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Research Article

A Comparative Study of the Exactness of Certain Last Menstrual Period and Ultrasonography in Forecasting the Date of Delivery

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Abstract

The study aimed to determine between last menstrual period and ultrasonography which is more exact in predicting the delivery date.

This prospective comparative study utilized 311 participants with certain last menstrual period at between 8 to less than 24 week gestation. The participants were scanned and followed up to delivery. The date of birth as forecasted by the crown-rump length (CRL), biparietal diameter (BPD), and femur length (FL) were analyzed and compared with estimates derived from the last menstrual period (LMP).

The results showed that ultrasound biometry was better than certain LMP in estimating the day of delivery by a minimum of 0.7 days. Less than 10% of the subjects delivered on the day predicted altogether by the methods employed in calculating the date of delivery. The BPD was the best predictor of the date of delivery and the length of the pregnancy (mean and median duration being 279.2 and 279 days respectively) while the FL performed slightly more exact than the CRL. Combination of any two or three ultrasonic variables statistically did not improve the accuracy of prediction. When ultrasound was used instead of certain LMP, the number of post term pregnancies reduced from 4% to 0.4%. All predictions by CRL fell within term.

Ultrasound biometry was more exact than certain last menstrual period in dating, and its utilization, reduced the number of post term deliveries. A second trimester biparietal diameter was the best parameter in dating pregnancy. Combining more than one ultrasonic measurements did not result in improved dating accuracy.

Keywords: First Trimester; Second Trimester; Ultrasound; Gestational Age; Pregnancy Duration; Pregnancy Dating

Introduction

Precise determination of gestational age is the bottom line in managing patients in obstetric practice. It is a veritable tool for assessing fetal maturity and it is the yardstick for delineating iatrogenic prematurity or post maturity so that adequate management precautions are put in place. When a fetus is delivered premature or postmature there are associated fetal morbidities and mortality and this underscores the importance of accurately determining the gestational age of the fetus.

The expected date of delivery (EDD) is the projected date that the spontaneous onset of labour is due to commence. Before the advent of ultrasound scan the expected date of delivery had traditionally been determined using the last menstrual period. The accuracy of the EDD consequent on this method is premised on a precise recollection of the last menstrual period, adopts a regular 28-day cycle, and that both ovulation and fertilization occurs on day 14 of the cycle and no usage of contraceptives in the preceding 3 to 6 months. Campbell., *et al*. reported that only 45% of pregnant women were certain of menstrual dates as a result of the poor recall, irregular cycles, bleeding in early pregnancy, or oral contraceptive use within 2 months of conception [1].

Baerwald., *et al*. reported that ''albeit the menstrual history is correct, the exact time of ovulation, fertilization, and implantation cannot be known. Women may undergo several "waves" of follicular development during a normal menstrual cycle, which may mean ovulatory inconsistency during any given cycle" [2,3]. Grieger and Norman reported that only 16.32% of women have a median cycle length of 28 days [4]. Consequently, the use of the LMP to determine the delivery date may miscalculate the duration of gestation, as there are variations in the cycle length of women. These shortcomings with using the last menstrual period underlie the need for a more accurate and reliable means of determining the delivery date.

Following the introduction and evolution of ultrasound scan, myriad of parameters were developed to determine the correct gestational age. Whereas the use of the LMP to determine gestational age is based on assumptions and duration of days, ultrasound biometric measurements utilize the basis that dimensions of the embryo or fetus tallies with its age to determine the gestational age and the effects of growth restriction are still minimal at this early gestational ages [5]. Accordingly, the exactness of the ultrasound estimation of gestational age varies according to the gestational age.

Biological variation in size of the fetus is less in the first trimester compared to the other trimesters therefore ultrasound estimation of gestational age in the first trimester is more reliable than in later trimesters [6]. Direct measurement of the CRL provides the most accurate estimate of gestational age [7-10], no sex or race differences are appreciable, but maternal characteristics, such as age and smoking, may have a significant effect beyond 10 week' gestation [8]. However, Khambalia., *et al*. [12], reported that "there were no meaningful differences in the prediction of the date of birth by ultrasound scan date, an early dating scan less than 10 weeks is unnecessary if LMP is reliable'' [12]. Knight., *et al*. reported that "the crown-rump length, when used in the dating of pregnancies, overestimated the gestational age by 3 days when compared to those assessed by IVF pregnancies'' [13].

In the second and third trimesters, fetal biometry employed in determining gestational age consists of biparietal diameter, head circumference, abdominal circumference and femur length.

The practise of combining multiple parameters to determine gestational age achieves better result and reduces error margin than using only a single trimester fetal biometric parameter [14-16]. However, the significance of this benefit does not extend beyond three commonly used parameters [15-17]. The study was carried out to assess the performance of last menstrual period and ultrasonography in predicting the date of delivery in our locality.

Material and Methods

This prospective cross-sectional comparative study was undertaken at the department of obstetrics and gynaecology, Federal Medical Centre, Yenagoa from January 2, 2017 to December 31, 2019. The hospital has a 425-bed capacity and is situate in Yenagoa, the capital city of Bayelsa State in Southern Nigeria. It is a tertiary institution that provides all levels of health care services to patients, as well as training and research.

Every consecutive pregnant woman who presented for booking at the antenatal clinic that met the inclusion criteria was enrolled in the study and followed up until delivery. A detailed history was taken at presentation and the certain last menstrual period (LMP) was recorded. LMP was recorded as certain if the woman's recalled was spontaneous and affirmative, recall from a menstrual calendar or marked in her diary, the cycle length was regular which is that the difference between the shortest and the longest cycle length is not more than 5 days in the preceding 3 to 6 months and when her pregnancy ensued not less than 4 months after stoppage of hormonal contraception.

Employing the Naegele's rule (first day of LMP + 280 days), the expected date of delivery and the estimated gestation age were determined at booking. All patients whose gestational age from the

certain LMP were equal to or more than 8 weeks but less than 24 completed weeks as calculated from the Naegeles's rule were sent for ultrasound dating of the pregnancy [18] and subsequently followed up to delivery. The study was approved by the ethical committee of the centre and the subjects were informed about the study and its purpose.

All Sonograms were done using General Electric ultrasound Korea limited, Voluson S8. The determination of gestational age by ultrasound was based on CRL for early gestation (8weeks to 13 weeks and 6 days) and biparietal diameter (BPD) or femur length (FL) for older fetuses (14 weeks to 23 weeks and 6 days). The measurement employed for dating was the mean of two to three distinct CRL measurements gotten in the correct midsagittal plane, ensuring that the fetal spine and genital tubercle are longitudinal and the measurement was taken in a straight line spanning from the clearly defined cranium to the caudal rump. CRL was employed up to 80mm (corresponding to approximately 13 weeks and 6 days of gestation) and the BPD and or FL for measurements greater than 80 mm. The BPD measurement was determined as the maximum diameter of a transverse section of the fetal skull at the level of the parietal eminences. The FL was imaged in a horizontal plane as possible, with the angle of insonation of the ultrasound beam being at 90^0. Care was taken to ensure that the full length of the femur was visualized with no obscuring of either end by shadowing from adjacent bony parts.

Exclusion criteria; were CRL less than 17 mm (≤8 weeks) or more than 80 mm (≥ 14 weeks), BPD less than 26 mm (≤ 14 weeks) or more than 59 mm (≥ 24 weeks), multiple gestation, intrauterine fetal death, fetal malformation, uncertain LMP and all subjects who did not have spontaneous onset of labour (Women who had elective caesarean section or induction of labour).

Data collected from the study were analyzed using SPSS software (ver.20.0; IBM, Chicago, IL, USA).

The duration of pregnancy (DOP) was calculated for LMP, BPD and FL by subtracting the number of days between dates predicted by each method and the date of spontaneous onset of labour and delivery from 280 days (equaling pregnancy duration of 40 weeks).

The error (the discrepancy between the date of spontaneous delivery and predicted day of delivery) of each of the method of estimation was expressed as absolute error and signed error. The absolute error and signed error were summarized as mean and standard deviation and the skewness of the errors calculated. The errors in the predicted dates of delivery by LMP, BPD and FL were compared using Wilcoxon matched-pairs signed rank-sum test. Level of significant was sent at pValue < 0.05.

Results

Sociodemographic and obstetric factors of mothers and sex, with the birth weight of children

Of the 464 cases recruited initially at the booking clinic, 332 (71.6%) participants met the inclusion criteria and were followed up in this study. Only 311 (93.7%) participants were included in the analysis. 21 participants (6.3%) were lost to follow up as they did not complete their antenatal nor delivered in the hospital.

Characteristics	Frequency N = 311	Per cent (%)
Age of mother		
< 25 years	50	16.1
25 - 29 years	122	39.2
30 - 34 years	93	29.9
35 -39 years	46	14.8
Mean age (SD) in years	29.1 (4.9)	
Educational Attainment		
Primary	5	1.6
Secondary	119	38.3
Tertiary	187	60.1
Parity		
Nulliparous	140	45.0
Primiparous	91	29.3
Multiparous	67	21.5
Grandmultiparous	13	4.2
Median Parity (Range)	1 (0 – 8)	

Table 1: Sociodemographic and Obstetric features of mothers.

Table 1 shows that most of the mothers (39.2%) were aged between 25 – 29 years, with a mean age of 29.years and a standard deviation of 4.9 years. 60.1% of participants had a tertiary level

Characteristics	Frequency N = 311	Percent (%)
Sex of Baby		
Female	134	43.1
Male	177	56.9
Birth weight of Baby		
<2.5kg	12	3.9
2.5 - 4.0kg	280	90.0
> 4.0kg	19	6.1
Mean birth weight (±SD) in kg	3.2 (0.4)	

Table 2: Sex and Birth weight of babies.

of education and 45.0% of the study population were nulliparous.

Table 2 reveals 56.9% of the babies were males, while female babies accounted for 43.1% giving a male to female ratio of 1.3 to 1.0. The babies had a mean weight of 3.2±0.4kg and babies weighing between 2.5 – 4.0kg constituted 90.0% of babies delivered in the study.

The estimated duration of pregnancy by LMP and different ultrasound biometric parameters

The mean duration of pregnancy (DOP) estimated by last menstrual period is 278.5days with the highest variability as reflected by a standard deviation of 9.2 days (Table 3). The biparietal diameter was best in estimating DOP with a mean and median of 279.2 days and 279 days, respectively. The range of values for DOP was between 259 and 325 days for LMP and 258 and 297 days for biparietal diameter (Table 3).

Method of Estimation	Duration of Pregnancy (in days)			
	Mean	SD	Median	Range
Last menstrual Period (N = 275)	278.5	9.2	277	259 – 325
USS Crown-Rump Length (N = 94)	276.7	4.8	276	266 – 291
USS Biparietal Diameter (N = 155)	279.2	7.6	279	258 – 297
USS Femur length (N = 110)	277.5	8.1	278	259 – 297

Table 3: Duration of Pregnancy as estimated by LMP and different Ultrasound parameters.

The day delivery occurred and classification of deliveries

Less than a tenth of the pregnant women in the study were delivered on the dates predicted by all the methods of predicting expected dates of delivery. Nine women (8.2%), 9 women (5.8%), 14 women (5.1%) and 4 women (4.3%) were delivered on the exact dates predicted by femur length (FL), biparietal diameter (BPD) in USS, last menstrual period (LMP), and crown-rump length (CRL), respectively. The highest proportion of pregnancy (78.7%) was delivered within 7 days before or after the date predicted by crown-rump length, that for the BPD was 67.7% while delivery occurred within the same period only in 58.9% of study participants going by the predictions by the last menstrual period.

Going by the predictions of LMP, BPD and FL, 0.4%, 1.3% and 0.9% of pregnancies, respectively would have been delivered as premature babies, while 4.0% for LMP, 1.9% for BPD and 0.9% for FL were post-term dates for those pregnancies. All predictions of CRL fell within the term (between 37 completed weeks and 42 weeks) for the pregnancies.

Errors of the predicted dates of delivery from LMP and Different USS parameters

The absolute mean error in estimating (N = 275) the expected date of delivery was highest in the estimate by LMP having a mean absolute error of 7.3 days and variability of 5.7 days. BPD was most accurate in estimating EDD with the least error of 6.0 days and deviation of 4.7 days (Table 5). The absolute/signed error values for all the parameter of USS were normally distributed with skewness ranging between -0.49 to 0.94 (Table 5). While the absolute error values of the last menstrual period were positively skewed (skewness - 2.12), the signed error values were slightly negatively skewed (-1.07) as presented in table 5.

The results of the Wilcoxon matched-pair signed rank sum test is shown in Table 6. The error in estimating the expected dates of delivery by BPD was less than that of LMP in 74 cases (Negative ranks) and greater among 53 cases while there was a tie in 7 cases. Error in calculation was significantly lower in BPD estimation compared to LMP estimation (Z = -2.06; p – 0.040). Errors of estimation were also significantly lower in BPD estimation compared to

Method of Estimation	Pre- or Post-term delivery n (%)			Day delivery occurred – n (%)		
	Preterm (<259days)	Term (259–293days)	Post-term (≥294days)	D_p±0day	D_p±7days	D_p±14days
LMP (N = 275)	1 (0.4)	263 (95.6)	11 (4.0)	14 (5.1)	162 (58.9)	246 (89.5)
CRL (N = 94)	-	94 (100.0)	-	4 (4.3)	74 (78.7)	93 (98.9)
BPD (N = 155)	2 (1.3)	150 (96.8)	3 (1.9)	9 (5.8)	105 (67.7)	145 (93.5)
FL (N = 110)	1 (0.9)	108 (98.2)	1 (0.9)	9 (8.2)	71 (64.5)	93 (84.5)

Table 4: Classification of preterm and post-term deliveries according to the predicted dates of delivery.
D_p – Predicted date.

Method of Estimation	Mean Error (Standard deviation) in Days			
	Absolute error	Skewness of mean absolute error	Signed error	Skewness of mean signed error
Last menstrual Period (N = 275)	7.3 (5.7)	2.12	1.5 (9.2)	-1.07
USS Crown-Rump Length (N = 94)	4.8 (3.2)	0.71	3.3 (4.8)	-0.49
USS Biparietal Diameter (N = 155)	6.0 (4.7)	0.94	0.7 (7.7)	-0.01
USS Femur length (N = 110)	6.5 (5.3)	0.66	2.5 (8.1)	0.06

Table 5: Errors of the predicted dates of delivery from LMP and Different USS parameters.

FL estimation (Z = -2.63; p – 0.009). Comparing the absolute error between the three methods of estimation showed no significant difference in the error of estimation. From the findings, Biparietal diameter best predicted the expected date of delivery with the least deviation between the predicted date and the actual date of delivery (most accurate of the three method of estimation).

Method of Predicting date	Number within rank	Signed Error		Absolute Error	
		Wilcoxon Sign Ranks	p Value	Wilcoxon Sign Ranks	p Value
BPD* and LMP					
Negative Ranks	74	-2.06	0.040	-1.86	0.063
Positive Ranks	53				
Ties	7				
Total	134				
FL* and LMP					
Negative Ranks	35	-1.86	0.063	-0.30	0.764
Positive Ranks	57				
Ties	5				
Total	97				
FL* and BPD					
Negative Ranks	7	-2.63	0.009	-1.54	0.124
Positive Ranks	20				
Ties	0				
Total	17				

Table 6: Comparing the error of estimation between the different methods of predicting dates of delivery.
*reference method in each pair.

Discussion

The results above revealed that ultrasound biometric parameters estimated the date of spontaneous delivery better than the

certain LMP. The reasons for this are not far fetch; LMP is based on assumptions and it does not exactly pinpoint the actual date of fertilization and implantation [1-3] whereas ultrasound predicts the date of spontaneous delivery of an already formed embryo/fetus employing dimensions, determined from defined points/parts of the fetal anatomy.

In this study, less than 10% of the participants in the study were delivered on the dates predicted by all the methods of projecting the expected date of delivery. This is higher than that reported by other authors [12,19] Accordingly, this low and abysmal value underlines the need to counsel patients that the predicted EDD is a forecast and as such unnecessary concern need not be entertained by women when the duration of the pregnancy exceeds the due date.

As revealed above, ultrasound biometry was superior to certain LMP in predicting the day of delivery by at least 0.7 days. This is less than the values predicted in the study by other authors [20-22]. As similarly reported by other authors [19,20] the mean and median duration of pregnancy determined by the BPD was 279.2 days and 279 days respectively. However, the mean duration of pregnancy as determined by the LMP at 278.5 days was 3 days less than that reported by other researchers [20,23].

All the ultrasound biometry used in this study predicted the date of delivery better than the certain LMP however, the ultrasound parameter that best predicted the date of delivery was the second trimester ultrasound utilizing the BPD. A similar finding was reported by other researchers [20,22,23]. Olesen., *et al*. [23] reported that an ultrasound examination in the second trimester is the most valid method of predicting the date of delivery.

Delivery at term which is 259 days (37 completed weeks) to 393 days (which is 41 weeks and 6 days) is associated with reduced perinatal morbidity and mortality. Delivery less than 259 days and beyond 293 days is froth with increased perinatal morbidity and mortality. With the dating of pregnancy by certain LMP, post term delivery (≥ 294 days) was higher at 4% (table 4) compared to ultrasound biometry. In women with regular menstrual cycle, Taipale., *et al*. [20] and Tanon., *et al*. [24] reported higher values of 10.3% and 14% respectively post-term deliveries determined from the LMP. The reason for certain LMP resulting in more post-term delivery may not be unconnected to the vagaries and assumptions inherent in LMP.

All patients whose date of delivery were predicted by CRL all delivered at term while BPD was more associated with preterm delivery. The highest proportion of pregnancy (78.7%) was delivered plus or minus 7 days of the date of delivery predicted by CRL that for the BPD was 67.7% while delivery occurred within the same period only in 58.9% of study participants going by the predictions from the last menstrual period. For BPD 67.7% of women delivered within 7 days of the estimated day and 93.5% within 14 days of the estimated day. These are higher than that reported by Tunon., *et al*. [24] who reported 61.6% and 87.7% respectively.

Conclusion

Ultrasound biometry is superior to certain LMP in predicting the due date. Ultrasound biometry employing BPD is the most exact parameter in predicting the date of delivery.

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