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Original Research Article

MORPHOLOGY AND MORPHOMETRIC ANALYSIS OF PTERION WITH ITS NEUROSURGICAL IMPLICATIONS IN PTERIONAL APPROACH

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ABSTRACT

Introduction: Pterional approach is a minimally invasive procedure to reach the anterior and middle cranial fossae. Location of the pterion was observed to be race specific, which could be due to genetic or environmental factors affecting the craniometric indices of human skull. The present study aimed to find out the incidence of various sutural patterns of pterion and also to determine the location of pterion which would be of immense benefit while performing pterional approaches in micro neuro surgical procedures on south Indians.

Materials and Methods: The present study was carried out on 140 pterions of 70 dry human adult skulls of unknown sex. The sutural pattern of the pterion was determined on both sides of each skull, based on Murphy's classification. Measurements were taken from the center of pterion to mid point on zygomatic suture, posterolateral aspect of frontozygomatic suture, anterosuperior margin of external auditory meatus and inferior margin of mastoid process.

Results: The incidence of sphenoparietal pattern was predominant with 77.5%, frontotemporal type was 4.16 %, stellate type was 5.83 % and epipteric type was observed to be 12.5%. The average distance from the center of pterion to mid point on zygomatic arch was 37.40±3.92 mm, from the center of pterion to posterolateral aspect of frontozygomatic suture was 30.43±4.36 mm, from the center of pterion to anterosuperior margin of external auditory meatus was 51.67±3.96 mm, from the center of pterion to inferior aspect of mastoid process was 80.04±6.22 mm. There were no significant side variations in the distance from the midpoint of pterion to all the four anatomical landmarks.

Conclusion: The location of pterion and the variations in the sutural patterns of pterion plays an important role while performing pterional approaches in neurosurgical procedures on south Indians.

KEY WORDS: Pterional approach, Pterion, Sutural patterns, Sphenoparietal, Mastoid process

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INTRODUCTION

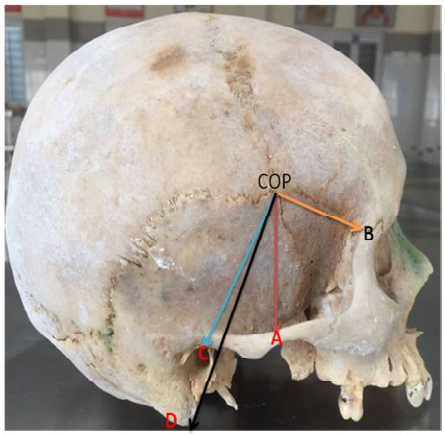
The pterion is a point of convergence of the sutures between four cranial bones namely the frontal, sphenoid, parietal, and squamous

temporal bones. The pterion corresponds to the site of the anterolateral fontanelle of the neonatal skull which closes at third month after birth [1]. Various patterns of articulation of these bones were observed and classified into three types by Broca. They were sphenoparietal, frontotemporal and stellate [2]. Murphy observed a new pattern and named it as epipteric type, where a small sutural bone is uniting all the four bones [3]. Pterion is an important anatomical landmark as this point corresponds to the location of anterior branch of the middle meningeal artery, Broca's area, the insula, and the stem of the lateral sulcus. In pterional fractures the anterior middle meningeal arterial ramus may rupture, leading to extra dural haemorrhage / haematoma [4]. Pterional approach is the most suitable and minimally invasive approach in neuro-surgery [5]. It is used for access to the structures of anterior and middle cranial fossae [6]. Pterional approaches have paved the way for the management of wide variety of neurological disorders with minimal tissue injury, so proper knowledge of the pterion, its topography and morphology is mandatory for the pterional approach used in microsurgery [7]. Location of the pterion was observed to be race specific that could be due to genetic or environmental factors affecting the craniometric indices of human skull [8]. This study is thus of immense benefit while performing pterional approaches in neuromicro surgical procedures on south Indians.

MATERIALS AND METHODS

The present study was carried out on 140 pterions of 70 dry human adult skull of unknown sex. Skulls with pathological lesions and damage were excluded from the study. The sutural pattern of the pterion was determined on both the left and right sides of each skull, based on Murphy's classification. Measurements were obtained from the center of pterion (COP) to various bony landmarks such as midpoint of zygomatic arch (A), posterolateral aspect of frontozygomatic suture (B), anterosuperior margin of external auditory meatus (C) and inferior aspect of mastoid process (D) (Figure 1).

Fig. 1: Skull showing measurements taken from the pterion to the midpoint zygomatic arch (A) and to the frontozygomatic suture (B), anterosuperior margin of external auditory meatus (C), and inferior aspect of mastoid process (D).



OBSERVATIONS AND RESULTS

All the four types of pterion patterns were observed. Among all, Sphenoparietal type (Figure 2) was 80%, frontotemporal (Figure 3) was 3.57 %, stellate type (Figure 4) was 7.14 % and epipteric type (Figure 5) was observed to be 9.28% (Figure 6).

Fig. 2: Sphenoparietal type.

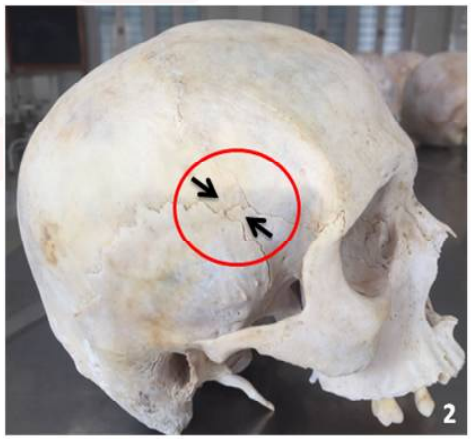


Fig. 3: Frontotemporal type.

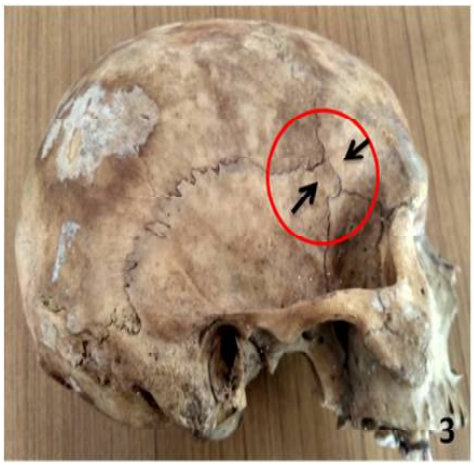


Fig. 4: Stellate type.

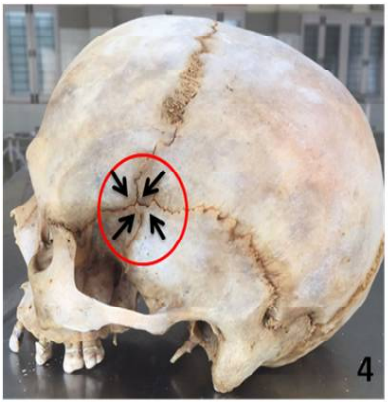


Fig. 5: Epipteric type.

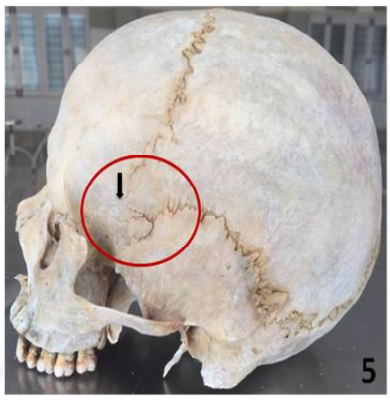
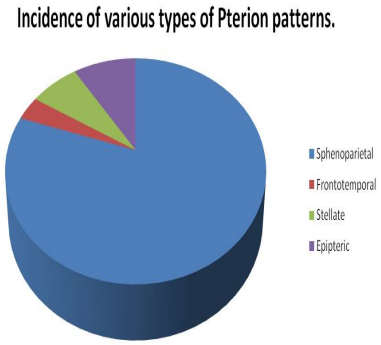


Fig. 6: Pie chart showing the distribution of various types of pterion patterns.



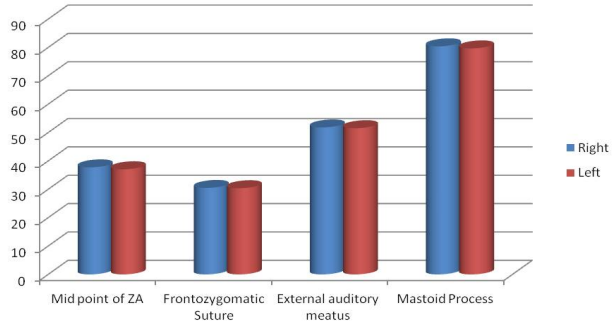
The distance between the center of pterion to midpoint on zygomatic arch, posterolateral end of frontozygomatic suture, anterosuperior margin of external auditory meatus and mastoid process were measured to determine the location of pterion (Figure 1). The mean and standard deviations of the distance between the center of pterion to various anatomical landmarks are tabulated in table 1.

Table 1: Showing the mean and Standard deviations of the distance between the center of pterion to various bony landmarks.

Parameters (From center of pterion to)	Right side	Left side	Both sides
Midpoint of zygomatic arch	37.74±3.66	37.07±4.19	37.40±3.92
Posterolateral aspect of frontozygomatic suture	30.48±4.06	30.39±4.70	30.43±4.36
Anterosuperior margin of external auditory meatus	51.81±4.08	51.54±3.89	51.67±3.96
Inferior aspect of mastoid process	80.40±6.43	79.68±6.08	80.04±6.22

There were no significant side variations in the distance from the midpoint of pterion to all the four anatomical landmarks (Frontozygomatic suture, midpoint of zygomatic arch anterosuperior margin of external auditory meatus and mastoid process) on the skull (Figure 7).

Fig. 7: Bar diagram showing the comparison of average distance from the center of pterion to various anatomical landmarks on right and left sides.



DISCUSSION

Pterional keyhole minicraniotomy via an outer canthal skin incision is proposed for the clipping of unruptured aneurysms of the middle cerebral artery (MCA) [8]. The supraorbital keyhole approach is most frequently used for anterior circulation aneurysms and for the treatment of lesions within the anterior cranial base, but this approach has some drawbacks, including cosmetically poor appearance of the scar, forehead deformity, and difficulty in dealing with some types of middle cerebral artery (MCA) and internal carotid artery (ICA) aneurysms which has led surgeons to develop an alternative approach to the anterior cranial fossa through pterion. Thus pterional approach was considered as the minimally invasive neurosurgical approach ideal for anterior and middle cranial fossa lesions [9]. So knowledge of its morphological variations and location is mandatory to carry out the pterional approach safely.

Sphenoparietal type of pterion was the predominant type in the present study. The high occurrence of the sphenoparietal pterion could have an evolutionary basis as this type is the most common type in humans and biped primates [10-12]. Literature suggests that the development of calvarial bones is tightly coordinated with the growth of the brain and requires interactions between different tissues in the sutures. Consequently, the increase in brain size in bipeds has caused morphological changes in the neurocranium that has led to the meeting of greater wing of the sphenoid and parietal bone [12,13].

The incidence of various pterional sutural types

observed in the present study are compared with the previous studies in table 2.

Table 2: Comparison of Incidence of various pterional sutural types.

Author	Sphenoparietal	Frontotemporal	Stellate	Epipteric
Lee et al. 2001 [14], Korean	76.5	-	-	40.5
Mwachaka PM 2009 [10], Kenyan	66	15	12	7
Ankur Zalawadia et al. 2010 [14], Gujarath, North Indian	91.7	2.4	1.2	4.8
Hari Prasadet al. 2015 [6], North Indian	89.2	3.3	5	2.5
Walulkar S et al. 2016 [15], North Indian	82.2	9	3.7	5
Present study, 2016, South India	80	3.57	7.14	9.28

The present study reported the incidence of sphenoparietal type as 80% which was similar to the north Indian studies, and the incidence of Epipteric type in the present study was more than the north Indian studies which was reported as 9.28% [6,14,15]. Mwachaka PM et al., reported the incidence of sphenoparietal type as 66 % in Kenyan population which is less than that found in Indian studies [10]. Lee et al reported the incidence of epipteric type of pterion as 40.5% which is very high compared to present study [14]. Ethnic variation was observed in the location of pterion as the average distance from the center of pterion to mid-point on zygomatic arch was 37.40±3.92 mm in the present study, which was less than that mentioned by the Ukoha et al., and Eboh et al., in Nigerian skulls but similar to that reported by Suchit et al., and Hari Prasad et al., in north Indian skulls [6,16,17,19]. The average distance between the center of pterion to fronozygomatic suture, anterosuperior margin of external auditory meatus and inferior point on mastoid process of the present study were similar to the results of North Indian studies. The location of pterion in different population groups are compared in Table 3.

Table 3: Comparison of the location of pterion in different studies.

Author	Ethnicity	Center of pterion to mid point on zygomatic arch		Center of pterion to posterior end of frontozygomatic suture	
		Right	Left	Right	Left
Ukoha et al. 2013 [16].	Nigeria	40.2	40.1	27.4	27.4
Eboh and Obaroefe et al. 2014 [17]	Nigeria	40.22	39.52	32.06	31.08
Apinhasmit et al. [18] (2011)	Thai	38.48	38.48	31.12	31.12
Suchit et al. 2013 [19]	North India	37.6	37.6	32.5	32.5
Hari Prasad et al.2015 [6]	North India	37.1	36.8	32	30.39
Present study	South India	37.74	37.07	30.48	30.39

CONCLUSION

The knowledge on various pterional sutural types and the location of the pterion in relation to bony anatomical land marks are important while performing micro surgeries or mini craniotomy to approach anterior or middle cranial fossa through pterional approach. The data provided in this study would be of immense benefit while performing pterional approaches in neurosurgical procedures on south Indians.

Conflicts of Interests: **None**

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