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RESEARCH ARTICLE

Ultrasonographic Bi- Parietal Diameter (BPD) Measurements VS Regular Last Menstrual Period (LMP) In Estimating the Day of Delivery (EDD) At ALTAWLID University Hospital

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ABSTRACT

To compare between regular last menstrual period (LMP) and ultrasonography Bi-Parietal Diameter (BPD) measurements in predicting delivery dates(EDD) in a Syrian population. This was a prospective observational study of women with a normal spontaneously conceived viable singleton pregnancy, a regular menstrual cycles, and spontaneous onset of labor at term. The LMP was considered certain in all cases. We used ultrasound to scan 678 fetuses (678 Healthy women) at 13 – 41[3] weeks. The BPD of each fetus was measured three times, the mean of which was used to derive the best-fit regression model for estimation of gestational age in relation to BPD. Data were collected prospectively and used for statistical analysis. The duration of pregnancy from the scan to the day of spontaneous delivery was predicted by BPD using regression model. The accuracy of each method in predicting the day of delivery was determined. The true delivery dates were compared with estimates based on LMP and BPD. In spite of LMP was more accurate in predicting the delivery date than BPD measurements, but in women who forget the exact LMP, we can rely on BPD measurements, because the differences were of little importance clinically.

INTRODUCTION

The LMP (last menstrual period) is considered the standard method to estimate the gestational age and the expected delivery date (EDD) by using Naegele's rule which presumes that the full term pregnancy is between 280-283 days [2-5].This is correct only if women have regular menses, ovulation on day 14 and can recall the exact first day of the LMP. However, only 30-40% of women can have these conditions. [1-5]

The method used nowadays to date pregnancy is fetal biophysical profile by ultrasound such as biparietal diameter (BPD). Many studies have compared the accuracy of BPD and LMP in estimating the EDD. Kieler H study is a good example in which he states that when the difference between LMP and BPD in predicting the EDD is more than 7 days, the latter is considered better.[4]. Furthermore, according to Tunon K and his colleagues, when the difference between the two methods is less than 7 days, the BPD by ultrasound between weeks 15-22 of pregnancy is considered the best method to measure the EDD and should be considered a routine procedure. [6-7].

MATERIALS AND METHODS

1- Study design: This study is a prospective descriptive longitudinal population one.

2- Setting: ALTAWLID University Hospital

3- Description of populations and variables: All the participants were pregnant women representing a specific geographic region from Damascus and its suburbs, who reviewed the hospital either to confirm pregnancy or for following up. 71.4% (484/678) of all participants were between 18-30 years old and most of them were housewives of a low socioeconomic status.

4- Inclusion criteria: 1-) voluntary participation with informed consent. 2-) A correct, accurate and reliable patient's knowledge of the first day of the LMP. 3-) Regular menstrual cycles (at least three previous regular menses). 4-) Singular alive normal fetus with a gestational age between 13-41 weeks. [3]. 5-) Spontaneous labor by full term pregnancy (259-293 days/37-41 weeks).

5- Exclusion criteria: Women who have one of the following:

Uncertainty of the LMP date. 2-) Irregular menstrual cycles. 3-) Multigestation or fetal demise. 4-) Oral contraceptive use (OCP) or

any recent hormonal treatment (3-4 months) before current pregnancy. 5-) Pregnancy during lactation. 6-) History of previous abortion or recent delivery preceding the current pregnancy. 7-) Diagnosis of fetal malformations during examination or after birth. 8-) Presence of any medical or obstetric complication with known effect on fetal growth. 9-) Smoking or drug addiction. 10-) BPD measures taken after week 41 of pregnancy. 11-) Pregnancies that ended in abortion preterm or postterm deliveries. 12-) Date of delivery (vaginal or cesarean section) is inaccurate. 13-) Malpositioned deliveries.

METHODS

Ultrasound examination: An ultrasound examination was made for 894 pregnant women (2067 fetuses) who reviewed the hospital between December 2015 and August 2016 to determine gestational age by measuring six different fetal parameters. (Mean sac diameter, crown rump length, BPD, head circumference, abdominal circumference and femoral length).

The total fetal measurements were 7098 including 1586 BPDs. A group of 678 women out of the 894 women was selected according to the previously explained inclusion and exclusion criteria, these 678 women had a transabdominal ultrasound between (13-41) weeks of pregnancy estimated by the first day of the LMP and had a spontaneous delivery vaginally or by cesarean section between (37-41)[6] weeks.

All women were followed until delivery.

STATISTICAL ANALYSIS METHODS

a- The complete sample (678 fetuses) was included in the statistical analysis and none of the fetuses was excluded before the inclusion of data. A specialized team did the statistical analysis. The following were measured: 1- Gestational age at the time of examination according to the first day of the LMP.2- The EDD using Naegele's rule (first day of the LMP+280 days). 3- The EDD using the BPD measures. 4- The remaining time until delivery.

b- Descriptive statistics were used to measure the values of table 1 and 5.

c- The regression model of the BPD was used to determine the EDD and in order to choose the best regression model we used the: 1- Coefficient of Determination (r^2) and the adjusted Coefficient of Determination ($\overline{r^2}$) and chose the one with the higher value. 2- The standard error (Std. Error) of both methods and chose the one least value. 3- Durbin–Watson Test and chose the one that gives a value close to the Std. Error. 4- The

significance of regression model by doing an analysis of variance. 5- The significance of the regression model constants' (parameters) using T test. 6- Estimating the SD of the EDD using the BPD regression model.

d- Paired – Samples T-TEST to test each method accuracy.

RESULTS

1-Real gestational age of the study participants': The gestational age measured by the BPD by ultrasound ranged between (92-293 days/13-41 weeks), and the real gestational age was between (259-293 days).

DISCUSSION

1- According to our data we found that the BPD nonlinear regression model was enough to estimate the EDD

2-The mean of the true gestational age according to the LMP and the mean of the expected gestational age according to the BPD were 275.2∓8.1 and 275.4∓11.7 days, respectively and both of them were close to the assumed normal gestational age (280 days). The median for both LMP and BPD was 276 and 274.5 days, respectively

3- The standard error and standard deviation (SD) (0.3, 8.1) respectively for the LMP and (0.4, 11.7) respectively for BPD (table 1 and 5).

4- The error in estimating the EDD according to the BPD ranged between (-27, +27) days (Figure 3, 6)

5- In the presence of a significant statistical difference between the two methods (z value= 10.48 and a P value <0.001), the previous statistical values showed the superiority of LMP over BPD in estimating the EDD. However, from a clinical point of view, these differences are minor and do not lower the BPD efficacy in estimating the EDD. The previous point is very important clinically, especially in women who cannot recall their LMP date precisely and thus BPD can be used.

6- The EDD was earlier than the true delivery date by more than 14, 7 and 3 days, respectively at 0%, 5.9% and 14.3% of the participants who used the LMP compared to 10.6%,27.9% and 39.7% of the participants who used the BPD. (Table 6).

7- The EDD came after the true delivery date by more than 14, 7 and 3 days, respectively at 53.9%, 37.7% and 13.7% of the participants who used the LMP compared to 36.6%, 27.4% and 11.9% of the participants who used the BPD. (Table 6).

8- 32.7% ,56.3% and 86.3% of the participants who had their EDDs by LMP compared to 23.7%, 44.5% and 77.4% of them who had their EDDs by BPD, both had their EDDs between ∓ 3, ∓ 7 and ∓ 14 days, respectively from the true delivery date. This means that the LMP is more precise than the BPD (PD percentages are less than the LMP percentages) and this opposes what Kieler H [8] and Tunon K [12, 13] stated in their studies.

9- 6.2% and 1.8% of the participants who had their EDDs measured by LMP and BPD, respectively had their EDDs equal to the true delivery date, which means that the LMP is more precise than the BPD. (Table 6).

10- Figures 5, 6 and table 6 showed that the EDDs according to the LMP came after the true delivery date opposing to the EDDs, which were earlier using the BPD.

CONCLUSION

If both BPD and LMP were available, the LMP should be used in estimating the EDD (more accurate), whereas if LMP is the only method available, the full term pregnancy should be calculated by adding 280 days to the first day of the LMP. However, if only the BPD is available it is considered a reliable method in estimating the EDD (no significant clinical difference between the two methods).

RECOMMENDATIONS

Emphasize the importance of doing a bigger more inclusive study to determine the accuracy of the fetal measurements in predicting the delivery date Encourage all reproductive aged women to validate their menses Using the BPD to determine the EDD especially in women who cannot recall their LMP accurately.

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Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of

the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent: Informed consent was obtained from all individual participants included in the study.

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DIAGRAM AND FIGURE

Statistical value (Day)	Descriptive Statistics	
275.2		Mean
274.5	Lower Bound	95% Confidence Interval for Mean
275.8	Upper Bound	
275.2		5% Trimmed Mean
276.0		Median
0.3		Std. Error
8.1		Std. Deviation
259.0		Minimum
293.0		Maximum
34.0		Range

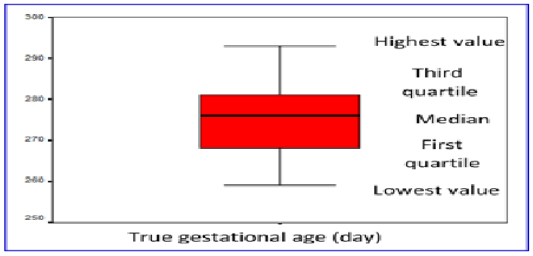

Figure 1: Box plot representing the first quartile (25th percentile), the median (50th percentile), the third quartile (75th percentile) and the lowest and highest values of the true gestational age.

2- Estimating the EDD using the BPD by ultrasound: We estimated remaining time until spontaneous delivery occurs from the date of the BPD ultrasound examination by using a nonlinear regression model. We found a third degree valuable regression equation ($p<0.001$) that we can use to get the EDD from BPD measures (mm). (Table 2, 3, 4- Figure 2)

EDD from BPD measures equation:

$$\hat{Y}_i = 169.88 + 1.54(BPD)_i - 0.058(BPD)_i^2 + 0.0002(BPD)_i^3$$

$\bar{r}^2 = 0.96$ Std Err =11.69 Sig=0.000

The $\overline{r^2}$ factor of the regression equation was 0.96 (0.75) which means that the correlation between the dependent variable (EDD) Y-line and the independent variable (BPD) X-line is very strong. (Figure 2)

The standard error (difference between the EDD and true delivery date) of the equation was 11.69. (Table 2- Figure 2). This value represents the effect of many factors that were not included in the regression model and influenced the dependent variable (EDD) Y-line. (Table 2)

Table 2: Coefficient of Determination and Standard Error of the Estimate of the EDD using the BPD:

Std. Error	$\bar{r}_2$	r2
Standard Error of the Estimate	Adjusted Coefficient of Determination	Coefficient of Determination
11.69	0.96	0.96

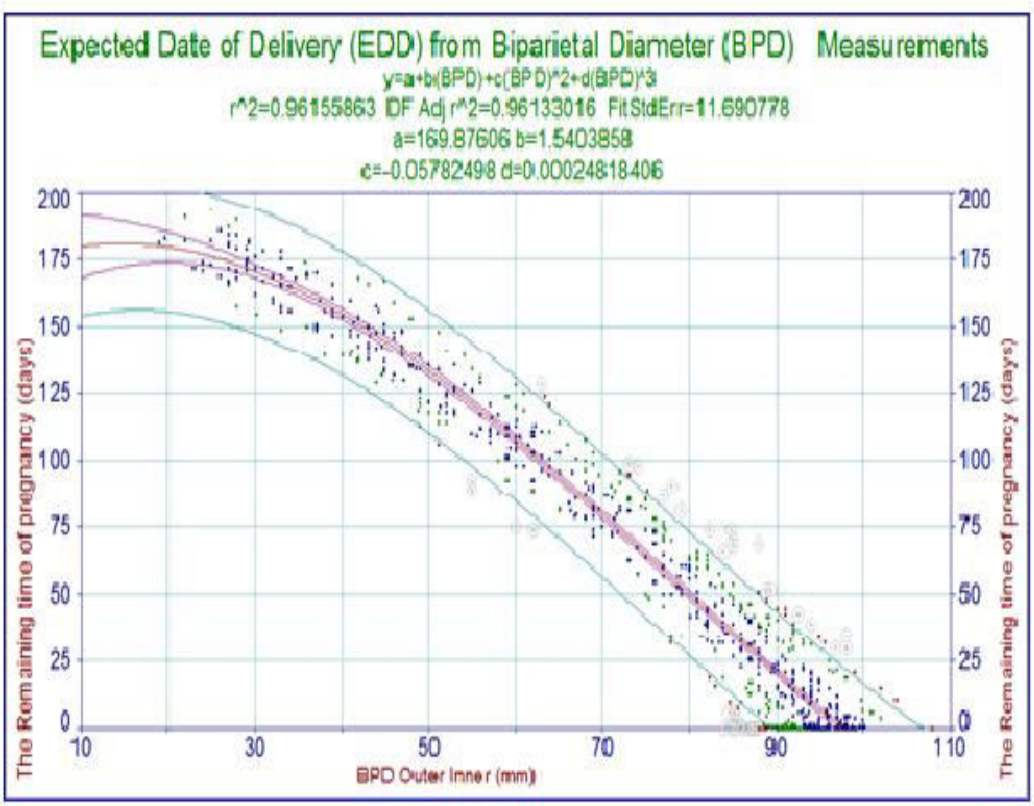

Figure 2: Estimating the EDD (day) from the BPD (mm)

Each point represents one fetus result

Table 3: T test for the constants of the regression equation

P>|t| Sig	95% Confidence Limits		t-value	Standardized Regression (Beta)	Std. Error	Value	Variable
	Upper bound	Lower bound					
0.000	191.28	148.48	15.59		10.90	169.88	A
0.009	2.70	0.38	2.60	0.58	0.59	1.54	B
0.000	0.038-	0.077-	5.854-	2.86-	0.010	0.058-	C
0.000	4-10 X3.50	4-10 X1.47	4.81	1.32	5-10 X5.16	4-10 X2.48-	D

Table 4: analysis of variance of the constants of the regression equation

P>F	F Statistic	Mean Square	DF	Sum of Squares	Source
0.000	5619.73	768072.89	3	2304218.70	Regression Model
		136.67	674	92118.47	Residual Error
			677	2396337.10	Total

3-The error in estimating the EDD using the regression equation: (Table 5, Figures 3 and 4) show the descriptive statistics of the EDD using the regression equation. The error in estimating the EDD by BPD measures was between (-27 and 27 days). (Figure 3)

The standard deviation (SD) in estimating the real gestational age was 11.7 days. (Table 6)

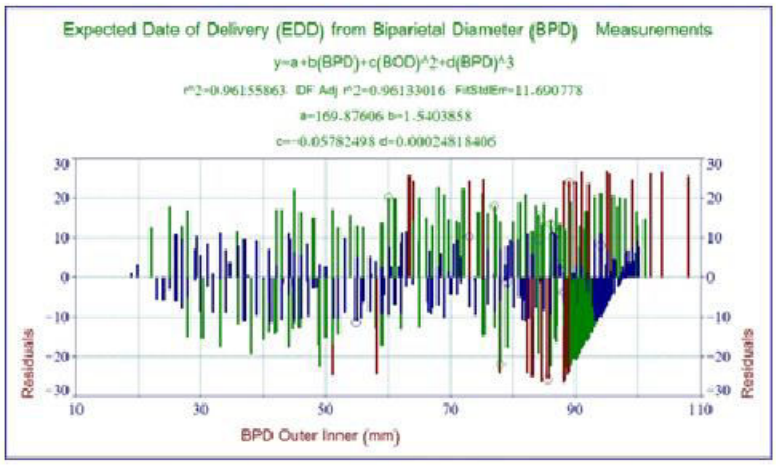

Figure 3: The error in estimating the true gestational age (horizontal line 0) and the EDD (colored vertical line) using the regression equation

Table 5: Descriptive Statistics of the EDD (day) from The BPD measures

Day		Descriptive Statistics
275.2		Mean
274.3	Lower Bound	95% Confidence Interval for Mean
276.0	Upper Bound	
275.0		5% Trimmed Mean
274.5		Median
0.4		Std. Error
11.7		Std. Deviation
244.2		Minimum
319.8		Maximum
75.6		Range

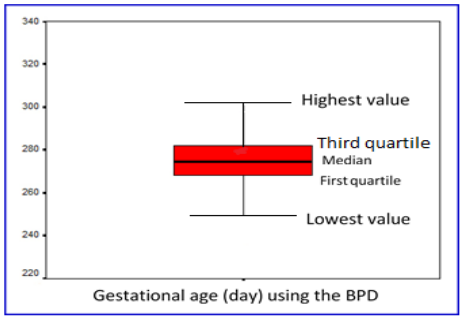

Figure 4: Box plot representing the first quartile (25th percentile), the median (50th percentile), the third quartile (75th percentile) and the lowest and highest values of the EDD using the BPD.

4-EDD by using the LMP: The gestational age was set as 280 days from the first day of the LMP and the SD was 8.1 days from the true delivery date.

5-Comparison between the EDD and the true delivery date by using both LMP and BPD:

Table 6 and figures 5, 6.

Table 6: Comparison between the EDD and the true delivery date by using both LMP and BPD

BPD	LMP	
11.7	8.1	SD of the true delivery date (day)
٪10.6	٪0	EDD is less than the true delivery date by more than 14 days
٪27.9	٪5.9	EDD is less than the true delivery date by more than 7 days
٪39.7	٪14.3	EDD is less than the true delivery date by more than 3 days
٪1.8	٪6.2	EDD=true delivery date
٪36.6	٪53.9	EDD is more than the true delivery date by more than 3 days
٪27.4	٪37.7	EDD is more than the true delivery date by more than 7 days
٪11.9	٪13.7	EDD is more than the true delivery date by more than 14 days
٪23.7	٪32.7	EDD is within 3 (∓ 3 days) from the true delivery date
٪44.5	٪56.3	EDD is within 3 (∓ 7 days) from the true delivery date
٪77.4	٪86.3	EDD is within 3 (∓ 14 days) from the true delivery date

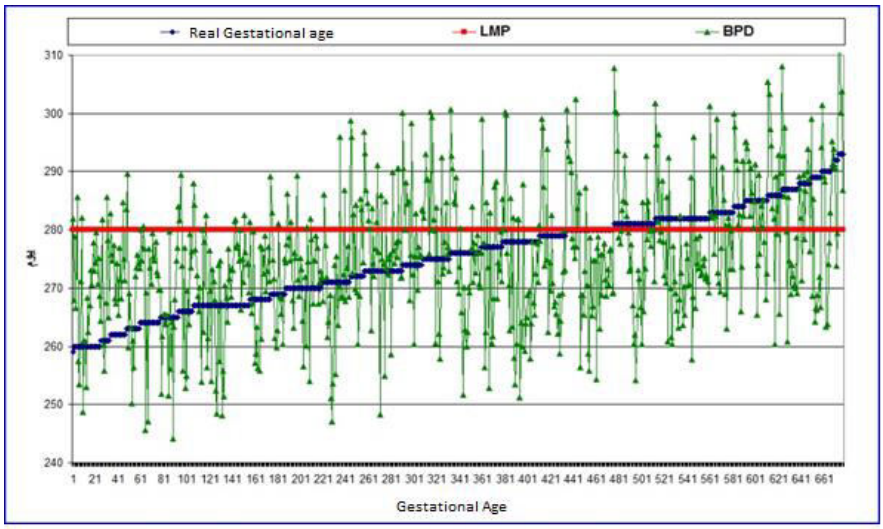

Figure 5: Comparison between the true gestational age (blue line) and the gestational age according to LMP (red line) and the BPD (green line)

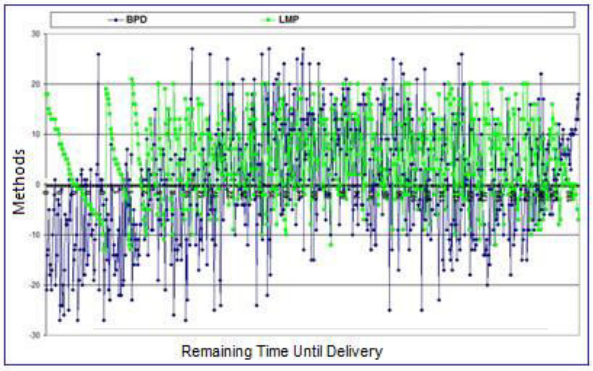

Figure 6: The difference between the true remaining time until delivery (black line) and the remaining time by the BPD (blue line) and the LMP (green line)