

Suture-like pattern formation in the pterygospinous bridge of the human sphenoid bone

JANUSZ SKRZAT, GRZEGORZ GONCERZ

Department of Anatomy, Faculty of Medicine, Jagiellonian University Medical College, Kraków, Poland

Corresponding author: Janusz Skrzat, Ph.D., D.Sc.

Department of Anatomy, Jagiellonian University Medical College

ul. Kopernika 12, 31-034 Kraków, Poland

Phone/Fax: +48 12 422 95 11; E-mail: j.skrzat@uj.edu.pl

Abstract: The paper presents an anatomical study involving rare variations in the pterygospinous bridges found in Mongolian skulls. These structures extend between the lateral pterygoid plate and the sphenoid spine. Particularly interesting is the division of these bridges into two distinct parts of the similar length. The junctions within these structures resemble morphological patterns characteristic for the plain and zigzag sutures, which articulate the cranial bones.

Keywords: pterygospinous bridge, pterygospinous ligament, pterygoid process, sphenoid bone.

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Introduction

The pterygospinous bridge is a structure that is not commonly present in human crania. It is formed when the fibrous bands, known as the pterygospinous ligament, ossify. This ligament extends between the lateral lamina of the pterygoid process and the sphenoid spine. Hence, ossification of the pterygospinous ligament forms a bony bar, which limits the so-called pterygospinous foramen situated between the upper edge of the ossified pterygospinous ligament and the cranial base. Both structures were originally described by the Italian anatomist Filippo Civinini in the 19th century, therefore they are also known as the foramen and ligament of Civinini [1].

Since then, the morphological features of the pterygospinous bridges and related foramina have gained interest of anatomists and clinicians due to their close proximity to the blood vessels and nerves supplying the structures of the infratemporal fossa, and



emerging from the middle cranial fossa [2–5]. Thereby, the clinical importance of the pterygospinous ligament relates to its location close to the oval foramen, which serves for the passage of the mandibular nerve a branch of the trigeminal nerve. In turn, the oval foramen serves as a natural surgical corridor to the middle cranial fossa when a percutaneous trigeminal rhizotomy has to be performed to provide relief from pain associated with trigeminal neuralgia [6–8].

The incidence of the pterygospinous bridges varies across human populations and may range from 1–10% or even more. The literature data shows discrepancies in total incidence of the ossified pterygospinous ligament regarding its incomplete or complete appearance, unilateral or bilateral existence, predominant side of the skull, and sex differences [9–12].

So far, morphological analyzes have focused on estimating the frequency of ossified pterygospinous ligaments, their clinical relevance rather than understanding how they form. Therefore, the objective of the current paper is to illustrate and analyze the patterns of osseous connections between the lateral plate of the pterygoid process and the sphenoid spine. We also performed comparisons between these morphological patterns and the sutures that typically join cranial bones together.

Materials and Methods

Peculiar forms of the pterygospinous bridges were found in two Mongolian skulls labelled as DIIa 39 and DIIa 41 (Fig. 1). Both skulls belong to the cranial collection housed in the Anthropological Department located in the Nature Education Centre of the Jagiellonian University. The whole Mongolian cranial collection comprises 37 skulls of an adult individuals of both sexes; however, such an outstanding anatomo-



Fig. 1. Lateral view of the adult skulls demonstrating outstanding features of the ossified pterygospinous ligament (pterygospinous bridge) presented in close-up in Fig. 2.

mical feature related to the appearance of the pterygospinous bridges was not found in the rest of the skulls. The examined skulls were well preserved, showed normal craniofacial anatomy, and any artificial or pathological deformations. The morphological features of the cranial base of each skull were assessed by visual inspection. The appearance of the pterygospinous bridges was documented by the photographs and compared to the corresponding images found in the available literature.

Results

The position of the pterygospinous bridge was similar in both skulls: DIIa 39 and DIIa 41. The bony bridges run below and laterally to the foramen ovale, limiting the space termed the pterygospinous foramen. Each of the pterygospinous bridges consisted of two opposing bony trabeculae, forming the complete connection between the posterior edge of the lateral plate of the pterygoid process and the sphenoid spine (Fig. 2).

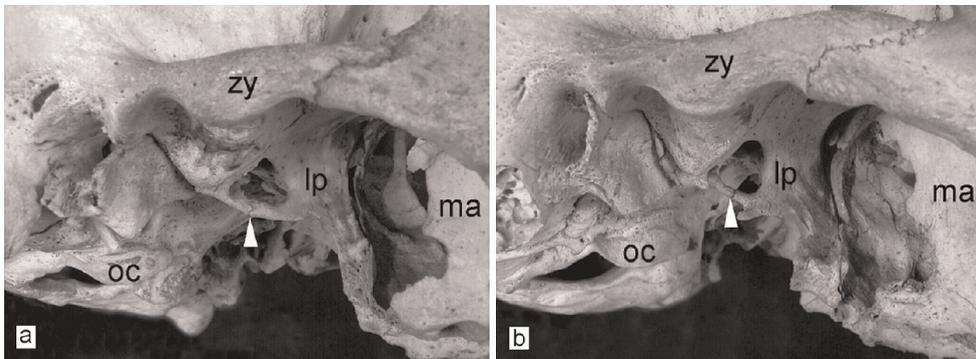


Fig. 2. Latero-inferior aspect of the basicranium with visible pterygospinous bridge indicated by the arrow (**a** — skull DIIa 39, **b** — skull DIIa 41); ma — maxilla, lp — lateral plate of the pterygoid process, oc — occipital bone, zy — zygomatic arch).

The pattern of connections existing between the opposing bony trabeculae forming the pterygospinous bridge was different in both cases; however, each of them resembled the pattern characteristic of articulations that can be found between two opposing cranial bones joined by a suture (Fig. 3). The opposing bony trabeculae seem to firmly adhere to each other, though the line of fusion is remarkably visible. In the case of the skull DIIa 39, the line of fusion resembles a short sinusoid line, like in the serrate sutures. The connection pattern of two trabeculae forming the pterygospinous bridge of the skull DIIa 41 corresponds to end-to-end sutures, where two bones are faced with their plane surfaces. In this case, the line of fusion is circumferential.

In both cases, the connection line is well demarcated and resembles cranial suture configuration. The connection within the bony bridge of the skull DIIa 39 is similar to

the serrate or limbous cranial suture, while the connection in the pterygospinous bridge of the skull DIIa 41 resembles a plane suture (Fig. 3a). It is likely that these bony formations are examples of atypical articulations that developed because of the extensive growth of the sphenoid spine and the pterygospinous process, which could interact in the place of their junction with the tooth-like protruding processes. Thus, their interlocking edges are serrated with possible bevelling visible in the pterygospinous bridge found in the skull DIIa 41, and depicted in Fig. 3b.

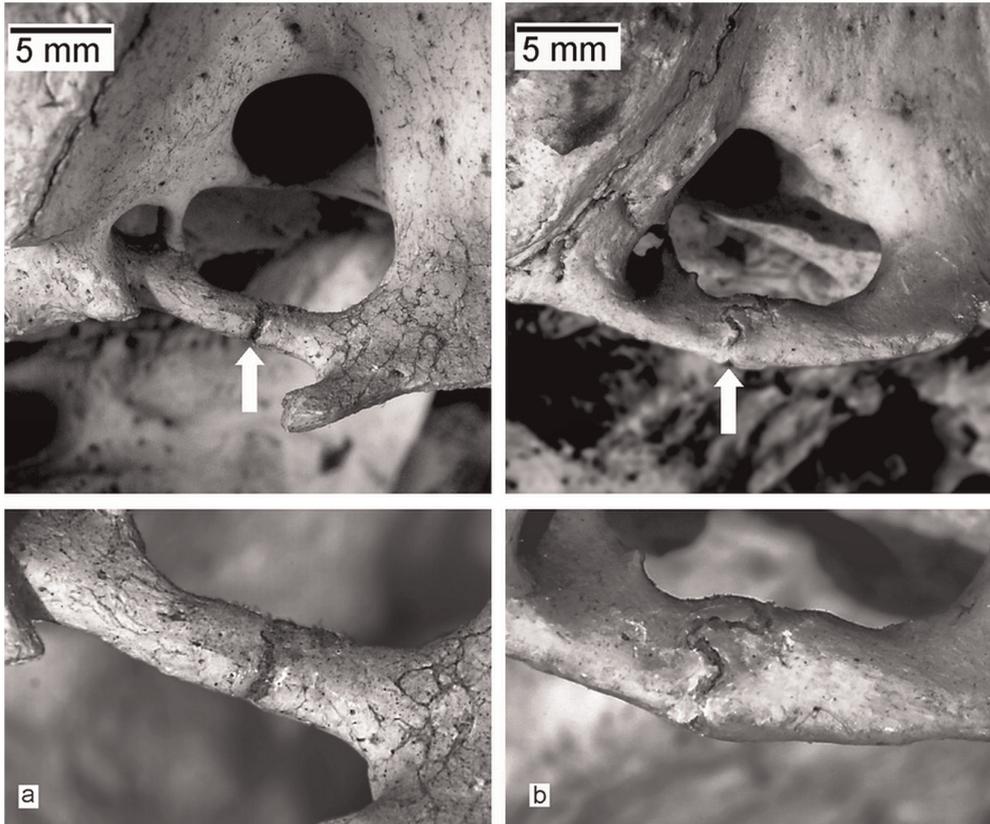


Fig. 3. Appearance of the connection (indicated by arrows) between the bony process arising from the pterygoid plate and the sphenoid spine forming the propterygospinous bridge. A close up view of the pterygospinous bridges reveals two different patterns of connection: plain (a) and zigzag (b).

Discussion

Anatomical variation of the lateral plate of the pterygoid process relates to possible ossification of the ligaments that from the posterior edge of the pterygoid process to the greater wing of the sphenoid bone. The lateral pterygoid plate is usually broad,

thin, and everted. Its lateral surface gives attachment to the lateral pterygoid muscle, while from the posterior edge, the pterygospinous ligament extends to the sphenoid spine [13]. Ligamentous structures attached to the pterygoid process of the sphenoid bone occasionally ossify and become bony structures of various sizes and shapes. They can manifest as complete or incomplete bony bridges existing unilaterally or bilaterally; moreover, the ossified sphenoid bone ligaments may occur in coexistence in various combinations [14–15].

However, suture-like patterns located in the bony bridges resulting from the ossification of the intra- or extracranial ligaments have been rarely found and their descriptions are scanty in anatomical literature. For instance, Özgür and Esen found suture-like configurations located in the middle part of the ossified petrosphenoid ligaments. They observed this morphological feature in 7 patients (4 men and 3 women) examined by computed tomography [16].

In the case of the studied skulls, the bony bridges occupy the position of the apparent ossified pterygospinous ligaments. However, their appearance seems to be different from typical bony pterygospinous bridges, because they are composed of two separated segments joined together in the middle part of the pterygospinous bridge.

In contrast to the abovementioned cases, the pterygospinous bridge can also be formed grossly by the pterygospinous process, which can be extended by the ossified pterygospinous ligament. Thus, the line of fusion (where the bones come together) is shifted toward the sphenoid spine, which is a place for attachment of the pterygospinous ligament.

These findings raise the question of whether the suture-like interosseous connection can be formed as a result of ossification of the pterygospinous ligament or results from extensive growth and elongation of the bony elements arising from the lateral plate of the pterygoid process and the sphenoid spine, which approach each other and finally form a tight osseous connection, demonstrating an apparent suture configuration with a visible subtle suture line.

The division of the pterygospinous bridge into two parts connected in the midline and the resemblance to specific suture types might have implications for understanding the development or evolutionary aspects of the formation of inconstant bony structures. Therefore, further morphological studies should focus on a detailed analysis of the ossification process that involves the cranial ligamentous structures.

Conclusions

The contribution of the pterygospinous ligament in complete ossification reveals various morphological patterns, which can manifest as a plain, or zigzag connection, or a complete bony fusion. The junction within the pterygospinous bridges exhibits

a similarity to the morphological patterns encountered in the cranial sutures. A distinctive characteristic of the examined pterygospinous bridges is their division into two separate parts being of approximately equal length.

Conflict of interest

The authors declare no conflict of interest nor any financial interest associated with the current study.

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