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ORIGINAL RESEARCH

The Morphometric Study of the Presence of Canaliculus Innominatus and Foramen Vesalius and Their Relevance to Clinical Consideration

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ABSTRACT

Background: The foramen Vesalius is situated within the bony plate between the foramen ovale and the foramen rotundum in the floor of the middle cranial fossa. The emissary veins that connect the pterygoid plexus of veins with the cavernous sinus pass via this foramen. Canaliculus Innominatus also called petrosal foramen or foramen of Arnold. CI is bony opening situated between the foramen ovale and foramen spinoum in the greater wing of the sphenoid bone.

Aim and objectives: To investigate the presence of Foramen Vesalius and Canaliculus Innominatus and conduct a morphometric analysis of these structures.

Materials and methods: The present study was conducted on 50 human skulls of both genders, sourced from the Department of Anatomy. All participants from whom the skulls were obtained were informed about the study, and their written consent was obtained. Relevant data, including the participants' names, ages, and genders, were recorded. Each skull was examined bilaterally from both external and internal aspects. The presence of Foramen Vesalius (FV) and Canaliculus Innominatus (CI) in the middle cranial fossa was assessed, noting their incidence as either unilateral or bilateral. Foramina that permitted a probe to pass through them were considered present.

Results: The morphological dimensions of the Foramen Vesalius were measured and compared between the right and left sides of the skulls. The mean diameter of the Foramen Vesalius on the right side was 0.79 mm, whereas it was slightly smaller on the left side with a mean diameter of 0.59 mm. However, this difference in diameter was not statistically significant (P = 0.15). The mean distance of the Foramen Vesalius from the foramen ovale was measured as 4.23 mm on the right side and 3.96 mm on the left side. Again, this difference was not statistically significant (P = 0.19). Regarding the shape of the Foramen Vesalius, it was found to be round in 27 cases on the right side and 21 cases on the left side. The irregular shape was noted in 20 cases on the right and 26 cases on the left. The oval shape was observed in 3 cases on both sides. The variation in shape distribution between the right and left sides was not statistically significant (P = 0.43). The morphological dimensions of the Canaliculus Innominatus were also measured and compared between the right and left sides of the skulls. The mean diameter of the Canaliculus Innominatus was 1.79 mm on the right side and slightly larger at 1.94 mm on the left side. This difference in diameter was not statistically significant (P = 0.95). The mean distance of the Canaliculus Innominatus from the foramen ovale was 1.64 mm on the right side and 1.55 mm on the left side. This difference was not statistically significant (P = 0.64). Regarding the shape of the Canaliculus Innominatus, it was round in 35 cases on the right side and 30 cases on the left side. The irregular shape was noted in 10 cases on the right and 15 cases on the left. The oval shape was observed in 5 cases on both sides. The variation in shape distribution between the right and left sides approached statistical significance (P = 0.05).

Conclusion: The present study adds to the body of knowledge on the morphological dimensions of FV and CI, demonstrating that while there are slight differences in dimensions and shapes between the right and left sides, these differences are generally not statistically significant. These findings are consistent with existing literature, underscoring the variability and complexity of cranial foramina morphology.

Keywords: Diameter, Canaliculus Innominatus, Foramen Versalius.

Introduction

Foramen Vesalius (FV) and Canaliculus Innominatus (CI) are lesser-known anatomical structures located in the middle cranial fossa, whose clinical significance and morphometric characteristics have garnered attention in recent anatomical and neurosurgical studies. FV, also known as the sphenoidal emissary foramen, provides a passage for an emissary vein that connects the pterygoid venous plexus to the cavernous sinus, potentially playing a role in the spread of infections or tumors from extracranial to intracranial sites. CI, sometimes referred to as the canal of Arnold, is an even less frequently encountered structure and is located medial to the foramen ovale. It transmits the lesser petrosal nerve, a branch of the glossopharyngeal nerve.[1-2] The Foramen Vesalius (FV) and Canaliculus Innominatus (CI) may be infrequently present. FV is also known as Canaliculus sphenodal, emissary sphenoidal foramen, or foramen venosus. FV is situated anteromedial to FO and lateral to the foramen rotundum, present close to FO in the middle of the cranial fossa.[3]

The clinical importance of FV and CI extends to their implications in surgical procedures involving the middle cranial fossa. For instance, their presence can complicate surgical approaches to the trigeminal ganglion or the treatment of conditions such as trigeminal neuralgia. Detailed knowledge of their anatomical variations is crucial for neurosurgeons to avoid iatrogenic injuries. Moreover, understanding these foramina's morphometric parameters can aid in the interpretation of imaging studies and the planning of surgical interventions.[4-7] Recent studies have highlighted significant variability in the incidence and dimensions of FV and CI across different populations. Morphometric studies have utilized advanced imaging techniques and meticulous dissection methods to provide comprehensive data on the size, shape, and precise location of these foramina relative to key anatomical landmarks such as the foramen ovale and the carotid canal. These studies underscore the necessity of accounting for ethnic and individual variations when assessing these structures.[8-10]

Aim and objectives

The present study aims to conduct a detailed morphometric analysis of FV and CI in a sample of human skulls. By measuring their dimensions, determining their incidence, and documenting their shapes, we seek to contribute valuable data to the existing body of anatomical knowledge.

Materials and methods

The present descriptive study was conducted on 50 human skulls of both genders, available in the Department of Anatomy, Nalanda Medical College, Patna, Bihar, India in collaboration with Department of Forensic Medicine and toxicology and Department of orthopaedic, Nalanda Medical College and Hospital, Patna, Bihar, India for a period of two years from February 2019 to January 2021. We examined the bilateral skull from both external and internal aspects. The study adhered to ethical standards and guidelines for anatomical research. Approval for the study was obtained from the Institutional Ethics Committee, and all bones used in the study were handled with respect and care. These bones were sourced from the anatomical collection of the department.

Inclusion criteria

The present study included 50 intact dry adult human skulls of unknown sex.

Exclusion criteria

The skulls with broken floor of middle cranial cavity or partially surrounding bones of the Foramen Vesalius (FV) and Canaliculus Innominatus (CI) were broken.

Examination Procedure

Each skull was examined bilaterally from both external and internal aspects. The presence of Foramen Vesalius (FV) and Canaliculus Innominatus (CI) in the middle cranial fossa was assessed, noting their incidence as either unilateral or bilateral. Foramina that permitted a probe to pass through them were considered present.

Morphometric Measurements

Measurements of FV and CI were taken using a Vernier caliper with a precision of 0.01 mm. Specific parameters measured included:

- The diameter of FV and CI.
- The distance of FV from the ipsilateral Foramen Ovale (FO).

Additionally, the shapes of these foramina were recorded as either round, oval, or irregular.

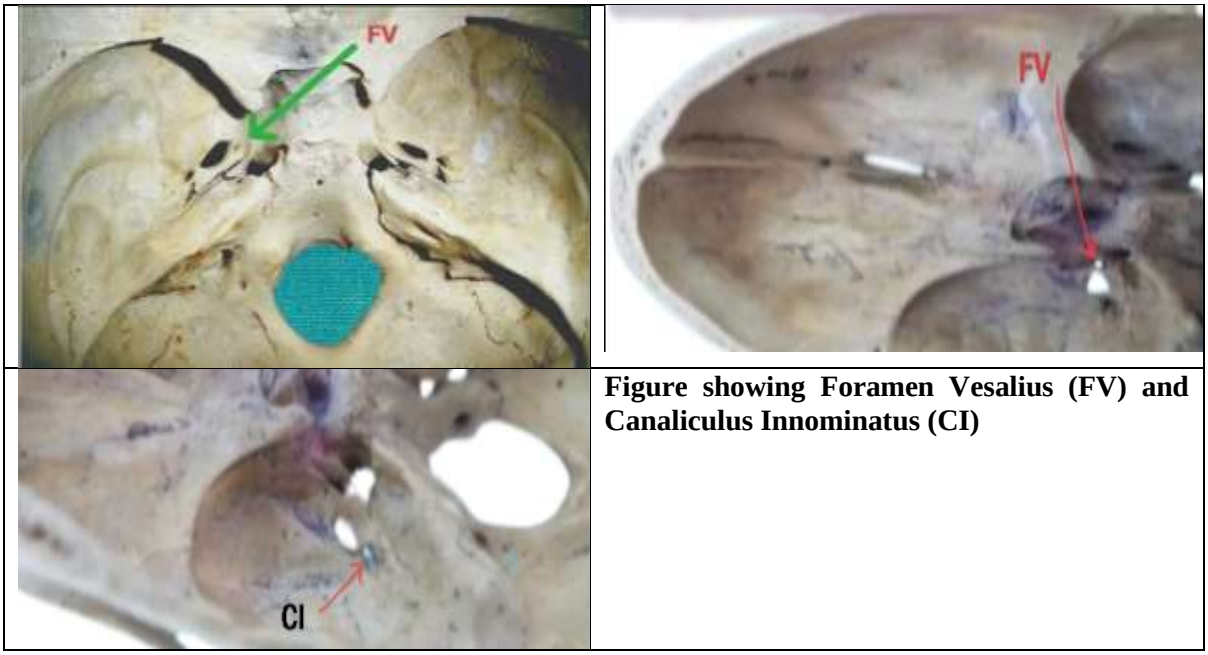


Figure showing Foramen Vesalius (FV) and Canaliculus Innominatus (CI)

Statistical Analysis

The data obtained from the measurements were subjected to statistical analysis using SPSS Version 21.0 and Microsoft excel. Descriptive statistics were used to summarize the data. The mean, standard deviation, and incidence rates were calculated. A p-value of less than 0.05 was considered statistically significant.

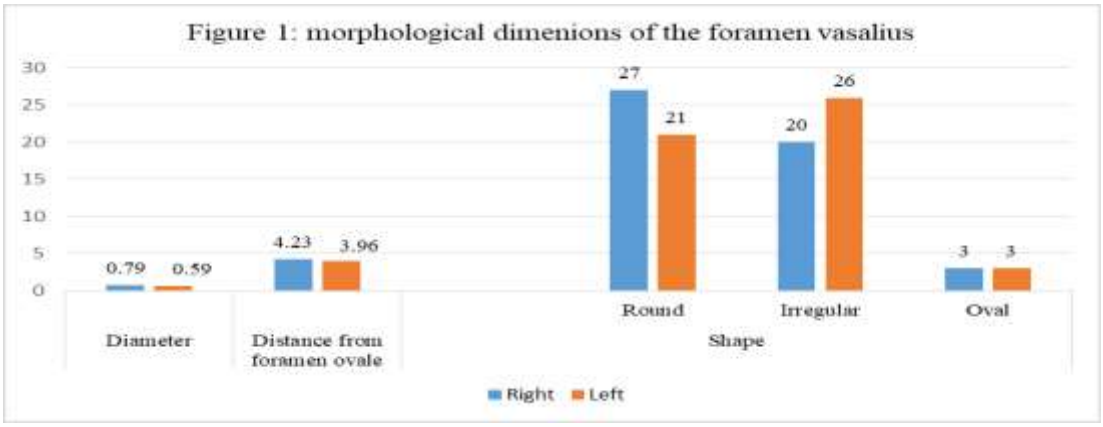
Ethical Considerations

This study was conducted in accordance with the ethical standards of the institution and the Helsinki Declaration. Ethical approval was obtained from the Institutional Ethical committee.

Results

Table I: Morphological Dimension of Foramen Vesalius

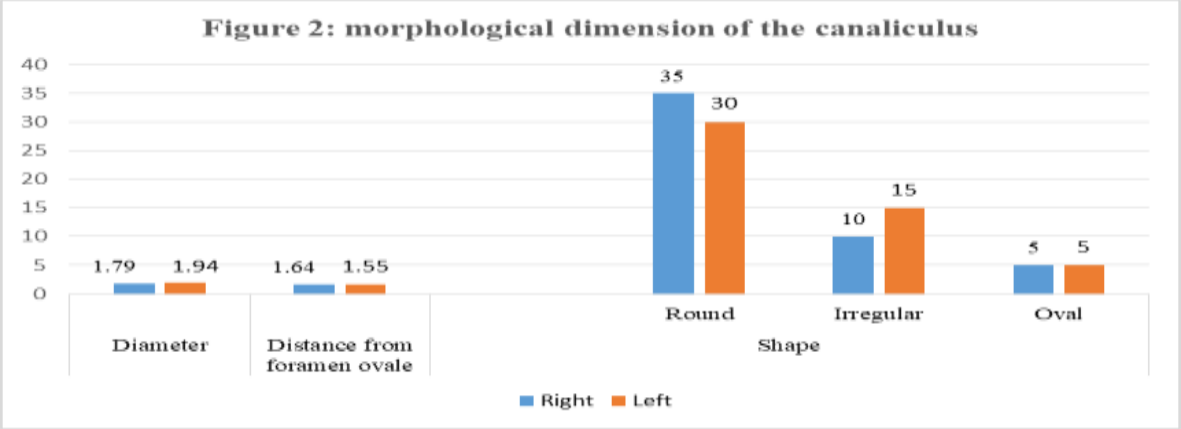
Parameters	Right	Left	P value
Diameter	0.79	0.59	0.15
Distance from foramen ovale	4.23	3.96	0.19
Shape			
Round	27	21	0.43
Irregular	20	26	
Oval	3	3	



The morphological dimensions of the Foramen Vesalius were measured and compared between the right and left sides of the skulls in table I and figure 1. The mean diameter of the Foramen Vesalius on the right side was 0.79 mm, whereas it was slightly smaller on the left side with a mean diameter of 0.59 mm. However, this difference in diameter was not statistically significant (P = 0.15). The mean distance of the Foramen Vesalius from the foramen ovale was measured as 4.23 mm on the right side and 3.96 mm on the left side. Again, this difference was not statistically significant (P = 0.19). Regarding the shape of the Foramen Vesalius, it was found to be round in 27 cases on the right side and 21 cases on the left side. The irregular shape was noted in 20 cases on the right and 26 cases on the left. The oval shape was observed in 3 cases on both sides. The variation in shape distribution between the right and left sides was not statistically significant (P = 0.43).

Table II: Morphological Dimension of Canaliculus Innominatus

Parameters	**Right**	**Left**	**P value**
Diameter	1.79	1.94	0.95
Distance from foramen ovale	1.64	1.55	0.64
Shape			
Round	35	30	0.05
Irregular	10	15	
Oval	5	5	



The morphological dimensions of the Canaliculus Innominatus were also measured and compared between the right and left sides of the skulls in in table II and figure 2. The mean diameter of the Canaliculus Innominatus was 1.79 mm on the right side and slightly larger at 1.94 mm on the left side. This difference in diameter was not statistically significant (P = 0.95). The mean distance of the Canaliculus Innominatus from the foramen ovale was 1.64 mm on the right side and 1.55 mm on the left side. This difference was not statistically significant (P = 0.64). Regarding the shape of the Canaliculus Innominatus, it was round in 35 cases on the right side and 30 cases on the left side. The irregular shape was noted in 10 cases on the right and 15 cases on the left. The oval shape was observed in 5 cases on both sides. The variation in shape distribution between the right and left sides approached statistical significance (P = 0.05).

Discussion

The present study investigated the morphological dimensions of the Foramen Vesalius (FV) and Canaliculus Innominatus (CI) in human skulls, focusing on diameter, distance from the foramen ovale, and shape. These findings were compared between the right and left sides of the skull and were also evaluated in the context of existing literature.

The mean diameter of the FV on the right side was 0.79 mm, which was slightly larger than the mean diameter on the left side (0.59 mm). This difference, however, was not statistically significant (P = 0.15). This is consistent with previous studies that have noted variability in the size of the FV, though specific measurements can vary. For instance, a study by Peker et al.[11] reported mean diameters of FV ranging from 0.5 to 2.2 mm, indicating a wide range of normal variability.

The mean distance of the FV from the foramen ovale was 4.23 mm on the right and 3.96 mm on the left. The lack of a significant difference (P = 0.19) aligns with findings by Tewari et al.[13] who observed similar proximities of FV to the foramen ovale without significant lateral differences.

In terms of shape, FV was predominantly round on both sides, followed by irregular and oval shapes. The lack of significant shape variation between sides (P = 0.43) is in agreement with other morphological studies, such as those by Ginsberg et al.[12] which also reported round as the most common shape of FV.

The mean diameter of CI was 1.79 mm on the right side and 1.94 mm on the left side, with no significant difference (P = 0.95). Similar findings were reported by Reymond et al.[14] who documented a slight but non-significant variation in CI diameter between sides.

The distance of CI from the foramen ovale was 1.64 mm on the right side and 1.55 mm on the left side, showing no significant difference (P = 0.64). These results are consistent with those of Muthu kumar et al.[15] who found comparable distances without significant lateral differences.

Regarding shape, CI was predominantly round on both sides, followed by irregular and oval shapes. The near-significant difference in shape distribution between sides (P = 0.05) may indicate slight lateralization tendencies, a finding that has been hinted at in some anatomical studies but not conclusively demonstrated.

Previous research has documented the morphological variability of FV and CI, often highlighting the wide range of normal anatomical variations. For example, the study by Peker et al.[11] provided a comprehensive analysis of FV and CI dimensions, noting significant inter-individual variability. Similarly, Tewari et al.[13] emphasised the proximity of FV to the foramen ovale, supporting our findings of consistent distances across sides.

In terms of shape, the predominance of round shapes in FV and CI observed in this study corroborates findings from studies such as those by Ginsberg et al.[12] and Reymond et al.[14] who also noted round shapes as most common, with irregular and oval shapes occurring less frequently.

Limitation(s) of the study

The shortcoming of the study is the small sample size (50 dry human skulls) and the short duration of the study. Hence, the resulting statistics might not accurately represent the population. Therefore, more studies are required with a larger sample size. Future studies incorporating larger sample sizes and multicenter collaborations could further validate and extend our results.

Conclusion

The present study adds to the body of knowledge on the morphological dimensions of FV and CI, demonstrating that while there are slight differences in dimensions and shapes between the right and left sides, these differences are generally not statistically significant. These findings are consistent with existing literature, underscoring the variability and complexity of cranial foramina morphology. Such information is expected to enhance clinical practices, particularly in neurosurgery and radiology, where precise anatomical understanding is paramount.

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