

กายวิภาคบริเวณทศดอกไม้และตำแหน่งสำหรับการผ่าตัดทางประสาทศัลยศาสตร์: การศึกษาจากร่างอาจารย์ใหญ่ในภาคใต้ของประเทศไทย

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บทคัดย่อ

บริเวณทศดอกไม้เป็นตำแหน่งของรอยประสานกะโหลกศีรษะทางด้านข้าง เป็นจุดที่กะโหลกหน้าผาก กะโหลกข้าง กะโหลกขมับ และกะโหลกสphenoid มาเชื่อมต่อกัน โดยความสำคัญของตำแหน่งและลักษณะกายวิภาคของบริเวณนี้คือ ใช้เป็นจุดอ้างอิงในการผ่าตัดเพื่อเข้าสู่ฐานกะโหลกส่วนหน้าและส่วนกลาง ดังนั้น การศึกษานี้มีวัตถุประสงค์เพื่อศึกษาสัณฐานวิทยาและตำแหน่งของกายวิภาคบริเวณทศดอกไม้ ซึ่งรวบรวมได้ทั้งสิ้น 60 ตำแหน่งจากร่างอาจารย์ใหญ่ทั้งสิ้น 30 ร่าง สัณฐานวิทยาและลักษณะรอยประสานกะโหลกบริเวณทศดอกไม้อ้างอิงตามการแบ่งประเภทของเมอร์ฟี ผลการศึกษาพบว่า ลักษณะรอยประสานกะโหลกของบริเวณทศดอกไม้ที่พบบ่อยในร่างอาจารย์ใหญ่ในภาคใต้ของประเทศไทยคือซินดิสฟิโนพาเรียทัล รองลงมา ได้แก่ ซินดิสฟิเทอริก ฟรอนโตเทมพอร์ล และซินดิสรูบราว ตามลำดับ นอกจากนี้ ยังศึกษาระยะห่างระหว่างบริเวณทศดอกไม้กับตำแหน่งกายวิภาคภายนอกของกะโหลกศีรษะ 5 ตำแหน่ง ได้แก่ ตำแหน่งรอยประสานฟรอนโตไซโกมาติก กึ่งกลางโค้งกระดูกโขนกแก้ม ปากกรู ปุ่มกกหู และมุมกระดูกโขนกแก้ม และระยะห่างจากตำแหน่งกายวิภาคภายในกะโหลกศีรษะ 2 ตำแหน่ง ได้แก่ สันสphenoid และช่องเส้นประสาทตา ผลของการศึกษานี้คาดว่าจะมีส่วนช่วยในการผ่าตัดทางประสาทศัลยศาสตร์ ในการเปิดช่องกะโหลกที่เหมาะสมในกรณีที่ขาดแคลนอุปกรณ์เครื่องมือและเป็นข้อมูลพื้นฐานสำหรับนักนิสิตมานุษยวิทยาในการศึกษาต่อไป

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Pterion and its location for neurosurgical approach: a cadaveric study in Southern Thailand

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Abstract

The pterion is a sutural confluence area in the lateral section of the skull where the frontal, parietal, temporal, and sphenoid bones are connected. A knowledge of the exact location and anatomical landmarks of the pterion is crucial in surgical intervention to approach the anterior and middle cranial fossae. Therefore, the present study aims to determine the types and positions of pterion. First, sixty pterions from 30 cadaveric skulls were obtained. Second, the morphology and sutural patterns of the pterion were determined based on Murphy's classification. The results found that the most common type of pterion among Southern Thai people in this study was the sphenoparietal type, followed by epipteric, frontotemporal and stellate types, respectively. Additionally, this study provided valuable data on the mean distance from the location of the pterion to five external landmarks, including the frontozygomatic suture, the mid-zygomatic arch, the external acoustic meatus, mastoid process, and the zygomatic angle; and two internal landmarks, the sphenoid ridge and the optic canal. All of the results in this study may be important for neurosurgery on the optimal bony aperture when neuronavigation devices are not available, and provide forensic anthropology information for further study.

Keywords: pterion, skull, surface anatomy, craniotomy

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Introduction

The pterion is a suture between the frontal, parietal, temporal, and sphenoid bones¹. In 1875, Broca first identified three types of pterion based on the location of its adjacent bones². The sphenoparietal type directly connects the sphenoid and the parietal bones, whereas the frontotemporal type shows direct conjunction of frontal and temporal bones. The stellate type is characterized by the four bones, frontal, parietal, temporal, and sphenoid bones, joining. In 1956, Murphy classified the epiteric type, the fourth type of pterion, that had a small bone(s) or Wormian bone(s) among the four bones³.

Knowledge of the location and anatomical landmarks of pterion is crucial for surgeons to approach the anterior and middle cranial fossae. The Pterion region is related to several structures in the cranial cavity such as the anterior branch of the middle meningeal artery, the lesser wing of the sphenoid bone, the anterior pole of the insula, motor Broca's area, anterior Sylvian point of the Sylvian fissure, and inferior frontal gyrus⁴⁻⁶. In neurosurgery, pterional approach is commonly performed for treatment of the anterior circulation artery aneurysm and of superior basilar complex aneurysms^{7,8}, removal of orbital or cranioorbital tumors⁹, sellar, and parasellar lesions^{10,11}. Up to date, the pterional approach, a traditional technique described by Yasargil, had been developed to a smaller bone flap opening as a mini-pterional approach by Pernecsky¹²⁻¹⁴. This provided the

basis for neuronavigation devices which are applied to identify the targeted area in the cranial cavity. However, not every hospital has access to a neuronavigation system¹⁵ and as it requires a certain amount of time for devices preparation it is not suitable for emergency cases. Thus, the morphology and location of pterion including the distance from five external landmarks (frontozygomatic suture, mid zygomatic arch, external acoustic meatus, mastoid process, and zygomatic angle) and two internal landmarks (sphenoid ridge and optic canal) to pterion¹⁶, are of interest mainly to surgeons providing the benefit on patient's treatment, aesthetic and recovery.

Materials and Methods

The authors conducted the study on adult human cadaveric heads obtained from the Anatomy Program, Division of Health and Applied Sciences, Faculty of Science. After the institute's ethics committee (REC.63-343-19-2) approval, 30 formalin-fixed cadaveric heads were collected. The heads presenting congenital anomalies of cranial or previous skull procedures were rejected. Then, all cadaveric data including age, sex, type of pterion, pterion thickness, and the location of pterion related to both external and internal anatomical landmarks were recorded and statistically analyzed.

Type of pterion

To identify the type of pterion, the pterion region, and relevant anatomical landmarks were opened by removing the scalp and temporalis muscles from the cadaveric

head. Morphology and sutural pattern of the pterion on both sides of each skull was determined based on Murphy's classification

including sphenoparietal, frontotemporal, stellate, and epipterical types³ (Fig. 1).

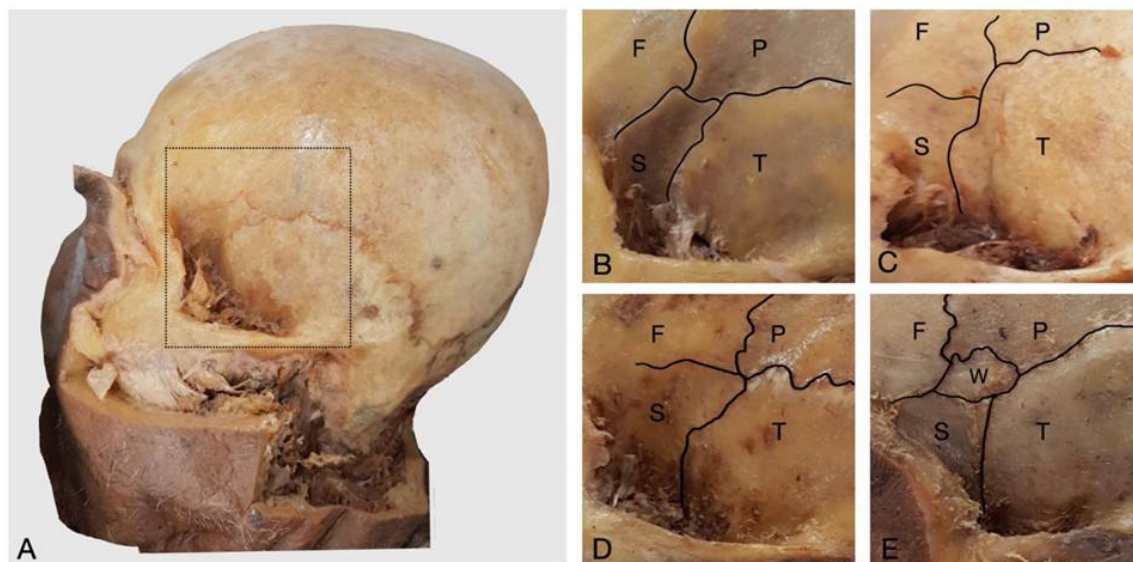


Figure 1 Type of pterion in cadavers of southern Thailand. (A) The pterion is a suture between the frontal, parietal, temporal, and sphenoid bones at the left side of the skull; (B) Sphenoparietal type, (C) Frontotemporal type, (D) Stellate type, and (E) Epipterical type. Frontal bone (F), Parietal bone (P), Temporal bone (T), Sphenoid bone (S), Wormian bone (W).

Location of pterion

After the recorded type of pterion, the authors located the center of pterion (cPT) as the smallest circle covering a part of four cranial bones; frontal, parietal, temporal, and sphenoid bones. The authors drilled a small hole of 2 mm in diameter at cPT perpendicular to the plane of the zygomatic arch. From this point, the authors measured the linear distance between the five outer bony landmarks, including the posterolateral aspect of frontozygomatic suture (FZ), the midpoint of the zygomatic arch (MZ), zygomatic angle (ZA), the mid-superior edge of external

acoustic meatus (EAM), and the tip of mastoid process (MP) to cPT (Fig. 2A). To determine the inner surface distance, the authors cut the cranium vault circumferentially at two centimeters above the supraorbital margin and the inion (Fig. 2B). After upper part of skull and brain removal, the distance from two inner bony landmarks was observed, the lateral end of the crest on the lesser wing as a sphenoid ridge (SR) of the sphenoid bone and distance from the lateral margin of the optic canal (OC) to the inner surface of cPT (iPT) recorded (Fig. 2B).

The authors used stainless steel sliding calipers (Mitutoyo®, Japan) with an accuracy

of 0.01 mm for all measurements. All measurements were taken four times by two

authors and then averaged to minimize bias errors.

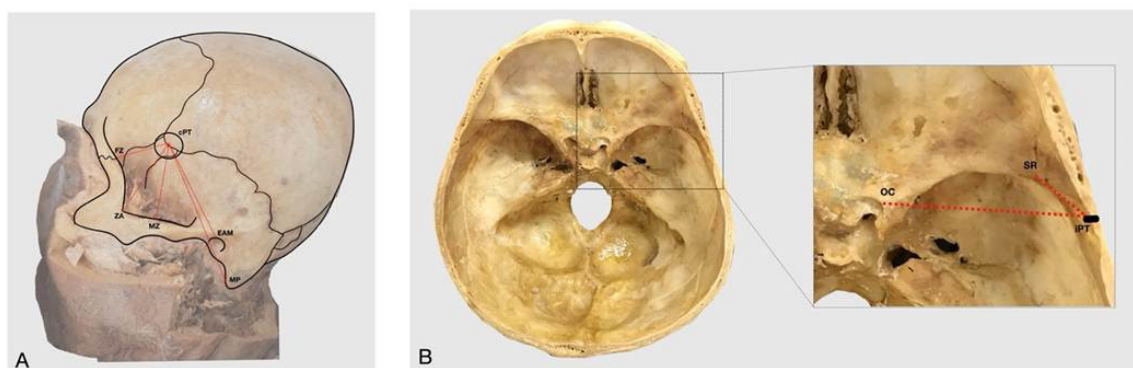


Figure 2 Location of pterion from external and internal landmarks (A) Distance from Frontozygomatic suture (FZ), Zygomatic angle (ZA), Midpoint of the zygomatic arch (MZ), the mid-superior edge of external acoustic meatus (EAM), and the tip of mastoid process (MP) to the external center of pterion (cPT). (B) Distance from Sphenoid ridge (SR) and the optic canal to the internal center of pterion (iCP).

Statistical analysis

All data were classified based on sex and skull sides. R Foundation for Statistical Computing (version 3.6.3) was used for statistical analysis. The differences in the type of pterion between male and female were statistically analyzed with the Chi-square test and expressed as mean and standard deviation (SD), whereas the distances of the location of pterion between sexes and each side were calculated with the unpaired t-test. A probability value among groups less than 0.05 ($P < 0.05$) indicated a significant difference.

Results

The 60 pterions from 30 formalin-fixed adult cadavers' heads, equally 15 cadavers for male and female were evaluated. The mean age of cadaveric was 79.80 ± 12.91 years,

when comparing between sexes, the mean age of males was higher than females (83.50 ± 9.15 years and 76.1 ± 15.10 years, respectively). For the sake of clarity, the authors present the results in four sections: 1) Type of pterion in cadaver, 2) Distance between external landmarks to cPT, 3) Distance between internal landmarks to iCP, and 4) The skull thickness at center pterion.

1) Type of pterion in cadaver

Four types of pterion including sphenoparietal, frontotemporal, stellate, and epipteric types were identified from 60 pterions. The authors found that the sphenoparietal type was the most common (76.7%), followed by epipteric (13.3%), frontotemporal (6.7%), and stellate (3.3%) (Table 1).

To compare the pterion type between sex, the male group was presented with 38.4% sphenoparietal type (on the right side 16.7% and the left side 21.7%), followed by 5% epipteric type on the right side, 3.4% frontotemporal type (on each side 1.7%), and 3.4% stellate type (on each side 1.7%). No

stellate type of pterion was observed in female cadavers. Females were presented with 38.3% sphenoparietal type (on the right side 18.3% and the left side 20%), followed by 8.3% epipteric type (on the right side 3.3% and on the left side 5%), 3.3% frontotemporal type on the right side (Table 1).

Table 1 Types of pterion

Sex	Side	Type of pterion			
		Sphenoparietal	Frontotemporal	Stellate	Epipteric
Male	Right	10 (16.7)	1 (1.7)	1 (1.7)	3 (5.0)
	Left	13 (21.7)	1 (1.7)	1 (1.7)	0
Female	Right	11 (18.3)	2 (3.3)	0	2 (3.3)
	Left	12 (20.0)	0	0	3 (5.0)
Total		46 (76.7)	4 (6.7)	2 (3.33)	8 (13.3)

Values are presented as number (%). (n=60)

2) Distance between external landmarks to cPT

To locate the pterion area, the authors measured the distance from five external skull landmarks to the center of the pterion (cPT). The mean distance from FZ to cPT, pterion in cadaveric males is located 26.4 ± 6.8 mm behind the anterior aspect of FZ on the right side and 30.6 ± 4.2 mm on the left side of skulls, whereas pterion in cadaveric females is located 32.0 ± 4.4 mm. behind the anterior aspect of FZ on the right side and 33.3 ± 6.2 mm on the left side of skulls. For both sexes, the distance from FZ to cPT showed a statistical difference (Table 2).

The mean distance from MZ to cPT, pterion in cadaveric males is located 41.7 ± 13.8 mm. above the superior aspect of

MZ on the right side and 43.3 ± 13.5 mm on the left side of skulls, while the pterion in cadaveric females is located 41.9 ± 3.0 mm above the superior aspect of MZ on the right side and 42.0 ± 5.6 mm on the left side of skulls (Table 2).

Concerning the mean distance from the EAM to cPT, the pterion in cadaveric males is located 55.1 ± 3.2 mm behind the EAM on the right side and 53.6 ± 3.1 mm on the left side of skulls, while pterion in cadaveric females is located 55.7 ± 4.4 mm behind the EAM on the right side and 54.8 ± 3.8 mm on the left side of skulls (Table 2).

The mean distance from the MP to cPT, pterion in cadaveric males is located 86.6 ± 5.7 mm upper the MP on the right side and 85.7 ± 5.0 mm on the left side of skulls,

whereas pterion in cadaveric females is located 85.5 ± 5.1 mm above the MP on the right side and 85.1 ± 4.5 mm on the left side of skulls (Table 2).

Finally, the mean distance from the ZA to cPT, the pterion in cadaveric males is located 38.7 ± 7.8 mm upper the ZA on the right side and 40.9 ± 4.5 mm on the left side of skulls, while the pterion in cadaveric females is located 42.6 ± 4.5 mm above the ZA on the right side and 42.7 ± 7.4 mm on the left side of skulls (Table 2).

3) Distance between internal landmarks to iCP

To determine the inner surface distance, the authors measured the distance from two inner bony landmarks to the inner surface of cPT. The mean distance from the SR to iPT, the pterion in cadaveric males is located 12.0 ± 1.8 mm lateral to the SR on the right side and 12.9 ± 4.2 mm on the left

side of skulls, while the pterion in cadaveric females is located 13.1 ± 4.8 mm lateral to the SR on the right side and 13.8 ± 5.3 mm on the left side of skulls (Table 2).

Regarding the mean distance from the OC to iPT, pterion in cadaveric males is located 45.2 ± 3.1 mm beyond the OC on the right side and 45.4 ± 3.6 mm on the left side of skulls, whereas the pterion in cadaveric females is located 46.7 ± 4.0 mm following of the OC on the right side and 46.1 ± 4.6 mm on the left side of skulls (Table 2).

4) The skull thickness at center pterion

The 60 small holes at cPT of all cadavers were measured. In male cadaver, skull thickness was 4.7 ± 1.5 mm on the right side and 5.1 ± 1.8 mm. on the left side, whereas in cadaveric females the skull thickness was 5.0 ± 1.7 mm on the right side and 5.4 ± 1.3 mm on the left side (Table 2).

Table 2 Location of pterion and skull thickness at center of pterion

Sex	Side	Distance to the external center of pterion (cPT)					Distance to the internal center of pterion (iCP)		
		FZ - cPT	MZ - cPT	EAM - cPT	MP - cPT	ZA - cPT	SR - iCT	OC - iCT	Thickness (mm $\pm$ SD.)
Male	Right	26.4 ± 6.8	41.7 ± 13.8	55.1 ± 3.2	86.6 ± 5.7	38.7 ± 7.8	12.0 ± 1.8	45.2 ± 3.1	4.7 ± 1.5
	Left	30.6 ± 4.2	43.3 ± 13.5	53.6 ± 3.1	85.7 ± 5.0	40.9 ± 4.5	12.9 ± 4.2	45.4 ± 3.6	5.1 ± 1.8
	Total	$28.5 \pm 5.9^*$	42.5 ± 13.4	54.4 ± 13.4	86.1 ± 5.3	39.8 ± 6.4	12.4 ± 3.2	45.3 ± 3.3	4.9 ± 1.6
Female	Right	32.0 ± 4.4	41.9 ± 3.0	55.7 ± 4.4	85.5 ± 5.1	42.6 ± 4.5	13.1 ± 4.8	46.7 ± 4.0	5.0 ± 1.7
	Left	33.3 ± 6.2	42.0 ± 5.6	54.8 ± 3.8	85.1 ± 4.5	42.7 ± 7.4	13.8 ± 5.3	46.1 ± 4.6	5.4 ± 1.3
	Total	$32.6 \pm 5.3^*$	42.0 ± 4.4	55.2 ± 4.1	85.3 ± 4.7	42.7 ± 6.0	13.5 ± 5.0	46.4 ± 4.3	5.2 ± 1.5
Total		28.5 ± 5.9	42.5 ± 13.4	54.4 ± 13.4	86.1 ± 5.3	39.8 ± 6.4	13.0 ± 4.2	45.8 ± 3.8	5.1 ± 1.5

Values are presented as mean $\pm$ SD (mm $\pm$ SD). *Significantly different at the 0.006 level. (n=60), Frontozygomatic suture (FZ), the midpoint of the zygomatic arch (MZ), zygomatic angle (ZA), the mid-superior edge of external acoustic meatus (EAM), the tip of mastoid process (MP), Sphenoid ridge (SR), the optic canal (OC)

Discussion

The present study provides valuable information on pterion types and their location in Southern Thai cadavers. Four types of pterion, including sphenoparietal, epipteric, frontotemporal and stellate, were observed and revealed with previous studies. The pterion type found in Southern Thai male cadaveric skulls is alike to females, where the sphenoparietal type is followed by the epipteric, frontotemporal and stellate types. The distribution of pterion of this study and earlier reports on Thai people is quite similar^{16,17}. Although the studies focused on different regions, Apinhasmit et al.¹⁶ is based on Thai skulls found in the northern and central region, and the report from

Chaijaroonkhanarak et al.¹⁷ is based on Thai skulls from the northeastern region, the same pattern is found in all regions. The most common type is the sphenoparietal followed by epipteric, frontotemporal and stellate, respectively. However, the epipteric type has a high risk for neurosurgical complications. The anterior edge of the woven bone was very close to the lateral orbital rim. So, bone penetration during the procedure might be dangerous when this pterion type was not recognized. Observing the bilateral symmetrical pattern of pterion, we found a high population in northern and central Thailand¹⁶, but higher in the southern region than the northeastern region¹⁷ (Table 3).

Table 3 Distribution of pterion types among recent study in the difference population

Authors (years)	Country	n	Type of pterion (%)				Bilateral symmetrical, (%)
			Sphenoparietal	Frontotemporal	Stellate	Epipteric	
Thailand							
Present study	South, Thailand	30	76.7	6.7	3.3	13.3	53.3
Apinhasmit W. et al. (2011)	North and Central, Thailand	268	81.2	1.1	0.4	17.4	84.7
Chaijaroonkhanarak et al. (2017)	Northeast, Thailand	55	87.3	4.6	0	8.1	43.0
Other countries							
Murphy T. (1956)	Australia	368	73.0	7.5	1.0	18.5	73.9
Matsumura G. et al. (1991)	Japan	614	79.1	2.6	17.7	0.6	NA
Enoh DEO. et al. (2014)	Nigeria	50	83	5	6	5	NA

Table 3 (Con.)

Authors (years)	Country	n	Type of pterion (%)				Bilateral symmetrical, (%)
			Sphenoparietal	Frontotemporal	Stellate	Epipteric	
Ruiz CR. et al. (2016)	Brazil	55	90.0	4.6	1.8	3.6	NA
Cimen K. et al. (2019)	Turkey	75	82.0	4.7	2.7	10.7	NA
Kamath VG. et al. (2019)	Karnataka, India	50	83	10	1	6	NA
Knezi N. et al. (2020)	Serbia	50	86	0	0	14	NA

Values are presented as percent (%). NA, not applicable.

The pattern of pterion in humans is different from other. The sphenoparietal type is the most common in humans on the contrary the frontotemporal type is the most found in the primate skull, whereas the stellate type is the least common in both human and primate skull¹⁸. There are some studies of different populations to determine the most common pterion type. As well as in Thai, the sphenoparietal type is always the most found in several ethnicities including Aboriginal Australian³, Japanese¹⁹, Nigerian²⁰, Brazilian²¹, Turkish²², Indian², and Serbian²³. However, the pattern of the latter types in the Thai population is not in accordance with that in previous studies. The frontotemporal type is the second most common in Brazilain²¹ and Indian² followed by the epipteric type, while the epipteric type is the second most common in Thailand, Australia³, and Turkish²², followed by the frontotemporal type. The stellate type is the second most common in Japanese¹⁹ and Nigerian²⁰ but it is the least

common in Thailand and other regions such as Australian³, Brazilian²¹, Turkish²², Indian², and Serbian²³. Therefore, the variation of pterion type may be due to ethnic differences.

The pterion location is historically positioned by two finger breadths posterior to the lateral orbital rim and one thumb breath above the zygomatic arch¹. These two distances were objectively studied in terms of the distance from FZ to cPT and MZ to cPT. In the case of the Thai people, the FZ-cPT distance in Southern Thai skulls was slightly shorter than Northern and Central Thai¹⁶ (28.5 ± 5.9 mm vs. 31.1 ± 4.9 mm), but the MZ-cPT length of Southern Thai heads was longer (42.5 ± 13.4 mm vs. 38.5 ± 4.4 mm) (Table 4). Additionally, other external skull landmarks for located cPT, such as external acoustic meatus, mastoid process, and zygomatic angle, differ between the ethnicities (Table 4). The relationship between the pterion and intracranial structure, such as sphenoid ridge (SR) and the optic canal (OC) was

determined. It could help the surgeon to more accurately perform the pterional craniotomy, especially in keyhole surgery. The distance

from SR to the inner skull surface cPT (iPT) and OC to iPT seem to be longer in Turkish^{22,24,25} than in Indian^{2,26} and Thai skulls (Table 4).

Table 4 Location of pterion according to external and internal skull landmarks among the difference population

Authors (years)	Country		Distance to the external center of the pterion					Distance to the internal center of pterion	
			FZ - cPT	MZ - cPT	EAM - cPT	MP - cPT	ZA - cPT	SR - iCT	OC - iCT
Thailand									
Present study	South, Thailand	M, Rt.	26.4 ± 6.8	41.7 ± 13.8	55.1 ± 3.2	86.6 ± 5.7	38.7 ± 7.8	12.0 ± 1.8	45.2 ± 3.1
		M, Lt.	30.6 ± 4.2	43.3 ± 13.5	53.6 ± 3.1	85.7 ± 5.0	40.9 ± 4.5	12.9 ± 4.2	45.4 ± 3.6
		F, Rt.	32.0 ± 4.4	41.9 ± 3.0	55.7 ± 4.4	85.5 ± 5.1	42.6 ± 4.5	13.1 ± 4.8	46.7 ± 4.0
		F, Lt.	33.3 ± 6.2	42.0 ± 5.6	54.8 ± 3.8	85.1 ± 4.5	42.7 ± 7.4	13.8 ± 5.3	46.1 ± 4.6
		M	28.5 ± 5.9	42.5 ± 13.4	54.4 ± 13.4	86.1 ± 5.3	39.8 ± 6.4	12.4 ± 3.2	45.3 ± 3.3
		F	32.6 ± 5.3	42.0 ± 4.4	55.2 ± 4.1	85.3 ± 4.7	42.7 ± 6.0	13.5 ± 5.0	46.4 ± 4.3
		Rt.	30.6 ± 5.7	42.2 ± 11.2	54.8 ± 3.6	85.7 ± 5.1	41.2 ± 5.9	13.0 ± 3.7	45.8 ± 3.3
		Lt.	30.2 ± 5.2	41.7 ± 8.5	54.0 ± 3.7	84.4 ± 5.0	40.7 ± 5.8	12.8 ± 4.4	45.2 ± 3.9
	All	28.5 ± 5.9	42.5 ± 13.4	54.4 ± 13.4	86.1 ± 5.3	39.8 ± 6.4	13.0 ± 4.2	45.8 ± 3.8	
Apinhasmit W. et al. (2011)	North and Central, Thailand	All	31.1 ± 4.9	38.5 ± 4.4	NA	NA	NA	11.7 ± 4.8	38.9 ± 3.8
Other countries									
Oguz O. et al. (2004)	Turkey	Rt.	33.0 ± 4.0	40.5 ± 3.9	NA	NA	NA	14.0 ± 3.3	43.9 ± 4.0
		Lt.	34.4 ± 3.9	38.5 ± 2.5	NA	NA	NA	14.8 ± 3.2	43.6 ± 4.0
Aksu F. et al. (2014)	Turkey	Rt.	31.8 ± 4.5	40.0 ± 4.1	53.3 ± 4.6	82.5 ± 5.5	41.5 ± 5.0	NA	NA
		Lt.	31.4 ± 4.7	39.9 ± 4.0	56.2 ± 4.6	81.8 ± 5.5	41.4 ± 5.1	NA	NA
Vikram Rao KE. et al. (2017)	India	All	30.4 ± 4.4	37.4 ± 3.9	51.7 ± 4.0	80.0 ± 6.2	NA	NA	NA
Cimen K. et al. (2019)	Turkey	M	32.8 ± 4.8	36.5 ± 6.6	57.1 ± 7.7	82.6 ± 5.1	NA	NA	NA
		F	31.6 ± 4.4	35.5 ± 5.9	53.4 ± 3.6	76.2 ± 6.0	NA	NA	NA
Kamath VG. et al. (2019)	India	M, Rt.	29.9 ± 4.4	38.3 ± 4.1	NA	NA	NA	10.7 ± 2.7	43.1 ± 2.6
		M, Lt.	27.8 ± 4.6	36.8 ± 3.5	NA	NA	NA	10.8 ± 3.2	43.3 ± 3.6
		F, Rt.	26.9 ± 2.7	36.3 ± 2.7	NA	NA	NA	10.1 ± 2.4	41.8 ± 4.3
		F, Lt.	27.1 ± 5.0	35.9 ± 3.3	NA	NA	NA	10.4 ± 1.9	41.5 ± 4.41

Values are presented as mean ± SD (mm ± SD). NA, not applicable. Frontozygomatic suture (FZ), the midpoint of the zygomatic arch (MZ), zygomatic angle (ZA), the mid-superior edge of external acoustic meatus (EAM), the tip of mastoid process (MP), Sphenoid ridge (SR), the optic canal (OC)

Conclusions

Our study is the first pterion study in Southern Thailand. The sphenoparietal type occurs most commonly whereas the stellate type is rare. The skull thickness at the center of the pterion is measured about 5 mm. For both sexes, the distance from frontozygomatic suture to the center of pterion is statistically different. However, other distances to skull landmarks including mid-zygomatic arch, zygomatic angle, external acoustic meatus, the mastoid process, sphenoid ridge, and lateral aspect of the tic canal did not show a significant difference. The variation in type and location of the pterion from external and internal bony landmarks are provided and compared with other populations. All findings in this investigation provide data and information to neurosurgeons, anthropologists and forensic pathologists.

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