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Clinical anatomy of the human anterior cranial fossa during the prenatal period

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We examined the prenatal development of the human anterior cranial fossa and considered its clinical aspects. Our purpose was an evaluation of anterior cranial fossa geometry, its measurements and connections with the nasal cavity and middle cranial fossa.
The study was performed on 29 foetuses from the first and second trimester of pregnancy. New methods of computer image analysis, Scion for Windows 98 and ELF v 4.2, were applied to examine this anatomical region. Different options used were binarisation, equalisation, filters, linear and non-linear transformations and mathematical operations of images. This enabled the dynamics of prenatal development to be accurately evaluated for parts of the base of the human skull. Measurements were taken of angles of the cranial base. The anterior cranial base angle (the apex in the middle of the sella turcica and the arms running through the zygomatic ossification points) decreased gradually between C-R 6 to 23.5 cm from 170 to 120 degrees and afterwards became constant. The contrary-medial cranial base angle (adjacent to the anterior cranial base angle and with a second arm running through the auricular cartilage) increased from 50 to 70 degrees. The anterior cranial fossa was first located on the same level as the middle and posterior fossae. The process of descent of the middle and posterior cranial fossa begins in the 4th gestational month.
The geometry of the anterior cranial fossa changes rapidly, especially in the first trimester of pregnancy. The first trimester of pregnancy is crucial for the development of its defects. Preconception prophylaxis of inborn defects of the anterior cranial fossa is therefore extremely important.

key words: foetal skull base, premature craniosynostosis, computer image analysis

INTRODUCTION

The human anterior cranial fossa is limited from the rear by the back margins of the lesser wings of the sphenoid bone and the anterior margin of the chiasmatic sulcus lying between them. It contains the frontal lobes of brain (with the anterior horns of lateral ventricles) and the first pair of cranial nerves, olfactory nerves which, as olfactory filaments, pass through openings in the lamina cribrosa to the nasal cavity. During ontogenesis all external and internal dimensions of the skull enlarge several times, although not to the same degree. Between 10th and 40th week of development the linear dimensions of skull, brain and the structures of the anterior cranial

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fossa enlarge 6 to 7 times, while at the same time the structures of the posterior cranial fossa enlarge only 4 to 5 times [2].

The development of the anterior cranial fossa is especially interesting because of premature craniosynostosis, one of more frequent congenital malformations [3]. Other congenital central nervous system malformations which refer to the anterior cranial fossa include central region malformation eg. septum pellucidum cavity. In recent years premature craniosynostosis has become the target of interesting experiments on animals. Surgical treatment of premature coronal craniosynostosis in sheep foetuses has been successful [9, 10].

Grieg hypertelorismus is a kind of malformation in which there is hypertrophy of the lesser wings and hypotrophy of the greater wings of the sphenoid bone, which can lead to enlargement of the distance between the orbits, not infrequently connected with medial restriction of the visual field and mental retardation. Sometimes also corpus callosum dysgenesia and malformations of septum pellucidum appear, a syndrome which can be familial, with dominant inheritance [1].

Other congenital malformations include hydrocephalus, microcephalia or anencephalia.

Examinations of human skull base development have been conducted using X-rays of foetal bones. The conclusion has been that the anterior cranial fossa grows forward in a concentric manner and the anterior cranial base angle (Fig. 1), with its top in the middle of the hypophyseal fossa (point S) and arms running directly to the zygomatic bone ossification points (ZL and ZR), becomes constant during the foetal period [8].

In recent years progress has taken place in information technology and image analysis methods provide the opportunity of obtaining more information from images of the brain [4–7].

The purpose of our work was an evaluation of the geometry and measurements of the anterior cranial fossa and to assess its connections with the nasal cavity and middle cranial fossa.

MATERIAL AND METHODS

29 human foetuses from natural abortions, C-R 6 to 23.5 cm, were examined. The material was kept in 10% formaldehyde solution for at least one month. Afterwards section were performed. Anthropological measurements of each foetus (C-R dimension and head and thorax dimensions) were taken first then using Scammon and Calcins tables, foetal age was calculated. The skull cap was removed with parabasal section and then the brain and the skull base was exposed. Image acquisition was performed by means of a Sony video camera connecting to a computer containing special image transforming module LFG468//UVC. Two image analysis systems were used: Scion for Windows 98 and ELF v 4.2 for the measurement of the distances between point of the skull base. Computer image analysis systems enabled measurements to be taken with an accuracy of one pixel, allowed image quality to be enhanced and also helped in the visualisation of some structures.

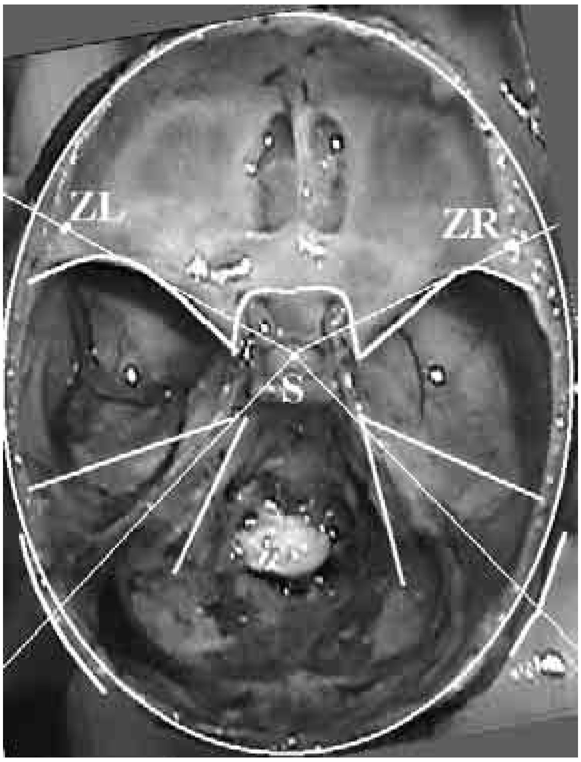

Figure 1. Anterior, middle and posterior cranial base angles.

RESULTS AND DISCUSSION

We performed accurate measurements on established points on the skull base. This allowed the dynamics of prenatal development of parts of base of human skull to be accurately evaluated. Measurements were made of the angles of the cranial base: the anterior, the posterior (at its top the same as the anterior in the middle of hypophyseal fossa and with arms running through the auricular cartilages, more often also located near the base of the temporal pyramids) and two in the middle (each between anterior and posterior, Fig. 1). The anterior cranial base angle decreased gradually between C-R 6 to 23.5 cm from 170 to 120 degrees and afterward became constant. The contrary-medial cranial base angle (adjacent to the anterior cranial base angle and with a second arm running through auricular cartilage) increased from 50 to 70 degrees. The anterior cranial fossa was first located on the same level as the medial and posterior fossae. The process of the descent of the medial and posterior cranial fossa began from the 4th gestational month.

Other measurements enabled us to establish that the posterior cranial base angle is constant during the first trimester (while the middle cranial base angle and middle cranial fossa increases at the expense of the anterior cranial base angle and the anterior cranial fossa). In older foetuses the increase in the anterior cranial base angle stops, its value becomes constant and the middle cranial base angle then increases at the expense of a decrease in the posterior cranial base angle.

The conclusion of our work is that during the development of the human skull base the middle cranial base angle increases continuously, at first at the expense of the anterior cranial base angle and next at the expense of the posterior cranial base angle. This is a modification of results from earlier skull base measurements [6], which used different techniques.

Anterior cranial fossa congenital malformations such as hypertelorismus can therefore arise during the first trimester. This is why prophylaxis of congenital malformations is most important in early pregnancy and before possible pregnancy (eg. by administration of folic acid by women intaking antiepileptic drugs).

REFERENCES

1. Dąmbska M, Traczyńska-Kubin H (1985) Wady rozwojowe ośrodkowego układu nerwowego. In: Czochańska J (ed.) Neurologia dziecięca. PZWL, Warszawa, pp. 299.
2. Ford HR (1956) The growth of the fetal skull. J Anat Physiol, 90: 63–72.
3. Friede H (1981) Normal development and growth of the human neurocranium and cranial base. Scand J Plast Reconstr Surg, 15: 163–169.
4. Glonek M, Kędzia A (2001) Metrological analysis of the human fetal supratentorial ventricular system by means of the computer technics. Folia Morphol, 60: 125 (Abstract).
5. Kędzia A (1995) Characteristics of periventricular matrix vascularisation in image computer transformation system. Folia Neuropathol, 33: 267–270.
6. Kędzia A, Karkowska H, Błaszczyk E (1996) Evaluation of „ELF" program usefulness in metrological examination of fetal brain. Folia Morphol (Warsz), 55: 318–320.
7. Kędzia A, Kędzia W (1996) Analysis of contemporary methods of anatomical structures visualisation in IMTRON 2000 system, Image C package. Folia Morphol (Warsz), 55: 321–323.
8. Lee SK, Kim YS, Jo YA, Seo JW, Chi JG (1996) Prenatal development of cranial base in normal korean fetuses. Anat Rec, 246: 524–534.
9. Mehrara BJ, Longaker MT (1999) New developments in craniofacial surgery research. Cleft Palate Craniofac J, 36: 377–387.
10. Stelnicki EJ, Vanderwall K, Harrison MR, Longaker MT, Kaban LB, Hoffman WY (1998) The in utero correction of unilateral coronal craniosynostosis. Plast Reconstr Surg, 101: 287–296.