Alqalam Journal of Medical and Applied Sciences. 2025;8(1):471-475
https://doi.org/10.54361/ajmas.258166

Original article

Morphological Measurements and Anatomical Variations of The Clivus Bone Using Computed Tomography in Adults, Benghazi

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Abstracts
The clivus is the central part of the skull base that extends from the anterior part of the foramen magnum to the dorsum sellae. This study aimed to assess the morphological measurements including clivus length, width, and the anatomical variations of the clivus, including fossa navicularis magna (FNM), canalis basalis medianus (CBM), and clivus pneumatization, on computed tomography (CT) images. A total of 152 brain and cervical CT scans (96 males and 56 females), were retrospectively evaluated, the cases were over 18 years of age and randomly selected from the CT suit of the Radiology department at Aljalaa Hospital for Surgery and Accidents / Benghazi in duration from April 2017 to July 2018. The measurements of clivus width and length were assessed, in addition to the presence or absence of anatomical variants like fossa navicularis magna, canalis basilaris medianus, and clivus pneumatization. Data were analyzed through one-way ANOVA and T-test. The mean length and width of clivus were significantly longer in males (46.10 mm), (34 mm), than in females (44.9 mm), (33.73 mm) respectively (P<0.001). In the present study, regarding the anatomical variants Fossa Navicularis Magna was noted in (1.3%) cases, Canalis Basalis Medianus in (5.3 %) cases, and (1.3%) cases had incomplete pneumatization. Knowing the measurements of the clivus bone and the anatomical variations is important for radiologists and ENT surgeons for proper diagnosis and a safe and successful clival surgery.
Keywords. Morphological, Anatomical, Variations, Clivus, Navicularis.

Introduction

The clivus is one of the central structures of the posterior skull base (also known as Blumenbach's clivus). The word clivus is derived from Latin; meaning slope or hill [1]. It is formed by the occipital bone and sphenoid bone fusing at the spheno-occipital synchondrosis and the midsagittal section of the clivus presents a wedge-shaped appearance of clivus with a thin posterior and thick anterior part; extending from the dorsum sella till the anterior margin of foramen magnum. While the posterior surface of the clivus is the anterior limit of the prepontine and premedullary cisterns, the anterior margin of the clivus borders the sphenoidal sinus. The posterior nasopharyngeal surface is represented by the inferior margin. The clivus is bordered laterally by the petrooccipital fissure, which begins near the cavernous sinus and extends inferiorly to the jugular foramen [2].

The clivus performs a crucial role in maintaining the brainstem. safeguarding some of our nervous system's most important components. Directly resting on the clivus are the pons and medulla oblongata, which regulate vital processes including heart rate and breathing. Without this support, these critical structures would be at risk of damage or displacement. Anatomical variations of the clivus, such as Fossa Navicularis Magna (FNM), are uncommon but crucial for radiologists to recognize to avoid misdiagnosis. FNM is a benign anatomical variant that appears as a notch in the basioccipital bone on radiologic images, typically in the lower clivus region [3].

The canalis basilaris medianus (CBM), also known as the clival canal, is a rare anatomical variation occas ionally found in the basilar part of the occipital bone. Clinically, understanding the various form of the ca nal can be helpful in cases of uncertain clival fracture or during neurosurgical procedures in this region [4]. Anatomical variations include additionally the clivus cavitation so that the sphenoid sinus can pneumatize this bone (incompletely or completely) [5,6]. This study aimed to assess the morphological measurements including clivus length, width and the anatomical variations of the clivus, including FNM, CBM, and clivus pneumatization, on Computed Tomography (CT) images.

Methods

A descriptive retrospective study was used by reviewing 152 CT scan images. Human cases were over 18 years of age and randomly selected from the CT suit of Radiology. department at Aljalaa Hospital Surgery and Accidents / Benghazi in duration from April 2017 to July 2018. The approval of the head of the radiology department in Al Jalaa Hospital was taken before starting the collection of data.

Patients were divided into four groups in terms of age: 18-35 years, 36-50, 51-65 years and above 65 years. Exclusion criteria include samples whose clivus bone was obscured by tumor, patients with trauma, and those with confirmation of severe degenerative illness who were omitted from the study. The measurements the length and width of the clivus were assessed using General Electric optima, a multi-slice machine. All

***Received**: 22-01-2025 - **Accepted**: 16-03-2025 - **Published**: 20-03-2025*

https://doi.org/10.54361/ajmas.258166

measurements were performed in the Multiplanar Reconstruction (MPR) in the sagittal, axial, and coronal planes. beside the presence or absence of congenital anomalies like fossa navicularis magna, clivus pneumatization. and canalis basilaris medianus

Clivus width: Axial plane measurement of the longest left-to-right distance, taken near the inferior anterior edge of the foramen magnum. (Figure 1-A.). Length of the clivus: On a sagittal plane, the clivus length is measured as the longest distance from the superior point of the dorsum sellae to a line drawn posteriorly to the anterior edge of the foramen magnum. (Figure 1-B.).

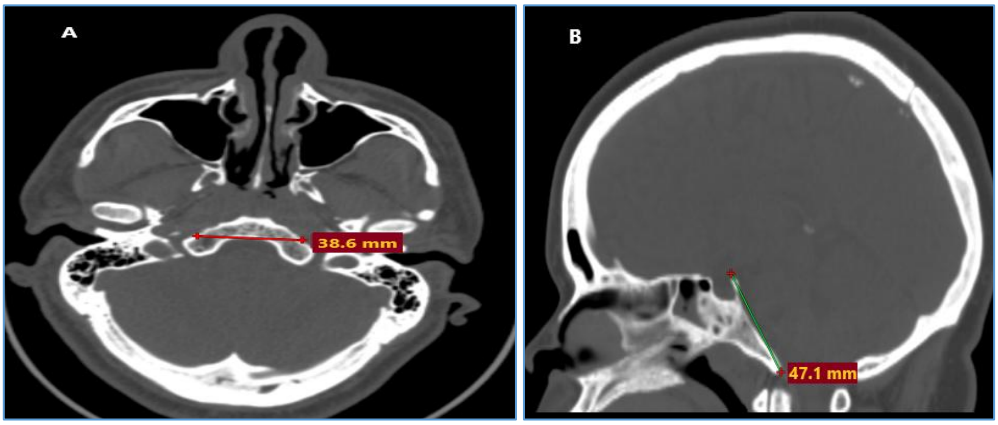

Figure 1. A: CT scan axial view shows the width of clivus B: sagittal view shows the length of clivus.

Results

A total of 152 CT image cases were used to study the morphological and anatomical variations of the clivus bone, most of the individuals (63.2 %) of the sample are male as shown in table 1.

Table 1. The distribution of males and females in the sample.

Gender	Frequency	Percent
Male	96	63.2 %
Female	56	36.8 %

In Table 2, the sample is divided into 4 Age groups, each is considered as a sample of all individuals belonging to that group (population). Moreover, 39.5 % of the sample their ages in the interval (18-35 years), as illustrated in (Figure 2).

Table 2. Age groups of the cases

Age Intervals	Frequency	Percent
18 - 35 years	60	39.5 %
36 - 50 years	34	22.4 %
51 - 65 years	33	21.7 %
Above 65 years	25	16.4 %

Table 3. Mean length and width in both genders

Age group	18 - 35 years (n=60)	36-50 years (n=34)	51-65 years (n=33)	Above 65 years (n=25)	P-value (ANOVA)
Clivus Length (mm)	43.07 ± 1.784	43.82 ± 1.285	44.70 ± 1.617	45.24 ± 1.924	0.000***
Clivus Width (mm)	32.70 ± 1.073	32.00 ± 1.737	32.93 ± 1.386	33.53 ± 1.241	0.000***

****Significant at α = 0.01 0.05 0.10; **Significant at α = 0.05 0.10*

In this study, the mean length as well as the width of clivus was considerably longer in males (46.10 mm), (34 mm), than in females (44.9 mm), (33.73 mm) respectively (P<0.001), as shown in the table 3.

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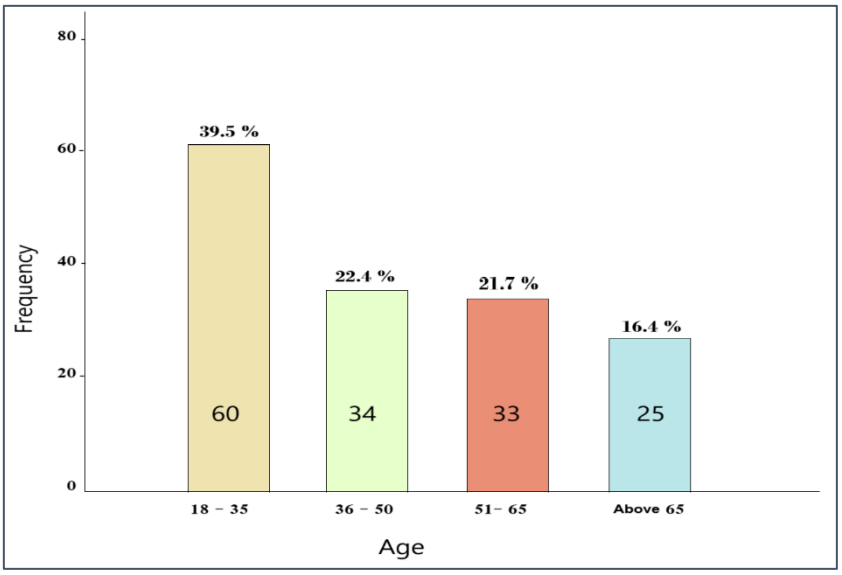

Figure 2. Bar graph illustrating the distribution of the age groups.

Here, in Table 4, the ANOVA test tests whether there are statistically significant differences among the 4 population means. The length as well as width of clivus differences among the 4-population means were found highly significant.

Table 4. The mean length & width of clivus bone in different age groups:

Gender	**Male (*n = 96*)**	**Female (*n=56*)**	**P-value (*t-test*)**	**Average Difference**
Clivus Length (mm**)**	44.49 ± 1.616	43.01 ± 1.894	*0.000****	*Significant*
Clivus Width (mm**)**	32.62 ± 1.368	32.00 ± 1.737	*0.026***	*Significant*

****Significant at α = 0.01 0.05 0.10; **Significant at α = 0.05 0.10*

We found in the current study regarding the anatomical variants among 152 CT images 2 cases of Fossa Navicularis Magna (FNM) as shown in (Figure 3), 8 cases show Canalis Basalis Medianus (CBM) with a male prediction (Figure 4), and two cases of in-complete pneumatization as shown in (Figure 5).

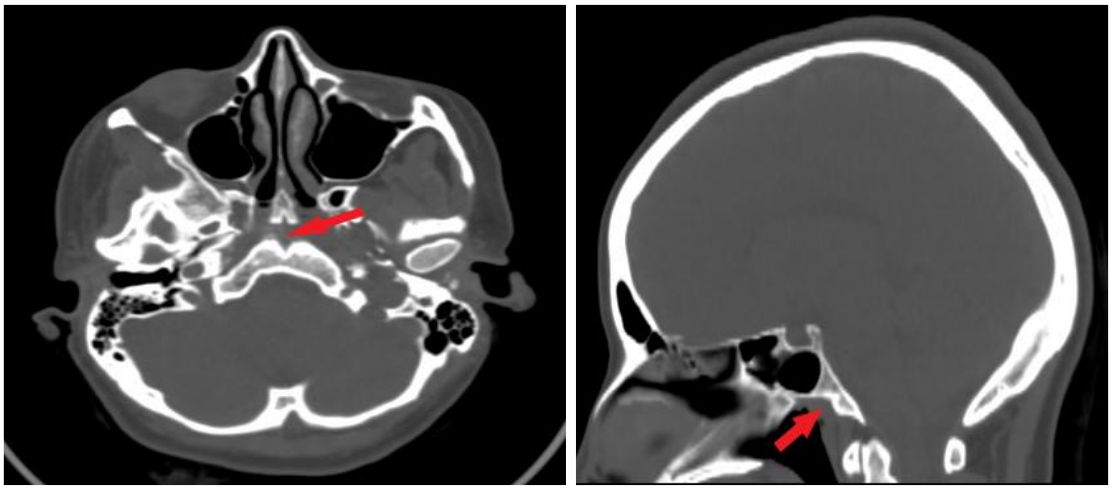

Figure 3. CT image axial & sagittal view shows a case with fossa navicularis.

Received*: 22-01-2025 -* ***Accepted****: 16-03-2025 -* ***Published****: 20-03-2025*

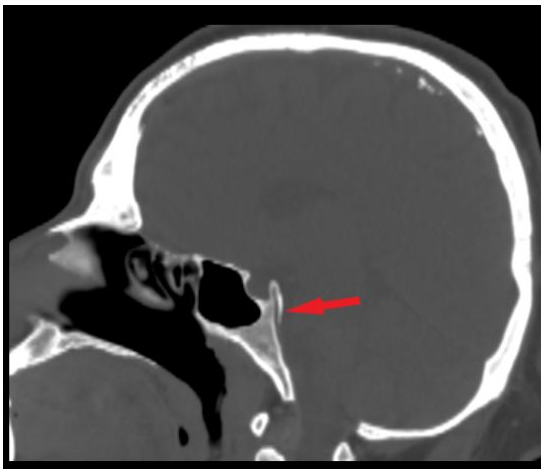

Figure 4. CT image sagittal view shows Canalis basalis medianus.

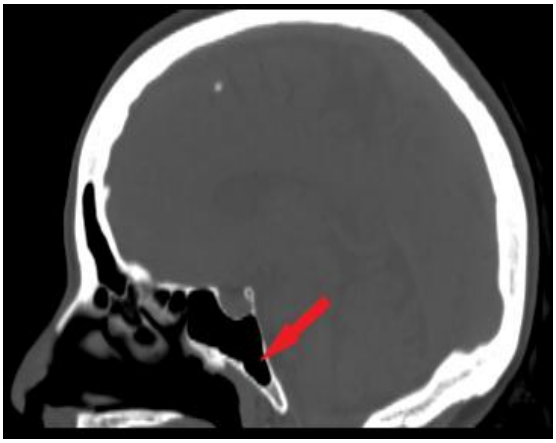

Figure 5. CT scan sagittal view shows clivus pneumatization.

Discussion

In the current study, the mean length as well as width of the clivus bone was significantly longer in males (46.10 mm), (34 mm) than in females (44.9 mm), (33.73 mm) respectively. In comparison with Caurasia, et al, [7] were This study aims to investigate age- and sex-related variations in clivus dimensions (length and width) in the Indian population, they found a statistically significant difference ($p<0.05$) was found in the mean clivus length between males and females, with males having a higher value. In contrast, no significant difference ($p>0.05$) was observed in the mean clivus width between the two sexes. Similar study results were done by Abdolmaleki M, et al, [8] A study of clivus length and width in Iranians found that men had a mean clivus length of 45.72mm, significantly longer than the mean length of 41.56mm in women ($P<0.001$), but the mean width has no significant difference between the two genders. In the same line, Hedayatian M, et al, [9] - The average clivus length was significantly greater in males compared to females and had a significant correlation with age ($p< 0.001$).

Regarding the length and width of clivus differences among the 4-population means were found highly significant. Similar results to Caurasia, et al, [7] found the length and width of clivus bone were statistically significant between all age groups (P value <0.05). On the other hand, Abdolmaleki et al, [8] found the length of the clivus was not significantly different among various age groups ($p = 0.203$).

In the present study, 8 cases (5.3%) of CBM were observed among the sample with male prediction, 2 cases (1.3%) of the fossa-navicularis magna and 2 cases (1.3%) showed incomplete pneumatization. Our results are in line with Murjani et al, [10] assessed the prevalence of anatomical variants in clivus bone by reviewing a total of 350 CBCT scans, the FNM was noted in 19.4% of cases, and CBM in 9.7% of cases. In contrast to Serindere et al, [11] the FNM was recognized in 5.4% and CBM in 4%. While Darwin et al, [12] estimate the overall prevalence of CBM in Indian people as 9.5% was present in 13% of males and 3% of females ($p = 0.021$). Tasleem et al, [13] the study aims to find the prevalence along with morphometry of fossa navicularis magna in the Pakistani people, which was found to be 5.3% of the sample.

Conclusion

In the present study, the mean of clivus length and width was significantly higher in males than females, which can be used to determine the age and gender and used as an additional parameter to differentiate males from females by anatomists and forensic experts. The CBM was the commonest (5.3%) anomaly among

Received*: 22-01-2025 -* ***Accepted****: 16-03-2025 -* ***Published****: 20-03-2025*

the studied variations. Despite the anatomical variations in clivus bone being rare, knowledge of these variants to radiologists and neurosurgeons, as it is situated near numerous important structures such as the brainstem and basilar artery, is important to distinguish these abnormalities from traumatic damages and helping a proper diagnosis and management. The measurements reported in this study provide a valuable reference for future research for further investigations involving the clivus bone of the skull base in Libyan subjects.

Author conflict

The authors report no conflict of interest.

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المستخلص

المنحدر هو الجزء المركزي من قاعدة الجمجمة، ويمتد من الجزء الأمامي للثقبة الكبرى إلى ظهر السرج. هدفت هذه الدراسة إلى تقييم القياسات المورفولوجية، بما في ذلك طول المنحدر وعرضه، والاختلافات التشريحية فيه، بما في ذلك الحفرة الزورقية الكبرى والقناة القاعدية الوسطى ، وتهوية المنحدر، باستخدام صور التصوير المقطعي المحوسب .(CT) تم تقييم ما مجموعه 152 فحصًا مقطعيًا محوسبًا للدماغ والعنق (96 ذكرًا و56 أنثى) بأثر رجعي، وكانت الحالات فوق سن 18 عامًا وتم اختيارها عشوائيًا من بدلة الأشعة المقطعية بقسم الأشعة في مستشفى الجلاء للجراحة والحوادث / بنغازي في الفترة من أبريل 2017 إلى يوليو 2018. تم تقييم قياسات عرض وطول المنحدر، بالإضافة إلى وجود أو عدم وجود متغيرات تشريحية مثل الحفرة الزورقية الكبرى والقناة القاعدية الوسطى وتهوية المنحدر. تم تحليل البيانات من خلال تحليل التباين أحادي الاتجاه واختبار .T كان متوسط طول وعرض المنحدر أطول بشكل ملحوظ في الذكور (46.10 مم) و (34 مم) منه في الإناث (44.9 مم) و (33.73 مم) على التوالي .(P <0.001) في هذه الدراسة، وفيما يتعلق بالمتغيرات التشريحية، لوحظ وجود الحفرة الزورقية الكبرى (Fossa Navicularis Magna) في (1.3٪) من الحالات، والقناة القاعدية الوسطى (Canalis Basalis Medianus) في (5.3٪)، ووجود تهوية غير مكتملة في (1.3٪) من الحالات. تعدّ معرفة قياسات عظمة الجرف (Clivus) والاختلافات التشريحية أمرًا بالغ الأهمية لأطباء الأشعة وجراحي الأنف والأذن والحنجرة لضمان التشخيص الدقيق وإجراء جراحة جرف آمنة وناجحة.

Received*: 22-01-2025 -* ***Accepted****: 16-03-2025 -* ***Published****: 20-03-2025*