

Cephalometric Measurements in Infants with Congenital Heart Disease Compared to Healthy Infants

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Abstract

Introduction: The lack of adequate blood perfusion through different organs of the body, including the brain and skull, can be caused by any type of circulation abnormality. The purpose of this study is to compare cephalometric indices between infants under the age of 12 months who have congenital heart disease (CHD) and normal infants.

Materials and Methods: This case-control study was carried out on infants aged one to 12 months who were admitted to Heshmat Heart Hospital and 17 Shahrivar Infant Center Hospital, with those who attended Golha-e-Iran Daycare in Rasht. Cases consisted of infants diagnosed with CHD and control group comprised normal healthy infants. Cephalometric indices, along with anatomical measurements of the head and face as measured by a Martin spreading caliper and graded tape measure were obtained. The volume and weight of the brain, and head and face indices were calculated using related formulas, then analyzed by the SPSS statistical software package.

Results: There was a significant difference between weight, height, head length and head circumference in cases and controls ($P < 0.01$), however no significant difference in indices such as volume and weight of the brain, head and face width, and head height was observed. Head indices significantly differed between the two groups ($P = 0.011$). Cases had evidence of a hyperbrachycephalic head shape whereas normal infants had a brachycephalic head formation.

Conclusion: The results of this study confirmed the presence of growth retardation caused by CHD. This retardation did not lead to any major anthropometric differences. Possibly, proper diagnosis and effective treatment of these abnormalities could improve the quality of life for infants and children with CHD.

Keywords: Congenital heart disease, Cephalometry, Anthropometry, Infant

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Introduction

In humans, during the embryonic period the brain grows to its highest level; the rest of its growth occurs after birth and is accompanied with brain hypertrophy. During the embryonic period, the skull size is considerably larger than other parts of the body. During the first trimester, the brain is half of the fetus height, one third during the fifth month and one fourth at birth [1]. After birth the rate of brain development significantly increases. Cephalometry is one of the most important branches of anthropology that measures head and face dimensions and indices. It is related to brain growth and facial shapes. Head length and width are the most important dimensions of the skull. The skull index is calculated by measuring these two variables [2].

Studies of specific age and sex groups have shown that the size and dimension of neonates' bodies are the basis of future annual changes. Thus it is important to know the normal range of changes in their measurements. One of the health evaluation indices for neonates is their anthropometric measurements. The brain and skull grows at different rates from the first month of birth until sixth years of age; most changes occur during this period [3]. Growth and development of the skeletal system has an important role in determining body formation. Bone growth is a complex process for which different pathways such as cephalometry can be involved. In addition to brain growth, growth of deciduous teeth [3], development of paranasal sinuses [4], hereditary factors [5], and environmental agents that include residence and weather [6] are factors that affect formation of the head and face.

Height, weight and cephalometric dimensions are variable among fetuses and infants where sometimes these variables differ from the

infant's calculated age. Most of these effective factors are genetic however environmental factors also play an important role. Major structural abnormalities are seen in 2% to 3% of neonates at birth; other abnormalities are diagnosed by the end of the fifth year after birth. Congenital heart disease (CHD) is considered an important factor that causes growth retardation of different parts of the body [1]. CHD affects growth and development of infants because of the perfusion insufficiency to different organs of body, including the brain. Therefore, CHD may cause different cephalometric dimensions. Clinical knowledge about these effects could be helpful in early diagnosis, treatment and ensuring proper growth in early life. The purpose of this study is to survey indices of the skull, face, and brain volume and weight in infants with CHD compared to normal infants who reside in Rasht, Iran.

Materials and Methods

This case-control study used the convenient random sampling method to enroll 137 infants of both sexes, aged one to 12 months who were admitted to Heshmat Heart Hospital, 17 Shahrivar Infants' Center Hospital, and those who attended Golha-e-Iran Daycared in Rasht between March 2010 until May 2012. Cases consisted of infants diagnosed with CHD and controls comprised healthy infants. Infants with known abnormalities such as mental retardation, those with surgical histories, twins or the presence of concurrent disease were excluded. All study procedures were approved by the Medical Ethics Committee Guilan University of Medical Sciences, Rasht, Iran.

Anthropometric variables such as head length (the maximum distance between the frontal tuberosity and anion), head width (the

maximum distance between two parietal bones), head height (distance between tragus and top of the head), head circumference (maximum horizontal circumference from the frontal bone to the anion), face width (direct distance between two zygomatic arches) and face length (distance between the gonion and nasion) were measured by a Martin spreading caliper and graded tape measure[7]. All measurements were performed by one of the colleagues of this project and all of the above variables were estimated in millimeters.

Head index, face index, brain volume and brain weight were calculated according to the following formulas [2]:

Head index= [head width (mm)/head length (mm)]×100

Face index= [face length (mm)/face width (mm)]×100

Brain volume for males (mm³) = 0.000337×[head length (mm)-11]×[head width (mm)-11]×[head height (mm)-11] + 406.01 cc

Brain volume for females (mm³) = 0.000400×[head length (mm)-11]×[head width (mm)-11]×[head height (mm)-11] + 206.60 cc

Brain weight (g) = Brain volume (mm³) × 1.035

Statistical analysis was performed by SPSS for Windows software, version 17.0 (SPSS Inc., Chicago, IL, USA). Continuous variables were expressed as mean and standard deviation (mean±SD) and the independent one-sample t-test was used to compare the means of the two groups (CHD vs. normal infants). Categorical variables were compared with Pearson's chi-squared test. P<0.05 were considered statistically significant.

Results

This study evaluated 137 infants, from which 86 were diagnosed with CHD. There were 41 females (48%) who had CHD and the

others were normal (29 males and 22 females, P=0.606; Table 1). The mean age of normal infants was 6.34±3.44 months; for CHD infants, it was 6.67±3.50 months (P>0.05). Normal infants weighed significantly more (7.79± 2.46 kg) than the case group (6.43±2.11 kg; P=0.001).

Table 1: Infants' clinical data (n=137).

Male sex (M : F = 1.17)	74 (54%)
Age (months)	5.92±3.49
Weight (kg)	6.92±2.33
Length (cm)	64.00±9.31
Patient (Patient : Healthy = 1.69)	86 (62.8%)
TF	5 (3.6%)
PDA	4 (2.9%)
ASD	22 (16.1%)
VSD	18 (13.2%)
PS	3 (2.2%)
ASD+VSD	21 (15.3%)
ASD+PS	4 (2.9%)
ASD+PDA	4 (2.9%)
Others	5 (3.6%)

TF: Tetralogy fallot, PDA: Patent ductus arteriosus, ASD: Atrial septal defect, VSD: Ventricular septal defect, PS: Pulmonary stenosis.

Thus, weight growth in the normal group was better. The mean height in the normal group was 66.76±10.69 cm and in the case group it was 62.50±8.17 cm which was significantly different (P=0.012). The mean±SD of anthropometric variables for normal and CHD infants are presented in Table 2. Head length in the normal group was 14.35±1.33 cm and in the case group it was 13.62±1.60 cm which was significant (P=0.007). However, other head variables that included head width and height showed no significant differences between these two groups (P>0.05).

Table 2: Mean±SD of anthropometric variables in normal infants and those with congenital heart disease (CHD).

Variables	Normal infants (n=51)			CHD infants (n=86)		
	Females (n=22)	Males (n=29)	Total	Females (n=41)	Males (n=45)	Total
Head length, cm	13.84±1.34	14.74±1.20	14.35±1.33	13.20±1.25	14.01±1.79	13.62±1.60**
Head width, cm	11.76±1.26	11.77±1.30	11.76±1.27	11.28±1.22	11.74±1.37	11.52±1.31
Head height, cm	9.85±1.08	9.91±0.96	9.88±1.00	9.55±1.24	10.01±1.11	9.79±1.19
Head circumference, cm	41.64±3.70	44.05±4.74	43.01±4.45	40.08±3.42	41.39±3.91	40.77±3.72**
Face length, cm	7.88±0.99	8.00±1.01	7.95±0.99	7.39±0.97	7.59±1.00	7.49±0.98*
Face width, cm	8.05±0.69	8.15±0.73	8.11±0.71	7.81±0.89	8.00±1.21	7.91±1.07
Head index (%)	85.10±5.86	79.80±5.94	82.09±6.42	85.66±7.60	84.32±8.62	84.96±8.13*
Face index (%)	98.14±12.46	98.32±11.78	98.24±11.96	95.17±12.64	96.13±15.41	95.67±14.08

Normal vs. CHD infants (both sexes): * P<0.05, ** P<0.01

Head circumference in the normal group was 43.01±4.45 cm and for the case group it was 40.77±3.72 cm which was significant (P=0.002). Face length in normal group was 7.95±0.99 cm and the case group had a mean face length of 7.49±0.98 cm which was significantly different (P=0.011). The face length of cases was smaller. Despite these results, face width showed no significant difference in these two groups (P>0.05).

There was no significant difference between groups in terms of calculated, estimated brain volume and weight (P>0.05). Surveys based on face index showed that both groups had a hyperlipoprosopic face formation, however the mean head index was 82.09±6.42 in the normal group and 84.96±8.13 in the case group which was significantly different (P=0.033). This result suggested that the brachycephalic head formation was present in the normal group and a hyperbrachycephalic head formation was noted in the case group.

Discussion

Cephalometry is an important part of anthropometry where head and facial

dimensions are measured [8]. Results of cephalometric surveys are used for pediatrics, legal medicine, plastic surgery, jaw surgery and orthodontics [9] Dimensions of the human body are affected by racial, geographical, regional, sexual and age factors [10].

In the current study, head and facial indices in the normal group indicated a brachycephalic head formation and hyperlipoprosopic face formation, respectively. In a study by Safikhani et al. [7], head index was calculated to be a brachycephalic head formation in normal group. In support of the current results, Safikhani reported the presence of a brachycephalic head formation in patients with CHD.

Measurement of anthropometric factors in infants can be an early estimation for the recognition of anomalies [5]. Possibly, different studies should be designed that demonstrate anthropometric changes caused by these diseases.

The results of this study have shown significant differences in weight and length between the two groups which could be related to factors such as inadequate use of

food, malabsorption and the increase in basic energy level according to an increased body metabolism. One of the most important agents that affect development is inadequate use of food in patients with CHD [11]. Previous studies have proposed different theories about growth retardation in infants with CHD. Some studies reported no relationship between degrees of cyanosis in children with cyanotic CHD and severity of growth retardation [12]. However, others found that the degree of growth impairment was closely associated with the severity of the hemodynamic impairment [13, 14]. Linde et al. [15] showed that weight and height retardation of cyanotic children was higher than acyanotic children.

In our study, there was a significant difference between weight, height, head length and head circumference ($P < 0.05$). In a report by Manzar et al., patients with CHD had smaller heads at birth [16]. Safikhani et al. reported similar results and attributed the source of this phenomenon to oxygen inadequacy and blood perfusion insufficiency of the brain tissue [7]. Yung et al. studied 305 consecutive neonatal autopsies and showed a high correlation between head circumference and crown-rump length. When the head circumference was significantly smaller than crown-rump length, there was a higher incidence of CHD [17]. Dimiti et al. showed that head circumference in children with CHD was smaller than the normal population [18], which supported the results of the current study. According to previous

studies, the most important factor might be malnutrition and brain perfusion inadequacy. Donoferio et al have concluded that inadequate cerebral flow in CHD fetuses, despite auto-regulation, might alter brain growth [19]. Therefore, this phenomenon cannot be easily explained. Today, most CHD patients are quickly diagnosed by developed diagnostic methods (Echocardiography, Angiography, Single Photon Emission Computer Tomography and ...), worked up and treated; therefore complications do not have adequate enough time to completely appear.

As a limitation, we used instruments to measure the outside of the skull. Therefore, this method could not accurately calculate brain indices. However, our calculation methods of brain weight were similar to previous studies.

This study showed evidence of growth retardation caused by CHD. This retardation did not lead to any major anthropometric differences. Possibly, proper diagnosis and effective treatment of these abnormalities could improve the quality of life of infants and children with CHD.

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