Morphological analysis of the skull shape in craniosynostosis

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1. Introduction

Craniofacial skeleton is composed of the bones, the cranial sutures and connective tissues. Growth of skull bones is strictly connected with the expanding growth of the brain. An abnormal head shape resulting from cranial malformations or prematurely fused sutures (craniosynostosis) in infants is a diagnostic and therapeutic challenge [3]. It is important to perform the objective evaluation of deformity as soon as possible, because untreated progressive craniosynostosis could lead to brain growth’s inhibition, and an increase of intracranial and intraorbital pressure.

2. Methods

The diagnosis of craniosynostosis relies on physical examination, plain radiography, and computed tomography with 3D reconstructions. Craniosynostosis is a group of head deformations in children, due to prematurely fusion of one or more sutures, there are a few types of deformations [1] according to which suture have fused. They are presented in the Fig. 1.

![Fig. 1. Types of craniosynostosis: a) scaphocephaly b) trigonocephaly c) brachycephaly d) plagiocephaly [1]](image)

An engineering software Mimics v.13.1 and 3-matic v.4.4 enable to generate the 3-dimensional model of head, based on the pictures obtained from CT. It is also possible to indicate the dimensions, between the characteristic anatomical points. These measures are helpful during planning the neurosurgical operation, because the surgeon can strictly specify the incisions before surgery, that is important to provide the maximal safety of a child.

The procedure of examination in craniosynostosis is presented at the schema below.

![Fig. 2. Schema of process of examination for patient with scaphocephaly](image)
3. Results

In this paper a child with scaphocephaly was examined. As results obtained 3D geometric model of skull, before and after the surgery. On these models there were performed simulations of bone’s thickness and also there were generated the characteristic cross-sections based on the parallel planes through going the points of nasal bone and occipital bone (N-P in the Fig. 4)

![Fig. 3. a) determined cross-sections of skull before the surgery, b) models of head before (inside) and after (outside) the surgery](image)

**Fig. 3.** a) determined cross-sections of skull before the surgery, b) models of head before (inside) and after (outside) the surgery

**Fig. 4.** a) cross-section B-B before the surgery, b) selected results of measuring in 3-matic software

4. Discussion

Performed measurements are the supplement of full neurological diagnosis in children. By measuring the dimensions specified in article, the clinician is able to estimate the neurological consequences in case of higher pressure on brain’s lobes. Depending on the obtained results the surgeon makes a decision about method of cranioplasty of cranial vault.

References

[1] Erlanger Health System Tennessee Craniofacial Center (1997), nr 1(800), str. 418-3223


