

THE ANGLE OF LANDZERT (SPHENOIDAL ANGLE) AS A POSSIBLE NEW AGE ESTIMATOR IN FORENSIC ANTHROPOLOGY

G. LEONETTI^{1,2} and O. DUTOUR²

¹*Service de Médecine Légale, Université de la Méditerranée, Faculté de Médecine, 27, Bd Jean Moulin, 13385 Marseille Cedex 5, France;*

²*Laboratoire d'Anthropologie Biologique, Faculté de Médecine de Marseille - UMR 6578 CNRS/Université de la Méditerranée, 13385 Marseille Cedex 5, France.*

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Abstract

The general morphology of the human cranial base is mainly characterized by the angulations between the three cranial fossae. Numerous angles have been studied in comparative anatomy, ontogenetic and phylogenetic studies and human paleontology. However, the variability of these angles is not well defined in modern humans and consequently no forensic applications have been described to date. In this work, a study was made of the variability of the main angle of cranial flexion (sphenoidal angle) on a sample of 330 human skulls of known sex, ethnicity and age from the HAMAN-TODD anatomic collection (Cleveland Museum of Natural History, Ohio, USA). The study suggested that the age is the most important factor in the variation of this angle. This first result permits a consideration of its possible application in forensic anthropology.

Key words: forensic anthropology, age determination, aging, skull base, main angle of cranial flexion, sphenoidal angle.

Introduction

The morphology of the human cranial base is mainly characterized by the angulations between the three cranial fossae, clearly evidenced on mesial sagittal sectioned crania. Study of the angles of the skull base is of interest in comparative anatomy (CAMERON, 1927; LAITMAN et al., 1978), in ontogeny (BOLK, 1909), in phylogeny (AIELLO and DEAN, 1990) and in the speech production abilities of the fossil hominids (LIEBERMAN, 1984). Changes induced in the cranial base angles by artificial cranial deformation have been also reported by several authors (BJORK, 1955; MOSS, 1958; ANTON, 1989).

However, the parameters of variability of the cranial base angles are poorly documented in modern *Homo sapiens*. Magnetic resonance imaging recently evidenced age-related changes in the bone marrow of the normal clivus (KIMURA et al., 1990; OYAR et al., 1996). Our interest in the dynamic pattern in human skeletal biology led us

to the question of whether morphological changes in the human skull base could also be detected by gross examination and whether applications in forensic science can be deduced.

In order to establish the influence of age, sex and ethnicity on the general variability of the human skull base, we decided to study the variability of the main angle of the cranial base, constituted by the planes of the anterior and middle cranial fossae (sphenoidal). This angle has been described as the main angle of cranial flexion (CAMERON, 1927).

Materials and methods

This study was performed on a randomized sample of 330 human skulls of known age, sex and ethnicity (African and European origins) sectioned in the mesial sagittal plane, from the HAMAN-TODD anatomic collection (Department of Physical Anthropology, Cleveland Museum of Natural History, Ohio, USA). The sample was composed of 183 males (88 "whites", 95 "blacks") and 147 females (74 "whites", 73 "blacks"). No statistical differences appeared in the distribution of this sample, as tested by the chi-squared test. The age range was from 17 to 90 years. Analysis of the 5-year categories revealed a moderate surplus in the middle categories (35-55 years) and a moderate shortage in the oldest and youngest categories (Fig. 1), which corresponds to the structure of the entire collection. It should be noted that this sample includes 30 individuals younger than 25 years.

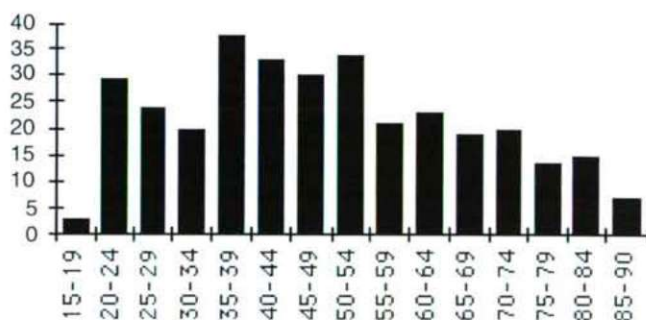


Fig. 1. Age distribution of the analysed sample (5-year categories).

After separation of the two half-skulls, the angle was measured directly with a goniometer on the left side. The individual data (age, sex and ethnicity) were unknown to the person conducting the measurements (blind test). The angle constituted by the anterior fossa plane and the middle fossa plane was measured. At the middle of the anterior fossa, the cribriform plate of the ethmoid bone is located between the left and right orbital processes of the frontal bone; these form the roof of the orbital cavities. The anterior plane is known as the planum sphenoidale. The crista galli is located at the front of the cribriform plate. The plane of the middle cranial fossa is represented by the planum of the clivus: this slope is formed by the posterior part of the dorsum sellae, in continuation with the superior aspect of the basilar process of the occipital bone.

Several techniques are used to measure the sphenoidal angle (OLIVIER, 1965): that of WELCKER using the nasion, the ephippion and the basion; that proposed by CAMERON (1925), using the nasion, the pituitary and the basion; measurement of the nasion-prosphenion-basion angle; and the method of LANDZERT, which measures the angle constituted by the clivus and sphenoidale plana. We chose the LANDZERT method, as it is the simplest and most accurate. However, according to OLIVIER (1965), the results are similar whatever the technique used.

According to the LANDZERT technique, we measured the angle as follows: one branch is placed on the clivus plate, from the basion to the pituitary, while the other one is placed on the planum sphenoidale. The vertex of the angle often corresponds to the posterior part of the sella turcica. The planum sphenoidale more often reaches the nasion, but we did not take this into account in the measurement.

The 30 individuals of the sample who were younger than 25 years old were analysed separately: before this age, the growing process is not ended and the fusion of the sphenoccipital synchondrosis is not complete. This fact could induce differences in the mean values of the sphenoidal angle. The present paper will mainly concentrate on the results obtained in the adults. The results were analysed by classical statistical tests (mean, standard deviation, standard error of mean, correlation, regression, t-test and chi-squared test).

Results and discussion

The overall variation in the sphenoidal angle in the sample is from 85 to 155°. Analysis of the variability from 25 to 85 years, in 5-year classes, showed a progressive decrease in the mean value with the age ($r^2: 0.882$) and a "stepwise" aspect of this decreasing phenomenon, recognizable in 4 main stages (Fig. 2, Table 1).

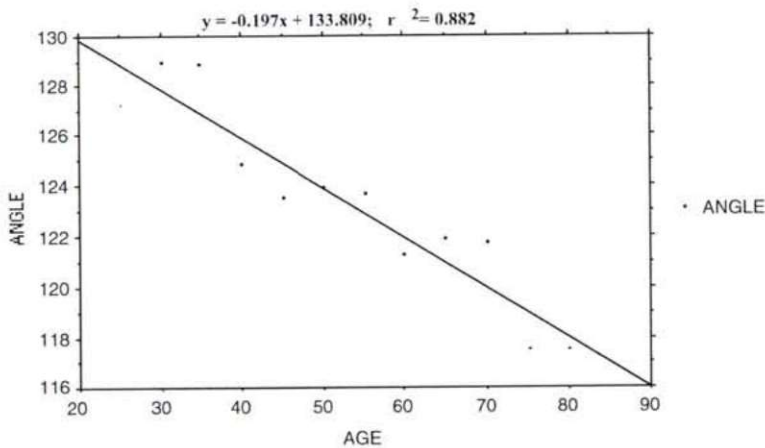


Fig. 2. Decrease in the mean value of the angle of LANDZERT with the age (regression curve) and the „stepwise“ aspect of this decreasing phenomenon.

This study constitutes the first evidence of an age-related variation in the sphenoidal angle (main angle of cranial flexion) in adults. Some recent studies involving the use of magnetic resonance imaging indicated the age modification of the clivus bone marrow (OYAR et al., 1996), but did not take into account the sphenoidal angle. No evidence for a modification related to the sex, reported previously (CAMERON, 1927), was observed in our analysis. The mean value of the angle appeared to be statistically different as a function of the ethnicity: the Afroamerican sample presents a larger mean value.

Table 1. Means of the angles for the 4 successive stages of age.

	Number	Mean	ECART-type
Stage 1	82	128.45	8.61
Stage 2	118	124.08	9.20
Stage 3	62	121.51	8.43
Stage 4	32	117.03	11.66

However, the tendency is the same in the two samples ("black" and "white"), showing that the age is a major factor of the variation in the sphenoidal angle. The effect of the aging processes on the cranial base is characterized by an increase in the flexion of the base. The 5-year classification from 25 to 90 years revealed a "stepwise" decreasing phenomenon, with an r^2 value of 0.882.

4 successive steps or stages can be discerned with this 5-year classification (Table 1):

- the first group is represented by people aged from 25 to 39 (stage 1), with a mean value of the angle of about 128° ;
- the second group (stage 2) corresponds to the people aged from 40 to 59 years (sphenoidal angle mean value of about 124°);
- stage 3 is represented by individuals from 60 to 74 years old (about 121°);
- the people older than 75 years old (mean 116°) belong in the last category (stage 4).

The t-test confirms the validity of this classification, showing highly significant differences between the stages; for the intermediate categories (stages 2 and 3), the differences are only for a risk level of 0.1.

In fact, the aging process of the flexion of the cranial base could evolve in adults in 3 major phases, corresponding to 3 categories: young, middle-aged and old. When this classification is made, the differences are highly significant at a level of 0.05.

Conclusions

This new result is of interests from various aspects. From an anatomical point of view, it demonstrates the age-related variation in an anatomic structure which was hitherto considered to be stable in adults. From a paleontological point of view, it underlines the necessity of taking into account the intraspecific factor of variation in the phylogenetic reconstruction, using the morphology of the cranial base. From an anthropologic and forensic points of view, it could constitute a new age indicator in adults. A more detailed analysis of this phenomenon and its causes will allow a clarification of its applications in the future.

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