ORIGINAL RESEARCH

Ultrasonographic Study of Cephalic Index among Foetuses and Correlation with Gestational Age

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ABSTRACT

Introduction: Ultrasonic measurement of biparietal diameter has been used commonly and widely to assess foetal age and growth. Cephalic index has been shown to increase with gestational age though few studies contradict the same. The study has been conducted to see the correlation of cephalic index with advancing age of foetuses.
Material & Methods: The present study was conducted on 233 healthy pregnant women subjected for ultrasonography during 2nd and 3rd trimester with a single live foetus after obtaining informed and understood consent. The gestational age for each woman was recorded. The foetuses were screened for occipito-frontal diameter and bi-parietal diameter. The cephalic index was calculated and the foetal heads were categorised as dolicocephalic, mesocephalic, brachycephalic and hyperbrachycephalic head. Correlation of gestational age with occipitofrontal diameter, biparietal diameter and cephalic index was calculated and assessed. A p- value <0.05 was considered significant.
Results: There was gradual increase in occipitofrontal diameter and biparietal diameter with increase in gestational age which was statistically significant (p value <0.0001).
Majority of the foetuses represented with brachycephalic head. However, we could not observe any statistical correlation of cephalic index with gestational age.
Conclusions: In our study, brachycephalic head has been found to be prevalent among the population, and cephalic index has been gestational age independent.

Key Words: Ultrasonography; Gestational Age; Biparietal Diameter; Occipitofrontal Diameter; Cephalic Index

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INTRODUCTION

Physical anthropometry deals with the measurement of human body dimensions. Cephalometry is one of the important parts of anthropometry in which dimensions of head and face are measured. The human body dimensions are affected by ecological, biological, geographical, racial, gender and age factors.[1-3]
Ultrasonic measurement of biparietal diameter (BPD) has been used commonly and widely to assess foetal age and growth provided the foetal head development is normal. It may be misleading if the shape of the foetal head is abnormal. Cephalic index is the ratio of biparietal diameter of the skull to the occipitofrontal diameter and can detect asymmetry in the skull during development.[4]
Gray et al (1989)[5] reported that cephalic index varies with advancing gestational age, with the highest and lowest values being 81.5 and 78.0 at 14 and 28 weeks respectively. On the contrary Jeanty (1984)[6] found that cephalic index is independent of gestational age. In India, Tuli et al (1995)[3] found dolichocranial type of cephalic index in 73% of foetuses at term. Anthropometric studies have shown that the shape of the vault of the skull is not directly related to the cerebral growth but to genetic factors.
In Bareilly region ultrasonographic study of cephalic index among foetuses and correlation with gestational age has not been carried out so far. Therefore, the present study has been chalked out to study correlation of cephalic index with gestational age of foetuses in this part of country.

MATERIAL AND METHODS

The present study was conducted in the Department of Radiodiagnosis, Rohilkhand Medical College & Hospital, Bareilly and at Ganesh diagnostic, Bareilly U.P. (India) on pregnant women who were advised for ultrasonography with certain indications. We included two hundred thirty three healthy pregnant women in the 2nd and 3rd trimester with a single live foetus after taking informed and understood consent. Pregnant women with diabetes mellitus, hypertension, renal disease, thyroid disease, and asthma and with complications of pregnancy known at the moment of the ultrasound scan e.g. bleeding, pre-eclampsia, etc. were excluded from the study. If abnormal foetal cranial morphology and other foetal malformation were detected during the examination, the subject was excluded from the study. The gestational age for each woman was recorded.

Average gestational age (Mean ± SD in weeks) was calculated by BPD, OFD and femur length. The foetuses were divided into groups with four weeks of age intervals. The foetuses were screened for occipito-frontal diameter (OFD) and bi-parietal diameter (BPD). Both diameters were measured from outer to outer margin using a gray scale real time ultrasonographic scanner, medison sonoace X-8, 3.5MHz sector transducer. The data thus compiled was analyzed using computer software MS Excel and SPSS 14.0 version software. At each gestational age (GA), OFD and BPD were reported as mean standard deviation (SD).

Foetal bi-parietal diameter measurements were made in an axial plane at the level where the continuous midline echo is broken by the cavum septum pellucidum in the anterior third and that includes the thalamus.[7]

This transverse section should demonstrate an oval symmetrical shape. Measurement of BPD was from the outer edge of the closest temporomandibular bone to the outer edge of the opposite temporo-mandibular bone. The occipito-frontal diameter (OFD) was measured in the same plane between the leading edge of the frontal bone and the outer border of the occiput.

The cephalic index (CI) was calculated as the ratio of the same two diameters (BPD/OFD × 100). Based on CI value, the foetal heads were categorised as dolicocephalic, mesocephalic, brachycephalic and hyperbrachycephalic head with cephalic index value ≤74.9, 75 - 79.9, 80 - 84.9 and 85 - 89.9 respectively. Correlation between GA and OFD, GA and BPD as well as correlation between GA and cephalic index were calculated and assessed. A p- value <0.05 was considered significant.

RESULTS

Foetal head measurements were taken in 233 healthy pregnant women. Table - 1 depicts correlation of OFD, BPD and cephalic index with gestational age. The mean OFD ranged from 29.457 ± 6.408 mm at 12.1 - 16 weeks to 113.984 ± 4.258 mm at 36.1 - 40 weeks gestational age. There was gradual increase in OFD with increase in gestational age which was statistically significant (p value <0.0001). Similarly, we noted increasing trend in BPD from 24.662 ± 5.761 mm in 12.1 - 16 weeks to 92.934 ± 2.484 mm at 36.1 – 40 weeks

Gestational Age (Weeks)	**Number (n=233) (%=100)**	**Average Gestational Age (Week) (Mean ± S.D.)**	**OFD (mm) (Mean ± S.D.)**	**BPD (mm) (Mean ± S.D.)**	**Cephalic Index (Mean ± S.D.)**
12.1 - 16	21 (9.01%)	13.690 ± 1.238	29.457 ± 6.408	24.662 ± 5.761	83.457 ± 3.453
16.1 - 20	25 (10.73%)	17.748 ± 1.150	49.196 ± 4.736	40.568 ± 4.665	82.196 ± 2.974
20.1 - 24	26 (11.16%)	21.507 ± 1.035	66.173 ± 4.966	51.988 ± 3.464	78.961 ± 4.494
24 .1- 28	26 (11.16%)	25.819 ± 1.273	82.408 ± 5.891	66.111 ± 4.268	80.276 ± 2.803
28.1 - 32	29 (12.45)	30.586 ± 0.944	98.734 ± 8.267	76.727 ± 6.835	76.658 ± 10.380
32.1 - 36	74 (31.76%)	34.151 ± 0.939	107.456 ± 3.122	86.763 ± 3.175	80.705 ± 2.889
36.1 - 40	32 (13.73)	37.071 ± 0.845	113.984 ± 4.258	92.934 ± 2.484	81.284 ± 2.193
r			0.9857	0.9886	-0.1022
t-value			88.904	99.793	-1.5614
p-value			0.0000	0.0000	0.1197
OFD: Occipitofrontal diameter, BPD: Biparietal diameter, S.D.: Standard deviation					

Table-1: Correlation of OFD, BPD and Cephalic Index with gestational age of gestational age. This increase in BPD was also statistically significant (p value < 0.0001) when correlated with gestational age. It is obvious from the table - 1 that values of OFD and BPD are minimum at 13th week and maximum at full term and thus, correlating well with the advancement of gestational age.

We noted maximum value of cephalic index 83.457 ± 3.453 during 12.1 - 16 weeks gestational age followed by 82.196 ± 2.974 during 16.1 - 20 weeks. Gestational age 28.1 - 32 weeks recorded the minimum CI value of 76.658 ± 10.380 whereas during 36.1 - 40 weeks the value recorded was 81.284 ± 2.193 only.

This denoted that during 12.1 - 20 weeks and 32.1 - 40 weeks gestational age, the foetuses had brachycephalic heads whereas during 20.1 - 24 weeks and 28.1 - 32 weeks they had mesochephalic heads. Thus, majority of the foetuses among the study population represented with brachycephalic head. However, we could not observe any statistical correlation of cephalic index with gestational age. A comparison of BPD with earlier studies was also done (Table - 2) and we also noted increase in BPD with advancement of pregnancy from second trimester to full term as noted in earlier studies.

DISCUSSION

It has been shown clearly and repeatedly that genetic variation within a population is greater than that between populations and that there is no genetic basis to divide humans into discrete separate race groups.[8,9] However, Williams et al (1995)[10] recorded a racial variation in the cranium. Okupe (1984)[2] reported higher foetal BPD in Nigerian women than those of Europeans, with weekly increase from second trimester up to full term. The statistical analysis with student's t - test showed significant difference near term. Dubowitz and Goldberg (1981)[11] conducted study over foetuses of Caucasian, Negro, Indian and mixed origin but did not find any significant differences except after 30 weeks of gestational age. Parker et al (1982)[12] noted no significant difference between Asian and European foetues in their study. Campbell (1969)[13], Dewhurst et al (1971)[14], Varma (1973)[15], Sabbagha et al (1974)[16], Ott (1985)[17] and Tuli et al (1995)[3] observed close correlation between BPD and foetal age. As per their observations, the foetal head growth was almost linear until approximately the 30th week of gestation after which the co-ordinates showed a flattening pattern.

In the present study, majority of the foetuses among the study population represented with brachycephalic head that too during early second trimester and late third trimester of gestation. Although during 20th to 30th week of gestation the foetal head happened to be mesocephalic. We could not observe any statistical correlation of cephalic index with gestational age. Our observation was well supported by Jeanty et al (1984)[6] who also found the cephalic index age independent. A constant cephalic index of 78.3 ± 4.4 from 14 – 40 weeks was also observed by Hadlock et al (1981)[18] with no significant change as the fetal age increases. Tuli et al (1995)[3] also noted a constant value of 76.4 ± 5.1 from 12 - 40 weeks.

In contrast to our finding, Gray et al (1989)[5] and Rajlakshmi et al (2001)[19] observed a change in cephalic index with increasing age of fetus, and reported a wide normal range for cephalic index. Mador et al (2010)[20] also in their study concluded that the cephalic index of fetuses of Nigerian women changed from mesocephalic type at 12 weeks of gestation to brachycephalic type at term.

A comparison of BPD (in mm) reported by various workers is given in Table - 2. Hern (1984)[21] reported slower growth rate up to 28 weeks. Campbell (1969)[13], Varma (1973)[15] and Tuli et al (1995)[3] reported higher growth rates up to 30th week and slower growth rates from 30th to 40th week of gestation. Rajlakshmi et al

Week of gestation	Hern 1984	Campbell 1985	Tuli et al 1995	Rajan 1996	Rajlakshmi et al 2001	Present Study 2015
12.1 - 16	26.6	27.4	18	30	28.1	24.66
16.1 - 20	42.5	43.6	26	41	39.5	40.57
20.1 - 24	54.0	56.3	31	52	46.8	51.99
24.1 - 28	60.5	69.2	46	65	59.5	66.11
28.1 - 32	-	81.7	53	75	70.0	76.73
32.1 - 36	-	89.7	63	82	80.0	86.77
36.1 - 40	-	94.7	63	87	87.8	92.93

BPD: Bi-parietal diameter

Table-2: A comparison of BPD (mm) with earlier studies

(2001)[19] also observed highest growth rate during 24 - 28 weeks and slowest during 28 - 32 weeks of gestation. In the present study, we also noted almost similar pattern of growth rate.

Cephalic index was first developed in the 1840s by Anders Retzius as one of the most influential craniometric techniques. Soon after its development, the cephalic index gained popularity in Europe and the United States as a way to classify individuals into races based on similar measurements. As a measure of racial differences, however, the cephalic index proved problematic. In 1911, German-born American anthropologist Franz Boas showed that skull shape was significantly influenced by the environment (the basis for this influence remains unknown), undermining the use of the cephalic index as a racial marker. Nonetheless, scientists continued to use this and other anthropometric measurements as bases for racial classification, age determination and identification well into the mid-20th and 21st century.[20]

CONCLUSION

In our region, this is the first time, cephalic index is determined in foetuses and brachycephalic head has been found to be prevalent among the population, though it has been gestational age independent. Moreover, the sample size of our study is small and the result may not be applicable to the population at large, therefore further study with larger sample size is recommended.

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