

RESEARCH ARTICLE

**ULTRASONOGRAPHIC FETAL  
CROWN-RUMP LENGTH (CRL)  
MEASUREMENTS VS REGULAR LAST  
MENSTRUAL PERIOD (LMP) IN  
ESTIMATING THE DAY OF DELIVERY  
(EDD)**

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**ABSTRACT**

To compare between regular last menstrual period (LMP) and ultrasonography crown-rump length (CRL) measurements in predicting the 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 101 fetuses (72 Healthy women) at 6<sup>6</sup>-12<sup>6</sup> weeks. The CRL 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 CRL. The duration of pregnancy from the scan to the day of spontaneous delivery was predicted by CRL using regression model. The accuracy of each method in predicting the day of delivery was determined by Paired-Samples T-TEST. The true delivery dates were compared with estimates based on LMP and CRL. The results were represented as tables & diagrams. The LMP gave later estimates, while CRL gave earlier estimates from true Delivery dates. in spite of the is significant difference (P<0.001) between CRL measurements and LMP in predicting the delivery date, but these were small clinically, and CRL was more accurate. This is of clinical importance, especially in women who forget the exact LMP, and therefore we can rely on CRL measurements.

## INTRODUCTION

Most pregnant women in Syria cannot recall their LMP (Last Menstrual Period) accurately and due to the difficulties in reaching hospital and care centers during the Syrian Crisis, there must be another reliable method in estimating the EDD (Expected Delivery Date) which might improve the pregnancy outcomes. 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 CROWN-RUMP LENGTH (CRL). There are only few studies that have compared the Expected Delivery Day (EDD) using the CRL and the actual gestational age [3,6,9,11]. Drumm study [3] found that CRL and LMP were the same in estimating the EDD, while two other studies stated that the CRL by ultrasound between weeks 10-14 of pregnancy [1,13] was better than the LMP in estimating the EDD.

## 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. 68.1% (49/72) 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 6-12 {6} 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:

1- ) 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- ) CRL measures taken out the weeks 6-12 {6} of pregnancy. 11- ) Pregnancies that ended in abortion preterm or post term deliveries. 12- ) Date of delivery (vaginal or cesarean section) is inaccurate.

## **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, CRL, head circumference, abdominal circumference and femoral length).

The total fetal measurements were 7098 including 500 CRLs. A group of 72 women out of the 894 women was selected according to the previously explained inclusion and exclusion criteria, these 72

women had a trans abdominal and transvaginal ultrasound (101/500 CRL measurements) between days (48-90) of pregnancy (weeks 6-12 {6} of pregnancy) estimated by the first day of the LMP and had a spontaneous delivery vaginally or by cesarean section between (37-41)<sup>6</sup> weeks.

All women were followed until delivery. Some women had more than one CRL measurement taken from them in the same pregnancy or other pregnancies and each new measurement was considered as a new fetus.

## **STATISTICAL ANALYSIS METHODS**

a- The complete sample (101 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 CRL 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 CRL 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 CRL regression model.

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

We believe that this study is the first of its kind in Syria.

1- According to our data we found that the CRL 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 CRL were  $272.8 \pm 7.4$  and  $272.8 \pm 4.5$  days, respectively and both of them were close to the assumed normal gestational age (280 days). The upper and lower bounds of the 95% Confidence Interval for Mean were close in both LMP and CRL (274.3, 271.4) and (273.7, 271.9) days, respectively. The

median for both LMP and CRL was 273 and 272.7 days, respectively.

3-The standard error and standard deviation (SD) (0.7, 7.4) respectively for the LMP and (0.4, 4.5) respectively for CRL (table 1 and 5).

4- The error in estimating the EDD according to the CRL ranged between (-15, +17) days (Figure 3, 6)

5-In the presence of a significant statistical difference between the two methods (z value= 8.3 and a P value <0.001), however, from a clinical point of view, these differences are minor and do not lower the CRL efficacy in estimating the EDD. The previous point is very important clinically, especially in women who cannot recall their LMP date precisely and therefore it cannot be used.

6- The EDD was earlier than the true delivery date by more than 14, 7 and 3 days, respectively at 0%, 2% and 4% of the participants who used the LMP compared to 1%, 16.8% and 34.6% of the participants who used the CRL. (Table 6).

7- The EDD came after the true delivery date by more than 14, 7 and 3 days, respectively at 22.8%, 46.5% and 63.4% of the participants who used the LMP

compared to 3%, 16.8% and 38.6% of the participants who used the CRL. (Table 6).

8- 32.7% 51.5% and 77.2% of the participants who had their EDDs by LMP compared to 26.7%, 66.3% and 96% of them who had their EDDs by CRL, both had their EDDs between  $\bar{\pm}3$ ,  $\bar{\pm}7$  and  $\bar{\pm}14$  days, respectively from the true delivery date. This means that the CRL is more precise than the LMP (LMP percentages are less than the CRL percentages) and this is the same as what most studies have stated. {1,13}

9- 5% and 4% of the participants who had their EDDs measured by LMP and CRL, respectively (close values). (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 using the CRL.

## CONCLUSION

If both CRL and LMP were available, any of them can be used (no significant clinical difference between the two methods), 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 CRL

is available it is considered a reliable method in estimating the EDD.

## RECOMMENDATIONS

Emphasize the importance of doing a bigger more inclusive study to determine the accuracy of the fetal measurements in predicting the delivery date.

Using the CRL to determine the EDD especially in women who cannot recall their LMP accurately.

## Compliance with Ethical Standers

**Funding:** This study was funded by Syrian Private University, **Conflict of Interest:** Author Hisham Al-Hammami declares that he has no conflict of interest. Author Mhd Nezar Alsharif declares that he has no conflict of interest. Author Yaser Fawaz declares that he has no conflict of interest. **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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## FIGURE AND TABLE

1-Real gestational age of the study participants': The gestational age measured by the CRL by ultrasound ranged between (48-90 days/6-12 weeks {6}), and the real gestational age was between (260-290 days). Table 1 and Figure 1.

Statistical value (Day)	Descriptive Statistic	
272.8		Mean
271.4	Lower Bound	95% Confidence Interval for Mean
274.3	Upper Bound	
272.8		5% Trimmed Mean
273		Median
0.7		Std. Error
7.4		Std. Deviation
260		Minimum
290		Maximum
30		Range

Table1: Descriptive statistics of the true gestational age (day) of the study participants'

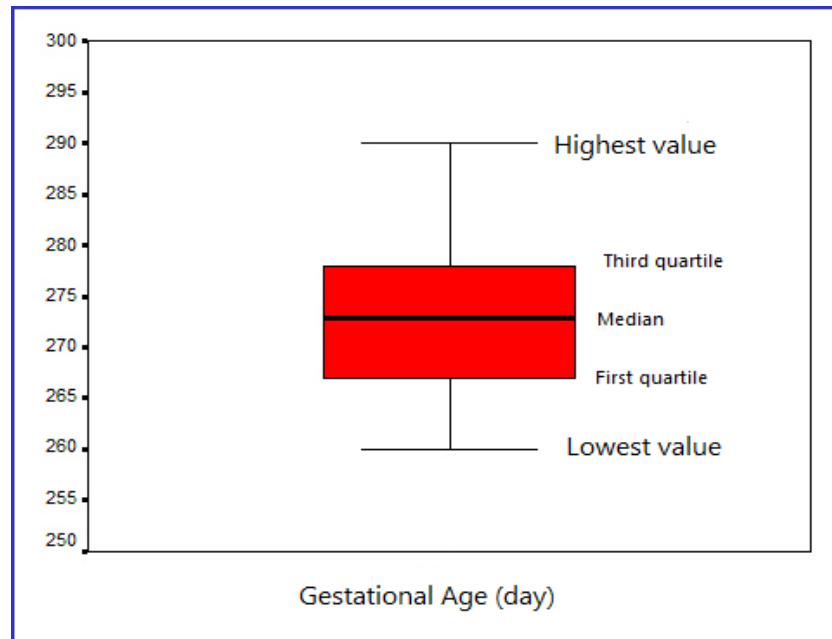


Figure 1: Box plot representing the first quartile (25<sup>th</sup> percentile), the median (50<sup>th</sup> percentile), the third quartile (75<sup>th</sup> percentile) and the lowest and highest values of the true gestational age.

2- Estimating the EDD using the CRL by ultrasound: We estimated remaining time until spontaneous delivery occurs from the date of the CRL 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 CRL measures (mm). (Tables 2, 3, 4 and Figure 2)

**EDD from CRL measures equation:**

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

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

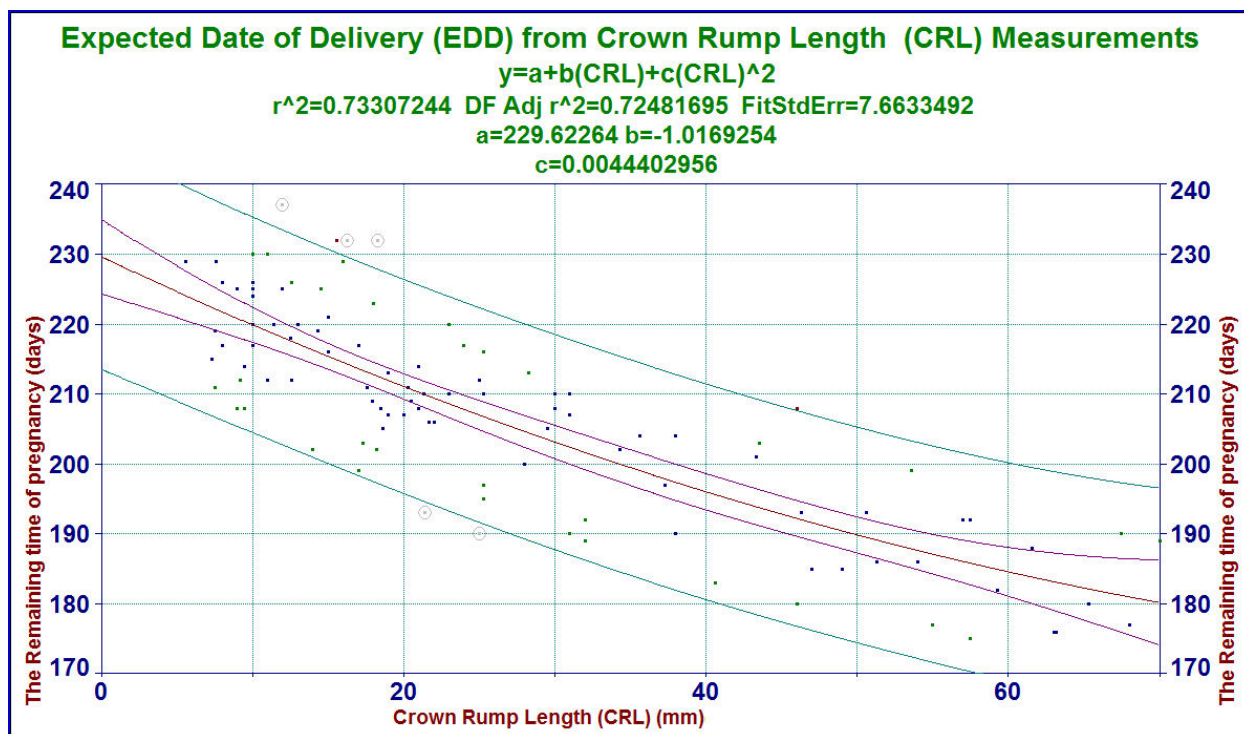
The  $\bar{r}^2$  factor of the regression equation was (0.72 > 0.70) which means that the correlation between the dependent variable (EDD) Y-line and the independent variable (CRL) X-line is strong. (Table 2, Figure 2)

The standard error (difference between the EDD and true delivery date) of the equation was 7.66. (Table 2 and 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: Coefficient of Determination and Standard Error of the Estimate of the EDD using the CRL:**

Std. Error	$\bar{r}^2$	r <sup>2</sup>
Standard Error of the Estimate	Adjusted Coefficient of Determination	Coefficient of Determination
7.66	0.72	0.73





**Figure 2: Estimating the EDD (day) from the CRL (mm)**

Each point represents one fetus result

**Table 3: T test for the constants of the regression equation using CRL:**

P> t  Sig	95% Confidence Limits		t- value	Standar dized Regressi on (Beta)	Std. Error	Value	Variable
	Upper bound	Lower bound					
0.000	234.93	224.31	85.81	--	2.68	229.62	<i>a</i>
0.000	0.64-	1.40-	5.30-	1.22-	0.19	1.02-	<i>b</i>
0.100	<sup>4</sup> -10x9.76	<sup>4</sup> -10x8.76-	1.66	0.38	<sup>3</sup> -10x2.68	<sup>3</sup> -10x4.44	<i>c</i>

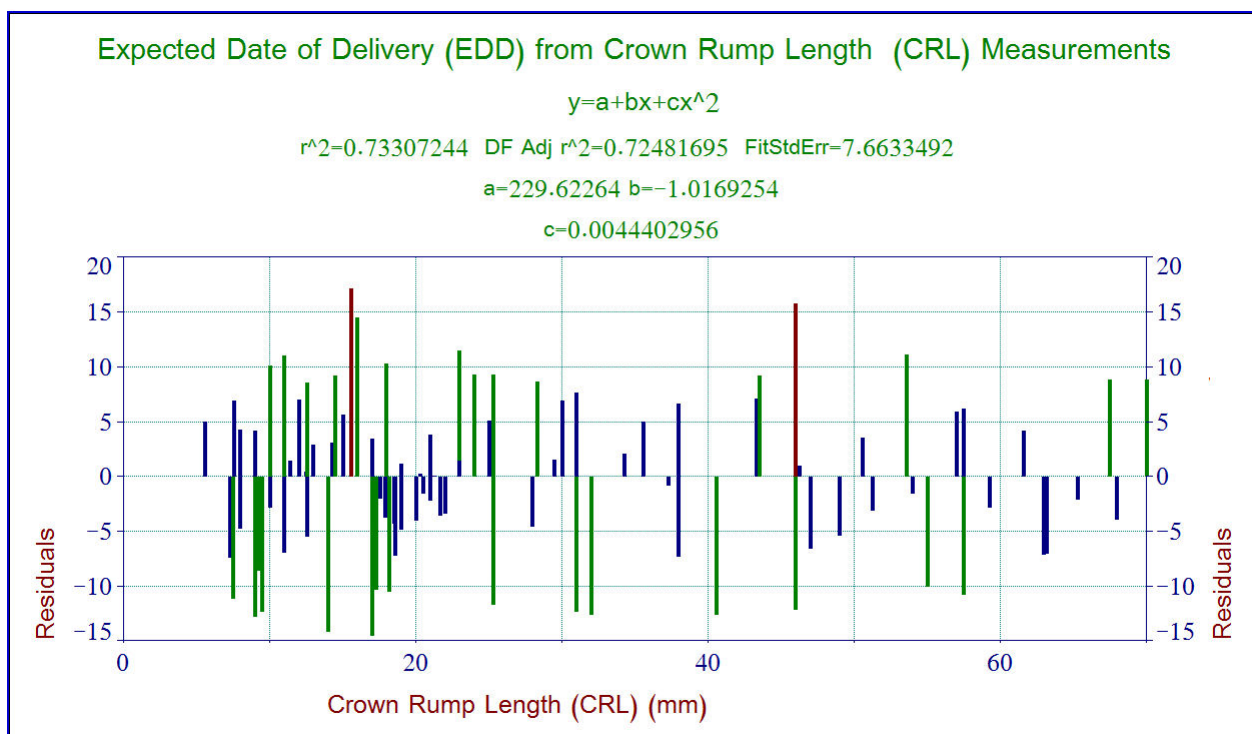
**Table 4: analysis of variance of the constants of the regression equation**

<b>P&gt;F</b>	<b>F Statistic</b>	<b>Mean Square</b>	<b>DF</b>	<b>Sum of Squares</b>	<b>Source</b>
<b><u>0.000</u></b>	<b>134.57</b>	<b><u>7902.91</u></b>	<b>2</b>	<b>15805.81</b>	<b>Regression Model</b>
		<b>58.73</b>	<b>98</b>	<b>5755.24</b>	<b>Residual Error</b>
			<b>100</b>	<b>21561.05</b>	<b>Total</b>

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 CRL measures was between (-15 and 17 days). The standard deviation (SD) in estimating the real gestational age was 7.6 days. (Table 6)

Table 5: Descriptive statistics of the true gestational age (day) of the study participants’.

<b>Statistical Value (Day)</b>	<b>Descriptive Statistic</b>	
<b>272.8</b>		<b>Mean</b>
<b>271.9</b>	<b>Lower Bound</b>	<b>95% Confidence Interval for Mean</b>
<b>273.7</b>	<b>Upper Bound</b>	
<b>272.6</b>		<b>5% Trimmed Mean</b>
<b>272.7</b>		<b>Median</b>
<b>0.4</b>		<b>Std. Error</b>
<b>4.5</b>		<b>Std. Deviation</b>
<b>263.8</b>		<b>Minimum</b>
<b>287.6</b>		<b>Maximum</b>
<b>23.8</b>		<b>Range</b>



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

4 -Predicting the EDD by using the LMP: The gestational age was set as 280 days from the first day of the LMP and the SD was 7.4 days from the true delivery date.

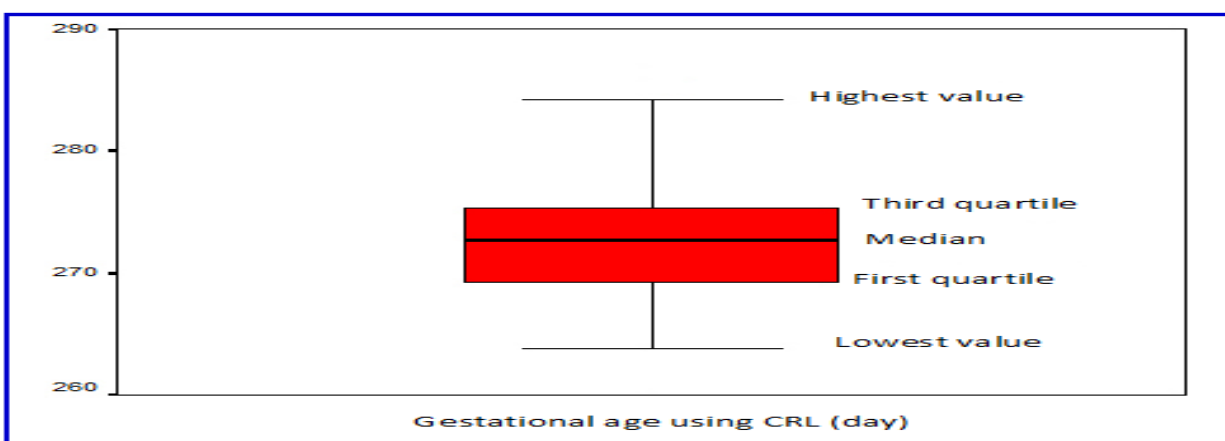
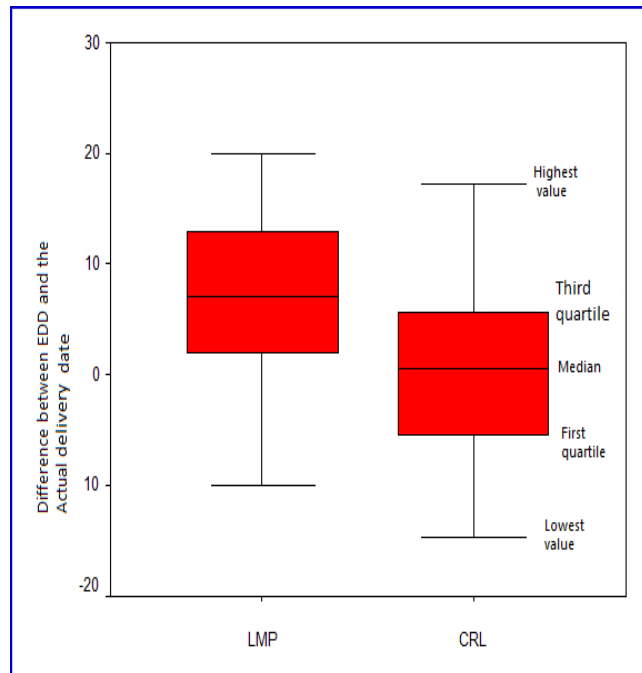


Figure 4: Box plot representing the first quartile (25<sup>th</sup> percentile), the median (50<sup>th</sup> percentile), the third quartile (75<sup>th</sup> percentile) and the lowest and highest values of the EDD using the CRL. 5- (Table 6 and figures 5, 6,7) show a comparison between the EDD and the true delivery date by using both LMP and CRL:

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

<b>CRL</b>	<b>LMP</b>	
<b>7.6</b>	<b>7.4</b>	
<b>%1</b>	<b>%0</b>	<b>SD of the true delivery date (day)</b>
<b>%16.8</b>	<b>%2</b>	<b>EDD is less than the true delivery date by more than 14 days</b>
<b>%34.6</b>	<b>%4</b>	<b>EDD is less than the true delivery date by more than 7 days</b>
<b>%4</b>	<b>%5</b>	<b>EDD is less than the true delivery date by more than 3 days</b>
<b>%38.6</b>	<b>%63.4</b>	<b>EDD=true delivery date</b>
<b>%16.8</b>	<b>%46.5</b>	<b>EDD is more than the true delivery date by more than 3 days</b>
<b>%3</b>	<b>%22.8</b>	<b>EDD is more than the true delivery date by more than 7 days</b>
<b>%26.7</b>	<b>%32.7</b>	<b>EDD is more than the true delivery date by more than 14 days</b>
<b>%66.3</b>	<b>%51.5</b>	<b>EDD is within 3 (<math>\mp</math>3 days) from the true delivery date</b>
<b>%96</b>	<b>%77.2</b>	<b>EDD is within 3 (<math>\mp</math>7 days) from the true delivery date</b>



**Figure 5: Box plot comparing the EDD and the actual delivery date using both CRL (right box) and LMP (left box).**

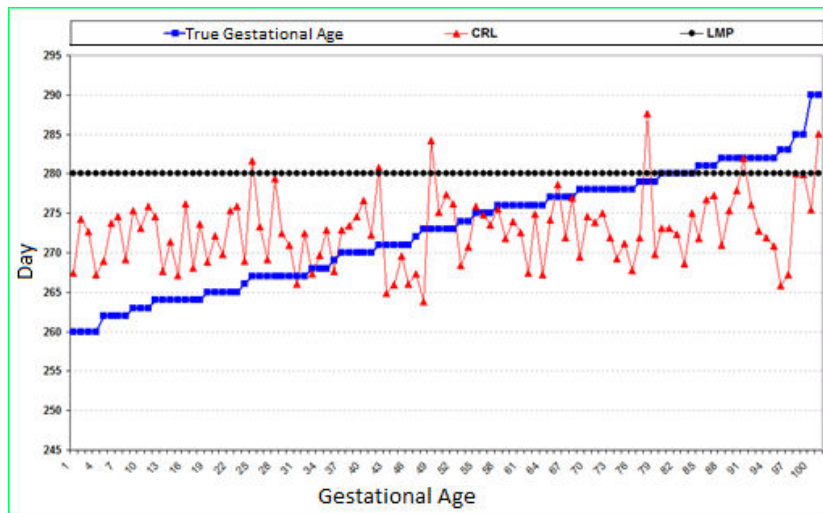


Figure 6: Comparison between the true gestational age (blue line) and the gestational age according to LMP (black line) and the CRL (red line)

There was a significant difference between the EDD calculated by the CRL and by the LMP in which Z value using the Wilcoxon Signed Ranks Test was 8.3 and the value is important with P value < 0.001.

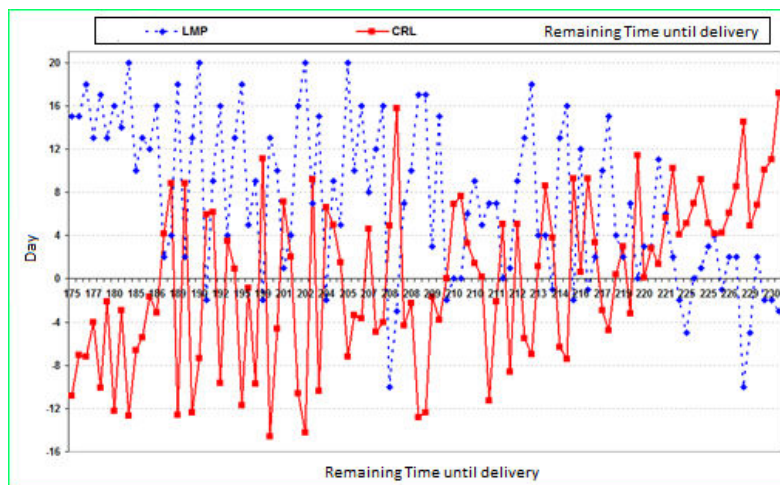


Figure 7: The difference between the true remaining time until delivery (black line) and the remaining time by the LMP (blue line) and the CRL (red line)