%) and bilateral (n=6 - 15.38%). No significant differences were identified in the prevalence of PP between age groups (p-value = 0.94).

Table 3
Prevalence of *Ponticulus posticus* among age groups.

Ponticulus posticus	Age Groups			Total n (%)	p-value
	18-33 n (%)	34-48 n (%)	>48 n (%)		
Partial Right Side.	5 (12,82%)	2 (5,12%)	1 (2,56%)	8 (20,51%)	
Partial Left Side.	6 (15,38%)	4 (10,25%)	1 (2,56%)	11 (28,20%)	
Complete Right Side.	4 (10,25%)	1 (2,56%)	0 (0,00%)	5 (12,82%)	0,941
Complete Left Side.	3 (7,69%)	1 (2,56%)	2 (5,12%)	6 (15,38%)	
Bilateral.	6 (15,38%)	2 (5,12%)	1 (2,56%)	9 (23,07%)	

Source: The authors.
Note. *Considered significant if ≤ 0.05; Fisher's exact test.

In Tables 3 and 4, it can be observed through the Fisher's exact test that there was no association between any symptomatology and the types of PP classifications (p-value > 0.05). However, for questions Q1 and Q2, related to headache and migraine symptoms respectively, it was noted that these occurred at least twice a month, and furthermore, patients experienced these symptoms for 11.90 (1.15 ± 22.65) and 13.58 (2.55 ± 24.61) years, respectively. Headaches were frequent throughout all daily periods, and migraine episodes were recurring during the nighttime. Concerning dizziness symptoms (Q6), it was observed that they occurred at least once a month. Additionally, patients had been experiencing these symptoms for 6.30 (1.16 ± 11.44) years, with an average daily duration of 0.91 (0.63 ± 1.19) hours. The dizziness was frequent in the morning and associated with head movements upwards or downwards (Q7).

Based on patient responses, it was identified that none of them presented symptoms related to speech limitations (Q14). However, hearing problems (Q17) were present in patients' lives for an average of 22.50 (3.76 ± 41.24) years, more frequently on the right side. It was observed that the null hypothesis that the intra-rater agreements are purely random was rejected through the intraclass correlation coefficient (ICC) for all variables under study (p-value < 0.05). In other words, the agreements were met, with coefficients ranging from 0.89 to 0.98 (Landis & Koch, 1977). The PP is located in a region of extreme significance for the full functioning of vital vascular and nervous structures. It is described in the literature as an anatomical variation in the first human vertebra, with a strong relationship in the passage of structures, such as the vertebral artery, the first cervical nerve and the internal vertebral venous plexus (Cirpan et al., 2017).

In view of its location, the PP consequently becomes a hindrance in cases of surgery for the implementation of screws in the region, as it may confuse the surgeon, giving a false impression of a wide posterior arch (Gibelli et al., 2016). In addition, it can limit the possible space to position the screw. Therefore, standard techniques are contraindicated due to the high risk of injury to the vertebral artery and adjacent structures (Arslan et al., 2018). Therefore, knowledge of its prevalence in a given population is extremely important. However, its prevalence is still a topic of discussion, with no consensus in the literature. Nevertheless, data can be found indicating a variation between 5.14% and 37.83% in the Western population (Stubbs, 1992; Wight; Osborne & Breeen, 1999; Young et al., 2005). In the present study, it was found this alteration in 24.81% of the sample.

This finding aligns with another study conducted with the Brazilian population, yielding a result of 21.89% (Closs et al., 2017), and also agrees with several studies conducted in samples from other countries, in which values ranged from 11.1% (Mudit, et al., 2014) to 68,4% (Chitroda et al., 2013) found in lateral cephalometric radiographs, and from 7% (Chen et al., 2015) to 36,8% (Ercan et al., 2015) in cone beam computed tomography.

Other studies also report similar results, attributing the prevalence of PP to several factors, such as lifestyle, patient health conditions and ethnic and genetic characteristics of a heterogeneous population (Blásquez, Alva & Márquez, 2020), which is consistent with the findings of this work. The results obtained in this study showed no statistical significant relationship regarding the difference between the sexes, coinciding with Brazilian, Indian, North American and South American samples (Elliott & Tanweer, 2014; Closs et al., 2017; Tambawala et al., 2017; Garcìa Blásquez, 2021). We also did not find statistical differences in relation to the ages of individuals, similar to the results of Adisen and Misirlioglu (2017).

Another point that remains controversial and requires further research relates to the fact that some authors associate the presence of PP with the occurrence of clinical manifestations, examples being migraine with or without aura, headache, cervical and shoulder pain, dizziness, tear disturbances, and even syndromes, such as Barré-Liéou syndrome (Limousin, 1980).

In general, most studies that look for a symptomatic correlation with PP highlight migraine and headache as the main manifestations (Pekala et al., 2018). Some authors believe that pain symptoms occur due to compression of nerves or nerve roots (Tubbs et al., 2007).

Thus, due to the mechanism of neuronal convergence between the upper cervical nerves and the trigeminal branches, at the level of the trigeminocervical nucleus in the central nervous system, the process of pain may occur, originating from the cervical nerves, referred to the head and face region (Bogduk & Govind, 2009). Other authors suggest that the pain is caused by irritation of the plexus accompanying the vertebral artery (Restivo, 1985), or it may be related to direct compression of the artery (Restivo, 1985; Sawrasewicz-Rybak, 2002).

The prevalence of headache in patients with the presence of PP can vary in the literature from 5% (Klaus & Doubrava, 1960) to 90% (Split & Sawrasewicz-Rybak, 2002), in which the multifactorial origin of these symptoms, with extrinsic and intrinsic mechanisms, may increase their frequency (Bogduk & Govind, 2009), which can be a source of error in the results, especially when respondents answer the questionnaire. This is one of the biases in all studies conducted so far, including this one.

According to Rasmussen (Rasmussen, 1995), stress and mental tension are the two main triggers for both migraine and headache, followed by alcohol, smoking, and climate changes, factors that are gradually present in today's daily life. The same author also indicates a prevalence of tension-related headache in 78% of cases during a person's lifetime.

Table 4

Results of the association of symptomatology with *Ponticulus posticus* classifications and descriptive analysis of variables related to symptom frequency and duration time.

		Partial RS n (%)	Partial LS n (%)	Complete RS n (%)	Complete LS n (%)	Bilateral n (%)	p-value	Modal frequency (Monthly)	AM ± sd (In years)	DDA ± sd (In hours)	Most frequent period
Q1.	**Yes.**	3(7,69%)	6(15,38%)	3 (7,69%)	5 (12,82%)	4 (10,25%)	0,53[1]	2x	11,90 (1,15±22,65)	0,90 (0,07±1.83)	All.
	No.	5(12,82%)	5(12,82%)	2 (5,12%)	1 (2,56%)	5 (12,82%)					
Q2.	**Yes.**	3(7,69%)	5(12,82%)	3 (7,69%)	3 (7,69%)	3 (7,69%)	0,88[1]	2x	13,58 (2,55±24,61)	1,11 (0,33±1,89)	Night.
	No.	5(12,82%)	6(15,38%)	2 (5,12%)	3 (7,69%)	6 (15,38%)					
Q3.	**Yes.**	0(0,00%)	0(0,00%)	0 (0,00%)	0 (0,00%)	0 (0,00%)	0,98[1]	-	-	-	-
	No.	8(20,51%)	11(28,20%)	5 (12,82%)	6 (15,38%)	9 (23,07%)					
Q4.	**Yes.**	0(0,00%)	0(0,00%)	0 (0,00%)	0 (0,00%)	1 (2,56%)	0,72[1]	-	-	-	-
	No.	8(20,51%)	11(28,20%)	5 (12,82%)	6 (15,38%)	8 (20,51%)					
Q5.	**Yes.**	0(0,00%)	1(2,56%)	0 (0,00%)	0 (0,00%)	0 (0,00%)	0,96[1]	-	-	-	-
	No.	8(20,51%)	10(25,64%)	5 (12,82%)	6 (15,38%)	9 (23,07%)					
Q6.	**Yes.**	4(10,25%)	5(12,82%)	3 (7,69%)	4 (10,25%)	7 (17,94%)	0,67[1]	1x	6,30 (1,16±11,44)	0,91 (0,63±1,19)	Morning.
	No.	4(10,25%)	6(15,38%)	2 (5,12%)	2 (5,12%)	2 (5,12%)					
Q7.	**Yes.**	1(2,56%)	2(5,12%)	2 (5,12%)	2 (5,12%)	3 (7,69%)	0,73[1]	**Most frequent type of movement**: When lowering or raising the head.			
	No.	7(17,94%)	9(23,07%)	3 (7,69%)	4 (10,25%)	6 (15,38%)					
Q8.	**Yes.**	2(5,12%)	2(5,12%)	1 (2,56%)	1 (2,56%)	2 (5,12%)	0,98[1]	-	-	-	-
	No.	6(15,38%)	9(23,07%)	4 (10,25%)	5 (12,82%)	7 (17,94%)					
Q9.	**Yes.**	2(5,12%)	4(10,25%)	2 (5,12%)	1 (2,56%)	3 (7,69%)	0,91[1]	-	-	-	-
	No.	6(15,38%)	7(17,94%)	3 (7,69%)	5 (12,82%)	6 (15,38%)					
Q10.	**Yes.**	2(5,12%)	3(7,69%)	2 (5,12%)	1 (2,56%)	3 (7,69%)	0,94[1]	1x	9,18 (1,24±17,12)	-	-
	No.	6(15,38%)	8(20,51%)	3 (7,69%)	5 (12,82%)	6 (15,38%)					
Q11.	**Yes.**	0(0,00%)	4(10,25%)	2 (5,12%)	1 (2,56%)	2 (5,12%)	0,33[1]	1x	8,44 (2,69±14,19)	-	-
	No.	8(20,51%)	7(17,94%)	3 (7,69%)	5 (12,82%)	7 (17,94%)					
Q12.	**Yes.**	2(5,12%)	0(0,00%)	0 (0,00%)	0 (0,00%)	0 (0,00%)	0,07[1]	1x	10,00 (2,93±17,07)	-	-
	No.	6(15,38%)	11(28,20%)	5 (12,82%)	6 (15,38%)	9 (23,07%)					
Q13.	**Yes.**	0(0,00%)	1(2,56%)	0 (0,00%)	0 (0,00%)	1 (2,56%)	0,99[1]	1x	13,00 (2,03±23,97)	-	-
	No.	8(20,51%)	10(25,64%)	5 (12,82%)	6 (15,38%)	8 (20,51%)					
Q14.	**Yes.**	0(0,00%)	0(0,00%)	0 (0,00%)	0 (0,00%)	0 (0,00%)	0,97[1]	0x	0,00	-	-
	No.	8(20,51%)	11(28,20%)	5 (12,82%)	6 (15,38%)	9 (23,07%)					
Q15.	**Yes.**	1(2,56%)	0(0,00%)	1(2,56%)	0(0,00%)	0(0,00%)	0,21[1]	1x	12,50 (8,97±16,03)	-	-
	No.	7(17,94%)	11(28,20%)	4(10,25%	6(15,38%)	9(23,07%)					
Q16.	**Yes.**	1(2,56%)	0(0,00%)	1(2,56%)	0(0,00%)	0(0,00%)	0,21[1]	1x	1,00 (0,26 ± 1,74)	-	-
	No.	7(17,94%)	11(28,20%)	4(10,25%)	6(15,38%)	9(23,07%)					
Q17.	**Yes.**	0(0,00%)	1(2,56%)	0 (0,00%)	1(2,56%)	0(0,00%)	0,65[1]	-	22,50 (3,76±41,24)	**Frequency of pain location:** Right Side	
	No.	8(20,51%)	10(25,64%)	5(12,82%)	5(12,82%)	9(23,07%)					

Source: The authors.

Note. *Considered significant if ≤ 0.05; 1 Fisher's exact test; RD: Right side; LS: Left side; SD – standard deviation; AM – average time; DDA – daily average duration.

In view of this, even with certain studies suggesting that there is in fact this relationship (Wight, Osborne & Breen, 1999; Split & Sawrasewicz-Rybak, 2002; Tambawala et al., 2017; Pekala et al., 2018) between the presence of PP and the appearance of symptoms, Klausberger and Samec (1975) found that patients with PP experienced migraines more frequently (31.5%) than patients without PP (20.5%), although, according to the author himself, without significance (Klausberger & Samec, 1975).

The numbers still remain inconclusive and warrant further research and discussion. Despite the higher number of positive occurrences in this study being related to headache and migraine, the results did not indicate direct association between anatomical variation and the occurrence of clinical manifestations.

However, it is possible to conclude that patients who reported suffering from headaches or migraines stated an average duration of 0.90 and 1.11 hours daily, which supports the findings of Pekala et al. (2018).

According to Limousin (1980), in 1926, it was described a syndrome known as "Barré-Lieou Syndrome", characterized by symptoms of headache, retro-orbital and vasomotor pain, facial disturbances and recurrent disturbances of vision, swallowing and phonation, due to alteration of blood flow within the vertebral arteries and an associated disturbance of the peri-arterial nerve plexus. The aforementioned researcher believed that PP could be associated as an etiological factor. As a result, the listed symptoms of the syndrome were also added to the questionnaire drawn up for this study, however, none of the results showed a significant correlation.

This study is one of the pioneers in addressing the prevalence and symptomatic correlation with PP in a Brazilian sample. It is suggested that subsequent studies make use of these data to provide a more refined outcome regarding the relationship with clinical manifestations, prevalence, and potential regional variations.

CONCLUSION

The *Ponticulus posticus* was found to be a relatively common variation, present in 24.81% of the studied population. No relationship with gender and age was found. Similarly, it was possible to conclude that there is no proven correlation between the presence of PP and the presence of clinical manifestations.

COMPETING INTERESTS

The authors declare that there are no conflicts of interest.

FUNDING ACKNOWLEDGEMENTS

The authors declare that they have no financial interests.

AUTHOR CONTRIBUTIONS

Conceptualization: M. C. S. *Data curation*: P. H. C. S. *Formal analysis*: P. H. C. S. *Investigation*: M. C. S. *Methodology*: P. G. V. C. *Project administration*: M. C. S. *Resources*: M. H. F. *Supervision*: E. S. T. *Validation*: B. G. S. *Visualization*: B. G. S. *Writing the initial draft*: B. C. F. *Revision and editing of writing*: B. C. F.

ETHICAL CONSIDERATIONS

Approved by the Ethics Committee (CAAE #03629118.4.0000.0104) of the State University of Maringa.

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