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ORIGINAL ARTICLE

Ultrasound Assessment of Gestational Age Using Fetal Binocular Distance in Uncomplicated Pregnancies, Correlating with Standard Fetal Biometry Parameters at a Tertiary Care Hospital in Nepal

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ABSTRACT

Background: Fetal biometry, typically using parameters like biparietal diameter (BPD), Head circumference (HC), abdominal circumference (AC), and Femur length (FL), estimate gestational age. Recent literature highlights the utility of orbital dimensions, particularly fetal binocular distance (FBD) for precise fetal gestational age estimation (FGAE). Due to a lack of published data on FBD in Nepal, this study aimed to fill this gap by assessing GA using FBD from 18th week in healthy women with uncomplicated pregnancies.

Methods: Obstetric USG was performed in 288 women with uncomplicated pregnancy to evaluate the efficacy of FBD as a measure to calculate the predicted GA. GA ranged from 18 weeks to term. Only patients with known clinical GA, previous history of normal menstrual cycle, and who fit the inclusion criteria were included in the study.

Results: The correlation between FBD in mm and gestational age (GA)in weeks was analyzed. The correlation was highly significant ($r=0.987$, $p<0.001$), assisting in compiling a nomogram of FBD and GA for Nepalese women. A highly significant correlation was also found between the FBD and other parameters as well.

Conclusion: Fetal binocular distance correlates linearly with clinical gestational age and positively with other standard fetal biometry parameters such as biparietal diameter, head circumference, abdominal circumference, and femur length. Thus, fetal binocular distance proves to be a reliable parameter for determining gestational age.

Keywords: Gestational age, Fetal Binocular distance (FBD), Ultrasonography (USG)

INTRODUCTION

Routine obstetric ultrasound (USG) has become a crucial tool in prenatal care, improving outcomes worldwide. Accuracy in determining fetal gestational age (FGA) and expected delivery date (EDD) is essential in treatment plans, especially in high-risk pregnancies.

Inaccuracy of GA has significant adverse effects on prenatal and postnatal outcomes.

Before USG integration, pregnancy dating relied on clinical parameters like Nagele's rule, McDonald's method, and X-ray estimation. However, these parameters have high variability.

USG biometric measurements determine GA based on the concept that the size of the fetus is consistent with its age. First trimester is more accurate due to less biological variation in size. [1] However, diagnostic accuracy is greater in the mid-second trimester due to the larger size and more advanced development of the fetus. Accurate GA is important for anticipating normal

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spontaneous delivery, evaluating fetal growth, scheduling invasive procedures, and influencing management decisions if the fetus is diagnosed with anomalies. Therefore, routine obstetric USG is a vital component in antenatal care (ANC).

USG-derived dates are the best method for determining GA in clinical practice, with advancements in diagnostic USG over the past three decades. This is due to its non-invasive, non-ionizing nature, cost-effectiveness, and exemplary safety record.[2]

USG has not caused abnormalities in the fetus, has no reported risks of ionizing radiations, and is not interventional. It has not been associated with significant harm to early fetal life, growth, hearing, vision, or neurological development.[3]

USG alone is more accurate than last menstrual period (LMP) or other clinical parameters for determining GA in the first (0 to 12+6d weeks), and second trimesters (13-28) in spontaneous conceptions and is the best method for estimating EDD.

In the first trimester gestational age estimation (GAE) is made by using parameters like Gestational sac diameter (GSD) and Crown-rump length (CRL), CRL being the most reliable. In the second and third trimesters (13 to ≥40 weeks), a combination of biometric indices, BPD, FL, HC and AC, used for dating due to increased reliability, especially in cases where one parameter may be affected by a condition like achondroplasia on FL. Other indices like trans-cerebellar diameter (TCD), foot length, clavicle length, kidney length, sacral length, and other long extremity bones have also been evaluated. Accurate determination of GA age in late second or third trimesters remains a challenge, especially for women who are uncertain of their LMP date.

and attend ANC late POG.

Using all the above parameters this variability can be reduced by 25 to 30%.[4] In conditions such as Oligohydramnios, multiple gestation, breech presentation, and intrauterine growth restriction (IUGR), fetal skull shape can be altered, affecting BPD prone increasing variability. Multiple gestations and IUGR can also impact abdominal and femoral measurements.[5]

While standard measurements for fetal gestational age estimation (FGAE) are well-documented, there is limited research on FBD. This study aimed to validate FBD as an additional morphological measurement for fetal growth in the Nepalese population, particularly after 18 weeks of gestation when assessing parameters like BPD and Head circumference (HC) becomes challenging.

The study is the first of its kind in Nepal, providing insights into variations in the population across different GA groups and establishing a FBD nomogram for Nepalese fetuses. This baseline metric measurement not only aids in accurate FGAE for the specific racial phenotype but also helps identify orbit anomalies and supports forensic anthropology.

The study aims to determine GA in uncomplicated pregnancies in a Nepalese tertiary care hospital by estimating using GA, ultrasonographically measured FBD after the 18th week. It also establishes correlations between FBD and GA, clinically determined from the 18th week to term using standard fetal biometrics (SFB).

METHODS

This was a prospective, observational analytical study carried out in the Department of Radiology and Imaging in TUTH, IOM. The study was carried out from October 2020 to October 2021.

Probability sampling was used for data collection. Islam et al concluded that there was a highly significant correlation between FBD in cm and gestational age (GA) in weeks, as r = 0.973(10).

A sample size of 288 was calculated using the sensitivity formula with a confidence level of 95%, a level of significance of 5%, and a reasonable estimate of key proportions to be measured in the study was 5%.

Inclusion and Exclusion Criteria

Healthy women with uncomplicated pregnancy between the 18th week of gestation and term were included in the study. Exclusion criteria encompass individuals with unknown or inaccurately reported dates of the last menstrual period, those lacking a first-trimester scan leading to uncertain gestational age, cases involving multiple gestations, fetal malformations, and chromosomal abnormalities. Additionally, pregnancies affected by conditions such as maternal diabetes, autoimmune disorders, pre-eclampsia, oligohydramnios, placental insufficiency, and intrauterine growth restriction (defined as fetal weight below the 10th percentile for gestational age) are excluded from the analysis.

Informed written consent was taken from the patients after explaining about the study. No extra cost was charged to the patients for the study. The study was conducted after ethical clearance from the Institutional Review Board, Institute of Medicine, Tribhuvan University. Participants were selected as per the inclusion and exclusion criteria set. All the relevant data was recorded in predestinated Performa.

All relevant clinical history was obtained and the correct LMP was confirmed. USG was performed with the patient in the supine position. Good acoustic coupling was obtained using synthetic USG gel.

Obstetric USG scans were performed using a Samsung Accuvix A30 USG scanner using a 3.5 MHz convex probe. Images were recorded in the films using the mobile phone camera. In all the patients, the following parameters were obtained. They are BPD, HC, AC, FL, FBD, fetal heart rate (FHR), estimated fetal weight, amniotic fluid index (AFI), and placental position.

The plane used for measuring BPD and HC was sectioned through the third ventricle and thalamus. Cavum septi pellucidi should be visible in the anterior portion of the brain and the tentorial hiatus in the posterior portion of the brain. The cursors were positioned

on the outer edge of the near calvarial wall to the inner edge of the far calvarial wall for BPD. For HC the cursors were positioned on the outer edge of the near calvarial wall and the outer edge of the far calvarial wall.

AC was taken outer margin to the outer margin in the plane showing the umbilical vein perpendicular to the fetal spine and the stomach bubble.

The FL was obtained by aligning the transducer to the long axis of the diaphysis. Measurement cursors were placed at the junction of the cartilaginous epiphysis and bone.

FBD was identified in the occipital-transverse or occipital-posterior foetal positions. With the head in the occipital-transverse position, the transducer can be placed in two possible planes. That is, along the coronal plane approximately 2cm posterior to the glabella-alveolar line, or along the orbit-meatal line approximately 2-3cm caudal to the level of biparietal diameter. In both of these views, the midline, nasal processes, orbital rings, and portions of the maxillae can be demonstrated. In the occipital-posterior position, the transducer was placed in a plane that transected the occiput, orbits, and nasal processes. The correct plane was identified when the two orbits had the same diameter, with the symmetric image at the level of the largest diameter of the orbits (Figure 1A and B). Measurements were obtained only when the foetal face was directly perpendicular to the uterine wall since measurements in an oblique plane were considered to be unreliable.[6]

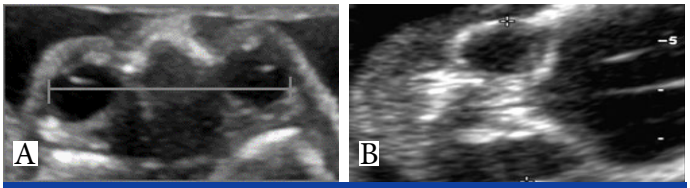

Fig 1: Grey Scale USG image showing the Axial (A) and Coronal (B) images with measurement of FBD.

Statistical Analysis: Data were collected in predesigned proforma and entered in Statistical Package of Social Services (SPSS) IBM version 23. The discrete data were represented in frequency (%) categorical data were represented in Mean ± SD and analytical statistics were performed using the independent sample "t" test. Pearson chi-square test was used to test the association between the qualitative data. The p-value of <0.05 shows the statistical significance difference. Pearson's correlation coefficient was used to see the correlation between two continuous variables.

For predicting GA from a foetal binocular distance, a regression equation was used.

Regression equation

CGA = 1.291 + 0.598 FBD

R2 = 97.5 %

RESULTS

In this study, 288 patients referred for obstetric USG scans meeting our inclusion and exclusion criteria were included in the study. The age range of patients included in the study was between 20 to 39 years (mean 27.0 ± 3.8).

Based on the parity of the study most of them were primi (57.3%) while the multiparous female was about (42.7%)

This prospective study of 288 healthy women with uncomplicated pregnancy suggested a correlation between FGA and FBD. A linear relationship was found during the mid-second (18 to 27 weeks) and third (28 to term) trimesters between the FBD measured in mm and the GA age in weeks. The relationship was statistically significant (Figure 2).

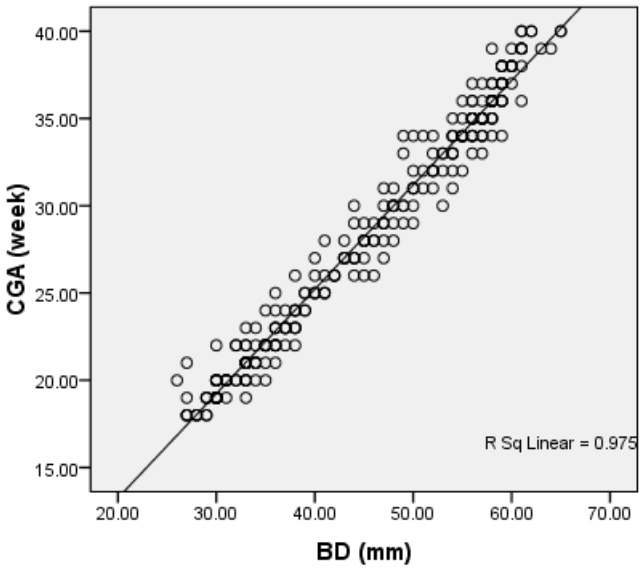

Fig 2: Correlation between the Binocular distance in mm and Calculated Gestational age in a week.

In the present study, FBD correlates well with GA with a correlation coefficient of 0.987 from the mid-second trimester to term. Overall, the FBD correlates with gestational age with the highest correlation coefficient of 0.987 as compared to other parameters (BPD= 0.983, HC= 0.980, AC= 0.976, FL= 0.977). A progressive increase from the second trimester towards term was noted (Table 1).

Table 1: Correlation study of Fetal Binocular distance with Various other parameters.

	correlation between BD and other parameters				
	CGA	BPD-GA	HC-GA	AC-GA	FL-GA
Pearson Correlation	0.987	0.983	0.98	0.976	0.977
Statistical Significance(p)	<0.001	<0.001	<0.001	<0.001	<0.001

Table 2: Nomogram of FBD in Nepalese population according to GA

	Calculated Gestational Age (week)					Predicted GA				
Binocular Distance(mm)	Mean	SD	5th	50th	95th	Mean	SD	5th	50th	95th
26	20	0	20	20	20	16.8	0.0	16.8	16.8	16.8
27	18.8	1.3	18	18	21	17.4	0.0	17.4	17.4	17.4
28	18	0	18	18	18	18.0	0.0	18.0	18.0	18.0
29	18.6	0.5	18	19	19	18.6	0.0	18.6	18.6	18.6
30	19.5	0.8	19	19	22	19.2	0.0	19.2	19.2	19.2
31	19.9	0.4	19	20	20	19.8	0.0	19.8	19.8	19.8
32	21	1.2	20	21	22	20.4	0.0	20.4	20.4	20.4
33	21.0	0.7	19.4	21	22.7	21.0	0.0	21.0	21.0	21.0
34	21.3	1.0	20	21	23	21.6	0.0	21.6	21.6	21.6
35	21.9	1.0	20	22	24	22.2	0.0	22.2	22.2	22.2
36	22.7	1.2	21	22.5	25	22.8	0.0	22.8	22.8	22.8
37	23.0	0.6	22	23	24	23.4	0.0	23.4	23.4	23.4
38	23.6	1.2	22	23.5	26	24.0	0.0	24.0	24.0	24.0
39	24.5	0.6	24	24.5	25	24.6	0.0	24.6	24.6	24.6
40	25.6	0.9	25	25	27	25.2	0.0	25.2	25.2	25.2
41	25.8	1.3	25	25	28	25.8	0.0	25.8	25.8	25.8
42	26	0	26	26	26	26.4	0.0	26.4	26.4	26.4
43	27.2	0.4	27	27	28	27.0	0.0	27.0	27.0	27.0
44	27.7	1.5	26	27	30	27.6	0.0	27.6	27.6	27.6
45	27.7	1.0	26	28	29	28.2	0.0	28.2	28.2	28.2
46	27.8	1.3	26	28	29	28.8	0.0	28.8	28.8	28.8
47	29.0	1.3	27	29	31	29.4	0.0	29.4	29.4	29.4
48	29.7	1.0	28	30	31	30.0	0.0	30.0	30.0	30.0
49	31.2	2.2	29	30	34	30.6	0.0	30.6	30.6	30.6
50	31.1	1.6	29	31	34	31.2	0.0	31.2	31.2	31.2
51	32.3	1.5	31	32	34	31.8	0.0	31.8	31.8	31.8
52	32.3	1.0	31	32	34	32.4	0.0	32.4	32.4	32.4
53	32.0	1.4	30	32.5	33	33.0	0.0	33.0	33.0	33.0
54	33.2	1.2	31	33	35	33.6	0.0	33.6	33.6	33.6
55	34.1	0.9	32	34	36	34.2	0.0	34.2	34.2	34.2
56	34.9	1.0	33	35	37	34.8	0.0	34.8	34.8	34.8
57	34.9	0.9	33	35	37	35.4	0.0	35.4	35.4	35.4
58	36.0	1.1	34	36	39	36.0	0.0	36.0	36.0	36.0
59	36.8	1.2	34	37	38	36.6	0.0	36.6	36.6	36.6
60	38.0	0.6	37	38	39	37.2	0.0	37.2	37.2	37.2
61	38.8	1.3	36	39	40	37.8	0.0	37.8	37.8	37.8
62	40	0	40	40	40	38.4	0.0	38.4	38.4	38.4
63	39	0	39	39	39	39.0	0.0	39.0	39.0	39.0
64	39	0	39	39	39	39.6	0.0	39.6	39.6	39.6
65	40	0	40	40	40	40.2	0.0	40.2	40.2	40.2

Table 2 shows calculated Nomogram - FBD in Nepalese population with 5th, 50th and 95th percentiles and predicted GA.

DISCUSSION

Diagnostic USG introduced by Ian Donald in the late 1950s, is a non-invasive and safe method for antepartum fetal surveillance. Stuart Campbell, in 1960, utilized USG for the first diagnosis of a congenital malformation of fetus (CMF) like anencephaly. While standard measurements such as BPD, FL and HC for FGAE are well-documented, FBD values have been comparatively underexplored. Studies indicate a linear relationship between FBD in millimeters and GA in weeks. This study aimed to establish reference ranges and identify potential variable differences in the Nepalese population was effective.

Predicted binocular values at various gestation were comparable to the results of other investigators.[7,9] The variability associated with the predicting GA from FBD in the second trimester was higher than that of the third trimester in the present study.

USG study on 120 normal fetuses from the 12th to 40th weeks of pregnancy, estimating GA using LMP and standard foetal biometry. The study found a strong correlation between foetal binocular distance measurement and GA, suggesting that these parameters are valuable in estimating gestational age when the last menstrual period date or fundal height does not align with dates. The mean foetal BD was found to be shorter when compared to our study.[6]

A conclusion derived that FBD is a reliable and sometimes the only available dimension in GA estimating, particularly in cases of congenital malformed feus (CMF) like hydrocephalus or skeletal dysplasia where standard measurements like BPD and FL are imprecise through a study including 177 fetuses, confirming a linear relationship between FBD and GA.[9]

A Thai study consisting of 555 fetuses (14th to 40th weeks), establishing an excellent correlation between FBD and GA. They created a Thai population FBD nomogram for GA estimation and screening orbital anomalies. Similar to our findings, a progressive increase in FBD was noted from the second trimester to term, aligning with Western studies. Racial factors minimally affected binocular growth, and no significant changes were observed compared to our study.[10]

Our study affirms a linear increase in mean FBD with GA, supporting the use of FBD as a crucial sonographic parameter for accurate FGA prediction. Combining FBD with other biometric parameters like BPD, HC, AC and FL improves GA estimation, although the optimal combination remains undetermined.

A single USG examination for determining GA is unreliable after 30 weeks. Therefore, FBD measurement, in combination with BPD, HC, FL, and AC, serves as an additional parameter for accurate estimation in the late trimester.

Our FBD charts, derived from cross-sectional data, are suitable for comparing FBD at a known GA but not for assessing orbital growth over time.

Obtaining FBD measurements can be prone to observer and technical errors, with uncertainties in endpoints and off-axis images of the orbits being major sources. Challenges arise with fetal position, especially in occiput-posterior presentations, making accurate distal orbital margin definition difficult due to acoustic shadowing from the nose. Maternal habitus and advanced fetal age are additional challenging factors. Although these potential errors were not specifically evaluated in this study, the measurements taken were reasonably accurate despite the mentioned pitfalls.

CONCLUSION

A strong correlation between fetal binocular distance and gestational age was derived offering a reliable estimate in pregnant women with unknown last menstrual period or discrepancies in fundal height thus suggesting binocular distance to be adopted as a standalone predictor advanced age) or seeking ANC at late gestation or CMF to provide valuable nomogram for the Nepalese population, aiding gestational age estimation, assessing fetal orbital architecture and abnormalities, particularly in diverse racial phenotypes.

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