RESEARCH ARTICLE

Morphometric localisation of pterion for lateral neurosurgical planning and approach

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Abstract

Objectives: To localise pterion, as a safe landmark, on dry skulls, for performing various neurosurgical procedures. To analyse the variation in the type and location of pterion among Pakistani male population.

Methods: This cross sectional study was conducted form August 2018 to May 2019 on 50 dry skulls obtained from The anatomy departments of different medical colleges of Rawalpindi and Islamabad. Shape of the pterion was noted and different measurements of the pterion from the two reference points, frontozygomatic suture and superior border of zygomatic arch, were recorded. Mean differences between the right and left sides were compared using SPSS version 23.

Results: The pattern of pterion suture was sphenoparietal in 47 skulls, 2 skulls had epipteric type and 1 skull had a stellate type of pterion. The mean distance of pterion, on the right side, from posterolateral aspect of frontozygomatic suture was 2.490±0.596cm, 1.485±0.497cm, 2.922±0.697cm measured as horizontal, vertical and direct respectively. The mean horizontal, vertical and direct frontozygomatic measurements on the left side were 2.265±0.574cm, 1.395±0.548cm, 2.717±0.665cm respectively. The mean frontozygomatic horizontal and direct measurements were significantly greater on the right side as compared to the left side (p value 0.001). The mean distance from superior border of zygomatic arch to the centre of pterion on the right and left sides were 3.744±0.444cm and 3.644±9.473 respectively.

Conclusion: The findings of the study provided important information regarding the probability of type and location of pterion in Pakistani males for lateral skull neurosurgical planning, especially when CT scan facility is not available.

Keywords: Pterion, Lateral skull approach, Neurosurgical procedure. (JPMA 70: 1779; 2020)

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Introduction

In underdeveloped countries like Pakistan, CT-scan and magnetic resonance imaging (MRI) are available only in the tertiary care hospitals. CT scan facilities' locations in big towns, their high cost or less availability has made them inaccessible to patients as well as to practitioners.'

Accidents causing head injury are a frequent cause of morbidity and mortality in underdeveloped countries. The exploratory burr hole has a very limited role in the modern management of traumatic brain injury but it is still practiced in low and middle-income countries.[1] In underdeveloped countries and in places where there is a lack of availability of CT scan, the only option is performing exploratory burr hole.[2] The outcomes for burr hole are well known as seen in a study where a traumatic brain injury with unilateral mydriasis associated with motor deficit, showed remarkable results with trephination.[3] Cranial burr hole via pterion can partially decompress most extracerebral intracranial haematomas.[4]

In most of the rural areas where timely access to neurosurgeon is not possible, the properly trained general surgeon performed craniotomy for expanding epidural and subdural haematomas, thus decreasing morbidity.[5] Immediate drainage in a patient with epidural haematoma and cerebral herniation showed a good prognosis compared to poor prognosis in cases where there is delay in decompression.[6] Apart from chronic subdural haematoma, pterion could be used to gain access to the sphenoid ridge and optic canal.[7] Archeological and forensic science also relied on pterion for age estimation and sex determination.[8]

The pterion is derived from the Greek word "pteron" meaninig wing. Pterion is a point on each side of skull behind the temple where the four bones of skull, frontal, parietal, greater wing of sphenoid and temporal bones meet in a sutural pattern. It lies above the midpoint of the zygomatic arch. It is not marked by eminence or

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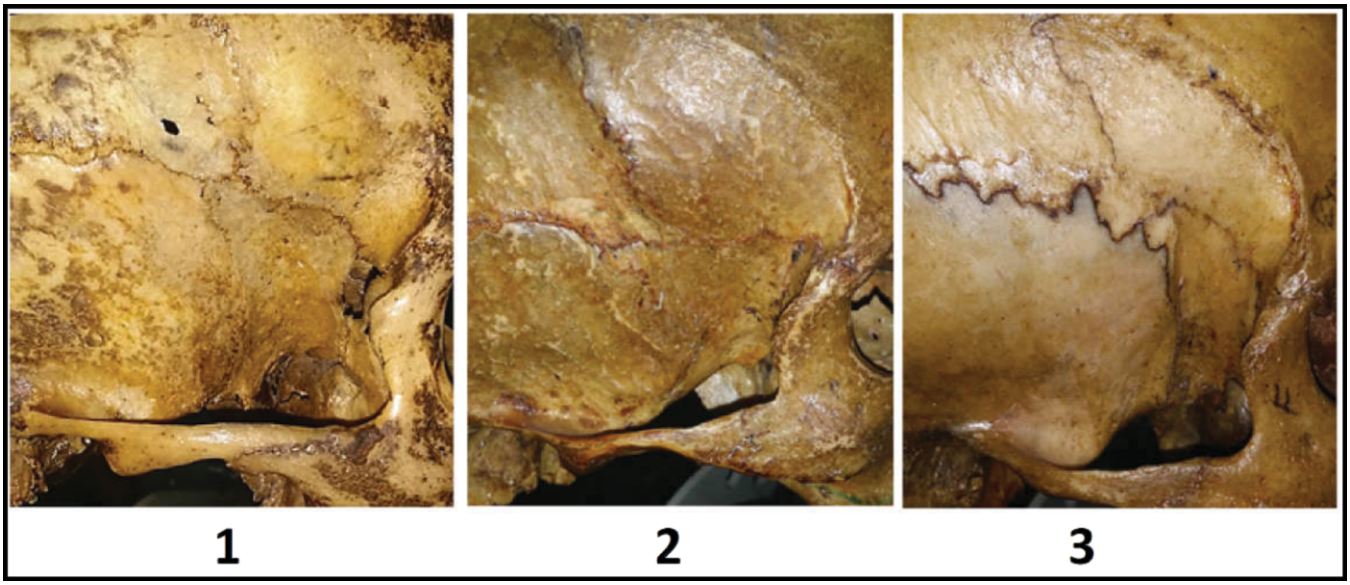

Figure-1: Types of pterion found in the Pakistani male skulls. 1) Stellate, 2) Sphenoparietal, 3) Epipteric.

depression.[9] Pterion is regarded as an anthropometric landmark because it corresponds to the site of antero-lateral fontanelle of the neonatal skull, that closes in the third month after birth.[9]

There are four varieties of pterion mentioned by Murphy.[10] Sphenoparietal type, where all the four bones of skull namely frontal, parietal, sphenoid and temporal meet in an 'H' shaped suture. The second type is frontotemporal type in which the frontal and temporal bones are in direct contact. The third one is the stellate variety formed as a result of meeting of 4 bones at a point instead of H shaped suture. The fourth type was named as the epipteric type in which there is a small suture bone among all the bones forming the pterion[10] (Figure-1).

The surface anatomy of pterion in Pakistani population is inconsistently reported. The studies providing accurate anatomical knowledge about the correct point to start a craniotomy are limited in number. Most of the head injury victims are males and mortality due to head injury is rising day by day.[2] The sex determination of the dry skull was determined by the criteria given by Keen.[11] Therefore, this study was conducted in an attempt to determine the reliability of the pterion as an important external landmark for neurosurgical procedures through pterion.

Materials and Methods

The cross sectional study was carried out after obtaining an institutional review board (IRB) approval from Shifa college of Medicine, Shifa Tameer-e-Millat University. The study was conducted from August, 2018 till May 2019. All the skulls with third molar tooth were considered adults and included in the study. The deformed or broken skull samples were excluded from the study.

The dry skulls from anatomy departments of different medical colleges of Rawalpindi and Islamabad were selected that fulfilled the inclusion criteria. The dry skulls had been brought to the anatomy departments of colleges of Rawalpindi and Islamabad from all parts of Pakistan. This is important to know to ensure the variation of skulls among different ethnic group population of Pakistan. The sex of the dry cadaveric skulls was determined using an established criteria by Keen in his study on difference between male and female skulls.[11] The morphometric study of the pterion was carried out by the methodology described by Zawaldia et al.[12] The skull was placed in a Frankfurt plane. A circle of a small radius connecting all four bones forming pterion was drawn with while chalk on skull. The centre of the circle was taken for measurements of distance from posterolateral margin of frontozygomatic suture and superior border of zygomatic arch. Following measurements were obtained both on the right and left sides[13] (Figure-2).

1. Frontozygomatic (horizonal)- horizontal distance from the posterolateral margin of frontozygomatic suture to centre of pterion.

2. Frontozygomatic (vertical)- vertical distance from the posterolateral margin of frontozygomatic suture to centre of pterion.

3. Frontozygomatic (direct)- direct distance from the frontozygomatic suture to the center of the pterion.

Figure-2: The sphere joining all four bones forming the pterion. The centre is marked with an*. 1- Horizontal distance from the posterolateral margin of frontozygomatic suture to centre of pterion. 2- Vertical distance from the posterolateral margin of frontozygomatic suture to centre of pterion. 3- Vertical distance from the zygomatic arch to the centre of pterion. 4- Direct distance from posterolateral aspect of frontozygomatic suture.

student's t test was used to compare the mean distance of pterion on the right and left sides.

Results

The sutural pattern of pterion found in the Pakistani male population was sphenoparietal variety among 47 (94%). The epipteric variety was found in only 2 (4%) skulls. Only 1 skull (2%) had a stellate type of pterion (Figure-1).

The mean distance of centre of pterion from posterolateral aspect of frontozygomatic suture on the right side of the skull was 2.490±0.596cm, 1.485±0.497cm, 2.922±0.697cm when measured from horizonatal, vertical and direct reference points, respectively (Table).

Similarly the mean horizontal, vertical and direct frontozygomatic measurements on the left side were 2.265±0.574cm, 1.395±0.548cm, 2.717±0.665cm respectively (Table).

The analysis of data after applying the paired sample t test showed that the mean frontozygomatic horizontal and direct measurements were significantly greater on the right side as compared to the left with p values 0.001 and 0.009 respectively. However, no significant difference was noted between the vertical frontozygomatic measurements on both sides (Table).

Table: Means and standard deviations of various measurements of the pterion. Paired student t test used for the comparison of means with a p value <0.05 considered as significant.

Measurements	Mean (cm)	Standard Deviation	Paired Samples t Test		
			95% Confidence Interval of the Difference		p Value
			Lower	Upper	
Right Frontozygomatic (Horizontal)	2.490	0.596	0.102	0.347	0.001
Left Frontozygomatic (Horizontal)	2.265	0.574			
Right Frontozygomatic (Vertical)	1.485	0.497	-0.039	0.217	0.167
Left Frontozygomatic (Vertical)	1.395	0.548			
Right Frontozygomatic (Direct)	2.922	0.679	0.053	0.357	0.009
Left Frontozygomatic (Direct)	2.717	0.665			
Right Zygomaticotemporal (Vertical)	3.744	0.444	-0.006	0.206	0.064
Left Zygomaticotemporal (Vertical)	3.644	0.473			

4. Zygomaticotemporal (vertical)- vertical distance from the superior border of zygomatic arch to the centre of pterion.

A precise vernier calliper with an accuracy of 0.005cm was used. The tips of the vernier calliper were finely adjusted to fit across the points to be measured.

The measurements were taken twice and the reliability between the two measurement values were taken by intraclass correlation co-efficient.

Data was analysed using SPSS version 24 software. Means and standard deviations of the skull measurements were computed. Paired samples

The mean zygomaticotemporal measurements on the right and left sides were 3.744±0.444cm and 3.644±9.473 respectively and were not significantly different with a p value of 0.064 (Table).

Discussion

The present study was taken to mark the morphometric anatomy of pterion in Pakistani population. The rationale of the study is to give the exact point for burr hole in lateral neurosurgical approach. Previously various studies have been conducted to identify the exact location of pterion in different ethnic groups across the world. The

studies were conducted on Turkish male skulls,[14] Korean male skulls,[15] Nigerian and Indian skulls[16] and Japanese skulls.[17] There is a genetic reason behind this variation in the suture pattern of pterion. These variations could be due to age, sex, ethnicity and side of skull. The sutural pattern of pterion is affected by environmental factors as well. Mutations of MSX 2 gene have been observed in diseases such as Persistent Parietal Foramen Type 1 and Craniosynostosis Type 2. This is because the articulation of calvarial bones at pterion is under the influence of MSX 2 (on 5q35.2), a gene of homeobox family involved in cranial suture morphogenesis.[18]

The reference to the population group is important to know the exact anatomy of pterion. A study conducted by Zawaldia et al.concluded that sphenoparietal was most common type found in almost all ethnicities, varying from 66% to 95.3%. The sphenoparietal variety was highest in Indian population as well, constituting 95.3%.[19] Almost 92% of pterion was Sphenoparietal type in our study. The type of pterion is affected by sex whereas sex, side of the skull and age affects the location of pterion.[20]

The burr hole is a procedure of choice in many hospitals because it is simple, safe and efficient. The exact location of pterion, in a new technique of twisted drill evacuation, carried out at bedside of the patient without the help of monitored anaesthesia and anaesthetist, is highly relied on.[21] The morphology and exact craniometric location of pterion is very crucial for surgeries carried out in the region of sylvain fissure, trauma to middle meningeal artery, middle cerebral artery aneurysms etc.[22]

This study provided valuable data to the radiologists regarding the variations in the morphological pattern of pterion among Pakistani population. For example, a radiologist might mislead the diagnosis of a normal variant of the suture pattern to a fracture line.[23]

The measurement on both sides of the skull was taken to find any difference between right and left pterion. Our study showed that the right pterion lay more posteriorly or higher than left. This could be explained on account of the fact that the developing brain tissue coordinates the suture pattern and development of calvarium during embryonic period. There was a prevalence of frontotemporal variety of pterion seen among monkeys who have smaller brains[24] compared to humans where sphenoparietal variety of pterion predominates. The presence of wormian bone in epipteric variety is due to development of abnormal ossicles resulting from extra ossification centres within the cranium. The formation of wormian bone is still unclear, however genetic and environmental factors have been proposed. The increased dural strain and sutural width during embryonic life could also be the cause of presence of wormian bones. Decreased ossification was also seen in metabolic bone diseases affecting the number and location of wormian bones.[25]

The limitation of the study was the non-availability of the dry cadaveric skulls. We could not find the cadaveric female dry skulls so the location and morphology of female pterion in Pakistani population could not be studied. However, CT scan localisation and measurement of the same reference points could provide an important data regarding the position and type of female pterion in a Pakistani population.

Conclusion

The suture pattern of pterion exhibit population based variation. The location and type of pterion in Pakistani male population provided important information for surgical interventions via pterion. The mean frontozygomatic horizontal and direct measurements were significantly greater on the right side compared to the left side. These two measurable distances, from the posterolateral aspect of frontozygomatic suture could be precisely used to determine the centre of pterion, while performing burr hole surgery.

The information is equally helpful to radiologists because different types of suture pattern of pterion might be mistaken for fracture lines. The data is also helpful for anthropologists and forensic scientists for determination of age and sex.

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