

Original Communications**PTERION TYPES AND MORPHOMETRY IN MIDDLE AND SOUTH ANATOLIAN ADULT SKULLS****Kaan Cimen, Ilhan Otag, Mehmet Cimen***Department of Anatomy, Faculty of Medicine, Cumhuriyet University, Sivas, Turkey***ABSTRACT**

Pterion is an irregular H letter shaped sutural confluence in the temporal fossa formed by frontal, parietal bones, great wing of sphenoid bone and temporal squama. Pterion is classified in 4 types as follows: sphenoparietal, frontotemporal, epipteric and stellate. The pterion represents: anterior branch of the middle meningeal artery, middle cerebral artery, Broca's motor speech area, insula and stem of the lateral cerebral sulcus. This pterion junction has been used as a common extra-cranial landmark for surgeons in microsurgical and surgical approaches pertaining to important pathologies of this region. In the present study, our aim was to determine pterion types, to estimate distances between pterion and some special landmarks by which means to contribute to the related literature by comparing the data with other studies focusing on various populations. Pterion types identified by observation and measurements were taken by steel Vernier caliper. This study was conducted with 75 adult skulls (both sides 150 pterion). Skulls were classified with regard to gender as: 47 male and 28 female. Pterion types observed in both genders were classified as: sphenoparietal type 82% (84.04% in male, 78.57% in female), frontotemporal type 4.66% (5.31% in male, 3.57% in female), epipteric type 10.66% (8.51% in male, 14.28% in female) and stellate type 2.66% (2.12% in male, 3.57% in female). These findings will be useful for clinicians, anthropologists and forensics.

Key words: Pterion; morphometry; human skull; human anatomy; morphology.

en 4 tipos de la siguiente manera: Esfenoparietal, frontotemporal, epiptérico y estrellado. El pterion representa: la rama anterior de la arteria meníngea media, la arteria cerebral media, el área motora del habla de Broca, la ínsula y el vástago del surco cerebral lateral. Esta unión del pterión se ha utilizado como un hito extracraneal común para los cirujanos en enfoques microquirúrgicos y quirúrgicos relacionados con patologías importantes de esta región. En el presente estudio, nuestro objetivo es determinar los tipos de pterion, estimar las distancias entre el pterión y algunos puntos de referencia especiales para contribuir a la literatura relacionada mediante la comparación de los datos con otros estudios que se centran en diversas poblaciones. Los tipos de pterión identificados por observación y mediciones fueron tomados por un calibrador a Vernier de acero. Este estudio se realizó con 75 cráneos adultos (ambos lados 150 pterion). Los cráneos se clasifican en función del género como: 47 hombres y 28 mujeres. Los tipos de pterion observados en ambos sexos se clasifican en: tipo esfenoparietal 82% (84,04% en hombres, 78,57% en mujeres), tipo frontotemporal 4,66% (5,31% en hombres, 3,57% en mujeres), tipo epiptérico 10,66% (8,51% en hombres, 14,28% en mujeres) y tipo estrellado 2,66% (2,12% en hombres, 3,57% en mujeres). Estos hallazgos serán útiles para los clínicos, antropólogos y médicos forenses.

Palabras clave: pterion; morfometría; cráneo; anatomía; morfología.

RESUMEN

El pterion es una confluencia sutural con forma de letra H irregular en la fosa temporal formada por los huesos frontales, parietales, el ala mayor del hueso esfenoides y la escama temporal. Pterion se clasifica

* Correspondence to: **Kaan Cimen.**
kcimen@cumhuriyet.edu.tr

Received: 18 October, 2018. **Revised:** 5 November, 2018.
Accepted: 21 November, 2018.

INTRODUCTION

Pterion is usually characterized by an H letter shape sutural structure formed by frontal, parietal, temporal and greater wing of sphenoid bones on temporal fossa. Four pterion types were classified as: sphenoparietal, frontotemporal, epipteric and stellate by Murphy (1956).

The center of the pterion is located approximately 3.5 - 4 cm above arcus zygomaticus and 3 - 3.5 cm behind the suture frontozygomaticus. In practice, the pterion is located two finger widths above the arcus zygomaticus and a thumb-width behind the processus frontalis of os zygomaticus (Moore, 1992). Pterion has a different morphology because of meeting point of skull base, calvaria and facial skeleton (Urzi et al., 2003). Pterion also forms the base of temporal fossa. Pterion is known as the Sylvian point. This is the point where the sulcus lateralis is divided into

ramus anterior, ascendens and posterior branches. Pterion corresponds to the fontanella anterolateralis (sphenoidalis) in the newborn cranium that disappears 3 months after birth (Moore, 1992). Pterion is crucial intraoperative field in surgical approaches. In neurosurgery, pterional approaches are used in such various interventions and treatments as removal of complicated tumors, medial cerebral artery, internal carotid artery and traumatic optic neuropathy (Mori et al., 2007). This pterion junction has been used as a common extra-cranial landmark for surgeons in microsurgical and surgical approaches pertaining to important pathologies of this region (Urzi et al., 2003). In the present study, our aim was to determine pterion types, to estimate distances between pterion and some special landmarks by which means to contribute to the related literature by comparing the data with other studies focusing on various populations.

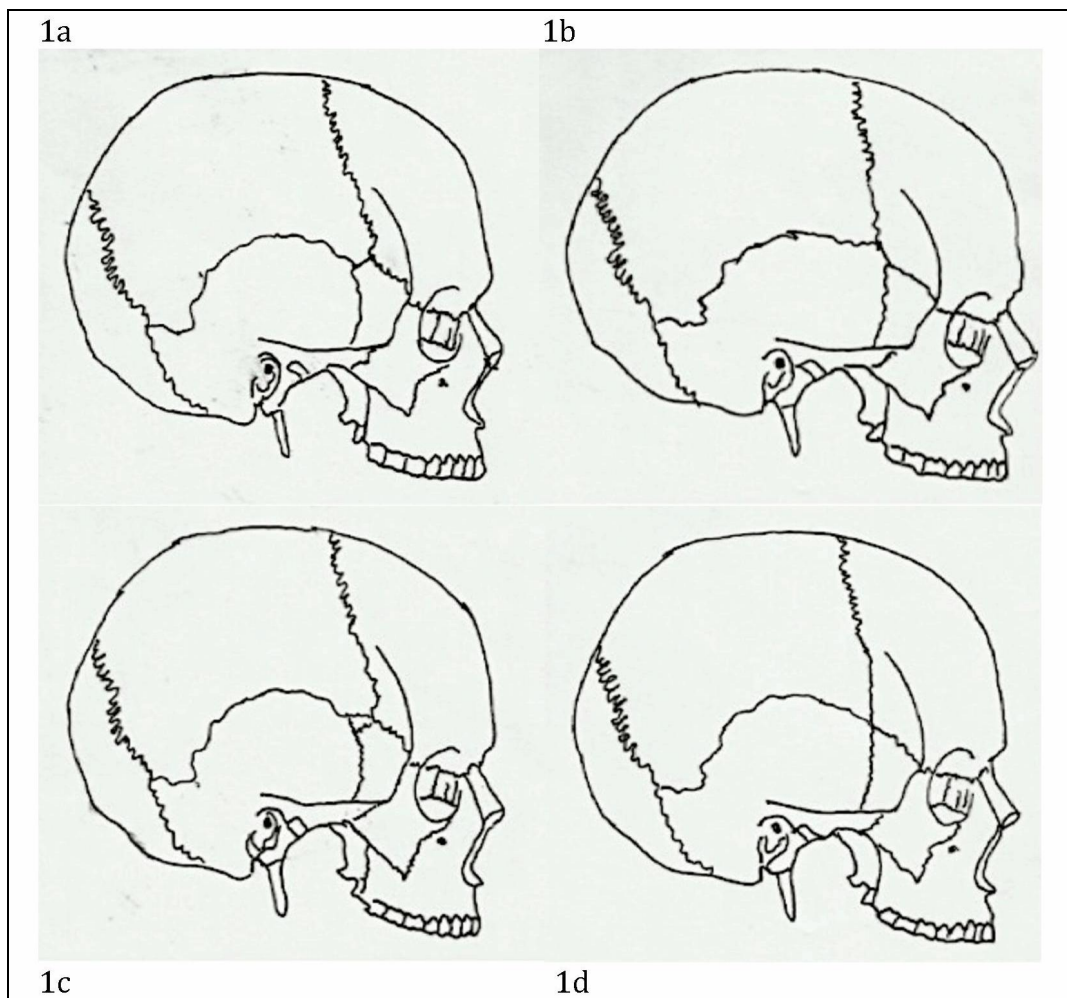


Figure 1: (A) sphenoparietal type of pterion, (B) frontotemporal type of pterion, (C) epipteric type of pterion, (D) stellate type of pterion.

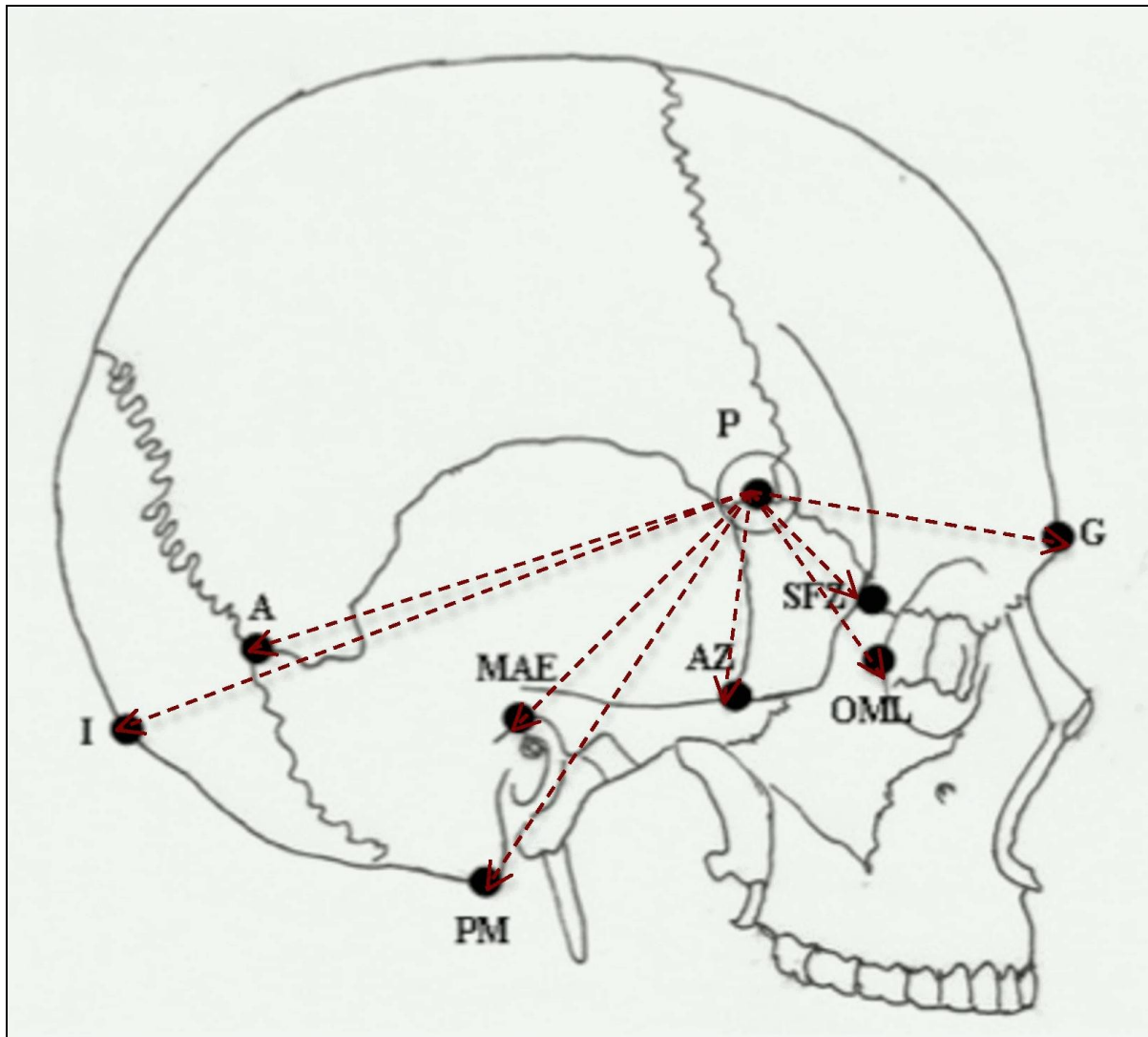


Figure 2: Showing distances of pterion to some special landmarks. P: Pterion, SFZ: Posterior Aspect of Sutura Frontozygomaticus, AZ: Midpoint of the Arcus Zygomaticus, OML: Posterior Edge of the Orbita Margo Lateralis, PM: Inferior Pole of the Processus Mastoideus, MAE: Upper Edge of the Meatus Acusticus Externus, G: Glabella, I: Inion, A: Asterion.

MATERIAL AND METHOD

In the present study, 75 (both side 150 pterions) adult skulls, which have shown non-trauma, were examined. Examined skulls were obtained from the laboratories: Anthropology Department of the Faculty of Letter and Anatomy Department of the Faculty of Medicine of Cumhuriyet University and Anatomy Department of the Faculty of Medicine, Erciyes University. Morphometrical measurements were taken by steel Vernier caliper and outer diameter compass.

This study was done by determining the sutural patterns of the pterion on both sides of each skull based on the description of Murphy (Fig. 1a, 1b, 1c, 1d). In the sphenoparietal type: sphenoid and parietal bones are directly in contact (Fig. 1a). In

the frontotemporal type: frontal and temporal bones are directly in contact (Fig. 1b). In the epipteritic type, the presence of sutural bones is located between sphenoid and parietal bones (Fig. 1c). In the stellate type: frontal, temporal, sphenoid and parietal bones meet at same junction point (Fig. 1d).

Distance parameters were taken as: between pterion center (P) and posterior aspect of sutura frontozygomaticus (SFZ), midpoint of the arcus zygomaticus (AZ), posterior edge of the orbita margo lateralis (OML), inferior pole of the processus mastoideus (PM), upper edge of the meatus acusticus externus (MAE), glabella (G), inion (I), asterion (A). Also distance between glabella (G) and inion (I) was measured (Fig. 2).

The data obtained from our study were loaded on the SPSS (Ver: 22.0) program, and the t-test was used in independent subjects to compare the

parameters in the evaluation of the data. ANOVA was used in the comparison of the pterion types and the error level was taken as 0.05.



Figure 3: Arrows indicate that: (A) sphenoparietal type of pterion on female skull, (B) frontotemporal type of pterion on male skull, (C) epipteric type of pterion on female skull, (D) stellate type of pterion on male skull.

RESULTS

In classifying pterion types; sphenoparietal type was the most dominant one with 79 sides (84.04%), 44 sides (78.57%) in male and female skulls respectively and totally 123 sides (82%) (Fig. 3a, b, c, d) (Table 1).

Mean distance between pterion and sutura frontozygomaticus was measured as 32.8 ± 4.8 mm, 31.6 ± 4.4 mm in male and female skulls (Table 2) respectively and totally 32.4 ± 4.7 mm (Table 3).

Mean distance between pterion and arcus zygomaticus was measured as 36.5 ± 6.6 mm, 35.5 ± 5.9 mm in male and female skulls (Table 2) respectively and totally 36.1 ± 6.4 mm (Table 3). Mean distance between pterion and orbita margo lateralis was measured as 38.0 ± 6.9 mm, 35.7 ± 6.6 mm in male and female skulls (Table 2) respectively and totally 37.2 ± 6.9 mm (Table 3). Mean distance between pterion and processus mastoideus was measured as 82.6 ± 5.1 mm, 76.2 ± 6.0 mm in male and female skulls (Table 2) respectively and totally 80.2 ± 6.3 mm (Table 3).

	Male				Female				Both Sides (Regardless gender)		
	Right	Left	Both Side	%	Right	Left	Both Side	%	Right	Left	%
Sphenoparietal	41	38	79	84.04	23	21	44	78.57	64	59	82
Frontotemporal	2	3	5	5.31	1	1	2	3.57	3	4	4.66
Epipteric	3	5	8	8.51	3	5	8	14.28	6	10	10.66
Stellate	1	1	2	2.12	1	1	2	3.57	2	2	2.66

Table 1: Frequency and distribution of the pterion types in terms of gender and side.

	P-SFZ	P-AZ	P-OML	P-PM	P-MAE	P-G	P-I	P-A	G-I
Male (n=94)	32.8±4.8	36.5±6.6	38.0±6.9	82.6±5.1	57.1±7.7	78.2±4.6	135.5±6.2	89.3±5.4	173.0±7.9
Female (n=56)	31.6±4.4	35.5±5.9	35.7±6.6	76.2±6.0	53.4±3.6	73.9±4.6	126.2±6.3	83.5±3.9	162.3±8.3
(p<0.05)	0.109	0.357	0.048	0.000*	0.001*	0.000*	0.000*	0.000*	0.000*

Table 2: Evaluation of distances between pterion and special landmarks in terms of gender. P: pterion; SFZ: sutura frontozygomaticus, OML: orbita margo lateralis, PM: processus mastoideus, G: glabella, I: inion, A: asterion.

	P-SFZ	P-AZ	P-OML	P-PM	P-MAE	P-G	P-I	P-A	G-I
Sphenoparietal (n=123)	32.4±4	36.5±6	37.2±7	80.7±6.1	56.2±7.0	76.6±4.7	132.4±7.7	87.78±5.4	169.2±10
Frontotemporal (n=7)	31.9±6	38.0±8	38.2±8	79.7±6	56.3±5	76.9±4	132.1±5	83.0±9	170.1±3
Epipteric (n=16)	32.9±7	32.8±6	35.6±9	77.4±6	52.3±4	77.1±7	129.9±8	84.7±5	168.4±11
Stellate (n=4)	29.9±5.5	35.9±6	38.5±6	77.4±10	53.7±4	74.4±5	128.8±8	84.0±2	163.5±9
Total (n=150)	32.4±5	36.1±6	37.2±7	80.2±6	55.7±7	76.6±5	132.0±8	87.1±7	169.0±10

Table 3: Distances between pterion types and some special landmarks. P: pterion; SFZ: sutura frontozygomaticus; OML: orbita margo lateralis; PM: processus mastoideus, G: glabella, I: inion, A: asterion.

Mean distance between pterion and meatus acusticus externus was measured as 57.1±7.7 mm, 53.4±3.6 mm in male and female skulls (Table 2) respectively and totally 55.7±6.7 mm (Table 3).

Mean distance between pterion and glabella was measured as 78.2±4.6 mm, 74.0±4.6 mm in male and female skulls (Table 2) respectively and totally 76.6±5.0 mm (Table 3).

Mean distance between pterion and inion was measured as 135.5 ± 6.2 mm, 126.2 ± 6.3 mm in male and female skulls (Table 2) respectively and totally 132.0 ± 7.7 mm (Table 3).

Mean distance between pterion and asterion was measured as 89.3 ± 5.4 mm, 83.5 ± 3.9 mm in male and female skulls (Table 2), respectively and totally 87.1 ± 5.6 mm (Table 3).

Mean distance between glabella and inion was measured as 169.0 ± 9.6 mm. In the determination whether the skeletal length correlates with the pterion type, we concluded that there is no link between the two parameters.

When the male and female values of the mean distance between the pterion and orbita margo lateralis were examined, it was seen that there is no significant difference between the right and left sides but when the average values were taken into consideration, it is concluded that the difference between male and female is significant ($p=0.048$) (Table 2).

When the mean distance between the pterion and the processus mastoideus was examined, it was concluded that there was a significant difference between the male and female ($p=0.000$) in terms of the mean values of both sides (Table 2).

When the mean distance between the pterion and meatus acusticus externus was examined, it was found that between male and female; there was no significant difference in the right-sided values, but a significant difference was found between the left-sided and total mean values between the two gender types ($p = 0.001$) (Table 2).

When the mean distance between pterion and glabella was examined, it was concluded that there was a significant difference between the both-sided values and the mean values between male and female ($p = 0.000$) (Table 2).

When the mean distance between the pterion and the inion was examined, it was concluded that there was a significant difference between the two-sided values and the mean values between male and female ($p = 0.000$) (Table 2).

When the mean distance between the pterion and the asterion was examined, it was concluded that there was a significant difference between the two-sided values and the mean values between male and female ($p = 0.000$) (Table 2).

When the mean distance between glabella and inion was examined, it was concluded that there was a significant difference between male and female ($p = 0.000$) (Table 2).

In our symmetry study; in skulls used in this study, pterion types were classified as 78.72% in males and 78.57% in females bilaterally. Sphenoparietal type was found to be the most symmetrical type with 74.46% in males and

67.85% in females. The stellate type pterion was not seen symmetrically.

DISCUSSION

Pterion is an important landmark for optic nerve pathologies, orbit, ridge of the sphenoid lesser wing (Lang, 1984) and, it also represents anterior ramus of the middle meningeal artery, middle cerebral artery, Broca's motor speech area on left side, anterior pole of the insula and stem of the sulcus lateralis (Urzi et al., 2003). A blow on the side of the head can cause the breakdown of the thin bones forming the pterion and the tearing of the ramus anterior to the medial meningeal artery that crosses the pterion. This may cause hematoma that presses the underlying cerebral cortex. Medial meningeal artery hemorrhage may cause death if not stopped within a few minutes (Moore, 1992). Pterion keyhole approach may achieve the best operative effect for the treatment of intracranial anterior circulation aneurysms in a selective group of patients with several advantages over traditional craniotomy including minor tissue damage, less brain retraction, a superior cosmetic result and a shorter duration of surgery (Cheng et al., 2006). The pterional approach used in brain surgery is defined as the most popular intervention (Yasargil et al., 1987). Nowadays, the technique, which is characterized by opening a hole that is less than 1.5 cm at the pterion, provides minimal bleeding in patients with coronal craniosynostosis, less operation time, the minimization of the bony defects and protection of the dural structures (Choi et al., 2009). Pterion is an important guide for age and sex determination as well as archaeological and forensic estimation (Lovejoy et al., 1985).

According to the common result of research on the incidence of pterional types, it is seen that the one with the highest incidence among the four types is the sphenoparietal type. The incidence of frontotemporal type in our study is compatible with the studies performed in other populations and it has the third frequency among the four pterion types. When we compare our study with studies in other populations, the incidence of epipteric type is compatible with the studies in other populations. The incidence of stellate type in our study is the lowest among the pterion types. It is seen that the incidence of stellate type is low in our study and, our results are compatible with the studies in other populations (Table 4).

When the samples used in the study are compared between male and female; the sphenoparietal type appears to be the most dominant type in both sexes. However, the

incidence of sphenoparietal type was found to be higher in males in comparison to females. The

incidence of frontotemporal type does not show a significant difference between male and female.

Author	Population	n	Spheno parietal (%)	Fronto temporal (%)	Epipteric	Stellate
Murphy (1956)	Australian	368	73.23	7.75	18.34	0.68
Ersoy et al. (2003)	Turkish	300	96	3.8	9	0.2
Oğuz et al. (2004)	Turkish	26	88	10	2	---
Mwachaka et al. (2008)	Kenyan	50	66	15	12	7
Zalawadia et al. (2010)	West Indian	42	91.7	2.4	4.8	1.2
Ilayperuma et al. (2010)	Sri Lanka	52	74.04	4.81	21.15	---
Ma et al. 2012	New Zealandian	76	78.3	5.2	16.4	---
Ukoha et al. (2012)	South-East Nigerian	56	75.5	19.6	3.6	1.8
Sunday et al. (2013)	Nigerian	62	86.1	8.3	---	5.6
Eboh et al. (2014)	Nigerian	50	83	5	6	6
Aksu et al. (2014)	West Anatolian	128	85.2	1.1	8.2	5.5
Seema and Mahajan (2014)	North Indian	50	89	7	12	4
Chaijaroonkhanarak et al. (2017)	Thai	55	87.27	4.55	8.18	---
Present Study	Middle and South Anatolian	75	82	4.66	10.66	2.66

Table 4: Comparison of pterion types in different populations. Data is given as percentages.

The epipteric type rate is the second most common type of pterion observed in both genders. The incidence in females is higher than males. Stellate type is the least common pterion type in our study and there is no significant difference between male and female incidence.

It has been reported in literature that the pterion is located 3.0-3.5 cm behind the sutura frontozygomaticus (Moore, 1992). When we compare the results with the studies conducted in other populations, our data show compatibility with others (Table 5).

It has been reported in literature that the pterion is 3.5-4 cm above the arcus zygomaticus (Moore, 1992). When we compared our data with the studies performed in other populations, the data show compatibility with each other (Table 5).

Ersoy et al. (2003) measured the mean distance between pterion and orbita margo lateralis; the

values gathered were 27.9 ± 5.6 mm for epipteric propria, 24.3 ± 1.7 mm for epipteric antierius, 33.2 ± 5.0 mm for epipteric posterius and, 27.4 ± 4.8 mm for ossa epipterica. Aksu et al. (2014) measured the mean distance between the pterion and the orbita margo lateralis only in the skulls with epipteric type pterion and reported 31.0 ± 5.8 mm on the right and, 32.3 ± 5.8 mm on the left. When we compare our data with other studies, our results are higher than the data of Ersoy et al. (2003) and, Aksu et al. (2014). A high incidence of epipteric type pterion may cause differences in mean values. The distance between these two parameters and the possibility of the presence of sutural ossicles in the pterional region are important for surgical intervention. Because of the presence of the sutural bones, the pterion center may be miscalculated and lead to various intraoperative problems. These sutural

bones, which can be found in the pterional region during pterional intervention used in accessing the orbit, can cause various complications. For

this reason, the possibility of epipteric type pterion should be considered for surgical interventions.

Author	P-SFZ (mm)		P-AZ (mm)	
	Right	Left	Right	Left
Oguz et al. (2004)	33.0±4.0	34.4±3.9	40.5±3.9	38.5±2.5
Mwachaka et al. (2008)	30.35±3.4	30.3±4.3	38.9±3.5	38.2±3.5
Ari et al. (2009)	39.0±4.0 (Byzantine)	39.0±4.2 (Byzantine)	45.0±4.0 (Byzantine)	39.0±4.6 (Byzantine)
	38.0±5.0 (Contemporary)	41.0±7.0 (Contemporary)	42.0±3.0 (Contemporary)	43.0±2.0 (Contemporary)
Zalawadia et al. (2010)	37.3±0.5	35.5±0.4	31.2±0.4	29.7±0.3
Ilayperuma et al. (2010)	34.0±0.4	35.2±0.9	38.6±0.2	36.7±0.3
Ukoha et al. (2012)	27.4±0.7	27.4±0.6	40.2±0.5	40.1±0.3
Ma et al. (2012)	26.0±4.0	25.0±4.0	34.0±4.0	34.0±4.0
Sunday et al. (2013)	31.5±0.7	30.8±0.8	39.1±0.6	38.8±0.6
Eboh et al. (2014)	32.1±2.6	31.1±2.2	40.2±3.0	39.5±3.3
Seema and Mahajan(2014)	31.0±4.4	34.0±4.0	41.0±4.5	44.0±3.2
Aksu et al. (2014)	31.8±4.5	31.4±4.7	40.0±4.1	39.9±4.0
Present Study	32.0±4.5	32.7±4.8	37.5±5.4	34.7±6.9

Table 5: Comparison of the distances between pterion and some special landmarks in different populations. P: pterion, SFZ: sutura frontozygomaticus, AZ: arcus zygomaticus

Ari et al. (2009) measured mean distance between pterion and processus mastoideus is by manual measurements in Byzantine samples as 83.0 ± 3.4 mm on the right and, 85.0 ± 2.6 mm on the left, in the contemporary samples as 82.0 ± 5.0 mm on the right and 81.0 ± 7.7 mm on the left. Aksu et al. (2014) measured pterion with proc. mastoideus were 82.5 ± 5.5 mm on the right and, 81.8 ± 5.5 mm on the left. Our results are consistent with the results of these two studies.

Aksu et al. (2014) measured mean distance between pterion and meatus acusticus externus is 53.3 ± 4.6 mm on the right and, 56.2 ± 4.6 mm on the left. Comparisons with our study indicate consistencies.

Eboh and Obaroefe (2014) measured mean distance between pterion and glabella 78.3 ± 3.8 mm on the right, 76.7 ± 4.2 mm on the left. When the studies are compared, the results show compatibility with our findings.

Ari et al. (2009) measured mean distance between pterion and inion in the Byzantine samples by manual measurements 138.0 ± 5.0 mm on the right side and 137.0 ± 4.0 mm on the left side, in the contemporary samples $136.0 \pm$

8.0 mm on the right side and, 136.0 ± 6.0 mm on the left side, respectively. When the studies are compared, it shows compatibility with the results obtained from our study.

Ari et al. (2009) measured mean distance between pterion and asterion in the Byzantine samples by manual measurements 89.0 ± 4.0 mm on the right side and, 93.0 ± 6.5 mm on the left side, in the contemporary samples 87.0 ± 7.0 mm on the right side and, 86.0 ± 8.0 mm on the left side, respectively. Compared with the studies, this value is higher on the left side of the samples belonging to the Byzantine period and shows compatibility with the values in other studies.

Mean distance between glabella and inion was measured as 169.0 ± 9.6 mm. In the determination whether the skeletal length correlates with the pterion type, we concluded that there is no link between the two parameters.

Mwachaka et al. (2008) measured the mean distance between pterion and sutura frontozygomaticus in Kenyan men as 30.7 ± 3.7 mm. Ma et al. (2012) measured the mean distance between pterion and sutura frontozygomaticus in New Zealand men 26 ± 4 mm. Sunday et al. (2013) measured the mean

distance between the pterion and the sutura frontozygomaticus in Nigerian men as 31.9 ± 0.6 mm. Oğuz et al. (2004) measured mean distance between pterion and sutura frontozygomaticus in the study performed in Turkish men 33.0 ± 4.0 mm on the right and, 34.4 ± 3.9 mm on the left. Ari et al. (2009) measured the mean distance between the pterion and the suture frontozygomaticus in male samples of the Byzantine period by manual measurements 39.0 ± 4.0 mm on the right and, 39.0 ± 4.2 mm on the left. According to the results of our study, male pterion and sutura frontozygomaticus values are higher than the New Zealanders, lower than the Byzantine group, while they are compatible with the Kenyan and Nigerian populations.

Mwachaka et al. (2008) measured the mean distance between pterion and arcus zygomaticus in Kenyan men as 39.3 ± 3.3 mm. Ma et al. (2012) measured the mean distance between pterion and arcus zygomaticus in New Zealand men as 34 ± 4 mm. Sunday et al. (2013) measured the mean distance between pterion and arcus zygomaticus in Nigerian male as 39.7 ± 0.5 mm. Oğuz et al. (2004) measured mean distance between pterion and arcus zygomaticus in the study carried out in the samples of Turkish men, 40.5 ± 0.4 mm on the right and, 38.5 ± 0.3 mm on the left. Ari et al. (2009) measured the mean distance between pterion and arcus zygomaticus in male samples of the Byzantine period by manual measurements 37.0 ± 2.0 mm on the right and, 39.0 ± 4.6 mm on the left. According to the results of our study, pterion and arcus zygomaticus values in males, in comparison to different populations, are higher than New Zealanders, which is significantly lower than the values obtained in both of the studies in Turkey.

Ari et al. (2009) measured the mean distance between the pterion and the processus mastoideus in the male samples of the Byzantine period by manual measurements 83.0 ± 3.4 mm on the right and, 85.0 ± 2.6 mm on the left. These two studies show comparability of data when compared.

Ari et al. (2009) determined the mean distance between pterion and asterion in male samples of Byzantine period by manual measurements 89.0 ± 4.0 mm on the right and, 93.0 ± 6.5 mm on the left. When the studies are compared, it is observed that while the right side shows compatibility, the left side shows that our values are lower.

Ari et al. (2009) measured the distance between pterion andinion in male samples of Byzantine period 138.0 ± 5.0 mm on the right and, 137.0 ± 4.0 mm on the left. When studies compared results show compatibility.

Mwachaka et al. (2008) measured the mean distance between pterion and sutura frontozygomaticus in Kenyan women as 29.7 ± 3.4 mm. Ma et al. (2012) measured the mean distance between pterion and sutura frontozygomaticus in New Zealand women as 25 ± 4 mm. Sunday et al. (2013) measured the mean distance between pterion and sutura frontozygomaticus in Nigerian women as 30.34 ± 0.8 mm. When the studies were compared, it was observed that our results were higher than the other three populations.

Mwachaka et al. (2008) measured the mean distance between pterion and arcus zygomaticus in Kenyan women as 37.4 ± 3.0 mm. Ma et al. (2012) measured the mean distance between pterion and arcus zygomaticus in New Zealand women as 34 ± 4 mm. Sunday et al. (2013) measured the mean distance between pterion and arcus zygomaticus in Nigerian women as 38.0 ± 0.7 mm. When we compare the results, it is observed that our results are higher than the New Zealand women.

In conclusion, identification and morphometrical measurements of pterion types are important studies frequently performed in various populations. It is clinically important to know the attachment types of the bones that shape the pterion to the main axis, and the distances of the pterion to various special landmarks. Different measurement results in different populations it may be the indicate that the geographic, genetic, evolutionary differences. We believe that these findings will be usefull for clinicians, anthropologists and forensic specialized.

Conflict of Interest

Authors state that there is no conflict of interest.

Fundings

There were no fundings to conduct this study.

Ethical Approval

This study approved by Cumhuriyet University Ethical Committee for Non-Interventional Clinical Trials. Decision number 2016-02/15.

Informed Consent

It does not correspond.

Contributions

The authors in this article have made the following contributions: with collaboratively MC, IO, KC: study design and manuscript drafting; KC: data acquisition, literature research, manuscript editing; IO: statistical analysis; MC: figure drawings.

ACKNOWLEDGMENTS

The authors thanks for the contributions of Department of Anatomy members of Erciyes University and Department of Anthropology members of Cumhuriyet University.

REFERENCES

- Aksu F, Akyer SP, Kale A, Geylan S, Gayretli O. 2014. The localization and morphology of pterion in adult west anatolian skulls. *The Journal of Craniofacial Surgery* 25: 1488-91.
- Ari I, Kafa IM, Bakirci SA. 2009. Comparative study of variation of the pterion of human skulls from 13th and 20th century anatolia. *Int J Morphol* 27: 1291-98.
- Chajjaroonkhanarak W, Woraputtaporn W, Prachaney P, Amarttayakong P, Khamanarong K, Pannangrong W, Welbat JU, Iamsaard S. 2017. Classification and incidence of pterion patterns of thai skulls. *Int J Morphol* 35: 1239-42.
- Cheng WY, Lee HT, Sun MH, Shen CC. 2006. A pterion keyhole approach for the treatment of anterior circulation aneurysms. *Minim Invasive Neurosurg* 9: 257-62.
- Choi JW, Koh KS, Hong JP. 2009. One-piece frontoorbital advancement with distraction but without a supraorbital bar for coronal craniosynostosis. *J Plast Reconstr Aesthet Surg* 62: 1166-73.
- Eboh DEO, Obaroefe M. 2014. Morphometric study of pterion in dry human skull bones of nigerians. *Int J Morphol* 32: 208-13.
- Ersoy M, Evliyaoglu C, Bozkurt MC, Konuksan B, Tekdemir I, Keskil IS. 2003. Epipteric bones in the pterion may be a surgical pitfall. *Minim Invasive Neurosurg* 46: 363-65.
- Ilayperuma I, Nanayakkora BG, Palahepitiya KN. 2010. Types of pterion in sri lankan skulls. *The Ceylon Journal of Medical Science* 53: 9-14.
- Jovejoy CO, Meindl RS, Mensforth RP, Barton TJ. 1985. Multi factorial determination of skeletal age at death: a method a blind tests of its accuracy. *Am J Phys Anthropol* 68: 1-14.
- Lang J. 1984. The pterion region and its clinically important distance to the optic nerve, dimensions and shape of the recess or the temporal pole. *Neurochirurgia (Stuttg)* 27: 31-35.
- Ma S, Baillie LJ, Stringer MD. 2012. Reappraising the surface anatomy of the pterion and its relationship to the middle meningeal artery. *Clinical Anatomy* 25: 330-39.
- Moore KL. 1992. *Clinically Oriented Anatomy*. 3th ed. Lippincott Williams and Wilkins, Baltimore. Pp 641,642,723.
- Mori K, Osada H, Yamamoto T. 2007. Pterional keyhole approach to middle cerebral artery aneuroms through an outer canthal skin incision. *Minim Invasive Neurosurg* 50: 195-201.
- Murphy T. 1956. The pterion in the australian aborigine. *Am J Phys Anthropol* 14: 225-44.
- Mwachaka P, Hassanali J, Odula P. 2008. Anatomic position of the pterion among kenyans for lateral skull approaches. *Int J Morphol* 26: 931-33.
- Oguz O, Sanli SG, Bozkir MG, Soames RW. 2004. The pterion in turkish male skulls. *Surg Radiol Anat* 26: 220-24.
- Seema, Mahajan A. 2014. Pterion formation in north indian population:an anatomico-clinical study. *Int J Morphol* 32: 1444-48.
- Sunday AA, Funmilayo EO, Modupe B. 2013. Study of the location and morphology of the pterion in adult nigerian skulls. *ISRN Anatomy* 1-4.
- Ukoha U, Oranusi CK, Okafor JI, Udemezue OO, Anyabolu AE, Nwamarachi TC. 2013. Anatomic study of the pterion in nigerian dry human skulls. *Nigerian Journal of Clinical Practice* 16: 325-28.
- Urzi F, Ianello A, Torii A, Foti P, Mortellaro NF, Cavallaro M. 2003. Morphological variability of pterion in the human skull. *Ital J Anat Embr* 108: 83-117.
- Yasargil MG, Reichman MV, Kubin S. 1987. Preservation of the frontotemporal branch of the facial nerve using the interfacial temporalis flap for pterional craniotomy: technical article. *J Neurosurg* 67: 463-466.
- Zalawadia A, Vadgama J, Ruparelia S, Patel S, Rathod SP, Patel SV. 2010. Morphometric study of pterion in dry skull of gujarat region. *NJIRM*. 1: 25-29.