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Percentile-based assessment of craniosynostosis

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ABSTRACT

Perioperative assessment of craniosynostosis is based mostly on subjective scores. In this study, we sought to find an objective method to assess cranial deformation based on normative craniofacial percentiles.

Anthropometric datasets from 104 (79 males, 25 females) patients with craniosynostoses were included. Anthropometric data were compared with normative age-dependent percentiles. Deviations above the 90th or below the 10th percentile were defined as significant cranial deformation.

The cohort comprised 69 children with sagittal, 22 metopic, nine coronal, two bicoronal, one lambdoid, and one with coronal + lambdoid craniosynostosis. Most children with sagittal synostosis were above the 90th percentile for cranial circumference and length, whereas only 27.9% were below the 10th percentile for cranial width. Most (83%) children with scaphocephaly had cranial indices below the 10th percentile. For trigonocephaly, we found normal cranial circumference values in most patients (10th–90th percentile), 40.9% were above the 90th percentile for cranial length, and 63.1% and 57.9% were above the 90th percentiles for sagittal and transverse circumferences. For unicoronal synostosis transverse circumference was above the 90th percentile in 83.3% of children.

Matching of anthropometric data of craniosynostosis patients with craniofacial norms could be useful in grading the clinical picture and potentially adapting the operative procedure.

1. Introduction

To “create what is normal” for patients with craniofacial deformities was one of Paul Tessier’s major goals during surgical procedures for craniosynostosis correction. This goal, however, remains hard to achieve (Habal, 2013). Due to different approaches to initial assessment (Beckett et al., 2012; Birgfeld et al., 2013; Bruneteau and Mulliken, 1992; Gioan et al., 2012), different operative procedures (Okada and Gosain, 2012), and various, mostly subjective, guidelines for postoperative estimation (Hankinson et al., 2010; Metzler et al., 2013a, 2013b, 2013c; Whitaker et al., 1987), achieving consistency in craniofacial assessment is difficult. Because the indication for surgical correction should be made on a solid clinical basis and cosmetic reasons are assumed to be the main criteria for surgery (Hankinson et al., 2010), a reliable tool for the initial classification of premature craniosynostosis is desirable.

Premature fusion of different cranial sutures leads to typical deformations of the infant skull (Cohen and MacLean, 2000). Individual sutures are affected with different frequencies, with a predominance of scaphocephaly and a rising number of trigonocephaly cases in recent years (Kolar, 2011; van der Meulen et al., 2009) for as yet unknown reasons. In an epidemiological study, Kolar (2011) found that the male:female sex distribution for craniosynostosis was 3.8:1 for sagittal, 2.8:1 for metopic, and 1:1.6 for unicoronal synostosis. Multisutural synostoses and true lambdoid synostoses are rare, with only sporadic presentations at most clinics.

Matched-pair evaluations are frequently used for the assessment and control of cranial growth and shape (Christofides and Steinmann, 2010; Farkas, 1994; Metzler et al., 2013a, 2013b, 2013c). A newly developed algorithm based on more than 400 healthy Caucasian infants was published recently (Wilbrand et al., 2012a). The percentiles presented in this study were based on reliable and standardized anthropometric measurements and allow an illustrative clinical assessment of non-synostotic craniofacial deformities. The aim of the present study was to examine whether

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these data are suitable for the initial assessment and eventual classification of cranial shape in premature craniosynostosis.

2. Material and methods

Of 334 procedures performed between January 2000 and January 2013, preoperative anthropometric data were available for 104 children. Anthropometric parameters were taken in a standardized manner defined previously (Wilbrand et al., 2011). Previously reported normative percentiles for cranial circumference, length, width, cranial index, and sagittal and transversal circumferences were generated from anthropometric measurements of 401 healthy Caucasian children in the first year of life (Wilbrand et al., 2012a).

All available preoperative craniofacial measurements of children with diagnoses of single or complex craniosynostosis were compared with the existing normative percentiles. Parameter values above the 90th or below the 10th percentile were defined as significantly aberrant. Matching of the anthropometric parameters was performed by age and sex. Descriptive statistics were used for analysis of the data.

3. Results

In total, 104 children with diagnoses of premature craniosynostosis were included in this study. Of them, 79 (72.1%) children were male and 25 (27.9%) were female (male:female ratio = 3.2:1). Sixty-nine (66.3%) children had premature closure of the sagittal suture; 55 (79.7%) of them were male and 14 (20.3%) were female (male:female ratio = 3.9:1).

In total, 22 (21.2%) children were diagnosed with metopic synostosis; 17 (77.3%) patients in this group were male and five (22.7%) were female (male:female ratio = 3.4:1).

Nine (8.7%) patients were diagnosed with unicoronal synostosis; four (44.4%) children in this group were male and five (55.6%) were female (male:female ratio = 1:1.25).

One (0.95%) male patient had a single lambdoid synostosis, one (0.95%) male patient had unicoronal and single lambdoid fusion, and two (1.9%) patients were diagnosed with bicoronal synostosis (male:female ratio = 1:1).

Results of comparisons of the anthropometric data from children with craniosynostosis with the normative percentiles are shown in Figs. 1–7.

3.1. Cranial circumference

Children with premature fusion of the sagittal suture had significantly increased cranial circumference values. Values from 47 (68.1%) children fell at or above the age- and sex-matched 90th percentiles for this parameter. For trigonocephaly, we found that only 18% of values fell above the 90th percentile and 9% fell below the 10th percentile. All children with unicoronal or lambdoid

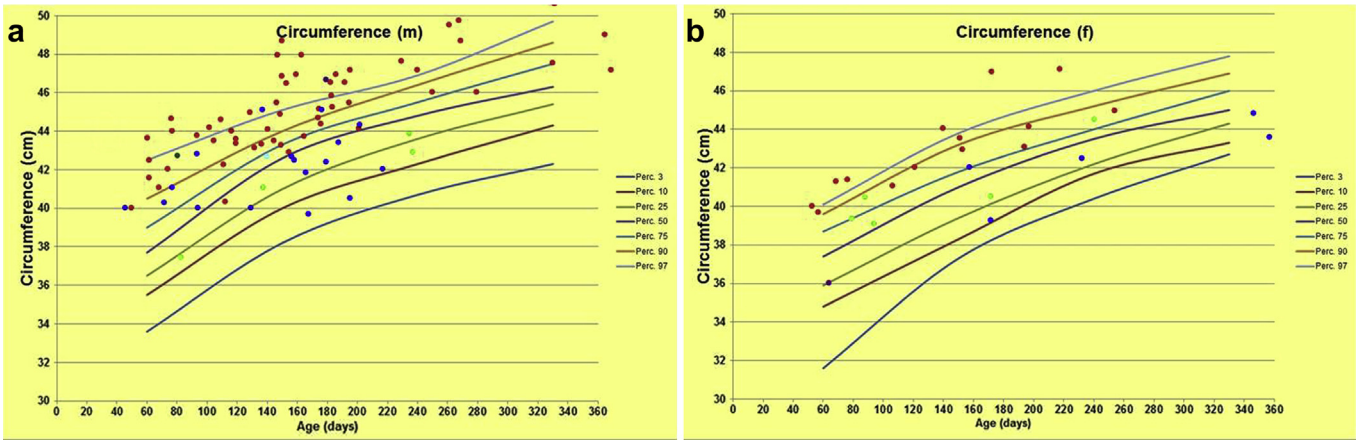

Fig. 1. Anthropometric measurements of children with craniosynostosis compared with normative percentiles: cranial circumference (a: male, b: female). Red: sagittal, blue: metopic, green: unicoronal, violet: bicoronal, turquoise: lambdoid, dark green: unicoronal/lambdoid synostosis.

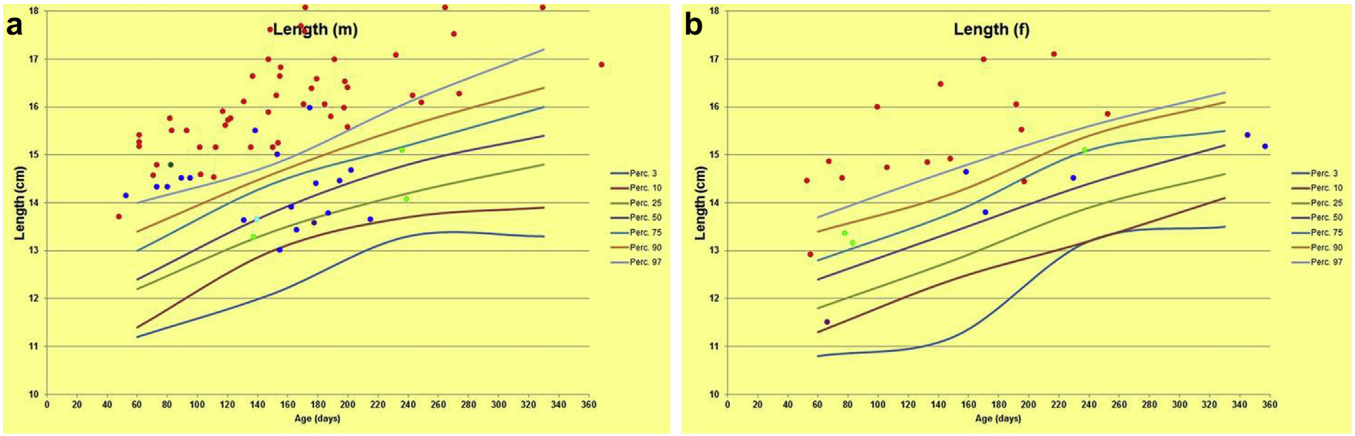

Fig. 2. Anthropometric measurements of children with craniosynostosis compared with normative percentiles: cranial length (a: male, b: female). Red: sagittal, blue: metopic, green: unicoronal, violet: bicoronal, turquoise: lambdoid, dark green: unicoronal/lambdoid synostosis.