# Metopic index

Previous research has shown that patients with metopic craniosynostosis have significantly reduced intracranial volumes (ICVs) compared to normal healthy children. Furthermore, the metopic index (ratio of midfrontozygomatic diameter to maximal cranial width) has been described as an anthropometric cranial index for patients with metopic craniosynostosis.

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The metopic index (MI) consists of the midfrontozygomatic diameter (EuD). The MFZD is the minimum width between the midfrontozygomatic (MFZ) points, or the midpoint along the recess above the brow ridge between the anteroinferolateral frontal bone and frontal bone zygomatic process.

The eurion-eurion diameter (EuD)was measured as the maximum cranial width (i.e., distance between the lateral extremes of the skull). The available high-resolution head CT scans were reviewed and measurements were performed by 2 observers. Agreement between the 2 reviewers was assessed, and the intraclass correlation coefficient was found to be adequate at 0.82. The average of the measurements of the 2 reviewers were used for further analysis. In the clinical setting, the corollary of the above measurement was determined with measuring calipers. Caliper points were placed in the recesses of the brow ridge that were visible from the superior vantage point. In infants with metopic craniosynostosis, these recesses were consistently pronounced and medially displaced compared with the position in infants without craniosynostosis, due to the lateral restriction of the forehead. Available measurements from clinical records were used to compare the clinically obtained measurements from those derived from CT scans. EuDs, MFZDs, and MIs for patients with metopic synostosis were compared with measurements obtained in the complete set of 324 scans obtained in the control group as well as a subset of 112 scans obtained in exact age–matched controls using the unpaired Student t-test. For patients with pre- and postoperative head CT scans, as well as to compare clinically obtained and CT-obtained measurements, MIs were compared using the paired Student t-test. Statistical significance was defined as $p < 0.05$. All statistical analyses were performed using Stata/IC 12 (StataCorp LP)

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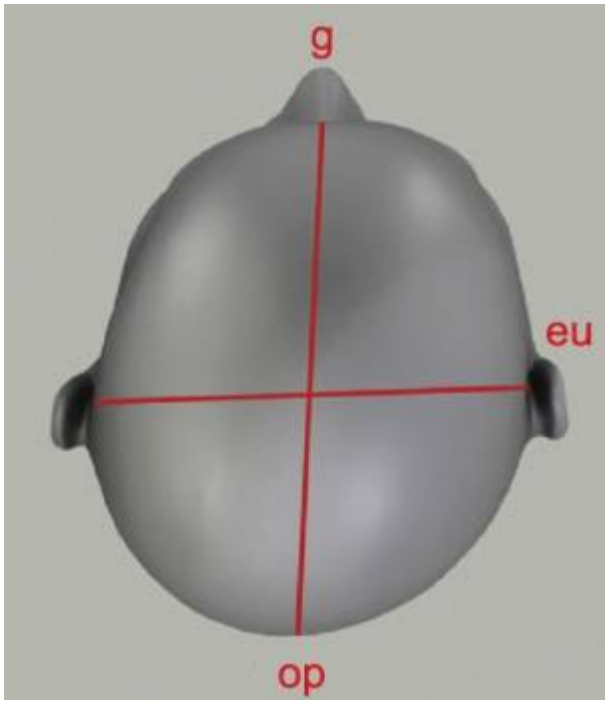


The most lateral point of the neurocranium

g: Glabella

op: Opisthocranion

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Because the metopic suture normally fuses during infancy, there are varying degrees of severity in head shape abnormalities associated with premature fusion. A method for the objective and reproducible assessment of metopic craniosynostosis is needed to guide management, as current methods are limited by their reliance on aesthetic markers. The object of a study was to describe the metopic index (MI), a simple anthropometric cranial measurement. The measurements can be obtained from CT scans and, more importantly, from palpable cranial landmarks, and the index provides a rapid tool for evaluating patients in both pre- and postoperative settings.

High-resolution head CT scans obtained in 69 patients (age range 0-24 months) diagnosed with metopic craniosynostosis were retrospectively reviewed. Preoperative 3D reconstructions were available in 15 cases, and these were compared with 3D reconstructions of 324 CT scans obtained in a control group of 316 infants (age range 0-24 months) who did not have any condition that might affect head size or shape and also in a subset of this group, comprising 112 patients precisely matched to the craniosynostosis patients with respect to age and sex. Postoperative scans were available and reviewed in 9 of the craniosynostosis patients at a mean time of 7.1 months after surgical repair. 3D reconstructions of these scans were matched with controls based upon age and sex.

The mean preoperative MI for patients with trigonocephaly was 0.48 (SD 0.05), significantly lower than the mean values of 0.57 (SD 0.04) calculated on the basis of all 324 scans obtained in controls ($p < 0.001$) and 0.58 (SD 0.04) for the subset of 112 age- and sex-matched controls ($p < 0.001$). For 7 patients with both pre- and postoperative CT scans available for evaluation, the mean postoperative MI was 0.55 (SD 0.03), significantly greater than their preoperative MIs (mean 0.48 [SD 0.04], $p = 0.001$) and comparable to the mean MI of the controls ($p = 0.30$). In 4 patients, clinically obtained postoperative MIs by caliper measurement were comparable to measurements derived from CT (p =

0.141).

The MI is a useful measurement of the severity of trigonocephaly in patients with metopic synostosis. This simple quantitative assessment can potentially be used in the clinical setting to guide preoperative evaluation, surgical repair, and postoperative degree of correction [1].

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Pindrik et al., hypothesize that normative values of the new indices as well as for established measures like the cephalic index can be drawn from the evaluation of CT scans of normal individuals.

High-resolution 3D CT scans obtained in normal infants (age 0-24 months) were retrospectively reviewed. Calvarial measurements obtained from advanced imaging visualization software were used to compute cranial indices. Additionally, metopic sutures were evaluated for patency or closure.

A total of 312 participants were included in the study. Each monthly age group (total 24) included 12-18 patients, yielding 324 head CT scans studied. The mean cephalic index decreased from 0.85 at age 0-3 months to 0.81 at 19-24 months, the mean frontoparietal index decreased from 0.68 to 0.65, the metopic index from 0.59 to 0.55, and the towering index remained comparatively uniform at 0.64 and 0.65. Trends were statistically significant for all measured indices. There were no significant differences found in mean cranial indices between sexes in any age group. Metopic suture closure frequency for ages 3, 6, and 9 months were 38.5%, 69.2%, and 100.0%, respectively.

Radiographically acquired normative values for anthropometric cranial indices during infancy can be used as standards for guiding preoperative decision making, surgical correction, and postoperative helmeting in various forms of craniosynostosis. Metopic and towering indices represent new cranial indices that are potentially useful for the clinical evaluation of metopic and bicoronal synostoses, respectively. The present study additionally shows that metopic suture closure appears ubiquitous after 9 months of age [2].

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Wang JY, Dorafshar AH, Liu A, Groves ML, Ahn ES. The metopic index: an anthropometric index for the quantitative assessment of trigonocephaly from metopic synostosis. J Neurosurg Pediatr. 2016 Sep;18(3):275-80. doi: 10.3171/2016.2.PEDS15524. PubMed PMID: 27153376.
2)
Pindrik J, Molenda J, Uribe-Cardenas R, Dorafshar AH, Ahn ES. Normative ranges of anthropometric cranial indices and metopic suture closure during infancy. J Neurosurg Pediatr. 2016 Dec;25(6):667-673. PubMed PMID: 27589596.