AN ULTRASONOGRAPHIC EVALUATION OF FOETAL CEPHALIC INDEX

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ABSTRACT

Cephalic index is the ratio of head's breadth to length, which reflects the cranial dimensions and is an important parameter in anthropometry. Cephalic index is also known as cranial index and was defined by Swedish professor of anatomy Anders Retzius. It is useful to differentiate different types of crania belonging to different races, gender, age, geographical zones, tradition and nutrition, etc.

AIMS

To estimate foetal cephalic index by ultrasonography, to classify foetal heads as per international categories and to know the frequent head types in second and third trimesters of pregnancy.

MATERIAL AND METHODS

This prospective cross-sectional study included 100 normal singleton pregnant women with foetuses in the duration 12 to 40 weeks of gestational age. By ultrasonography, foetal head breadth and length was measured. Cephalic index was calculated by Breadth/Length X 100 and all the heads were classified as per international categories.

RESULTS

Of the total 100 foetal heads in the gestational age of 12 to 40 weeks, the mean cephalic index was 78.95±03.01. Mean biparietal diameter was 68.04±22.26. Mean occipitofrontal diameter was 86.38±28.61. According to cephalic index value 51% mesocephalic, 38% brachycephalic, 10% dolichocephalic and 1% hyperbrachycephalic heads were noticed. A mean cephalic index of 80 at 12-16 weeks, 78.48 at 36-40 weeks and a constant cephalic index of 78 to 79 was observed between 16-36 weeks.

CONCLUSIONS

The mean cephalic index in the present study was 78.95 and is of mesocephalic phenotype in our study. It is the most frequent head type noticed. A linear correlation was observed between gestational age versus biparietal diameter and occipitofrontal diameter. No linear relationship was seen between gestational age and cephalic index. Brachycephalic heads at 12-16 weeks, mesocephalic heads at 36-40 weeks and a constant cephalic index of 78 to 79 was noticed from 16 to 36 weeks of gestation.

KEYWORDS

Cephalic Index, Ultrasonography, Foetal Biparietal Diameter.

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INTRODUCTION: Cephalic Index (CI) is defined as the ratio of biparietal diameter (BPD) to the occipitofrontal diameter (OFD) of the skull. Basically, it reflects the cranial dimensions and is an important parameter in Anthropology. Anthropology is the study of the human race, its culture & society and its physical development.[1] Cephalic index is also known as cranial index and was defined by Swedish professor of Anatomy Anders Retzius (1796-1860) and first used in physical anthropology to classify ancient human remains found in Europe.[2] The measures used by Retzius when applied to living individuals, it is called as cephalic index and when referring to dry skulls, Cranial Index.[3,4]

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Cephalic index helps to differentiate types of crania belonging to different races, gender, age, geographical zones, tradition and nutrition, etc. Craniometric data is useful for obstetricians, paediatricians, forensic experts, plastic surgeons and dentists. It is useful to identify age sex and race, valuable for orthodontic and reconstructive surgeries, and essential for age estimation in medico legal cases.

On the basis of cephalic index, skull shapes are generally classified into four international categories. They are dolichocephalic (Long and Thin Skull) [Figure 1], Brachycephalic (Short and broad skull) [Figure 2], Mesocephalic (Intermediate length and width) [Figure 3] and hyperbrachycephalic (Very short and broad).[5] There are evidences to show clear racial trend in cranial dimensions and indices among different populations. Australian aborigines and native southern Africans are dolichocephalic, Europeans and the Chinese are mesocephalic, Mongolians and Andaman Islanders have brachycephalic skulls.[6]

Most of the studies on cephalic index were done on adults, dried skulls and on cadavers. There are very few studies on foetal heads in India for cephalic index estimation. In India, mesocephalic, brachycephalic and hyperbrachycephalic heads are shown to be frequent among foetuses of different population as far as gestational age group has been concerned.[7,8] Ultrasonography (USG) is helpful to evaluate foetal skulls in estimation of cranial parameters. USG measurement of cranial dimensions is very accurate and easy as we have observed in our series.

AIMS AND OBJECTIVES: The aims and objectives of this study are – (1) To estimate foetal cephalic index by USG. (2) To classify foetal heads as per international categories and (3) To know the distribution of different head types in second and third trimesters of pregnancy.

MATERIAL AND METHODS: This prospective cross-sectional study was conducted in the Department of Radiodiagnosis of our hospital. Ethical Committee approval was obtained for the study. Pregnant women who were referred for routine antenatal USG examination were selected for the study. Informed consent was obtained from all the patients. Sonoline G50 Real Time, Grey Scale ultrasound system with 3.5 MHz curvilinear probe was used for all patients to record cranial dimensions. Patients were examined transabdominally in supine posture and all the foetuses were screened for viability, position, lie and for any anomalies. Liquor quantity was assessed. Placental position and maturity was noted. All patients with any obstetric disorders including cranial anomalies were excluded from the study. Patients with systemic disorders like diabetes, hypertension, anaemia, tuberculosis, etc. were deleted from the study. Patients with multiple gestations were also excluded. Patients with correct last menstrual dates, correlating with dating scans were included for the study. Only normal singleton live intrauterine gestations in the duration of 12 to 40 weeks were selected and included for the study.

The gestational age (GA) of all the foetuses was assessed by routine USG biometric parameters. Foetal BPD and OFD were measured on the axial section of the foetal head at the level of thalamus where the continuous midline echo is broken by the cavum septum pellucidum in its anterior third [Figure 4]. This section demonstrates the oval and symmetrical shape of the skull. BPD was measured from the outer edge to outer edge of the temporomandibular bone at its widest diameter. The OFD was measured in the same section of the skull from the leading edge of the frontal bone to outer border of the occiput in its longest diameter.[9]

RESULTS: Among the 100 pregnant women in the age group of 18 to 35 years, 50 were primiparous and 50 were multiparous. Out of 100 foetuses, 73 were in cephalic, 09 in breech and 18 were in unstable presentations. The data obtained from 100 normal foetuses was tabulated and analysed. Descriptive and inferential statistical analysis was done.

Mean with standard deviations and correlation coefficients were calculated. Pearson correlation was carried out to find the degree of relationship between the variables. The gestational age was recorded in weeks. The BPD and OFD were measured in mm. Cephalic index was calculated by using the formula BPD/OFD x 100. All the heads were classified as per the international classification by Williams et al [Table 1].[5] Of the total 100 foetuses in the duration of 12 to 40 weeks of gestation, the number of foetal head measurements for each gestational age ranged from 1 to 7, thus covering all the weeks. The data related to head length, head breadth and cephalic index was analysed [Table 2].

Based on the cephalic index value, all the 100 foetal heads were grouped into four head types along with their mean cephalic index [Table 3]. The gestational period of 12 to 40 weeks was divided into intervals of 4 weeks each, and the foetal head types were analysed in each group. Analysis of number of foetuses, head types and percentage in each gestational age group [Table 4]. Among the 100 foetuses, the mean BPD, OFD and cephalic index was calculated in each gestational age group. The values are correlated with advancing gestational age, correlation coefficients and p value were calculated to evaluate the relationship of BPD, OFD and CI with advancing gestational age [Table 5]. Scatter graphs were plotted between gestational age versus BPD, [Figure 5] and gestational age versus OFD. [Figure 6].

Fig. 1: USG Image of Dolichocephalic Head (Long and Thin) with BPD-67 mm, OFD-91 mm & Cephalic Index-73.6.

Fig. 2: USG Image of Brachycephalic Head (Short and Broad) with BPD-37 mm, OFD-44 mm & Cephalic Index-84.0.

Fig. 3: USG Image of Mesocephalic Head (Intermediate Length and Width) with BPD-57 mm, OFD-72 mm & Cephalic Index-79.1.

Fig. 4: USG Image of Axial Section of Foetal Head for the Measurement of BPD & OFD

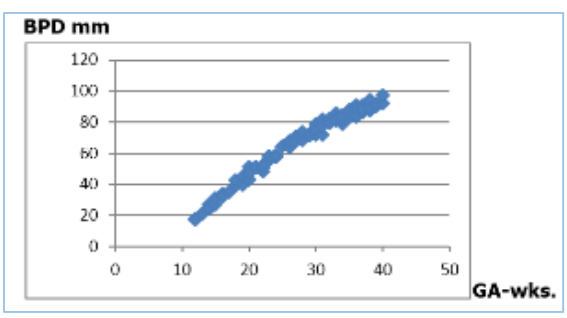

Fig. 5: Scatter Graph Showing Growth Trend between Gestational Age and BPD

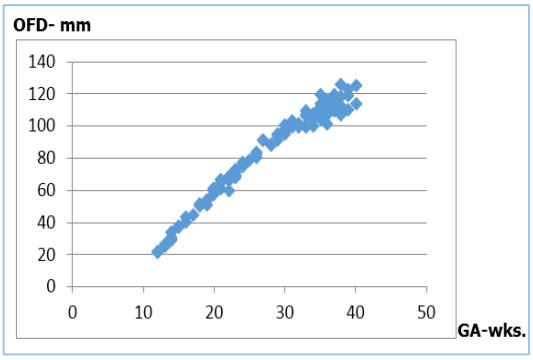

Fig. 6: Scatter Graph Showing Growth Trend between Gestational Age and OFD

Head type	Cephalic Index Range
Dolichocephalic	Less than 74.9
Mesocephalic	Between 75.0 to 79.9
Brachycephalic	Between 80.0 to 84.9
Hyperbrachycephalic	Between 85.0 to 89.9

Table 1: Cephalic Index Classification

	Minimum	Maximum	Mean±SD
Gestational age	12.00	40.00	28.32±08.16
Head breadth	17.00	97.40	68.04±22.26
Head length	21.00	125.70	86.38±28.61
Cephalic index	72.20	85.20	78.95±03.01

Table 2: Descriptive Statistics

Head Types	No. of Heads	%	Mean±SD
Dolichocephalic	10	10%	73.90±1.06
Mesocephalic	51	51%	77.56±1.19
Brachycephalic	38	38%	81.97±1.44
Hyperbrachycephalic	01	01%	85.20±0.00
Total	**100**	**100**	**78.95±3.01**

Table 3: Foetal Head Types & Mean Cephalic Index

Gest. Age Group	Dolicho cephalic Heads	Mesocephalic Heads	Brachy cephalic heads	Hyperbrachycephalic Heads	Total
12-16	01(08.3%)	03(25.0%)	08(66.7%)	00(00.0%)	12
16-20	01(11.1%)	04(44.4%)	04(44.4%)	00(00.0%)	09
20-24	01(06.7%)	09(60.0%)	04(26.7%)	01(06.7%)	15
24-28	01(12.5%)	03(37.5%)	04(50.0%)	00(00.0%)	08
28-32	03(21.4%)	08(57.1%)	03(21.4%)	00(00.0%)	14
32-36	01(04.2%)	14(58.3%)	09(37.5%)	00(00.0%)	24
36-40	02(11.1%)	10(55.6%)	06(33.3%)	00(00.0%)	18
Total	**10(10.0%)**	**51(51.0%)**	**38(38.0%)**	**01(01.0%)**	**100**

Table 4: Gestational Age Group Wise Distribution of Foetal Head Types

Gestational Age	12-16	16-20	20-24	24-28	28-32	32-36	36-40	p-value	r-value
No. of foetuses	12	09	15	08	14	24	18	-	-
Mean BPD	25.08	43.60	54.41	68.14	76.42	85.31	90.67	<0.001**	0.987
Mean OFD	31.42	54.69	68.91	85.58	98.36	108.02	115.60	<0.001**	0.984
Mean Cephalic index	80.00	79.60	79.00	79.69	77.66	79.00	78.48	-	-

Table 5: Gestational Age Group Wise Analysis of Cranial Parameters

Head types	Present study	Lokesh Goyal et al
Dolichocephalic	10	04
Mesocephalic	51	34
Brachycephalic	38	54
Hyper brachycephalic	01	08

Table 6: Comparison of Foetal Head Types

Gestational Age in weeks	12-16	16-20	20-24	24-28	28-32	32-36	36-40
Number of heads	12	09	15	08	14	24	18
Mean Cephalic index	80.00	79.60	79.00	79.69	77.66	79.00	78.48

Table 7: Gestational Age Group Wise Mean Cephalic Index

DISCUSSION: Out of 100 foetuses in the gestational age of 12 to 40 weeks duration, the mean cephalic index was 78.95±03.01. Grouping of all the 100 foetal heads according to cephalic index value showed, 51% mesocephalic heads constituting a major portion, followed by 38% brachycephalic heads. Together they constituted 89% showing that mesocephalic and brachycephalic heads are the most frequent ones in this geographical region. Dolichocephalic heads constituted for 10%, and remaining 1% was hyperbrachycephalic heads which is the least. It is in agreement that the south Indian population shows predominance of mesocephalic heads in both sexes.

A study conducted on north Indian foetuses showed 54% brachycephalic heads constituting a major portion followed by 33.6% mesocephalic heads. Hyperbrachycephalic heads were 8.4% and dolichocephalic heads were 4%.[1] It was observed 88% of the head types in north Indian foetuses were also mesocephalic and brachycephalic type [Table 6]. This shows that mesocephalic and brachycephalic heads are the most frequent ones in Indian population. Both these types of heads are round in shape which are commonly seen in temperate zones.

Mesocephalic and brachycephalic type of heads are commonly seen in temperate zones. India being partly in temperate and tropical zone and the present study showed more mesocephalic and brachycephalic heads which is in agreement with above fact. In addition to geographical zone, several other factors are also responsible for variations in cephalic index like hereditary factors, environmental factors, nutritional factors, hormonal influence, etc.

Gestational age group wise analysis of cephalic index and head types in our study showed brachycephalic heads with mean CI 80 at 12 to 16 weeks, mesocephalic heads with mean CI 78.48 at 36-40 weeks and almost a constant mean CI of 78.00 to 79.00 was seen between 16 to 36 weeks of gestation [Table 7]. This shows that there is a change in foetal head types from brachycephalic heads in early gestation to mesocephalic heads at term.

This is the evidence of growth of brain in lateral direction with a tendency towards mesocephalisation.

Lokesh Goyal et al study on north Indian foetuses showed brachycephalic heads at 12 to 24 weeks, mesocephalic heads at 24 to 32 weeks and again brachycephalic heads at 32 to 40 weeks.[1] In other studies conducted on ethnic groups of Nigerian and Manipuri populations, the foetal head types changed from mesocephalic head type in early gestation to brachycephalic head type at term showing brachycephalisation which is said to be due to ethnic speciality of that particular race.[8,10] In addition to ethnicity factor, the anthropometrical variations in cephalic index may also be due to influence of several other factors on the human skeletal growth like nutritional status, environmental & cultural factors, hormones, etc.

In our study, the mean BPD was 68.04 mm (min 17 mm & max 97.4 mm), the mean OFD was 86.38 mm (min 21 mm & max 125.7 mm) and the mean cephalic index was 78.95 (min 72.20 & max 85.20). When the growth trends of BPD and OFD were correlated with advancing gestational age of the foetus, both BPD and OFD showed a good linear correlation with advancing GA which is evident by correlation co-efficients and p-value. (GA vs BPD: r=0.987 & p- value <0.001**, GA vs OFD: r=0.984 & p-value <0.001**). Scatter plots between GA vs BPD and GA vs OFD also showed a linear relationship supporting this. This is consistent with previous studies.[8,10]

Cephalic index versus advancing gestational age did not show any linear relationship and it was independent of GA. Jeanty et al found that CI is independent of GA.[11] A constant CI of 78.3 from 14 to 40 weeks was observed by Hadlock et al with no significant change with advancing foetal age.[12] Tuli et al too noticed a constant value of 76.4 from 12 to 40 weeks.[7] In our study, the CI was almost

constant from 16 to 36 weeks. On the contrary, a study by Mador E S et al on Nigerian foetuses showed a linear relationship between CI and GA from 12 to 16 weeks, after 16 weeks the relationship was weak and CI becomes relatively constant.[10] Study by Rajlakshmi et al reported an increasing CI value with advancing foetal GA showing a linear relationship in Manipuri population which was statistically significant and was attributed to the ethnic speciality of that particular race.[8] CI is useful anthropologically to find out racial and sexual differences. Evidence shows a clear racial trend in cranial dimensions and cephalic indices in many different populations. The age, gender and population based cephalometric data is useful in various branches of medicine. In India, several population based cephalometric studies have revealed valuable information. As per various studies, the mean CI in north Indian population males was 79.14 & females 80.74. Mean CI in south Indian population males was 79.66 & females 81.26. According to this study, the mean CI among the foetuses in this part of our country is 78.95.

Craniometric study helps in determining shapes and sizes of skulls. Deformities of head shape and reduced size of cranium are noticed in children with mental retardation. Shailaja et al found 40% of the mentally retarded children in the age group of 5-15 years were having microcephaly in their study.[13] Also assumption of craniometry is that skull size and shape determine brain size which determines such things as intelligence and capacity of moral behavior.[14] Hence assessment of cranial dimensions and determining head size and shape are clinically useful. Elaborative craniometric studies on foetal heads are essential in this aspect.

CONCLUSIONS: From the observations of the present study, it shows that the most frequent head type in this region is mesocephalic which is 51%. Next commonest is brachycephalic with 38%. Together with 89% mesocephalic and brachycephalic heads are the frequent ones in this geographical region. The mean cephalic index in the present study is 78.95 which is of mesocephalic phenotype. A linear correlation was seen between GA versus BPD and OFD. No linear correlation was observed between CI and GA. The brachycephalic head type in early weeks of gestation changed over to mesocephalic head type at full-term (Mesocephalisation).

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