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Original Research Paper

Anatomy

CT-BASED MORPHOMETRIC STUDY OF THE ANTERIOR CLINOID PROCESS AND ITS IMPACT ON SKULL BASE SURGERY

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ABSTRACT

Background: The anterior clinoid process (ACP) is a small but surgically significant bony projection of the sphenoid bone. Its proximity to critical neurovascular structures, including the internal carotid artery, optic nerve, and cavernous sinus, makes detailed anatomical knowledge vital for neurosurgical and skull base procedures. **Objective:** To evaluate the morphometric characteristics of the ACP using computed tomography (CT) and highlight their surgical implications in anterior clinoidectomy and skull base approaches. **Methods:** 150 adult patients undergoing CT of the head were included. High-resolution CT scans were analyzed to measure ACP length, width, thickness, and pneumatization. Side-to-side differences and sex-based variations were recorded. **Results:** The mean ACP length was 8.07 ± 1.14 mm on the right and 7.88 ± 1.16 mm on the left. Thickness showed no significant asymmetry. The mean ACP base was 8.88 ± 1.41 mm on the right and 9.11 ± 1.53 mm on the left. On comparing the values between the genders, males had larger ACP dimensions than females across all parameters. The overall frequency of pneumatization was approximately 15–20% of cases, with unilateral involvement (either right or left) being more common than bilateral. **Conclusion:** Morphometric variations of the ACP on CT have important surgical implications. Preoperative recognition of ACP size, pneumatization, and asymmetry can reduce complications during anterior clinoidectomy and optic nerve decompression.

KEYWORDS : Anterior Clinoid Process, Morphometry, CT Scan, Skull Base Surgery, Anterior Clinoidectomy.

INTRODUCTION

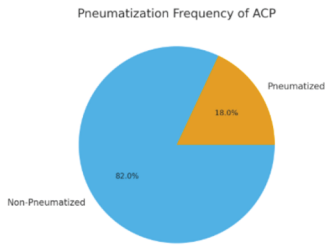
The anterior clinoid process (ACP) is a projection of the lesser wing of the sphenoid bone forming part of the lateral margin of the optic canal. Its anatomical variability poses significant challenges in neurosurgery, particularly during procedures such as anterior clinoidectomy, aneurysm clipping, optic nerve decompression, and removal of tumors in the parasellar region. Osawa etal[(1)] focused on the importance of localization of internal carotid artery at foramen lacerum and vidian canal during extended endoscopic approaches. Noguchi etal [(2)] stated that the morphology of the ACP, which is usually removed during the surgical removal of sellar region tumors or aneurysms,is clinically (surgically) significant. Better understanding of skull base anatomy to avoid complications during extended endoscopic approaches has been highlighted by Naresh etal [(3)] . Removal of the ACP supply improved exposure of structures in and around the ACP and mobilization of ICA and optic nerve, also minimizing chances of brain retraction as demonstrated by Menasinkai etal in her study [(4)]. Injury to adjacent structures such as the optic nerve, internal carotid artery, or cavernous sinus can result in catastrophic complications. Hence, precise morphometric knowledge of the ACP is essential. Computed tomography (CT) provides accurate measurements, enabling surgeons to plan individualized approaches. This study aims to analyze the morphometry of the ACP using CT imaging and to discuss its surgical relevance.

MATERIALS AND METHODS

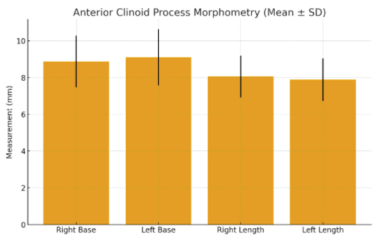
This is a Cross-sectional observational study with a Sample size of 150. Inclusion criteria: Adults (>18 years) with normal cranial CT scans performed for non-neurological reasons. Exclusion criteria: Patients with skull base fractures, bone pathology, congenital anomalies, or prior cranial surgery. CT scan reports were observed for the length, thickness, base and pneumatisation of ACP on both sides. The results were analysed statistically and represented graphically.

RESULTS

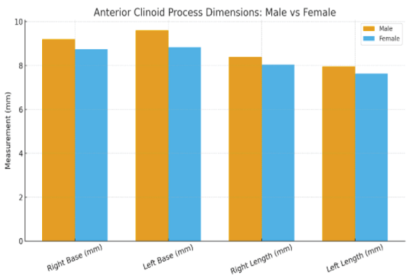
The mean data obtained from the measured ACP from the CT scans were as follows: Right Base: 8.88 ± 1.41 mm, Left Base: 9.11 ± 1.53 mm., Right Length: 8.07 ± 1.14 mm, Left Length: 7.88 ± 1.16 mm. analyzing the comparison between the genders, Right Base:Male: 9.21 mm, Female: 8.74 mm. Left Base: Male: 9.60 mm, Female: 8.83 mm. Right Length: Male: 8.40 mm, Female: 8.05 mm., Left Length:Male: 7.96 mm,Female: 7.64 mm.



Graph:1- Pie Chart: Shows frequency of pneumatization



Graph:2- Bar Chart (Mean ± SD): Compares right vs. left ACP base and length



Graph:3- Bar Chart (Mean ± SD): Compares right vs. left ACP base and length in males and females

The grouped bar chart clearly shows males have larger ACP dimensions than females across all parameters.

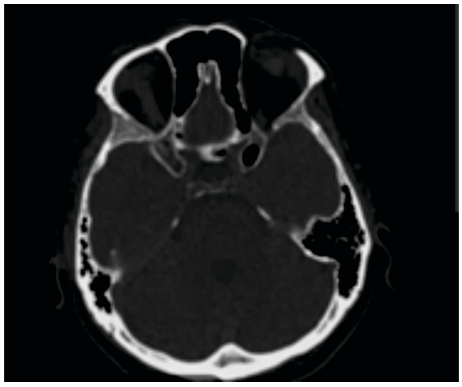


Fig 1 : CT Scan Report Showing the ACP

DISCUSSION

The present study highlights morphometric variations of the ACP on CT and their relevance in skull base surgery.The ACP forms the lateral margin of the optic canal; variations in its dimensions may alter the surgical exposure of the optic nerve. Pneumatized ACP increases the risk of cerebrospinal fluid leak during clinoidectomy if unrecognized. Dhakal etal [5] evaluated that the optic nerve and the internal carotid artery are directly overlain and obscured by the ACP, which is one of the region's most significant prominences. Anterior clinoidectomy: Larger ACPs may require extended drilling, increasing operative time. Da costa etal [6] concluded that the clinoid space is the space exposed following anterior clinoidectomy, and its dimensions vary with the ACP dimensions. Aneurysm clipping: Knowledge of ACP dimensions ensures safer exposure of the carotid-ophthalmic region. Optic nerve decompression: Thin ACP may allow easier decompression, but excessive pneumatization requires cautious drilling. Drilling through bone to access lesions in the parasellar and paraclinoid regions carries the risk of damaging nearby vessels and nerves or causing ananeurysm as explained by Boyan etal [7]. Tumor surgery: Parasellar and suprasellar lesions may displace or erode ACP, emphasizing the need for individualized CT evaluation. The present study clinches the anatomical importance of the measurements of ACP from the CT scan reports and its surgical implications.

CONCLUSION

Morphometric analysis of the ACP on CT provides essential insights for neurosurgeons. Recognition of variations in size, shape, and pneumatization aids in surgical planning, minimizing complications, and optimizing outcomes. Preoperative imaging should always include detailed assessment of the ACP in patients undergoing skull base procedures.

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