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Research Paper:

Investigating the Prevalence of Positional Plagiocephaly With 3D Scan in Children Under One Year of Age in Mofid Hospital

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Conflict of interest

The authors declare that there is no conflict of interest.

ABSTRACT

Background and Objectives: Positional plagiocephaly is one of the most common skull deformities that ultimately lead to the asymmetry of the head and face in different ranges. This study aimed to estimate the prevalence of plagiocephaly and analyze the relationship between risk factors and the severity level of the deformities in children referred to the Mofid hospital.

Methods: In a cross-sectional study, the cranial vault asymmetry index was calculated from a routine head scan with a noninvasive laser shape digitizer. Data were recorded and categorized by the type and severity of deformation. Also, for the analysis of risk factors, data about sitting, feeding, and sleeping positions were gathered from parents.

Results: The study participants included 90 children, and the prevalence of head deformity was 35% (32 infants) with mild to moderate severity. According to the risk factors, infant positions are significantly correlated with the severity of plagiocephaly.

Conclusion: Parents' awareness of changing the head position plays an important role to reduce the risk of plagiocephaly in children.

Keywords: Deformity, 3D imaging, Plagiocephaly

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What is "already known" in this topic:

In the last decade, the incidence of positional plagiocephaly has increased substantially due to many factors, including supine sleeping position for a long time.

What this article adds:

This cross-sectional study in Tehran showed that the prevalence of head deformity was 35%, with mild to moderate severity. So we need public education for Iranian parents about all infant positions in sleeping, milking, and playing.

Introduction

Plagiocephaly is the most common skull deformity that eventually leads to the deformity of the head and the asymmetry of the baby's skull bone [1]. Clinical signs of this deformity include unilateral flattening of the occipital bone on one side; changes in the position of the ear, in more severe cases; the protrusion of the forehead on the same side; the protrusion of the skull on the opposite side, and asymmetry in the face [2, 3]. According to these changes, the skull becomes the same as a parallelogram from the upper view [4]. Numerous risk factors play role in the development of plagiocephaly deformity; these factors can be divided into two categories: modifiable, non-modifiable. Modifiable risk factors can be promptly controlled through training and follow-up and their effect can be neutralized. Among the most important risk factors are male gender, multiple pregnancies and first delivery, delivery using assistive devices (vacuum and forceps), small uterus, large fetus, torticollis, neck disorders (limited neck movement tends to be in a fixed position), prolonged stay in the prone position in sleep, allocating inadequate time to be in the supine position during playing [5-11].

Sometimes in cases of severe deformity or rapid progression of deformity, surgical interventions for correction are on the agenda [12, 13]. Fortunately, conservative treatment is sufficient in most cases. The first line of treatment includes the teaching of positional therapy to the family, next, orthotic treatment is recommended when positional therapy is not enough. Teaching positional therapy to the family includes teaching parents how to position the baby's head properly during sleeping, waking, breastfeeding, and carrying. This consultation should also specify the duration of the use of restraints, such as car seats or strollers during the treatment period [14].

A lot of evidence shows the delayed mental and motor development of this group of infants [2, 7, 8, 15-18]. There is no report on the incidence and prevalence of this deformity in Iran, while many babies seem to have this problem. In other words, owing to the lack of scientific information about this anomaly, the problem remained unaddressed in the macro-planning of prevention and treatment of the Iranian society. On the other hand, the evaluation method and criteria are very effective in diagnosing and determining the severity of the deformity. Some previous studies [19] have used clinical scales to diagnose head deformity, while the validity and accuracy of such instruments depend on the examiner's experience and are controversial. However, there is a significant relationship between the 3D and CT scans as diagnosing deformity. The present study aimed to define the prevalence of head deformities using the 3D scan and analyze the head parameters.

Materials and Methods

A total number of 90 children and their parents were included in this study. Inclusion criteria for children were the age of under 12 months and the lack of synostosis deformity. Initially, the parents were informed about the aim and procedure of the study. Then, they were asked to complete the consent form. After completing the child information forms and conducting a short interview to determine the risk factors, the child was prepared for 3D photography. First, cloth or nylon was placed on the child's head so that the child's face and ears were not covered. Then, we laid the child on the prepared table in the prone position and started scanning the head. During the scan, the minimum changes should be made in the position of the child's head; this will be achieved since the scan time is very short. After analyzing the scanner and the therapist's approval, the scanning phase is over. After preparing the 3D file, the landmarks were identified and the desired variables were measured in the

prepared software. During this stage, first with different measurements on the child's head, the amount of Cranial Vault Asymmetry Index (CVAI) and other parameters were measured to determine the severity of the deformity, then, information about risk factors was taken from the family.

3D scan

The 3-dimensional scanning device of the child's head consists of two parts: hardware and software.

Hardware part

This part consists of a 3D scanner made by Microsoft (Xbox scanner, model: One's 2016). The accuracy of this scanner at a distance of 50 cm is equal to 1 mm. During the scan, the therapist rotates the scanner around the child's head to record information. Besides, the scanners are connected to a computer via a cable. This system is specifically designed to perform head-to-head scans and poses no danger to a child's eyes.

Software part

Special software has been designed that matches the scans of different images prepared by the scanner and finally forms a 3-dimensional image of the child's head. This software can match the images prepared by the scanner. The second part of the software is responsible for landmarking and measuring the desired variables. The analyzed variable in this study included CVAI as a parameter for categorizing the deformity of the head.

Results

The scans of 90 children were included in the study. The prevalence of head deformity was 35% (32 children). We analyzed these 32 infants about the risk factors of deformity and the relationship between risk factors and deformation severity. Also, the Mean±SD age of the children was 7.82±3.03 months with an age range of 1.5 to 13 months. Moreover, the Mean±SD CVAI score was 6.01±3.35 percent. In this study, the Mean±SD score of The Overall Symmetry Ratio (OSR), Oblique Cranial Length Ratio (OCLR), and Cranial Index (CI) was 29.5±65.89, 106.19±4.17, and 114.11±1.32, respectively (Table 1).

The normality of the data was examined using the Kolmogorov-Smirnov and Shapiro-Wilk statistical tests. The results approved the normal distribution of the variables of age, CVAI, OCLR, score, and satisfaction, however, the data of the other variables were not normally distributed.

The results show that the CVAI variable is negatively and significantly correlated with the variables of the duration of tummy position (laying on the stomach during playing) at P<0.001. Also, there is a significant positive correlation between CVAI and severity at the level of P<0.001. According to the result, the awareness variable has a significant negative correlation with the CVAI and disease severity variables at the level of P<0.01. Moreover, in a fixed position, the position of the neck is positively and significantly correlated with the CVAI variable and the disease severity at the level of P<0.001.

Relationship between the variance of disease severity and the studied variables

Based on the Kruskal-Wallis test results, the variance of disease severity affects CVAI, OSR, and satisfaction (P<0.001) as well as the position of the neck in a fixed position, sleep on stomach duration, and the awareness of parents (P<0.05). Concerning the variable of satisfaction, the severity of the mild, moderate, and somewhat severe disease has a statistically significant relationship with CVAI. So, CVAI is the best index for estimating the severity of positional plagiocephaly.

Evaluation of the frequencies of positional deformity and quartiles based on CVAI index

Table 1. The mean and standard deviation of variables measured in the skull

Satisfaction	Severity	CHOA	Prefrence	Tummy	Awareness
5.81±2.520	2.09±0.928	2.47±1.24	1.41±0.499	1.38±0.492	1.38±0.492

Score	OCLR	OSR	CI	Circumf Erence	Age, Year	Sex	CVAI
1.20±0.42	106.19±4.17	89.65±5.292	114.11±1.32	382.15±148.6	7.82±3.03	1.47±0.50	6.01±3.35

CHOA: Children's Healthcare of Atlanta Scale; OCLR: Oblique Cranial Length Ratio; OSR: The Overall Symmetry Ratio; CI: Cranial Index; CVAI: Cranial Vault Asymmetry Index.

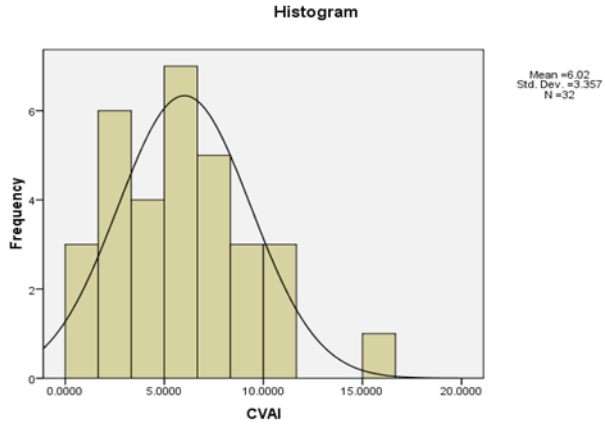

Figure 1. The CVAI data histogram

To examine this index, information, such as mean, middle, upper limit, lower limit, variance, standard deviation, and other criteria were examined. The highest frequency, the lowest value, and the highest value for this index were 6, 1.1, and 16.3, respectively. The results of quarter frequency showed that the numbers 3.2, 6.6, 7.7, and 10 were repeated twice. Besides, the results show that the average CVAI data is equal to 6.02 (Figure 1).

Positional deformity regression analysis based on CVAI index

The analysis of variance was significant at the level of P<0.001, indicating the effectiveness of regression analysis. Also, the results show that there is a statistically significant relationship for the regression coefficients of the two variables of gender and OCLR at the levels of P<0.05 and P<0.01, respectively.

Discussion

Various studies have obtained similar results as the current study. For example, in a study entitled Clinical Classification of Positional Plagiocephaly, Argenta measured the incidence of plagiocephaly in children of different age groups using digital cameras; the highest incidence rate was reported as 19.7% in four months infants. Measuring the amount of OCLR and CI, we obtained the incidence of plagiocephaly to be 35.5% in children under one year of age. Also, consistent with the present study, the mentioned study reported a CI greater than 93% and an OCLR greater than 106 in children with plagiocephaly deformity [8]. In a study, Arnivalla considered CVAI as a reliable criterion for measuring plagiocephaly. It was stated that if CVAI is between 3% to 7%, plagiocephaly is mild and shows a higher rate of up to 12% of severe plagiocephaly [3]. In the present study, CVAI was used to measure plagiocephaly, and it was observed that the average CVAI is about 6.01% (SD=3.35), while the CVAI was up to 16.30%, which indicates the severity of the disease.

The present study is consistent with the work of Mawji et al. 2010, which noted the relative superiority of the 3D imaging method for determining head deformities [20]. The 3D imaging provides more data in less time and can be a good alternative to the anthropometric method with a caliper. Also, consistent with the present study, Schaff et al. considered the CVAI index in the diagnosis of positional deformity. Given their relatively large sample size, it seems possible to match the results of their research with the present study. Generally, the criterion of CVAI and the use of 3D imaging is a good solution for the diagnosis of head deformities.

According to the Spearman nonparametric test in the present study, there is no significant correlation between gender, age, head circumference, and CI cranial index and other variables studied. On the other hand, the CVAI variable is negatively and significantly correlated with the variables of the duration of tummy position. Furthermore, the CVAI variable has a significant positive correlation with disease severity. The results show that awareness has a significant negative correlation with CVAI and disease severity.

The position of the neck in a fixed position has a negative and significant correlation with CVAI. In a 2017 study, Aarnivala et al. examined the accuracy of measurements to quantify cranial asymmetry in plagiocephaly. The results showed that age had an insignificant effect on CVAI. Generally, the results showed that CVAI is a good scale for measuring plagiocephaly deformity [2]. In the present study, age and gender were insignificant-

ly correlated with all of the parameters of asymmetry, which is in line with the results of the mentioned study.

In 2017, Huloka et al. reported a relationship between the duration of tummy time and severity and between awareness and severity, which are also mentioned in the present study [21]. A 2013 study by Maoji et al. found a commonality between the two studies regarding the 2.7-fold probability of head deformity in children who slept in the fixed position. Also, the present study observed a slightly higher degree of positional deformity in boys. Thus, in the case of the head in a fixed position, the result of the study can be generalized to the present study with a relative approximation. One advantage of the Maoji et al. research is the large sample size they reviewed, which makes it more likely to describe the results [22].

In 2012, Yoo et al. used cranial molding therapy and also the CVAI index to measure the degree of plagiocephaly deformity; they found that this treatment reduced the percentage of CVAI and increased parental satisfaction in using it [4]. In the present study, it was observed that the two variables of CVAI and parental satisfaction were significantly and negatively correlated with each other, which confirmed the results of this study.

The results of this study show that based on the Kruskal-Wallis test, the variance of disease severity affects CVAI, the variables of the neck in a fixed position, the duration of tummy time, and the awareness of parents. Concerning the variable of satisfaction, it is observed that the severity of the disease has a strong relationship with the increase in satisfaction. Moreover, the severity of mild, moderate, and somewhat severe disease has a statistically significant relationship with CVAI.

Conclusion

The incidence of the deformity was estimated at 35.5% in children referred to Mofid hospital. Besides, the severity of plagiocephaly was assessed based on CVAI and classified as mild to moderate in severity for infants with head deformity. Also, among the mentioned indicators, the CVAI index showed more practical value than the other indicators. Based on the analysis of research data, sleeping in the same position was positively and significantly related to the severity of plagiocephaly, so it is better to change the head position during sleep. Also, there was a signwificant relationship between the parents' awareness of positional deformity and also lying on their stomachs and the severity of plagiocephaly, so we need public education for parents about all positions of a child during sleeping, milking, playing, etc.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Ethics Committee of the Iran University of Medical Sciences.

Funding

The paper was extracted from the MSc. thesis from the first author at the Department of Orthotics and Prosthetics, School of Rehabilitation Sciences, Iran University of Medical Sciences, Tehran.

Authors' contributions

Data gathering: Esmaeil Chahaki; Supervision: Mohammad Ali Javanshir; Methodology: Hassan saeedi; Investigation, Writing – review & editing: All authors.

Conflict of interest

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مقاله پژوهشی

شیوع پلاژیوسفالی وضعیتی با اسکن سه‌بعدی در کودکان زیر یک سال مراجعه‌کننده به بیمارستان مفید

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چکیده

مقدمه دفرمیتی پلاژیوسفالی وضعیتی، یکی از شایع‌ترین دفرمیتی‌های جمجمه است که سبب غیرقرینگی در سر و در موارد شدیدتر سبب غیرقرینگی در صورت می‌شود. هدف از انجام این مطالعه، ارزیابی میزان شیوع دفرمیتی پلاژیوسفالی در کودکان مراجعه‌کننده به بیمارستان مفید و همچنین بررسی ارتباط میان ریسک‌فاکتورهای ایجادکننده دفرمیتی و شدت دفرمیتی بود.

مواد و روش‌ها در این مطالعه شاخص غیرقرینگی جمجمه از طریق عکس‌برداری سه‌بعدی که عاری از خطر تشعشعات بود، محاسبه شد و بر اساس این داده کودکان بر اساس شدت طبقه‌بندی شدند. سایر اطلاعات مربوط به نحوه نشستن، شیر خوردن و وضعیت خوابیدن از خانواده پرسیده شد.

یافته‌ها ۹۰ کودک در این مطالعه شرکت کردند که از بین آن‌ها ۳۲ کودک دفرمیتی پوزیشنال پلاژیوسفالی داشتند که شدت آن‌ها از خفیف تا متوسط دسته‌بندی شد. بر اساس آنالیز داده‌ها ارتباط مثبت و قابل ملاحظه‌ای میان خوابیدن در یک وضعیت ثابت و شدت دفرمیتی یافت شد، بنابراین بهتر است وضعیت خوابیدن کودک حین خوابیدن توسط والدین مکرراً تغییر داده شود. همچنین ارتباط معنی‌داری میان آگاهی والدین از پلاژیوسفالی و راه‌های پیشگیری ـ درمان و خوابیدن روی شکم و شدت دفرمیتی یافت شد.

نتیجه‌گیری با توجه به شیوع زیاداین دفورمیتی در نوزدان و وابستگی آن به وضعیت دهی سر دردوران نوزادی نیاز به آموزش والدین وجود دارد

کلیدواژه‌ها:
پلاژیوسفالی، دفورمیتی، تصویربرداری سه بعدی

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