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# Pterion types in males and females

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**Abstract.**
The material for the study was 60 male and 91 female skulls (21–60 years old). For male skulls on the left side as well as on the right side in four cases, it was impossible to determine the pterion (6.7%); on the rest of the skulls, a sphenoparietal (83.3%), a stellate (3.3%), and an epipteric (6.7%) type were determined. On the right side of male skulls, sphenoparietal (81.7%), frontotemporal (1.7%), stellate (1.7%), and epipteric (8.3%) types of pterion were detected. For 91 female skulls in four cases, it was not possible to determine the pterion on both sides. The sphenoparietal (74.7%), frontotemporal (2.2%), and epipteric (18.7%) types were determined on the left sides of female skulls. On the 68 skulls on the right, the pterion was identified as sphenoparietal (74.7%), frontotemporal (1.1%), and epipteric (19.8%) types. On the female skulls, on both sides, the pterion's stellate type has not been determined.The difference in sex between the male and female skulls for left pterion was not statistically significant $P\chi^2$ =0,066; PU=0,094. Also, there was no significant difference between the male and female skulls for the right pterion $P\chi^2$ =0,259; PU=0,154. The use of the Pearson Chi-Square Test and the Mann-Whitney U test showed that the difference in the between the male and female skulls for frequency of occurrence was statistically significant $P\chi^2$ =0,010; PU=0,010. Also, there was a significant difference between the male and female skulls for the occurrence by sides (uni- or bilaterality of occurrence) $P\chi^2$ =0,035; PU=0,010.

**Key words:** pterion, sphenoparietal type, epipteric bones, frontotemporal type, stellate type.

## 1. INTRODUCTION.

As follows from classical anatomical and neurosurgical textbooks, as well as from anthropological sources, the name "pterion" is translated from the Greek word πτερου, which means "wing".The pterion forms an important landmark on the lateral part of the skull over two important intracranial structures: the anterior branch of the middle meningeal artery and the lateral cerebral fissure. Otherwise, the lateral cerebral fissure is called the Sylvian fissure, so the pterion is also called the Sylvian point. Pterion corresponds to the anteroinferior or sphenoidalfontanelle of the fetal and neonatal skull; this fontanelle closes around three months after birth [1,2].This term refers to a place in the temporal fossa where the greater wing of the sphenoid bone, the anterior inferior angle of the parietal and frontal bones, and the squamous part of the temporal bone converge.[2] Popov explained that the pterion varies in its width, which depends on the width of the greater wing of the sphenoid bone and the anterior inferior angle of the parietal bone. The pterion varies in its form. [3] A.Rafi et al, indicate that the right pterion is located behind and higher than the left. This can be explained by the fact that the developing brain tissue coordinates the sutures that form the pterion and the cranial vault as a whole in the embryonic period.

The most common form of the pterion can be compared with the letter "H", but even in this form of the pterion, there are small deviations not only in different skulls but even on different sides of the same skull. These deviations depend on the properties of the parietal margin of the greater wing of the sphenoid bone and the greater or lesser growth of the anterior inferior angle of the parietal bone. In this case, the direction of the sphenoparietal suture is important, as is the length of the suture. An even

more prominent influence on the shape of the pterion is the greater or lesser ingrowth into it of the squamous part of the temporal bone or the coronal margin of the frontal bone [2,4]. [4] VG.Kamathet al, did not find a specific relationship between the type of pterion and the side of the skull or the sex of the person. This is also consistent with the data from S.Babacanet al.[5].

The significance of the pterion as an anatomical landmark in clinical practice is very high. Accordingto A.Muchesurgical access through the pterion is referred to as the most widely used approach to the proper treatment of intracranial anterior circulation aneurysms [6]. [7] S.Tsutsumiet al, showed that part of the diploic venous outflow drains extracranially in the pterional region. This area can provide an important interface between the diploic veins of the cranial vault and the extracranial venous system.

Also, pterional access allows reaching the supratentorial basal cisterns and the uppermost and median infratentorial cisterns. Accordingly, it is the approach of choice for most extra-axial lesions involving the anterior and middle skull bases and a large number of intra-axial lesions that damage the basal forebrain and anterior midbrain [8]. With the minipterional approach, the methods of splitting or retraction of the anterior-superior edge of the temporalis muscle lead to less postoperative muscle atrophy [9]. Using the 4-quadrant subdivision and taking into account anatomical data, it was identified as a way to perform surgical procedures more easily and reliably. Even with the use of modern localization technologies, anatomical landmarks can be useful to the neurosurgeon [10].

The pterion is one of the most interesting junctions of bones in craniofacial osteology, and its complex morphology stems from the fact that it is the point of contact between the elements of the facial skeleton, the base of the skull, and the calvaria.Minimal tissue damage that occurs during pterional craniotomy or its modifications, which form the basis of neurosurgical practice, should be sought to achieve the best functional and cosmetic results [11,12,13].

The presence of the epipteric bones adds even more clinical significance to the area of interest and is enriched by new research. According to M.Ersoyof the 490 sides in the pterion, epipteric bones were found in 44 (9%), and in these skulls, the most anterior connection of the bones can be located at a distance of up to 16 mm from the lateral edge of the orbit [14].Suture and suture bone variations can easily be misdiagnosed with fractures of adjacent bone regions in unconscious patients with multiple injuries [15].

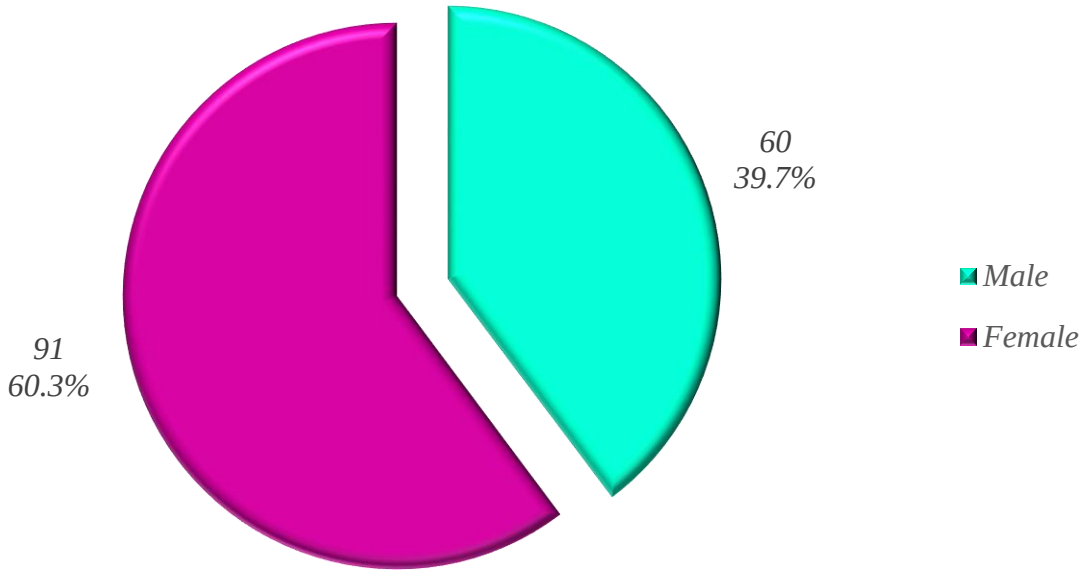
Despite the rather extensive material on the topic of anatomical variants of the pterion and their applied significance, the sex differences between them, especially with regard to the epipteric bones, have not been fully elucidated. The last type, called the epipteric type, according to Murphy (1956), is especially important in neurosurgery and neurotraumatology since this type can largely lead to medical errors and erroneous diagnoses. Based on this, we undertook research to determine the anatomical types of pterion on the craniological material of the Museum of the Department of Human Anatomy and Medical Terminology of the Azerbaijan Medical University. In all skulls, sex and age were identified.

## 2. MATERIALS AND RESEARCH METHODS

The material for the study was 60 male and 91 female skulls belonging to the adult age period (21-60 years), stored in the craniological collection of the Museum of the Department of Human Anatomy and Medical Terminology. Material for research is presented in the form of Diagram 1. The study used the cranioscopic method. Исследовалисьвсетипыптериона. Then, according to Murphy's (1956) pterion classification, of all the skulls, those on which epipteric bones were identified were selected [16].Then, according to [17] Natsiset al., taking into account the number of sutures that bound the epipteric bones and the capital letters of the bones between which these sutures were located (frontal bone: F, parietal bone: P, sphenoid bone: S, temporal bone: T), the epipteric bones were subdivided as follows: a single epipteric bone bounded by all four bones forming the pterion (four-suture bone); a single epipteric bone located between three bones, a three-suture bone (this variant has also been subdivided into FPT, FTS, FPS, and PTS); an epipteric bone located between two sutures; several epipteric bones, or multiple forms.For analyzing the obtained arithmetic data, the

Pearson Chi-Square Test, Mann-Whitney U test were used. Statistical analysis was carried out using the program "IBM Statistics SPSS-26". The study of the epipteric bones was conducted under normal lighting; in case of difficulties in identifying the sutures, limiting the epipteric bones and the pterion itself (the degree of the closure of sutures, changes in the color of the bone, complicating the detection of the type of pterion and epipteric bone, etc.), artificial lighting was used and the study field was enlarged with a magnifying glass.

Diagram 1. The studied craniological material.




## 3. RESULTS

According to Murphy's (1956) classification, the pterion is defined as being of the following types: sphenoparietal, frontotemporal, stellate, and epipteric. A study of 60 male skulls revealed that on the left side, in four cases, due to the closure of the sutures, it was not possible to determine the pterion (6.7%); on 50 skulls, a sphenoparietal type of the pterion was identified (83.3%) (fig. 1).

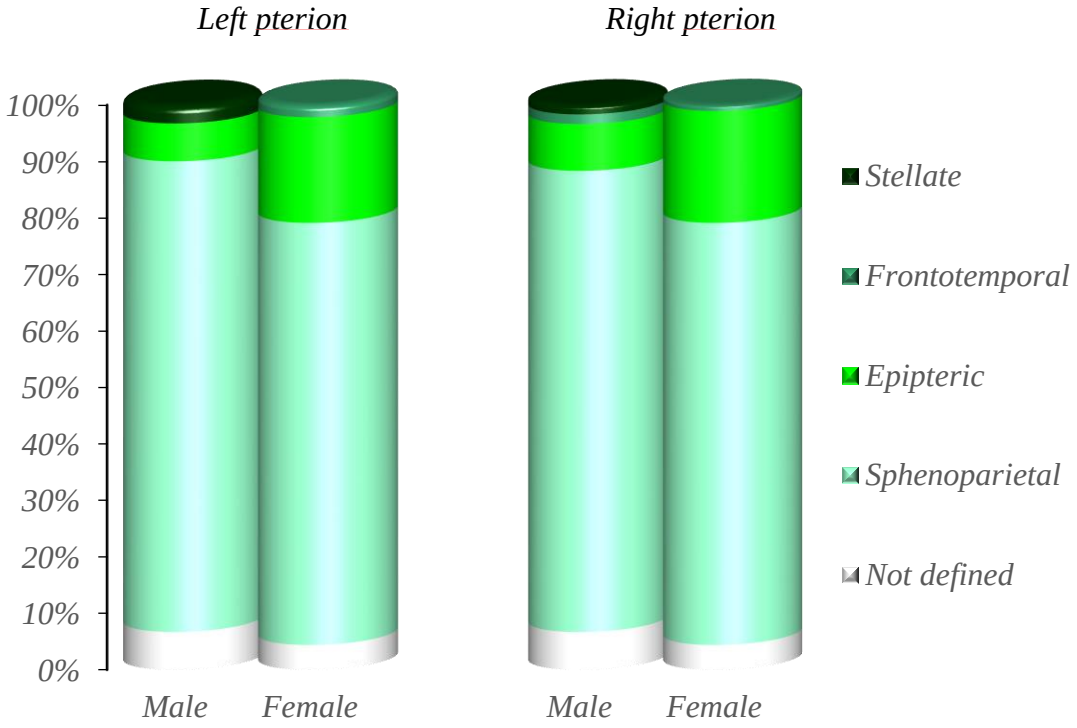
Figure.1. The male pterion of the sphenoparietal type is on the left side.

In 2 cases (3.3%), a stellate type of pterion was detected. The epipteric type of the pterion on male skulls on the left was determined in four cases (6.7%). It should be noted that the frontotemporal type of the pterion was not identified on the maleskullson the left. On the right side of the male skulls as well as on the left, in four cases it was not possible to determine the type of the pterion due to the closure of the sutures that formthe pterion (6.7%); in 49 cases (81.7%) the pterion was sphenoparietal type. The frontotemporal type of the pterion on the right side of male skulls was identified in only one case, accounting for 1.7%. Also, a stellate type ofpterion was identified only on one male skull on the right side (1.7%). In fivecases, the epipteric type of the pterion was determined on the right (8.3%).A study of 91 female skulls made it possible to establish that in four cases, due to the closure of the sutures, it was not possible to determinethe pterion on the left side (4.4%). In 68 cases, the sphenoparietal type of pterion was identified on the left (74.7%). In two cases, the pterion was of the frontotemporal type (2.2%). An epipteric type of pterion on the left side of female skulls was examined in 17 cases (18.7%). We did not find the stellate type of pterion on female skulls.Analysis of the pterion on the right side of the female skulls made it possible to establish that, as on the left side, in four cases, due to the closure of the sutures, it was impossible to determine the shape of the pterion (4.4%). On 68 skulls on the right, the pterion was identified as sphenoparietal (74.7%); in one case, the pterion was of frontotemporal type (1.1%) (fig.2).

Figure.2. The female pterion of the frontotemporal type is on the right side.

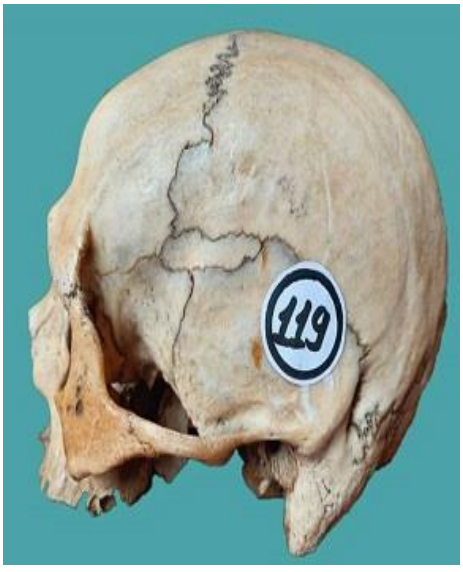

The epipteric type of pterion on the right was found, according to our investigation, on 18 skulls (19.8%). On the female skulls, on the right as well as on the left, the pterion stellate type has not been determined. The use of the Pearson Chi-Square Test and the Mann-Whitney U test showed that the difference in the sex between the male and female skulls for left pterion was not statistically significant $P\chi^2$ =0,066; PU=0,094. Also, there was no significant difference between the male and female skulls for the right pterio $P\chi^2$ =0,259; PU=0,154. Pterion types for male and female skulls are presented in Diagram 2.

Diagram 2. Pterion types for male and female skulls.




A study of the epipteric type of the pterion on male skulls revealed that this type is determined in 7 skulls (11.7%). On 53 male skulls (88.3%), other types of pterion were identified. On five male skulls (8.3%), the epipteric type was located unilaterally and on two (3.3%) bilaterally.On the left side, four epipteric bones were distributed as follows: one epipteric bone was located between two sutures (25%), two epipteric bones were limited by three sutures (known as three-suture bones), but the sutures that bound these bones were different. One of them was limited by the frontal, parietal, and sphenoid bones (FPS, anterior, 25%); another had limitations established by the parietal, temporal, and sphenoid bones (PTS, posterior, 25%).Finally, one epipteric bone was limited by all bones (four-suture bone) that formed the pterion (25%) (fig.3).

Figure 3. The male epipteric bone is bounded by four bones on the left side.



Multiple, as well as the other three-suture epipteric bones, such as FPT, superior, and FTS, inferior, had not been found on the left side of male skulls. Analysis of the epipteric type of pterion and epipteric bones involved in the formation of the indicated type on the right side showed that in one case, FPS, the anterior type of epipteric bone has been observed (20%).
The PTS type, or posterior type, of the epipteric bone was found in our investigation in 3 cases (60%). Like on the left side, on the right side, one epipteric bone was bound by four sutures (20%). Multiple, three-suture bones like FPT and FTS, as well as bones limited by two sutures, were not found on the right side of male skulls.On the studied female craniological material, epipteric type of the pterion was found in 27 (29.7%) skulls (fig. 4). Other types of pterion were identified on 64 skulls. The epipteric bones were observed unilaterally in 19 (20.9%) and bilaterally in 8 (8.8%) female skulls.

Figure 4. The female epipteric bone is bounded by three bones (FPS) on the right side.


Epipteric bones that were limited by two sutures were not found on the left side of female skulls. Also, subtypes ofepipteric bones surrounded by three sutures, such as FPT, superior, and FTS, inferior, were absent.On the left side of the female skulls, the predominant epipteric bone type was that limited by three sutures, or, to be more precise, PTS, posterior (7 epipteric bones, 41.2%).
Epipteric bones, limited by four sutures, were found on the left side (6 epipteric bones, 35.3%). According to our data, two epipteric bones were limited by three sutures: frontal, parietal, and sphenoid on the left side of the female skulls (FPS, anterior, 11.8%). Also, two epipteric bones belonged to the multiple subtype. One epipteric bone had limitations, which were established by two sutures on the right side of female skulls (5.6%). Two epipteric bones, each delimited by three sutures – frontal, parietal, and sphenoid (i.e. belonging to the subtype FPS, anterior) were found on the right side of female skulls (11.1%).
The frequency of occurrence of the epipteric type of the pterion on male and female skulls is presented in Diagram 3, and the uni- or bilateral localization of them is shown in Diagram 4.

Also, all pterion-forming bones limited the epipteric bones in five cases (four-suture bone, 27.8%). In one case (5.6%), an epipteric bone of multiple type was found. The predominant subtype of epipteric bones on the right side of female skulls were nine bones limited to parietal, temporal, and sphenoid bones (PTS, posterior, 50%) (fig.5).

Figure 5. The female epipteric bone is bounded by three bones (PTS) on the right side.

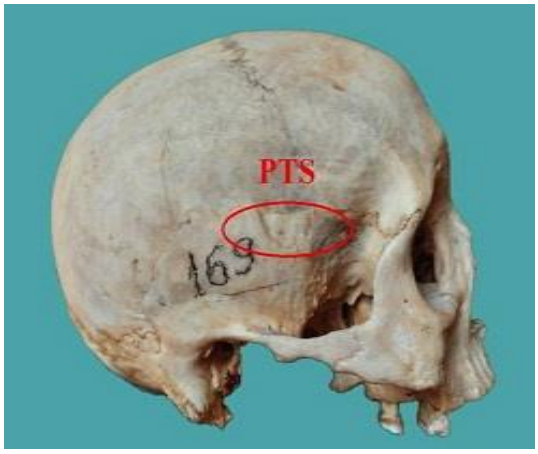



Diagram 3. The frequency of occurrence of the epipteric type of the pterion on male and female skulls.

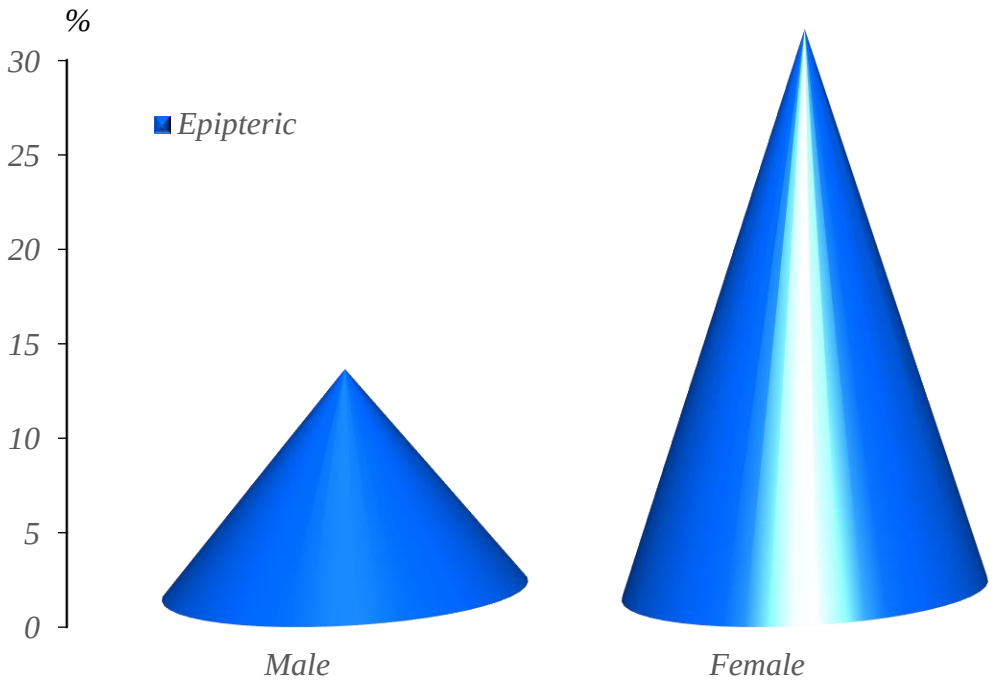
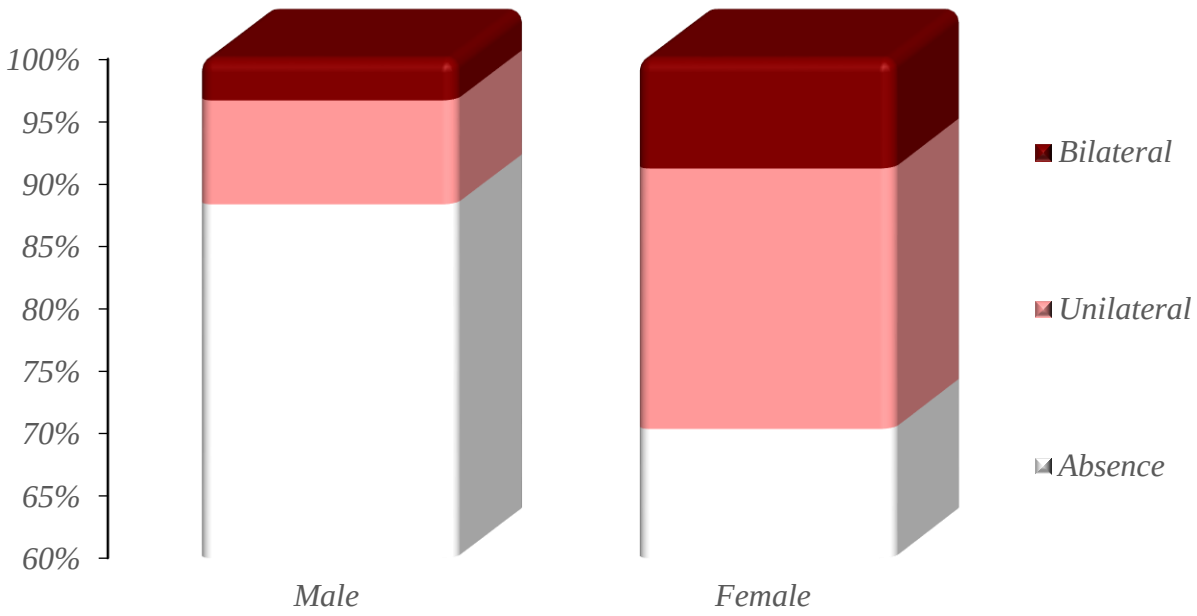
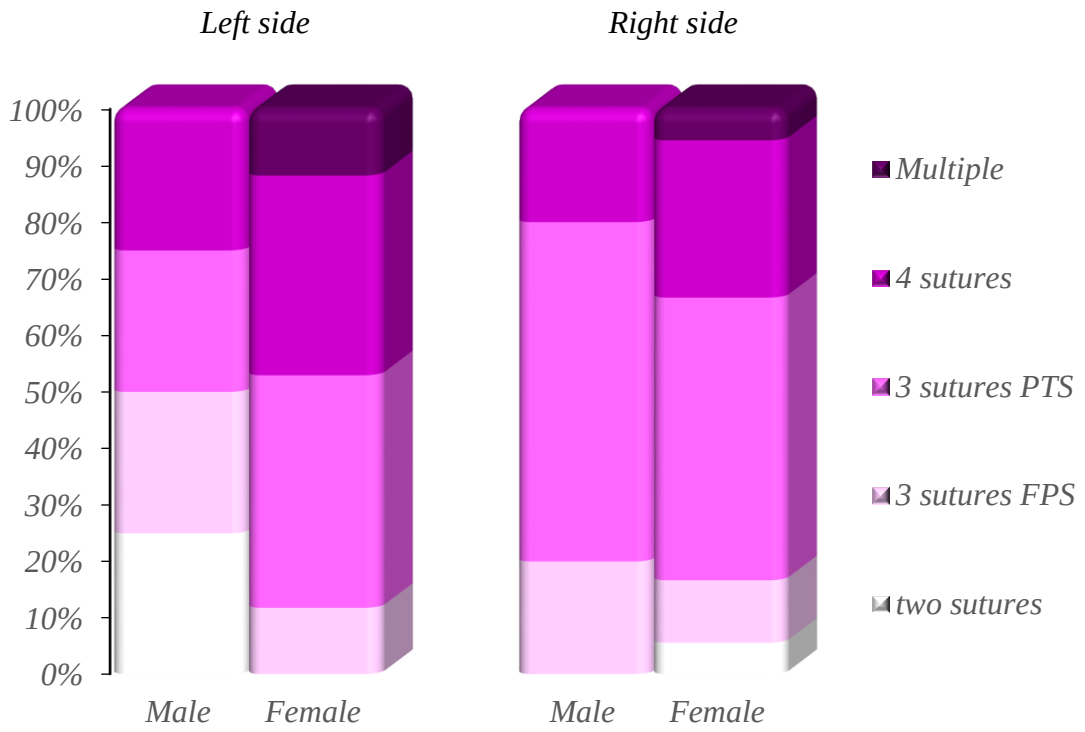


Diagram 4. Uni- or bilateral localization of the epipteric type of the pterion on male and female skulls.




Only three-suture bones like FPT and FTS were not found on the right side of female skulls. The use of the Pearson Chi-Square Test and the Mann-Whitney U test showed that the difference in the between the male and female skulls for frequency of occurrence was statistically significant $P\chi^2$ =0,010; PU=0,010. Also, there was a significant difference between the male and female skulls for the occurrence by sides (uni- or bilaterality of occurrence) $P\chi^2$ =0,035; PU=0,010.The frequency of occurrence of the epipteric type of pterion according to the sides on male and female skulls is shown in Diagram 5.

Diagram 5. The frequency of occurrence of the epipteric type of pterion according to the sides on male and female skulls.




## 4. DISCUSSION.

The bone of the sphenoid fontanel or epipteric bone is located between the frontal, parietal bones, the greater wing of the sphenoid bone and the squama of the temporal bone [18].Pterion is the weakest part of the skull wall. It protects the anterior branch of the middle meningeal artery, which runs along the pterion's inner side. Pterion can be easily fractured, which means that trauma to the skull may be followed by intracranial extradural hemorrhage. In most adults, the pterion lies within a circle with a diameter of one centimeter, 2.6 cm behind and 1.3 cm above the posterolateral margin of the fronto-zygomatic suture. This area overlaps the anterior branch of the middle meningeal artery in two-thirds of the cases[19].

Extensive material has been devoted to the study of the pterion, as noted. Especially the types of pterion are considered in anthropological terms. The morphological types of the pterion in the skulls of adults from southeastern China were sphenoparietal (SP) (85%), epipteric (12.4%), frontotemporal (1.4%), and stellate (1.2%) types. Pterion in the skulls of adults from southeastern China is predominantly of the sphenoparietal type, being mainly symmetric. Most of the frontal branch of the middle meningeal artery is situated below the mid-posterior segment of the lateral pterion [20].In our study, pterion types were studied separately on both sides (right and left) and in the sexual aspect. The data on sphenoparietal type is generally consistent with the study [20]. However, the frequency of epipteric types on female skulls in our study was higher.

According to [21], the pterion is an important landmark in surgical interventions to the anterior and middle cranial fossa. The sphenoparietal type was 75% on the right side and 76% on the left side; the frontotemporal type was 19.6% on both sides; and the stellate type was 1.8% on the right side and absent on the left side. The epipteric type was 3.6% on both sides. The study was conducted on Nigerian dried skulls. Although the sphenoparietal type is prevalent, as in our study, the study draws attention to the low incidence of the epipteric type. According to our data, the lowest frequency of occurrence found on the left side of male skulls was 6.7%.It is especially valuable that the authors emphasized the necessity of the pterion as a significant anatomical landmark for surgical interventions to the anterior and middle cranial fossa.As pointed out by [22], the frequency of the sphenoparietal pterion is high in both races (Indians 95.3%, Nigerians 84.79%), while the frontotemporal (Indians

3.46%, Nigerians 10.11%) and the stellate (Indians 1.38%, Nigerians 5.06%) pterion are more common in Nigerians. The frequency of epipteric bone is high in Indians (11.79%, Nigerians 3.79%) and is more commonly associated with the sphenoparietal pterion. No epipteric bone is associated with stellate pterion in both races.

[23] W. Apinhasmit et al, having studied the pterion on Thai skulls from the point of view of pterional surgical approach, concluded that the two most common types of the pterion are the sphenoparietal (81.2%) and the epiteric (17.4%). According to our data, female skulls have a high prevalence of epiteric type (on the left side 18.7%, on the right side 19.8%).

[24] O.Oguz et al, described the pterion in Turkish male skulls. According to them, the significance of the pterion lies in its connection with the middle meningeal artery, Broca's motor-speech area on the left, and surgical interventions associated with pathologies of the sphenoid ridge and optic canal. The sphenoparietal type of pterion was the most common (96% on the right, 79% on the left), followed by the frontotemporal (4% on the right, 17% on the left), and finally the epipteric type (4% on the left only).According to our data, the highest frequency of occurrence of the sphenoparietal type of pterion was found on the left side of male skulls and amounted to 83.3%. On the left side, a high frequency of the sphenoparietal type of pterion was also found on male skulls (81.7%).

[25] F.Aksu et al, also explained that the location and shape of the pterion are important because it is an anatomical landmark and should be used in surgical approaches and operations through the pterion. The incidences of types of pterion in the skulls were also found as the sphenoparietal type (85.2%), the epipteric type (8.2%), the stellate type (5.5%), and the frontotemporal type (1.1%).

## 5. CONCLUSION

As a result of our study, it was found that the stellate type of pterion is not found on female skulls. We also found a very low frequency of the frontotemporal type. A study of the epipteric type of pterion revealed a statistically significant difference between male and female skulls.Our study of the pterion, the frequency of occurrence on adult male and female skulls, and the distribution of pterion types on the left and right sides can be useful both in theoretical and clinical aspects.

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