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Evaluation of positional plagiocephaly: Conventional anthropometric measurement versus laser scanning method

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ABSTRACT

Background: The incidence of plagiocephaly has increased in the 25 years since the "Back to Sleep" campaign in 1991 to prevent sudden infant death. Plagiocephaly is not considered to be a pathological condition. It is more of an esthetic impairment and could have potentially negative psychological or psychosocial consequences; therefore, treatment is recommended. The aim of this study is to compare conventional anthropometry and laser scanning – two different measurement methods – as diagnostic instruments for plagiocephaly. The present study also tests the measurement time of both methods and whether one method is easier on the patient than the other.

Material and methods: A total of 44 children (21 girls, 23 boys) with a mean age of 8.8 months were involved in the present study. Of all patients, the following parameters were routinely evaluated using a standard protocol with the conventional anthropometric method and the scan method: head circumference, head length, head width, head diagonals, and distances ex-t. Furthermore, the time required to obtain measurements and the behavior of the children during measurement were documented. For statistical analysis, a *t*-test and a Wilcoxon test were used to analyze differences between the two methods.

Results: The results for head circumference showed a mean of 441.5 mm for the anthropometric measurements and 441.6 mm for the scan method, with no significant difference between the two methods. A significant difference was found regarding the head width, head length, diagonals, and distance ex-t. The measurement process using the scan method needed a mean of 579.6 s in contrast to the manual anthropometric method, which required a mean time of 180.5 s.

Discussion: In comparison with the conventional anthropometric method, measurements made with a 3D laser scanner yield inconsistent results. Moreover, the current state of technology of 3D cephalometry has no advantages compared with the conventional anthropometric method. Disadvantages worth mentioning appear to be the higher technical outlay and the considerable acquisition, service, and maintenance costs.

1. Introduction

Concerns about the shape of a child's head are among the more frequent reasons for consulting a pediatric neurosurgeon (Piatt, 2004). When plagiocephaly (PP) is suspected, parents may be upset if the diagnosis and the necessity of treatment are unclear (Hutchison et al., 2011).

PP and brachycephaly are skull deformities that arise during the growth phase of the head (Bruneteau and Mulliken, 1992). Positional deformities can start at different times. Prenatal skull deformities may develop due to factors that restrict the space around the fetus. Thus, postnatal cranial flattening is present in up to 56% of multiple births but in only 13% of single births (Peitsch et al., 2002). Perinatal deformation that occurs when the head moves through

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the birth canal is physiological, but is usually temporary and resolves spontaneously within 6 weeks in healthy children with unimpaired motor development (Kane et al., 1996; Pomatto et al., 1997; Miller and Clarren, 2000; Peitsch et al., 2002). Manifest PP can therefore not be diagnosed until the child is at least 6 weeks old (Bialocerkowski, 2008).

The incidence of PP has increased in the last 25 years. Most cases involve postnatal conditions that encourage the development of PP, and the most frequent cause is sleeping on the back (Kane et al., 1996; Turk et al., 1996; Argenta et al., 1996; Mulliken et al., 1999). There was thus a massive increase in PP (Argenta et al., 1996), after the "Back to Sleep" campaign in 1991 to prevent sudden infant death (Engelberts and de Jonge, 1990; Fleming et al., 1990; Dwyer et al.,1991) called on parents to allow infants to sleep only on their backs (Kane et al., 1996; Turk et al., 1996; Argenta et al., 1996). There are varying opinions on the possible consequences of PP. Some studies found an increased risk of delayed cognitive, neurological, and motor development in children with pronounced PP (Miller and Clarren, 2000; Speltz et al., 2010; Hutchison et al., 2011; Collett et al., 2013). However, the level of evidence of these observations has been criticized, and no causal relationship between the presence of PP and later developmental delays has been recognized (Robinson and Proctor, 2009). Therefore, PP itself is not considered to be a pathological condition. It is more an esthetic impairment, which may, however, have potentially negative psychological or psychosocial consequences (Mortenson and Steinbok, 2006; Steinbok et al., 2007).

After the initial exclusion of a craniosynostosis, the diagnosis of PP is established primarily clinically (Pogliani et al., 2011). The finding is frequently merely documented by conventional photos or systematic observations from defined perspectives by an experienced clinician (Pollack et al., 1997; Littlefield et al., 1998; O'Broin et al., 1999; Argenta et al., 2004; Losee et al., 2007; Skolnick et al., 2014). The data obtained from the latter are assessed using scales (Vles et al., 2000; Losee and Mason, 2005; Losee et al., 2007) and classifications (Argenta et al., 2004). The accuracy of these methods has been criticized (Loveday and de Chalain, 2001), and correlative comparisons with manual anthropometry have yielded significant differences (Mortenson and Steinbok, 2006; Glasgow et al., 2007).

Direct anthropometry is the oldest objective method of evaluating PP and is deemed to be a simple, low-cost method that is easy to use in the clinical routine. It is conducted purely manually with measuring instruments in the form of calipers, tape measures, and sliding gauges (Farkas, 1981; Ripley et al., 1994; Kelly et al., 1999; Teichgraeber et al., 2002; Graham et al., 2005; Mortenson and Steinbok, 2006; Lee et al., 2008; Wilbrand et al., 2011).

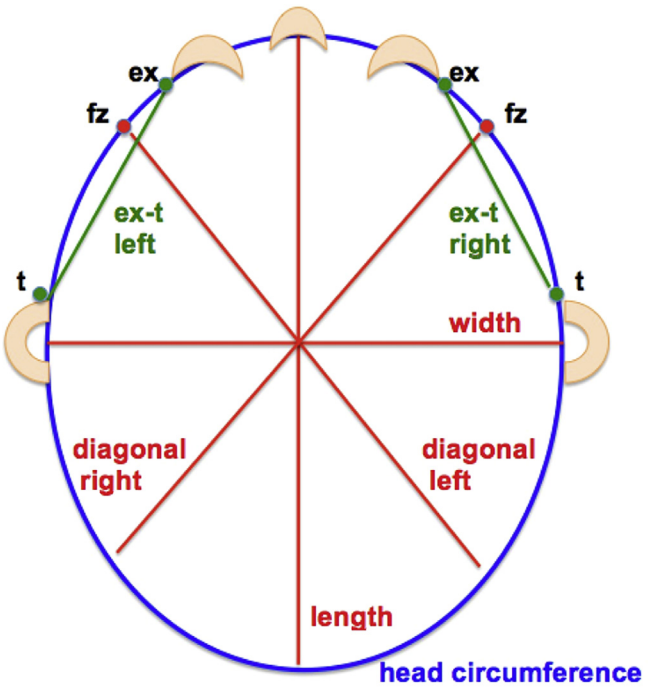

Fig. 2. Metric parameter of the measurements.

Laser scanning systems to measure PP were first introduced in 2004. The 3D technique allows new asymmetry indexes to be determined. Plank et al. (2006) calculated what are termed the anterior, posterior, and overall symmetry ratio (ASR, PSR, and OSR) to monitor the progress of orthotic treatment by comparing the volumes of corresponding quadrants (Plank et al., 2006). In 2012, Meyer-Marcotty et al. used the terms anterior and posterior cranial asymmetry index ("ACAI" and "PCAI") (Meyer-Marcotty et al., 2012). Both authors deemed these indexes suitable for monitoring development and progress.

The aim of this study was to measure established metrical parameters with the widely used manual anthropometry in comparison with laser scanning methods. This is done to test whether

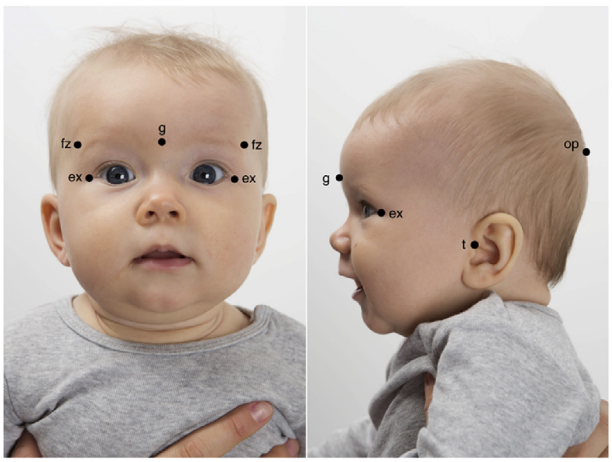

Fig. 1. Landmarks of the metric measurements described by Farkas (1981): glabella (g), opistocranion (op), exocanthion (ex), frontozygomaticus (fz) und tragion (t).

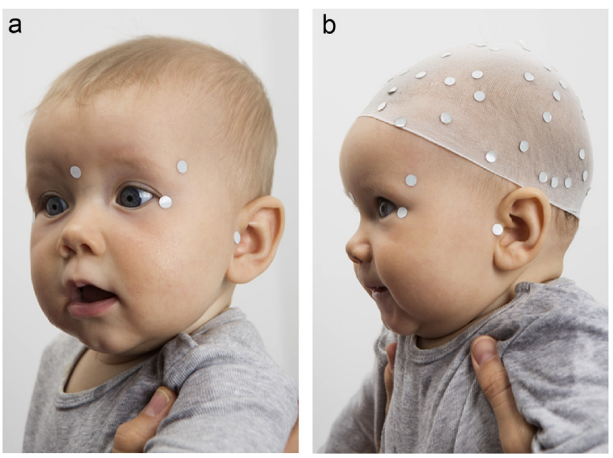

Fig. 3. a + b Reflector dots (a) and nylon hood (b) for the scan measurements described by Farkas (1981).

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