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Original Article

Ultrasonographic Comparative Study of Head Circumference In Fetuses of North Indian Women

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ABSTRACT

Accurate pregnancy dating is important to establish gestational age for evaluation of fetal growth and prediction of the date of delivery. Ultrasonographic fetal biometry is the most widespread method used to establish gestational age, estimate fetal size and monitor its growth.

Head Circumference measurement is performed routinely during the prenatal ultrasound screening in the pregnancy. Early ultrasound assessment, preferably between 10 and 12 weeks, provides a better prediction of gestational age.

To offset difference in growth of these ultrasonographic parameters in different populations, it is important to construct and use ultrasonic fetal biometric parameter specific to the population and ethnic groups. To construct reference ranges of head circumference of north india, baseline data for head circumference measurements in millimetre, with real-time transabdominal ultrasonograms were taken in 1405 general obstetric population of north india and cross sectional study was performed. A cross-sectional view of the fetal head at the level of the ventricles should be obtained.

For each Gestational Age, all Head Circumference measurements, mean Head Circumference and Standard Deviation were tabulated using Microsoft Excel data functions. To draw more informative conclusions from this study, comparison and analysis of variation of mean HC between 2 groups were performed by using **Unpaired t-test.**

On comparing the result of this study with other studies, we found there was significant difference found in some weeks of second trimester & some weeks in earlier part of third trimester. So, this study supports the idea that there is an ethnic and racial variation in different populations for biometric measurements and emphasizes the need for a locally generated fetal growth reference, along with prospective data on obstetric and perinatal outcomes, to enable the development of better clinical guidelines.

Keywords*: Head Circumference, Gestational Age, Standard Deviation, fetal biometry.*

INTRODUCTION

The assessment of gestational age is paramount in obstetric care. The practice of assessing gestational age in early gestation is valuable in detection of growth aberration in later stages of pregnancy.

In the past prediction of gestational age was based on menstrual history, assessment of uterine size by bi-manual examination in the first trimester and uterine fundal height measurement. However it has been reported that, even in best known cases, the menstrual history and fundal height measurement techniques are also fraught with error. Timed ovulation and in vitro fertilization with known date of conception are expected to estimate the gestational age accurately.

However in most pregnancies the date of ovulation or conception cannot be as accurately predicted as outlined by other methods and hence gestational age must be estimated by other methods.

There is a tremendous progress in application of ultrasound as a diagnostic modality revolutionizing the management towards better antenatal care has been seen. Ultrasound has the broadest diagnostic spectrum, as there is no other modality that can detect as many fetal abnormalities throughout the pregnancy as ultrasound.

Fetal biometry (Measurement of various fetal body parts) is of great interest in obstetrical practice[1]. It is helpful in the estimation of gestational age especially in the women who do not remember the dates of their last menstrual period or whose fundal height on abdominal examination does not correspond to dates. Biometric data provide a tool for checking the progress of pregnancy with regard to gestation age by comparing it with reference charts.

Prenatal measurements of fetal parameters and estimated size and weights vary among different populations, depending upon their racial, demographic characteristics and nutrition. It is therefore important that fetal biometry be performed for local population and local charts of normal biometry be constructed for these populations and ethnic groups.

Ultrasonic measurement of BPD (biparietal diameter) is commonly used to assess fetal age and growth. But it gives misleading conclusions due to differing craniofacial dimensions arising out of ethnic diversity. Therefore for the fetuses with a dolicocephalic head shape, the head circumference will be within expected limits, but the BPD recorded will be smaller than the normal value for a given GA. The head circumference is estimated with the help of both biparietal diameter and occipitofrontal diameter, so head circumference measurement give more correct result than measuring biparietal diameter alone.
Here, in this study we are trying to establish growth charts for fetal head circumference for the North Indian population and its correlation with the available references.

MATERIALAND METHOD
This was a cross-sectional study conducted in the Department of Anatomy, in collaboration with Department of Obstetrics and Gynaecology and Department of Radiology of M. L. N. Medical College, Allahabad.

Our study group consisted of 1405 pregnant women from north India, who were under follow up at Department of Obstetrics and Gynaecology and underwent their routine antenatal sonographic assessment in the department of Radiology.

All the women whether primigravida or multigravida were included in this study primarily pregnant women those were certain about their LMP devoid from any chronic illness and resident of urban or rural region of Allahabad or North Indian ancestry (both the father and mother) except for those under following exclusion criteria: Uncertain date of last menstrual period, History of irregular menses, History of prolonged substance abuse (alcohol, smoking etc), Multiple pregnancies, Fetal malformations (e.g. IUGR), Chronic maternal disease (e.g. diabetes mellitus, hypertension) or medication that could affect the growth of the fetus, Uterine anomaly or large fibroids, Intrauterine dead fetus (IUD).

Data Acquisition:
For fetal biometric measurements, real-time transabdominal ultrasonograms were taken using “Siemens G- 50” and “GE Logiq 400 pro” ultrasound machines equipped with 3.5-MHz curvilinear transabdominal probes. The measurements were taken to the nearest millimetre. Head circumference measurements are reliable from 11 weeks gestation.The imaging plane required for the head measurements is usually easily obtained up to 30 weeks gestation. In the late third trimester, satisfactory images may not be achieved due to the fetus being too deeply engaged.

BPD and OFD are measured on a transverse axial section of the fetal head which includes the falx cerebri anteriorly and posteriorly, the cavum septum pellucidum anteriorly in the midline, the thalami and the choroid plexus in the antrum of each lateral ventricle. In this study head circumference was calculated with *two distance method* from outer edge to outer edge analogs of BPD and OFD is measured perpendicular to the BPD, mid skull to mid skull. The results of the measurements were stored electronically and resultant of head circumference calculated independently using the formula already installed in machine.

Statistical Analysis
Only fetuses for which all measurements were available were included in the statistical analysis. For gestational age, fractions of weeks were computed to the nearest week by calculating the contribution each day in proportion of making week, with fractions of <4 days and ≥4 days being assigned to the lower and higher weeks, respectively. For each GA, all HC measurements, mean HC and SD were tabulated using Microsoft Excel data functions. Standard deviation measures the variability about the mean of a data set. A confidence interval of 95% was used that interval equates to **(mean)** +/-

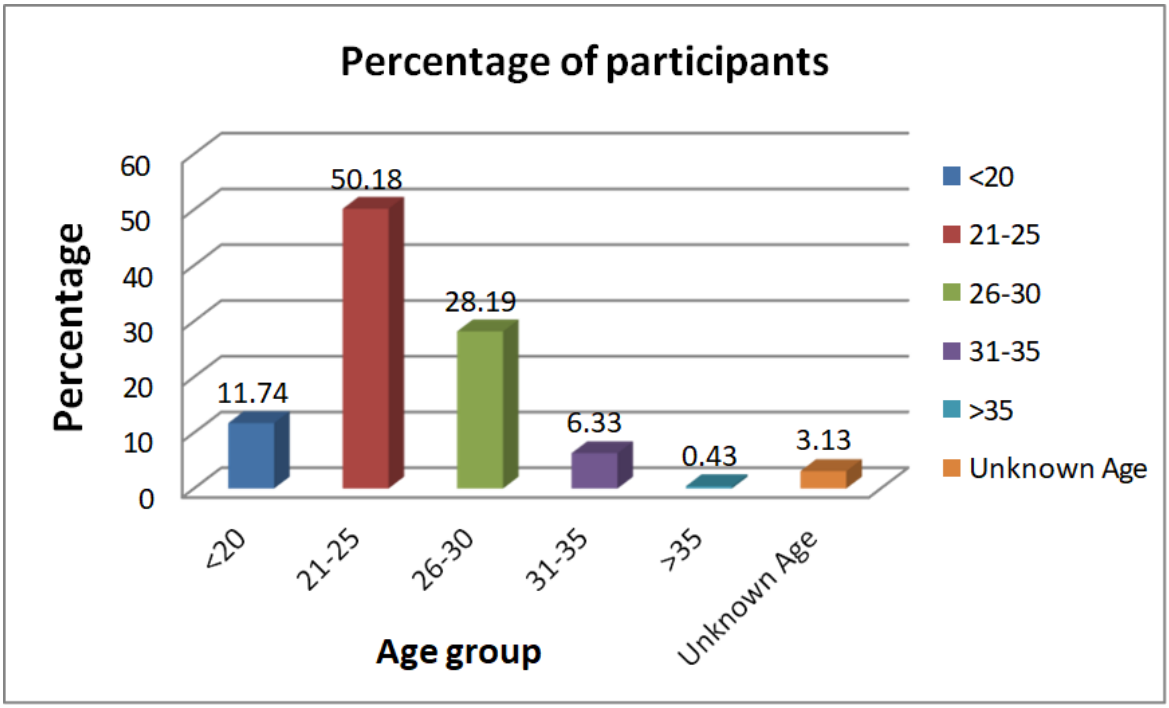
(2×SD), 95% of sample means present within this range. Then standard error was calculated as:
SE= SD/√n

The mean values of various previous studies were compared with mean values (including +/- SE) of our study. To draw more informative conclusions from this study, comparison and analysis of variation of mean HC between 2 groups were performed by using **Unpaired t-test** which was done by calculating differences of means (X_1-X_2), estimated standard error (SE), degree of freedom (df) and t-value (t_{cal}). Values of *P* for each companion were derived from *"t – table"* with their respective degree of freedom and differences were accepted as *statistically significant at a P- value <0.05.*
Data were entered and analysed using SPSS software, regression analysis was then applied to the raw point-to-point data to produce an analytic description. A regression analysis was examining linear (HC = a + b × GA), square (HC= a + b × GA + c × GA^2) and cubic (HC = a + b × GA + c × GA^2 + d × GA^3) models for the association with gestational age.

Among linear, square and cubic regression models best fitted model to estimate the relationship between fetal head circumference (in millimetres) and gestational age (in weeks) were selected. A value of $P < 0.05$ and $R^2 > 0.99$ was considered statistically significant.

OBSERVATION
This study was done to establish normal ultrasonic fetal head circumference measurement charts based on ultrasonic measurements of head circumference of North Indian pregnant women fetuses between 10 and 42 weeks' gestation. Among 1537 pregnant women scanned, a total of 132 women were excluded as they were not fitted in the inclusion criteria.

The cross sectional data was recorded from 1405 pregnant women ranged from 18 to 36 years with a mean of 24.87 years and age of 44 subjects (3.1%) were not record.



The percentage of females belonging to both urban area (52.7%) and rural area (45.9%) was almost equivalent. Majority of females were literate(64.3%) and few were illiterate(22.4%).The most common presentation of fetuses found during ultrasonographic measurements, was cephalic (71%) and mostly females were multipara (63.8%).

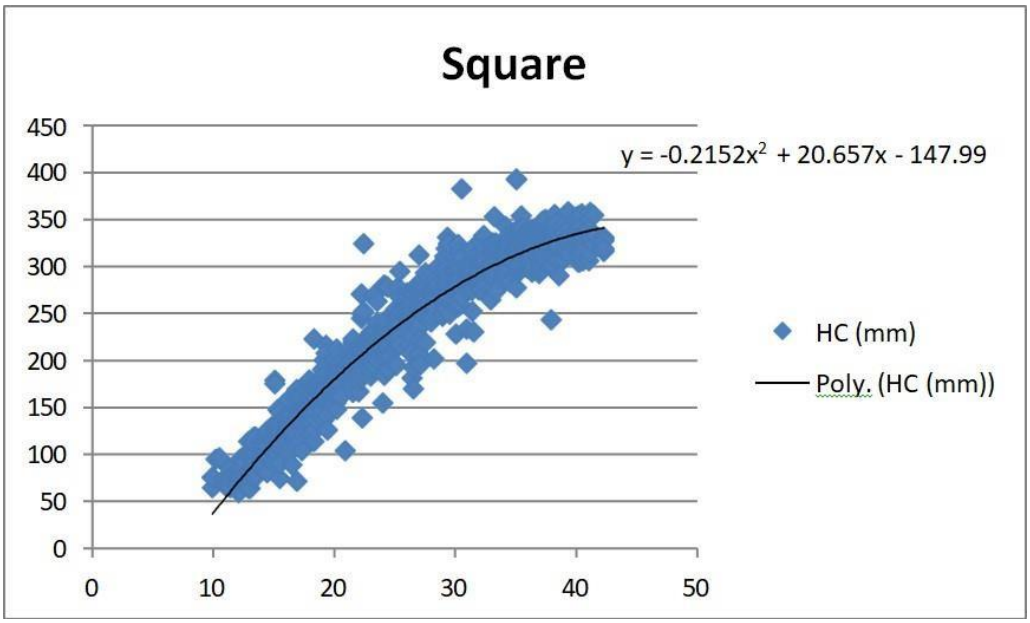
The collection of measurements is called raw data (head circumference), which is entered into a software program MS-Excel Sheet to enable graphs to be produced. Mean and standard deviation values of the head circumference are computed. The 95% range for our sample means was obtained by **"mean +/- t.SE_{est}"** and compared with previously published reference nomograms as follows:

To draw more informative conclusions from this study, comparison and analysis of variation between 2 groups were performed by using *Unpaired t-test.*

Data was entered and analysed using SPSS software. Regression analysis is then applied to the raw point-to-point data to produce an analytic description.

Considering the findings of R^2, we can appreciate the *Square Regression*** *Equation* as the best for this study, *Cubic Regression Equation**** can also be used but no appreciable increase in R^2 value so according to least squares criteria *Square Regression Equation is best fitted model.*

Square regression equation:
HC** = -147.997+ 20.6569 × GA – 0.215227 × GA^2 (r^2= 95.11)



DISCUSSION
Real-time ultrasonography is necessary to confirm the presence of fetal life through observation of cardiac activity and active movement.

The assessment of gestational age is fundamental to obstetric care and should be a carefully thought-out process. Assessment should depend on history and physical examination, as well as ultrasound evaluation[7].

Hadlock[3] (1982) discussed the use of the head circumference measurement in predicting menstrual age, estimating fetal weight, and in detecting intrauterine growth retardation. They predicted menstrual age values (± 2 SD) associated with a given head circumference measurement and presented them in tabular form.

The difference of north Indian mean HC measurements for each gestational age was compared with mean HC from that of **Hadlock et al[3]**, no appreciable difference could be found up to 15-32 weeks. After 32 weeks this average difference of mean HC comes out [+1.6] which continuously increases [+13.5] to [+26] from 37-40 weeks onward.

On comparing values of north Indian mean HC with that of **Brons et al[2]** study **(TABLE 9)**, we found average difference of mean HC is less [-] initially. There is uniform increase in average difference of mean HC of Brons et al study [+] 6.1 in 37-38 weeks to [+] 11.5 from 39 weeks and thereafter.

Same results is found with HC table of **Krampl et al[4]** but consistent and significant differences in mean HC measurements could be observed with table of **Loughana et al[6]**, initially [+] 1.3 mm in 16-18 weeks. Then, in 24-25 weeks average difference in mean HC increases [+] 3mm and then consistent rise in average differences in mean HC up to end of gestation.

The average difference in mean HC with **Snijder & Nicolaides[10]** study consistently increases throughout the observation [+] 5.56 mm to [+] 9.2 mm.

To draw more informative conclusions from this study, comparison and analysis of variation of mean HC between 2

groups were performed by using **unpaired t-test.**

While on performing the *t-test* with Hadlock et al[3], there is no significant difference in *P-value* throughout gestation only significant difference found during last week's from 38 week onward. So, there is no significant difference between the two means**.**

On comparing result of *t-test* with those of studies carried by Shahida Zaidi et al[11] (Pakistan), Piyamas et al[9] (Thailand) & Kurmanavicius et al[5] (Zurich) shows there is significant difference found in almost one-third to one-fourth *P-values* particularly, in some weeks of second trimester & in some weeks in earlier part of third trimester [25-29 week & 32-33 week]. This difference increases near the term. It is generally thought that the small size of Indian neonates at birth is attributable to small maternal size, an inadequate nutrient supply during late pregnancy (due to maternal undernutrition and/or placental insufficiency)[8], or both; but that early fetal growth, when nutrient requirements are very small and there are no constraints on space for growth, is similar to that of other populations. This suggests that any interventions to increase fetal growth in North Indian mixed populations would need to occur before conception or during early pregnancy also along with mid or late pregnancy.

This study supports the idea that there is an ethnic and racial variation in different populations for biometric measurements and emphasize, the need for a locally generated fetal growth reference, along with prospective data on obstetric and perinatal outcomes, to enable the development of better clinical guidelines.

CONCLUSION

Accurate pregnancy dating is important to establish gestational age for evaluation of fetal growth and prediction of the date of delivery. Ultrasonographic fetal biometry is the most widespread method used to establish gestational age, estimate fetal size and monitor its growth.

Head Circumference measurement is performed routinely during the prenatal ultrasound screening in the pregnancy. Early ultrasound assessment, preferably between 10 and 12 weeks, provides a better prediction of gestational age.

To offset difference in growth of these ultrasonographic parameters in different populations, it is important to construct and use ultrasonic fetal biometric parameter specific to the population and ethnic groups. To construct reference ranges of head circumference of north India baseline data for head circumference measurements were collected from 1405 general obstetric population of north India and cross sectional study was performed.

On comparing the result of this study with those of carried by Shahida Zaidi et al[11](Pakistan), Piyamas et al[9] (Thailand) Kurmanavicius et al (Zurich)[5] & even with western countries Snijder & Nicolaides[8] (UK) shows there was significant difference found in some weeks of second trimester & some weeks in earlier part of third trimester. This difference increases near term.

It is generally thought that the small size of Indian neonates at birth is attributable to small maternal size or due to an inadequate nutrient supply during late pregnancy.

On applying regression analysis, we found square regression correlation is there between HC & GA and best fitted formula for calculating HC from GA for north Indian population is as follows:

$$\mathbf{HC^{**} = -147.997 + 20.6569 \times GA - 0.215227 \times GA^2 \ (r^2 = 95.11)}$$

This study provides reference charts for ultrasound dating of pregnancy based on head circumference for north Indian population from 14 weeks of gestation onwards for head circumference.

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