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Research Article

Ultrasonographic estimation of fetal gestational age by bi-parietal diameter - A cross-sectional study in an urban area of Bangladesh

Authors
Dr Aysha Sultana[1], Dr M. Lutfor Rahman[2]
[1]M Phil Researcher, Bangladesh University of Professionals and Senior Lecturer,
Department of Medical Ultrasound, State University of Bangladesh
[2]Associate Professor, Institute of Statistical Research and Training, University of Dhaka

Abstract
Antenatal ultrasound scanning is widely used and accepted technique to monitor fetal well-being and growth. It also helps to estimate fetal gestational age (GA) and predict expected date of delivery (EDD). Accurate estimation of GA in pregnancy is an important component of the antenatal obstetrical care. This study intends to estimate GA in second and third trimesters with the help of ultrasonographic measurements of one of the essential fetal parameter namely, the bi-parietal diameter (BPD) in the population of Bangladesh living in Dhaka city. A total of 103 healthy pregnant females were investigated with the known last menstrual period. GA is determined by measurement of fetal BPD with real time ultrasonography using Hadlock method[1-2]. There is linear relationship between GA and BPD and therefore, linear models for GA by last menstrual period (LMP) and GA by ultrasonographic measurements have been fitted by taking BPD as sole explanatory variable. Apparently, there was no violation of model assumptions during the linear model fitting process.

Keywords: *Antenatal, Ultrasonography, Bi-parietal diameter (BPD), Gestational Age (GA), Expected date of delivery (EDD).*

Introduction

Antenatal ultrasound examination is a key component of healthy pregnancy. To encompass a healthy baby appropriate antenatal care is indispensable. Accurate knowledge of fetal GA depends on clinical dating from LMP and assessment of fundal height of the pregnant mother and most importantly ultrasound examination. Antenatal ultrasound has established to be an important and precise technique for determining GA of the fetus[3]. Ultrasound provides a significant component in both normal and abnormal fetal growth. The ultrasonographic evaluation of fetus that is pregnancy profile provides information about fetal growth and well being, more precise estimation of GA, estimation of fetal weight and expected date of delivery. In addition, fetal biometry distinguishes the normal from abnormal fetal structures. It is particularly useful in the estimation of GA in the women who do not remember the dates of their LMP or whose fundal height on abdominal examination does not corresponds to dates. The practice of assessing gestational age in early gestation is essential in

detection of growth abnormality in later stages of pregnancy.

Conventionally, fetal BPD and femoral length is used for ultrasound based GA and EDD. There are a number of fetal biometric parameters to establish GA sonographically[4]. One of the most commonly used fetal parameter is BPD which is most accurate in determining the age of the fetus from 13 weeks to 18 weeks[3,5]. However, most commonly used fetal parameters to establish GA is crown-rump length in early pregnancy i.e. in first trimester pregnancy. In second and third trimester fetal BPD, head circumference and femur length for determining GA of the fetus and abdominal circumference used for estimating fetal weight. Some authors feel that BPD as a single parameter is better in the second trimester for estimating GA and it becomes less accurate with increasing gestational age. Antenatal assessment of fetal parameters may possibly vary among different inhabitants depending upon the demographic and racial characteristics. Therefore, biometric parameters or percentiles of one group of population may under or over estimate the gestational age of fetus if used for different group of population. This study has undertaken to evaluate GA with measurement of BPD by ultrasonography in the population of Dhaka city and to compare these values with western normograms[6-8] and other Indian sub continental studies[9-13].

Materials and Methods

This is a cross sectional and prospective study to evaluate GA of the fetus with the help of BPD by ultrasonography in the population of Dhaka city, Bangladesh. This study has been conducted in Ad-din Medical College & Hospital and attached group of Ibne-Sina Diagnostic Centre in Dhaka. In the study participants have been considered from all over the country as they appeared from different parts of the country to the capital city of Dhaka to settle, work or just came for health check-up. The study has been carried out to measure BPD of the fetus in a total of 103 gravid females by using a grey scale real time Sonography Machine employing a 3.5 MHz convex transducer (Toshiba color Doppler Nemio XG and GE Voluson 730 pro). From 12th week onwards, the bi-parietal diameter is considered to be more accurate. It measures the maximum distance between the two parietal bones taken from the leading edge of the skull to the leading edge i.e. outer to inner. It can also be measured from outer to outer table of the skull. This axial plane passes through the widest portion of skull where the continuous midline echo of falxcerebri is broken by cavum septum pellucidum with both the thalami enclosing the slit like opening of the 3rd ventricle of brain. Figures 1-3 show some pictures of BPD measured through these techniques. Other materials used were aqua saline jelly, single coated sonographic films. Healthy females with a singleton pregnancy with known LMP and regular menstrual cycles (28–30 days), women who did not develop maternal or fetal complications during pregnancies and had normal blood pressure were included in the study. In addition, the patients who had multiple gestation, maternal complications such as diabetes, hypertension, pre-eclampsia, pregnancy-induced hypertension, fetal complications such as sonog-raphic evidence of major fetal malformations, oligohydramnios or polyhydranmnios have been excluded from this study.

Descriptive statistics have been presented for gestational age by LMP and USG corresponding to BPD ranging 20-100. GALMP and GAUSG have been regressed linearly on BPD using statistical software Minitab 17.

Figure 1: Bi-parietal diameter 5.02 cm at 21 week and 2 day of gestation

Figure 2: Bi-parietal diameter 5.70 cm at 23 week and 3-day of gestation

Figure 3: Bi-parietal diameter 7.14 cm at 28 week and 5 day gestation

Results

Table 1 shows the observed BPD and corresponding gestational ages under USG and LMP. The table has been constructed by grouping BPD taking interval of 5 and summary statistics of GA have been computed against each group of BPD. Usually GA and BPD increase simultaneously with the advancement of pregnancy. In the simplest case, practitioners can find average, median, minimum and maximum values of GA for a given range of BPD whenever a point estimate of BPD is available from ultrasound measurement. For example, if a clinician has a point estimate of BPD as 57, then corresponding average, median, minimum and maximum values of GA by LMP would be 23.37, 23.30, 22.20, and 24.00 weeks respectively and GA by USG would be 23.32, 23.35, 22.30 and 24.30 weeks respectively. However, more precise estimate of GA would be found through linear modeling approach shown in Table 2.

Table 1: Observed BPD and gestational ages in weeks (total cases 103)

BPD (mm)	Number of cases	Gestational age by LMP (weeks)				Gestational age by USG (weeks)			
		Mean	Median	Min	Max	Mean	Median	Min	Max
20.0-25.0	1	14.50	14.50	14.50	14.50	13.5	13.5	13.5	13.5
35.1-40.0	2	18.50	18.50	18.40	18.60	17.35	17.35	17.30	17.40
40.1-45.0	3	18.40	18.60	17.60	19.00	18.27	18.60	17.60	18.60
45.1-50.0	3	21.47	21.00	20.30	23.10	20.57	20.60	20.00	21.10
50.1-55.0	6	22.10	22.30	20.00	23.00	21.85	21.85	20.50	23.20
55.1-60.0	12	23.37	23.30	22.20	24.00	23.32	23.35	22.30	24.30
60.1-65.0	5	25.00	25.00	23.30	26.10	24.76	24.60	24.40	25.40
65.1-70.0	12	26.78	27.00	25.40	28.20	26.69	26.70	25.00	28.60
70.1-75.0	9	28.92	29.00	26.00	30.40	27.83	27.60	25.40	30.30
75.1-80.0	9	30.71	30.40	28.10	33.40	30.04	30.00	28.20	32.30
80.1-85.0	9	32.44	32.20	31.10	34.00	32.03	32.00	30.10	34.20
85.1-90.0	20	36.63	36.40	34.30	40.40	35.18	35.35	31.60	38.00
90.1-95.0	10	38.69	38.85	36.60	40.40	37.10	36.40	35.50	40.60
95.1-100.0	2	39.50	39.50	39.00	40.00	37.90	37.90	37.50	38.30
Total	103	29.69	29.50	14.50	40.40	28.92	28.60	13.50	40.60

If the date of LMP is not available, one can predict that using ultrasonographic measurement BPD by fitting a regression line. The practitioners can determine GA by using the following chart whenever the measurement of BPD is available. As the model of GA, LMP fits better without the intercept term, so we use the model

GALMP = 1.026+0.3958*BPD

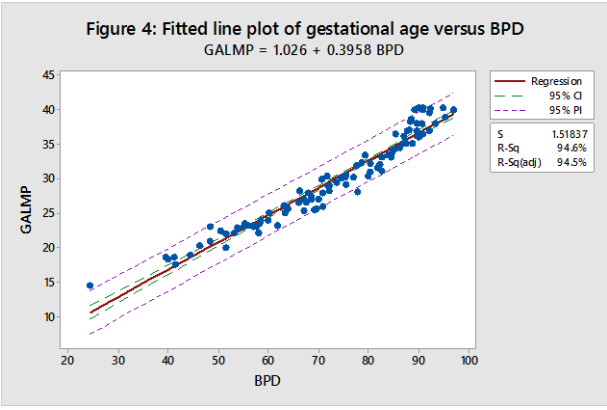
for prediction purposes (see Table 2). However, in case of modeling GAUSG we use the model

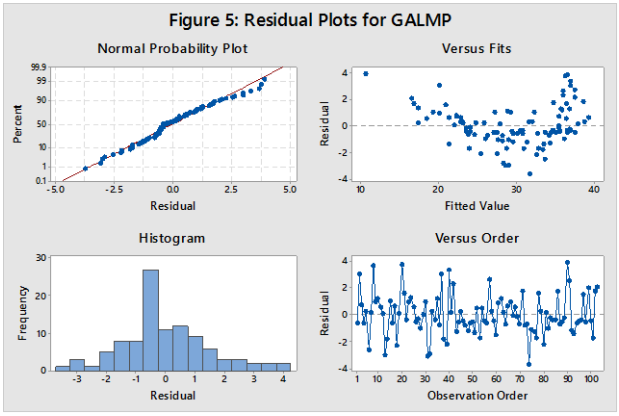
GAUSG = 2.029 + 0.3714*BPD.

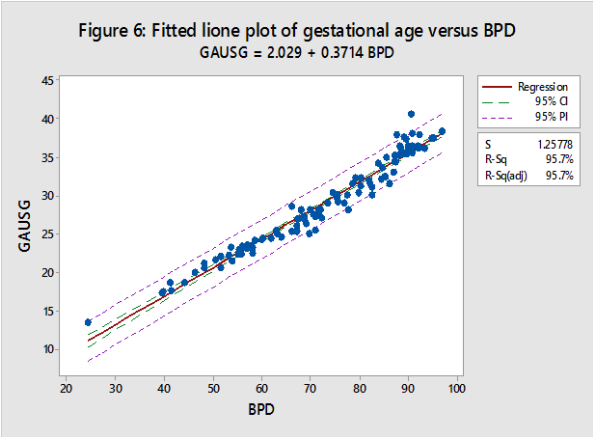
Figure 4 shows the linear relationship between BPD and GALMP with 95% prediction and confidence intervals of GALMP against BPD. Usually prediction interval is wider than confidence interval as prediction interval covers uncertainty of a random variable. In this case, GA is considered as a random variable for a given value of BPD. Figure 5 shows the model diagnostics through residual analysis. Apparently, there is no violation of model assumptions i.e. mainly no violations of normality and constant variance assumptions of errors. Figure 6 shows the linear relationship between BPD and GAUSG with 95% prediction and confidence intervals. Figure 7 shows that clearly there is no violation of model assumptions while fitting model of GAUSG on BPD.

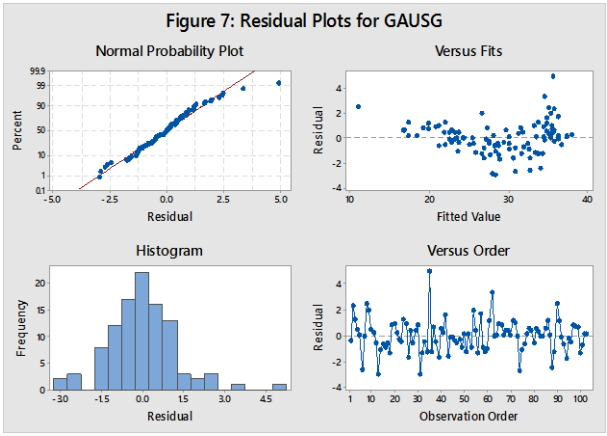
Table 2: Regression of gestational age (based on LMP or USG) on BPD

BPD	GALMP	GAUSG	BPD	GALMP	GAUSG
20	8.19	9.46	61	24.97	24.68
21	8.59	9.83	62	25.38	25.06
22	9.00	10.20	63	25.78	25.43
23	9.41	10.57	64	26.19	25.80
24	9.82	10.94	65	26.60	26.17
25	10.23	11.31	66	27.01	26.54
26	10.64	11.69	67	27.42	26.91
27	11.05	12.06	68	27.83	27.28
28	11.46	12.43	69	28.24	27.66
29	11.87	12.80	70	28.65	28.03
30	12.28	13.17	71	29.06	28.40
31	12.69	13.54	72	29.47	28.77
32	13.10	13.91	73	29.88	29.14
33	13.51	14.29	74	30.29	29.51
34	13.92	14.66	75	30.70	29.88
35	14.32	15.03	76	31.11	30.26
36	14.73	15.40	77	31.51	30.63
37	15.14	15.77	78	31.92	31.00
38	15.55	16.14	79	32.33	31.37
39	15.96	16.51	80	32.74	31.74
40	16.37	16.89	81	33.15	32.11
41	16.78	17.26	82	33.56	32.48
42	17.19	17.63	83	33.97	32.86
43	17.60	18.00	84	34.38	33.23
44	18.01	18.37	85	34.79	33.60
45	18.42	18.74	86	35.20	33.97
46	18.83	19.11	87	35.61	34.34
47	19.24	19.48	88	36.02	34.71
48	19.65	19.86	89	36.43	35.08
49	20.05	20.23	90	36.84	35.46
50	20.46	20.60	91	37.24	35.83
51	20.87	20.97	92	37.65	36.20
52	21.28	21.34	93	38.06	36.57
53	21.69	21.71	94	38.47	36.94
54	22.10	22.08	95	38.88	37.31
55	22.51	22.46	96	39.29	37.68
56	22.92	22.83	97	39.70	38.05
57	23.33	23.20	98	40.11	38.43
58	23.74	23.57	99	40.52	38.80
59	24.15	23.94	100	40.93	39.17
60	24.56	24.31			









Discussion

More precise estimation of GA can improve antenatal obstetrical care throughout the gestation and allowing the best possible timing for necessary interventions and reduce post-dates pregnancy related complications. The actual size of the gravid uterus, traditionally estimated through pelvic or per abdominal examination and most of the time this estimation more or less correlated with gestational age. Some factors that have an effect on uterine size, such as uterine fibroids and maternal body individuality such as, obesity will affect such an estimate. To determine GA the ultrasound based fetal biometric measurements of the embryo or fetus is more consistent with its GA. Biological discrepancy in size is less during the first trimester than in the third trimester. Ultrasound estimation of GA in second trimester by using BPD is therefore more precise than late third trimester in pregnancy.

Conclusion

The commonly used measurement BPD is found to be important to determine GA in this study. Precise information about GA is the key for successful antenatal care and preparation for appropriate perinatal management. This study presents sonographically derived measurements of fetal BPD from local Bangladeshi population and compares it with Western studies and other Indian sub continental studies [14-17]. The observations by Hadlock et al.[18] are in close consistency with present study with minor exception. In this study, BPD as a single parameter is better in the second trimester for estimating gestational age and it becomes less accurate with increasing gestational age.

Precise estimation of gestational age of the fetus and growth by using ultrasonogrphy can reduce perinatal mortality and morbidity. Therefore, a large range country wide examination and analysis is necessary to produce population specific reference tables and further studies considering multiple fetal parameters might be essential to support the above mentioned findings.

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Declarations

Author's contribution: This study intends to estimate GA in second and third trimesters with the help of ultrasonographic measurements of one of the essential fetal parameter namely, the bi-parietal diameter (BPD) in the population of Bangladesh living in Dhaka city. A total of 103 healthy pregnant females were investigated with the known last menstrual period. GA is determined by measurement of fetal BPD with real time ultrasonography using Hadlock method**.** There is linear relationship between GA and BPD and therefore, linear models for GA by last menstrual period (LMP) and GA by ultrasonographic (USG) measurements have been fitted by taking BPD as sole explanatory variable.

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Conflict of interest: It is a part of M.Phil. research. It is declared that this paper has not been submitted elsewhere for publication. Apparently, there was no violation of model assumptions during the linear model fitting process.

Ethical approval: It is an authentic record of our own work.

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