STUDY ON SKULL ASYMMETRY

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Abstract

The aim of this study is to determine the type of skull as well as to examine its internal appearance and configuration of skull base. Special attention is given to the direction and position of the pyramid of the temporal bone, the volume and appearance of all the three cranial fossas, and the direction and appearance of crista alaris - all of those compared to the skull type.
Considering the obtained results (specially for crista alaris and middle fossa) we can ascertain outstanding independence of sphenoid bone and its parts in the formation of cranial base. Located in the middle of the skull, in front of strong pyramids transversal axis and two vertical axis, frontal crest and internal occipital crest, it by itself with her lesser wing presents an important transversal axis of cranial base. Cases in which crista alaris with its position does not follow the type of skull (in 20 % cases crista alaris does not follow skull protuberances), may probably be explained by strong and independent development of this bone, which is placed among other bones of cranial base like a peg. It also, by itself dictates form and configuration of the middle part of skull. That is also confirmed by middle fossa which, according to its position in the middle of cranial base and relation with sphenoid bone, shows significant deviation with respect to posterior fossa (follows the type of skull in 47 % cases).

Keywords: skull, asymmetry

Introduction

Asymmetry of brain and skull has always been an object of scientific research, as well as their interaction and possible involvement with concrete clinical cases. If we take a look at history of research into asymmetry of brain and skulls we can note that research from XIX century indicate that the determining factor for the definitive form of skull is triple rotation of the temporal bone, which by its growth dictates brahicefalic development of human skull. Authors made typological classification and determined two basic skull types: frontopetal and occipitopetal. The first type is predominant in uncivilized, and the occipitopetal type in civilized nations. Relationship between the skull base and temporal bone was also observed and it led us to conclusion that the whole configuration of the skull base is closely dependant on changing configuration and position of temporal bone. We also examined differences between the capacities of the right and the left half of the human skull. Booth halves of the skull were found to be identical in 5 % of the cases, while the left part of the skull was larger in 64,7 % of the cases. We draw the conclusion that the human skull is markedly asymmetrical not only with regard to the dimensions of individual bones but in the topological sense as well. It indicated that the number of symmetrical skulls was insignificant. The skull was observed from the functional point of view as well, and three axis inside the skull base were listed: smaller wings of sphenoid bone, temporal bone pyramid and internal occipital. These axis correspond to the direction of forces which shape the skull base. It is stated that the dependence exists only between the capacity of skull and development of brain while the configuration of skull depends mostly on the position of head and body in space, and the influence of gravitation. Human skull balances on the top of vertical vertebral column, when a balance between the activity of nuchal mussels on the rear end of the skull and the influence of gravitation on skull viscera exists. Flexion of cranial base leads to descend of posteror cranial fossa, which follows the change of vertebral column position and causes increase in sphenoid angle. Thus, the brain gets new space for its development. Process of cranial base flexion allows more intensive development of neurocranium and increased capacity of the skull. It became known that the process of skull-base flexion does not end in adolescence, but it continues to old age, and follows the changes in bending of the cervical part of vertebral column. Also, it was indicated that the capacity of skull intensively increases during the growth of skull and that it is even more intensive than the flexion of cranial base. So, the dependence of the skull capacity on the flexion of skull - base seems logical.

Materials and methods

Studied material consisted of 200 skulls from osteological collection of the Institute of Anatomy, School of Medicine in Sarajevo. Osteological material included 200 skulls, 110 of them were whole while 90 were opened. For the first part of the analysis, i.e. determination of the skull type on the basis of appearance we considered 100 skulls, which sex and age were ignored. We determined:

A. Type of skull with respect to the appearance of its occipital, temporo parietal and frontal part

B. Direction and position of the temporal bones' pyramids in compare with respect to the skull type

C. Direction and position of crista allaris and

D. Appearance of all three skull fossas (posterior, middle and anterior)
B., C. and D. analyses were done on opened skulls

E. Analyses of asymmetry of middle skull fossa by alginate imprints metod.

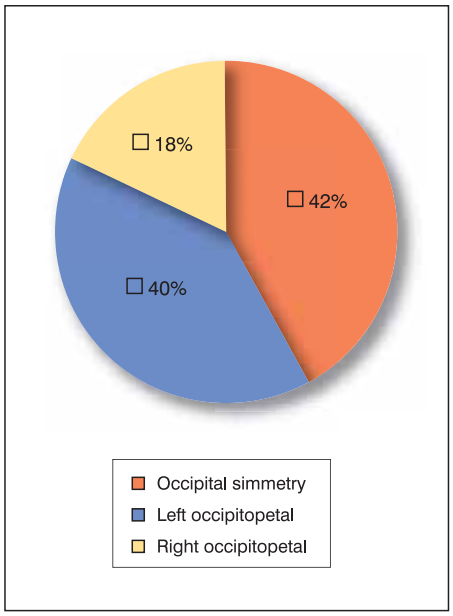
Results

ANALYSES OF OSTEOLOGICAL MATERIAL - MACERARE AND DEEGREES SKULL

Considering appearance and configuration of occipital part of the skull three main types are established noted as:

1. symmetrical
2. left occipitopetal
3. right occipitopetal

Of 100 skulls that were investigated, 42 had occipital symmetry or 42 %, 40 had left occipitopetal or 40 % and 18 skulls had right occipitopetal or 18 %.



Graph 1. Percentage of skull types presence considering the appearance and configuration of the occipital part

Each of these types is almost regularly associated with temporo-parietopetalia, frontopetalia or both of them. These combinations can be onesided, or more frequently, contralateral, i.e. associated with protuberance on the left side of one part with protuberance on the right side of other part and vice versa.

Of all 100 analyzed skulls, 42 had occipital symmetry or 42%.

Of those we found:

Total symmetry	3
Occipital symmetry associated with protuberances in other parts of skull	3 9

In the second group we found:

Occipital symmetry associated with right temporoparietopetalia	2 6
Occipital symmetry associated with left temporoparietopetalia	7
Occipital symmetry with right fronto – and temporoparietopetalia	2
Occipital symmetry with left fronto – and temporoparietopetalia	1
Occipital symmetry with left frontopetalia	1
Occipital symetry with right temporoparietopetalia and left frontopetalia	2

Results are shown in percentages -%.

In this group of skulls the most frequent type of occipital symmetry is associated with right temporoparietopetalia, actually 26 % of all investigated cases.
A2 Second group of skulls consists of skulls with left occipital protuberance, actually there were 40 cases of left occipitopetalia, or 40 %.

In this group we did not find any clean cases i.e., left occipitopetalia is always associated with protuberance on the same or opposite side.

Left occipitopetalia with right temporoparietopetalia	1 6
Left occipitopetalia with right fronto – and temporoparietopetalia	9
Left occipitopetalia with left temporoparietopetalia	3
Left occipitopetalia with left temporoparietopetalia and right frontopetalia	5
Left occipitopetalia with right temporoparietopetalia and left frontopetalia	1

Results are shown in percentages -%.

Picture 1. Occipital symmetry

Picture 2. Left occipitopetalia

In this group of skulls the most frequent type is left occipitopetalia associated with protuberance on the contralateral side, i.e. with right temporoparietopetalia. Total of 16 % of the investigated cases.

A3 The third group presents the prominence of the occipital portion on the right side. In this group we found 18 skulls or 18 % of all the investigated skulls.

In this group we found 1 case (1 %) of pure right occipitopetalia that is not associated with any protuberances in other parts of skull.

Right occipitopetalia	1
Right occipitopetalia with left temporoparietopetalia	7
Right occipitopetalia with left fronto – and temporoparietopetalia	5
Right occipitopetalia with left frontopetalia	2
Right occipitopetalia with right temporoparietopetalia	1
Right occipitopetalia with right frontopetalia	1
Right occipitopetalia with right temporoparietopetalia and left frontopetalia	1

Results are shown in percentages -%

In this group right occipitopetalia with left temporoparietopetalia dominates and appears in 7 cases or 7 %.

B In all the cases anteroposition of the occipital part of the skull, posterior cranial fossa, pyramid of the temporal bone shows anteroposition on the same side. In cases of left occipitopetalia when we have anteroposition of the right part of the skull, posterior cranial fossa, pyramid of the right temporal bone is displaced forward, it is in anteroposition. In cases of right occipitopetalia, left pyramid of the temporal bone shows anteroposition. In symmetrical skulls, the pyramids of temporal bones show symmetrical position and there is no anteroposition.
However, in occipital symmetry associated with right or left temporopetalia, pyramids are in anteroposition on the same side as temporoparietal protuberance.

Volume of middle skull fossa on the left side is 50 ml, and 44 ml on the right side. Volume ratio is 1,14:1, i.e. left volume is by 1,14x bigger then the right i.e. by 14 %.

C Crista alaris is of special importance because of its functional meaning as frontal transversal axis of the cranial base (Beninghoff). Investigation of crista alaris gave us very interesting results.
Position of crista alaris follows anteroposition of the occipital part of the skull and pyramid of the temporal bone in 50 % cases.

n cases of occipital symmetry associated with temporoparietopetalia or frontopetalia of the right or left side, crista alaris was in anteroposition on the side of temporoparietopetalia in 30 % cases. In 20 % cases crista alaris does not follow skull protuberances.

Picture 3. Right occipitopetalia

Picture 4. Cranial base - occipital symmetry with right temporoparietopetalia

Crista alaris

Follows anteroposition of the occipital part of the skull and of the temporal bone pyramid	5 0
Follows temporoparietopetalia or frontopetalia in occipital symmetry	3 0
Does not follow skull protuberances	2 0

Results are shown in percentages -%.

Volume of middle cranial fossa on the left side is 35ml and 38 ml on the right side. Ratio between the volumes is 1:1,09, i.e. right volume is by 1,09x bigger then the left i.e. by 9 %.

D In all the cases of anteroposition of the occipital part of the skull, as well as temporal bone pyramid, posterior fossa of the skull shows anteroposition on the same side. The middle cranial fossa, accoding to its position in the middle of the skull, as well as its relation with sphenoid bone, shows great difference with respect to posterior fossa. The middle fossa corresponds to the appearance of the occipital part in 47 % of all the examined specimens, and the anterior fossa in 70 %.

Follows the type of the skull

Posterior cranial fossa	1 0 0
Middle cranial fossa	4 7
Anterior cranial fossa	7 0

Results are shown in present -%.

Volume of middle cranial fossa on the left side is 40 ml and 31 ml on the right side. Ratio between the volume is 29:1, i.e. the left volume is bigger by 1,29x than right , i.e. for 29 %.

Discussion

In the beginning of the writing of this study we mentioned that asymmetry of brain and skull are everlasting objects of scientific interest, as well as their interaction and involvement in concrete clinical cases.
Considering research on asymmetry of skull we found data in literature from XIX century to recent days. Authors observe different aspects of the skull development and asymmetry. Also, O. Schaeffer - in 1892. (1) concluded that the definitive form of skull is determined

Table 1. Percent of representation of the temporal bone pyramids anteroposition considering the side and type of skull

Type of skull	Anteroposition of the right pyramid	Anteroposition of the left pyramid
Left occiopitopetalia	100	-
Right occiopitopetalia	-	100
Occipital symmetry	-	-

Picture 5. Cranial base - left occipitopetalia

Picture 6a. Alginate imprint of middle cranial fossa at right occipitopetalia

Picture 5a. Alginate imprint of middle cranial fossa at left occipitopetalia

Picture 6. Cranial base - right occipitopetalia

by triple rotation of the temporal bone pyramid, which with its growth dictates brahicefalic tendency of human skull development. Vasilije Nikoli} and Pavao Rudan 1971 - 1972. (2) emphasize the importance of cranial base flexion and in connection with that the torsion of the pyramid and the whole temporal bone. Schonemann concluded that the whole configuration of the cranial base depends upon the changing structure and position of the temporal bone. Knauer - 1914. said (1) that the upright position of human being influences configuration of pyramid and skull. Nikoli} and Rudan - 1970.(2,3) accent that the flexion of cranial base causes upright position of human being. Delattre and Ferart - 1951. prove that the flexion of skull - base leads to the descent of posterior cranial fossa, which follows the change in vertebral column position and sphenoid angle increases. According to Delattre and Fenart - (1960) thus brain receives new space for its development. Process of cranial base flexion allows more intense development of neurocranium and bigger capacity of the skull. Almost identical research we found in: Weidenreich - (1950), Kummer - (1952), and [ercera and Krmpoti} (1960). Nikoli} and Rudan - 1970.(2,3) prove statistically significant correlation between the angulation of cranial base and capacity of skull noticed only on skulls that are in the processing of growing. After the end of growth this correlation is not statistically significant. Authors prove that statistically significant correlation between of the angulatio of cranial base and capacity of skull in adults disapears because of great variability of the angulatio of cranial base as well as capacity of skull. Froriep made typological classification with two basic skull types: frontopetal and occipitopetal. Almost identical research we found in publication Shinido - Takuici 1912 .(3) Minkin S. - 1925. (3) introduced in literature a completely new type - parijetopetalia and temporoparijetopetalia. Hadziselimovi} - 1964. (1) tried to

decide which is the most frequent type of human cranial base. According to the appearance and configuration of occipital part, he found that the most frequent type is occipital symmetry, than left occipitopetalia, and in the end right occipitopetalia. Each of these types is associated with temporo-parietopetalia, frontopetalia or both. This combination can be on the same side, or more frequently, contralateral, associated protuberance on the left side of one part with protuberance on the right side of the other part and contra. Our results concur with Hadziselimovic's results where the most frequent type of symmetry is occipital symmetry - 42 %, and than occipitopetalia sinistra - 40 % and the and right occipitopetalia 18 % of all the studied cases. The most frequent combination is contralateral i.e. occipital symmetry associated with temporoparietopetalia on the right side - 26 % , left occipitopetalia associated with right temporoparietopetalia - 16 % and right occipitopetalia associated with left temporoparijetopetalia - 7 % of all studied cases. Then, the temporal bone pyramid in all the studied cases follows configuration of occipital part of skull. Crista alaris with its position follows anteroposition of the occipital part of the skull and pyramid of the temporal bone in 50 % cases. We obtained analog results at middle fossa, actually middle fossa corresponds to the appearance of the occipital part in 47 % of all the examined specimens, which we explain according to its position in the middle of skull, as well as its relation with sphenoid bone.

Conclusions

On the basis of our analysis we can conclude:

1. Asymmetry of skull is evident
2. Every one of the analyzed asymmetries shows the same characteristics in the group, in which we emphasize variations.
3. We also emphasize the importance of presence of conciseness in individual characteristics of every one of the parameters in the shading light on asymmetry of skull
4. Sphenoid bone is like a peg placed among other bones of skull base. By itself it dictates form and configuration of the middle part of skull.

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