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Impact of Anterior Clinoid Process Pneumatization on Adjacent Anatomical Structures

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ABSTRACT

The Anterior clinoid process is closely related to many important anatomical structures including vessels, nerves, and paranasal sinuses. In the majority of cases, this process is osseous, but its pneumatization has been recorded as an anatomic variant. Coronal CT scans of the head region that were done for thirty-seven patients at Tanta University hospitals were collected to be used in teaching radiological anatomy for medical students. During their routine investigation, a case of a female aged 21 years showed bilateral pneumatization of the anterior clinoid processes associated with some variants of the adjacent anatomical structures. These findings were discussed on anatomical basis with referral to their possible clinical implications. If a surgical removal of the anterior clinoid process is recommended, a comprehensive knowledge of its anatomy, pneumatization, and associated regional anatomic variants is crucial for neurosurgeons to avoid risky complications.

Keywords: *anatomical variations, anterior clinoidectomy, anterior clinoid process, optic strut, pneumatization, sphenoid sinus.*

INTRODUCTION

The anterior clinoid process (ACP) is an intracranial, medial projection of the lesser wing of sphenoid bone. It is pyramidal in shape having a freely hanged apex and a fixed base. Its base has three bony attachments; medially to the planum sphenoidale, laterally to the lesser wing of sphenoid and inferomedially to the optic strut which forms the lateral wall of the optic canal [Figure 1].[1]

As the process projects posteriorly and medially into the middle cranial fossa, it forms a roof to the anterior segment of the cavernous sinus. Here, the inferomedial surface of ACP is related to the cavernous and cerebral parts of the internal carotid artery (ICA), and to the ophthalmic artery as well.[2,3] The optic nerve in the optic canal forms the medial boundary of the ACP. The inferolateral surface of the process forms a roof to the superior orbital fissure, and consequently ACP is related to motor nerves of the extraocular muscles. Both the optic canal and the medial portion of the superior orbital fissure are separated by the thin bony formation; optic strut.[1]

Anterior clinoidectomy is the surgical removal of ACP. This procedure is required in many conditions like huge suprasellar adenomas, cavernous sinus lesions, ophthalmic artery aneurysm or paraclinoid ICA aneurysm.[4,5] The complex anatomy of this region renders the surgical removal of ACP associated with many risks. These risks include injury of cavernous sinus or nearby arteries, harm of a paranasal sinus, leakage of cerebrospinal fluid, and even death. Postoperatively, some patients suffered from visual disturbance and oculomotor paresis or even palsy.[6,7]

Besides to the complex surrounding anatomy of the ACP, different anatomical variations were recorded in the form of its pneumatization or the formation of bone bridges with the middle and posterior clinoid processes. In case of its fusion with the medial clinoid process, a bony foramen (caroticoclinoid) is formed around the ICA. Anterior clinoid pneumatization is usually associated with variations of the nearby anatomical structures. These anatomical variations increase the possible risks and complications of microsurgical treatments.[1] This case report tries to spot the light on ACP anatomy, its important relations,

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its associated regional variants, and possible clinical implications in case of its pneumatization.

CASE REPORT

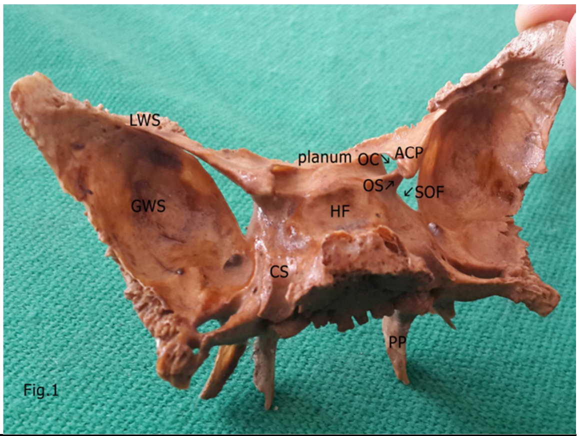

Figure 1: A postero- superior aspect of a dry sphenoid bone showing: lesser wing of sphenoid (LWS), greater wing of sphenoid (GWS), planum sphenoidale (planum), anterior clinoid process (ACP), optic canal (OC), optic strut (OS), superior orbital fissure (SOF), hypophyseal fossa (HF), pterygoid process (PP), and carotid sulcus (CS).

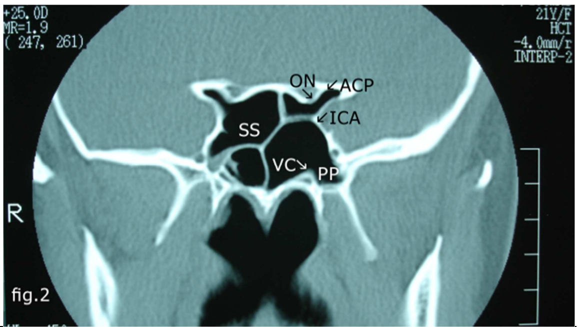

Figure 2: A coronal CT scan of the head region of a female aged 21 years showed bilateral pneumatization of anterior clinoid process (ACP) and partial pneumatization of left pterygoid process (PP). The following structures are protruded into the sphenoid sinus; bilateral optic nerves (ON), bilateral internal carotid arteries (ICA), and left vidian canal (VC). Notice the multiple intersphenoid septa inside the sphenoid sinus (SS).

Thirty–seven coronal CT scans for the head region that was done for patients at Tanta university hospitals,Egypt (during the period from December 2015 to June 2016) were collected. The CT scans were done for 26 males and 11 females with their ages ranged from 18-71 years. Routine investigation was done for these CT scans to assess their suitability for their use as a material for teaching radiological anatomy for medical students. This investigation was approved by the ethical committee of the faculty of medicine, Tanta University. All of the investigated cases showed bilateral osseous anterior clinoid processes except for a case of a female aged 21 years, which showed bilateral pneumatization of these processes. The pneumatization appeared as an extension from the sphenoid air sinus. Bilateral protrusion of the optic nerve into the sphenoid sinus was seen. Multiple intersphenoid septa were seen dividing the sphenoid cavity into 4 unequal partitions. One of these septa terminated laterally on the left carotid artery prominence. Bilateral protrusion of internal carotid arteries into the sphenoid sinus was observed. The pneumatization of the lower left partition of the sphenoid sinus extended into the pterygoid process with protrusion of the left vidian canal [Figure 2].

DISCUSSION

Multiple studies have been found in the literature exploring the pneumatized ACPs on cadavers or using radiographies. The incidence of this variation differed in different studies. This difference may be attributed to different populations, sample size or study methodology. Generally, the majority of ACPs are osseous. The incidence of ACP pneumatization may range from 4% up to 29% of investigated cases in different studies.[6,8-10] In the current study, only one case of bilateral pneumatization of ACPs was observed among the 37 studied cases. Because of our small sample, the incidence was discarded.

Pneumatization of ACPs in our case appeared as an extension from the sphenoid sinus. This case also showed incomplete extension of pneumatization of sphenoid into left pterygoid process. Developmentally, the sphenoid sinus is present at birth, but its developmental pneumatization continues until adulthood when it reaches its final size. Extensive pneumatization of the sphenoid sinus may occur and results in its extension into any of the sphenoid bone components. If pneumatization extends into ACP, it can encroach the optic nerve. The pneumatization of the sphenoid sinus can also extend into the pterygoid plates which may be either complete or incomplete.[11,12]

The present case showed also some associated variants in the sphenoid sinus. The sinus possessed multiple intersphenoid septa which divided its cavity into four unequal partitions. Other researchers postulated that, there is usually an intersphenoid septum which usually deviates to one side, dividing the sinus into two unequal cavities. They demonstrated great variability of the intersphenoid septa, and they recorded multiple transverse or vertical septa in many patients.[13] In a study done on an Egyptian sample, 6.4% of the investigated cases showed multiple sphenoid septation with different orientation.[14] In our case, one of the intersphenoid septa was directed laterally to be inserted into the left internal carotid artery prominence. Sareen et al. declared that intersphenoid septum is frequently seen inserted into the bony bulges over the optic nerve or the internal carotid artery.[15]

In our case, the pneumatization of ACP was associated with protrusion of both optic nerves and ICAs into sphenoid sinus. Meanwhile, it also showed concomitant presence of pneumatized left pterygoid process and protrusion of left vidian canal. A previous study found highly significant association between these variants. It declared that if the ACP is pneumatized, an opticocarotid recess is formed which lead to protrusion of ipsilateral optic nerve as well as internal carotid artery into the sphenoid sinus. It also emphasized involvement of vidian nerve in sinus disease in case of its protrusion into sphenoid sinus.[16] Another study explained that because the development of optic nerve, carotid arteries, and vidian nerve occur prior to the paranasal sinuses, congenital variations in the walls of the sphenoid sinus happen.[17]

Many researchers claimed that intraoperative neural or vascular damage happens more often in pneumatized ACP than in osseous ones. They suggested that the rotating drill bore into the pneumatized process more vigorously and may cause injury to the regional anatomic structures, including brain cortex, cavernous sinus, optic nerve, occulomotor nerve, ICA or orbital contents. They recommended preoperative radiographic evaluation of air cell infiltrate into the ACP if a decision of bony destruction in the middle cranial fossa is taken.[3,18]

CONCLUSION

A perfect understanding of ACP anatomy, variations and regional vital relations is crucial for neurosurgeons for prevention of surgical complications. Moreover, the surgeon must put in his consideration that the optic nerve and the internal carotid artery may bulge in the area of the sphenoid in case of pneumatization of ACP, and that these two vital structures may be highly injured.

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