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Incidence of Carotico-clinoid Foramen and Interclinoid Osseous Bridge in Dry Human Skulls in Sudan_ Neurosurgical Interest

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Abstract

Background: Anterior clinoid process is usually drilled in order to approach cavernous sinus and related structures in neurosurgical operations. The presence of carotico-clinoid foramen and interclinoid osseous bridge create difficulties while approaching anterior clinoid process and increases the risks of injury to the internal carotid artery and nearby structures.
Aim: To observe incidence, anatomy of carotico-clinoid foramen and interclinoid osseous bridge in the Sudanese dry skulls.

Methods: This was a cross sectional study, conducted in the departments of anatomy in different medical schools in Sudan between the period from June 2019 to January 2020. Total 30 dry adult human skulls were examined to observe incidence of carotico-clinoid foramen and of interclinoid osseous bridge.

Result: The incidence of carotico-clinoid foramen was 13.3% (4 skulls out of 30). The foramen was bilaterally present in one skull (n=1/30, 3.3%) and unilateral in 3 skulls (n=3/30, 10%). Type I bridge is the carotico-clinoid foramen itself, the Type II interclinoid osseous bridge was found in one skull (n=1/30, 3.3%) , no Type III and Type IV bridges were observed in the present study.

Conclusion: the presence of this foramen and interclinoid osseous bridge can complicate neurosurgical operations in cavernous sinus, sellar and para-sellar regions. Therefore, the detailed anatomical knowledge is very important to decrease complications and to increase success rates of neurosurgical operations in this area.

KEY WORDS: carotico clinoid foramen, clinoid process, clinoidectomy, clinoid drilling

Introduction:

Thus, carotico-clinoid foramen is one of the inconstant foramen situated in the base of the cranial cavity. There are three clinoid processes present on each side of sella turcica, anterior, middle, and posterior . This foramen is believed to be due to ossification of the ligament connecting anterior and middle clinoid processes. There are other ligaments which connect certain parts of sphenoid bone which occasionally may ossify. The interclinoid ligament (between the anterior and posterior clinoid processes) is an example which sometimes get ossified [1].

Henle in 1855, firstly described the carotico clinoid foramen which is is formed by an osseous bridge between the tip of the middle and anterior clinoid processes of the sphenoid bone[2,3].

The body of the sphenoid is centrally hollowed out into the pituitary fossa, or sella turcica The tuberculum sellae, in front which has a small elevation, the middle clinoid process, at each side . Lateral to this a larger anterior clinoid process projects backwards from the medial ends of the lesser wings. At the back is the dorsum sellae , its upper border ends at each side as the posterior clinoid process [4].

A sheet of fibrous dura mater, the diaphragma sellae, sweeps across from the tuberculum sellae to the dorsum sellae, roofing the pituitary fossa. It is continuous laterally with the roof of the cavernous sinus, which lies on each side of the sphenoid body . The diaphragma sellae is perforated centrally for the pituitary stalk, and the roof of each cavernous sinus is pierced anteriorly by the internal carotid artery, between the middle and anterior clinoid processes. A flange of dura mater, attached above to the medial and posterior clinoid processes, descends vertically between the cavernous sinus and the pituitary fossa, and sweeps medially to floor the fossa. The anterior and posterior clinoid processes give attachment to the free and attached margins, respectively, of the tentorium cerebelli [1, 4].

Internal carotid artery is the artery supplying majority of forebrain. The artery is divided into cervical part, petrous part, cavernous part and intracranial part. After traversing through cavernous sinus it curves up medial to anterior clinoid process. Finally, the artery emerges through dural roof of cavernous sinus [5].

The clinoidal segment of artery is situated in the collar of dural lining of cavernous sinus where it is completely encased by connective tissue. Here, the artery is situated between proximal and distal dural rings. The proximal (lower) ring is formed by medial extension of dura mater from lower surface of anterior clinoid process and distal (upper) ring is formed by medial extension of dura mater from upper surface of anterior clinoid process[6].

The interclinoid osseous bridge is divided into four types according to classification proposed by Archana R et al., [7]:

Type I: Bridge present between anterior and middle clinoid process (carotico-clinoid foramen)
Type II: Bridge between anterior, middle and posterior clinoid process;
Type III: Bridge between anterior and posterior clinoid process;
Type IV: Bridge between middle and posterior clinoid process.

Neurosurgeons have to approach the parasellar region in case of aneurysm of the intracavernous and clinoid segment of the ICA, carotico-clinoid fistula and tuberculum sella meningiomas. In these cases removal of anterior clinoid process is mandatory for proper visualization of the structures. Presence of an osseous bridge between clinoid processes makes removal of anterior clinoid process more difficult and enhances the risk of hemorrhage, especially if an aneurysm is present. ICA in clinoid segment and Oculomotor nerve may be damaged through the removal of anterior clinoid process. Drilling of anterior clinoid process may also cause inadvertent injury to the optic nerve[2,3, 5, 8].

Desai S et al [9] oberved 223 dry skulls, they found an incidence of 37.19% of the foramen. Also Kanjiya D et al [10] detected an incidence of 14.5% in 200 skulls. While 3 % of foramen presence reported by Magadum A[11]. Inoue et al [12] reported 25% in Americans.

Presence of carotico-clinoid foramen foramen represents a considerable percentage among different populations. Therefore, detailed anatomical knowledge of the carotico-clinoid foramen and interclinoid osseous bridge are required to obtain successful results during operations on this region for different clinical conditions.

Standard anatomy textbooks do not provide anatomical and morphological descriptions of the carotico-clinoid foramen. In addition, no reported data was found regarding the carotico-clinoid foramen in Sudanese population. So, the present study may represent a data base for the carotico-clinoid foramen among Sudanese, in addition to it may add to previous data about how it is important for neurosurgeons operating in the sellar and para-sellar regions.

Methodology:

This was across sectional study carried out in the departments of anatomy of different medical schools in Sudan . Thirty adult dried human skulls without sex distinction were included. Integrity of the clinoid process was evaluated. The damaged clinoid processes were excluded from the samples. Presence of the carotico-clinoid foramen foramen was studied in form of incidence, unilateral or bilateral; also presence of bridge was assessed in form of complete or incomplete. Photos of the skulls under the study had been taken for the study and for documentation purposes.

Ethical approval was obtained from ethical committees of the different medical schools included in the study.

Data was collected using data collection sheet and analysis was done by using SPSS version 20. Results were presented in tables and graphs using excel soft-ware.

Results:

Incidence of carotico-clinoid foramen is seen in 4 skulls (n=4/30, 13.3%) ; figure (1). It is observed bilaterally in one skull (n=1/30, 3.3%) and unilateral in 3 skulls (n=3/30, 10%) table (1). Type I bridge is the carotico-clinoid foramen itself, the Type II interclinoid osseous bridge was found in one skull (3.3%) no Type III and Type IV bridges were observed in the present study ; table (2). Illustrations from the study group are shown in figure (2).

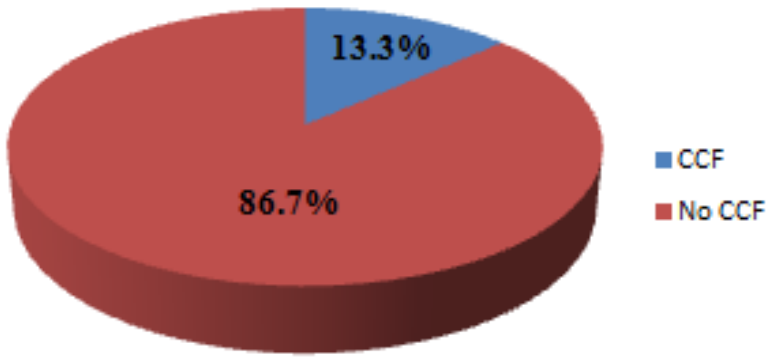

Figure 1: Presence of Carotico-clinoid foramen (CCF) among the study group; (n=30)

Table 1: Presence of Carotico-clinoid foramen according to side among the study group; (n=30):

Presence of Carotico-clinoid foramen	Frequency	Percent
Bilateral	1	3.3 %
Unilateral	3	10 %
Total	4	13.3 %

Table 2 : Presence of interclinoid osseous bridge among the study group; (n=30):

Interclinoid osseous bridge	Frequency	Percent
Type I (carotico-clinoid foramen)	4	13.3 %
Type II	1	3.3 %
Type III	0	0%
Type IV	0	0%

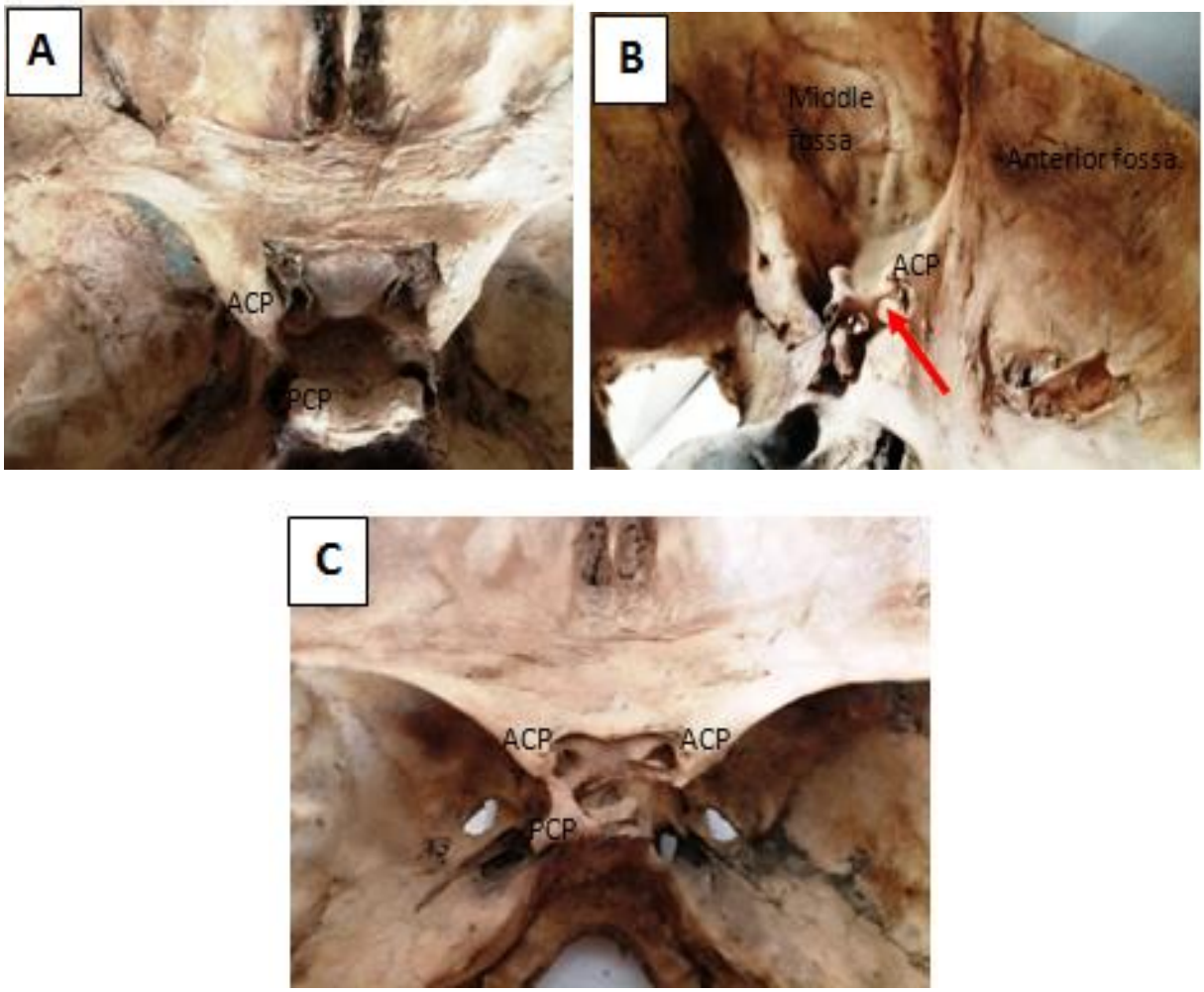

Figure 2: Illustrations from the study group
(A): Normal anterior and posterior clinoid process with no bridges (no carotico-clinoid foramen). (**B):** Bridge present between anterior and middle clinoid process (carotico-clinoid foramen shown by red arrow). (**C):** Bridge present between anterior and middle and posterior clinoid process (Type II); **APC:** anterior clinoid process, **PCP:** posterior clinoid process

Discussion:

Hochstetter F et al. [13], stated that an osseous carotico-clinoid foramen and interclinoid osseous bridge are developmental anomalies and showed the existence of the same structures in fetal and infant skulls . Thus, ossification of interclinoid ligament is not age dependent and not results because of complex sphenoid bone ossification. Ossification of ligamentous structures can be possible reason for compression of neighbouring structures. Sometimes, they produce complications while performing regional surgery [1].

carotico-clinoid foramen means bridging of ligament between middle and anterior clinoid and some times the bridging may extends between middle and posterior clinoid processes. These bridges may be complete to form foramen or incomplete forming just a contact type bridge [7].

Ozdogmus O et al. [14], conducted a study on 50 fresh autopsy bodies, they found complete ossification of carotico-clinoid ligament in 27 sides and the incomplete one was observed in 55 sides of skull of autopsy case . Bilateral complete ossification of interclinoid ligament was found in three male autopsy cases.

Although the number of skulls under the present study is less than in previous studies, results of the present study showed a considerable percent of the carotico-clinoid foramen, with same or near prevalence rates found among worldwide studies. so meticulous preoperative assessment is mandatory, surgeons treating patients with para-sellar pathologic entities should always be aware regarding the carotico-clinoid foramen.

The incidence of carotico-clinoid foramen has been studied by various researchers worldwide in different populations. Table (3) below shows some studies results in comparison to the present study.

Table (3): Comparison of the incidence of the carotico-clinoid foramen in different populations:

Author	Number of skulls	Percent	Population
Magadum A [11]	50	3%	Belgaum
Bindu A et al., [15]	70	15.72%	Indian
Azeredo RA et al., [16]	270	6.27%	Portuguese
Freire A et al., [17]	80	6.25%	Brazilian
Praveen R Sing [18]	200	10.5%	Gujarat region
Deda H et al., [19]	88	14.77%	Turkish
Present study	**30**	**13.3%**	**Sudanese**

The presence of carotico-clinoid foramen can produce compression, stretching or tightening of internal carotid artery which give rise to headache and other neuronal symptoms due to insufficient blood supply to brain[14]

Drilling and removal of anterior clinoid process is an important step of neurosurgery while approaching cavernous sinus for the management of proximal Internal carotid artery aneurysms or meningioma, and optic canal decompression. clinoid segment of internal carotid artery is situated on the inferomedial aspect of anterior clinoid process. On the lateral wall of cavernous sinus, the oculomotor, trochlear, abducent and ophthalmic division of trigeminal nerve travel within a dural fold just below and lateral to anterior clinoid process. So clinoid segment of internal carotid artery and Oculomotor nerve can be damaged during removal of anterior clinoid process [3,14,17,20].

The presence of a carotico-clinoid foramen has been implicated in both endonasal and transcranial surgery. Its variant reflects anatomy variant of the parasellar area and its manipulation during anterior clinoidectomy can result in ICA injury.

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Authors' contributions

Made substantial contributions to conception and design of the study and performed data collection and analysis and interpretation: **Yasser Seddeg Abdulghani;**

Performed data collection and analysis, as well as provided administrative, technical, and article writing: Kamalelden Elbadawi Babiker

Availability of data and materials

Authors declare that the data supporting the findings of this study can be found as data repositories at : **ribat.edu.sd** or can be published as supplementary in to the journal upon request.

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Non

Conflict of interest:

"All authors declared that there are no conflicts of interest.".

Consent for publication

Not applicable.

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