MORPHOMETRIC STUDY OF PTERION AND ASTERION IN ADULT HUMAN SKULLS OF INDIAN ORIGIN

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ABSTRACT

Introduction: The pterion and asterion are regions of sutural confluence in the skull. They represent important extra-cranial landmarks allowing surgical and microsurgical approach for surgeons.

Aims: To study the morphology and morphometry of the pterion and asterion in the adult human skulls of Indian origin.

Materials and methods: 78 dry human skulls were studied. Sutural pattern of pterion were classified into sphenoparietal, frontotemporal, epipteric or stellate type. Position of pterion was determined in relation to four specific bony landmarks. Length and thickness were also measured using slide calipers. Sutural morphology of asterion was classified.

Results: All four types of pterion were observed in the skulls analyzed. Sphenoparietal was the predominant type observed. Stellate type was least common. Bilateral asymmetry was seen. Mean distances from centre of pterion were 38.15 +/-3.67 (right side) and 36.69 +/-3.64 (left side) superior to zygomatic arch; 29.35 +/-3.60 (right side) and 27.35 +/-3.60 (left side) posterior to fronto-zygomatic suture, 8.80 +/-2.25 (right side) and 8.66 +/- 2.21 (left side) from lateral edge of sphenoidal ridge and 39.58 +/-3.49(right side) and 38.84 +/-3.48 (left side) from lateral margin of optic canal. Mean length of pterion was 14.06 +/-2.96 on right side and 14.58 +/- 4.06 on left side. Mean thickness of skull at pterion was 5.72 +/-1.41 on right side and 5.77 +/-1.29 on left side. Type 1 and type 2 of asterion were observed in the skulls.

Conclusion: The present study is in agreement with previous studies on different populations and concludes that the morphologic and morphometric patterns of pterion and asterion in skulls of Indian origin are similar to those in other populations.

KEY WORDS: Pterion, asterion, morphometry, skull, frontozygomatic suture, sutural bones, sphenoparietal.

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INTRODUCTION

The pterion is a region of sutural confluence in the Norma lateralis of the skull where the frontal, parietal, squamous part of temporal and greater wing of sphenoid bones meet. It lies in the anterior part of floor of the temporal fossa about 4 cm above the zygomatic arch & 3.5 cm behind the fronto-zygomatic suture [1]. It represents an important extra-cranial landmark for surgeons, as it allows surgical and
microsurgical approach to - anterior branch of middle meningeal artery, Broca’s motor speech area on the left side, the Sylvian fissure, internal capsule, optic canal, orbit, and sphenoidal ridge [2, 3]. The pterion is also used as a guide for age estimation and sex determination on the basis of suture closure [4]. The region of the pterion occurs as the membranous antero-lateral fontanelle during fetal life and at birth, and generally ossifies completely after birth [5]. The presence of sutural bone at the pterion site is thought to be a surgical pitfall as a burr hole placed over it may cause inadvertent penetration into the orbit [6]. The fronto temporal craniotomy, also known as pterional craniotomy is the commonest neurosurgical approach for microsurgical clipping of intracranial aneurysms – almost all aneurysms of anterior circulation & a few of the basilar artery aneurysms [7].

The asterion refers to the junction of the parietal, mastoid part of temporal and occipital bones of the skull, seen in Norma occipitalis. It is also an important surgical landmark for the posterior cranial fossa, corresponding to the location of the transverse sinus [1].

Objectives: The morphologic and morphometric study of type and location of the pterion and asterion have clinical relevance, and forms the basis for this study, which aims to enhance the knowledge on the prevalence of different types of pterion and its relative position on the skull, and the types of asterion, in the Indian setting.

**MATERIALS AND METHODS**

**Study design:** Cross-sectional study

**Place of study:** Ramaiah Medical College, Bengaluru.

**Duration of study:** 3 months – two months for data collection & one month for data analysis

**Sample Size:** Based on previous studies, 78 dry human skulls of Indian origin, of unknown age and sex, were studied with an expected proportion of 0.91 (or 91%), relative precision of 7% and desired confidence level of 95%.

**Source of data:** Human skulls in Department of Anatomy at Ramaiah Medical College, Bengaluru

**Inclusion Criteria -** Only those skulls which were regular in shape, with no obvious deformity or malformation, and with the calvarium separated above the level of pterion were selected

**Exclusion Criteria:** Skulls with bilateral absence of pterion, due to breakage or synostosis.

**Parameters:** The following parameters were observed in pterion and asterion

**Pterion**

**Type of pterion:** Type (sutural pattern) of pterion was classified in accordance with Murphy’s criteria, into one of 4 types-sphenoparietal, frontotemporal, epipetric or stellate.

**Position of pterion:** Position of pterion was determined in relation to four specific bony landmarks in the skull. A circle of smallest diameter was drawn which passed through all the 4 bones converging at the pterion. Linear distances were measured from the midpoint of this circle to the following specific bony landmarks

- **P-ZA**-from centre of pterion to superior margin of zygomatic arch
- **P-FZS**-from centre of pterion to posterolateral margin of the frontozygomatic suture.
- **P-OC**-centre of pterion on internal aspect of skull to lateral margin of optic canal
- **P-SR**-centre of pterion on internal aspect of skull to lateral end of sphenoidal ridge on sphenoid bone.

**Length of the pterion:** Measured along line of articulation of sphenoid and parietal bones in case of sphenoparietal type of pterion and between frontal and temporal bones in case of frontotemporal type of pterion. This parameter is inapplicable in case of epipetric and stellate type.

**Thickness of skull at pterion** was also measured, at the centre of pterion.

All the above mentioned measurements were made using a digital slide caliper (“Yamayo Digimatic Caliper-Classic”), with least count of 0.01 mm. All parameters were evaluated bilaterally, observations tabulated and analyzed.

**Asterion:** Sutural morphology of asterion was classified as T1 (presence of a sutural bone at asterion) and T2 (absence of sutural bone at asterion)

**Statistical Analysis:**

Data was tabulated in a MS Excel data sheet, and quantitative parameters of frequency and...
mean (and median, where applicable) of linear distance, calculated using the same. The Chi-square test was used for the analysis of the data.

**Fig. 1:** Sphenoparietal type of Pterion.

**Fig. 2:** Frontotemporal type of Pterion.

**Fig. 3:** Epipteric bone at Pterion.

**Fig. 4:** Position of Pterion (P) from superior margin of zygomatic arch (ZA) and posterolateral margin of frontozygomatic suture (FZS).

**RESULTS**

All four types of pterion were observed in the 78 skulls analyzed. Sphenoparietal was the predominant type of pterion observed. Stellate type was least common. Bilateral asymmetry was seen. (Table 1)

The position of pterion with respect to bony landmarks was calculated. Mean distances from centre of pterion were 38.15 +/- 3.67 (right side) and 36.69 +/- 3.64 (left side) superior to zygomatic arch; 29.35 +/- 3.60 (right side) and 27.37 +/- 5.80 (left side) posterior to fronto-zygomatic suture, 8.80 +/- 2.25 (right side) and 8.66 +/- 2.21 (left side) from lateral edge of sphenoidal ridge and 39.58 +/- 3.49 (right side) and 38.84 +/- 3.48 (left side) from lateral margin of optic canal. Mean length of pterion was 14.06 +/- 2.96 on right side and 14.58 +/- 4.06 on left side. Mean thickness of skull at pterion was 5.72 +/- 1.41 on right side and 5.77 +/- 1.29 on left side. (Table 2)

Both types (Type 1 and type 2) of asterion were
observed in the skulls, with sutural bone (Type 1) occurring in 13.46% of asterion. (Table 3)

Table 1: Prevalence of various types of Pterion.

| Pterion type       | Right n=78 | Left n=78 | Both sides |
|--------------------|------------|-----------|------------|
| Sphenoparietal     | 66 (84.62%)| 63 (80.77%)| 82.70%     |
| Frontotemporal     | 3 (3.84%)  | 2 (2.56%)  | 3.20%      |
| Stellate           | 1 (1.28%)  | 3 (3.84%)  | 2.56%      |
| Epipetric          | 8 (10.26%) | 10 (12.2%) | 11.54%     |

n = sample size

Table 2: Relative position, length and position of Pterion.

| Distance               | Right (Mean+/-SD) | Left (Mean+/-SD) |
|------------------------|-------------------|------------------|
| Length (mm)            | 14.06+/-2.96      | 14.58+/-4.06     |
| Thickness (mm)         | 5.72 +/-1.41      | 5.77+/-1.29      |
| P-ZA (mm)              | 38.15+/-3.67      | 36.69 +/-3.64    |
| P-FZS (mm)             | 29.35+/-3.60      | 27.37+/-5.80     |
| P-SR (mm)              | 8.80 +/-2.25      | 8.66 +/-2.21     |
| P-OC (mm)              | 39.58+/-3.49      | 38.84+/-3.48     |

P-ZA = Pterion to zygomatic arch; P-FZS = Pterion to frontozygomatic suture; P-OC = Pterion to optic canal; P-SR = Pterion to sphenoidal ridge; SD = Standard deviation

Table 3: Prevalence of type of Asterion.

| Type of asterion | Right n=78 | Left n=78 | Mean occurrence |
|------------------|------------|-----------|-----------------|
| Type 1           | 11 (14.10%)| 10 (12.82%)| 13.46%          |
| Type 2           | 67 (85.90%)| 68 (87.18%)| 86.54%          |

DISCUSSION

The commonest type of pterion in the present study is sphenoparietal type which is similar to that reported in 19 studies mentioned in Table 4, though the prevalence varies from 66% to 96%. The second commonest is epipetric type of pterion in the present study and the same has been reported in studies conducted by Saxena (1988), Manjunath (1993), Ankur Zalawadia (2010), W Apinhasmit (2011), Mary Antony Praba et al. (2012), R Sudha et al. (2013) & Prashant Natrekar (2016); the prevalence varying from 4% to 51.5%. The third commonest type is fronto-temporal type of pterion coinciding with studies conducted by Saxena (1988), Oguz (2004), Saxena RC (2008), Mwachaka PM (2009), Hussain Saheb S (2011), Sunil D. Adejuwon (2013); the prevalence varying from 2.4% to 7.5%. The fourth & last type of pterion in present study was stellate type, prevalence of which ranged from 0.4% to 5.6% & coincided with studies conducted by Saxena (1988), Manjunath (1993), Ankur Zalawadia (2010) & W Apinhasmit (2011). (Table 4)

Table 4: Comparison of types of Pterion in different populations.

| STUDY                        | Sample size | Pterion |
|------------------------------|-------------|----------|
| Australian aborigines        | 388         | 150      | 150      | 18.50% | 1%     |
| Nigerian - Saxena et al. (1988) | 41          | 150      | 150      | 18.50% | 1%     |
| Indian - Saxena et al. (1988) | 52          | 150      | 150      | 18.50% | 1%     |
| Japanese - Matsuura (1993)   | 614         | 150      | 150      | 18.50% | 1%     |
| Kenyans - Mwachaka PM (2009) | 300         | 203      | 203      | 18.50% | 1%     |
| Australian aborigines        | 308         | 150      | 150      | 18.50% | 1%     |
| Nigerian - Saxena et al. (1988) | 41          | 150      | 150      | 18.50% | 1%     |
| Indian - Saxena et al. (1988) | 52          | 150      | 150      | 18.50% | 1%     |
| Japanese - Matsuura (1993)   | 614         | 150      | 150      | 18.50% | 1%     |
| Kenyans - Mwachaka PM (2009) | 300         | 203      | 203      | 18.50% | 1%     |
| Australian aborigines        | 388         | 150      | 150      | 18.50% | 1%     |
| Nigerian - Saxena et al. (1988) | 41          | 150      | 150      | 18.50% | 1%     |
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| Kenyans - Mwachaka PM (2009) | 300         | 203      | 203      | 18.50% | 1%     |
| Australian aborigines        | 388         | 150      | 150      | 18.50% | 1%     |
| Nigerian - Saxena et al. (1988) | 41          | 150      | 150      | 18.50% | 1%     |
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| Kenyans - Mwachaka PM (2009) | 300         | 203      | 203      | 18.50% | 1%     |

It has been postulated that several genes acting in cranial suture growth and morphogenesis are involved in regulating pterion variability. This includes the MSX2 gene, which plays a crucial role in craniofacial morphogenesis by influencing fusion of sutures through a homeodomain transcription factor. The development of calvarial bones is tightly coordinated with the growth of the brain, giving rise to the varying sutural patterns of pterion. The most common type of pterion in modern humans, bonobos, orangutans & gibbons is sphenoparietal type & in chimpanzees & gorillas it is fronto temporal type [3]. This suggests an evolutionary basis as well for pterion morphology, corresponding to an increase in size of human brain [24].

A detailed knowledge of type of pterion and its location in relation to surrounding bony landmarks and underlying soft tissues is important in pterional approaches especially with respect to neurosurgery & vascular microsurgery [6, 20]. A minimally invasive procedure is the main objective in neurosurgery in the successful treatment of pathologies [4]. The incidence of sutural bone at pterion is high in Indians, and the presence of sutural bones may or may not...
be associated with cranial & central nervous system anomalies [25].

The type 2 asterion was found in present study & all studies reported in Table 5 with the prevalence varying from 76.85% to 92.5%. The present study findings are similar to the studies reported by Berry (1967) in Egyptians & Indian Burma population. (Table 5) It has been postulated that the formation of sutural bones at asterion may be a result of physiological processes that are genetically determined. However, there may also be the presence of pathological influences like hydrocephalus [16].

**CONCLUSION**

The present study is in agreement with previous studies on different populations and concludes that the morphologic and morphometric patterns of pterion and asterion in skulls of Indian origin are similar to those in other populations.

Findings of the present study may be correlated with other modern commonly used modalities such as radiological analysis to better predict the structure of pterion and asterion and allow better surgical safety and efficacy.

**Conflicts of Interests:** None

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