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Original Research Article

MORPHOMETRIC ANALYSIS OF PTERION IN ADULT HUMAN DRY SKULL OF GUJARAT REGION

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ABSTRACT

Background: Pterion is an area present on anterior part of floor of temporal fossa, formed by four bones frontal, parietal, squamous temporal and greater wing of sphenoid joined each other and form 'H' shaped suture. There are important neurovascular structure lies beneath the pterion. It is weakest area of skull, as the bones here are very thin so it is more prone to fracture by traumatic blow over it or by indirect blow from top or back of head. Pterion is an important extracranial landmark for lateral or pterional approaches in various neurosurgical procedures.

Objectives: The aim of this study was to observe various types of pterion and to determine exact location of pterion from various bony landmarks like Frontozygomatic suture and zygomatic arch.

Materials and methods: The present study was carried out on 326 adult human dry skulls collected from various medical colleges of Gujarat. The lateral side of skull was visually assessed for the various types of pterion as per Murphy's classification. The measurements were carried out from center of pterion to superior edges of midpoint zygomatic arch (PMPZ) and from center of pterion to posterolateral aspect of frontozygomatic suture (PFZS). Measurements were taken using a digital vernier caliper.

Results: We found all four types of pterion in our study. The most common type of pterion is Sphenoparietal 523 (80.21%), followed by Epipteric 71 (10.89%), Frontotemporal 34 (5.22%) and Stellate 24 (3.68%). The mean distance of PMPZ was 36.85 ± 3.61 mm and PFZS was 29.69 ± 3.91. The Mean & SD of PMPZ & PFZS on right side was little more as compared to left side.

Conclusion: The knowledge of various types of the pterion and exact location of center of pterion from various bony landmarks are important not only to anatomist but also important for neurosurgeon for pterional approaches in various neurovascular surgery, for radiologist to accurate interpretation of radiograph, CT & MRI of skull and for anthropologist to racial comparison.

KEY WORDS: Pterion, Skull, zygomatic arch, Frontozygomatic suture.

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INTRODUCTION

The anterior part of floor of temporal fossa is formed by four bones, namely frontal, parietal, greater wing of sphenoid and squamous temporal bone. All four bones are joined with each other and forms a roughly H-shaped sutural junction termed as pterion [1,2,3,4].

Clinically the center of Pterion is an important anthropometric bony landmark as it commonly overlies on anterior branch of the middle meningeal artery, the middle meningeal vein and the stem of lateral sulcus of cerebral hemisphere (sylvian point) [1-6]. Other structure related to pterion are Broca's area 44, 45, anterior pole of insula, middle cerebral artery [7]. The Pterion situated within 1 cm diameter circle centered approximately 2.6 cm posterior and 1.3 cm superior to the posterolateral margin of Frontozygomatic suture [1, 6]. Various authors report the distance of center of pterion to Frontozygomatic suture, which ranges from 2.5 cm to 3.5 cm [3, 4].

The pterion is located approximately 4 cm above the midpoint of zygomatic arch [1-4,8]. Pterion is weakest area of skull as the bones here are very thin, so it is more prone to fracture by traumatic blow over it leads to rupture of middle meningeal vessels beneath it and form extradural hematoma, which may exert pressure on underlying motor area in the precentral gyrus of cerebral cortex. To stop the hemorrhage, the torn artery or vein must be ligated or plugged. The burr hole through the skull wall should be placed about 1 to 1.5 inch (2.5 to 4 cm) above the midpoint of the zygomatic arch [1,2,5,]. There are four types of pterion classified by Murphy; (1) Sphenoparietal type: Sphenoid and parietal bone are in direct contact, (2) Fronto-temporal type: Frontal & squamous temporal bones are in direct contact, (3) Stellate type: All four bones articulate with each other at one point, (4) Epipteric type: There are small sutural bone are present between this four bones **(Figure-1)** [9]. The knowledge of center of pterion and its relation with middle meningeal artery surface anatomy is important for accurate positioning of burr-holes to evacuate extradural hematoma and reduce cerebral compression. Morphometric analysis of the Pterion of dry human skulls in Gujarat region was carried out to demonstrate the anatomical variations in morphology.

MATERIALS AND METHODS

With prior permission taken from head of anatomy department of various medical colleges of Gujarat, we conducted the study on 652 Pterion of completely ossified 326 adult human dry skulls of unknown age and sex. The skulls were accepted as adults according to tooth eruption. Any skulls showed signs of congenital anomalies, obliterated suture due to cranio-synostosis, prior cranial surgery, damaged, with any pathological condition were excluded. The Skulls were macroscopically examined on both right and left side of Norma Lateralis of skull for different types of Pterion and noted as Sphenoparietal, Frontotemporal, Stellate and Epipteric, as per Murphy's classification (Figure-1) [9]**.** In this study we have measured the distance between center of pterion to superior edges of midpoint of zygomatic arch (PMPZ) and Center of pterion to posterolateral aspect of Fronto-zygomatic suture (PFZS) (Figure-2). The measurements were taken on both sides of skull by using digital vernier caliper with an accuracy of 0.01 mm. The measurements were taken with due care to ensure accurate measurements. The statistical analysis was done using Epi Info software ver. 7.2.2.1.

OBSERVATIONS

In present study we found all four types of pterion. The most common type of pterion is Sphenoparietal 523 (80.21%), followed by Epipteric 71 (10.89%), Frontotemporal 34 (5.22%), and Stellate 24 (3.68%). We found 273 (83.74%) skulls showing similar types of pterion on both side, out of which 238 (73.00%) skulls have Sphenoparietal type and 19 (5.83%) skulls have Epipteric type of pterion. We found 53 (16.26%) skulls showing different types of pterion on both side, out of this 17 (5.21%) skull have right side Sphenoparietal and left side Epipteric type of pterion. In 11 (3.37%) skull have right side Epipteric and left side Sphenoparietal type of pterion seen (Table-1 & 2). So combinations of Sphenoparietal and Epipteric type of pterion were common.

The mean PMPZ is 36.85 ± 3.61 mm with range from 27.26 mm to 52.78 mm and the mean PFZS is 29.69 ± 3.91 mm with range from 19.50 mm to 43.72 mm**.** On the right side mean PMPZ is 37.36 ± 3.62 mm with range from 27.26 mm to 52.78 mm and mean PFZS is 30.17 ± 3.91 mm with range from 19.58 mm to 43.72 mm. On left side mean PMPZ is 36.34 ± 3.54 mm with range

Table 1: Various types of Pterion on Right, Left and both side of skull.

Types of pterion	Right side (N=326)	Left side (N=326)	Both side (N=273)	Total pterion (RT+LT) (N=652)
Spheno-Parietal	266 (81.59%)	257 (78.83%)	238 (73.00%)	523 (80.21%)
Epipteric	32 (9.82%)	39 (11.96%)	19 (5.83%)	71 (10.89%)
Fronto-Temporal	16 (4.91%)	18 (5.52%)	09 (2.76%)	34 (5.22%)
Stellate	12 (3.68%)	12 (3.68%)	07 (2.15%)	24 (3.68%)
TOTAL	326 (100%)	326 (100%)	**273 (83.74 %)**	**652 (100%)**

Table 2: Different types of Pterion on either side of skull (N=53).

Types of Pterion on Right side	Types of Pterion on Left side	Total Number of Skull 53 (16.26 %)
Right - Sphenoparietal	Left - Epipteric	17 (5.21%)
	Left - Frontotemporal	07 (2.15%)
	Left - Stellate	04 (1.23%)
Right - Epipteric	Left - Sphenoparietal	11 (3.37%)
	Left - Frontotemporal	02 (0.61%)
	Left - Stellate	00 ----
Right - Frontotemporal	Left - Sphenoparietal	04 (1.23%)
	Left - Epipteric	02 (0.61%)
	Left - Stellate	01 (0.31%)
Right - Stellate	Left - Sphenoparietal	04 (1.23%)
	Left - Epipteric	01 (0.31%)
	Left - Frontotemporal	00 -----

Table 3: PMPZ and PFZS of Right, Left and Total pterion.

Distance	Right (N=326)	Left (N=326)	Total (N=652)
PMPZ	37.36±3.62	36.34±3.54	36.85±3.61
PFZS	30.17±3.91	29.23±3.85	29.69±3.91

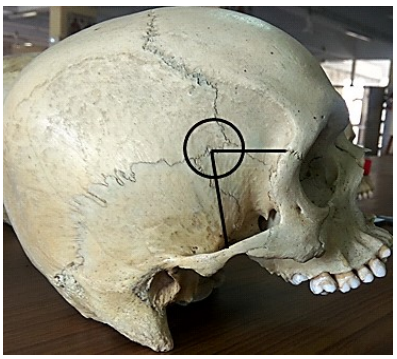
Table 4: PMPZ and PFZS of various types of pterion.

Types of Pterion	Spheno-parietal (N=523)	Epipteric (N=71)	Fronto temporal (N=34)	Stellate (N=24)
PMPZ	37.18±3.68	35.17±3.18	35.44±2.29	36.58±3.2
PFZS	30.05±3.83	29.0±3.37	26.20±4.51	29.03±3.69

Fig. 1: Various types of Pterion.

SPHENOPARIETAL (SP) FRONTOTEMPORAL (FT) EPIPTERIC (E) STELLATE (S)

Fig. 2: Measurements of PMPZ & PFZS.



from 27.26 mm to 46.95 mm and mean PFZS is 29.23 ± 3.85 mm with range from 19.50 mm to 40.90 mm (Table-3). The distance were a little more over right side as compared to left side of skull. When we analyzed The Mean & SD of PMPZ & PFZS of various types of pterion, the Sphenoparietal types of pterion has highest PMPZ 37.18±3.68 mm & PFZS 30.05±3.83 while Frontotemporal pterion has lowest PMPZ 35.44±2.29 mm & PFZS 26.20±4.51 mm (Tab-4).

Table 5: Comparison of percentages of types of pterion in different populations.

Author	Population	Sample size (N)	Spheno Parietal	Epipteric	Fronto temporal	Stellate
Present study	Gujarat, India	326	80.21	10.89	5.22	3.68
Ma S et al [6]	India	76	78.3	16.4	5.2	-
Warille AA et al [10]	Jhansi UP	71	80.3	7	5.6	7
Modasiya U P[11]	North Gujarat	110	80.9	8.18	-	10.9
Walulkar S et al[12]	Maharashtra	350	82.2	5	9	3.7
Charulata S.[13]	Maharashtra	85	82.94	7.05	2.94	5.29
Vivaan dutt et al[14]	Karnataka	78	82.7	11.54	3.2	2.56
Manjunath H et al[15]	South India	282	80.53	2.62	13.62	3.09
R. Sudha [16]	South India	150	80	11.3	3	5.3
Kalthur S G et al[17]	South India	50	78	17	4	1
K.E.Vikram rao[18]	Telangana	70	80	9.28	3.57	7.14
Anjana.S[19]	South kannad	32	82.8	9.4	3.1	4.7
Saxena SK et al[20]	Indian	72	95.3	-	3.46	1.38
Saxena RC et al[21]	Lucknow UP	203	84.72	-	10.01	5.17
Zalawadia et al[22]	Gujarat	42	91.7	4.8	2.4	1.2
Khatri CR et al[23]	Gujarat	311	96.9	-	2.9	0.2
Hari Prasad et al [24]	North India	60	89.2	2.5	3.3	5
Suchit K et al [25]	Uttarakhand	40	86.25	--	11.25	2.5
Nayak G et al[26]	Odisha	50	85	10	0	5
Wadekar PR et al[27]	Maharashtra	55	74.54	14.54	7.27	3.63
Vasudha TK et al[28]	Karnataka	150	69.33	14	5.67	11
Gindha G S[29]	North India	65	72.31	23.08	4.61	0
Ukoha U et al [8]	Nigeria	56	75.5	3.6	19.6	1.8
Murphy T [9]	Australian	388	73	18.5	7.5	1
Mwachaka P [30]	Kenyan	79	66	12	15	7
Alper Sindel [31]	Turkey	150	63	16	2	19
Lee et al[32]	Korean	149	76.5	40.3	0	0
Matsumura et al[33]	Japanese	614	79.1	0.6	2.6	17.7
Wandee A et al[34]	Thailand	268	81.2	17.4	1.1	0.4
Asala et al[35]	Nigerian	212	82.1	5.7	23.6	0
Eboh D.E.O et al[36]	Nigerians	50	83	6	5	6
Saxena S.K et al [20]	Nigerian,	40	84.79	-	10.11	5.06
Ruiz C R[37]	Brazil	55	90	3.64	4.54	1.82
Oguz O et al [38]	Turkish	26	88	2	10	0
Ersoy [39]	Turkey	300	87.35	0.2	3.47	8.98
Adejuwon SA et al [40]	Nigerian	37	86.1	-	8.3	5.6

Table 6: Comparison of PMPZ and PFZS in different populations (IN MM).

Authors	Population	Sample (N)	PMPZ (RT)	PMPZ (LT)	PFZS (RT)	PFZS (LT)
Present study	Gujarat	326	37.36±3.62	36.34±3.54	30.17±3.91	29.23±3.85
Siyan Ma et al [6]	India	76	34 ± 4	34 ± 4	26 ± 4	25 ± 4
Ukoha U et al [8]	Nigeria	56	40.2 ± 0.5	40.1± 0.3	27.4 ± 0.7	27.4 ± 0.6
Warille AA [10]	Jhansi UP	71	36.2 3.5	36.7 3.5	31.9 3.8	32.0 4.1
Walulkar S [12]	Maharashtra	350	40.1±0.5	39.2±0.3	27.2±0.6	27.0±0.5
Vivaan dutt [14]	Karnataka	78	38.15±3.67	36.69±3.64	29.35±3.60	27.37±5.80
Kalthur S G [17]	South India	50	40.5 4.3	39.0 3.6	33.2 5.0	32.3 5.3
Vikram Rao [18]	Telangana	70	37.74±3.66	37.07±4.19	30.48±4.06	30.39±4.7
Anjana.S [19]	Southern India	32	40.0±5.0	40.0±2.0	30.0±4.0	29.0±2.0
Zalawadia A [22]	Western India	42	31.2±4.4	29.7±3.3	37.3±5.1	35.5±4.2
Hari Prasad [24]	North India	60	37.1 3.9	36.8 3.5	32.0 3.9	31.1 4.0
Suchit K [25]	Uttarakhand	40	37.7 ± 3.5	36.9 ± 3.0	35.0 ± 4.4	34.1 ± 4.8
Nayak G [26]	Odisha	50	40.1±1.9	39.4±2.0	34.8±2.1	34.1±1.6
Wadekar PR [27]	Maharashtra	55	36.63	37.12	32.27	31.86
Gindha GS [29]	North India	65	39.00±2.56	37.00±3.35	38.71±3.10	36.29±3.73
Mwachaka P [30]	Kenyan	50	38.88±3.49	38.24 ±3.47	30.35±3.4	30.34±4.30
Alper Sindel [31]	Turkey	150	39.8		34	
Lee et al [32]	Korean	149	36.9 ± 3.8		26.8 ± 4.5	
Wandee A [34]	Thailand	268	38.48 ± 4.38		31.12 ± 4.89	
Eboh DEO [36]	Nigerian	50	40.22±2.98	39.52±3.32	32.06±2.62	31.08±2.24
Oguz Ozkan [38]	Turkish	26	40.5±3.9	38.5±2.5	33.0±4.0	34.4±3.9
Adejuwon SA [40]	Nigerian	37	39.1±0.58	38.77±0.63	31.52±0.68	30.82±0.81

Sphenoparietal type of pterion is commonest type of pterion observed by various authors among different population of India and world. The incidence of various types of pterion observed in the present study is compared with the previous studies in Table 5. In present study Sphenoparietal (SP) type of pterion (80.21%) is commonest type of pterion. Our findings of various types of pterion are almost similar to the findings of Charulata S. [13], Vivaan dutt et al [14], R. Sudha [16], K.E.Vikram rao [18], Anjana.S [19]. Predominance of Sphenoparietal type of pterion was observed by Saxena SK et al [20], Khatri CR et al [23], Zalawadia et al [22], Oguz O et al [38], and Ersoy [39]. Study done by Mwachaka P [30], Alper Sindel [31] was found Lowest percentages of Sphenoparietal type of pterion as compared to our study. In present study second most common type of pterion is Epipteric (E) (10.89%). Ma S et al [6], Kalthur S G et al[17], Wadekar PR et al[27], Gindha G S[29] in Indian population and Murphy T [9] in Australian population, Lee et al[32] in Korean population, Wandee et al [34] in Thai population found higher incident of Epipteric type of pterion compared to present study. While study done by Walulkar S et al [12], Manjunath H et al [15], Zalawadia A [22] Hari Prasad [24] in Indian population and Ukoha U et al [8] & Asala [35] in Nigerian population, Matsumura G [33] in Japanese population, Ruiz C R [37] in Brazilian population, Oguz O et al [38], & Ersoy [39] in Turkish population found lowest incidence of Epipteric bone as compared to our study. In present study Third commonest type of pterion is Frontotemporal (FT) (5.22%). Manjunath H [15], Saxena RC [21], Suchit K [25] in Indian population and Ukoha U [8], Saxena S.K [20], Asala [35], Adejuwon SA [40] in Nigerian population, Mwachaka P [30] in Kenyan population found higher incidence of FT type of pterion as compared to our findings.

In present study Fourth, Least type of pterion is Stellate (S) (3.68%). Modasiya UP [11], K.E.Vikram rao [18], Vasudha TK [28], in Indian population and Alper Sindel [31],Ersoy [39] in Turkish, Matsumura G [33] in Japanese population found higher incidence of Stellate type of pterion.

In present study the PMPZ is 37.36 ± 3.62 mm on Right & 36.34 ±3.54 on left side were compared with the previous studies in table-6. Our findings of PMPZ were corresponding with findings of Warille AA [10], Vivaan dutt [14], Vikram Rao [18], Hari Prasad [24], Suchit K [25], Wadekar PR [27], Lee et al [32]. While study done by Anjana.S [19], Kalthur S G [17], Nayak G [26], Ukoha U[8], Eboh DEO [36], Adejuwon SA [40] in Nigerian population, Oguz O [38], Alper Sindel [31] in turkish population have reported higher PMPZ and Siyan Ma [6], Zalawadia A [22] have reported lower PMPZ than our findings. In present study the mean PFZS is 30.17±3.91 on right and 29.23 ± 3.85 mm on left side. Our finding are similar with finding of Vivaan dutt [14], Vikram Rao [18], Anjana.S [19], Mwachaka P[30], While study done by Siyan Ma [6], Ukoha U [8],Walulkar S [12], Lee et al [32],have reported lower PFZS and Zalawadia A [22], Nayak G [26], Gindha G S [29], Oguz O [38], Suchit K [25], Alper Sindel [31] have reported higher PFZS as compared to our study. As the pterion is an important surface bony landmark used by neurosurgeon, presence of Epipteric bone in this region may leads to difficulties in surgical procedure. In Epipteric type of pterion if Centre of pterion mistakenly accessed at the anterior most junction of bones and burr hole in this region may cause inadvertent orbital penetration. The data of present study was compared with the data reported by other authors of India and World; we observed that there are so many variations in types of pterion and location of center pterion from various bony landmarks in different population and different region.

CONCLUSION

Sphenoparietal (80.21%) type of pterion is commonest type of pterion, Mean PMPZ and PFZS was 36.85±3.61 mm and 29.69±3.85 mm respectively. As there are so many variation in types and location of center of pterion in different population among India and world, the knowledge of various types of pterion and exact location of center of pterion from various bony landmarks are important for neurosurgeon in pterional approaches of various neurosurgical procedures to approaches various neurovascular structure lies beneath it. The knowledge

of various types of pterion is important for radiologist & neurosurgeon as in Epipteric type of pterion there are one or more small sutural bone is present, it may leads to confusion as fracture of skull and it may produce difficulty for surgical orientation. This study provides information about morphology and Morphometry of pterion is important not only to anatomist but also important for forensic expert, anthropologist and radiologist.

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ABBREVIATION

PMPZ- Distance from center of pterion to upper edges of midpoint of zygomatic arch.

PFZS- Distance from center of pterion to posterolateral aspect of frontozygomatic suture.

Conflicts of Interests: None

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