

## MORPHOMETRIC STUDY OF PTERION AND ITS CLINICAL SIGNIFICANCE

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## ABSTRACT

**Objective:** Pterion is an area formed by the union of frontal, parietal, temporal, and sphenoid bones. It exhibits variations in the sutural pattern of fusion of constituent bones. Basing on this, the pterion can be classified into four varieties. According to Murphy, these are sphenoparietal, frontotemporal, stellate, and epipteretic. The anatomical location of the pterion is necessary for the surgical management of extradural hemorrhage, aneurysm, and brain tumors located in the anterior and middle cranial fossae. The purpose of this study is to find out the prevalence of different varieties of pterion and determine the position of pterion using anatomical landmarks.

**Methods:** The present study included fifty skulls of unknown age and sex. The skulls were studied macroscopically for the anatomical variations of pterion. The distance between the center of the pterion to the midpoint of zygomatic arch and pterion to the frontozygomatic suture was measured using Vernier calipers.

**Results:** The sphenoparietal variety was the most common variety of pterion found in the study followed by the epipteretic variety and the stellate variety, respectively. The distance between pterion and back of the frontozygomatic suture was found to be  $3.48 \pm 0.21$  cm on the right side and  $3.41 \pm 0.16$  cm on the left side. The distance between pterion and the midpoint of upper border of the zygomatic arch was found to be  $4.01 \pm 0.19$  cm on the right side and  $3.94 \pm 0.2$  cm on the left side.

**Conclusion:** The findings will be helpful for radiologists and neurosurgeons.

**Keywords:** Pterion, Midpoint of zygomatic arch, Frontozygomatic suture.

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## INTRODUCTION

Pterion represents the junction of frontal, sphenoid, parietal, and temporal bones in the temporal fossa. It is situated within 1 cm diameter of a circle centered approximately 2.6 cm posterior and 1.3 cm superior to the posterolateral margin of the frontozygomatic suture. Alternatively, the pterion is located approximately 4 cm above the midpoint of upper border of the zygomatic arch [1]. Pterion usually marks the position of the anterior (frontal) branch of the middle meningeal artery, lateral sulcus of brain and Broca's motor speech area [1]. Knowledge of the location of the middle meningeal artery is important for the accurate position of the burr holes to evacuate extradural hematoma caused due to injury to middle meningeal vessels [1]. Pterion is also a primary site in surgeries to gain access to sphenoid ridge and optic canal [2]. Hence, the location of the pterion is very important in neurosurgery.

The pterion corresponds to the site of anterolateral fontanelle of the neonatal skull, which closes at 3 months of age [1]. The fontanelles provide for the molding of the fetal head during its passage through the birth canal as well as the rapid growth of the brain during infancy.

The pterion exhibits variations in the sutural pattern of fusion of constituent bones. Basing on this, the pterion can be classified into various types. According to Murphy [3], these are - sphenoparietal, frontotemporal, stellate, and epipteretic. In sphenoparietal variety, sphenoid and parietal bones are in direct contact. Frontotemporal type is a sutural pattern in which the frontal and temporal bones are in direct contact. In stellate type, all four contributing bones such as frontal, parietal, sphenoid, and temporal bones articulate at a point. The fourth one is the epipteretic type, which has the presence of small sutural bones between sphenoid and parietal bones. These variations are important for anthropologists.

As pterion is an important neurosurgical landmark and it exhibits variations in its sutural pattern, the present study was conducted to define the types of pterion and map its location.

## METHODS

The present study included fifty dry, human skulls of unknown age and sex available in the Museum of Department of Anatomy of a Medical College at Bhubaneswar. Skulls exhibiting pathological changes and congenital anomalies were excluded from the study. Broken skulls and skulls with obliterated sutures due to synostosis were also excluded from the study. The skulls were studied macroscopically to find the sutural pattern of the pterion on both the sides.

For locating the pterion the smallest circle involving the four contributing bones was drawn. The center of the circle was taken as the center of the pterion [4,5]. Two linear measurements were taken on the external aspect of the skull from the center of the pterion to determine its location. One measurement was taken vertically from the center of the pterion to the posterolateral aspect of frontozygomatic suture (PFZS), and the other was from the center of the pterion to the midpoint of upper border of the zygomatic arch.

The measurements were taken on both sides of the skull with a digital Vernier caliper. The measurements were taken twice, and then the average was calculated to minimize bias error. All the data obtained were tabulated and analyzed using Microsoft Excel software.

## RESULTS

In the present study, three types of sutural patterns of pterion were observed. Sphenoparietal variety (Fig. 1) was the most common variety.

The frequency was 40 (80%) on the right side and 45 (90%) on the left side. The second most common variety was epipteric type (Fig. 2). The frequency was 7 (14%) on the right side and 3 (6%) on the left side. Stellate type of pterion (Fig. 3) was observed in 3 (6%) cases on the right side and 2 (4%) case on the left side. This was the third most common variety. No skulls exhibited the frontotemporal type of pterion in the study. The frequency of different types of pterion after combining both the sides is depicted in Table 1.

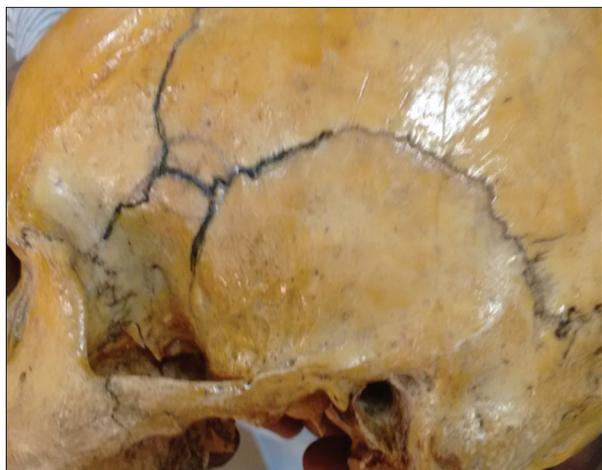


Fig. 1: Sphenoparietal variety of pterion



Fig. 2: Epipteric variety of pterion



Fig. 3: Stellate variety of pterion

The distance between the midpoint of pterion and the posterolateral aspect of frontozygomatic suture was found to be  $3.48 \pm 0.21$  cm on the right side and  $3.41 \pm 0.16$  cm on the left side. The distance between the center of pterion to the midpoint of upper border of zygomatic arch was found to be  $4.01 \pm 0.19$  cm on the right side and  $3.94 \pm 0.2$  cm on the left side. The distances were higher on the right side than the left side. However, the difference was not found to be statistically significant (unpaired t-test was applied and  $p < 0.5$ ). Combining both the sides, the center of the pterion was found to be located at a distance of  $3.46 \pm 0.2$  cm from the posterolateral aspect of frontozygomatic suture and at a distance of  $3.98 \pm 0.2$  cm from the midpoint of upper border of zygomatic arch. The distances measured are represented in Table 2.

## DISCUSSION

In neurosurgery, it is important to approach through the most suitable bony aperture to be minimally invasive [6]. Pterional access either alone or in combination with other approaches has come up as a minimally invasive approach for a wide variety of neurosurgical disorders. Hence, the knowledge of the peculiar morphology of pterion is necessary for the pterional approach used in neurosurgery [7].

The present study observed that the most common type of pterion was sphenoparietal (85%) followed by epipteric (15%) and stellate (5%), respectively.

This is similar to the findings of studies by Murphy [3], Matsumura et al. [8], Lee et al. [9], Eboh et al. [10], Oguz et al. [11], Katri et al. [12], and Saxena et al. [2].

Murphy [3] reported 73% sphenoparietal, 18.5% stellate, 7.5% frontotemporal, and 1% epipteric type of pterion in an Australian population. Matsumura et al. [8] in their study in Japan, have reported 79.1% sphenoparietal, 17.7% stellate, 2.6% frontotemporal, and 0.6% epipteric type of pterion. Lee et al. [9] have reported 76.5% sphenoparietal and 23.5% epipteric type of pterions in their study involving Korean population. They could not find any frontotemporal or stellate type in their study. Eboh et al. [10] reported 83% sphenoparietal, 6% stellate and 6% epipteric, 5% frontotemporal type in their study in Nigeria. Oguz et al. [11] have found 88% sphenoparietal, 10% frontotemporal, and 2% epipteric type in Turkey. They did not find any stellate variety of pterion in their study. In India, Katri et al. [12] have observed 86% sphenoparietal, 11.7% epipteric, 2% frontotemporal, and 0.3% stellate type of pterion in their study. Another study in India by Saxena et al. [2], has reported 87.7% sphenoparietal, 16% frontotemporal, and 2.3% stellate type of pterion. They have found no epipteric variety in their study.

The present study has revealed the distance between the center of pterion and posterolateral aspect of frontozygomatic suture to be

Table 1: Frequency of different types of pterion in the present study

Type of pterion	Frequency (%)
Sphenoparietal	85 (85)
Epipteric	10 (10)
Stellate	5 (5)

Table 2: Distance of pterion from various bony landmark

Side of skull	Parameter	Mean $\pm$ SD (cm)
Right	PFZS	3.48 $\pm$ 0.21
Right	PMZA	4.01 $\pm$ 0.19
Left	PFZS	3.41 $\pm$ 0.16
Left	PMZA	3.94 $\pm$ 0.20

SD: Standard deviation, PFZS: Pterion to the posterolateral aspect of frontozygomatic suture, PMZA: Pterion to the midpoint of upper border of the zygomatic arch

3.48 ± 0.21 cm on the right side and 3.41 ± 0.16 cm on the left side. This is similar to the findings of Zalawadia *et al.* [4] (3.73 ± 0.51 cm on right side; 3.55 ± 0.42 cm on left side); Eboh *et al.* [10] (3.2 ± 0.3 cm on right side and 3.1 ± 0.2 cm on left side); Mwachka *et al.* [13] (3 ± 0.3 cm right side and 3 ± 0.4 cm on left side) and Anjana *et al.* [5] (3 ± 0.4 cm on right side and 2.9 ± 0.2 cm on left side).

The current study has revealed the distance between the center of pterion and the midpoint of upper border of zygomatic arch to be 4.01 ± 0.19 cm on the right side and 3.94 ± 0.2 cm on the left side. This is similar to the findings of Eboh *et al.* [10] (4 ± 0.3 cm on right side and 3.9 ± 0.3 cm on left side); Anjana *et al.* [5] (4 ± 0.5 cm on right side and 4 ± 0.2 cm on left side); Mwachka *et al.* [13] (3.9 ± 0.3 cm on right side and 3.8 ± 0.3 cm on left side). However, Zalawadia *et al.* [4] have reported the distance as 3.12 ± 0.44 cm on the right side and 2.97 ± 0.33 cm on the left side.

#### Significance of sutural patterns of pterion

The knowledge of the sutural patterns of pterion is important for the following reasons:

- In epipteric variety of pterion, burr holes placed over the anterior junction for evacuation of extradural hematoma may cause inadvertent penetration into orbit [6]
- The sutural pattern of pterion gives a hint towards the volume of brain. The development of the calvarium is tightly coordinated with the type of brain. This explains the prevalence of frontotemporal pattern of sutures among monkeys who have smaller brains compared to humans with larger brains who have sphenoparietal pattern of suture at pterion [14]
- The variation of sutural pattern even finds a probable genetic basis. The gene responsible for the articulation of cranial bones in pterion is MSX 2 (on 5q35.2), a gene of homeobox family involved in cranial suture morphogenesis. Working in mice models, it has been proved that MSX 2 gene may be responsible for pterion type and asymmetry [15]. Mutations of MSX 2 gene has been observed in diseases such as Persistent Parietal Foramen Type 1 and Craniosynostosis Type 2. In Craniosynostosis, there is premature fusion of the cranial sutures. Hence, there seems to be a definite role of MSX 2 gene in cranial suture morphogenesis and hence variations of sutural pattern of pterion.

#### Significance of location of pterion

Mapping of pterion finds great application in neurosurgery as pterional access has come up as a minimally invasive approach for a number of procedures such as evacuating extradural hematoma, surgery of olfactory meningioma on undersurface of frontal lobe [16], operations on Broca's motor speech area and clipping the aneurysms of middle cerebral artery and upper basilar complex [17].

The pterion is used as an anterolateral landmark in "Cranial suture closure methodology" for determination of age and sex [18]. Hence, locating the pterion is important in archaeological and forensic specimens.

#### CONCLUSION

The most common variety of pterion in the present study was found to be of the sphenoparietal type. The study revealed the distance from the center of pterion to posterolateral aspect of frontozygomatic suture as 3.46 ± 0.2 cm and from the center of pterion to the midpoint of upper border of zygomatic arch as 3.98 ± 0.2 cm. This will be useful to neurosurgeons, radiologists, anthropologists, and forensic scientists.

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