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Sutural Morphology of Pterion and Asterion among Dry Human Skulls in Marathwada Region of Maharashtra

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Abstract

Background: The pterion and asterion are the important landmarks seen on the lateral aspect of the human skull. Both these points are related to the various important structures intracranially. These landmarks are used for various neurosurgical procedures. This study was carried out to determine the different types of pterion and asterion in Marathwada region of Maharashtra. *Methods*: This study was done on 96 adult dry human skulls which consisted of 66 male and 30 female skulls. Data obtained were subjected to statistical analysis using chi square contingency table. *Results*: Most common type of pterion was sphenoparietal in both male as well as female skulls followed by epipteric, frontotemporal and stellate. In case of asterion type II was the most observed type in male and female skulls. *Conclusion*: This will be very useful for surgeons planning surgeries on cranium using these landmarks, radiologists for interpreting the radiological images as well as for anthropologists and forensic pathologists.

Keywords: Pterion; Asterion; Frontotemporal; Sphenoparietal; Epipteric; Stellate.

Introduction

The floor of the temporal fossa is formed by frontal and parietal bones, the greater wing of the sphenoid and the squamous part of the tempral bones. All bones meet on each side at an H- shaped junction termed as pterion. This is an important landmark on the side of the skull because it overlies both the anterior branch of middle meningeal artery and the lateral cerebral fissure intracranially (it is also known as Sylvian point). The pterion corresponds to the site of the anterolateral (sphenoidal) fontanelle in the neonatal skull, which disappears about three months after birth [1]. It is the thinnest part of the lateral wall of the skull [2]. The pterion is one of the most interesting bone meeting point in craniofacial osteology and its complex morphology derives from the fact that, the pterion is the contact point of the facial skeletal elements, skull base and calvarium. Knowledge of its peculiar morphology is mandatory for the pterional approach used in microsurgery and surgery [3]. Pterion is a crucial surgical landmark for surgical approaches to the middle meningeal artery particular lesions and tumors in the brain [4].

Various classifications of pterion have been proposed. The pterion was first classified into three types – sphenoparietal, frontotemporal and stellate, by Broca in 1875 [5]. Later on Murphy [6] defined four types of pterion – sphenoparietal, frontotemporal, stellate and epipteric while Wang et al [7] described six different types of pterion – sphenoparietal, frontotemporal stellate, epipteric, zygomaticoparietal and zygomaticotemporal.

The anatomic points of reference to analyze the topography of the posterolateral surface of the skull are asterion, external occipital protruberance, suprameatal crest, apex of the mastoid process, root of zygomatic arch, Frankfurt horizontal plane and the mastoid foramen. The asterion is the junction of the parietal, temporal and occipital bones. Occurrence of sutural bones in this craniometric point has been reported to vary among different populations [8]. Presence of sutural bones at these points may complicate the surgical orientation leading to pitfalls [9].

As not much literature is present on the studies of these landmarks in Aurangabad region of

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Maharashtra, the present study was done- 1) to determine the pterion and asterion types in dry human skulls of known sex of marathwada region. 2) To evaluate different types of these landmarks and compare the data in male and female skulls and also to compare this study with the other studies. The study will be of interest to anthropologists and forensic pathologists.

Material and Methods

This was a descriptive anthropometric study carried out in the department of Anatomy of JIIU's Indian Institute of medical Science and Research, Warudi, Jalna, Maharashtra. The study comprised 96 dry adult human skulls of known sex, comprising 66 male and 30 female skulls obtained from the museums of Government College Aurangabad, JIIU's IIMSR Warudi and MGM medical college Aurangabad.

This study was done by determining the sutural patterns of the pterion and asterion on both sides of each skull. Sutural morphology of pterion was done by using description given by Murphy [6]. The sphenoparietal type was defined as a sutural pattern in which the sphenoid and parietal bones are in direct contact (Figure 1a). The frontotemporal type is a sutural pattern in which the frontal and temporal bones are in direct contact (Figure 1b). The stellate type is characterized by articulation of four bones (frontal, temporal, parietal and sphenoid) at a point (Figure 1c). The last epipteric type was defined as presence of a small sutural bone between the parietal bone and the greater wing of the sphenoid bone (Figure 1d).

Fig. 1 showing different types of pterion

The sutural morphology of asterion was studied by conventional classification which consists of two types. Type I – sutural bone (wormian) located among the other bones that form the asterion. TypeI I –union of the parietomastoid, lamboid and occipitomastoid sutures i.e. absence of wormian bone.

Skulls with irregular shape, without obvious evidence of any dystrophy, deformity or trauma were selected for study.

While skulls showing fusion or breakage of adjacent bones leading to obscured pterion identification were excluded from the study. Also fetal, neonatal or children skulls were not included in this study.

The data obtained were subjected to statistical analysis using frequency distribution, and chi square contingency table with the aid of the statistical package for social sciences (SPSS) version 16. $P<0.05$ was considered statistically significant.

Results

Table 1 shows the frequency distribution of the pterion types on both sides of male and female skulls. All the four types of pterion types described by Murphy [6] i.e. spheno-parietal, fronto-temporal, epipteric and stellate were seen in the dry human skulls of Marathwada region (Table1). The dominant pterion type was spheno-parietal on both sides of skulls in males as well as in females. The sphenoparietal type occurred more bilaterally. The epipteric type was more frequently observed in female skulls. But frontotemporal type was not observed in female skulls (Table1). The statistical analysis showed no statistical significance for the degree of association between pterion type and sex of the skull.

Both types I as well as type II asterions were seen (Table 2). The predominantly variery was of type II which was 88.33%. Regarding the side, type I was more commonly observed on right side of male skulls.

Table 1: Showing % frequency distribution of different types of pterion in male & female skulls

Pterion type	Male				Total	Female				Total	Male + Female	
	L		R			L		R				
	No	%	No	%		No	%	No	%		No	%
Spheno-parietal	59	89.3	62	93.9	91.66	24	80	23	76.6	78.3	168	87.5
Fronto-temporal	3	4.54	2	3.03	3.78	0	0	0	0	0	5	2.60
Epipteric	4	6.06	1	1.51	3.78	5	16.6	6	20	18.3	16	8.33
Stellate	0	0	1	1.51	0.75	1	3.33	1	3.33	3.33	3	1.56

Table 2: Showing % frequency distribution of asterion in present study

Asterion type	Male				Total	Female				Total	Male + Female	
	L		R			L		R				
	No	%	No	%		No	%	No	%		No	%
Type I	7	10.6	15	22.7	16.65	3	10	1	3.33	6.66	26	11.65
Type II	59	89.39	51	77.27	83.33	27	90	29	96.66	93.33	166	88.33

Table 3: Showing % frequency distribution of pterion type among different regions of India

Authors	Region	Sphenoparietal	Frontotemporal	Stellate	Epipteric
Manjunath et al[11] (1993)	South India	93.55	3.52	2.93	17.3
Saxena et al[5] (2003)	Uttar Pradesh	84.72	10.01	5.17	0
Zalawadia et al[12] (2010)	Gujarat	91.7	2.4	1.2	4.8
Hussain Saheb et al[13] (2011)	Karnataka	69.25	17.35	9.7	3.7
Natekar et al[14] (2011)	Goa	85.33	8	10.6	51.4
Praba & Venkatramniah[15] (2012)	Tamilnadu	74	3	9	14
Present study (2016)	Aurangabad (Maharashtra)	87.5	2.60	1.56	8.33

Table 4: Showing % frequency distribution of different types of pterion among various population groups

Authors	Region	Sphenoparietal	Frontotemporal	Stellate	Epipteric
Asala & Mbajiorgu[20] (1996)	Nigeria	82.1	23.6	0	5.7
Lee et al[21] (2001)	Korea	76.5	0	0	40.3
Oguz et al (2004)	Turks	88	10	0	2
Apinhasmit et al (2011)	Thai	81.2			17.4
Mwachaka[22] (2009)	Kenya	66	15	7	12
Eboh & Obaroefe[23] (2014)	Nigeria	83	5	6	6

Table 5: Showing % frequency distribution of asterion in different populations

Authors	Region	Type I	Type II
Berry & Berry[8] (1967)	North America	12	88
Berry & Berry [8](1967)	South America	7.5	92.5
Berry & Berry [8](1967)	Egypt	14.4	85.6
Berry & Berry [8](1967)	India- Burma	14.7	85.3
Berry & Berry [8](1967)	India Punjab	16.9	83.1
Kellock & Parsons[24] (1970)	Australia	19.8	80.2
Gumusburum[25] (1997)	Turks	9.92	90.08
Mwachaka[22] (2009)	Kenya	20	80
Leon[26] (2013)	Mexico	25.6	74.4
Present study (2016)	India	11.65	88.33

Discussion

It has been reported that the pterion is also an important landmark for the anterior branch of the middle meningeal artery, Broca's area, the insula and the stem of the lateral sulcus. It is also a primary site during surgery to gain access to the sphenoid ridge and optic canal [5]. The pterion is also commonly used in cranial suture closure methodology as an important guide for age estimation and sex determination in archaeological and forensic specimens [10].

In the present study all the four types of pterion were observed in the dry human skulls of Aurangabad region (Table1). The most common type was sphenoparietal as was also observed by other different studies done in different populations (Table 3 & 4). The next type seen in this study was epipteric followed by frontotemporal. The least observed type was the stellate type.

The landmark pterion can mistakenly be assessed to be at the most anterior junction of bones in skulls with an epipteric bone variation where placement of a burr hole can lead to inadvertent penetration into the orbit [16].

Previous studies also showed the sphenoparietal being the most predominant type in different populations. But in nonhuman primates frontotemporal type is the most predominant type. In primate evolution, the anterosuperior segment of the squamous part of the temporal bone of lower primates detached from its parent and incorporated into the posterosuperior angle of the greater wing of the sphenoid bone of the humans. This changed the pterion pattern from frontotemporal type of nonhuman primates to the sphenoparietal type of humans. Furthermore it has been shown that the development of calvaria bones is tightly co-ordinated with the growth of the brain and requires interactions between different tissues in sutures [17]. The high occurrence of the sphenoparietal pterion could have an evolutionary basis [18]. Sphenoparietal type is the most common type in humans and biped primates such as bonobos, orangutans. Consequently the increase in brain size in bipeds may have caused morphological changes in neurocranium that lead to meeting of greater wing of sphenoid and parietal bone [19].

Although the control of pattern of articulation of bones forming the pterion and asterion is unknown, genetic factors may play some role [7]. The MSX2 gene, which encodes a home domain transcription factor, plays a crucial role in craniofacial morphogenesis by influencing fusion of sutures [18]**.** The basis for the ethnic variations observed could be genetic and environmental [20].

In case of asterion, type II was most frequently observed type in this study. This is in accordance with other studies in different populations (Table 5). The presence of sutural bones should be kept on mind by the radiologists and neurosurgeons while interpreting radiological interventions. The mechanism of formation of the sutural bones is not fully known. However they appear in great numbers in hydrocephalic skulls linking to pathological basis, while some believe that sutural bones develop from normal process and are genetically determined.

Conclusion

The sutural morphology of the pterion and asterion in the Aurangabad population does not differ from that of other populations. This data may be useful for planning surgeries to the cranium through these craniometrical points and also when interpreting radiological images.

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