Morphometric Analysis of Anterior Clinoid Process and Optic Strut: A Cadaveric Study

SHARADA B MENASINKAI\(^1\), V SAVITHA\(^2\)

**ABSTRACT**

**Introduction:** Anterior Clinoid Process (ACP) is a bony projection on the posterior border of lesser wing of sphenoid. It is related to optic nerve, internal carotid and ophthalmic arteries. Optic strut (OS) is a bony formation located between upper side of body and lesser wing of sphenoid bone.

**Aim:** To observe the variations in length, width of ACP and location of optic strut on right and left side in dry skulls among South Indian population.

**Materials and Methods:** An observational study was done in the Department of Anatomy, Adichunchanagiri Institute of Medical Sciences, Mandya, Karnataka, India, from August 2021 to December 2021. Total 37 dry skulls were collected from department and also from bone sets from first year MBBS (Bachelor of Medicine and Bachelor of Surgery) students. Various parameters (length, width of ACP, distance from tip of ACP and OS, distance between tips of ACP) were measured on both sides using digital vernier callipers. Independent t-test was applied to compare the means of different groups.

**Results:** Mean width of ACP was 14.86±4.47 mm on right side and 12.71±3.13 mm on left side (p-value 0.019). Mean length was 12.45±2.85 mm on right side and 12.05±3.11 mm on left side (p>0.05). Mean distance from tip of ACP to optic strut was 9.48±2.86 mm on right side and 9.31±3.03 mm on left side (p>0.05). Distance between the tips of ACP ranged from 27.09±28.89 mm and mean was 26.29±3.77 mm. Optic strut was located at anterior two-fifth of ACP on right side in 17 (45.95%) and on left side in 14 (37.83%) of skulls.

**Conclusion:** There was variation in mean width of ACP on right and left side. The knowledge will help in preoperative planning and preventing unnecessary injury to neurovascular structures present in vicinity of anterior clinoid process and optic strut.

**Keywords:** Carotico clinoid ligament, Internal carotid artery, Optic strut

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**INTRODUCTION**

Anterior Clinoid Process (ACP) is a bony projection located on the medial end of lesser wing of the sphenoid bone [1,2,3]. It is connected to the body of sphenoid by two roots. Superior root forms roof of the optic canal and continues as jugum sphenoidale and inferior root forms lateral and ventral wall of optic canal [1]. ACP is related medially to the optic nerve, inferolateral to oculomotor nerve and infero medially to internal carotid artery (ICA) [1,2]. ACP is a part of the anterior roof of cavernous sinus [3]. In different approaches used to access parasellar and suprasellar regions, ACP pose difficulties for safe exposure by obscuring direct visualisation of important neurovascular structures [4].

Optic strut (OS) is a bony formation located between upper side of body and lesser wing of sphenoid bone. Optic strut separates optic canal from the superior orbital fissure and is closely related to significant structures such as cavernous sinus, Internal Carotid Artery, optic nerve, pituitary gland [5].

The morphology of the ACP shows significant population specific variations in dimensions. The dimensions are used to determine the types of ACP, and choice of surgical technique employed during anterior clinoidectomy [6]. During operations for tumors or aneurysms in the sellar region, the ACP and optic strut are often removed from the lesser wing of sphenoid bone [3]. Anterior clinoidectomy provides improved exposure of structures in and around the optic nerve, and enhances mobilisation of the ICA and optic nerve with less brain retraction [7,8]. Since there are few studies reported in South Indian population [9,10,11], tip of Anterior Clinoid Process (ACP) and the Optic Strut (OS) the present study was taken with an aim to observe the variations in length, width of ACP and location of optic strut in relation to tip of ACP on right and left side and to measure the distance between the tips of ACP in dry skulls among South Indian population.

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**RESULTS**

Mean width of ACP was 14.86±4.47 mm on right side and 12.71±3.13 mm on left side (p-value 0.019). Mean length was 12.45±2.85 mm on right side and 12.05±3.11 mm on left side (p>0.05). Mean distance from tip of ACP to optic strut was 9.48±2.86 mm on right side and 9.31±3.03 mm on left side (p>0.05). Distance between the tips of ACP ranged from 27.09±28.89 mm and mean was 26.29±3.77 mm. Optic strut was located at anterior two-fifth of ACP on right side in 17 (45.95%) and on left side in 14 (37.83%) of skulls.

**CONCLUSION**

There was variation in mean width of ACP on right and left side. The knowledge will help in preoperative planning and preventing unnecessary injury to neurovascular structures present in vicinity of anterior clinoid process and optic strut.

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**MATERIALS AND METHODS**

An observational study was done in the Department of Anatomy Adichunchanagiri Institute of Medical Sciences Mandya, Karnataka, India, from August 2021 to December 2021. Total 37 dry skulls were collected from department museum and also from bone sets from first year MBBS students irrespective of gender.

**Inclusion criteria:** Skulls with erupted third molars, without any obvious deformities in parachinoid region.

**Exclusion criteria:** Damaged skulls in parachinoid region.

The location of ACP was identified on both sides. Position of OS was determined based on relation between the length of ACP and the distance measuring from OS to the tip of ACP as shown in [Table/Fig-1] labelled ‘c’. The position of OS in relation to length of ACP was calculated as anterior one-fifth, anterior two-fifth, anterior three-fifth, anterior four-fifth, at tip of ACP. Following parameters of ACP were measured on both sides using digital Vernier callipers as shown in [Table/Fig-1].

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**REFERENCES**


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**Table/Fig-1:** Measurements a- width, b-length, c-distance between tip and OS, d-inter ACP.
(a) Width was measured at the base of ACP, from lateral margin of optic canal to lateral margin of ACP. 
(b) Length was measured from base (medial point) to tip of ACP.
(c) Distance from tip of ACP to posterior margin of optic strut.
(d) Distance between the tips of ACP.

We followed a study reported by William Sibuor et al., for reference points and classification of ACP based on dimensions [6]. All the measurements were recorded in mm and classified as four types based on length and width. 

**Classification of ACP [6]:**
- **Type I** - short (<10.5 mm) and wide (>8.14 mm)
- **Type II** - long (>10.5 mm) and narrow (<8.14 mm)
- **Type III a** - short (<10.5 mm) and narrow (<8.14 mm)
- **Type III b** - long (>10.5 mm) and wide (>8.14 mm)

The data was collected by a single observer and each measurement was taken thrice and arithmetic average was taken to minimise the intra observer bias.

**STATISTICAL ANALYSIS**

The mean and standard deviation were calculated for all variables and measurements. Data was entered in Microsoft excel and analysed using Statistical Package for Social Sciences (SPSS) software version 20.0. Independent 't' test was applied to compare the means of different groups. All statistical analyses were carried out at 5% level of significance and p-value <0.05 was considered significant.

**RESULTS**

Mean width of ACP was 14.86±4.47 mm on right side and 12.71±3.13 mm on left side. The p-value was significant [Table/Fig-2]. Mean distance between the tips of ACP was 26.29±3.77 mm (range 27.09-28.89 mm).

Optic strut was located at anterior two-fifth of ACP on right side in 45.95% and on left side in 37.83% of skulls [Table/Fig-3].

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<th>Parameters (mm)</th>
<th>Right</th>
<th>Left</th>
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<td>Width of ACP</td>
<td>14.86±4.47</td>
<td>12.71±3.13</td>
<td>0.019</td>
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<tr>
<td>Length of ACP</td>
<td>12.45±2.85</td>
<td>12.05±3.11</td>
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<tr>
<td>Tip of ACP to optic strut</td>
<td>9.48±2.86</td>
<td>9.31±3.03</td>
<td>0.805</td>
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</table>

**DISCUSSION**

The present study was done by collecting data from skulls that belonged to South Indian population. Morphologically the most common type of ACP in the present study was type III b, 26 (70%) and least type was type III a (2.7%). Cecen A et al [7], reported a study done in Istanbul (Turkey) during 2016, on 121 Computed Tomography (CT) scans of (57 male, 64 female) and they compared the ACP measurements with that of 27 dry skulls. Regarding the type of ACP, 85.7% belonged to type III, 17.8% type II and 16.5% type I. Sibuor W et al., [6], reported a study in 2018 by collecting 51 dry skulls that belonged to Kenyan population, most common type of ACP was type III b seen in 48 (47.1%) and least common type was III a, 8 (7.8%). This could be due to racial variations.

The mean length of ACP was 9.7 & 9.6 mm on right and left side respectively in a study by Ahmad et al [4] [Table/Fig-8], while the mean width of ACP on right and left side was 7.3 mm and 7.2 mm respectively in a study by Akture E and Baskaya MK [4] [Table/Fig-7]. The mean width of ACP on right and left side was 7.3 and 7.2 mm respectively in a study by Ahmad et al [4] [Table/Fig-8].

According to the classification based on dimensions, 26 (70%) skulls belonged to type III b (long and wide) [Table/Fig-4] & 8 (21.6%) skulls type I (short and wide), 2 (5.4%) skulls type II (long and narrow) and 1 (2.7%) skull type III a (short and narrow). There were 3 skulls with ossified carotico clinoid ligament on left side. [Table/Fig-5, 6(a-c)].

**Different skulls showing ossified carotico clinoid ligament- a, b and c.**

**Table/Fig-2:** Width, length of ACP on right & left side and distance from tip of ACP to optic strut on both sides.

**Table/Fig-3:** The location of Optic strut in relation to ACP. Total N=37 in both sides.

**Table/Fig-4:** Skull showing wide and long anterior clinoid process.

**Table/Fig-5:** Skull showing left short ACP with ossified carotico clinoid ligament (images from left to right).
In 2013 Lee H W et al., [1], reported a study done on 10 formalin fixed specimens of cadaveric heads that belonged to Korean population. The length was 7.65±1.64 mm and 7.58±1.35 mm right and left side respectively and width was 10.7±2.11 mm, 10.93±1.46 mm on right and left side respectively. Hunnargi S et al., [10], reported a study in 2008 by collecting and studying 25 skulls that belonged to South Indian population. The length of ACP was 10.68±1.19 mm on right side and 9.96±1.71 mm on left side [Table/Fig-7]. The width of ACP was 12.4±2.58 mm on right side and 11.12±1.81 mm on left side [Table/Fig-8]. Sella turcica is an important area, due to the anatomical relations with the cavernous sinus and contents, sphenoid sinus, pituitary gland. In the superior approach to the cavernous sinus, radical removal of tumours and paracarotid aneurysms, complete or partial removal of ACP is an important step. Removal of ACP combined with completely ossified carotico-clinoid foramina (CCF) may have high risk [7].

Lone M et al [12], reported a study on 50 skulls harvested from formalin fixed specimens in Maharashtra population. The inter ACP distance was 22.9±1.9 mm (20-27 range). Akture E and Baskaya MK [4] reported the distance between tips of ACP mean 24.1 mm (range 19-29.3 mm). In the present study, inter ACP distance was 26.29 mm (range 27.09-28.89 mm). Following [Table/Fig-9] shows that in 42%-47% the location of optic strut was in posterior one-fifth of ACP. The present study contributes to the knowledge of variable morphology of anterior clinoid process and optic strut in Indian population. It is of clinical importance to neurosurgeons operating in parasellar region. The knowledge will help in preoperative planning and preventing unnecessary injury to neurovascular structures present in vicinity of anterior clinoid process and optic strut.

REFERENCES

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<td>• Plagiarism X-checker: Jan 28, 2022  • Manual Googling: May 05, 2022  • iThenticate Software: May 11, 2022 (11%)</td>
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