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Original Article

Anatomy Section

Prevalence and Distribution of Pterion in Adult Dry Human Skull and its Clinical Importance

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ABSTRACT

Introduction: The pterion is a topographic point on the lateral aspect of the skull, where frontal, sphenoid, parietal and temporal 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.

Aim: To determine the prevalence of type and position of the pterion using the standard cranial anatomical points.

Materials and Methods: The present cross-sectional study was conducted from July 2020 to September 2020 in NSCB Medical college Jabalpur (M.P.). One hundred and eighty dry human skull obtained from Department of Anatomy. Sutural pattern of pterion were classified into sphenoparietal, frontotemporal, epipteric or stellate type. Position of pterion was also determined in relation to three specific bony landmarks. All parameters were evaluated bilaterally, observations tabulated and analyzed using SPSS software version 23.

Results: In present study, it was found that 84% (n=180) skull posses sphenoparietal type of pterion bilaterally, then epipteric type (7.73%) followed by frontotemporal (6.61%) and the least variety was stellate type (1.83%). The mean distance from upper end of zygomatic arch up to centre of pterion on right side was 35.12±4.1mm and on the left side was 36.26±3.88mm. The distance from posterolateral margin of frontozygomatic suture up to centre of pterion on right side was 28.84±5.80mm and on the left side was 30.10±4.79 mm.

Conclusion: The study concluded that in present study, sphenoparietal type of pterion was most common bilaterally and stellate type was least common. The detailed data about the location of the pterion serves as a benchmark for neurosurgeons to localize the correct position for burr hole during all invasive surgeries.

Keywords: Upper end of zygomatic arch, Frontozygomatic suture, Sphenoparietal, Sutural bones

INTRODUCTION

The word Pterion means 'wing' [1]. This H-shaped suture is generally seen at the floor of temporal fossa covered by fan shape muscle Temporalis [2]. During the study of Norma lateralis of skull, the pterion is an important bony landmark seen as H or K-shaped suture. The pterion denotes the meeting point of four bones of skull. In this point, squamous part of frontal bone, sphenoid angle of parietal bone, squamous part of the temporal bone and greater wing of sphenoid bone meet [2]. In foetal skull, the pterion is a site of anterolateral fontanelle (sphenoidal fontanelle).These are unossified membranous gap present at the angles of parietal bones. The fontanelles provide for the moulding of the foetal head during its passage through the birth canal as well as the rapid growth of the brain during infancy. By the process of membranous ossification, the gap is filled by fibrous tissue generally at three months after birth [3,4].

For the first time, Broca (1875) classified three types of pterion (sphenoparietal, frontotemporal and stellate). In 1956, Murphy expanded the list with another type; the epipteric [5,6]. Murphy reported that variations of the pterion are likely a result of a combination of environmental and genetic factors. Population-based differences suggest that various genetic variations in humans underlie the different sutural patterns of the pterion (Wang et al.) [7]. In the sphenoparietal type, the sphenoid and parietal bones touch directly and form the suture, without the frontal and temporal bones making contact with one another. In the frontotemporal type, the frontal and temporal bones touch directly and form the suture, without the sphenoid and parietal bones making contact with one another. In the stellate type, frontal, parietal, sphenoid and temporal bones connect together at one point. The characteristic of the epipteric type are the presence of Wormian bones or sutural bones between the frontal, parietal, sphenoid and temporal bone [5,6]. The sutural bones are small irregular bones formed by additional ossification centres mostly in the region of fontanelles [2].

In neurosurgery, it is important to have the most suitable bony aperture in order to be minimally invasive. To achieve optimum craniotomy where neuronavigation devices are not available, the surgeon then relies on external landmarks such as pterion. The pterion is an important clinical landmark because deep to pterion there lies the middle meningeal vein, anterior division of middle meningeal artery and stem of lateral sulcus of brain. A strong blow to this region can fracture the bones around the pterion. If the underlying artery is damaged, it results as chief source of extradural haemorrhage. Initially, the injured person may be normal without any signs of underlying trauma (symptoms of unconsciousness) as there is lucid interval phase. So, if prompt diagnosis and treatment does not occur, fatality may happen. This implies that the neurosurgeon must locate the pterion centre precisely as drilling for cerebral decompression surgeries [8,9,10].

For the past decades, a clear tendency to minimally invasive approaches has been observed in surgery of the anterior skull base. Technical development and interdisciplinary co-operation have made it possible to treat even complex pathologies. In this context, for example, improvements of the video-endoscopic displays, the development of special instruments, improvement of imaging, and performing surgeries together in the four-hands technique.

The present study was to be done to provide additional information about the exact location, type and mean distances from centre of pterion upto specific bony landmarks for all surgeons. The results shown epipteric type of pterion as a second most common variety. As this type of pterion can mistakenly be assessed to be at the most anterior junction of bones and a burr hole placed over there may cause inadvertent penetration into the orbit. So to avoid surgical

pitfall, the neurosurgeons kept this finding and will take extra precaution before any surgery at the pterionic region of skull [11].

MATERIALS AND METHODS

It is a cross-sectional study performed in Department of Anatomy, N.S.C.B. Medical College Jabalpur (M.P.) in a duration of three months (two months for data collection and one month for data analysis). The source of data was human skulls in Department of Anatomy at N.S.C.B. Medical College Jabalpur (M.P.). The sample size was based on previous studies, 180 dry human skulls of Indian origin, of unknown age and sex.

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.

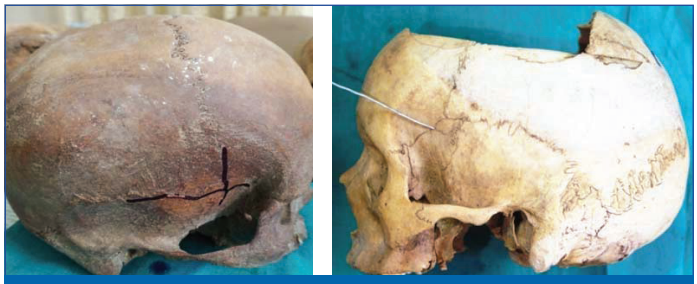
Exclusion criteria: Skulls with bilateral absence of pterion, due to breakage or synostosis.

Type (sutural pattern) of pterion was classified in accordance with Murphy's [6] criteria, into one of four types-sphenoparietal, frontotemporal, stellate or epipteric [Table/Fig-1,2,3,4]. Position of pterion was determined in relation to three specific bony landmarks in the skull. A circle of smallest diameter was drawn which passed through all the four bones converging at the pterion marked as Centre Point (CP). Linear distances were measured from the CP to the following specific bony landmarks [12,13].

Linear distances were measured from the CP to the following specific bony landmarks-P-ZA-from CP of pterion to superior margin of zygomatic arch.

P-FZS-from CP to posterolateral margin of the frontozygomatic suture.

[Table/Fig-1]: Sphenoparietal Type of Pterion.
[Table/Fig-2]: Frontotemporal Type of Pterion. (Images from left to right)



[Table/Fig-3]: Stellate Type of Pterion.
[Table/Fig-4]: Epiperic Type of Pterion. (Images from left to right)

All the above mentioned measurements were made using a digital vernier caliper with least count of 0.01 mm [Table/Fig-5,6].

STATISTICAL ANALYSIS

All parameters were evaluated bilaterally, observations tabulated and analyzed using Statistical Package for the Social Sciences (SPSS) software version 23.0. Student's t-test and p-value was also applied in the analyzed data to make it significant.

RESULTS

The results were analyzed and tabulated. In present study, 180 skulls means total 360 pterion on both right and left sides were studied. Out of 180 skulls, the most common type of pterion was sphenoparietal in 84.18% of skulls with slight more number on left side as compare to right. The second common type was epipteric type, then frontotemporal type and the least was stellate type [Table/Fig-7]. Out of all 180 skull analysed in present study, total 173 skull (96.11%) have same type of pterion on both sides. Only four stellate types and three epipteric type of pterion presented themselves unilaterally and on the other side there was a sphenoparietal type [Table/Fig-8]. The mean distances from the centre of pterion upto the upper end of zygomatic arch and posterolateral margin of frontozygomatic suture were displayed [Table/Fig-9] that shows the distances on left side was slightly greater than the right side on both parameters. If the values of both sides are compared, CP-UZA become statistically insignificant (p-value=0.07). The p-value obtained for CP-FZS (p=0.26) was also statistically insignificant on both sides (p≤0.05 is significant).

[Table/Fig-5]: Measuring the distance from the center of Pterion up to upper end of Zygomatic Arch.
[Table/Fig-6]: Measuring the distance from the center of Pterion up to Posterolateral Margin of Fronto zygomatic Suture. (Images from left to right)

Pterion type	Right (n= 180)	Left (n=180)	Both sides
Sphenoparietal	148 (81.61%)	155 (86.76%)	84.18%
Fronto-temporal	12 (6.61%)	12 (6.61%)	6.61%
Stellate	05 (2.94%)	01(0.73%)	1.83%
Epipteric	15 (8.82%)	12 (5.88%)	7.35%

[Table/Fig-7]: Prevalence of various types of Pterion

Pterion type	Sphe-noparietal left (n)	Fronto-temporal left (n)	Stellate left (n)	Epipteric left (n)	Total (n=180)
Sphenoparietal right	148	00	02	01	151
Fronto-temporal right	00	12	00	00	12
Stellate right	02	00	01	00	03
Epipteric right	02	00	00	12	14

[Table/Fig-8]: Frequency and Distribution of Right and Left side of Pterion

Distance	Right (mean+/-SD)	Left (mean+/-SD)	p-value
CP-UZA (mm)	35.12±4.1mm	36.26±3.88mm	0.07
CP- FZS (mm)	28.84±5.80mm	30.10±4.79mm	0.26

[Table/Fig-9]: Relative position of pterion; CP = central point of pterion. UZA= upper end of zygomatic arch.
FZS: Frontozygomatic suture; p-value (≤0.05 is significant) {Students t-Test}; SD: Standard deviation

DISCUSSION

The morphological and morphometric variations of the pterion have been detected in various populations. Pterion type is subject to evolutionary, ethnic and regional variations. In present study, the sphenoparietal type of pterion was most common variety bilaterally (84.18%) that was an agreement with the past studies done by many Indian anatomists such as Sudha R et al., Hariprashad et al., Natekar PE et al., Dutt V et al., Seema and Mahajan A [14,15,16,17,18]. Current study results also matched with some studies done in foreign countries among their citizens as Australian aborigines by Murphy [6], Nigerian population by Adejuwon SA et al., [12]. Present

study differs from studies done by Mwachaka PM et al., [19] among Kenyan skulls, Saheb SH et al., [20] in Indian skulls [Table/Fig-10] [6,12-22]. This may due to different sample size and some genetic factor. The second commonest type of pterion observed was epipteric type (7.35%). These are small irregular ossicles differ in number may be one, two or three formed due to additional ossification centres at the meeting point of cranial bones. This may serve as a marker for various underlying neurocranial abnormalities. Therefore, it is relevant to surgeons and radiologists to have this essential information before and during surgical intervention [21,22, 23]. The third commonest type is fronto-temporal type of pterion (6.65%). Among previous studies its prevalence varying from 2.4% to 7.5%. The fourth & last type of pterion in the present study was stellate type (1.83%), prevalence ranged from 0.4% to 5.6%.

Study	Type of Pterion				
	Sample size (n)	Sphenopa-rietal (%)	Frontot-ermporal (%)	Stellate (%)	Epipteric (%)
Australian aborigines - Murphy– (1956) [6]	388	73%	7.50%	18.50%	1%
Adejuwon, S. A.,Olopade, F. E. & Bolaji, (2013) [12]	37	86.10%	8.30%	5.60%	Nil
Nigerian - Saxena et al. (1988) [13]	40	87.79%	10.11%	5.06%	3.79%
Sudha R et al., (2013) [14]	150	80%	03%	5.30%	11.30%
Hariprasad et al. (2015) [15]	60	89.20%	3.30%	05%	2.50%
Natekar PE et al., (2016) [16]	150	85.33%	08%	10.60%	51.54%
Dutt V et al., (2017) [17]	78	82.70%	3.20%	2.56%	11.54%
Seema & Anupama Mahajan (2014) [18]	50	89%	07%	04%	12%
Kenyans - Mwachaka PM et al (2009) [19]	79	66%	15%	12%	07%
Hussain SS et al. (2010) [20]	125	69.25%	17.35%	9.70%	3.70%
Japanese Matsumura (1991) [21]	614	79.10%	2.60%	17.70%	0.60%
Manjunath et al. (1993) [22]	172	93.55%	3.52%	2.93%	17.30%
Present Study (2020)	180	84.18%	6.61%	1.83%	7.35%

[Table/Fig-10]: Comparison of present study with the past in according to types of pterion [6,12-22].

Sutures are of great importance for craniofacial growth. The development of calvarial bones is tightly coordinated with the growth of the brain and requires interactions between different tissues within the calvarial sutures [24]. According to Nambi G [25] hypothesis, the pterion suture length is influenced by biomechanical stressors related to mastication [25]. The phylogenetic theory of formation of different types of pterion was given by Ahuja UK et al., [26]. According to this theory, the frontotemporal type of pterion was common in primates and sphenoparietal type was common in human beings. The anterosuperior segment of the squamous part of the temporal bone of the primates may have detached from the parent bone and got incorporated in the posterosuperior angle of the greater wing of sphenoid during phylogenesis, thus changing the pattern from frontotemporal to sphenoparietal type of the pterion. If however the desquestrated portion remained permanantly detached from both of the bones, it becomes the epipteric type.

Present observations among the laterality of pterion, it was clear from [Table/Fig-8] that bilateral same type of pterion of all three types was more common except in stellate variety. The reason behind this was not clear, but it seems to be correlate with the ethnicity, age, genetic factor and could be due to the different sample sizes used in the studies. This is an agreement with the findings among Indians Saxena RC et al., [27] but differs with that among Turks, where the occurrence of a different combination of pterion found on the left and right sides Oguz O et al., [28]. The mean distance from centre of pterion upto upper end of zygomatic arch and posterolateral margin of frontozygomatic suture were respectively 35.12±4.1 mm and 28.84±5.80 mm on right side. On the left side, the result was 36.26±3.88 mm and 30.10±4.79 mm. The findings was also an agreement with previous studies done about mean distances that ranges between 35-45 mm in case of CP-UZA and 25-35mm in respect to CP-FZS [Table/Fig-11] [15,17,18,20,29].

Study populations	Sample size (n)	Distances in mm			
		From FZS to CP		From UZA to CP	
		Right	Left	Right	Left
Zalawadia et al., (2010) [29]	42	37.3±0.51	35.5±0.42	31.2±0.44	29.7±0.33
Hussain S S et al., (2010) [20]	125	34.7±0.48	34.0±0.45	39.0±0.35	37.8±0.35
Seema and Mahajan et al., (2014) [18]	50	31.0±0.44	34.0±0.40	41.0±0.45	44.0±0.32
Hariprasad et al., (2015) [15]	50	32.0±0.39	31.1±0.40	37.1±0.39	36.8±0.35
Dutt V et al., (2017) [17]	78	29.35±3.60	27.37±5.80	38.15±3.67	36.69±3.64
Present study (2020)	180	28.84±5.80	30.10±4.79	35.12±4.1	36.26±3.88

[Table/Fig-11]: Comparison of present study with the past in according to Relative position of pterion [15,17,18,20,29].
CP: Central point of pterion; UZA: Upper end of zygomatic arch; FZS: Frontozygomatic suture

Limitation(s)

The study do not have a record about the male and female skulls.

CONCLUSION

The results on the variations of pterion, its prevalence, mean distances from standard anatomical points was more consistent with previous studies. Sphenoparietal type was most common on both sides. Previous studies and present study have different observation for second and third most common type of pterion. The study also concluded that the pterion types on both sides of skulls were same in most of the samples. But it was not a rule in all cases. The knowledge of the sutural morphology of the pterion with the obliteration of it, as well as the verification of the distance with a cranial anatomical point offer a great support in the clinical and forensic field. The present information may be applicable with other commonly used method like radiological analysis for better prediction of different type of sutural morphology.

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