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Morphological study of Pterion in skulls of corpses of the Institute of Legal Medicine and Forensic Sciences (Ditanfor), Lima - Peru 2018

Original Article

Murrieta-Angulo, Shirley ¹, Tejada-Valdivia, César Andrés ¹,
Arriola-Guillén, Luis Ernesto ¹

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¹ Scientific University of the South, Division of Thanatology, Institute of Legal Medicine and Forensic Sciences, Academic Department of Professional Career in Stomatology, Lima, Peru.

Corresponding author: [Shirley Murrieta Angulo, murrietashirley@gmail.com](mailto:murrietashirley@gmail.com)

SUMMARY

Introduction: Pterion is a craniometric point of sutural confluence, observable from a lateral view of the skull; it represents a point of reference and access

in the neurological field, as well as in the forensic field and legal medicine due to its morphological differences existing in certain groups of individuals. The present study seeks to establish similarity criteria

between the most prevalent morphology within the Lima, Peru population.

Methods: 90 adult skulls were examined bilaterally including both pterion points; photographs of both areas were taken, looking for determining the most prevalent morphology within the study sample; the average distances between the ossification center of the pterion and the posterior edge of the zygomatic arch were obtained. The sample was constituted by the skulls of the corpses arrived at the Institute of Forensic Medicine and Forensic Sciences DITANFOR of Lima, Peru in the period of September - November of 2018, using an inclusion criterion of being only skulls of male cadavers of ages between 25 at 75 years, the photographic images were obtained

during the necropsy of Law to each one of them.

Results: The types of pterion were identified according to the classification of Murphy, 1956; finding the types: sphenoparietal (70%), frontotemporal (24%), starry (6%) and epipheric in none of the cases. It was recorded that the average distance is 40 mm for all cases.

Conclusions. The results obtained in the sutural morphology of the pterion and the results of the measurements are of importance for the neurosurgical approach of the skull, registration in legal medicine, forensic odontologic as well as anthropological studies.

Key words: Pterion, morphometry, suture, corpses, forensic identification.

INTRODUCTION

Pterion is a craniometric point that is located bilaterally; represents the sutural confluence of four cranial bones: frontal, parietal, sphenoid and temporal; it is visible from a side view of the skull [1]. In general, pterion is located two fingers above the zygomatic arch, with a width of the thumb at its back to the frontal process of the zygomatic bone [2]. The morphology of pterion was studied for the first time by Broca in 1875; it was classified into three types: sphenoparietal, frontotemporal and stellate. Sequentially, Murphy in 1956 classified them into four types: sphenoparietal, frontotemporal, stellate and epipheric [3].

These studies on morphology were of great importance in terms of the coincidental relationship in families of primate individuals of the new world; in the platyrrinos the pterion is composed of the frontal, sphenoid, parietal and

zygomatic bones; while in the catarrhines it is composed of the frontal, sphenoid, parietal and temporal bones [4]. These were the fundamental differences between the morphologies of pterions of the first primates of the New World (platyrrinos) and the Old World (catarrhinos); this allows to compare it with the morphology of current human beings, in order to have an evolutionary record of the morphology of the pterion in current human beings; this would facilitate identification in an investigation within the forensic field, as well as in the clinical setting during an intervention of surgical approach in neurology.

This is the case of Natekar's study, which attributes the importance for surgeons and radiologists of this essential information, before and during a surgical intervention [5]; it highlights the location of its anatomical site, since it is very close to the middle meningeal artery and on the left side, to the motor area of Broca's

speech, a decisive implication when proceeding to perform surgical approaches of the anterior and middle cranial fossae [6]. The investigation of the morphology of the pterion was followed from the observations of Broca and Murphy, who divided them into two trajectories with respect to the nature of the pterion. The initial studies were exploratory and descriptive, in which patterns of articulation in pterion in humans and primates were identified [7].

In Murphy's study, it was revealed that there are four types of pterion: sphenoparietal, frontotemporal, stellate and epiphelic [8]. The epiphelic bones (wormianos) are small and irregular, formed due to additional centers of ossification near the sutures lambdoidea, pterión and asterión. These Wormian bones, epipteric or also called Inca bones, are markers of various diseases, being important in the primary diagnosis of osteogenesis imperfecta, and of neurocranial variables that can be deceptive in the diagnosis of fractures [9].

To study the morphologies of the pterion, we must take into account the current studies such as those of Praba and Venkatramaniah in 2012, in which they describe that the variants regarding the types of pterion are due to some factors such as sex, age, ethnicity and the state in which the skull is examined; these variations usually appear in relation to the way in which the bones come together and form the region of the pterion. Praba and Venkatramaniah classify the pterions in frontotemporal, sphenoparietal, epiphelic and stellate [10].

On the other hand, a more recent study in human skulls reveals that the most common form of the pterion is that of a sphenoparietal joint, with an incidence of

76.5% [11]. It must be taken into account that the type of pterion is not always the same on the right and left sides, but there was a 77% coincidence in this type of pterion [12]. In all the studies, it was established that the skulls are of normal characteristics, without obvious evidence of dystrophy, deformities and trauma, due to rupture or fusion of adjacent bones (synostosis) [13]. Sex was also taken into account in studies of interparietal bones since they were observed in two male skulls and a female skull (0.99%) [14]; the difference was not specific, so sex is excluded in this work to have accurate and comparable data. Regarding the presence of metopism, ossicles in the skull and sutural abnormalities, this may be associated with other cranial deformities and justifies a meticulous clinical approach that should not be forgotten in order to identify the differences between a current human being and an old one [15]. The presence of the sutural bone in the bregma may be due to the appearance of an abnormal ossification center [16], linked to the prehispanic cultures of humans of that time; makes clear the differences between the bilateral symmetry of the lines that form the pterions [17].

The study of the Pterion currently continues to have a significant importance since it is a craniometric point that is related to several structures in the cranial cavity, such as the anterior branch of the middle meningeal artery, the Broca area, the insula and the stem of the lateral groove. [18]; its location and frequency is the basis for surgical interventions; there are ancient studies, such as the case of Murphy's original work, in which they worked with 400 Australian aborigine skulls to establish location and the 4 types of pterion, taking into account their provenance and purity of race [19]. To

complement these studies it is explained that the sutural obliteration is involved in the location; it is assumed that there is a genetic predisposition (genes that allow the formation of secondary ossification centers) and that Wormian bones are under direct genetic control regardless of the presence or absence of detectable cultural deformation [20].

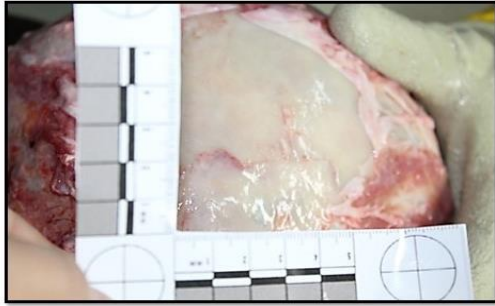
METHODS

The study sample consisted of 90 corpses of cadavers that entered the Institute of Legal Medicine and Forensic Sciences, each of which presented as data, their background and RENIEC record (National Identity Registry); for classification purposes, sex, age and place of origin were taken into account; these data were taken under criteria of confidentiality and anonymity for each corpse, not having to request an informed consent from the family member, since the corpse, upon being admitted to the Institute of Thanatology, is under the responsibility of the state; there was no data vulnerability or human integrity.

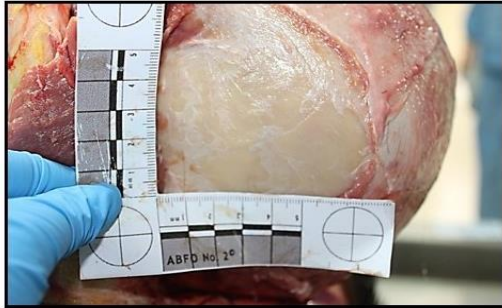
After having passed the reviews by the established adviser and jury and after having received the resolution for execution, the research project was carried out in the scheduled months; the study group consisted of corpses of the Forensic Tanatological Division, belonging to the

Public Ministry of Lima, Peru, with which the university maintains an agreement and therefore no ethical vulnerability exists. Likewise, it should be noted that the personal data of the corpses were not identified; these counted with the permission granted by the Institute of Legal Medicine and Forensic Sciences; confidentiality was assured with the management of the results, which gave evidence of the total sample taking under the supervision of a forensic specialist.

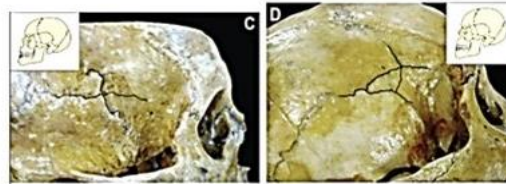
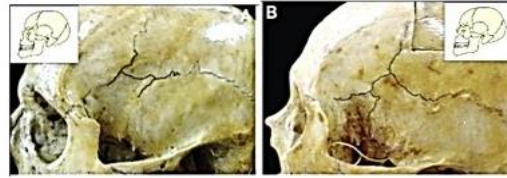
The 90 skulls were evaluated bilaterally (180 sides); to demonstrate the results, a photographic record was taken. Data for each evaluated side were compiled in a data collection form designed by the researcher with the approval of the advisor. For each case, the most prevalent morphology of the pterion was identified for each side in the skulls of the corpses, using the classification of Murphy (1956); the degree of sutural obliteration at the level of the bones that make up the pterion was also classified, using the System of the ectocranial obliteration of sutures according to Meindl & Lovejoy (1985) and White (2000), as well as the average distance of the ossification center of the pterion. with the back part of the zygomatic arch; for the measurement an ABFO rule was used and it was recorded in millimeters in the file. The data were taken during the necropsy of law for each corpse (figure 1).



9.1 Pterion esfenoparietal izquierdo.



9.2 Pterion esfenoparietal derecho



- A. Esfenoparietal**
- B. Frontotemporal**
- C. Estellar**
- D. Epiptérico**

Figure 1. On the left side, photographs of the bilateral analysis of the pterion morphology; on the right side, Pterion types according to the Murphy Classification. Source: Own file

For the photographic shot, the camera authorized by the Institute of Legal and Forensic Medicine of Lima, Canon Reflex brand, previously calibrated to a gradual ISO of portrait shot, under the supervision of a forensic specialist, was used. The taking of the area of the pterion per hemispherical was carried out together with the metric witness (ABFO rule), which served as a reference guide to the measurements of the main anatomical regions. The data collection was finalized and all the data collection, analysis of results and conclusions files were studied.

The analysis was carried out through the statistical program SPSS version 22.0. The presentation of the results was started in tables with descriptive summary measures (mean and standard deviation) for the variable "pterion morphology" in each study side; then the chi-squared test was used to establish the distribution of the pterion

morphology per evaluated side; For the distance analysis, the Student's T test for paired samples was used, providing a level of significance of 0.05.

RESULTS

The morphology of the pterion was studied in 90 skulls (180 evaluated sides), as well as the average distance between the ossification center of the pterion and specific bone reference points (posterior part of the zygomatic arch).

Table 1 shows the 4 types of pterion; the most frequent type of pterion was sphenoparietal (70% of cases). Regarding the prevalence of the types on the evaluated side, it is evident that between the sphenoparietal and frontotemporal pterion types there is a level of coincidence of 70 and 30%, not differing by side or amount studied; as for the type of starry pterion it was found in 5-

6% of the amount under evaluation, being the least prevalent and appearing within that range in both sides evaluated.

‡

TABLA 1

Distribución de tipos de pterion según lado evaluado

Tipos de Pterion	Lado Derecho		Lado Izquierdo	
	Frecuencia	Porcentaje	Frecuencia	Porcentaje
Esfenoparietal	62	68.9	63	70.0
Frontotemporal	23	25.6	21	23.3
Estrellado	5	5.6	6	6.7
Epipterico	0	0.0	0	0.0
Total	90	100.0	90	100.0

P > 0.05

Prueba de chi cuadrado

In Table 2 it can be verified that in all the evaluated cases a degree 3 of sutural obliteration is evident, resulting in 100% of the cases; there was no difference on the evaluated side. The mean and the standard deviation for the measurement parameters for the grouped ossification center was

presented mathematically, including two intervals in the average measurements in order to establish a percentage and academic relationship; these were also analyzed bilaterally; These results are recorded in tables 3 and 4, expressed in millimeters.

TABLA 2

Obliteración sutural según lado evaluado

Grados de Obliteración	Lado Derecho		Lado Izquierdo	
	Frecuencia	Porcentaje	Frecuencia	Porcentaje
0	0	0.0	0	0.0
1	0	0.0	0	0.0
2	0	0.0	0	0.0
3	90	100.0	90.0	100.0
Total	90	100.0	90	100.0

Table 3 establishes that bilaterally the sample has a distance of 30.01 - 40.01 millimeters, coinciding in a 100% of total way in the samples. In Table 4, it was recorded that the average distance from the ossification center per evaluated side is for

the right side of 32.90 - 40.01 mm and for the left side it is 35.6 - 40.01 mm, taking as average and standard deviation data 38.70 and + - 1.57 and 38.91 + - 1.32, respectively.

TABLA 3

Distancia agrupada centro de osificación del pterion por lados (mm)

Intervalo	Lado Derecho		Lado Izquierdo	
	Frecuencia	Porcentaje	Frecuencia	Porcentaje
20.1-30	0	0.0	0	0.0
30.1- 40	90	100.0	90	100.0
Total	90	100.0	90	100.0

TABLA 4

Distancia promedio del centro de osificación del pterion por lado evaluado (mm)

Lado	N	Media	D.E	Mínimo	Máximo
Derecho	90	38.70	1.57	32.90	40.01
Izquierdo	90	38.91	1.32	35.60	40.01

P = 0.286

Prueba T de Student para muestras pareadas

DISCUSSION

The results found in the present study are compatible with various studies previously conducted in other populations of the world such as Murphy in 1956, Ersoy and Saxena in 2003, Matsumura in 1991, Mwachaka in 2009 and Morales in 2011, there being no reports of this type in a Peruvian population.

The understanding and knowledge of the type, degree of obliteration and location of the pterion in relation to a

specific bone point such as the zygomatic arch, has an important relation with respect to the clinic, used in neurosurgery, anthropology, forensic and legal medicine, in criteria of Human identification with unidentified bone remains.

It is known that there are differences in the sutural morphology of the pterion between the different existing ethnic groups, a fact that is also associated with the genetic and environmental factors of the place of origin of the human being; Therefore, the degree of sutural

obliteration was determined, since it is known from multiple studies of age estimation that the pterion point partially obliterates grade 2 and total grade 3 from the age of 25, achieving total obliteration of individuals older than 40 years [21]; it was evidenced in the study sample that 100% presented grade 3, not differentiating by age intervals, a difference that when compared with previous studies may be due to the incidence rate of sphenoparietal pterion type according to evolutionary bases; it has been shown that the development of the bones that make up the cranial vault is in close relation with the growth of the brain and requires interactions between the different tissues within the suture of the cranial vault; the growth of the brain in human organisms leads to morphological changes in the neurocranium, causing the greater wing of the sphenoid and parietal to be reunited, which would explain that the increase in closure capacity (complete obliteration) is present in the sample of the skulls studied, without differentiating their age.

It is also known that sphenoparietal type pterions appear more frequently in men (85.4%) than in women (71.4%) [22]; regarding the relationship caused by the early obliteration of the suture, the pattern of the sphenoparietal type pterion shows a trend with the early dome-cranial growth of the male individuals; this is directly related to age, with some variation according to the ethnic group.

In general, an association of these bones with sex is not found in the literature; some authors point out that there is no significant relationship between these variables; it is suggested to continue the studies in a unanimous group of sex. Cossedu et al. (1979) and Assala & Mbajjorgu (1996), make a statement with

which the author agrees Le Double, who said not knowing if there would be a predominance of one sex or the other [23].

The present study showed that the sphenoparietal pterion type morphology is present in 70% in a group of male skulls; it was observed in higher prevalence bilaterally compared to unilateral; this data was observed in another study, where Le Doublé found this type of pterion in 90% of the studied skulls, using the variables of side, sex and ethnic group with the presence of suture bones; they found a statistically significant relationship in white male individuals and bilaterally, leaving a specific relationship that in female samples is evidenced unilaterally [24].

According to our results, it can be established that there is a direct relationship between the morphological type of sphenoparietal pterion, the male sex and the white ethnic group worldwide coinciding with the mestizo group of the Peruvian population; this aspect can not be determined exactly, since Peru has a very varied population.

The prevalence of the frontotemporal type was in second place (24.6%), representing a result superior to that reported in studies conducted in Australians (7.5%), Turks (3.5%), Indians (10%), Japanese (2.6%), Kenyans (15%), Nigerians (3.36%) and Mexicans (2.35%); these data showed that this type of pterion has a low prevalence among the ethnic groups of Latin America [25], being able to relate it to the high migration of white individuals from other continents to the Peruvian territory; it is known that this type of pterion has a high prevalence in primates, but not in humans [26], which supports the theories of an evolutionary

process relating it to the current brain growth of human beings.

The lowest prevalence was found in the stellar type (6.15%), which represents a higher result than other studies done in Australians (1%), Turks (0%) and Japanese (0.6%); however, it was similar to that reported in studies conducted in Nigerians (5.06%), Mexicans (4.12%), Kenyans (12%) and Indians (5%). There was no record of the epipterical type, a result that differs in its entirety from the existing studies, thus evidencing the remarkable variations in frequency of the suture bones in the pterion between the different populations; the mechanism of formation of the suture bones is not completely understood until now, although some link it to the little development of the brain associated with environmental or genetic factors [27].

In previous studies, it has been reported that the pterion is at an exact location at 30.35 ± 3.40 mm and 30.34 ± 4.34 mm above the midpoint of the zygomatic arch on the right and left sides, respectively [26]. Men presented a pterion statistically superior in comparison with women, being of 39.31 ± 3.28 mm and 37.35 ± 2.97 . Therefore, in the present study we seek to directly relate this location in a Peruvian population, only with the male sex [28]; the results obtained show a great similarity (100% coincidence for both sides evaluated), registering a maximum measure of 40 mm on average, thus placing a record for the right side of 32.9 - 40.01 mm and for the left side of 35. + -40.01 mm; these values can be used as a guide to any future study of pterion morphometry. In the Peruvian skulls of our sample, the sphenoparietal pterion type had the highest prevalence (70%), followed by the frontotemporal (26%) and the stellate (4%).

In addition, the minimal variations obtained in the sutural morphology of the pterion within the male Peruvian population represent important data for anthropologists, pathologists, doctors and forensic odontologists; by comparing them with the different populations of the world already studied so far, a current record can be granted, thus complementing the analysis in conjunction with the estimation of age, sex, ethnic group within human identification during an investigation.

The knowledge of the sutural morphology of the pterion with the obliteration of it, as well as the verification of the distance with a cranial anatomical point offer a great support in the clinical and forensic field, thus strengthening the role of the current forensic dentist in his role with the human identification; in Peru there are cases of alleged Human Rights violations even in research and over time most are fragmented and skeletonized, scattered, finding them in parts; through the cranial analysis of Pterion we can study its morphology and degree of obliteration, in order to estimate the age and establish the ethnic group, primordial indicators in the process of human identification; the bone rest most found during an exhumation is the skull and having the pterion as a sutural craniometric structure with greater anatomical protection, a sutural morphology without changes over the years is evident.

It is a novel technique, little known and with good results, so it was decided to carry out the research in 90 Peruvian skulls in order to determine the effectiveness of the technique in the estimation of adulthood, ethnic group and determination of sex, according to its morphological analysis. With this, we can establish the following conclusions:

1. Pterion with the highest prevalence in a Peruvian population was the sphenoparietal type with a percentage of 70%, followed by the frontotemporal with 26%, there being no morphological differences in the bilateral study; finally, the type of pterion that obtained the lowest prevalence was the starred type with 6% and no data of the epipteric type was found.
2. Grade 3 sutural obliteration was found with greater prevalence in the bilateral evaluation of the male skull, without distinction of age interval.
3. The distance grouped according to the bilaterally evaluated side of the pterion taking into account the ossification center with the zygomatic arch is 40 millimeters (4 centimeters); This is measured vertically.
4. The average distance of the ossification center of the pterion in male individuals is for the right side 32.9 -40.01 mm and for the left side of 35.6 -40.01 mm.

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