

## Bilateral Asymmetry of *Os Zygomaticum*

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The aim of the study is to perform a comparative quantitative assessment of the manifestations of bilateral asymmetry of *os zygomaticum* on bone material. A total of 125 male crania from the ossuary at the National Museum of Military History, Sofia, were studied. The crania belong to adult individuals aged between 20 and 43 years. Two linear features were measured bilaterally – breadth of *os zygomaticum* and height of *os zygomaticum*. Scopically for both sides were investigated presence and number of *foramen zygomaticofaciale* and form of *processus frontalis ossis zygomatici*. The asymmetry assessment in the investigated male crania shows that the left zygomatic bones are higher and wider compared to the right ones. The asymmetry manifestations for the investigated scopic features are described as well.

*Key words:* asymmetry, *os zygomaticum*, *foramen zygomaticofaciale*, form of *processus frontalis ossis zygomatici*.

### Introduction

In the human skull as in the other parts of the skeleton may be found bilateral asymmetry manifestations as well. Due to the key role of *os zygomaticum* in the structure and the aesthetical appearance of the face, the evaluation of its bilateral asymmetry is of significant importance [1, 4, 5].

The aim of the study is to perform a comparative quantitative assessment of the manifestations of bilateral asymmetry of *os zygomaticum* on bone material.

### Material and Methods

A total of 125 male skulls from the ossuary at the National Museum of Military History, Sofia, were studied. The skulls belong to adult individuals aged between 20 and 43 years who died in the wars during the period 1913-1917.

Two linear features were measured for both sides – breadth of *os zygomaticum*, using the method of Aleksiev - Debet's [3] and height of *os zygomaticum*, feature introduced by us. Height of *os zygomaticum* represented the distance between the standard anthropometric landmarks – *zgomaxillare* and *frontomalare-orbitale*.

Scopically were investigated presence and the number of *foramen zygomaticofacialis* and the form of *processus frontalis ossis zygomatici* on both sides of the skull. The latter was recorded as straight, protruding and presence of *tuberculum marginale* [6]. In order to record the manifestations of asymmetry in scopic features, 16 combinations of different numbers of *foramen zygomaticofacialis* and 9 combinations of the three forms of *processus frontalis ossis zygomatici* either at the right or left side were used.

The data obtained were statistically processed through variation and alternative analysis (SPSS, version 13.0). The reliability of bilateral differences recorded for metric features was verified through Student's t-test at  $p < 0.05$ . Quantitative assessment of the bilateral asymmetry was performed using Wolanski's index for intergroup comparison. In this case, the index was used to determine the manifestations of bilateral asymmetry and is referred to as Index of Asymmetry (IA):

$$IA = \frac{2 \cdot (x_1 - x_2) \cdot 100}{x_1 + x_2},$$

$x_1$  – value of the feature to the right;  $x_2$  – value of the feature to the left.

The sign of the resulting IA value designates the direction of bilateral asymmetry: “-” shows asymmetry at the left (metric priority in favour of the left side), and “+” shows asymmetry at the right (metric priority in favour of the right side).

The degree of manifested bilateral asymmetry was assessed as slight, moderate and strong, using percentile analysis of the data for IA. The border values were set at  $P_{25}$  and  $P_{75}$ .

## Results

### Metric characterization

The data obtained from the biostatistical analysis of the linear features, borderline values for assessment of the asymmetry degree and percentage distribution are given in Table 1, Table 2 and Table 3.

**Breadth of *os zygomaticum*.** Data about the mean value for this feature at the right (53.13mm) and at the left (53.22mm) shows that there is presence of left-side asymmetry as a whole. Breadth of *os zygomaticum* at the left is 0.09mm greater than the value at the right. In the investigated cranial series, 26.84% of the skulls did not exhibit bilateral asymmetry for this feature. Total frequency of crania with right-side asymmetry (34.14%) is accounted with 4.88% more rarely compared to this whit left-side asymmetry (39.02%). Assessment of the asymmetry degree shows that slight asymmetry is

Table 1. Biostatistical data of the investigated linear features of *os zygomaticum*

Measurements of <i>os zygomaticum</i>	Right						Left					
	n	mean	min	max	SD	Sx	n	mean	min	max	SD	Sx
Breadth of <i>os zygomaticum</i>	123	53.13	40.00	63.00	3.89	0.35	125	53.22	43.00	63.00	3.67	0.33
Height of <i>os zygomaticum</i> (zm-fmo)	125	42.79	36.00	51.00	2.80	0.25	125	43.03	36.00	51.00	2.81	0.25

Table 2. Borderline values for assessment of the

Measurements of <i>os zygomaticum</i>	Slight (IU)	Medium (IU)	Strong (IU)
Breadth of <i>os zygomaticum</i>	$x - 0.66$	$0.67 - 3.32$	$3.33 - x$
Total height of <i>os zygomaticum</i> (zm-fmo)	$x - 1.08$	$1.09 - 3.31$	$3.32 - x$

Table 3. Frequency distribution of symmetry and asymmetry manifestations

Measurements of <i>os zygomaticum</i>	Left-side asymmetry (%)			Symmetry (%)	Right-side asymmetry (%)		
	strong	moderate	slight		slight	moderate	strong
Breadth of <i>os zygomaticum</i>	13.82	25.20	0.00	26.83	0.00	22.76	11.38
Total height of <i>os zygomaticum</i>	16.00	26.40	1.60	23.20	0.80	24.00	8.00

not recorded for both sides. Moderate left-side asymmetry (25.20%) is more frequent than moderate right-side asymmetry (22.76%). Strong bilateral asymmetry in favour of the right side is recorded for 11.38% of the skulls, and in favour of the left side – for 13.82%.

Height of *os zygomaticum*. In accordance with the mean value of this feature there is presence of left-side asymmetry, respectively 42.79 mm on the right side and 43.03 mm on the left side. Height of *os zygomaticum* at the right is 0.24 mm less compared to that on the left side. Symmetry for this feature is observed in 23.2% of the investigated skulls i.e. the values are equal for both sides. Total frequency of crania with right-side asymmetry of *os zygomaticum* is 32.80% and is with 11.20% more rarely accounted compared to this with left-side asymmetry (44.00%). Assessment of the asymmetry degree shows that slight asymmetry in favour of the left side (1.60%) is two times more common than of the right side (0.80%). Moderate asymmetry is established more frequently for the left side (26.40%) compared to the right side (24.00%). Strong asymmetry was again two times more frequent in favour of the left side (16.00%) compared to the right side (8.00%).

#### Scopic characterization

*Foramen zygomaticofaciale* is located on the front surface of *os zygomaticum*, through it passes a branch of *nervus zygomaticus – ramus zygomaticofacialis* and blood vessels. As normal anatomical variations, *foramen zygomaticofaciale* may be either absent or present in the form of several separate foramina.

In the investigated cranial series, the anatomical variations established for this scopic feature ranged from total absence of *foramen zygomaticofaciale* to the presence of three separate foramina. In general, the highest percentage of skulls has a single *foramen zygomaticofaciale* on both sides (47.58% to the right and 48.00% to the left). Presence of two facial zygomatic bone foramina at the right (26.61%) is found to be 2.42% more frequent than total absence of a foramen (24.20%). On the left side in 28.00% of the skulls *foramen zygomaticofaciale* is absent and is represented by two separate foramina in the 17.60%. Presence of three foramina on the right side is recorded for 1.61% of the skulls, while on the left side the percentage is comparatively higher – 6.40%.

In accordance with the 16 possible combinations of different numbers of facial zygomatic bone foramina for both sides the assessment of frequently distribution shows that the highest percentage of skulls are with bilateral presence of single facial zygomatic bone foramen (30.65%) (Table 4). Bilateral absence of *foramen zygomaticofaciale* is registered for 14.52% of the examined skulls, followed by the combination of two foramina at the right and one at the left – 12.10%. For 11.29% of the skulls, presence of a single foramen at the right and absence of a foramen at the left is established, while 9.68% of the skulls exhibits bilateral presence of two foramina. Absence of *foramen zygomaticofaciale* at the right and presence of a single one at the left is recorded for 5.65% of the skulls, while its absence on the right side and two foramina on the left

Table 4. Different combinations of number of *foramen zygomaticofaciale* on the right and left sides.

Combination №	Number of <i>foramen zygomaticofaciale</i>		%
	Right	Left	
1	0	0	14.52
2	1	1	30.65
3	2	2	9.68
4	3	3	0.81
5	0	1	5.65
6	0	2	3.23
7	0	3	0.00
8	1	0	11.29
9	2	0	1.61
10	3	0	0.00
11	1	2	4.03
12	1	3	1.61
13	2	1	12.10
14	3	1	0.00
15	2	3	4.03
16	3	2	0.81

side are established for 3.23% of the skulls. The combinations of one *foramen zygomaticofaciale* at the right and two at the left and the combination of two at the right and three at the left are established in equal percentages – 4.03%. Presence of two facial zygomatic bone foramina at the right and absence of such at the left is as common as presence of one foramen at the right and three at the left – 1.61%. The combination of bilateral presence of three facial zygomatic bone foramina and the combination of three foramina on the right side and two on the left side are most rarely established – 0.81%. In the investigated cranial series, no cases of the following three possible combinations are established: absence of *foramen zygomaticofaciale* at the right and presence of three foramina at the left; presence of three foramina at the right and absence at the left; presence of three foramina at the right and one at the left.

Descendent formula for the combinations of different number of *foramen zygomaticofaciale* on both sides.

2 (30.65%) > 1 (14.52%) > 13 (12.10%) > 8 (11.29%) > 3 (9.68%) > 5 (5.65%) > 11 (4.03%) = 15 (4.03%) > 6 (3.23%) > 9 (1.61%) = 12 (1.61%) > 4 (0.81%) = 16 (0.81%) > 7 (0.00%) = 10 (0.00%) = 14 (0.00%)

Lateral margin of *processus frontalis ossis zygomatici* is the insertion for *lamina superficialis fasciae temporalis*, one of the two layers of the fascia covering *musculus temporalis*. Depending on the extent of protrusion of the insertion of the fascia, the form of *processus frontalis ossis zygomatici* was scopically classified as straight (smooth), protruding or presence of *tuberculum marginale*.

In the investigated cranial series, the protruding form of *processus frontalis ossis zygomatici* is established to be most common bilaterally (56.45% on the right side and 57.60% on the left side), followed by the form represented as a *tuberculum marginale* (42.74% on the right side and 41.60% on the left side). The straight form of *processus frontalis ossis zygomatici* is least common (0.81% to the right and 0.80% to the left).

The assessment of frequently distribution of the 9 possible combinations resulting from the three forms of *processus frontalis ossis zygomatici* in both sides shows that bilaterally the protruding form is most common (50.81%) (Table 5). Bilaterally developed *tuberculum marginale* is established for 35.48% of the crania, followed by the combination of presence of a *tuberculum marginale* on the right side and protruding form of the lateral margin of the frontal process of the zygomatic bone on the left side

Table 5. Different combinations of form of *processus frontalis ossis zygomatici* on the right and left sides.

Combination №	Form of <i>processus frontalis ossis zygomatici</i>		%
	Right	Left	
1	straight	straight	0.81
2	protruding	protruding	50.81
3	<i>tuberculum marginale</i>	<i>tuberculum marginale</i>	35.48
4	straight	protruding	0.00
5	straight	<i>tuberculum marginale</i>	0.00
6	protruding	straight	0.00
7	<i>tuberculum marginale</i>	straight	0.00
8	protruding	<i>tuberculum marginale</i>	5.65
9	<i>tuberculum marginale</i>	protruding	7.26

(7.26%). Protruding form at the right and presence of a *tuberculum marginale* at the left are recorded for 5.65% of the crania, while bilaterally straight form of *processus frontalis ossis zygomatici* is observed for 0.81%. No cases of the other four possible combinations of different forms of *processus frontalis ossis zygomatici* either at the right or left side are established in the investigated cranial series.

Descendent formula for form of *processus frontalis ossis zygomatici* on both sides.

2 (50.81%) > 3 (35.48%) > 9 (7.26%) > 8 (5.65%) > 1 (0.81%) > 4 (0.00%) = 5 (0.00%) = 6 (0.00%) = 7 (0.00%).

## Conclusions

In accordance with the metric features asymmetry assessment shows that in the investigated male crania the left zygomatic bones are higher and wider compared to right ones.

In both metrical features the moderate asymmetry is the most common.

The scopic characterization shows that more frequently are found the following variations of different number of *foramen zygomaticifaciale*: bilateral presence of single foramen, bilateral absence of foramen, presence of two foramina at the right and one at the left side, presence of a single foramen at the right and absence of a foramen at the left. In the investigated cranial series, the protruding form of *processus frontalis ossis zygomatici* and presence of *tuberculum marginale* are established to be most common bilaterally.

The obtained data enrich the metrical and scopic characterization of cranium facial part. These data can be used as important information for distinction of different pathological changes of *os zygomaticum* from normal anatomical variations in this bone.

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