

## ***Ponticulus posticus* on the Posterior Arch of Atlas, Prevalence Analysis in Asymptomatic Patients**

***Ponticulus posticus* en el Arco Posterior del Atlas,  
Análisis de su Prevalencia en Pacientes Asintomáticos**

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**SUMMARY:** The *Ponticulus posticus* is a bony bridge located in the posterior arch of the atlas in relation to the passage of the vertebral artery. Its presence has been associated with development of cervical pain and cerebrovascular disorders. The purpose of this study was to assess its prevalence in asymptomatic patients. We examined 436 digital teleradiographs of patients aged from 5 to 70 years (mean of 18.44 years, SD. 9.59) of both sexes (173 men, 263 women). In 80.7% (n = 352) of cases, no radiographic evidence of ossification was found; 19.3% showed some degree of ossification, of which 10.1% had partial ossification and 9.2% complete ossification. The prevalence of complete ossification was slightly higher in women than in men and occurs in all the age groups analyzed. Our results suggest that the *Ponticulus posticus* is an anatomic condition with a protective function.

**KEY WORDS:** *Ponticulus posticus*; Atlas; Vertebral artery; Cervical pain.

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### **INTRODUCTION**

The *ponticulus posticus* is a bony arch that connects the retroglenoid tubercle located posterior to the superior articular fossa of the atlas with their posterior arch (Miki *et al.*, 1979). This element has been described in classical literature as an anatomical variation that originates in the ossification of the lateral segment of the posterior atlantooccipital ligament or the capsule of this joint (Testut & Latarjet, 1999; Paturet, 1951). Its importance lies in the relationship established with the vertebral artery, which, after leaving the foramen transversarium of the atlas vertebra, relies on its posterior arch and through the usually fibro-osseous foramen in search of the posterior atlantooccipital membrane, which it pierces to enter into the vertebral canal.

This bony bridge has been called by different names, such as sagittale foramen and atlantal posterior foramen by Loth-Niemirycz (1916); arcuate foramen, a variant of Kimmerle's anomaly (Kimmerle, 1930); upper retroarticular foramen (Brocher, 1955); canalis vertebralis (Wolff-Heidegger, 1961); retroarticular vertebral artery ring

(Lamberty & Zivanovic, 1973); arcuate foramen (Stubbs, 1992); retroarticular canal (Mitchell, 1998a); and retrocondilar vertebral artery ring (Mitchell, 1998b). However, its most accepted name is *ponticulus posticus* (Latin for little posterior bridge) (Cho, 2009; Young *et al.*, 2005).

According Miki *et al.*, radiographically, the *Ponticulus posticus* can be classified into three types:

Full type: it forms a complete bony ring.

Incomplete type: some portions of the bony ring are defective.

Calcified type: there is a linear or amorphous calcification.

In lateral cervical spine radiography, we can observe a bony ring (Fig. 1). The presentation of these bony arches or bony bridges can be unilateral or bilateral (Cho). While the observation of this calcification is not a diagnosis issue, determining their location (unilateral or bilateral) and identifying the affected side of C1 is very difficult with lateral and anteroposterior radiographic views.

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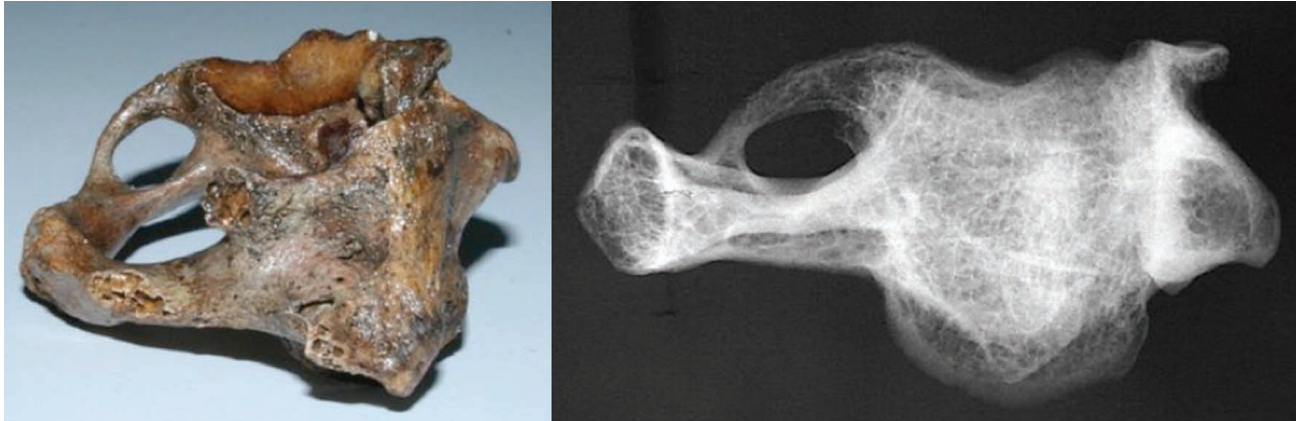


Fig. 1. *Ponticulus posticus*, bony arch that connects the superior articular condyle and the posterior arch of the atlas, we can observe the presence of one *Ponticulus posticus* in dry atlas and in radiographic of anatomical piece on lateral views.

There are numerous clinical considerations about this bony arch. The presence of the *Ponticulus posticus* has been linked to migraine development (Wight *et al.*, 1999). It must also be taken into account during the immobilization of the cervical spine with lateral mass fixation in C1, given the relationship of the bony arch or ring with the vertebral artery (Young *et al.*). In addition, the presence of the calcification has been related with shoulder and arm pain, neck pain, headaches, and dizziness (Cakmak *et al.*, 2005).

The prevalence of this anatomical variation is relatively high. In a study on 60 atlas vertebra in European individuals, 22 cases (36.6%) had this ossification; in 15% the ring was complete, and 21.6% had partial ring ossification (Lamberty & Zivanović).

Young *et al.* found a prevalence of 15.5% in lateral neck radiographs. On dry vertebrae, Simsek *et al.* (2008) found a prevalence of 5.6% with a partial bony arch (9 cases, 8 bilateral and 1 unilateral) and 3.8% with a complete bony arch in all samples. Cakmak *et al.*, also in a study of dry atlas, found a prevalence of 11.7% of cases with a complete bony arch and 3.3% cases with partial formation of the arch.

In terms of prevalence by sex, the presentation of a complete bony arch is slightly higher in men (11.11%) compared with women (9.3%) (Paraskevas *et al.*, 2005).

Paraskevas *et al.* believed the prevalence of the *ponticulus posticus* is related to age; however, there are no studies evaluating the presence of this formation in subadults.

Against this background, the purpose of this study is to determine the prevalence of the *ponticulus posticus* in a group of adults and subadults by observing telerradiographs.

## MATERIAL AND METHOD

We designed a descriptive cross-sectional study.

**Sample.** Using non-probability convenience sampling, we selected 436 digital lateral cephalometric radiographs of patients with orthodontic indication from the files of a private radiology center in the Maule region. The radiographs were obtained with a Siemens Sirona ORTHOPOS XG 5® in standard position. The patients, of which 60.3% were female and 39.7% were male, had a mean age of 18.44 years (SD 9.597). The sample characteristics are presented in Table I.

We excluded radiographs that showed lateral inclination of the posterior arch of the atlas, and mastoid process overjet on the body and the posterior arch of the atlas. Patients with a history of trauma or surgery in the cervical spine were also excluded from the study.

Table I. Sex distribution by age group.

		Age Group							Total
		< 10 years	11 to 20 years	21 to 30 years	31 to 40 years	41 to 50 years	51 to 60 years	61 to 70 years	
Sex	Female	36	142	56	20	5	3	1	263
	Male	28	108	14	17	5	1	0	173
Total		64	250	70	37	10	4	1	436

**Diagnostic Procedures.** The observation was made by two maxillofacial radiologists who made the diagnosis by consensus, eliminating from the sample those images that are subject to discussion. The images were viewed on a flat-screen TFT - LCD monitor (Thin Film Transistor - Liquid Crystal Display) with a resolution of 2808 x 2148 pixels in JPEG (Joint Photographic Experts Group) format with 24-bit grayscale.

Cases were classified into two categories (partial ossification and complete ossification) (Fig. 2), and the prevalence by sex and age group determined.

## RESULTS

Some degree of ossification were seen in 19.3% of cases, of which 10.1% had partial ossification and 9.2% com-

plete ossification (Fig. 3); the remaining 80.7%, corresponding to 352 cases, did not show radiographic evidence of ossification (Table II).

The age distribution data on the study sample indicate that the average age of patients without the ponticulus posticus is 17.8 years (SD 9.1). The average age corresponds to 19.5 years (SD 9.732) in patients with a partial bony bridge and 22.88 years (SD 12.279) in cases with complete formation of the bony ring.

The data indicate that the distribution of the presence of the bony bridge in the first cervical vertebra is higher in females than in males. The female patients had partial ossification of the ponticulus posticus in 29 cases (6.7% of total sample) and complete ossification in 17 cases (3.9%). In comparison, the male patients showed partial ossification in 15 cases (3.44%) and complete ossification in 23 cases (5.27%).

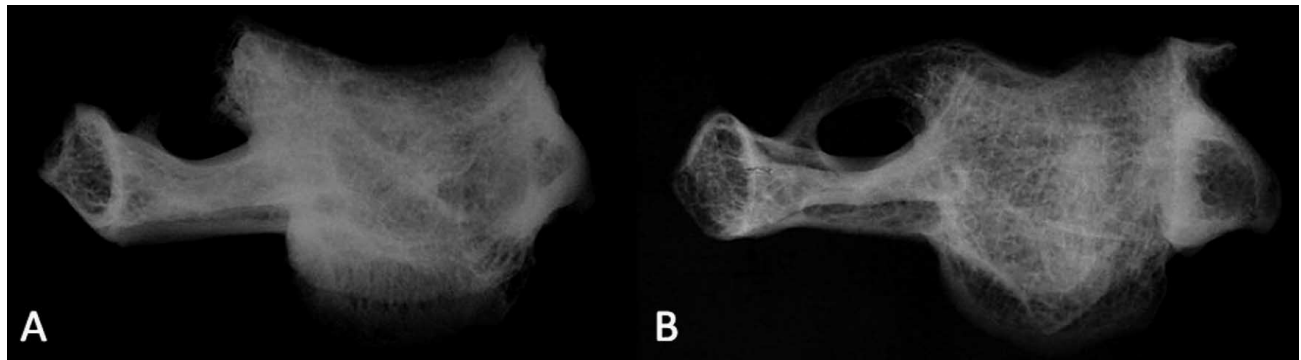


Fig. 2. Examples of ossification of the vertebral artery bony ring. (A) Partial ossification, (B) Complete ossification.

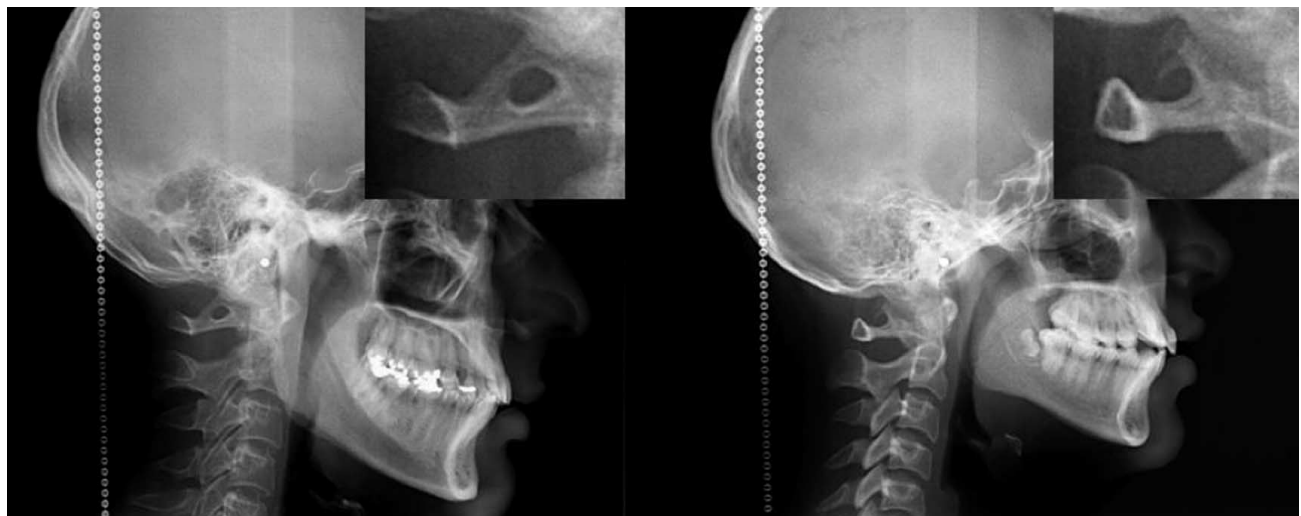


Fig. 3. In the left image observed a complete bony bridge while the right image shown a partial ossification.

Table II. Prevalence of *Ponticulus posticus*.

		Frequency	Percent	Valid	Cumulative Percent
<b>Valid</b>	<b>Absent</b>	352	80.7	80.7	80.7
	<b>Parcial</b>	44	10.1	10.1	90.8
	<b>Total</b>	40	9.2	9.2	100.0
	<b>Total</b>	436	100.0	100.0	

Table III. Distribution by age group of *Ponticulus posticus*.

			Age Group						Total	
			0 to 10	11 to 20	21 to 30	31 to 40	41 to 50	51 to 60	61 to 70	
			years	years	years	years	years	years	years	
<i>Ponticulus</i>	<b>Absent</b>	<b>Count</b>	57	206	52	27	7	2	1	352
		<b>%</b>	13.1%	47.2%	11.9%	6.2%	1.6%	.5%	.2%	80.7%
	<b>Parcial</b>	<b>Count</b>	4	24	11	3	2	0	0	44
		<b>%</b>	.9%	5.5%	2.5%	.7%	.5%	.0%	.0%	10.1%
	<b>Total</b>	<b>Count</b>	3	20	7	7	1	2	0	40
		<b>%</b>	.7%	4.6%	1.6%	1.6%	.2%	.5%	.0%	9.2%
<b>Total</b>		<b>Count</b>	64	250	70	37	10	4	1	436
		<b>%</b>	14.7%	57.3%	16.1%	8.5%	2.3%	.9%	.2%	100.0%

The distribution of the *Ponticulus posticus* prevalence (Table III) shows a greater concentration of cases in the age group of 11 to 20 years, with a prevalence of 5.5% for partial ossification of the bridge bone cases and 4.6% for total ossification, followed by the age group of 21 to 30 years, with a prevalence of 2.5% and 1.6% for partial and total ossification, respectively.

## DISCUSSION

This study found a slightly higher prevalence as described in the literature (Young *et al.*; Simsek *et al.*; Cakmak *et al.*). While prevalence is similar, the striking difference in gender distribution, showing a higher prevalence in female patients (10.6%) than men (8.71%), which differs from that described by Paraskevas *et al.* This may be explained by the distribution by sex in the sample, of which 60.3% were women.

Multiple pathological processes related to the presence of the *Ponticulus ponticus* (Wight *et al.*; Cakmak *et al.*) have been reported. However, the observations in this study are consistent with radiographic findings and the presenting complaints of these patients were prescribed orthodontic and no cervical symptoms.

As indicated by Hasan *et al.* (2001), the origin of the bony bridge is an issue. Previous studies have suggested it may be a product of congenital development (Allen, 1879; Cleland, 1960; Von Törklus *et al.*, 1975), a genetic trait (Selby *et al.*, 1955), an ossification due to age (Pyo & Lowman, 1959; Epstein, 1955; Breathnach, 1965; White & Panjabi, 1978), or the result of external mechanical factors (Taitz & Nathan, 1986).

Although the possibility that the calcification of the bony bridge progresses over time from an incomplete bony arch to complete ossification has been described by Paraskevas *et al.*, this study found no clear relationship with age, since we found 3 cases of children under 10 years with complete ossification and 4 cases with partial ossification. Thus, while ossification is most likely a gradual process, its initiation is not likely to be related to the age of the patient. This would confirm the findings of Lamberty & Zivanovic, who observed the ponticulus posticus cartilage in fetuses and children.

Taitz & Nathan studied 672 atlas vertebra, of which 25.9% had a partial posterior bridge and 7.9% a complete bony bridge. They found that partial bony bridges predominate in younger age groups (10 to 30 years) and complete bony bridges in the older age groups (30 to 80 years), which differs from our findings that both partial and

complete bone bridges had a higher prevalence among the age groups of 11 to 20 years and 21 to 30 years (Table III).

Our results suggest that the presence of the *Ponticulus posticus* is a condition independent of age, and therefore should not be considered a calcification or an ossification of

the lateral segment of the posterior atlantooccipital ligament, but rather an ossification with functional significance, developed in other primates (Krishnamurthy *et al.*, 2007) in order to protect the passage of the vertebral artery in a region which, by its sinuosity, is susceptible to being damaged or compressed as a result of craniocervical dynamics.

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**RESUMEN:** El *Ponticulus posticus* es un puente óseo ubicado en el arco posterior de atlas en relación al paso de la arteria vertebral. Su presencia se ha asociado al desarrollo de cervicalgias y trastornos vasculares encefálicos. El propósito de este estudio fue analizar su prevalencia en pacientes asintomáticos, para ello fueron examinadas 436 teleradiografías digitales de pacientes de entre 5 y 70 años (Media 18,44 años; DS 9,59), de ambos sexos (173 hombres; 263 mujeres). En el 80,7% (n=352) no se encontraron signos radiográficos de osificación, el 19,3% de los casos se pudo apreciar algún grado de osificación, de los cuales el 10,1% presentó una osificación parcial y el 9,2% completa. La prevalencia de osificación completa fue levemente mayor en mujeres y se presentó en todos los grupos etáreos analizados. Nuestros resultados sugieren que el *Ponticulus posticus* es una condición anatómica destinada a proteger el paso de la arteria vertebral y no debe considerarse una calcificación con significado patológico.

**PALABRAS CLAVE:** *Ponticulus posticus*; Atlas; Arteria Vertebral; dolor cervical.

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