

Anatomical Consideration of Pterion and Its Related References in Thai Dry Skulls for Pterional Surgical Approach

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Objective: Pterion is a crucial surgical landmark for surgical approaches to the middle meningeal artery, particular lesions, and tumors in the brain. The present study aimed to analyze the types of the pterion and its location related with nearby landmarks in dry skulls. In addition, variations of pterion in sex, age, and skull side were compared.

Material and Method: Bilateral sides of 268 adult human Thai dry skulls were investigated. Pterion types were classified as sphenoparietal, frontotemporal, epipteric, or stellate. To localize the pterion, linear distances were measured from the center of the pterion to neighboring landmarks.

Results: The results showed the two most common types of the pterion, the sphenoparietal (81.2%), and the epipteric (17.4%). Externally, the pterion was commonly located 38.48 ± 4.38 mm superior to the zygomatic arch and 31.12 ± 4.89 mm posterior to the frontozygomatic suture. Internally, it was located 38.94 ± 3.76 mm lateral to the optic canal and 11.70 ± 4.83 mm from the sphenoid ridge. Sex influenced the occurrence of the pterion type, while sex, skull side, and age affected its location. Mean skull thickness at the pterion was 5.13 ± 1.67 mm.

Conclusion: The pterion is predominantly sphenoparietal type and is typically located 39 mm superior to the zygomatic arch, 31 mm posterior to the frontozygomatic suture, 39 mm lateral to the optic canal and 12 mm from the sphenoid ridge. The data obtained from the present study should be clinically useful for localizing the position of pterion.

Keywords: Pterion, Pterional approach, Type, Localization, Skull

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Pterion, a significant region on the lateral aspect of the skull commonly used as a neurosurgical landmark, is usually an irregular H shape formed by the articulation of four bones: frontal, parietal, greater wing of sphenoid, and squamous part of temporal bones^(1,2). The pattern of bone articulation; however, can be varied and small epipteric bones may be present⁽³⁾. Its center is approximately 4.0 cm superior to the zygomatic arch and 3.0-3.5 cm posterior to the frontozygomatic suture⁽¹⁻³⁾. A pterional approach has been used in neurosurgery primarily for the treatment of a wide variety of neurosurgical disorders as it

provides an opportunity to treat lesions located in several brain structures and areas such as the frontal (anterior) branch of the middle meningeal artery, Broca's motor speech area on the left side, insula, the lateral (Sylvian) cerebral sulcus, internal capsule^(1,2,4-6), for treating lesions of optic canal, orbit, sphenoid ridge⁽⁷⁻¹⁰⁾ and for treating cerebral aneurysms and tumors^(6,9,11-14). Therefore, the anatomical considerations in location and related landmarks of the pterion are useful for surgical approaches through this structure. However, there is racial variation in the location of the pterion^(15,16) and few studies have addressed the morphology and morphometry of the pterion in relation to specific identifiable bony landmarks between sex, side and age, indicating more studies regarding the type and definite location of pterion between sex, side and age are needed.

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The present study aimed to analyze the type and the landmarks for localizing the pterion in adult Thai dry skulls. The factors of sex, side, and age were statistically evaluated the influence over the variation of pterion type and location. The obtained data would also be compared with those of various racial groups from previous studies.

Material and Method

The collection of skulls from three universities in accordance with the experimental protocols of the present study were approved by the Ethics Committee of the Faculty of Dentistry, Chulalongkorn University, Faculty of Medicine Siriraj Hospital, Mahidol University, and Faculty of Medicine, Chiang Mai University, Thailand.

Subjects

Two hundred sixty eight dry adult human skulls were selected from the collection at the Department of Anatomy, of three universities *i.e.*, Faculty of Medicine Siriraj Hospital, Mahidol University, Faculty of Medicine, Chiang Mai University and Faculty of Dentistry, Chulalongkorn University. All skulls were Thai adults and their sex and age were known according to the personal records of body donors. Only skulls with all regular in shape, without obvious evidences of dystrophy, deformities, and/or trauma were selected. Criteria of exclusion were those in which the pterion pattern could not be clearly identified owing to breakage or advanced synostosis. The skulls in the present study comprised whole skulls and skulls with a cut at the upper part of the cranium about two cm above the supraorbital margin anteriorly and above the inion posteriorly. The types of pterion and the parameters associated with external landmarks were identified in both groups of skulls, whereas the internal parameters could be examined in the cut skulls (Fig. 1, 2B).

Type and occurrence of pterion

Each pterion was studied and classified into one of four types, sphenoparietal, frontotemporal, stellate, or epipterice according to criteria previously described by Murphy⁽¹⁵⁾. The typical characteristics of four types of pterion were illustrated in Fig. 1. With the four types of pterion, 16 combinations are possible (four bilaterally symmetrical combinations with the same type on the right and left sides, and 12 bilaterally asymmetrical combinations with different types on the right and left sides)⁽¹⁵⁾.

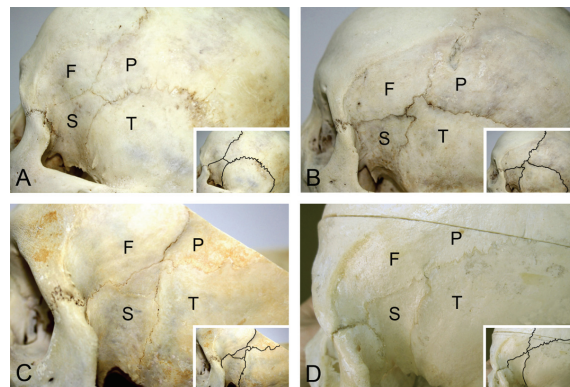


Fig. 1 Four types of pterion classified according to Murphy (1959). A. sphenoparietal; B. frontotemporal; C. epipterice; and D. stellate. The black lines in the insets show the patterns of pterion types. F, frontal bone; P, parietal bone; S, sphenoidal bone; and T, temporal bone

Location of pterion

A circle with the smallest radius was drawn connecting the four bones involved in the formation of the pterion, the center of which was marked as the center of the pterion (Fig. 2A). As the skull was placed in the plane which bilateral zygomatic bones were adjusted in horizontal plane, the corresponding position of the center of the pterion was located on the internal aspect of the pterion by placing calipers on the center of the pterion and perpendicular to the plane of the zygomatic bone and then marked (Fig. 2B). The skull thickness at the center of the pterion was also measured.

Measurements of the linear distances were performed bilaterally between the center of the pterion and four specific identifiable landmarks, two distances on the outer aspect *i.e.*, the center of pterion-zygomatic arch and the center of pterion-posterolateral margin of the frontozygomatic suture (Fig. 2A), and two distances on the inner aspect *i.e.*, the center of pterion-lateral margin of the optic canal and the center of pterion-lateral end of the crest of the ridge on the lesser wing of the sphenoid bone (Fig. 2B). The pterion was also assigned as a high pterion if it was at least 40 mm superior to the zygomatic arch and as a backward pterion if being least 35 mm posterior to the frontozygomatic suture⁽¹⁶⁾.

The length of the pterion suture (pterion value) was measured from the sphenoid and the parietal contact in the sphenoparietal type (Fig. 3A), or from the frontal and the temporal contact in the frontotemporal type (Fig. 3B). The pterion with stellate

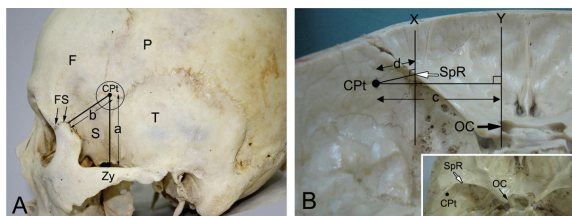


Fig. 2 Measurements of distances from the center of the pterion (CPt) to external parameters in A. and to internal parameters in B. and inset. a, the vertical distance from CPt to the zygomatic arch (Zy); b, the distance from CPt to the frontozygomatic suture (FS); c, the horizontal distance from the internal aspect of CPt to the lateral margin of the optic canal (OC); and d, the distance from the internal aspect of CPt to the lateral end of the ridge on the lesser wing of the sphenoid (SpR). F, frontal bone; P, parietal bone; S, sphenoidal bone; T, temporal bone; X, the vertical line drawn through the SpR; and Y, the vertical line drawn through the OC

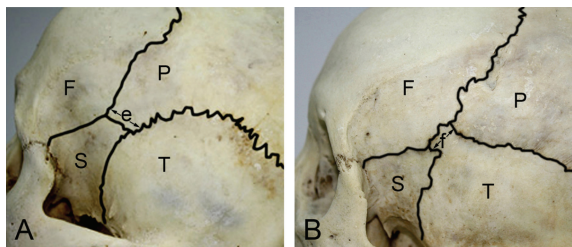


Fig. 3 Measurements of the suture length at pterion. A. the suture length (e) in the sphenoparietal type. B. the suture length (f) in the frontotemporal type. F, frontal bone; P, parietal bone; S, sphenoidal bone; and T, temporal bone

type (Fig. 1D) or with this suture complicated by epipteric bone(s) (Fig. 1C) were excluded from this measurement.

All measurements were made using sliding calipers (Mitutoyo®, Japan) capable of measuring to the nearest 0.01 mm with the exception of the skull thickness at the pterion, which was measured using a mini digital thickness gauge (Series: OI04, Tresna Instrument Co, Guilin, Republic of China) capable of measuring to the nearest 0.01 mm. To test the reproducibility of measurements, 20% of skulls were randomly selected and remeasured. The differences between two measurements of each linear distance were determined by the paired-t-test. There were no significant variations in measurements found in the present study.

Statistical analysis

All measurements and frequencies of the data were tabulated and separated according to sex, skull side, and age groups. Statistical Package for the Social Science (version 11.5) software (SPSS; Chicago, IL, USA) was used for the analysis. The Chi-square test was used to test for type differences. The mean, standard deviation (SD) and range for each of the measurements were assessed. Unpaired t-test was used to compare the age difference between sexes. A comparison of the values of all measurements was made among groups using One-way ANOVA and Scheffe's test in the data with equal variances or Brown-Forsythe test and Tamhane's test in the data with different variances. Differences among groups were considered statistically significant at p-values of less than 0.05.

Results

Two hundred sixty eight skulls investigated in the present study comprised 175 males (65.3%) and 93 females (34.7%) with the mean age of 59.31 ± 18.02 years (18 to 94 years). There was no significant age difference between male (60.59 ± 17.13 years) and female (56.86 ± 19.47 years) ($p = 0.112$).

Type and occurrence of pterion

Types of the pterion and their occurrence present in 536 sides of 268 Thai skulls are shown in Table 1. The most common type was the sphenoparietal type (81.2%), followed by the epipteric type (17.4%), the frontotemporal type (1.1%), and, the stellate type (0.4%). Chi-square test demonstrated the significant difference between sexes ($p < 0.05$), but not sides and ages.

There was variability in the number, shape, and extent of epipteric bones, but the classification of the epipteric bones was not included in the present study.

The present study determined the sphenoparietal type of pterion is predominantly present on either side of the skull. The results in Table 2 demonstrate two bilateral symmetrical pairings and seven bilaterally asymmetrical pairings of pterion types on both skull sides. Bilaterally symmetrical pairings (84.7%) were found much more often than asymmetrical ones (15.3%). The sphenoparietal type was a predominant feature in both symmetrical (87.2%) and asymmetrical series (95.1%).

The distribution of pterion types was also compared between male and female skulls (Table 2). The bilaterally symmetrical type was slightly more

Table 1. Pterion types in adult skulls and their comparisons between sex, side, and age range groups (n = 268)

Pterion types	Total	Side		Sex		Age range	
		Right	Left	Male	Female	≤ 25 years	> 25 years
Sphenoparietal	81.2%	81.0%	81.3%	83.4%	76.9%	76.5%	81.6%
Frontotemporal	1.1%	1.5%	0.7%	0.6%	2.2%	0%	1.0%
Epipteric	17.4%	17.5%	17.2%	16.0%	19.9%	23.5%	16.9%
Stellate	0.4%	0%	0.7%	0%	1.1%	0%	0.4%

Data are expressed as percentage of sides

Sex versus occurrence of pterion, $X^2 = 8.171$, $df = 3$, $p = 0.031$

Side versus occurrence of pterion, $X^2 = 2.680$, $df = 3$, $p = 0.575$

Age range versus occurrence of pterion, $X^2 = 1.385$, $df = 3$, $p = 0.596$

Table 2. Pairing of four types of pterion in adult skulls and their distributions between sex and age groups

Pairing of types		Total n = 268	Sex		Age	
Right	Left		Male	Female	≤ 25 years	> 25 years
Sp	Sp	73.9%	75.4%	71.0%	64.7%	74.7%
E	E	10.8%	8.6%	15.1%	11.8%	10.6%
E	Sp	6.3%	7.4%	4.3%	11.8%	7.2%
Sp	E	6.0%	7.4%	3.2%	11.8%	5.7%
F	Sp	1.1%	1.1%	1.1%	0%	0.8%
Sp	F	0.7%	0%	2.2%	0%	0.8%
F	E	0.4%	0%	1.1%	0%	0.4%
Sp	S	0.4%	0%	1.1%	0%	0.4%
E	S	0.4%	0%	1.1%	0%	0.4%
Total		100%	100%	100%	100%	100%
Bilateral		84.7%	84.0%	86.0%	76.5%	85.3%
Unilateral		15.3%	19.0%	14.0%	23.5%	14.7%

Data are expressed as percentage of skulls

Sp, sphenoparietal; F, frontotemporal; E, epipteric; and S, stellate

Sex versus occurrence of pterion, $X^2 = 14.666$, $df = 8$, $p = 0.034$

Age range versus occurrence of pterion, $X^2 = 2.453$, $df = 8$, $p = 0.781$

common in females (86.1%) than in males (84.0%). Nine combination types were observed in females, whereas only five combinations were found in males (Table 2). There was no statistical significance among the pairings of pterion types regarding sex and age (Table 2, Chi-square test, $p > 0.05$).

Location and bone thickness at pterion

Four linear measurements were taken from the center of the pterion for the determination of its location (Table 3). On the external aspect of the skull, mean distances measured from the center of pterion were 38.48 ± 4.38 mm superior to the zygomatic arch

and 31.12 ± 4.89 mm posterior to the frontozygomatic suture. On the internal aspect of the skull, mean distances measured from the corresponding point of the center of pterion were 38.94 ± 3.76 mm horizontally to the lateral margin of the optic canal and 11.70 ± 4.83 mm to the lateral end of the ridge on the lesser wing of the sphenoid.

Of total pteria, 37.1% were identified as high pteria and 22.9% were backward pteria. There was a significant difference between sides of the high pteria ($p = 0.025$), but no difference was seen between sex and age ranges. The backward pteria were more frequently observed in males (78.9%) than in females

Table 3. Location of the pterion in relation to identifiable skull landmarks compared among sex-side groups

Distance (mm)	n	Total	Male				Female			
			n	Right	n	Left	n	Right	n	Left
CPt-Zy	536	38.48 ± 4.38	175	38.92 ± 4.82	175	38.16 ± 4.12	93	38.87 ± 4.15	93	37.85 ± 4.12
CPt-FS	536	31.12 ± 4.89	175	31.73 ± 4.95 ¹	175	31.67 ± 5.13 ²	93	30.27 ± 4.37	93	29.83 ± 4.51 ^{1,2}
CPt-OC	282	38.94 ± 3.76	92	39.07 ± 4.43	92	38.70 ± 3.62	49	39.09 ± 3.14	49	39.00 ± 3.28
CPt-SpR	279	11.70 ± 4.83	91	11.75 ± 5.30	91	11.72 ± 5.02	48	11.92 ± 4.49	49	11.37 ± 3.89
Suture length at pterion	440	11.56 ± 4.51	147	12.05 ± 4.84	146	11.90 ± 4.50	74	10.38 ± 3.93	73	11.08 ± 4.19
Bone thickness at CPt	298	5.13 ± 1.67	99	5.22 ± 2.06	99	5.43 ± 1.71 ³	50	4.59 ± 1.03 ³	50	4.92 ± 1.01

Data are expressed as means ± SD of linear distances in mm. CPt, center of the pterion; Zy, zygomatic arch; FS, frontozygomatic suture; OC, lateral margin of the optic canal; and SpR, lateral end of the ridge on the lesser wing of the sphenoid. One-way ANOVA and Scheffe's test: 1, 2 indicated differences at $p < 0.05$. Brown-Forsythe test and Tamhane's test: 3 indicated differences at $p < 0.05$

(21.1%) ($p < 0.001$), and there were differences between sides and age ranges (data not shown).

Mean length of all pterion sutures was 11.56 ± 4.51 mm (Table 3) while mean lengths in sphenoparietal and frontotemporal types were 11.60 ± 4.48 mm and 9.04 ± 6.04 mm, respectively. Mean skull thickness at the center of pterion was 5.13 ± 1.67 mm.

Comparison of all studied distances and skull thickness among sex-side groups is shown in Table 3. There was no difference among sex-side groups for any of the measurements, except for the distance from the center of pterion to the frontozygomatic suture, there were significant differences between male right and female left, and male left and female left ($p < 0.05$). The thickness of the center of pterion was different between male left and female left ($p < 0.05$).

Comparisons of all measured distances and skull thickness were performed between age groups. No significant difference was apparent between age groups, except for the distance from the center of pterion to the frontozygomatic suture between the groups aged 25 years or younger (29.41 ± 3.86 mm) and those older than 25 years (31.29 ± 4.91 mm) ($p < 0.05$).

Discussion

In neurosurgery, successful treatment of pathologies with minimally invasive procedure is the main objective⁽⁸⁾. Pterional craniotomy is one of the most common and versatile approaches for the neurosurgeons because its use is amenable for gaining access to many lesions and tumors of the brain located in the anterior and posterior circulation, sylvian fissure, sellar and parasellar regions, superior orbital fissure, sphenoidal wing, cavernous sinus, orbit, optic nerve,

mesial temporal lobe, midbrain, and posterior-inferior frontal lobe^(6,8,9,11-14,17-20). Recently, Chao et al (2008) reviewed and reported successful microsurgical removal of sylvian fissure lipoma with pterion keyhole approach⁽⁶⁾. Therefore, detailed knowledge of pterion types and their location related to the surrounding identifiable landmarks is crucial for surgeons in the diagnosis, planning and treatment of vascular microsurgery and neurosurgery via pterional approaches^(9,11). Here the authors report in 268 Thai skulls. The two most common types of the pterion were sphenoparietal (81.2%) and epipteric (17.4%). Externally, the pterion was located 38.48 ± 4.38 mm superior to the zygomatic arch and 31.12 ± 4.89 mm posterior to the frontozygomatic suture. Internally, it was located 38.94 ± 3.76 mm horizontally from the optic canal and 11.70 ± 4.83 mm to the sphenoid ridge. According to the present result, two measurable distances from zygomatic arch and the frontozygomatic suture could be used in precisely determining the center of pterion for the external pterional approaches, especially in Thais. In addition, the neurosurgeons would be aware of the distances between the internal center of pterion and the two prominent landmarks, optic canal, and sphenoid ridge when approaching further inside the skull.

Type of pterion

The classification of pterion types was first described by Broca⁽²¹⁾ according to the sutural relationships between the corresponding bones, including *pterion en H* (sphenoparietal type), the *pterion retourne* (frontotemporal type) and *pterion en K* (stellate type). The configuration of pterion could

also be influenced by the number, form, extension, and location of the epipteric bones^(15,16). Therefore, the pterion types in the present study were identified according to the criteria of Murphy⁽¹⁵⁾ as sphenoparietal, frontotemporal, stellate, and epipteric types. In the present study, the shape and location of the sutural contact between contiguous bones at the pterion were rather variable. Murphy⁽¹⁵⁾ showed 16 possible combinations with four types of pterion, four bilaterally symmetrical and 12 bilaterally asymmetrical types. Four types of the pterion and their nine combinations were found in the present study (Table 1, 2, respectively).

The type of pterion is generated by the degree of relative growth of the pteric bones, forming varying sutural patterns⁽¹⁵⁾. It has been reported that the frontotemporal is the dominant type in primates while sphenoparietal is the dominant type in *Homo*⁽²²⁾. The anterosuperior segment of the squamous part of temporal bone of the lower primates detached and became incorporated in the posterosuperior angle of the greater wing of sphenoid of *Homo* during phylogenesis, thereby changing the pterion pattern from frontotemporal of primates to sphenoparietal of *Homo*. If the desequestered portion remains permanently detached from either of the two bones, it gives rise to an epipteric bone⁽²²⁾.

The pterion develops from the anteriolateral fontanelle on the neonatal skull approximately 3 months after birth⁽⁵⁾. A recent study of the pterion in 35 neonatal cadavers showed the lack of complete bony structure and the authors considered the formation of different shapes of the pterion may depend upon the varied rate of ossification of bony tissue in calvarium from childhood to adulthood⁽²³⁾.

Comparisons of the pterion types in Thais with other racial populations are shown in Table 4. The most predominant type in Thais was sphenoparietal (81.2%) which was comparable with previous records and its occurrence was between 71.7% in Northern Indians⁽⁴⁾ and 88.0% in Turkis⁽⁹⁾. In addition, there were variations of the epipteric type among racial populations (Table 4). It was found up to 17.4% in Thais which was comparable with Australian Aborigines⁽¹⁵⁾, but lower than Northern Indians⁽⁴⁾ and higher than Japanese⁽²⁴⁾, Indians, Nigerians⁽¹⁶⁾, and Turkish males⁽⁹⁾. The occurrence of the frontotemporal type (1.1%) and stellate type (0.4%) of the pterion in the present study were rather low and similar to those in others as shown in Table 4.

The symmetrical pairing of the pterion has been observed with all types in the present study, except the stellate type. The most common pterion in Thais was the sphenoparietal type (73.9%), which is in agreement with the occurrence in Asiatic Indians (73.6%)⁽¹⁶⁾, Nigerians (75.0-86.7%)⁽¹⁶⁾ and Turkis (77.0%)⁽⁹⁾, but higher than in Australian Aborigines (62.0%)⁽¹⁵⁾.

Murphy⁽¹⁵⁾ suggested sex, side, and age had no influence on the occurrence of the type of pterion, while Oguz et al⁽⁹⁾ stated the pterion on the right and left sides in the Turkish skulls were not always the same type; however, the symmetrical pattern was observed in up to 77% of cases. The reason for frequent side differences was the greater wing of the sphenoid on the left was broader than on the right side⁽⁹⁾. However, the statistical analysis in the present study indicated a significant sex difference in the type occurrence. The discrepancy in these results is probably due to the different racial groups and the

Table 4. Comparison of the occurrence of four types of pterion among racial groups

Investigators	Races	Skulls	Sides	Pterion types			
				Sphenoparietal	Frontotemporal	Epipteric	Stellate
Murphy ⁽¹⁵⁾	Australian aborigines	368	736	73.2%	7.7%	18.3%	0.7%
Agarwal et al ^{(4)*}	Northern Indians		900	71.7%	3.3%	23.3%	1.7%
Saxena et al ^{(16)*}	Nigerians	40	80	81.3%	11.3%	2.5%	5.0%
	Indians	72	144	82.6%	2.8%	13.2%	1.4%
Matsumura et al ⁽²⁴⁾	Japanese		580	82.4%	2.9%	14.0%	0.7%
Oguz et al ⁽⁹⁾	Turkish males	26	52	88.0%	10.0%	2.0%	0%
Present study	Thais	268	536	81.2%	1.1%	17.4%	0.4%

* The values was recalculated from the original data by combining the occurrence of pterion (sphenoparietal, frontotemporal, and stellate) and epipteric bones

different methods of the study. The present study is unique in that the material was collected with known race, sex, and age. The subjects from males and females have a known and similar age range, and the results were subjected to statistical analyses. It was therefore possible to investigate sexual dimorphism and age differences. In Murphy's study, sex of skulls was determined according to the observer's judgment and age was estimated according to the tooth eruption and the degree of tooth attrition⁽¹⁵⁾.

Location of pterion

The anatomic location of the pterion has been determined to be located 4.0 cm superior to the zygomatic arch and 3.0-3.5 cm posterior to the frontozygomatic suture⁽¹⁻³⁾. However, a comparative study of the distance between the center of pterion and the zygomatic arch reported differences between Nigerians and Indians⁽¹⁶⁾. In the present study, the mean of this distance (38.5 mm) was between that found in Indians (36.0-38.0 mm), Nigerians (39.6 mm)⁽¹⁶⁾, and Turks (38.5-40.5 mm)⁽⁹⁾. The distance between the center of pterion and the frontozygomatic suture in Thais was 31.1 mm, in the same range of previous studies in Nigerians (32.0-33.0 mm), Indians (32.0-34.0 mm)⁽¹⁶⁾ and Turks (33.0-34.4 mm)⁽⁹⁾. The two distances are of practical importance in pterional approaches to many regions of brain.

In the present study, differences in the distance from the center of the pterion to the frontozygomatic suture was observed between sex-side and age groups, while differences in distance from the center of the pterion to the zygomatic arch was found between sides in Turks⁽⁹⁾. The discrepancy of these results is likely due to the different races.

Saxena et al⁽¹⁶⁾ reported a higher occurrence of a high pterion in Nigerians (right, 19.0% and left, 15.2%) than in Indians (right, 13.9% and left, 12.7%), while a backward pterion in Indians (right, 19.4% and left, 11.1%) was higher than in Nigerians (right, 7.6% and left, 2.1%). In the present study, high pteria (37.1%) or backward pteria (22.9%) were much greater than found in Nigerians and Indians. However, high pteria were predominant on the right side as previously reported in Nigerians and Indians⁽¹⁶⁾.

The pterional approach may be used to reach tumors, such as meningiomas, located laterally in the brain⁽²⁵⁾, in which case the distance between the internal aspect of the pterion and the lateral end of the sphenoid ridge is useful information for the operation. In the present study, this distance was 11.70 ± 4.83 mm

(Table 3). The pterional approach can also be used to access the optic canal^(7,10), where the distance between the internal aspect of the pterion and the lateral margin of the optic canal is a crucial parameter. This distance in Thais found in the present study was 38.94 ± 3.76 mm (Table 3). It has been reported in Turkish adult males that distances of the pterion were 4.39 ± 0.40 cm (right) and 4.36 ± 0.40 cm (left) to the optic canal and 1.40 ± 0.33 cm (right) and 1.48 ± 0.32 cm (left) to the sphenoid ridge⁽⁹⁾. Both distances in the Turkis were longer than those in Thais⁽⁹⁾.

However, the measurements of other landmarks related to the pterion both on the external and internal aspects such as zygoma root, suprameatal spine (Henle's spine), mastoid tip, Frankfurt horizontal plane, asterion, lateral orbital rim, external occipital protuberance, dorsum sellae, optic chiasma and infundibulum of hypophysis may also be helpful to locate the pterion, especially when particular techniques such as radiotherapy are employed⁽²³⁾. These parameters would be advantageous to undergo minimal invasive keyhole surgery in and around pterional area⁽²³⁾.

Length of the pterion suture

The results from the present investigation indicated mean lengths corresponding to the sphenoparietal contact and the frontotemporal contact were 11.60 ± 4.48 mm and 9.04 ± 6.04 mm, respectively (Table 3). They were different from those (6.5 ± 3.6 mm in the sphenoparietal suture length and 11.2 ± 4.2 mm in the frontotemporal suture length) in Australian aborigines⁽¹⁵⁾.

Thickness of pterion

Pensler and McCarthy⁽²⁶⁾ measured the thickness of the frontal and the parietal bones and reported the parietal bone of blacks was thicker than that of whites, and the parietal bone of males thicker than that of females, and weight, race, and sex were significant variables, but not age and height. Hwang et al⁽²⁷⁾ reported the bone thickness at pterion of the left side was significantly thicker than the right side of Korean adult skulls. In the present study, mean thickness at the center of the pterion was 5.13 ± 1.67 mm, which is thicker than in Turks ($3.9-4.1$ mm)⁽⁹⁾ and Korean skulls (3.19 ± 0.85 mm). The results from the present study also demonstrated significant thickness difference among sex-side groups (between male left and female right) ($p < 0.05$), while age was not a significant variable. These findings are consistent

with previous studies in whites, blacks, and Koreans^(26,27). These data provide practical information to estimate the thickness of the pterion for a safe and effective approach for internal or external fixation during craniofacial procedures.

Localization of the position of pterion and its surrounding structures, using contemporary neurological techniques, advanced technological techniques including the development of endoscopic techniques for exposure to the lesion in the brain particularly, CT scans, or magnetic resonance angiography would determine more precise relationships between bony landmarks and the underlying soft tissues preoperatively. The present finding concerning the pterion and its localization was readily obtained from the examination of normal dry skulls and should be used as approximate measurements. Nevertheless, this basic information provides useful guidelines for surgeons to estimate the position of pterion before employing sophisticated equipment and methods.

Conclusion

Types and the position of the pterion in normal skulls vary among individuals and different racial groups. Sex has influence on the occurrence of the pterion type, while sex, side, and age affect the location of the pterion. Therefore, accurate and up-to-date data are required when performing intracranial surgery guided by recognizable bony landmarks. Preoperative radiographic assessment (CT images, magnetic resonance radiographs) of the pterion should be confirmed to be an anatomic guideline for surgeons in determining a safe location for performing surgical and microsurgical procedures.

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Potential conflicts of interest

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การพิจารณาทางกายวิภาคของบริเวณตัดดอกไม้และการวัดตำแหน่งอ้างอิงในกะโหลกสำหรับ ศัลยกรรมผ่านทางบริเวณตัดดอกไม้

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วัตถุประสงค์: บริเวณตัดดอกไม้เป็นจุดกำหนดที่สำคัญมากต่อศัลยกรรมที่จะผ่านไปสู่หลอดเลือดแดงมีดเคิลมีนิงเจียลรอยโรค และเนื่องจากบางชนิดในสมอง การศึกษานี้มีวัตถุประสงค์เพื่อวิเคราะห์ชนิดของบริเวณตัดดอกไม้ และตำแหน่งที่สัมพันธ์กับจุดกำหนดเฉพาะซึ่งอยู่ข้างเคียงในกะโหลก นอกจากนี้ยังทำการเปรียบเทียบการแปรผันของบริเวณตัดดอกไม้ระหว่างเพศ อายุ และด้านของกะโหลก

วัสดุและวิธีการ: การศึกษากระทำในกะโหลกคนไทยทั้งสองด้าน จำนวน 268 กะโหลก บริเวณตัดดอกไม้สามารถจัดจำแนกเป็น 4 ชนิด ได้แก่ ชนิดสฟีนอยด์โพสเทอริโอเรียล ชนิดฟรอนโทเทมโพเรียล ชนิดเทลเลต หรือชนิดเอพิเทริก การระบุตำแหน่งของบริเวณตัดดอกไม้กระทำโดยการวัดระยะจากจุดศูนย์กลางของบริเวณตัดดอกไม้ไปยังจุดกำหนดที่อยู่ข้างเคียง

ผลการศึกษา: ชนิดของบริเวณตัดดอกไม้ที่พบบ่อยที่สุดคือ ชนิดสฟีนอยด์โพสเทอริโอเรียล (ร้อยละ 81.2) และชนิดเอพิเทริก (ร้อยละ 17.4) เมื่อศึกษาจากด้านนอกกะโหลกมักพบบริเวณตัดดอกไม้อยู่เหนือต่อโค้งกระดูกโหลกแกมเท่ากับ 38.48 ± 4.38 มม. และอยู่หลังต่อรอยประสานหน้าผากและโหลกแกมเท่ากับ 31.12 ± 4.89 มม. เมื่อศึกษาจากด้านในกะโหลกบริเวณตัดดอกไม้มักพบห่างจากด้านข้างต่อคลองประสาทตาเท่ากับ 38.94 ± 3.76 มม. และห่างจากสันสฟีนอยด์เท่ากับ 11.70 ± 4.83 มม. โดยเพศมีอิทธิพลต่อการวัดของชนิดของบริเวณตัดดอกไม้ ในขณะที่ เพศ ด้าน และอายุของกะโหลกมีอิทธิพลต่อตำแหน่งของบริเวณตัดดอกไม้ ความหนาเฉลี่ยของบริเวณตัดดอกไม้เท่ากับ 5.13 ± 1.67 มม.

สรุป: บริเวณตัดดอกไม้ที่พบบ่อยที่สุดคือชนิดสฟีนอยด์โพสเทอริโอเรียล มักพบอยู่เหนือต่อโค้งกระดูกโหลกแกมเท่ากับ 39 มม. หลังต่อรอยประสานหน้าผากและโหลกแกมเท่ากับ 31 มม. อยู่ข้างต่อคลองประสาทตาเท่ากับ 39 มม. และห่างจากสันสฟีนอยด์เท่ากับ 12 มม. ข้อมูลที่ได้จากการศึกษานี้จะเป็นประโยชน์ในทางคลินิก สำหรับการระบุตำแหน่ง ของบริเวณตัดดอกไม้
