Cranial CT scan Evaluation of Morphological Variations of Bony Pattern & Location of Pterion in the Indore male population for a Lateral Neurosurgical Approach

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ABSTRACT

Objective:

The aim of the study is to identify morphological differences and the location of pterion in the male population of Indore.

Methods:

53 consecutive male cerebral CT scan images (aged 25 to 45 with no cranio-facial fracture were included)with a slice thickness of 0.5 mm were chosen . The dataset was obtained from the SIEMENS Somatom Scope with 16 slices. The images were loaded into the imaging programed PACS (WFM), where they were examined using three-dimensional (3D) Multiplanar reconstruction viewers. Measurements were made as a horizontal and vertical distance from the centre of the pterion to the posterolateral edge of the frontozygomatic suture in lateral projections

of the skull in the Frankfurt plane. Vertical distance between the pterion's centre and the superior border of the zygomaticotemporal arch. Additionally, the morphological types were identified.

Results:

Right side pterion types were 94.3% sphenoparietal and 5.6% frontotemporal, whereas left side pterion types were 90.5% sphenoparietal, 3.7% frontotemporal, 1.8% epipteric, and 3.7% stellate. On the right side, the average frontozygomatic measurements were 22.3 ±2.2 mm and 12.5 ±2.2 mm, respectively. The same measurements were 22.7± 2.5 mm and 12.26± 2.2 mm on the left side, respectively. On the right and left sides, the mean zygomaticotemporal measures were 34.5 ±2.9 mm and 34.4 ±2.5 mm, respectively.

Conclusion:

The study offers helpful information regarding the positioning of the pterion for secure neurosurgery procedures using the pterion. Additionally, the radiologist can distinguish between a fracture line and normal morphological variety thanks to their understanding of the various morphological kinds of pterion.

INTRODUCTION

Pterion is an H-shaped suture that runs through the frontal, sphenoid, temporal, and parietal bones and is located in the supratemporal fossa.[1] The term "pteron" relates to the wings that were attached to Hermes' head when he served as the Greek gods' messenger and has been used to describe this anatomical landmark since the 19th century.[2] A neurosurgical approach's entry point to significant cerebral structures is the pterion. The peritoneal approach exposes the Sylvian fissure and opercula, enabling the surgeon to access abnormalities in the basal cistern, insula, and midline tissues, including the basal ganglia, sellar and parasellar areas, hypothalamic area, and third ventricle.[3] In order to locate aneurysms and other vascular abnormalities in the anterior circulation and distal part of the posterior circulation, the pterion is a crucial craniometric point.[4] Transcranial surgery for cranioorbitaltumours can be approached through the pterion.[5]

In addition to neurosurgery, the pterion is important for forensic scientists due to the existence of morphological variations in different populations.[6] forensic anthropologists for sex analysis[7] and age determination. Among the many variables that affect the position and shape of the pterion are age, sex, the side of the head, and ethnicity.[8] Murphy had classified four varieties of pterion: sphenoparietal, frontotemporal, stellate, and epipteric, depending on the type of bone articulation pattern. A sutural pattern in which the sphenoid and parietal bones directly come together is the sphenoparietal variety. When the frontal and temporal bones were in direct contact, a frontotemporal variety. The third form, called stellate, appears as a start at the intersection of four bones, including the frontal, parietal, temporal, and sphenoid bones. The greater wing of the sphenoid bone and the parietal bone are connected by a little sutural bone, making up the fourth kind, known as the epipteric type. In the past, numerous studies have been carried out to determine the precise placement of pterion in various ethnic groups, e.g., Turkish male skulls[10] north Indian skulls[11] and Thai dry skulls.[12]

The study's justification is that morphological variation may have an impact on the anatomy of the supporting structures and, consequently, the surgical approach because pterion is a crucial surgical strategy for lateral neurosurgical skull surgeries. Since cranial CT scan examination of pterion morphology and localization has not yet been described in the literature, the majority of investigations on the morphology and location of a pterion are conducted on dried skulls. The various morphological patterns broaden the understanding of anthropologists, forensic scientists, and radiologists and give surgeons useful information for lateral skull approaches. Dry skulls have measured the pterion's distance from surrounding reference locations, but cranial CT scan measurements are not cited in the literature. Using a cranial CT scan, the aim of this study was to identify the morphological variations and position of the pterion in the male population of Indore. Additionally, it tries to distinguish between fracture lines and the typical morphological variation of the pterion in order to help surgeons and radiologists perform safe surgical interventions in the area of the pterion.

MATERIALS & METHODS

This research was conducted in Index Medical College, Hospital & Research CenterIndore, Madhya Pradesh (452016) it is a hospital-based cross-sectionalretrospective study in the anatomy and radio diagnosis departments. Open Epi, a web-based epidemiological and statistical calculator, was used to determine the sample size. [13]

Inclusion Criteria:

Males between the ages of 25 and 50 in North India are more susceptible to traumatic brain injury. [14] Males between the ages of 25 and 45 were included in the study. The only men who presented to the emergency room were those who underwent consecutive CT scans from 2021 to 2022 with a slice thickness of 0.5 mm.

Cranial CT scans: A total of 53 (fifty-three) male cranial CT scans with a slice thickness of 0.5 mm were chosen at random from the diagnostic radiology department at Index Medical College, Hospital & Research Center, Indore, between the years 2021 and 2022.Only patients with ages between 25 and 45, no cranial fractures, and signed reports were chosen. These patients were all men who were referred by Casualty and received a CT scan as part of their workup for a fall or vehicle accident injury. According to departmental practise, routine cranial CT scans also include a bone window slice thickness of 0.5 mm. A radiologist evaluates the best possible proton picture and Cranial CT scans. The fifty-three (53) cranial CT scans were chosen at random, and if any of the inclusion requirements were not met—for example, if the image could not be seen clearly—then a new random case was chosen. The dataset was acquired from a CT scanner with the following specifications: brand: SIEMENS; model: Somatom Scope [G-XL-91368]; version: CTVC30; and number of slices: 16. The slices were each 0.5 mm thick. The images were imported into the imaging application PACS (WFM) and evaluated in bone window and maximum intensity projection mode with three-dimensional (3D) multiplanar reconstruction views using 90 mm slab thickness to produce the best surface rendered images. Using lateral projections of the skull, the pterion in the Frankfurt plane was imaged using reference points that provided the clearest views of the frontozygomatic suture, zygoma, and pterion. In about 10% of cases, measurements are carried out again at random.

On the right and left sides of the cranial CT scan, the following parameters or measurements were taken: (Figure 1).

1. **Frontozygomatic (Horizontal):** Horizontal distance from the posterolateral border of the frontozygomatic suture to the pterion's centre.
2. **Frontozygomatic (Vertical):** Vertical distance between the pterion's centre and the frontozygomatic suture's posterolateral edge.

3. **Zygomaticotemporal (Vertical):** Height between the superior border of the zygomatic arch and the pterion's centre.

RESULTS

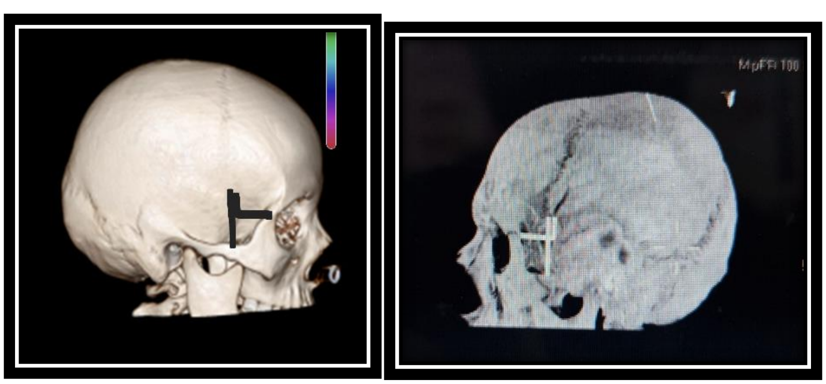
Table-I: Percentage and number of different types of pterion.

Morphological types	Right		Left	
	Number	Percentage	Number	Percentage
Sphenoparietal	50	94.3%	48	90.4%
frontotemporal	03	5.6%	02	3.7%
Stellate	00	-	02	3.7%
Epipteric	00	-	01	1.8%

Table-II: Mean distance of Pterion from the fronto-zygomatic suture and zygomatico-temporal arch

Measurements	Mean (mm)	Standard Deviation	Paired Samples t Test		
			95% Confidence Interval of the Difference		
			Lower	Upper	p-Value
Frontozygomatic (Right Side H)	22.30	2.27	-1.09	0.18	0.162
Frontozygomatic (Left Side H)	22.75	2.53			
Frontozygomatic (Right Side V)	12.53	2.19	-0.28	0.81	0.336
Frontozygomatic (Left Side V)	12.26	2.25			
Zygomaticotemporal (Right Side V)	34.58	2.98	-0.62	0.81	0.795
Zygomaticotemporal (Left Side V)	34.49	2.57			

Figure-1: Measurements from the midpoint of pterion.



Using percentages and frequencies, several morphological pterion types were analyzed. Our sample consisted of 53 males, and 106 pterions were assessed using cranial CT scans (right and left sides). The criteria on the right and left sides were different types. All the bones on the right side join together at an H-shaped suture, making up 94.3% of the right side population (n=50).A pterion-found intersutural bone characterizes the 5.6% (n=3) frontotemporal type (Table I). According to the cranial CT scan, the left side of the skull has 48 (90.5%) sphenoparietal, 2 (3.7%) frontotemporal, 1 (1.8%) epipteric, and 2 (3.7%) stellate bones. (Table-I).

Where the pterion data was found: SPSS version 23 was used to enter the data. The pterion's horizontal and vertical separation from the posterolateral margin of the frontozygomatic suture served as the continuous variables.The vertical distance between the zygomaticotemporal arch and the pterion's midpoint was also measured. The pair-sample t test was used to compare the average separation between the pterion and the aforementioned reference locations on the right and left sides of the skull.The frontozygomatic measurements on the right side were 12.5± 2.19 mm and 22.3± 2.2 mm in the horizontal and vertical planes, respectively.

On the left side, the average frontozygomatic measurements were 22.7± 2.5 mm and 12.26±2.2 mm, respectively (Table II). The mean and SD data on either side were not distinguished by statistics. The pterion is thus 22.3 mm posterior and 2.2 mm above the frontozygomatic suture in the right side of the skull of men from the Indore region. Males from the Indore region have a pterion on the left side of the skull that is 22.7 mm posterior and 12.26 mm above the frontozygomatic suture. The mean zygomaticotemporal measurements on the right and left sides, respectively, were found to be 34.5±2.9mm and 34.4±2.5mm, with a p-value of 0.79 showing no significant difference between them. (Table-II)

DISCUSSION

The pterion is a significant craniometrical point that is evaluated using cranial CT scans. These scans map the pterion for a variety of minimally invasive surgical approaches.[4,5] The radiologically detectable variance of pterion in the population of the Indore region was defined in this study. Males were chosen since they make up the majority of those hurt in India's traffic accidents. A better neuroimaging infrastructure is required for managing traumatic brain injuries.[16] For an accurate diagnosis, radiologists should be familiar with the numerous types of pterion to distinguish between fracture lines and sutures, and neurosurgeons should be qualified to do surgery at the pterion. [17] As the brain grows from infancy through childhood, the cranial sutures experience a number of morphological changes. [18] Despite the fact that the precise causes of the sutural pattern created by the articulation of the cranial bones are not entirely understood, The homeobox gene MSX2 affects the development of the cranial bones. It could result in racial and ethnic variances in suture patterns. [19] Forensic pathologists, anthropologists, and anatomists all value the morphology of pterion.[20] An impeccable understanding of the architecture of the brain and skull is required for preoperative planning for brain tumour resection. Brain tumour resection preoperative planning heavily relies on knowledge of palpable bone landmarks and accurate measurements by radiological scans as an objective guide to resection. Pterion is a crucial craniometric point, and the variations in its form and placement have a significant effect on preoperative neurosurgery planning.[21] An accurate assessment is provided by morphometric analysis utilising contemporary radiological techniques like a CT scan. This investigation demonstrated that the pterion's distance from the skull's trustworthy reference points is nearly identical on both sides. On all sides, the SD measurements were statistically insignificant. This demonstrates the symmetrical placement of pterion in both halves of the skull, regardless of pterion type. The study also comes to the conclusion that the type of pterion has no bearing on where or how pterion develops during embryogenesis. According to research done on dry skulls, there is no discernible variation between the distances between the pterion and the frontozygomatic suture and the zygomaticotemporal arch on the right and left skulls of various ethnic groups. [10,11] The findings of our study are in excellent agreement with previous research on dried human skulls from various eras, races, and nations.

According to Zawaldia et al.[22], who examined the type of pterion in eight different ethnic groups, the most common type of pterion in this study is the sphenoparietal variety (90.5%), which is also the most common variety in most ethnic groups and is present in the majority of Indore's male population. The prevalence of the sphenoparietal variation varies throughout population groupings, ranging from 66% to 95.3%. [22] The outcomes match those from our research. This study discovered that 5.6% of Indore male skulls were of the epipteric kind. Epipteric variation occurs as a result of the presence of wormain or intersutural bones near the pterion.[23] The relevance of morphological variation is minimal, but some researchers link genetic influences to the development of epipteric bones. Wormian bones may accompany osteogenesisimperfecta and cleidocranialdysostosis. [24] The sutural bones become important when interpreting radiographs and CT scans of patients who have had serious head injuries. The differential diagnosis between sutured bones and fractures is the responsibility of the radiologists. When reporting the bone windows in CT scans, the morphological changes of the cranial suture may cause misinterpretation. [25] The epipteric bone at the pterion may make it challenging to make a surgical burr hole there. As a result, radiologists and neurosurgeons must be aware of the prevalence and frequency of these structures worldwide and in the population of Indore in particular.

Another pterion variant identified in this study is the stellate type (2.7%), which was only seen in the cranial CT scans of two males. Nigerians (5.0%) and West Anatolians (5.5%) had greater incidences of the stellate form pterion. [27] Only one skull (1.8%) in this study has the epipteric variation of pterion on one side of the skull. Compared to Turkish (10%) and South Indian (3.5%) populations, the prevalence of epipteric pterion is lower in the Indore population. The epipteric variation of the pterion is present in the small-brained primates[28] skulls. The sphenoparietal type is more prevalent in humans because of their larger brains. The left side of three skulls in our study had sphenoparietal-type pterion in all three cases, while the right side had stellate-type and frontotemporal pterion in two and one skull, respectively. In one of the studies done on Nigerian skulls, the degree of connection between pterion type and sideness was not statistically significant. [25] It can be explained by the fact that the MSX gene 17, whose expression may differ on the two sides of the skull, controls the morphological pattern of sutures. Understanding the anatomical differences of the pterion is crucial because, in the epipteric form, the burr hole used to drain an extradural hematoma may pierce the orbit. [29] Pterion was employed by anthropologists and forensic scientists as an anterolateral landmark to ascertain the age and gender of corpses. [30] This study identifies morphological changes in pterion that can be used to prevent potential morbidity, death, and the incorrect interpretation of fractures as having normal sutures.

Study's limitations:

It needs to be investigated whether or not pterion morphological diversity reflects in the anatomical position of the cranial components. It is a retrospective observational research that exclusively included male Indore region.

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