Original Article

Location and morphological study of pterion – A landmark for keyhole neurosurgical procedures

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Abstract

Background: Pterion is the conjunction of four bones of the skull, which is clinically significant because of the middle meningeal artery that passes beneath it. It forms an important landmark for neurosurgical approaches to the anterior and middle cranial fossa.

Methods: Two hundred and forty dried human skulls were studied on both sides for variations in the morphology of pterion. Distance of the significant anatomic landmarks was calculated from the centre of the pterion using slide callipers.

Results: Sphenoparietal type (70%) was most commonly found among the specimens followed by stellate (25%) and epipteric (5%) pterion. No intertype variation was noted. Higher percentage of asymmetric combinations (60%) were observed compared to symmetric combinations (40%).

Conclusions: Variation in the morphology as well as the location is crucial for drilling burr holes for evacuating extradural haematomas and performing other procedures.

Keywords: Morphometry, neurosurgery, pterion

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INTRODUCTION

Pterion is derived from the Greek word *pteron* meaning wing. It is formed by the conjunction of four bones: squamous part of the temporal bone, parietal, greater wing of the sphenoid and frontal bone within the temporal fossa. The site is related to the anterolateral fontanelle of the skull, which closes nearly at 3–6 months of age.[1] Significant variations may be found in the suture fusion pattern of the constituent bones. Pterion lies at a distance of 2.6 cm posterior and 1.3 cm anterior to the posterolateral border of the frontozygomatic suture.[2] Conversely, it is located at a distance of 4 cm superior to the midpoint of the zygomatic arch. With respect to surface marking, pterion is located one thumb length posterior to the frontal process of zygomatic bone and two fingers superior to the zygomatic arch; the angle thus formed between the thumb and upper finger represents the site of pterion.[3] Deep to the pterion lies the frontal or anterior branch of the middle meningeal artery, Broca's area and the lateral sulcus of the brain. The pterion forms a crucial landmark in neurosurgery providing an approach

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to the anterior and middle cranial fossa, tumours such as olfactory meningioma and also berry aneurysms.[4] It also helps in locating the middle meningeal artery, thus helping in precisely drilling burr holes to drain extradural haematoma. The pterion can also be used to access the optic canal and the sphenoid ridge.[5] It has been classified into four types (Figure 1).[5-7] In sphenoparietal (Sp) type, the sphenoid and parietal bones are in direct contact. In the frontotemporal (Ft) type, frontal and temporal bones are in direct contact. In stellate stellate (St) type the frontal, parietal, temporal and sphenoid articulate at a single point. In the epipteric (Ep) type a suture is located between the four bones that constitute the pterion.[7]

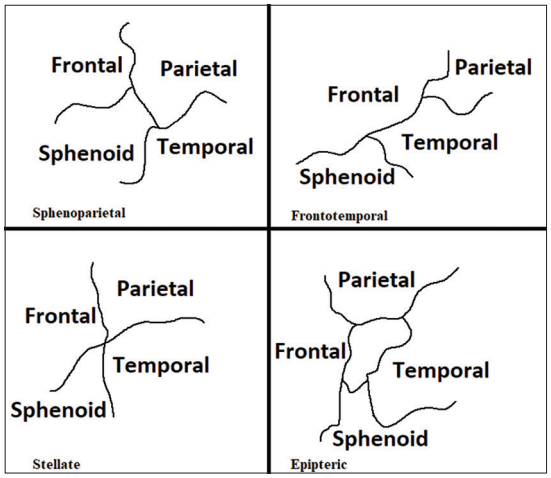

Figure 1: Types of pterion according to Murphy's classification[1]

The exact location of pterion will help neurosurgeons to localise the various important structures underlying the pterion. In addition, after thorough literature review, no such study has been found in North Bengal region. The present study was designed to study the various anatomic variations of the pterion; and to calculate the distance of pterion from certain distinct anatomic landmarks.

MATERIAL AND METHODS

Both sides of 240 dry human skulls of unknown sex and race were collected and studied from the anthropology and anatomy departments of various colleges in North Bengal. Skulls with deformity; fractured skulls; skulls that could not be studied due to advanced synostosis or unknown reasons were excluded.

Both sides of the pterion have been studied to examine the location and morphology. The findings recorded are as per the classification system given by Murphy.[1] Linear distances from the centre of the pterion to crucial neurosurgical landmarks have been recorded using slide callipers. Certain parameters that have been observed were (i) centre of the pterion to middle of frontozygomatic suture (C-FZ) (Figure OA); (ii) centre of the pterion to middle of zygomatic arch (C-ZA) (Figure 2 OB); (iii) centre of the pterion to middle of temporozygomatic suture (C-TZ) (Figure 2 OC); and (iv) centre of the pterion to anterior most point of external acoustic meatus (C-EAM) (Figure 2 OD).

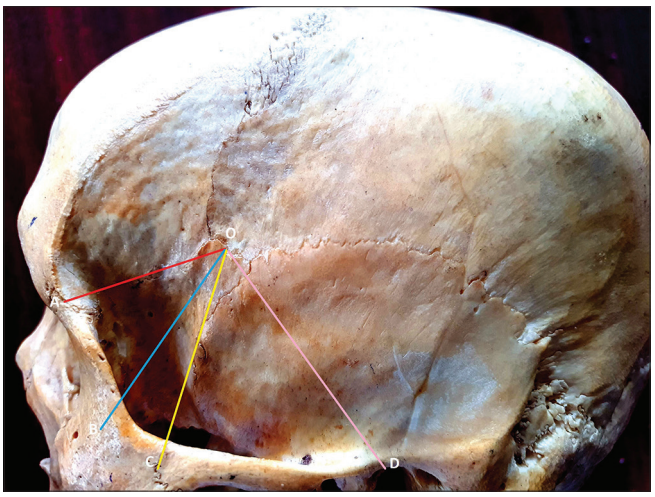

Figure 2: Sphenoparietal type of pterion. Centre of the pterion to middle of frontozygomatic suture (OA); Centre of the pterion to middle of zygomatic arch (OB); Centre of the pterion to middle of temporozygomatic suture (OC); Centre of the pterion to anterior most point of external acoustic meatus (OD)

Statistical analysis

The data collected were recorded and cleaned in MS Excel 2017. All statistical calculations have been done using IBM Statistical Packages for the Social Sciences (SPSS) version 22.0 (IBM Corp Somers NY, USA).

RESULTS

We observed the left and right sides of 240 human skulls, thus making the sample size of 480. Out of the four prevailing varieties, only three varieties of morphology have been obtained (frontotemporal not found). The most common type was found to be sphenoparietal (n = 336, 70%) (Figure 2) followed by stellate (n = 120, 25%) (Figure 3)and epipteric (n = 24, 5%) (Figure 4). Considering the right side, the order was sphenoparietal (n = 144, 30%) followed by stellate (n = 96, 20%) and epipteric (0). The left side also showed traits similar to the right: sphenoparietal (n = 192, 40%) > stellate (n = 24, 5%) and epipteric (n = 24, 5%). No epipteric type has been found on the right side.

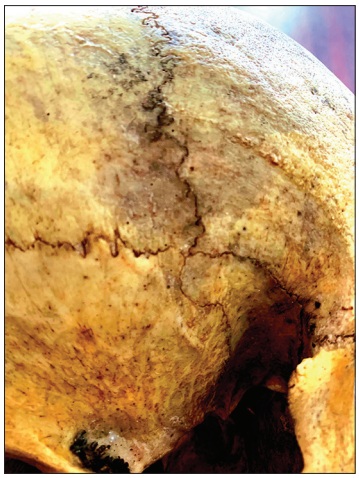

Figure 3: Stellate type of pterion

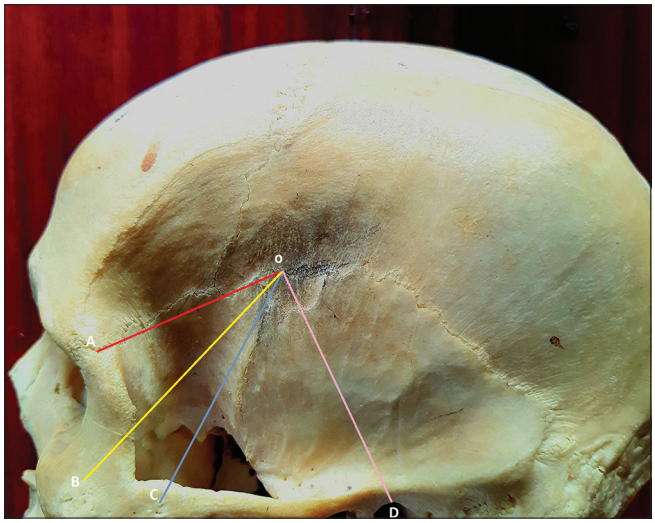

Figure 4: Epipteric type of pterion. Centre of the pterion to middle of frontozygomatic suture (OA); Centre of the pterion to middle of zygomatic arch (OB); Centre of the pterion to middle of temporozygomatic suture (OC); Centre of the pterion to anterior most point of external acoustic meatus (OD)

The mean and the standard deviations of the different measurements obtained from different types of pterion are shown in Table 1. In addition, the variations in the left and right sides in certain distinct anatomical landmarks are tabulated in Table 2. Four different combinations among various types of both sides of the skull are presented in Table 3.

Table 1: Distance of various significant anatomic landmarks from pterion (mm)*

Parameter (mm)	C-FZ	C-TZ	C-ZA	C-EAM
SP	34.7 ± 5.5	44 ± 4.2	44.3 ± 3.9	55.7 ± 4.4
S	33.6 ± 7.5	43.8 ± 4.9	43 ± 5	54.8 ± 5
E	46 ± 7.1	54 ± 5.6	50 ± 2.8	56 ± 4.2

* Data are presented as mean ± standard deviation
SP=Sphenoparietal; C-FZ=Centre of the pterion to middle of frontozygomatic suture; C-TZ=Centre of the pterion to middle of temporozygomatic suture; C-ZA=Centre of the pterion to middle of zygomatic arch; C-EAM=Centre of the pterion to anterior most point of external acoustic meatus; S=Stellate; E=Epipteric

Table 2: Distance of various significant landmarks based on the side of the skull (mm)*

Parameter	C-FZ	C-TZ	C-ZA	C-EAM
Right	35.1 ± 6.7	45 ± 4.7	44.5 ± 4.7	57.5 ± 3.5
Left	34.9 ± 6.3	43.9 ± 5	44.1 ± 4	53.6 ± 3.4

* Data are presented as mean ± standard deviation
C-FZ=Centre of the pterion to middle of frontozygomatic suture; C-TZ=Centre of the pterion to middle of temporozygomatic suture; C-ZA=Centre of the pterion to middle of zygomatic arch; C-EAM=Centre of the pterion to anterior most point of external acoustic meatus

Table 3: Incidence of various combination of pterion morphologies

Pattern of pterion		Frequency (No)	Incidence (%)
Left	Right		
SP	SP	96	40
SP	ST	96	40
ST	SP	24	10
EP	SP	24	10

SP=Sphenoparietal; ST=Stellate; EP=Epipteric

Table 4 indicates higher prevalence of sphenoparietal type in the left side and stellate type in the right side. No epipteric type has been found in the right side of any of the skulls. Higher incidence of asymmetrical combinations (60%) has been discerned from the data collected in which Sp-St (40%) type had the highest incidence followed by equal incidence (10%) of St-Sp and Ep-Sp types. Symmetrical combination (40%) has been observed only in the sphenoparietal type.

Table 4: Various pterion morphologies based on the side of the skull

Parameter	Total No. (%)	Right No. (%)	Left No. (%)
SP	336 (70)	144 (30)	192 (40)
EP	24 (5)	0 (0)	24 (5)
ST	120 (25)	96 (20)	24 (5)

SP=Sphenoparietal; ST=Stellate; EP=Epipteric

DISCUSSION

The articulation of the cranial bones is thought to be under genetic influence, predominantly *MSX2* gene, which is ultimately responsible for the type of pterion and its conformation.[8] The most common type of pterion found in West Bengal, India, is sphenoparietal type, which is in similar lines with the findings of Nigeria,[9] Kenya[10] and Turkey.[11] A study[12] assessed the correlation of size of brain to the type of pterion. This can be a possible explanation as to why humans (having greater cranial capacity) have higher incidence of sphenoparietal type, while monkeys have higher incidence of frontotemporal type.

The order of prevalence of type of pterion found in the current study: sphenoparietal (70%) > stellate (25%) >

epipteric (5%). No intertype variations have been observed in the left and right sides of the same skull, but significant variations have been found in different skulls due to ethnicity, race, sex and age.[13] Four standard parameters have been taken to locate the position of the pterion. High precision and in-depth knowledge about the pterion and related underlying structures are of utmost importance for keyhole neurosurgical interventions. In a study[14] the maximum distance of the zygomatic arch from the centre of the pterion was found to be 40 mm.[14]

We consider distance more than 40 mm as high type and lower than 40 mm as low type. We observed all high-type varieties in sphenoparietal type. This is important because if the pterion is of high variety, there will be anomalies in the position of anatomical structures. Suture distance of 35 mm was considered normal.[14] In this study, the maximum frequency of this was observed in Sp and Ep varieties.

This study thus helps in locating the position of the pterion and important anatomical landmarks which will serve as an essential marker to the surgeon and avoid complications during procedures.

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Conflicts of interest
There are no conflicts of interest.

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