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Cranial shape, size and cervical motion in normal newborns

Henri E.I. Aarnivala [a,c,*], A. Marita Valkama [a], Pertti M. Pirttiniemi [b]

[a] Department of Pediatrics and Adolescence, Oulu University Hospital, Oulu, Finland
[b] Department of Orthodontics, Oulu University Hospital, Oulu, Finland
[c] University of Oulu, Oulu, Finland

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ABSTRACT

Background: Deformational plagiocephaly (DP) and torticollis are commonly seen in infants and they often co-occur, but little is known of the prevalence and relationship of these conditions in the immediate newborn period. No previous studies focusing on the relationship between cranial shape and cervical motion in newborns can be found.

Objectives: Determining the incidence rates and characteristics of DP and torticollis and examining the relationship between cervical range of motion (ROM), cranial size and cranial shape in neonates.

Methods: A single-center, descriptive cross-sectional study including 155 healthy neonates was conducted. Participants were examined during their birth hospitalization. Oblique Cranial Length Ratio (OCLR) and Cephalic Index (CI), indicating cranial asymmetry and shape, were measured from standardized digital photographs with a computer-based cephalometric method. Cervical ROM was measured with goniometry.

Results: 7.7% of the newborns had DP and 3.9% had torticollis. 46.4% presented lesser cervical imbalances. DP was associated with gestational diabetes (adjusted OR 5.6; $p < 0.01$) and vacuum assisted delivery (adjusted OR 6.8; $p < 0.01$), but not at all with torticollis. CI correlated strongly with cervical ROM in all directions, while no definite association between cranial asymmetry and cervical motion could be found.

Conclusions: DP and torticollis are common and minor cervical imbalances very common in normal newborns. Our results support the theory that in most cases neither DP nor torticollis is congenital, but rather develops and worsens synergistically in early infancy. Still, although no direct association between DP and torticollis was found, cranial shape is linked to cervical motion at birth.

1. Introduction

A dramatic rise in the prevalence of Deformational Plagiocephaly (DP) in infants has been observed throughout the world during the past two decades. This has generally been perceived as a consequence of the now standard supine sleeping position recommended since the Back To Sleep-campaign [1–3], initiated in 1992 by the American Academy of Pediatrics [4]. The phenomenon has led to increasing amounts of research being undertaken to determine the incidences and possible risk factors for cranial deformations in both newborns [5–7] and older infants [8–13], as well as to find out effective methods for prevention and treatment [13–20], as not only does DP increase the risk for subsequent facial and mandibular asymmetry, but it has also been associated with an elevated risk of auditory processing disorders, visual field abnormalities and delayed psychomotor development [21–25].

The prevalence of DP reportedly rises in the first months of life, whereafter it gradually decreases [8,9]. DP has also long been known to be associated with torticollis, where congenital muscular torticollis is usually recognized as the predisposing factor for secondary cranial deformations [26]. In later infancy up to 97% co-occurrence rates between DP and torticollis have been reported [27,28]. However, very little is known of the association between cranial shape and cervical motion in the immediate newborn period; the few studies that touch the subject have shown no connection between DP and torticollis at birth, but no study has explored the relationship in detail [5–7]. There is also discrepancy between the theory of DP primarily developing as a result of congenital cervical imbalance, the reported high incidence rates for DP in later infancy and the relatively low incidence rates for torticollis in neonates [5–8,11–13,29,30].

The purpose of our study was to determine the incidences and characteristics of DP and cervical imbalances in normal newborns and to explore the relationship between the cervical range of motion (ROM) and cranial shape in detail. Normative values for anthropometric measurements describing newborn head size and shape were provided as well.

2. Patients & methods

This was a population-based cross-sectional study. Included newborns were born in the Oulu University Hospital on pre-selected

* Corresponding author at: Dpt of Pediatrics, Oulu University Hospital and University of Oulu, Oulu, Finland. Tel.: +358 45 136 4342.
E-mail address: henri.aarnivala@student.oulu.fi (H.E.I. Aarnivala).

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dates between February 2012 and September 2013. Out of 235 infants that were asked to participate, a total of 155 were enrolled after written, informed consent was obtained from the parents. 5 newborns were excluded from the study due to chromosomal anomalies (2), cleft lip and palate (2) and craniosynostosis (1). The study was approved by the ethics committee of the Oulu University Hospital.

Background data regarding infant's gender and size, gestation, birth rank, mother's age, mother's medical history, problems with pregnancy (such as oligohydramnios, abnormal intrauterine positions), problems with mothers anatomy (such as uterine or pelvic anomalies), presentation at delivery, mode of delivery, color of amniotic fluid, single/multiple birth, length of the first and second stages of labor and Apgar scores were collected from maternal and newborn medical records.

2.1. Quantifying head size and shape

A photographic technique was used to quantify asymmetry of the cranial vault. In short, a standardized 2D digital photograph of the vertex view was obtained and locations of both ears, nose and opisthocranion were marked on the plane of maximum head circumference. Custom caps were used to cover the infant's hair and help the visualization of landmarks for computer-based cephalometric analysis. As an indicator of asymmetry, Oblique Cranial Length Ratio (OCLR — the ratio between the longest and shortest oblique transcranial diameter × 100%) was used. The transcranial diameters were measured in a 40° angle to the sagittal midline. The cut-off point used to determine plagiocephaly was OCLR ≥ 104.0%, a higher value indicating more severe plagiocephaly [6,8]. Cephalic Index (CI — the ratio between skull width [euryon–euryon] and skull length [glabella–opisthocranion] × 100%) was used to indicate brachycephaly and dolicocephaly. As the two-dimensional photographic analysis only assesses cranial proportions on a horizontal plane, the distances from ear to ear (e–e) and from glabella to external occipital protuberance (g–eop) were also measured manually, as described by Christofides & Steinmann, along with head circumference [31]. Landmarks for all measurements are shown in Fig. 1.

2.2. Physical examination

All newborns were examined during their birth hospitalization, 30 to 72 h after birth. Infants were first examined by an experienced neonatologist (MV) for possible clavicular fractures, sternocleidomastoideal masses and other malformations and deformations that could account for the supposed cervical imbalances. The presence of a hematoma or a caput succedaneum was noted. All three anthropometric measurements were performed repeatedly by MV in an alternating sequence until three matching values (less than 5 mm difference) were obtained. A regular non-stretch measuring tape was used. To assess the neck ROM, digital goniometry was used. First the infant was put on its back on an examination table with the shoulders at the edge and calmed down. Then the head was rotated (chin past shoulder) passively by supporting the head from below and allowing it to turn freely as far as possible. Lateral flexion (ear to shoulder) and forward flexion (chin to chest) were assessed by applying very gentle pressure until resistance was noted. All of the aforementioned assessments were performed by MV and the goniometer (Scheppach® portable digital goniometer) was always operated by HA. Measurements were performed three times in an alternating sequence and the results were rounded to the nearest full degree. Torticollis was defined as a ≥15° difference in lateral flexion or rotation from right to left, comparing the highest values [28]. Lesser cervical imbalances were also categorized as moderate (10–15°), mild (5–10°) and nonexistent (0–5°). The vertex photograph was obtained from a standardized angle and distance, with the infant placed at the edge of a soft examination table. All photographs were taken by HA with a Canon EOS 600D DSLR camera. Lighting and other environmental factors remained unchanged throughout the study. Cephalometric analyses of the vertex photographs were performed by HA using custom software. SPSS (v20.0, IBM®) was used for statistics. T tests, cross-tabulation, linear regression and logistic regression were used to analyze the data. Tables of descriptive statistics and anthropometric values as well as figures of relevant correlations were created.

3. Results

The cohort consisted of 151 singletons and two sets of twins. All included neonates were born after ≥36 weeks of gestation and fit enough

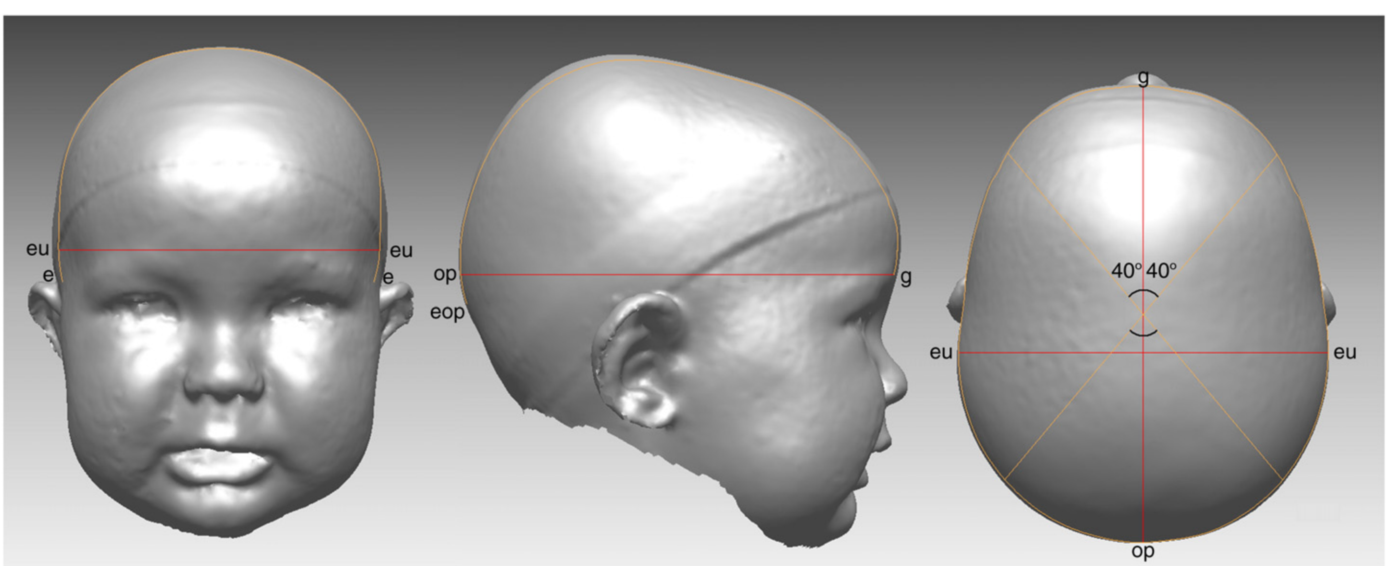

Fig. 1. Illustrations of e–e, g–eop, head circumference, OCLR and CI measurements. e represents the point where the ear attaches to the temporal scalp (otobasion superior) and the e–e measurement is taken from one otobasion to the other directly over the head along the coronal sutures. The g–eop measurement is taken from the glabella over the head along the sagittal suture to the external occipital protuberance. The oblique lines represent the transcranial diagonals used to calculate the OCLR and the straight lines represent eu–eu and g–op measurements for the Cephalic Index. eu = euryon, g = glabella, op = opisthocranion, e = otobasion superior, eop = external occipital protuberance.