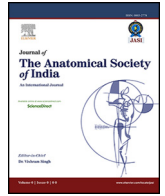




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### Original Article

# A study on the pterion position variation and its neurosurgical implications

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#### ARTICLE INFO

##### Article history:

Received 29 December 2015

Accepted 13 June 2016

Available online xxx

##### Keywords:

Keyhole surgery

Neurosurgery

Pterion position variation

Pterional craniotomy

#### ABSTRACT

**Objective:** The pterion is a neurosurgical landmark on the lateral aspect of the skull providing access to vital structures such as sylvian fissure, circle of Willis, optic nerve, para-sellar regions, middle meningeal vessels and cavernous sinus. The bilateral and gender variation in the pterion position was analyzed. **Methods:** The linear distance of the centre of the pterion from midpoint of zygoma and frontozygomatic suture was measured bilaterally in both sexes in adult dry skulls of Indian ethnic group. This was analyzed statistically using histogram, Student's *t*-test, binary logistic regression and receiver operating characteristic curve.

**Results:** The mean distance of the centre of the pterion from midpoint of zygoma was  $36.85 \pm 4.12$  mm and  $34.35 \pm 3.18$  mm and its distance from frontozygomatic suture was  $31.90 \pm 4.14$  mm and  $29.72 \pm 3.75$  mm in males and females respectively. The position of the pterion exhibited statistically significant sexual dimorphism, with distance of the pterion from midpoint of zygoma having a *p* value  $<0.001$  and a sex predictability of 67% and its distance from frontozygomatic suture a *p* value of 0.001 and sex predictability of 65.3%.

**Conclusion:** The pterion position is higher in males than females and literature review also reveals significant ethnic variation. This knowledge of gender and ethnic variation is essential for a neurosurgeon while drilling a burr hole at the pterion to prevent orbital penetration due to an anterior drilling and an ineffective access for instrumentation due to a posterior drilling.

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## 1. Introduction

The pterion is a neurosurgical landmark on the lateral aspect of the skull that marks the confluence of the frontal, parietal, greater wing of sphenoid and squamous part of temporal bone converging into an H-shaped suture. This landmark corresponds to the anterolateral fontanelle of the neonatal skull and overlies vital structures of profound clinical significance.<sup>1</sup> The pterion provides access to middle meningeal and middle cerebral vessels, sylvian fissure, circle of Willis, anterior pole of insula and Broca's area in surgeries such as trephination for extradural haematoma, repair of aneurysms and in surgeries involving these areas.<sup>2</sup> Deeper

structures such as the optic nerve and the orbit can also be accessed through the pterion.<sup>3</sup> The pterion was first classified by Murphy into sphenoparietal, frontotemporal, stellate and epipteric types with sphenoparietal involving fusion of greater wing of sphenoid and parietal bone, frontotemporal involving frontal and temporal bones, stellate where all the four bones articulate and epipteric where a sutural bone is present in the pterion.<sup>4</sup> The surface projection of the pterion is approximately 4 cm above the midpoint of zygomatic arch and 3.5 cm behind frontozygomatic suture.<sup>5</sup> The studies by Apinhasmit et al. in Thai ethnic group,<sup>6</sup> Ukoha et al. in Nigerian ethnic group,<sup>7</sup> Ilknur et al. in Anatolian skulls of thirteenth and twentieth century,<sup>8</sup> Mwachaka et al. in Kenyan ethnic group<sup>9</sup> and Oguz et al. in Turkish ethnic group<sup>10</sup> are a few studies on the pterion involving diverse ethnic groups. The pterion position exhibits moderate variation in different ethnic groups and also exhibits sexual dimorphism. Therefore, a study on its location in different ethnic groups is important considering its clinical implications. The anterolateral fontanelle closes 3 months after birth. The pterion position also exhibits sexual dimorphism. This knowledge is often used for age estimation and

**Abbreviations:** ZAP, the linear distance from the midpoint of the zygomatic arch (ZA) to the centre of the pterion (P); FZSP, the linear distance from the midpoint of the frontozygomatic suture (FZS) to the centre of the pterion (P); ROC, receiver operating characteristic curve; BLR, binary logistic regression.

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<http://dx.doi.org/10.1016/j.jasi.2016.06.004>

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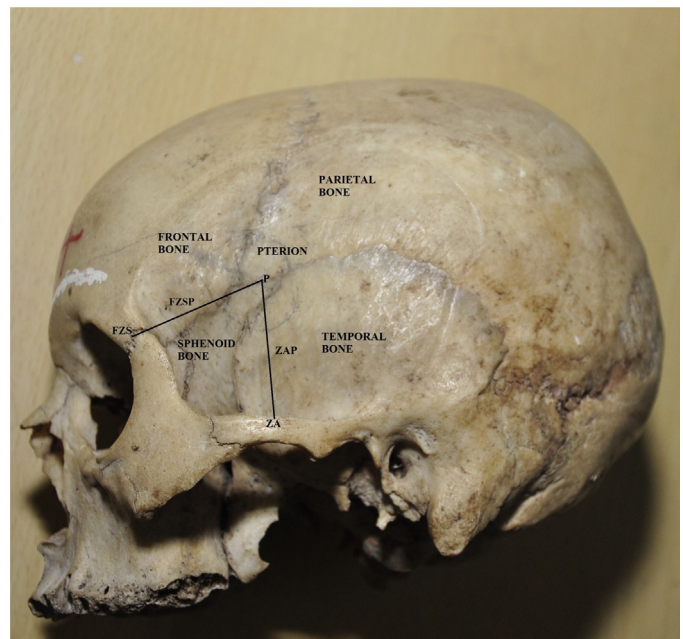
sex determination of forensic and archaeological specimens.<sup>11</sup> There are also studies that describe the pterional or lateral approach accessed by neurosurgeons in several neurosurgical procedures. "Removal of a cranio-orbital foreign body by a supraorbital-pterion approach",<sup>12</sup> "Surgical management of meningiomas involving the optic nerve sheath",<sup>13</sup> "The lateral pterional approach used in surgeries on olfactory meningiomas",<sup>14</sup> "A pterion keyhole approach for the treatment of anterior circulation aneurysms"<sup>15</sup> and "Side selection of the pterional approach for superiorly projecting anterior communicating artery aneurysms"<sup>16</sup> are a few clinical studies on the pterion which suggest that the precise location of the pterion is of profound significance for a neurosurgeon. The significance of the pterion in neurosurgery is its location, as it overlies vital structures such as the frontal lobe with Broca's area, the temporal lobe, amygdala, hippocampus, insula, sylvian fissure that provides access to the circle of Willis, optic nerve and chiasm, orbit, superior orbital fissure, supra-sellar and para-sellar regions and pituitary, middle meningeal and middle cerebral vessels, cavernous sinus and the midbrain.<sup>2,3,17</sup> The pterional approach is hence, preferred by neurosurgeons in treating vascular aneurysms of circle of Willis and ophthalmic arteries,<sup>15</sup> optic and olfactory meningiomas,<sup>13,14</sup> cavernous sinus haemangioma,<sup>18</sup> selective amygdalohippocampotomy<sup>19</sup> and large tumours in supra-sellar and para-sellar regions.<sup>20</sup> The present study analyzes the variation in the position of the pterion in Indian ethnic group. The study clearly shows that the pterion location is higher in males than females. A review of literature also reveals significant ethnic variation in pterion position. This knowledge of gender and ethnic variation is essential for a neurosurgeon while drilling a burr hole at the pterion to prevent orbital penetration due to an anterior drilling and an ineffective access for instrumentation due to a posterior drilling.

## 2. Materials and methods

The study involved 41 male skulls and 31 female skulls aged between 25 and 65 years. The sex confirmation was done previously from departmental records. The sex was further ascertained by defining the skeletal morphology. The measurements were made by a single observer to avoid inter-observer errors. The measurements were done using a sliding digital caliper (Lianying 0005) graduated to the last 0.01 mm. The linear distance from the midpoint of the zygomatic arch to the centre of the pterion (ZAP) was measured. The linear distance from the midpoint of the frontozygomatic suture to the centre of the pterion (FZSP) was also measured. The distances measured are shown in Fig. 1. The distance was measured bilaterally in males and females. The technique involved repetition of the measurements twice. If there was a difference of more than 0.1 mm, then a third measurement was taken in accordance to the technique recommended by Krag et al., 1988 for spinal morphometry.<sup>21</sup> The data were analyzed using SPSS (Statistical Package for Social Sciences, version 20.0, SPSS Inc, Chicago, IL, USA) software. A two-tailed Student's *t*-test ( $p < 0.05$ ), binary logistic regression and receiver operating characteristic curve were used to analyze the data. The sex predictability of the position of the pterion was determined using binary logistic regression and receiver operating characteristic curve.

## 3. Results

The mean distance of the centre of the pterion from midpoint of zygomatic arch was  $36.85 \pm 4.12$  mm and  $34.35 \pm 3.18$  mm in males and females respectively and its distance from the midpoint of the frontozygomatic suture was  $31.90 \pm 4.14$  mm and  $29.72 \pm 3.75$  mm in males and females respectively. As observed, there is a significant



**Fig. 1.** The measurements of centre of the pterion as linear distances from centre of the frontozygomatic suture and midpoint of zygomatic arch.

difference in its position between the sexes. This variation is depicted using a histogram in Figs. 2 and 3 and it is evident from the histogram that the position of centre of the pterion is significantly higher in males than in females. Fig. 2 depicts the variation in the distance of the centre of the pterion from midpoint of zygomatic arch and Fig. 3 depicts the variation in its distance from the centre of the frontozygomatic suture. The inter sex variation observed was further confirmed statistically using two tailed Student's *t*-test. The pterion position exhibited statistically significant sexual dimorphism, with the distance of the centre of the pterion from the midpoint of the zygomatic arch being significant with a *p* value less than 0.001 and its distance from the midpoint of frontozygomatic suture also being significant with a *p* value of 0.001. The data was then analyzed using binary logistic regression and its predicted probabilities were analyzed by receiver operating characteristic curve. The area under the curve was obtained and this area is a measure of the sex predictability of the dimension. The area under the curve was 0.670 for the distance of the centre of the pterion from the midpoint of zygomatic arch and 0.653 for distance of the centre of the pterion from the midpoint of the frontozygomatic suture. This suggests that the sex predictability percentage of distance of the centre of pterion from midpoint of zygomatic arch is 67% and the sex predictability percentage of distance of the centre of pterion from the midpoint of frontozygomatic suture is 65.3%. The study therefore confirms the sexual dimorphic trait exhibited by the pterion. The receiver operating characteristic curves for the above mentioned variables are shown in Figs. 4 and 5, where Fig. 4 represents the receiver operating characteristic curve for the distance of the centre of pterion from midpoint of zygomatic arch and Fig. 5 represents the receiver operating characteristic curve for the distance of the centre of pterion from the midpoint of the frontozygomatic suture.

The mean distance of the centre of the pterion from midpoint of zygomatic arch was  $36.09 \pm 4.0$  mm and  $35.45 \pm 3.77$  mm on right and left sides respectively and its distance from the centre of the frontozygomatic suture was  $31.00 \pm 4.10$  mm and  $30.92 \pm 4.13$  mm on right and left sides respectively. As observed, there is no significant variation in its position bilaterally and this was confirmed statistically by applying Student's *t*-test which revealed that the difference was statistically insignificant with a *p* value of 0.334 for the distance of the

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