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Variants of Sagittal Craniosynostosis: Strategy for Surgical Treatment

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The premature closure of the sagittal suture is one of the most frequent forms of cranial synostosis. Its frequency is between 21.1% - 65-68% of all synostosis.
During the period 1980-2000 in the Neurosurgical Clinic of the Alexander's University Hospital, Sofia, 81 children have been investigated and treated. The clinical diagnose was "sagittal craniosynostosis" and this represents 48.8% of all craniosynostosis. The mean age of the treated children was 9.68 months.

The authors examine the received variants of the sagittal cranial synostosis, which is of great importance for the achieving of the surgical correction of the cranial deformity.

Key words: craniosynostosis, sagittal suture, cranial sutures.

Introduction

The premature closure of the cranial sutures or craniosynostosis is a problem, often observed in the neurosurgical practice. Its frequency varies but approximately is about 0.4-0.7 to 1000 born alive [1, 4, 8, 11, 12, 15]. It is interesting to notice that the craniosynostosis is more frequent with the white race than the black and yellow ones [1, 4, 8, 11, 12].

When there is a closure of one or more sutures a compensatory expansion of the cranium towards the remaining sutures may appear. This leads to an expected cranial deformation and in some cases to a compression of the underlying brain [4, 10, 11, 13, 15]. In dependence of the damaged suture there is a different configuration of the head with a specified cranial deformation for every specific form of the craniosynostosis. The most common form is the closure of the sagittal suture (26.1% — 55-60% of all craniosynostosis) [1, 2, 4, 5, 8, 10-13].

The purpose of the surgical correction is the restoration of the deformity to esthetically pleasing skull and in many cases to release the compressed brain. Optimal results require the good understanding and prediction of the deformities in the different variants of the synostosis of the sagittal sutures [6, 14]. These variants represent an interest for the neurosurgeon because of the difference in the methods for their treatment.

Material and Methods

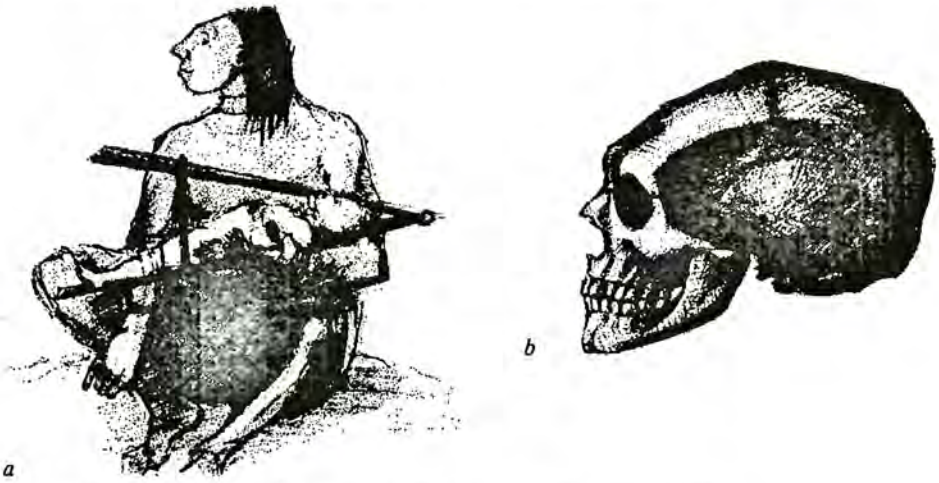
The clinical material comprised the patients treated in the Neurosurgical clinic of UH "Alexander's", Sofia, for the period 1980-2000. 164 children with synostosis of the cranial sutures were investigated and treated. 81 (48.78%) were with sagittal craniosynostosis. In 65 (80.24%) the synostosis covered the whole suture, in 7 (8.6%) only the front half and in 9 (11.11%) the back half. The mean age was 9.68 months as the youngest was 2 months old and the oldest 12 years. 24 children (29.63%) during the surgical intervention were 1 year old as the deformity was significantly expressed and the surgical correction was considerably complicated.

Discussion

The cranial form and especially its deformities have provoked interest still the prehistorically times. In these deformities the ancient civilizations have seen a divinity belonging with an increase of the intellectual abilities. The deformed skull, because of the belief in a divine sign, easily became an esthetical criterion which many people have tried to reproduce in their generation. The ancient Incas have put the new-born in a special mechanism-cradle, with which they pressed and flattened the forehead (Fig. 1 — *a*, *b*).

Induced deformities have existed also in Europe, mainly in Normandy, Braitagne and Toulouse (up to the end of XIX century) (Fig. 2 — *a*, *b*).

The first investigations on the craniosynostosis dated from the beginning of XIX century but the majority of authors admit that Virchow puts the bases of the pathology of this decease in 1851. He introduced the term "craniosynostosis" and confirmed that the cranial deformity is closely related with the premature closure of the cranial sutures. The modern investigations of rabbit models of Babler et all., as well as the critical analysis of the compensatory cranial growth in patients with different forms of craniosynostosis of D e l a s h a w et al. [6] show that the compensatory growth is observed in the sutures belonging to the affected synostosis.



a *b*

Fig. 1. The mechanism used by ancient Incas to cause cranial deformities
a — mechanism-cradle; *b* — resulting cranial deformity

Fig. 2. Technique used in Toulouse to cause cranial deformities
a — Head cloths used in Saint Gaudens and Toulouse; *b* — "Toulouse" skull

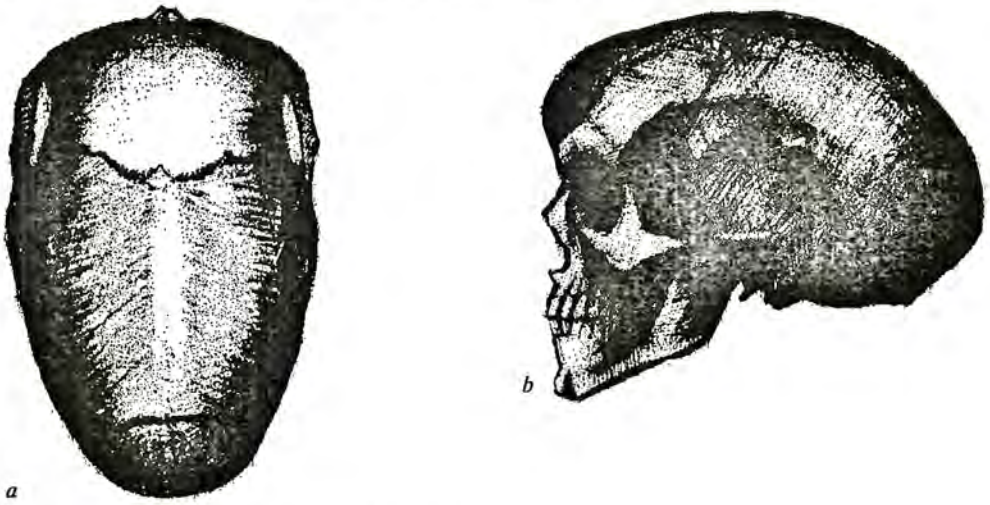


Fig. 3. The deformities with closure of the whole sagittal suture
a — overview; *b* — profile

Every form of the craniosynostosis and the accompanying deformity due to premature closure of one cranial suture may be predicted on four main rules [4, 6].

1. Premature closure cranial vault bones act as a bone plate with a decreased growth potential.

2. On the surrounding sutures there is an abnormal asymmetric bone accumulation (heavily increased far from the bone plate).

3. The surrounding sutures lying to the premature closure suture compensate in the growth more than those, which are far from the suture stenosis.

4. The noncircular suture, which is a continuation of the premature closure suture, is subjected to an increased symmetric bone accumulation alone the both end.

Based on these 4 rules we can understand and predict every single deformity appearing in the different covering of the sagittal suture. This in its turn helps us to plan the surgical correction [4, 6, 14].

Thus for instance in the premature closure of the whole sagittal suture (in 65 (80.24%) of our cases) a biparietal bone plate with a decreased bone growth is formed. The limited growth in this plate leads to a narrow biparietal size (Virchow deformity). The tangential to this limited bone plate, coronar and lambdoid sutures, compensate with an increased bone accumulation on the end of the frontal and occipital bones.

The noncircular metotopic suture, which is a continuation of the sagittal one also compensates with a symmetric bone expansion on its suture line. Following the rules of the calvarian growth, the compensatory growth alone the coronary, metotopic and lambdoid sutures leads to the characteristic frontal and occipital protuberance, observed in the sagittal synostosis. As the squamous sutures are far from the closed suture and are with a limited growth potential, they do not take significant part in the compensatory growth process. The deformities with the closure of the whole sagittal suture do not include prominating bitemporal regions (Fig. 3).

In the closure of the front — in 7 (8.64%) of our cases, or the back — in 9 (11.11%) of our cases, half of the sagittal suture, according to these rules, also can predict the newly formed deformities. The parietal bones remain limited in growth. In the closure of the front half is added by the characteristic frontal prominence, which is result of the compensatory growth process of the tangential coronary and metotopic sutures (Fig. 4).

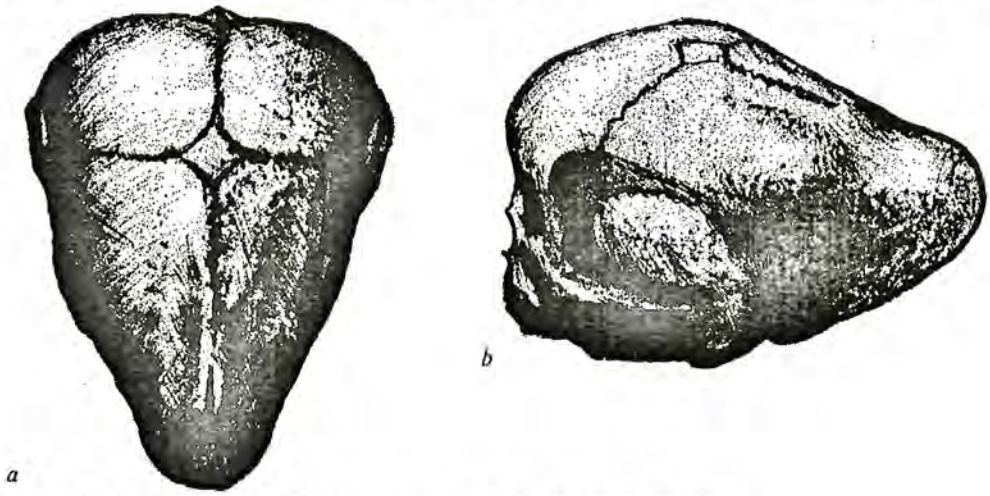


Fig. 4. The deformities with closure of the front half of the sagittal suture
a — overview; *b* — profile

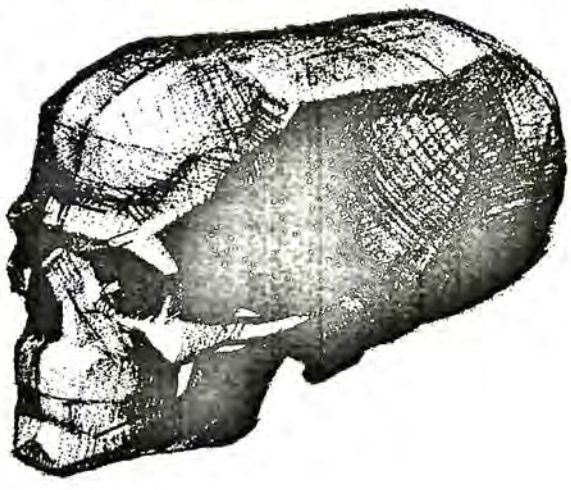


Fig. 5. Severe deformity, non treated surgically

The increased bone accumulation on the occipital bones along the lambdoid sutures creates occipital prominence in the back sagittal synostosis without added significant cranial vault deformity.

It is important to note that with the growth of the child these deformities worsen [2, 4, 9-11, 15], as in 24 (29.63%) children of our investigation. On the other hand, the received heavy deformities (Fig. 5) require the use of more extensive remodulating techniques.

This determines the time of choice for the surgical correction of these deformities — this is the early infancy (before the worsening of craniosynostosis).

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