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Case Report

# OSSIFICATION OF CAROTICOCLINOID AND PETROSPHENOIDAL LIGAMENTS OF SKULL

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## ABSTRACT

Ossification of various ligaments in the body may result in clinical symptoms due to compression of neighbouring structures and complications in regional surgeries. This case reports of a dry skull that presented with two rare bony anomalies - caroticoclinoid and petrosphenoid bridges. Simultaneous occurrence of both these anomalies is a unique morphological event with neurovascular implications. Considering the fact that majority of textbooks in anatomy do not provide a detailed description of these entities, the present report is very much relevant for neurosurgeons and radiologists in day to day practice.

**KEY WORDS**: Caroticoclinoid ligament, petrosphenoidal ligament, clinoid processes, abducent nerve, internal carotid artery.

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## INTRODUCTION

A myriad of intricate structures are found in the petroclival region, which are especially important in procedures involving the skull base. Knowledge of anatomy of this area is essential for successful surgical treatment of lesions in this region. Surgical approaches to the clivus, petroclival region and cavernous sinus require an excellent knowledge of the anatomy of this region [1].

Ossification of ligaments around the sella turcica may give rise to bony bridges that connect the clinoid processes with other surrounding structures. These sellar bridges can develop unilaterally or bilaterally and vary in frequency [2]. As a result of abnormal development in anterior, middle and posterior clinoid processes, these bony structures could fuse, forming osseous bridges. Bridge formation could either occur between the anterior and middle (caroticoclinoid bridge forming caroticoclinoid foramen of Henle), the anterior and posterior or between middle and posterior clinoid processes. In addition, a bony bridge could also develop between the posterior clinoid process and superior margin of petrous part of temporal bone, the sphenopetrous bridge [3].

The caroticoclinoid foramen is an inconstant structure of the middle cranial fossa, formed by ossification of the fibrous interclinoid ligament or dural fold between the anterior and middle clinoid process. It allows the passage of the clinoid segment of internal carotid artery as it turns upwards to supply the brain [4]. The presence of ossified caroticoclinoid ligament is likely to cause compression, tightening or stretching of internal carotid artery [5].

The petrosphenoidal ligament (Gruber's ligament) is located between the petrous apex and posterior clinoid process and forms the roof of Dorello's canal through which the abducent nerve passes [1]. Dorello's canal was described by Gruber in 1859 as an osteofibrous canal (foramen petro-sphenoideum) located at the apex of petrous bone containing the abducent nerve, inferior petrosal sinus and dorsal meningeal branch of meningohypophyseal trunk [1,6,7]. Clinicians might consider ossification of petrosphenoidal ligament in unexplained cases of abducent nerve palsy [6].

Records of the variations stated above are very few in medical literature and their simultaneous occurrence in same skull is exceptional and requires reporting. Descriptions of such entities are important because of their applicability in surgical interventions involving region surrounding the sella turcica.

## CASE REPORT

During routine osteology classes for first year medical students of 2013-14 batch, bilateral complete caroticoclinoid bridges were seen extending from anterior to middle clinoid process resulting in the formation of bilateral caroticoclinoid foramina which were circular in shape with smooth outline. They were located anterolateral to sella turcica, medial to superior orbital fissure and behind the optic canal on both sides. In addition, a completely ossified petrosphenoidal ligament was seen extending from apex of petrous temporal bone to the posterior surface of posterior clinoid process on right side of skull forming an elliptical bony foramen beneath this bridge.

## DISCUSSION

Incidence of caroticoclinoid foramen in various studies ranged between 6.27-36% [4,8-10]. Unilateral and incomplete caroticoclinoid foramen are more common than bilateral and complete foramen [4,10,11]. The incidence shows racial trends; showing high occurrence in Turks, Americans, Portuguese, Nepalese and low in Brazilians, Japanese, Koreans and Indians [4,9-13].

The caroticoclinoid bridge could cause pressure on the internal carotid artery that lies in the cavernous sinus, changing the morphology in the terminal end of the groove of internal carotid artery [3]. Due to greater calibre of internal carotid artery in this region compared to the diameter of caroticoclinoid foramen, the possibility of headache due to compression by the foramen is high. Caroticoclinoid foramen is an important structure due to its relations with cavernous sinus and its contents, sphenoid sinus and pituitary gland [5]. On one hand a wide foramen may provide safety cover for the artery; on the other hand it may confuse radiologists while doing carotid arteriograms and pneumat-

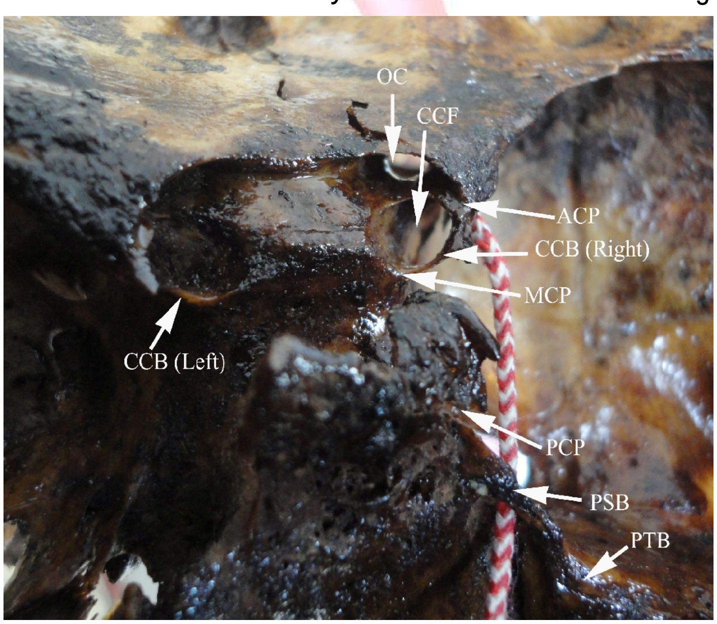


**Fig. 1:** Showing bilateral complete caroticoclinoid bridges and right sided complete petrosphenoidal bridge.

(CCB- Caroticoclinoid bridge, CCF- Caroticoclinoid foramen, ACP-Anterior clinoid process, MCP- Middle clinoid process, PCP- Posterior clinoid process, PSB- Petrosphenoidal bridge, PTB- Petrous part of temporal bone. OC- Optic canal)

-ization or marrow assessments of anterior clinoid process. It poses accessibility and bleeding problems during neurosurgical invasive procedures of the region [11].

The internal carotid artery enters the subarachnoid space through a thick ring of duramater called the distal dural ring. The internal carotid artery is also surrounded with another ring of dura, the proximal dural ring which is exposed after the anterior clinoid process is removed. The area in between these two rings is called the clinoidal space. The clinoidal segment of the internal carotid artery located in this space is exposed by removing the anterior clinoid process. During surgical approaches to the sellar region for tumors or aneurysms, the anterior clinoid process is removed carrying risk of damage to the internal carotid artery during these approaches [10]. Approach to the cavernous sinus commonly involves removal of anterior clinoid process to expose the structures in the superior part of cavernous sinus. Presence of caroticoclinoid bridge makes removal of anterior clinoid process more difficult and increases the risk of complications, especially if aneurysm is present. Oculomotor nerve may also be damaged during the removal of anterior clinoid process. So serious weighing of risks and benefits of operative approaches must be done before the operation because of the magnitude of operating procedure and risks of neural and vascular injury [3].

In presence of caroticoclinoid foramen it is impossible to retract or mobilize the cavernous segment of carotid artery even after releasing the proximal and distal carotid rings. Preoperative recognition of caroticoclinoid foramen is important because undue retraction of cavernous segment of internal carotid artery may tear or rupture it and cause fatal cerebral infarction [12].

Incidence of petrosphenoidal bridges in various studies was found to be 5-17.7% [1,3,7,14]. An ossified petrosphenoidal ligament may play a role in abducent nerve palsy and can be detected by multidetector computed tomogaphy [14]. The abducent nerve may be compressed within Dorello's canal by an accompanying artery usually the dorsal meningeal branch of meningohypophyseal trunk. If Gruber's ligament is ossified then vascular compression may be more likely [6].

The petrosphenoidal ligament is an important structure in the petroclival area, not only from anatomical point of view but also for surgical and endovascular practice. This ligament is located at the petrovenous confluence of superolateral part of the basilar plexus, the posterior portion of cavernous sinus, superior part of inferior petrosal sinus and anterior part of sphenoparietal sinus. This interdural region is commonly used for treatment of carotid cavernous sinus fistulas. The main function of petrosphenoidal ligament is reported to be fixation of sheath of abducent nerve in petroclival venous confluence. The nerve is also protected by this ligament during petrous bone drilling during anterior petrosal approach [1].

Ossification of fibrous ligaments is considered a normal physiological process that occurs with age [10]. There is statistically significant association between calcification of petroclinoid and interclinoid ligaments because of possibility that these ligaments are parts of same dural folds. Hence age may be a significant factor in risk of ossification of cranial ligaments [15]. However this process is an exception in the formation of caroticoclinoid foramen since it is present in foetuses and children [16,17 ]. Sellar bridges are laid down in cartilage during early stage of sphenoid development and ossify in early childhood [18].

Although Dorello's canal in modern human is an osteofibrous structure and elliptical in shape, in primates it is round osseous opening closed superiorly by the fused petrosal spine and accessory clinoid process. These differences between the primate and human configurations are the source of abducent nerve vulnerability. Changes in the anatomy of the cranial base during the course of human evolution, stemming possibly from the increase in endocranial capacity have brought about distancing of dorsum sella and petrous apex, thereby elongating the horizontal axis of Dorello's canal and causing the discontinuity of its osseous perimeter. Hence the petrosphenoidal ligament of Gruber replaced the bony bridge and Dorello's canal became an osseofibrous structure, rendering its contents susceptible to compression against the cranial base. A bony petrosphenoidal bridge is far more advantageous than a fibrous one as deformation inflicted on a ligament by intracranial masses would be greater. Apes are less prone to abducent neuropathies resulting from compression of the nerve than humans as the nerve is protected by an osseous canal [19].

## CONCLUSION

Considering the fact that anatomy textbooks do not provide detailed description of these entities, the present study is of relevance to neurosurgeons and radiologists in day to day clinical practice for understanding the etiology of clinical symptoms, reducing errors in diagnostic procedures and increasing success of surgical procedures. It is concluded that presence of these anomalies have important clinical implications and their knowledge is required for better planning of surgical treatments involving this region.

## List of abbreviations:

CCB- Caroticoclinoid bridge
CCF- Caroticoclinoid foramen
ACP-Anterior clinoid process
MCP- Middle clinoid process
PCP- Posterior clinoid process
PSB- Petrosphenoidal bridge
PTB- Petrous part of temporal bone
OC- Optic canal

## Conflicts of Interests: None

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