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## An Osteological Study of Incidence, Morphometry and Clinical Correlations of Carotico-Clinoid Foramen in Dried Adult Human Skulls

Archana BJ<sup>1</sup>, Shivaleela C<sup>1</sup>, Kumar GV<sup>2\*</sup>, Pradeep P<sup>3</sup>, and Lakshmiprabha S<sup>4</sup>

<sup>1</sup>Assistant Professor of Anatomy, Sri Siddhartha Medical College, Tumkur, Karnataka, India.

<sup>2</sup>Assistant professor of Pediatrics, Sri Siddhartha Medical College, Tumkur, Karnataka, India.

<sup>3</sup>Consultant Orthopedician, Prabha Ortho Care centre, Tumkur, Karnataka, India.

<sup>4</sup>Professor & HOD of Anatomy, Sri Siddhartha Medical College, Tumkur, Karnataka, India.

### ABSTRACT

The carotico-clinoid foramen was first described by Henle (1855), as an osseous bridge between the tip of the middle and anterior clinoid processes. The carotico-clinoid ligament connecting anterior and middle clinoid processes sometime get ossified forming the carotico-clinoid foramen which transmits one of the segment of internal carotid artery. The existence of a bony or osseous carotico-clinoid foramen may cause compression, tightening or stretching of the internal carotid artery, especially of the clinoidal segment. The aim of this study was to evaluate the incidence of carotico-clinoid foramen in South Indian skulls as well as to study their morphometry and to discuss its clinical correlations. This observational study was conducted on 50 dried human adult skulls which were collected from department of Anatomy, Sri Siddhartha Medical College, Tumkur, Karnataka, India. The occurrence of partial or complete carotico-clinoid foramen was observed and photographed. The incidence of carotico-clinoid foramen in this study was 4%. Out of 50 skulls studied 2 (4%) skulls had carotico-clinoid foramen. Out of these skulls, 1 (2%) skull had carotico-clinoid ligament forming a complete ring which was observed bilaterally and 1 (2%) skull had carotico-clinoid ligament forming an incomplete ring which was observed on right side. The mean diameter of carotico-clinoid foramen was noted to be 5.25mm. The knowledge of the incidence and morphometry of the ossified carotico-clinoid foramen will help the neurosurgeons to plan a safe and effective surgery in the region of sphenoid bone in middle cranial fossa. Therefore detailed anatomical knowledge of the carotico-clinoid foramen is of utmost importance, to increase the success of regional surgery.

**Keywords:** carotico-clinoid foramen, internal carotid artery, clinoid process, skull base surgery.

*\*Corresponding author*

## INTRODUCTION

The carotico-clinoid foramen was first described by Henle (1855), as an osseous bridge between the tip of the middle and anterior clinoid processes [1]. The anterior clinoid processes are formed by the medial and anterior prolongations of the lesser wing of the sphenoid bone, the posterior clinoid processes are present at the end of the dorsum sellae and the middle clinoid processes are present on either side of tuberculum sellae. The carotico-clinoid ligament connecting anterior and middle clinoid processes sometime get ossified forming the carotico-clinoid foramen which transmits one of the segment of internal carotid artery. Ossification of interclinoid ligament connecting anterior and posterior clinoid processes is termed as interclinoid osseous bridge or sella Turcica Bridge. Thus ossification of the ligaments connecting the clinoid processes of the sphenoid bone may give rise to bony bridges [2].

The existence of a bony or osseous carotico-clinoid foramen may cause compression, tightening or stretching of the internal carotid artery, especially of the clinoidal segment. Research studies have also reported the fact that an ossified carotico-clinoid ligament which makes the removal of anterior clinoid process more difficult, especially in the presence of an aneurysm [3]. Due to the great caliber of internal carotid artery in this region, the possibility of headache due to compression by the foramen is high [4]. This feature is crucial for the choice of surgical removal of the anterior clinoid process. The formation of the carotico-clinoid foramen may cause changes in the internal carotid artery, especially in clinoid segment, when comparing the transverse diameter of these structures. Changes in the internal carotid artery may cause compression of the cavernous sinus because of its medial position [5]. Thus, it is concluded that the presence of this foramen has important clinical implications, and its knowledge is required for better planning of surgical treatments that involve this region. The aim of this study was to evaluate the incidence of carotico-clinoid foramen in South Indian skulls as well as to study their morphometry and to discuss its clinical correlations.

## MATERIALS AND METHODS

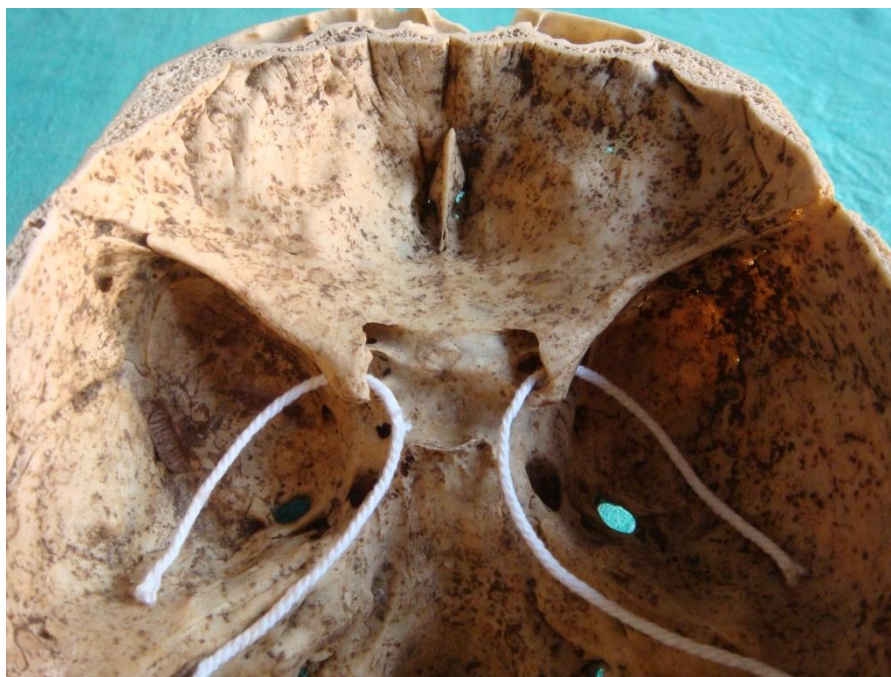
This observational study was conducted on 50 dried human adult skulls which were collected from department of Anatomy, Sri Siddhartha Medical College, Tumkur, Karnataka, India. The skulls were examined for the presence of carotico-clinoid foramen under day light. The integrity of clinoid process was evaluated to determine the inclusion criteria. Those with damaged clinoid processes were excluded from the study. The occurrence of partially or completely ossified ligamentous connection between the anterior and middle clinoid processes forming carotico-clinoid foramen was observed and photographed. The morphometry was performed using manual calipers and measuring the diameter of each carotico-clinoid foramen.

## RESULTS

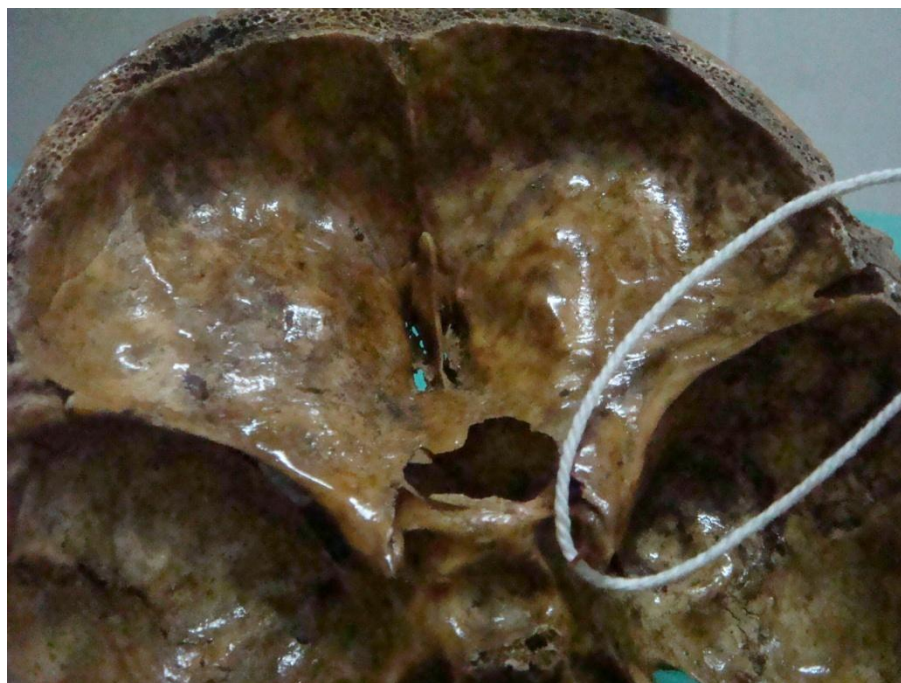
Out of 50 skulls studied 2 (4%) skulls had carotico-clinoid foramen (table-1). Out of these skulls, 1 (2%) skull had carotico-clinoid ligament forming a complete ring which was observed bilaterally (fig-1) and 1 (2%) skull had carotico-clinoid ligament forming an incomplete ring

which was observed on right side (fig-2). Morphometric measurements of carotico-clinoid foramen are noted (table 2). The mean diameter of carotico-clinoid foramen was noted to be 5.83 mm. The incidence of carotico-clinoid foramen in this study is 4%.

**Fig 1: Skull showing bilateral complete carotico-clinoid foramen**



**Fig 2 Skull showing incomplete carotico-clinoid foramen on right side**



**Table 1: Showing unilateral, bilateral and complete or incomplete carotico-clinoid foramen**

	Side	Complete	Incomplete
Bilateral	Right	1	-
	Left	1	-
Unilateral	Right	-	1

**Table 2: Morphometric measurements of carotico-clinoid foramen**

	Side	Diameter
Bilateral	Right	6.0 mm
	Left	5.5 mm
Unilateral	Right	6.0 mm

**Table 3: Comparison of incidence of carotico-clenoid foramen of present study with other studies**

Author	No of specimen	Carotico-clinoid foramen		Total
		Unilateral	Bilateral	
Azeredo et al (1988)	270	6 (2.22%)	11 (4.05%)	17 (6.27%)
Inoue et al. (1990)	50	11 (22%)	7 (14%)	18 (36%)
Kee et al (1997)	73	11 (15.06%)	1 (1.4%)	12 (16.4%)
Cireli et al (1990)	50	3 (6%)	-	3 (6%)
Deda et al (1992)	88	6 (6.82%)	7(7.95%)	13 (14.77%)
Gurun et al (1994)	198	16 (8.08%)	11 (5.55%)	27 (13.63%)
Erturk et al (2002)	171	41 (23.98%)	20 (11.69%)	61 (35.67%)
Desai et al (2010)	223	53 (23.74%)	30 (13.45%)	83 (37.19%)
Sanobar et al (2012)	100	10 (10%)	14 (14%)	24 (24%)
Present study (2013)	50	1 (2%)	1 (2%)	2 (4%)

## DISCUSSION

Anterior and middle clinoid processes in the living are normally linked by a ligament which is not seen in the dry skulls. However, sometimes if this ligament ossifies a foramen is formed through which internal carotid artery passes as it courses upwards medial to the anterior clinoid process to supply the brain. This foramen is known as "Foramen Clinoidae Caroticum" [6]. The ossification of fibrous ligaments is considered a normal physiological process that occurs with age [1]. However this process is an exception when one considers the formation of the carotico-clinoid foramen. Moreover the study by Hochstetter(1940 )and Kier(1966) revealed the presence of this foramen in fetuses and children skulls [7]. The study of Das et al showed that the presence of carotico-clinoid foramen causes morphological changes in the internal carotid artery especially of the clinoidal segment, in almost all cases [3]. The incidence of carotico-clinoid foramen in this study is 4% which is comparable with study conducted by Cireli et al. (1990) which had incidence of 6%. The incidences of carotico-clinoid foramen of other studies are shown in table 3. Mete Erturk et al. reported in a study involving 119 adult dry skulls and 52 adult cadaveric heads of Turkish population that carotico-clinoid



foramen was observed in 36.97% and 32.69% respectively; the total incidence being 61(35.67%). Raveendranath V observed out of 242 macerated skull bones of unknown sex, 34 (14.05%) skulls showed carotico-clinoid foramen which is more when compared to the present study. 9.92% of the skulls showed a complete carotico-clinoid foramen and 4.13% of the skulls showed an incomplete carotico-clinoid foramen [8].

Desai S.D studied 223 skull bones and found that 39 (17.47%) skulls had complete carotico-clinoid foramen and in 44 (19.71%) skulls had incomplete carotico-clinoid foramen. 30 (13.45%) skulls showed bilateral carotico-clinoid foramen and 53(23.74%) skull bones showed unilateral carotico-clinoid foramen. Complete bilateral carotico-clinoid foramen was found in 23 skulls (10.31%) and incomplete bilateral carotico-clinoid foramen was found in 7 skulls (3.13%). Complete unilateral carotico-clinoid foramen was found in 16 skulls (7.16%), out of which 9 skulls (4.03%) showed complete carotico-clinoid foramen on the right side and 7 skulls (3.13%) showed complete carotico-clinoid foramen on the left side. Incomplete unilateral carotico-clinoid foramen was found in 37 skulls (16.58%), amongst these, 20 skulls (8.96%) had incomplete foramen on the right side and 17 skulls (7.62%) had incomplete left carotico-clinoid foramen [9].

Lee H. Y's study in 73 dried Korean skulls, complete carotico-clinoid foramen was observed in 4.1% and an incomplete type was observed in 11.6% [10]. Freire A. et al studied 80 dry human skulls and found 2.5% of the skulls with bilateral foramen and 6.25% with unilateral foramen, the total incidence of the foramen being 8.75% which is also more when compared to the present study [11].

Out of 100 skulls used for the study by Sanobar I, it was observed that 24(24%) skulls had carotico-clinoid foramen. Amongst 100 skull bones, in 6 (6%) skulls, had complete carotico-clinoid foramen and in 18 (18%) skulls the carotico-clinoid foramen was incomplete. Bilateral carotico-clinoid foramen was found in 14 (14%) skull bones. Unilateral carotico-clinoid foramen was found in 10 (10%) skull bones, amongst these in 8 (8%) skulls, the carotico-clinoid foramen was found on the right side and in 2 (2%) skulls, it was found on the left side. Moreover, in 4 skulls of Bilateral CCF, 2 skulls showed a complete foramen on the right side and an incomplete foramen on the left side and the rest 2 skulls showed a complete foramen on the left side and an incomplete foramen on the right side [12].

## CONCLUSION

The knowledge of the incidence and morphometry of the ossified carotico-clinoid foramen will help the neurosurgeons to plan a safe and effective surgery in the region of sphenoid bone in middle cranial fossa. Pre-operative scanning and precautions can be taken to prevent fatal complications during surgery. Removal of the anterior clinoid process is an important step in regional surgery, for which additional risk is involved. Therefore detailed anatomical knowledge of the carotico-clinoid foramen is of utmost importance, to increase the success of regional surgery.



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