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Anatomical Study of the Pterygospinous and Pterygoalar Bony Bridges and Foramens in Dried Crania and its Clinical Relevance

Estudio Anatómico de los Puentes Óseos y Forámenes Pterigoespinoso y Pterigoalar en Cráneos Secos y su Relevancia Clínica

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SUMMARY: The ossification of the intrinsic ligaments of the sphenoid bone has been reported in the literature. The presence of bony bridges by ossification of the pterygospinous and pterygoalar ligaments has clinical significance in the infratemporal fossa contents. The purpose of this study is to analyze the prevalence of ossification of these ligaments and assess morphometrically the pterygospinous (Civinini's) and pterygoalar (crotaphitico-buccinatorius) foramens. A total of 312 human skulls from the collection of Universidade Federal de São Paulo (UNIFESP) were used to assess the presence of total or partial ossification in pterygospinous (Types I and II) and pterygoalar (Types III and IV) ligaments. Of the sample, 37.18% had some degree of ossification; in Type I, ossification was found in 1.6%, while Types II, III and IV had 13.14, 3.84, and 22.43%, respectively. The pterygospinous foramen presented an average diameter between 10.626–7.366 mm, whereas for the pterygoalar foramen it was between 5.202–3.793 mm. The presence of these formations must be considered in the therapeutic procedures that are performed in the infratemporal region, in assessing pain affecting the territory innervated by the mandibular nerve.

KEYWORDS: Pterygospinous ligament; Pterygoalar ligament; Infratemporal fossa; Foramen ovale; Porus crotaphitico-buccinatorius.

INTRODUCTION

The presence of ossification in the pterygospinous and pterygoalar ligaments have clinical significance as these ligaments establish relationships with the oval foramen and because of the effects that emerge from it, such as increasing difficulty in accessing the oval foramen in a therapeutic approach.

In terms of its prevalence, Nayak *et al.* (2007) analyzed 416 Indian dried skulls; 9.61% of the samples presented the pterygospinous bony bridges, of which 5.76% was complete and 3.84% was incomplete. On the other hand, Kapur *et al*. (2000) in an earlier study obtained a lower prevalence of 1.31% of complete pterygospinous ligament ossification, from a sample of 305 Croats' skulls. The pterygospinous ligament described by Civinini in 1835 (cited by Tebo, 1968) is directed from the spine of the sphenoid bone to the pterygospinous process when ossified, establishing the pterygospinous foramen.

Rouviére & Delmas (1999) stated that the pterygospinous ligament divides the sphenomandibular ligament into two independent, of which the interpterygoid fascia is thin. Lateral to the interpterygoid fascia is another fibrous plate inserted in the greater wing of the sphenoid and in the superior segment of the posterior edge of lateral plate in the pterygoid process. Its superior edge becomes flat and forms an innominated ligament, described by Hyrtl in 1862 (Cited by Tebo), and posteriorly called pterygoalar ligament (Antonopoulou *et al*., 2008) which when it is ossified, mold the pterygoalar foramen (porus crotaphitico-buccinatorius).

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These formations are related laterally with the oval foramen, from which the mandibular nerve emerges, and then enters in the infratemporal fossa. In this position, the mandibular nerve can be compressed as a result of the pterygoid muscle contraction causing pain (Krmpotic´-Nemanic *et al*., 1999). Peuker *et al.* (2001) described a case in which the lingual nerve was trapped between the pterygospinous bony bridge and the medial pterygoid muscle; this variation is associated with pain and alterations in speech.

It is known that the pterygospinous and pterygoalar bony bridges are of great importance to the anesthetic treatment of the mandibular nerve and for therapeutics for the trigeminal ganglion (Das & Paul, 2007; Singh *et al*., 1993), because their presence hinders access to the needle in the vicinity of the oval foramen.

The purpose of this study was to determine the prevalence of pterygospinous and pterygoalar bony bridges and to analyze morphometricaly the homonyms foramen in a collection of contemporary skulls and discuss their clinical implications.

MATERIAL AND METHOD

By nonprobability convenience sampling, 312 dry human skulls belonging to the collection of the UNIFESP with records of sex, age, and origin were selected. The ages of individuals up to the dates of death was between 18 and 100 years old, the average age of the sample was 42.32 (SD 14.842). Of the total sample, 212 (67.9%) were male skulls, whereas female skulls were 100 (32.1%). Of the 312 skulls, 284 represent Brazilians individuals, which constitute 91% of the group. The remaining 9% (n = 28) is distributed among 11 other nationalities. Skulls that showed visible evidence of abnormalities such as trauma or obvious morphological asymmetries were excluded from this study.

The skulls were examined by one observer, in groups of 40 skulls and those that had complete or partial ossification of the pterygospinous and pterygoalar ligaments were identified. The following descriptions are given for ossification of the two ligaments:

Type I: presented complete ossification of pterygospinous ligament: there is a bony bridge that leads from the pterygospinous process to the apex of the sphenoid spine. In this case, it is the pterygospinous foramen (Fig. 1).

Type II: presented incomplete ossification of pterygospinous ligament: there is a lengthening of the pterygospinous process, but fails to contact the sphenoid spine. In this case, the pterygospinous foramen is partially formed (Fig. 2).

Type III: presented complete ossification of pterygoalar ligament: there is a bony bridge between the superior segment of the posterior edge of the lateral lamina of the pterygoid process and a process that emerges from the anterolateral area of the base of sphenoid spine. In this case, it is the pterygoalar foramen (crotaphitico-buccinatorius) (Fig. 3).

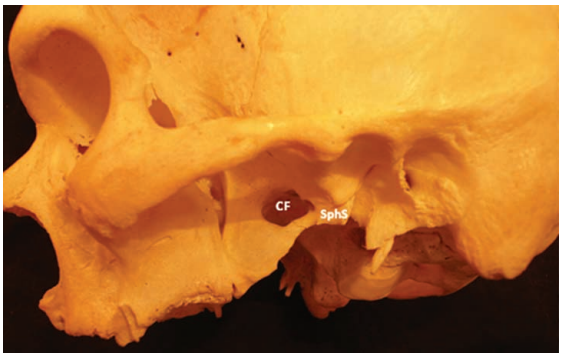

Fig. 1. Type I presented complete ossification of pterygospinous ligament. In this case, it is the pterygospinous or Civinini's foramen. CF: Civinini foramen, SphS: Sphenoid spine.

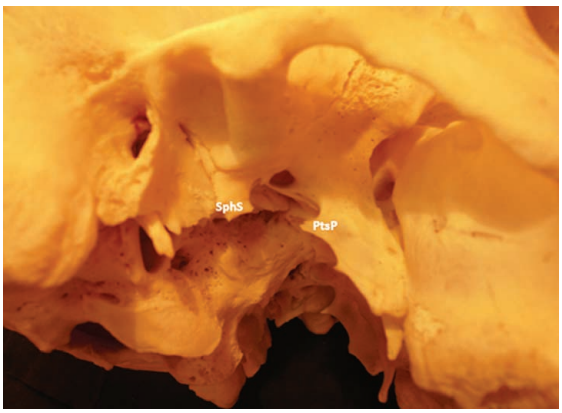

Fig. 2. Type II, incomplete ossification of pterygospinous ligament, there is a lengthening of the pterygospinous process. PtsP: Pterygospinous process, SphS: Sphenoid spine.

Type IV: presented incomplete ossification of pterygoalar ligament: there is an elongation of a process in spina shape that originates from the anterolateral area of the sphenoid spine base, but that does not reach sufficiently elongation to contact with the lateral lamina of the pterygoid process. This was an inclusion criteria for considering the elongated process that emerges from the sphenoid spine. It is a fact that in the lateral norma, at least half the foramen ovale is hidden (Fig. 4).

In cases where there was complete ossification of the ligaments (Type I and III), the maximum and minimum diameter of the pterygospinous foramen and pterygoalar foramen were determined.

With the data obtained, prevalence rates for the four proposed types were estimated, differentiating the bilateral, right, and left presentations.

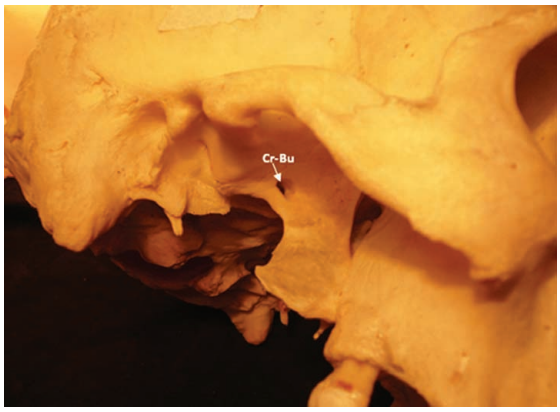

Fig. 3. Type III, complete ossification of pterygoalar ligament. In this case, it is the pterygoalar or crotaphitico-buccinatorius foramen. Cr-Bu: Crotaphitico-buccinatorius (white arrow).

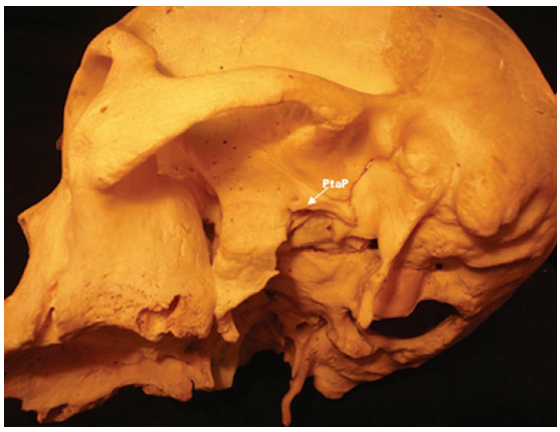

Fig. 4. Type IV, incomplete ossification of pterygoalar ligament: there is an elongation of a process in spina shape that originates from the anterolateral area of the sphenoid spine base. PtaP: Pterygoalar process (white arrow).

RESULTS

A total of 116 skulls (37.18%) had some kind of the variation; the most frequent was incomplete ossification of pterygoalar ligament. From the samples of 312 human dry skulls from the UNIFESP collection, the cases distribution of partial and complete pterygospinous and pterygoalar ligaments ossification are presented in Table I.

Of the total sample, only five (1.6%) present complete ossification of the pterygospinous ligament, constituting the foramen of the same name (Civinini's foramen) (Fig. 1). The maximum diameter of this foramen was 10.626 mm (SD 2.85) and the average minimum diameter was 7.366 mm (SD 1.29). The complete ossification of pterygoalar ligament was found in 12 cases (3.84%), which presents the formation of the pterygoalar foramen (crotaphitico-buccinatorius foramen) (Fig.3), whose maximum diameter was 5.202 mm (SD 1.005) and the minimum diameter was 3.793 mm (SD 1.54).

DISCUSSION

The sphenoid bone presents a series of intrinsic ligaments: interclinoid, caroticoclinoid, pterygospinosus, and pterygoalar ligaments. Ossification process with different clinical implications has been reported for all.

The present study analyzed the presence of total or partial pterygospinosus and pterygoalar ligaments ossification. These formations occupy a deep and high portion in the infratemporal fossa establishing important relationships with the mandibular nerve and its branches, the otic ganglion, the median meningeal artery and vein, the tympanic nerve, the medial and lateral pterygoideus muscles. These are compressed against the bone formations and are capable of generating clinically important alterations (Krmpotic´-Nemanic *et al.*; Peuker *et al.*; von Lüdinghausen *et al.*, 2006).

The prevalence of pterygospinosus bony bridges has been reported by different authors with different results. For a sample, Wood-Jones (1931) reported an 8% pterygospinosus ligament ossification in Hawaiian skulls. Nayak *et al.* indicated that such bridges was completely ossified in 5.76% of the cases analyzed by them. Peker *et al.* (2002) reported the presence of this bridge in 8.8% in skulls of an Anatolian population. In this study, the prevalence of complete pterygospinosus ligament ossification was only 1.6%, much lower than those reported in the earlier studies. This could be attributed to the age of this sample (average 42.32 years), as the emergence of ossification process is associated with increasing age of subjects (Cammisa *et al.*, 1998).

	Type I		Type II		Type III		Type IV	
	n	%	n	%	n	%	n	%
Bilateral	0	0.00	16	5.12	4	1.28	24	7.69
Right	2	0.64	35	11.21	8	2.56	38	12.17
Left	3	0.96	22	7.05	8	2.56	56	17.94
Total	5	1.60	41	13.14	12	3.84	70	22.43

Most cited investigations related to the pterygospinosus ligament ossification and the formation of the homonym foramen did not mention the implications of these variations; however, from a clinical point of view the presence of ossification in the pterygoalar ligament is even more important for two reasons: (i) when pterygoalar ligament is partially ossified the bony prominence not mentioned in anatomical nomenclature, is projected anterolaterally to be a spine that partially covers the access to the oval foramen from a lateral approach through the supra and the infrazygomatic via, decreasing the effectiveness of extraoral anesthetic treatment technique of the mandibular nerve; (ii) the complete ossification of the pterygoalar ligament determines the formation of the pterygoalar foramen (crotaphitico-buccinatorius), which is much smaller in diameter compared with the pterygospinosus foramen (Civinini's). The pterygoalar ligament completely prevents access to the mandibular nerve or trigeminal ganglion from foramen ovale by the supra or infrazygomatic via.

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RESUMEN: La osificación de los ligamentos intrínsecos del hueso esfenoides ha sido reportada en la literatura. La presencia de puentes óseos por osificación de los ligamentos pterigoespinoso y pterigoalar tiene importancia clínica debido a las relaciones que éstas formaciones establecen con el contenido de la fosa infratemporal. El propósito de este estudio fue analizar la prevalencia de la osificación de estos ligamentos y evaluar morfométricamente los forámenes pterigoespinoso (Cinivini's) y pterigoalar (crotaphitico-buccinatorius). Se utilizaron 312 cráneos humanos de la colección de la UNIFESP, se evaluó la presencia de osificación total o parcial de los ligamentos pterigoespinoso (Tipos I y II) y pterigoalar (Tipos III y IV). Un 37,18 % de la muestra presentó algún grado de osificación, el tipo I se encontró en un 1,6%%, el tipo II en un 13,14%, el tipo III en un 3,84% % y el tipo IV en un 22,43%. El foramen pterigoespinoso presentó un diámetro medio de entre 10,626 – 7,366 mm, mientras que para el foramen pterigoalar estuvieron entre 5,202 – 3,793 mm. La presencia de estas formaciones debe ser considerada en los procedimientos terapéuticos que se realicen en la región infratemporal y en la evaluación de cuadros dolorosos que afectan al territorio inervado por el nervio mandibular.

PALABRAS CLAVE: Ligamento Pterigoespinoso; Ligamento Pterigoalar; Fosa infratemporal; Foramen oval; Foramen crotaphitico-buccinatorius.

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