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Middle Cranial Foramina: A Rare Bilateral Foraminal Variant Associated with the Sella Turcica

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ABSTRACT: The middle cranial fossa contains several well-documented foramina namely the foramen ovale, spinosum, and rotundum each serving as critical conduits for neurovascular structures. While morphological variants of these lateral foramina have been explored, medial foramina associated with the sella turcica remain underreported, particularly in African populations. This study aimed to document and describe a rare anatomical variation involving bilateral foramina located anteroinferior to the sella turcica in an adult Ugandan skull. A dry adult skull from the osteological collection at Habib Medical School, Islamic University in Uganda, was examined during a routine anatomy lab demonstration. A detailed morphological and morphometric assessment was conducted using a magnifying glass, digital imaging, and calibrated vernier calipers. In addition to normal lateral foramina and a stenosed foramen rotundum; a unique pair of bilateral oval-shaped foramina (with maximum Left and Right; widths and lengths of 6.7 & 6.9 mm and 7.1 & 6.9 mm respectively) were observed inferior to the optic canals and anterior clinoid processes, within the anterior wall of the hypophyseal fossa. A probe inserted through these openings communicated directly with the sphenoid sinuses. No other abnormal cranial base features were identified. Morphometric data were collected and tabulated. This case represents a previously undocumented variant of middle cranial foramina medially positioned at the level of the Sella turcica. Its embryological origin may involve incomplete mesenchymal fusion, or alternatively, acquired erosion due to chronic sinusitis. The variant holds potential clinical relevance in neurosurgery and radiologic interpretation of skull base pathology.

KEY WORDS: Sella turcica foramina variant, Middle cranial fossa, Uganda.

INTRODUCTION

The cranial neuro- base is anatomically divided into three significant fossa, namely anterior middle and posterior cranial fossa. The middle cranial fossa is known for its rich endowment with multiple foramina that are conveyers of vital nerves and vessels to and from the cranium existing laterally within the greater wing and medially at the level of the sella turcica of the sphenoid bone (Standring, 2005). Studies have reported various morphometric and morphological variations of majorly three lateral foramina being, ovale, spinosum and rotundum which transmit the mandibular branch of the trigeminal nerve, middle meningeal artery, maxillary branch of the trigeminal nerve respectively in addition to the foramen lacerum, superior orbital fissures and the optic canal (Maina *et al*., 2007; Kumar *et al*., 2016; Thandalam, 2017). A rare foramen versalium / ovale accesorium (existing close to the foramen ovale) transmitting an emissary sphenoid vein to the pterygoid fossa has shown various incidences in different populations (Thandalam, 2017; Yadav, 2022).

The study of morphological variations is significant to both clinicians and anatomists especially in cases were Morphological, morphometrical variations in conjunction with pathological changes of middle cranial foramina have been known to create impingement, obstruction of traversing structures causing symptomatic scenarios in those that may be affected (Edwards *et al*., 2018). Despite a vast of research done regarding these lateral foramina, there is a paucity of information on medial foramina including those associated

with the sella turcica of the spenoid bone. To the best knowledge of the authors, no middle cranial variations have been documented in several African countries including the Ugandan population and none associated with the sella turcica as portrayed in this case report.

We therefore present a unique feature of middle cranial foramina/ perforations that involved the body of the sphenoid bone at the level of the sella turcica below the anterior clinoid processes and optic canal.

MATERIAL AND METHOD

This case involved a single skull base that was retrieved from the bone collection at the Department of human anatomy of Habib Medical School -Islamic University in Uganda. The identity of the used cadaver was unknown since this was from unidentified donor individual. We therefore could not ascertain the life or clinical history in this scenario. The foramina findings were coincidental during an osteological demonstration to medical students in the gross anatomy lab.

The dry skull in study had been previously prepared at the department for student study purposes. Dissected remains of a male cadaver had been boiled in water and sodium chloride concentrations, degreased with concentrations of acetone, bleached with hydrogen peroxide; aerated and dried at room temperature after intermittent washing (Nagawa *et al*., 2024).

The dry skull base was checked for completion and middle cranial foramina studied with a magnifying glass by the anatomists and a surgical neurosurgeon. Morphometrics regarding this variant and other surrounding foramina were taken using a calibrated vernier caliper and images taken with a 13 mega pixels digital camera.

RESULTS

Photographic analysis

Normal foramina. The foramina ovale, rotundum, spinosum, lacerum, superior orbital fissure and optic canal were clearly observed on the left and right side of the middle cranial fossa. These were lateral, patent and of normal morphology however with a significantly stenosed right foramen rotundum (Fig. 1).

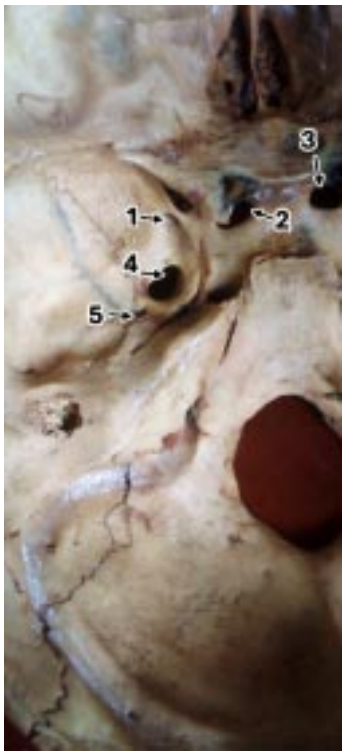

Fig. 1. Foramina in the middle cranial fossa. 1. Foramen rotundum; 2. and 3. Abnormal variant foramina ; 4. Foramen ovale; 5. Foramen spinosum.

Fig. 2. Stenosed foramen rotundum* *Black Arrow points at the stenosed foramen rotundum**Orange arrows point to the variant foramina.

Sella turcica foramen variant. An extra pair of bilateral oval shaped foramina were noted, inferior to the optic canal and the anterior clinoid processes of the sella turcica. These were at the anterior aspect of the hypophyseal fossa with bridging bone tissue. (Figs. 2 & 3) A probe inserted into the foramina ended into the immediate sphenoid sinuses below the sella turcica. No other abnormalities were observed from the middle cranial fossa.

Morphometric analysis. Average measurements of the width and length of the normal (foramens ovale, rotundum, spinosum) and variants were acquired with vernier caliper and parameters were noted as in Table I. A right foramen rotundum was noted to have smaller circumferences in comparison to other normal and the variant foramina.

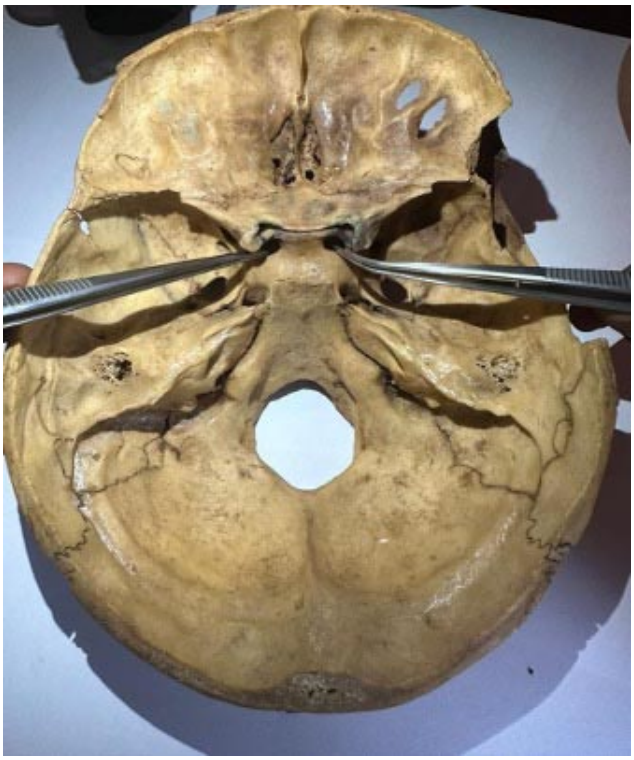

Fig. 3. Middle cranial foramina*. *Forceps showing abnormal variant foramina

DISCUSSION

The normal foramina in the middle cranial foramina have been reported to be ovale, spinosum and rotundum as portrayed in Figure 1 however variants have been documented over the years, with existence of additional foramina laterally (Krmpotic´-Nemanic´ *et al*., 2001; Raz *et al*., 2022), abnormal positioning of the ovale (Skrzat *et al*., 2006). The variation in morphometry and morphology hasn't been uncommon either, with stenosed or occluded and septal divided foramina (Thandalam, 2017; Paschopoulos *et al*., 2024). Such cases have pathologically affected conveying structures, impinging on cranial nerves and creating blood supply shortages to their areas of supply (Edwards *et al*., 2018).

In our case scenario, we yet report a unique variant associated medially with the cranial fossa at the level of the anterior sella turcica existing bilaterally below the optic canal. The morphometrics of these variants were 6.7mm and 6.9 mm in width and 7.1 and 6.9mm in length for the left and right respective foramen; sizably of equal circumferential parameters and patent. When compared to surrounding foramina, they were smaller than the oblong foramen ovale; almost equally sized as the optic canals and larger than the foramen rotundum

Table 1. Morphometrics of variant sella turcica foramina.

	Left	Right
Width (mm)	6.7	6.9
Length (mm)	7.1	6.9
Distance between (mm)	11.3	

and spinosum. We couldn't identify comparable studies since this was a unique finding, but the morphometric parameters could implicate passage of relatively large neurocranial structures like emissary veins and arterial branches.

A stenosed right foramen rotundum was noted with a width and length of 0.8mm and 0.5mm respectively in comparison to the left (1.9 and 2.3mm) (Table II). This coincides with findings by Santo Neto *et al*. (2005), Ismail *et al*. (2024) and Somnez *et al*. (2024), who reported foramina rotundum narrowing among patients with Trigeminal Neuralgia via radiological investigation (Santo Neto *et al*., 2005; Ismail *et al*., 2024; Sönmez *et al*., 2024). Presence of such a limitation in our case couldn't eliminate the possibility of the same pathological happening were the person to be alive.

The embryology of the skull base explains that

Table 2. Morphometrics of surrounding foramina.

	Average Width (mm)		Average Length (mm)	
	Left	Right	Left	Right
Optic canal	6.3	6.1	6.5	6.2
Foramen Rotundum*	1.9	**0.8**	2.3	**0.5**
Foramen spinosum	2.3	2.5	1.7	1.8
Foramen ovale	7.5	7.1	3.7	3.6

*Note the width and length of the foramen rotundum were remarkably reduced on the right side.

formation of foramina is as a result of mesenchymal connective tissues that lessen at positions already established cranial nerves and blood vessels (Akbareian *et al*., 2015). This with osteogenic changes orchestrate the formation of skull foramina malformations which can lead to morphological and morphometric variations that may cause stenosis, complete closure (Akbareian *et al*., 2015) or even false or abnormal foramina (Werner *et al*., 2022). The cause of the foramina reported in this case scenario is unknown since this was retrieved from an unidentified cadaver with no known prior clinical or life history; however, we infer this to have been an embryological malformation with failure of fusion at the skull base or local apoptosis of the mesenchymal tissues at a wrong cranial area and as elaborated by Akbareian *et al*., (2015).

It has also been noted that severe Sphenoid sinusitic inflammations can lead to bone erosions creating fistulas with nearby spaces in this case being the middle cranial fossa (Socher *et al*., 2008). A probe inserted through the studied foramina ended in the sphenoid sinuses. The possibility of these foramina being caused by bone erosion cannot be eliminated in our case, and were the individual to be alive, possible CSF leakages, sinus congestions could have been inevitable with patent fistulas. It is therefore important that thorough cranial investigations are done should foramina morphological influences such as nerve impingement and severe sinusitis be suspected in any symptomatic or asymptomatic individuals.

It is unknown which structures traversed these unique foramina since the studied specimen was a dry skull base with no known identity. Moreover these could have been perforations corroded with fibrotic connective tissues, or fistulas in communication with the hypophyseal fossa and the cerebral spinal space of the middle cranial fossa.

Given the uniqueness of our findings, and its possible clinical implications, there is still a need to investigate variations of the middle cranial foramina in the African population so as to inform clinicians and neurosurgeons for proper management of neurocranial errors.

CONCLUSION

This is a unique case of bilateral medial foramina at the anterior level of the sella turcica of the middle cranial fossa with inference to embryological malformation or bony erosion in severe sphenoid sinusitis as the possible cause in an adult unidentified cadaveric skull.

Availability of data and materials: The study specimen can be retrieved from the bone collection at Habib medical school. The data regarding this morphological case is readily available at the department of human anatomy at Habib medical school.

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Conflict of interest: The authors declare no conflict of interest.

Ethical approval:The use of the study specimen was approved by the head of Department of Human Anatomy and the Institutional Review Committee of the Faculty of Health Sciences at Habib Medical School.

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