Original Article

Prevalence of Caroticoclinoid Foramen and its Variations in Pakistani Population

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ABSTRACT

Objective: To assess the prevalence of caroticoclinoid foramen (CCF) and its variations in Pakistani population using Multi detector Computerized Tomographic scans (MDCT).

Study Design: Cross-Sectional.

Place and Duration of Study: This study was conducted at the Department of Anatomy / Radiology, Ziauddin Hospital Clifton, Karachi from March 2022 to August 2022.

Materials and Methods: A total of 250 study participants including 138 males and 112 females presenting to Radiology Department of Ziauddin Hospital were included in the study. MDCT (head) was performed and sequential images were obtained. All images were evaluated on Vitrea software (version 5.1). Axial plane was used to evaluate types of CCF. Analysis of CCF was carried out according to Keyes classification.

Results: Type 2 CCF was found to be the most frequent type i.e. 69.6%, followed by type 1 with a frequency of 26.5%. Type 3 was observed less frequently, that is 3.7%. The frequency of CCF formation is found to be similar in both genders except that type 3 CCF is totally absent in females on the left side.

Conclusion: This study provides data regarding presence of CCF and its variations in Pakistani population. It suggests that a pre-operative CT scan should be mandatory before surgery in sellar and parasellar region to understand anatomical variations. This will help to modify the surgical technique accordingly in order to avoid any intraoperative complications.

Key Words: Caroticoclinoid foramen, sellar region, anterior clinoid process, surgical anatomy.

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INTRODUCTION

The lesser wing of the sphenoid is an important bone in neurosurgical procedures[(1)]. The anterior clinoid process (ACP) which is a canine tooth shaped structure, is present on the medial aspect of the sphenoid's lesser wing [(2)]. The ACP is connected to the middle clinoid process by caroticoclinoid ligament (CCL)[(3)]. This ligament may ossify to form the caroticoclinoid foramen (CCF) [(4)]. Henle was the first to describe it in 1855[(5)].

The significance of CCF is because of its close proximation with surrounding structures including sphenoid sinus, cavernous sinus, pituitary gland, and internal carotid artery (ICA)[(6)]. The presence of ossified CCF may lead to compression, tightening or stretching of the clinoid part of the ICA [(5)].

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Therefore, its presence makes neurosurgical techniques more difficult in the parasellar area [(15)]. Surgical approach to the sellar region for tumors and aneurysms might require removal of ACP[(7)]. Clinoidectomy is an important procedure in skull base surgeries, therefore its anatomical relations are very important. The presence of CCF makes clinoidectomy more riskier [(8)]. It increases the chance of hemorrhage, especially if an aneurysm is present. The ICA in the clinoid area, as well as the oculomotor nerve, may be injured. The optic nerve may be injured inadvertently if the ACP is drilled [(9)].

Multiple classifications of CCF morphology have been reported in the literature by various writers. The foramen has a variety of morphological patterns, each of which has its own set of clinical characteristics [(2)]. The CCF becomes extremely crucial for neurosurgeons because if relevant pre-operative scanning with special attention to this structure is not performed, fatal problems during skull base surgery may occur[(10)]. Its variation reflects anatomical differences in the parasellar region[(7)]. Adjustment of the surgical technique according to the CCF variant is necessary for safe surgical access [(11)].

Currently, there is a lack of data on incidence of CCF in Pakistani population. Therefore, this study was conducted to analyze its presence and anatomical variations. This data will provide a better understanding

of variations in anatomy of parasellar region to avoid any complications while operating in this area and to pre-plan a safer approach.

MATERIALS AND METHODS

This was a cross-sectional study carried out at Radiology department of Ziauddin Hospital Clifton, Karachi. The study was approved by the Ethics Review Committee, Ziauddin University. Multi detector computed tomography scans of 250 adult patients (18 and above) without intracranial or paranasal sinus pathologies, or any trauma that may affect sphenoid bone structure were analyzed.

Patients having any pathology related to the sphenoid sinus affecting its anatomy including fractures, intracranial tumors or craniofacial anomalies were excluded from the study. Moreover, the patients with a history of surgery at the base of skull were also excluded from the study. An Informed consent was taken by all patients. MDCT (head) was performed on 16 slice Toshiba Alexion. Sequential axial images were obtained and processed to form volume data slice thickness of 3mm (120kV/ MA 150). All images were evaluated on Vitrea software (version 5.1). Axial plane was used to evaluate types of CCF. CCF was assessed according to Keyes classification [12] shown in Table 1 (Figure 1). The incidence of variation in types of CCF was determined from total number of foramina present, as well as variation was also observed according to gender and side.

Statistical Analysis: For the purpose of data entry and analysis SPSS v20 was used. All quantitative variables were expressed as mean and standard deviation. Chi square analysis was performed to associate the presence of CCF between gender and side (left, right, unilateral and bilateral). P value <0.05 was considered statistically significant at 95% confidence interval.

RESULTS

Analysis of total 250 scans (500 sides) was done for this study out of which 138(55.2 %) were males and 112(44.8 %) were females. The mean age of male participants was 51.67 ± 20.4 years while that of females was 53.53 ± 20 years.

Total 250 scans were analyzed, out of which only 61 (24.4%) scans showed presence of CCF. A total of 79 CCF were observed in these 61 individuals. Out of these 40(31.6%) were present on the right side while 39 (30.81%) were present on the left side. On comparing sides, right side showed type 1 frequency as 30%, type 2 as 65% and type 3 was found to be the least i.e., 6%. Similar pattern was observed on left side that showed a higher frequency of type 2 (74.35%), followed by type 1 (23.08%). Type 3 remains least with a frequency of only 2.56%.

The presence of CCF was also compared on each side in both genders. In females a total of 39 CCF were observed. Out of which 25 were on the right and 14 on the left side. On observing the right-side type 2 was found to be the highest (72%), followed by type 1 (24%) and type 3 remained least (4%). The left side shows a similar pattern in which type 2 remains higher with value of 78.57 %, followed by type 1 (21.4%). However, type 3 was completely absent (Figure 2).

A total of 40 CCF was found in males out of which 22 were on right side and 18 were on left side. The male gender also shows a similar pattern when compared with females except for the left side which shows the presence of type 3 CCF as 5.5% whereas it was completely absent in females (Figure 3).

Table No.1: Types of caroticoclinoid foramen (CCF) according to Keyes classification

CCF Type	Description
Type 1	Complete foramen without any break as there is complete fusion between anterior and middle clinoid processes.
Type 2	Foramen in which suture is present between anterior and middle clinoid processes.
Type 3	Foramen in which spicules of bones extended between anterior and middle clinoid processes.

Table No.2: Incidence of CCF and its variations (type 1, type 2, type 3) in total no of study participants.

Caroticoclinoid Foramen F (%)	Complete (Type 1) N (%)	Contact (Type 2) N (%)	Incomplete (Type 3) N (%)	Total N
Right 40	12	26	2	79
Left 39	9	29	1	

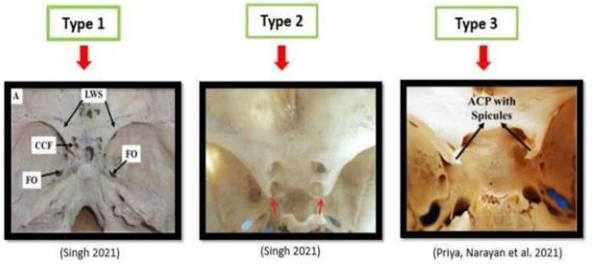

Figure No.1: Types of Caroticoclinoid foramen (Keyes classification)

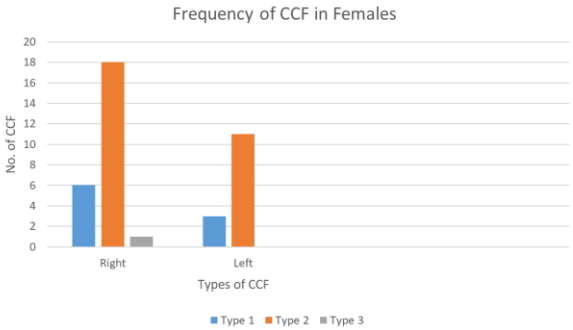

Figure No.2: Frequency of CCF and its types in females compared on both sides

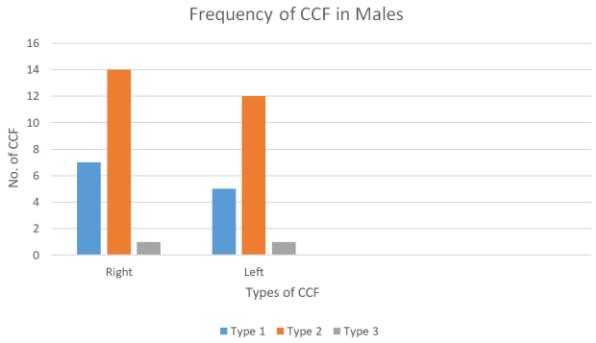

Figure No.3: Frequency of CCF and its types in males compared on both sides

Figure No.4 A.: 3D reconstruction (MDCT scan) showing complete type of foramen on right side, B- axial view showing type 1 CCF on left side, C- axial view showing incomplete type of CCF on left side

DISCUSSION

It is vital for surgeons to completely understand the variations in anatomy of sellar and parasellar region to avoid any intraoperative surgical complications. The ossification of fibrous ligaments is a physiological process that occurs with age; however, when it comes to the formation of the CCF, this is an exception [13]. Communication between the surgeon and radiologist is important for the interpretation of CT scans to modify the surgical technique accordingly.

The prevalence of CCF has been studied by various researchers in different populations. A study by Seval Bayrak et al in 2019 observed CCF prevalence of 3.83% in Turkish population when observed on 573 CT scans[14]. In 2018, Efthymioul et al in Greece reported CCF prevalence of 74% in their population[15]. Prevalence of 22.22% was reported by a study in India in 2019[16] whereas another study conducted in 2015 by K. Suprasanna1 et al observed a prevalence of 22.11% in Indian population[17]. This is in accordance with our study (prevalence of 24.4%). In 2013 a study done by Ye Cheng et al reported CCF prevalence of only 7.8% in Chinese population[18] whereas a study in Italy reported it to be 8.7%[19]. The reason for variations maybe due to difference in selection criteria of age groups as ossification of ligaments might occur with increasing age. Ethnicity also seems to play a role as genetic makeup differs in different populations.

Frequency of CCF formation was found to be 18.8% on right side and 12.8% on the left side in our study. A number of studies in India have reported the formation of CCF mostly on the left side [12, 20, 21]. A study done in Brazil reported frequency of 8.75% CCF on right side compared to 2.5% on left side [22]. O zdogmus et al reported 30% CCF on the right side and 24% on the left side in Turkish population [5].

In the current study, CCF frequency of 13.2% was observed in males whereas 11.2% was observed in females. Studies in various countries have also reported slightly higher frequency of CCF in males [15, 20, 22]. A study done in India reported CCF frequency of 33.3% in males and 25 % in females[15]. Another Study from Brazil showed a frequency of CCF in both males and females with a value of 7.5% and 5% respectively [17]. Higher frequencies of CCF in both genders have been reported in a study conducted on Greek population (19.7% in males and 18.4% in females)[16]. This marked difference may be mainly due to genetic variation in different populations.

In our study, type 2 CCF was found to be the most common type (69.6%), followed by type 1(26.5%) and type 3(3.7%). A study done in Greece on dry skulls reported frequency of 19.8% type 1 CCF, 69.3% type 2 and 10.8% type 3 CCF [15]. Another study by Singh et al in 2017 observed 52.3% type 1 and 47.6% type 2 CCF. Type 3 CCF was not observed[21]. In these studies, type 2 CCF was found to have the highest frequency which is similar to our study. Difference in values may be due to variance in genetics or because some studies might have included greater number of individuals in older age group that would increase the chances of CCL ossification. Another study in India by Suprassana et al reported 23% type 1, 57.1 % type 2 and 19% type 3 CCF. Variation in frequency compared to our study might be because they used modified type of Keyes classification [16].

CONCLUSION

For the treatment of parasellar pathologies involving the anterior clinoid process, anterior clinoidectomy is considered as the safest and the most successful modality[24]. The presence of CCF makes clinoidectomy more risky [25]. In current study, type 2 CCF was found to be the most common type (69.6%). This indicates potential risk of injury to internal carotid artery during surgery. Therefore, before undergoing neurosurgery procedures in the sellar or parasellar region, it is necessary to have a thorough knowledge of CCF anatomy.

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Author's Contribution:

Concept & Design of Study:	Sana Azwar
Drafting:	Mubina Lakhani
Data Analysis:	Mohammad Ali, Danish Muhammad Ali
Revisiting Critically:	Sana Azwar, Mubina Lakhani, Nuzhat Hassan
Final Approval of version:	Sana Azwar

Conflict of Interest: The study has no conflict of interest to declare by any author.

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