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Original Research Article

Pterion morphology and implications in neurosurgery

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Abstract

Background: The pterion, a key anatomical landmark, is the junction of four cranial bones: frontal, zygomatic, temporal, and sphenoid over the temporal fossa.
Aim & Objective: Analysis of variations in its morphology of the Pterion and its implications in neurosurgery.
Materials and Methods: This study was conducted on 80 human skulls, aimed to analyse pterion types and their incidence. Four parameters were measured precisely from various landmarks, bilaterally, using vernier callipers.
Results: Statistical analysis revealed sphenoparietal pterion as the most common (75.625%), followed by epipteric (15.625%) and stellate (8.75%), with no frontotemporal occurrences. The analysis showed SP-SP as the most frequent (68.75%). Mean distances from pterion to surrounding landmarks were recorded.
Conclusions: A study on 80 skulls were done and analysed and we came to the conclusion that the most prevalent among the 4 types of Pterion was sphenoparietal followed by epipteric, stellate and with no incidence of frontotemporal skulls. On the right side ,the mean distances of the Pterion from the frontozygomatic suture is 34.8655 ± 4.3402, from the highest point of zygomatic arch 52.5855±5.5418 and from the temporozygomatic suture 43.2237±4.2059 and from anteriormost point from external acoustic meatus 53.1221±3.8553.On the left side ,the mean distances of the Pterion from the frontozygomatic suture is 34.6915±4.7049, from the highest point of zygomatic arch 54.4586±4.1748 and from the temporozygomatic suture 43.2994±4.3303and from anteriormost point from external acoustic meatus 52.8978±3.7135.

Keywords: Pterion, Neurosurgery, Cranial bones, Anatomical landmark, Statistical analysis.

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1. Introduction

Pterion: (origin-Pterion) (Greek word for wing). [Greek mythology- Hermes, messenger of God was enabled to fly by wings attached at the pterion]. Pterion is formed at the temporal Fossa of the skull, with the contribution of thegreater wing of sphenoid, frontal bone, parietal bone, squamous part of Temporal bone. The 4 bones meet to form a 'H' shaped junction of sutures termed as pterion.[1] There are variations noticed in the pattern of conjunction of the constituent bones. Pterion is covered superficially by the scalp and the origin of temporalis muscle, and deep to pterion, lies various anatomical structures such as the anterior division of middle meningeal artery, Broca's speech area and lateral sutures of brain.[2] It is located around 3-3.5cm behind the (FZS) and 1-1.5cm above it. With respect to Surface Anatomy, Pterion is located about 2 fingers superior to the zygomatic arch.[16]

1.1. Clinical significance

It serves as an important anatomical and surgical landmark

1. Since the pterion overlies the anterior division of the middle meningeal artery, it helps in locating the artery precisely for drainage of hematoma.[3]
2. Pterion is the thinnest part of the skull/ weakest part of the skull, subjected to fracture on any traumatic blow, which would result in rupture of the middle meningeal artery.[18]
3. In Neurosurgical point of view, the exact location will help the surgeons to locate various significant underlying structures, and their approach in a minimally invasive manner. It also serves as landmark to cranial fossa - anterior, middle.

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This helps to approach various tumours and aneurysms like Berry aneurysms.56,18

1.2. Pterional approach

Introduced by Yasargil, in 1970, is the most widely used approach in neurosurgery.[19]

This is indicated in most of the anterior circulation aneurysm, median and paramedian aneurysm, AV malformations cavernous hemangioma.

1.3. Pterional keyhole craniotomy approach

Newer approach which enables the removal of much pathology by reducing the surgical morbidity. It reduces operative time and has better surgical and cosmetic outcomes.
(iv) Forensic scientists used pterion to determine the age of skeletal remains.[2-3]
(v) Access to optic canal, sphenoid ridge.

2. Materials and Methods

The study was conducted on 80 dry human skulls collected from Kempegowda Institute of Medical Science (KIMS), Bangalore and Bangalore Medical College and Research Institute (BMCRI), collected from the department of anatomy and th department of forensic medicine and toxicology. The parameters were recorded from pterions of both the sides of the skull.

2.1. Inclusion criteria

Undamaged adult skulls with visible pterion and required landmarks.

2.2. Exclusion criteria

Paediatric skulls, damaged skulls, fractured skulls, skulls with advanced synostosis where the parameters could not be measured.

2.3. Parameters studied

2.3.1. Types of pterion

The pterion was observed and analysed to note the type as per Murphy's classification.

Murphy's classification was used to classify the pterion into four types on the basis of bone articulation-sphenoparietal, frontotemporal, stellate, and epipteric as per (**Figure 1).**

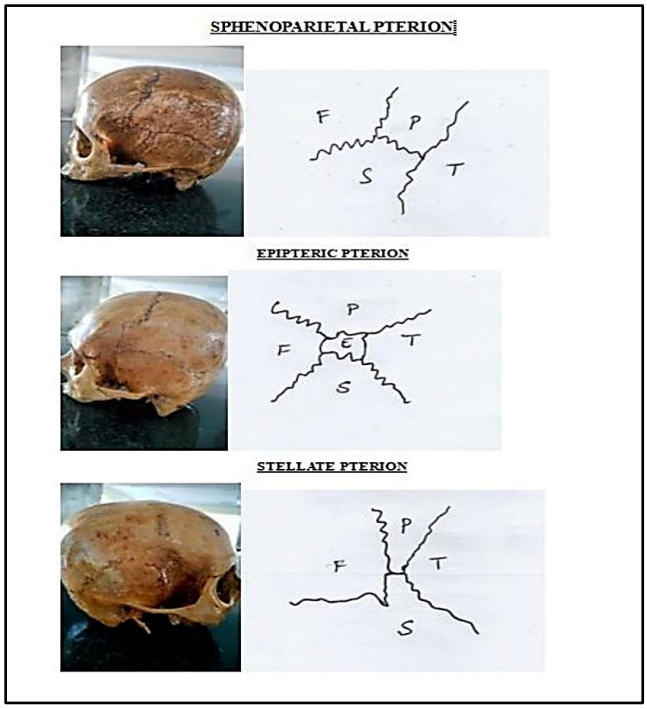

Figure 1: Four types on the basis of bone articulation-sphenoparietal, frontotemporal, stellate, and epipteric

2.3.2. Morphometric classification

There are 4 parameters recorded from both sides of the skull, with a vernier calliper to the precision of 0.01mm, which are:

1. Distance from the centre of the pterion to the middle of the frontozygomatic suture (PF).
2. Distance from the centre of the pterion to the middle of the zygomatic arch (PZ).
3. Distance from the centre of the pterion to the middle of the temporozygomatic suture (PT).
4. Distance from the centre of the pterion to the anterior most point of external acoustic meatus (PE).

This is depicted in (**Figure 2)**

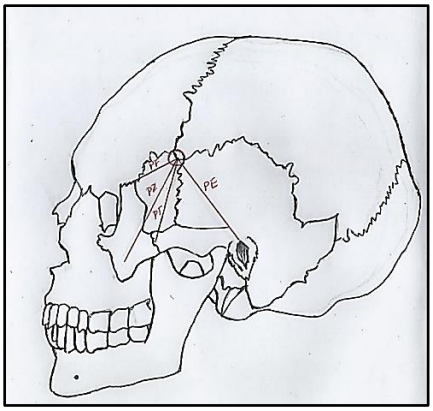

Figure 2: 4 parameters recorded from both sides of the skull

2.4. Statistical analysis

The data was recorded, tabulated and analysed using MS Excel version 2021, the mean, median and standard deviation were derived.

3. Results

The study was conducted on 80 human skulls on both sides with a sample size of 160.

Type of pterion: Four types of pterion were observed based on Murphy Classification and their incidence were tabulated as (**Table 1**).

The below graph depicts the variation of 4 parameters under study (PF,PZ,PT,PE). The X axis depicts the variation on individual skulls with a total of 80 skulls studied and the Y axis depicts the distance of each parameter from pterion **(Figure 3).**

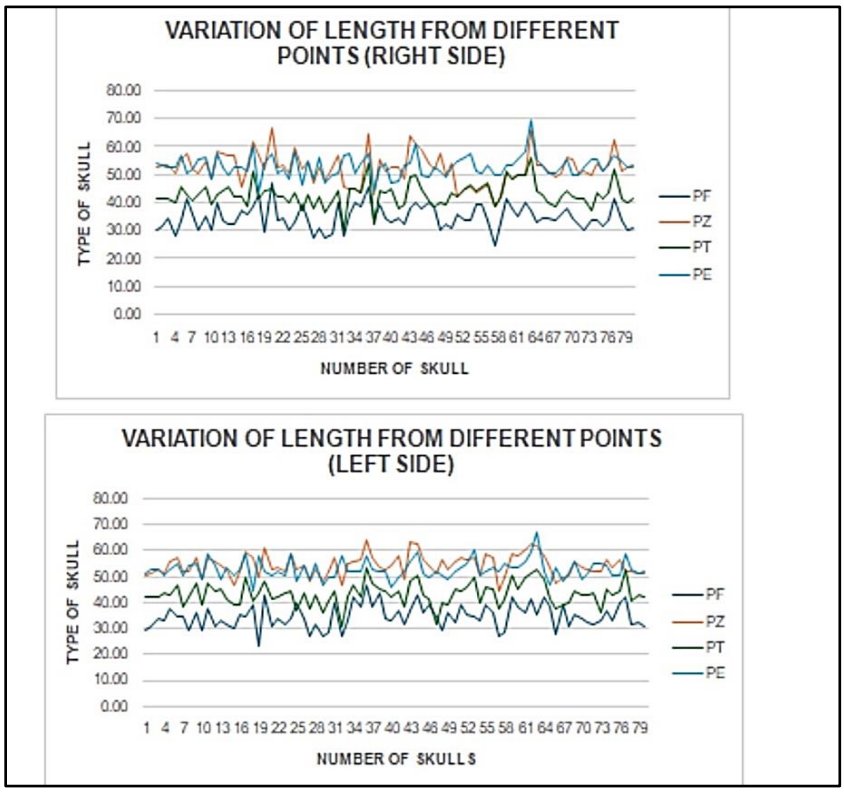

Figure 3: Variation of 4 parameters under study (PF,PZ,PT,PE).

Table 1: Incidence of various types of pterion based on murphy classification

Type of pterion	Right	Incidence	Left	Incidence
Sphenoparietal	60	75%	61	76.25%
Epipteric	13	16.25%	12	15.00%
Stellate	7	8.75%	7	8.75%
Frontotemporal	-	-	-	-

Table 2: Frequency of different combinations of pterions in the skulls studied

Combination	Frequency	Incidence
SP SP	55	68.75%
SP STE	6	7.50%
EPI SP	5	6.25%
EPI EPI	9	11.25%
STE STE	3	3.75%
STE EPI	2	2.50%

Table 3: Mean, median and standard deviations in morphometry (PF, PZ, PT, PE) of left and right side pterion respectively

Side	Left				Right			
Statistics	**PF**	**PZ**	**PT**	**PE**	**PF**	**PZ**	**PT**	**PE**
Mean	34.6915	54.4586	43.2994	52.8978	34.8655	52.5855	43.2237	53.1221
Median	34.28	53.83	43.09	52.18	34.13	52.64	42.85	53.00
Standard deviation	4.7049	4.1748	4.3303	3.7135	4.3402	5.5418	4.2059	3.8553

The proof of the graph is enclosed separately.

After careful measurement and tabulated analysis, it was concluded that sphenoparietal is the most common variety with an incidence of 60 out of 80 pterions on the right side (75%) and 61 out of 80 pterions on the left side (76.25%).

Epipteric is the second most common variety with an incidence of 13 out of 80 pterions on right side (16.25%) and 12out of 80 pterions on the left side (15.00%). Stellate has an incidence of 7 out of 80 pterions on the right and the left sides (8.75%). Frontotemporal pterion was not found.

Frequency of different combinations of pterions in the skulls studied are shown in (**Table 2**).

3.1. Morphometric measurements

The measurements which were taken and studied were from four points from pterion which are front zygomatic suture (PF), middle of zygomatic arch (PZ), temporozygomatic suture (PT) and external acoustic meatus (PE).

The mean, median, and standard deviation of the morphometric measurement (PF, PZ, PT, and PE) of different skulls were as follows (**Table 3**).

4. Discussion

The formation of pterion is governed by various genetic and environmental factors. MSX 2 gene is responsible of the formation and type of pterion.[2] The mutation of this gene is held responsible for skulls deformities. Sphenoparietal variety is the most common type of pterion in humans, this is due to the evolutionary basis. Brain development also has profound influence on these formation.

According to the study conducted on 80 dry human skulls, sphenoparietal is the most common variety of pterion with an incidence of 75.625% followed by epipteric with an incidence of 15.625% followed by stellate with an incidence of 8.75%.Frontotemporal skulls were not found.Similar findings were reported in the study conducted by Nayak et al [6],Prabha et al[7],Prashanth et al[8],Vasudha et al[17] and Roy et al[2] while the other studies had a variation in one or more parameters. All the studies unanimously showed Sphenopari et al as the most common pterion presentation. The other three parameters had variations in the incidence as mentioned below.

The second most common presentation in our study is Epipteric (15.625%) and similar results were reported in India Nayak et al(10%),Prabha et al (14%), Prashanth et al (51.4%), Vasudha TK(14%),Roy et al (25%), Zalawadia et al (3.8%), Saxena (11.79%), Dr Vivian Dutta (11.54%),Sharma et al(23.80%).International Muche et al (13.3%), Aksu et al (8.2%), Lucena JD et al (8.16%).

The third most common presentation in our study is Stellate (8.75%) and similar results have been reported in India Nayak et al(5%), Prabha et al(9%), Prashanth et al(10.6%), Vasudha TK (11%),Roy et al(5%),International Muche et al(2.2%), Aksu et al(5.5%), Lucena JD et al(3.06%). The least common presentation in our study is Frontotemporal (0) and similar results have been reported in India Nayak et al (0), Prabha et al (3%), Prashanth et al(8%), Vasudha TK (5.67%),Roy et al (0), International Muche et al (0), Aksu et al (1.1%), Lucena JD et al (3.06%).

Comparison of different types of Pterion in various studies. (**Table 4)**

Table 4: Comparison of different types of pterion in various studies

Author	Place of study	Number of skulls	Sphenoparietal (%)	Epipteric (%)	Stellate (%)	Frontotemporal (%)
Nayak et al[57]	Bhubaneswar	80	85	10	5	-
Prabha et al[7]	South India	50	74	14	9	3
Prashanth et al[8]	Goa	150	85.33	51.4	10.6	8
Vasudha TK[17]	Karnataka	150	69.33	14	11	5.67
Dr Suchit Kumar[16]	Uttarakhand	40	86.25	-	2.5	11.25
Roy et al[2]	North Bengal	240	70	25	5	-
Zalawadia et al[5]	Gujarat	42	91.7	3.8	1.2	2.4
Saxena et al[15]	Indian	72	95.3	11.79	1.38	3.46
Saxena et al[14]	North Indian	203	87.72	-	5.17	10.10
Umesh P Modasiya et al[9]	Gujarat	110	80.9	8.18	10.9	-
Dr Vivian Dutta[10]	Bangalore	78	82.70	11.54	2.56	3.20
Sharma et al[3]	Uttarakhand	40	72.50	23.80	-	3.80

Present Study	Karnataka	80	75.625	15.625	8.75	-
Murphy et al[1]	Australia	388	73	1	18.50	7.50
Muche A[18]	Ethiopia	90	84.4	13.3	2.2	-
Aksu et al[4]	Turkey	128	85.2	8.2	5.5	1.1
EBOH,D.E.O& OBAROEFF[11]	Nigeria	50	83	6	6	5
Lucena JD et al[12]	Brazil	98	85.71	8.16	3.06	3.06
K Natsis et al[13]	Greece	90	58.4	15.5	25	1.1
Present Study	Karnataka	80	75.625	15.625	8.75	-

Table 5: Comparison of parameters in various studies with the present study

Author	**PF**	**PZ**	**PT**	**PE**
Nayak et al[6]	R:34.8±2.1 L:34.1±1.6	R:40.1±1.9 L:39.4±2.0	-	-
Dr.Suchith Kumar[16]	R:35.00±4.49 L:34.10±4.82	- -	R:37.78±3.58 L:36.94±3.02	- -
Roy et al[2]	R:35.10±6.7 L:34.90±6.3	R:44±4.7 L:44.1±4.0	R:45±4.7 L:43.9±5.0	R:57.5±3.5 L:53.6±3.4
Zalawadia et al[5]	R:37.30 5.1 L:35.5 4.2	R:31.20 4.4 L:29.70 3.3	-	-
Dr Vivian Dutta[10]	R:29.35±3.60 L:27.37±5.80	R:38.15±3.67 L:36.69±3.64	-	-
Sharma et al[3]	R:30.42±5.89 L:28.69±5.91	R:37.69±5.01 L:36.16±4.82	- -	R:52.82±3.26 L:52.48±3.83
Present study	R:34.8655 L:34.6915	R:52.5855 L:54.4586	R:43.2237 L:43.2994	R:53.1221 L:52.8978
Aksu et al[4]	-	R:40.02		
EBOH,D.E.O& Obaroeff[11]	R:32.06±2.62 L:31.08±2.24	- -	- -	- -
Lucena JD et al[12]	Male – R:35.06±6.33 L:34.89±4.63 Female – R:34.58±6.20 L:32.89±6.93	-	-	Male – R:58.09±3.17 L:58.70±3.59 Female – R:56.06±4.17 L:57.04±3.78
Natsis et al[13]	R:34.7±6.1 L:35.2±6.5	- -	R:41.3±4.5 L:40.9±4.7	- -
Present study	R:34.8655 L:34.6915	R:52.5855 L:54.4586	R:43.2237 L:43.2994	R:53.1221 L:52.8978

Another parameter under study was with respect to the distances of pterion with respect to 4 different points i.e middle of Frontozygomatic suture (PF), middle of zygomatic arch (PZ), middle of temporozygomatic suture (PT) anteriormost point of external acoustic meatus. The present study had average Distance from the centre of the pterion to the middle of the frontozygomatic suture (PF) to be 34.7785.The following studies had values greater than the present study: India - Dr Suchith Kumar[16] (34.55),Roy et al[2] (35.00) ,Zalawadia et al[5] (36.40), Natsis et al.[13] (34.95) International Lucenda et al[12] (34.296) The following studies have values lesser than the present study, India - Sharma et al[3] (29.56), Dr Vivian[10] (28.36), Nayak at al[6] (34.45), International - Obeh, D O.E & Obaroeff[11] (31.57).

The present study had average distance from the centre of the pterion to the middle of the zygomatic arch (PZ) to be 53.52205 .The following studies had values lesser than the present study: India - Nayak et al[6] (39.75), Roy et al[2] (44.05) , Zalawadia et al[5] (30.35) , Dr. Vivian Dutta[10] (37.42) , Sharma et al[3] (36.925), International - Aksu et al[4] (40.02). There were no studies which reported a higher value. The present study had average distance from the centre of the pterion to the middle of the temporozygomatic suture (PT) to be 43.26155 .The following studies had values greater than the present study: India - Roy et al[2] (44.45). The following studies had values lesser than present study - India - Dr Suchith Kumar[16] (37.36), International[13](41.1).

The present study had average distance from the centre of the pterion to the anterior most point of external acoustic meatus (PE) to be 53.009 .The following studies had values greater than the present study: India - Roy et al.[2] (55.5), International - Lucena JD et al[12] (57.47), The following studies have values lesser than the present study, India - Sharma et al[3] (52.65).

Comparison of parameters in various studies with the present study.**(Table 5)**

5. Conclusion

A study on 80 skulls were done and analysed and we came to the conclusion that the most prevalent among the 4 types of Pterion was sphenoparietal followed by epipteric, stellate and with no incidence of frontotemporal skulls.,

On the right side, the mean distances of the Pterion from the frontozygomatic suture is 34.8655 ± 4.3402, from the highest point of zygomatic arch 52.5855±5.5418 and from the temporozygomatic suture 43.2237±4.2059 and from anterior most point from external acoustic meatus 53.1221±3.8553.

On the left side ,the mean distances of the Pterion from the frontozygomatic suture is 34.6915±4.7049, from the highest point of zygomatic arch 54.4586±4.1748 and from the temporozygomatic suture 43.2994±4.3303and from anteriormost point from external acoustic meatus 52.8978±3.7135.

5.1. Data availability statement

The data regarding the results have been enclosed as a separate document and submitted.

6. Source of Funding

None.

7. Conflict of Interest

None.

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