

Asymmetry of the ovale and spinous foramina in mediaeval and contemporary skulls in radiological examinations

Iwona Teul, Florian Czerwiński, Aleksandra Gawlikowska,
Violetta Konstany-Kurkiewicz, Grzegorz Sławiński

Department of Anatomy, Pomeranian Medical Academy in Szczecin, Poland

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The aim of this work was to evaluate the morphology and asymmetry of the ovale and spinous foramina. Examinations were carried out on 102 mediaeval and 85 contemporary male skulls. In both groups there predominated individuals who had died at mature (maturus) and adult (adultus) age. Radiological images in occipital projection were used in the study. Areas of the foramina ovale, distances between both openings and the distance from the midline running through the middle of the occipital foramen were calculated by means of PC software. The spinal foramen area could not be measured because of the too small surface accessible to the PC software used in our study. Correlation between the above measurements and cranial indexes (width-length and height-length) were calculated.

Significant variety of the ovale and spinous foramina in size, shape, relation to each other and to the midline were analysed. Asymmetry of structure and location was observed in both examined groups of skulls. No cases of the lack of the ovale and spinous foramina were stated.

key words: skull asymmetry, foramen ovale, foramen rotundum

INTRODUCTION

Symmetry and asymmetry have always been an interesting subject of study of scientists of different fields, i.e. anatomists, anthropologists, orthopaedists, neurologists and others. They analysed the asymmetry of the length and weight of long bones [5] and the asymmetry of the skull [2, 4–8, 10, 15, 16] and face, paying attention to its soft tissues — muscles and thickness of the fatty folds [2, 14].

As with most vertebrates, a human is built according to bilateral asymmetry. In the early stages of ontogenesis the first symptoms of asymmetry appear gradually i.e.: numerous differences in shape, size or location of paired organs, such as the kid-

neys, lungs, hemispheres of the brain. Features of the external structure confirm the presence of asymmetry of the muscular and bony systems. Opinions about the symmetry of the human body are divided. Some scientists underline a distinct lateralisation of human bodies but others say that asymmetry is changeable and statistically not significant.

The aim of our work was to estimate the morphology and asymmetry of the spinous and ovale foramina in mediaeval and contemporary skulls and the analysis of morphological changes of the medial cranial fossa appearing over the ages. The foramina were chosen for analysis because of their importance in neurosurgery. They are used as orientation points

of the infratemporal fossa, which can be easily identified both intra- and extra-cranially. Their topography is used in operations of the cavernous sinus performed by the lateral approach [1, 9, 13].

MATERIALS AND METHODS

Material of the study consisted of male skulls — 102 mediaeval from the mediaeval cemetery in Cedynia and 85 contemporary ones from the Central Cemetery in Szczecin. The age of all skulls was adultus and matusus. Only the skulls without damage and pre-death changes in the region of the occipital bone and the base of the skull were used. X-rays of the skulls were carried out in an occipital projection in the scale of 1:1.

For further calculations a sagittal line through the middle of the foramen magnum was done on x-ray images. Software was used to calculate the area of the foramen ovale, the distance between both ovale foramina and the distance between the spinous and ovale foramina and the orientation point lying in the midline on the anterior margin of the foramen magnum (Fig. 1). The area of the spinous foramen was not calculated because of its very small values, not measured by the software we used. The length, height, and width of the skull were measured according to Martin's method. The dependence between the three chosen anthropometrical indexes and measurements of the spinous and ovale

foramina were calculated. Statistically significant were values whose reality level was ≤ 0.05 . The results we obtained were compared to those available in literature.

RESULTS

In the spinous and ovale foramina great changeability of size, shape, relations to each other and to the midline were observed (Tables 1, 2). A lack of symmetry was observed in both groups of skulls. No case of undeveloped foramina was stated. On the basis of statistical calculation the following results appear:

1. The area of the left foramen ovale is greater in both groups of skulls (Fig. 2).
2. The distances between the ovale foramina are longer on the left side in both groups (Fig. 3).
3. The distances between the spinous foramina are longer on the left side in both groups (Fig. 4).
4. The distances between the anterior margin of the foramen magnum in the sagittal line and the ovale and spinous foramina are shorter on the left side in both groups.
5. The distance between the midline and both foramina is shorter on the left side in both groups.
6. The strict correlation between areas of the foramina ovale and width-length and height-width indexes is observed.
7. The distances between the foramen ovale and the foramen spinosum and their distance from

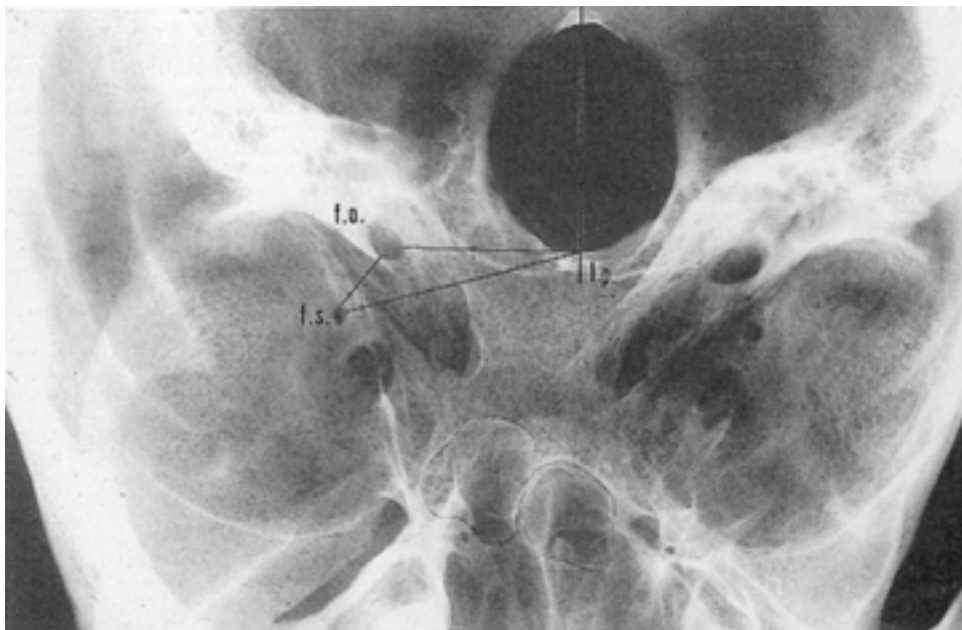


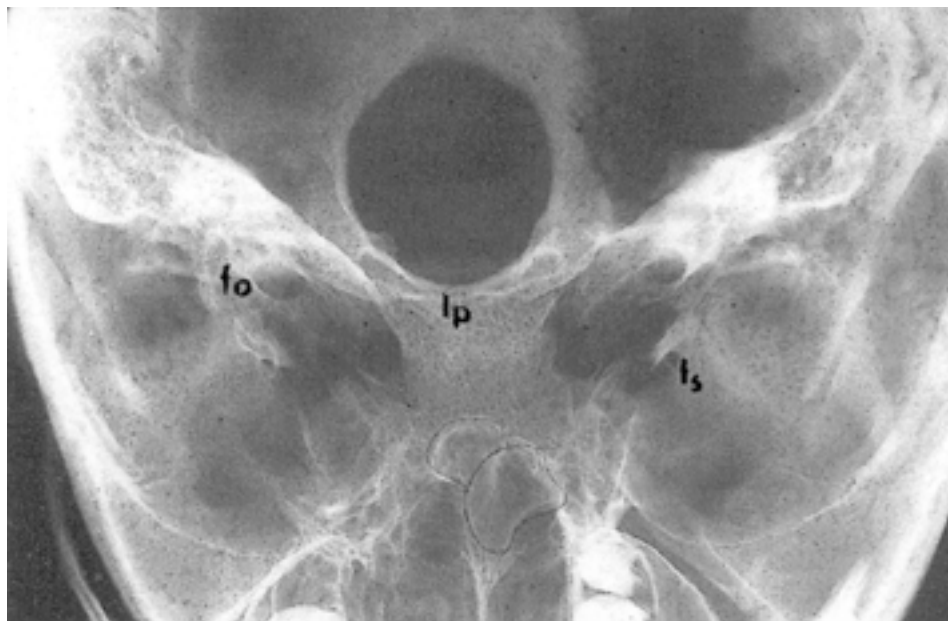
Figure 1. Occipital projection in the scale 1:1. Distance between both ovale foramina and the distance between the spinous and ovale foramina and the orientation point lying in the midline on the anterior margin of the foramen magnum; f.o. — foramen ovale, f.s. — foramen spinosum, l.p.— sagittal line through the middle of the foramen magnum.

Table 1. Mediaeval skulls

Mediaeval skulls	Min-Max value	Mean value	Median value	Std dev.
Area of the right ovale foramen	0.1–0.4	0.2	0.2	0.06
Area of the left ovale foramen	0.1–0.5	0.3	0.3	0.07
Distance between ovale and spinous foramina right	0.07–0.45	0.31	0.30	0.09
Distance between ovale and spinous foramina left	0.1–0.61	0.34	0.31	0.11
Distance between the ovale foramina and the midline right	2.55–3.75	3.50	3.49	0.23
Distance between the ovale foramina and the midline left	2.54–3.70	3.45	3.44	0.14
Distance between the spinous foramen and the midline right	2.83–3.85	3.23	3.20	0.25
Distance between the spinous foramen and the midline left	2.70–3.63	3.15	3.14	0.21

Table 2. Contemporary skulls

Contemporary skulls	Min-Max value	Mean value	Median value	Std dev.
Area of the right ovale foramen	0.1–0.4	0.2	0.2	0.06
Area of the left ovale foramen	0.1–0.5	0.3	0.3	0.07
Distance between ovale and spinous foramina right	0.05–0.45	0.31	0.30	0.09
Distance between ovale and spinous foramina left	0.06–0.60	0.34	0.31	0.11
Distance between the ovale foramina and the midline right	2.67–3.43	3.50	3.49	0.24
Distance between the ovale foramina and the midline left	2.58–3.35	3.45	3.44	0.15
Distance between the spinous foramen and the midline right	2.80–3.87	3.23	3.20	0.26
Distance between the spinous foramen and the midline left	2.27–3.85	3.15	3.14	0.20

**Figure 2.** Occipital projection in the scale 1:1. The area of the left foramen ovale is greater in both groups of skulls; f.o. — foramen ovale, f.s. — foramen spinosum, l.p.— sagittal line through the middle of the foramen magnum.

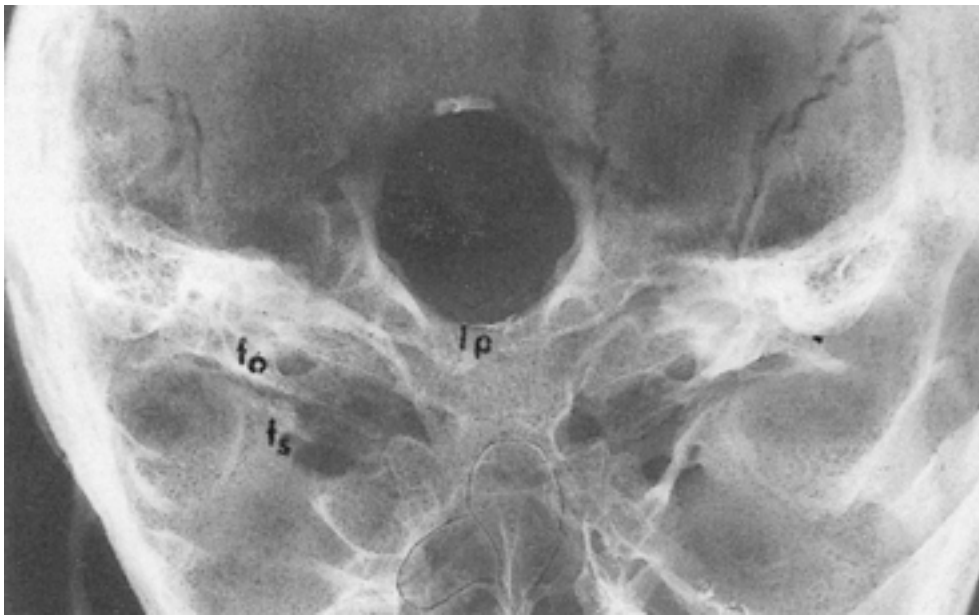


Figure 3. Occipital projection in the scale 1:1. The distances between the ovale foramina are longer on the left side in both groups; f.o. — foramen ovale, f.s. — foramen spinosum, l.p.— sagittal line through the middle of the foramen magnum.

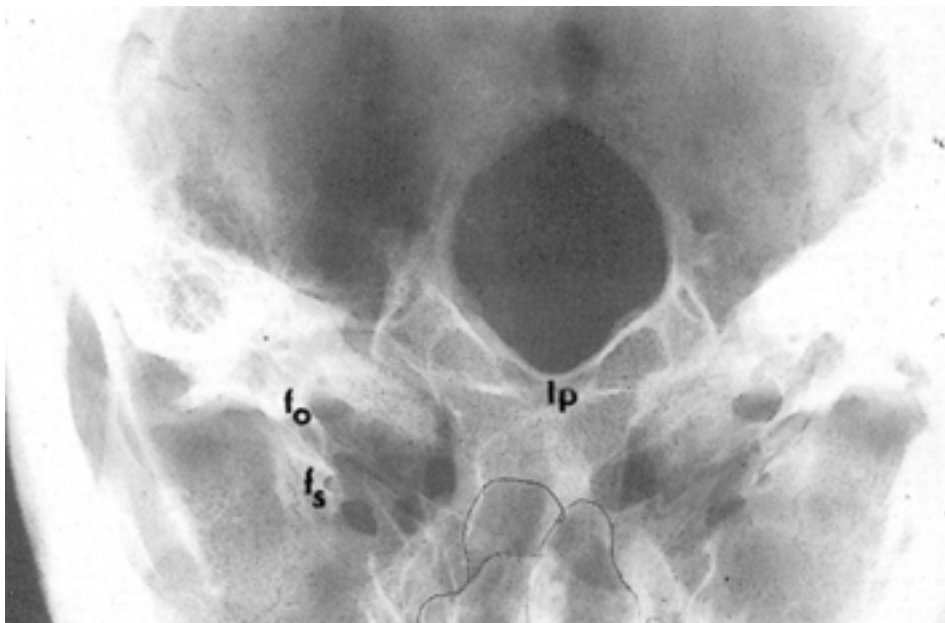


Figure 4. Occipital projection in the scale 1:1. The distances between the spinous foramina are longer on the left side in both groups; f.o. — foramen ovale, f.s. — foramen spinosum, l.p.— sagittal line through the middle of the foramen magnum.

the midline correlates to the length and width of the skull. The relation is stronger on the right side in both studied groups.

DISCUSSION

The symmetry of the skull was already studied in 1892 by Scheffer, who measured foetal skulls and stated that the shape and symmetry of the skull de-

pend on the development of the sphenoid and temporal bones. Other authors' investigations allow some basic reasons for asymmetry of the skull to be distinguished:

1. Some external tendency to asymmetric shapes may be caused by the intrauterine position of a foetus (asymmetric location of the auricles, halves of the nose, the ophthalmic fissure).

2. Damage to a bone of the skull or a muscle attached to it.
3. Partial atrophy of the skull — secondary to the pathological brain development.
4. A congenital defect of development of the mandible.
5. A defect in ossification connected with the presence of anomalies of other bones.
6. Asymmetric development of the temporal and sphenoid bones.
7. Asymmetric development of the brain [1, 3, 7, 8, 10, 11, 16].

Most examinations on face asymmetry proved that domination of the left side is more common in the human population [10]. In the research of Gundara and Zivanovic [7] in 1968, asymmetry was stated in 98% of the skulls and was observed mainly in parietal and occipital regions. Lanzieri et al. [10] observed asymmetry caused mainly by neoplastic invasion, in contrast to the study by Ginsberg et al. [6] comparing CT images of the skull. In this study asymmetry of the Vesalius foramen was not connected with a disease.

The research done in India denies the conception of skull asymmetry. Jain and Jain [8] proved that both halves of the skull are symmetrical and any differences are statistically meaningful. These observations were confirmed by Skvarilova [16], who showed the varying character of asymmetry and maintained that domination of the left or right side was coincidental. Skvarilova's [16] research was obtained after measuring children's faces and confirmed by the craniometric analysis of x-ray images of the skulls; significant differences between sides were found only in 3 out of 42 x-ray images.

Our studies confirm the conception of the presence of asymmetry of the skull. In both groups of skulls, mediaeval and contemporary, the asymmetry of the ovale and spinous foramina in the size, shape and distance from the midline was stated. The distance of both foramina from the anterior margin of the foramen magnum and the midline is shorter on the left side. This shows the domination of the right half of the skull. These results disagree with the former ones, which showed the dominance of the left side of the skull. It seems to be curious that the studied foramina have a smaller area on the dominating side. On the basis of anthropological and statistical calculation, we noticed the great influence of the length and width of the skull on the distance between the spinous and ovale foramina and their distance from the margin of the foramen magnum.

These results were obtained in both studied groups of skulls, mediaeval and contemporary, so we can say that there is a tendency for asymmetry of skulls to persist over the ages.

Knowledge of topography and of the changeability of the position of the ovale and rotundum foramina is important during operations of the cavernous sinus, performed by the lateral approach, which enables some complications to be avoided, e.g. injury of the trigeminal nerve. It also indicates some anatomical changes in the bony limits of the internal carotid artery, which is important in maintaining the haemodynamic control during operations of the internal carotid artery [12, 13, 17].

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