

## Use of colon caliber diameter as auxiliary method in pregnancy dating between 34-40 weeks of gestation

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### Abstract

**Objective:** to verify whether fetal colon caliber correlate with gestational age from 34 to 40 weeks of gestation and to develop equation and chart which can be used for pregnancy dating by measuring colon caliber. **Methods:** a total of 220 healthy pregnant women whose age range from 18- 35 years were collected. They were distributed as 30 patients for each of the following gestational ages 34, 35, 36,37,38,39 weeks and 40 patients for 40 weeks of gestation. Their head circumference, abdominal circumference, bi-parietal diameter and femoral lengths were assessed by ultrasound. In addition colon caliber was assessed in the transverse colon. **Result:** there was a highly significant correlation between colon caliber and gestational age in days. In addition a highly significant correlation between colon caliber and bi-parietal diameter, femoral length, head circumference and abdominal circumference were found with P values < 0.0001. A formula was developed to calculate gestational age directly from the fetal colon caliber alone. The equation accuracy was checked by Kappa- Cohen coefficient and found to be 0.71 indicating good predicative ability of this formula. **Conclusions:** despite a new easy to use formula and associated easy to use chart was developed yet we call for extreme caution in its use as we don't know its significance in real life obstetrical world. Further studies are required to confirm its reliability and safety.

**Keywords:** gestational age, fetal colon caliber, fetal dating, ultrasound

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### INTRODUCTION

Needless to say that ultrasound discovery and its applications represents one of the most ironic events in human history. Initially from a secret weapon used by US navy to track the Soviet submarine in 1961, to one of the most reliable medical investigation starting from 1971 until today <sup>[1]</sup>. In the field of obstetrics, gestational age dating stands as one of the most challenging problems which have been solved by routine ultrasound scan. The main biometric variables used in pregnancy dating are bi-parietal diameter and femoral length <sup>[2]</sup>. However, since early days of ultrasound use for gestational age calculation, it was clearly evident that ultrasound dating is none the less inaccurate after 34 weeks of gestation with standard deviation about  $\pm 2$  weeks <sup>[3,4]</sup>. This fact pushed many researchers in the world to use other biometric variables a substitute to improve ultrasound dating late in the third trimester. Fetal kidney and liver size, thalamic

density are among them <sup>[2]</sup>. Yet, those alternate biometric variables are more difficult to measure and less accurate equations were developed for them. In 2011 Ana and her colleagues <sup>[5]</sup> published a paper in which she described fetal colon as a biometric structure which can be used not only for pregnancy dating late in the third trimester but also for diagnosis of fetuses small and large for date at gestational age 36 weeks onwards. So the main aim of this study is to verify whether colon caliber is an independent biophysical parameter which correlates well with gestational age directly or with other parameters used to evaluate gestation like bi-parietal diameter. In addition a formula as well as table may be constructed through which gestational age can be easily evaluated from measuring colon caliber.

### PATIENTS AND METHODS

The study was conducted in Al-Yarmouk teaching hospital from April 2011 up to December 2012. During

this period a total of 220 patients have been chosen to participate in this study. All patients were collected from the outpatient department in the obstetric division in AL-Yarmook Teaching hospital. The study's protocol was approved by the Iraqi commission for medical specialization. For all the patients their verbal consent was taken. All the enrolled women were healthy pregnant ladies between 34 up to 40 weeks gestation, 18 to 35 years old.

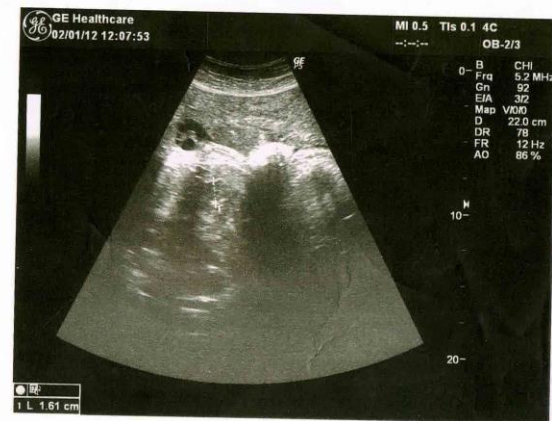
As far as the criteria of inclusion in this study were a singleton pregnant women whose ages between 18-35 years irrespective of their parity. Older and younger patients were excluded as factors which interfere with fetal growth profile are more common. First all the patients were questioned and examined thoroughly. Their last menstrual period (LMP) was taken accurately. Pregnant women with unsure LMP were excluded from the study. This included women who were breast feeding, women with irregular menstrual cycles, and those women who conceived immediately after stopping oral contraceptive pills. Virtually all the patients taken in this study were either primigravida or multi gravida using coitus interrupts or safe period, according to our society demographic profile. Meticulous physical examination was done and routine investigations including blood group, hemoglobin level and general urine examination. In addition routine ultrasound scan was done to exclude fetal anomaly, multiple pregnancy, abnormalities of liquor, mal presentation and placenta previa. Having a patient who has met all the above criteria she was chosen to participate in the study. For those patients who have accepted to participate, they were further sent for detailed ultrasound examination. During sonar scan, bi-parietal diameter, femoral length, head and abdominal circumferences were measured. In addition to colon caliber was assessed and recorded. Gestational age was measured by Naegles rule last menstrual period (LMP) plus 9 months plus 7 days or -3 months plus 7 days. The gestational age was recorded accurately also. At the end of this study a total of 220 patients were collected. As much as 30 women for each gestational age 34, 35, 36, 37, 38 and 39 gestational age in weeks and 40 women for 40 weeks gestational age were collected. All women in sub groups were exactly matched for age. As a matter of fact that was the only difficulty faced in collecting our groups and virtually took some 18 months to complete. Our aim is to have as much as possible homogenized groups so formula construction becomes more accurate and reliable.

#### ***Estimation of colon caliber diameter***

Figure 1 which shows colon caliber diameter corresponding to 16.1 millimeter taken in Ultrasound Department in AL Yarmook hospital. Colon image was acquired by visualizing the fetal abdomen in the transverse plane, and subsequently by changing the position of transducer, in order to visualize a contiguous segment of colon in the longitudinal plane. The measurement of Colon caliber was realized from the inner colon wall interfaces. Three measurements were obtained, and the largest was considered. Scans were acquired with an ultrasound device type Siemens G40.

#### ***Statistical analysis***

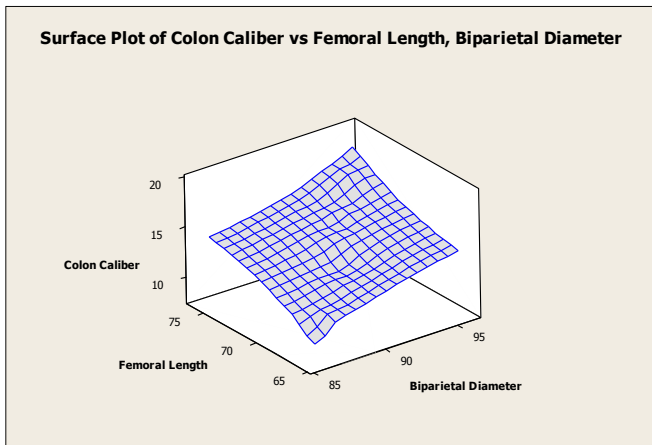
Continuous data were expressed as mean and standard deviation. Categorical variables were expressed as number and percent. Differences in the mean colon caliber among different gestational ages were assessed by One Way ANOVA. The correlation between colon caliber and gestational age was evaluated by construction of linear formula by the use of regression technique. From this formula a table was constructed which corresponds colon caliber for various gestational ages both in weeks and days. The accuracy of this formula was evaluated by assessment of Kappa- Cohen coefficient using the inter-rater statistical procedure. Medcalc statistical package version 13 was used for statistical analysis.



**Figure 1:** a sample of colon caliber taken in AL-Yarmook teaching hospital (*Colon\_Caliber*)

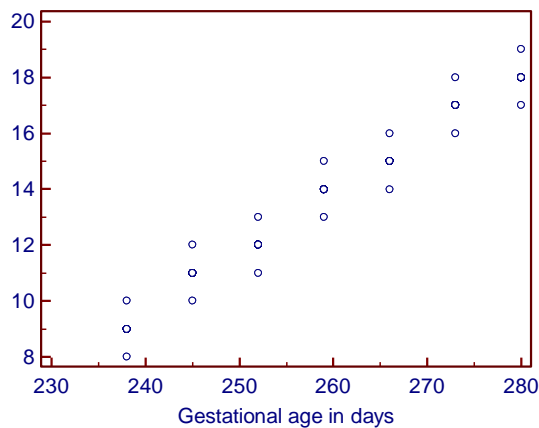
## **RESULTS**

Based on the famous quote “ Picture express 100 times than phrases” by Picasso the results was started by constructing a 3 dimensional surface plot in which the colon caliber is expressed as a function of bi-parietal diameter as well as femoral length as shown in figure 2.



**Figure 2:** Three dimensional surface plot shows colon caliber diameter as surface plot against bi-parietal diameter and femoral length.

Obviously the colon caliber increases with both BPD as well as FL in proportional way. This suggests that colon caliber may be useful in predicting gestational age. So the next analysis is to construct a linear regression between gestational age in days as shown below.



**Figure 3:** a regression line between colon caliber as dependent variable and gestational age in days as independent variable.  $y = -41.5493 + 0.2133 x$ ; Correlation coefficient  $r=0.9902$ ,  $P<0.0001$

As shown in figure 3 colon caliber has very high correlation coefficient and p value < 0.0001. In order to shed more light about correlation between colon caliber and other variables taken in gestational age dating by ultrasound, table 1 shows different correlations and their significance.

**Table 1:** correlation coefficients between colon caliber and head circumference, femoral length, head and abdominal circumference.

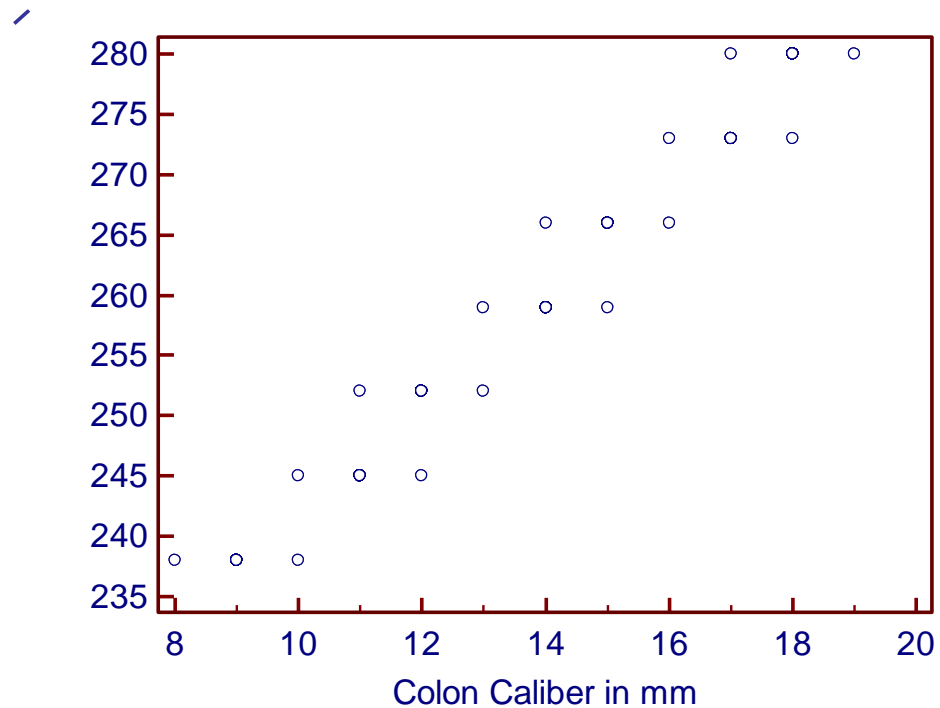
Parameters	Coefficient of correlation	P Value
Bi-parietal diameter Versus Colon caliber	0.9902	P<0.0001
Femoral length versus colon caliber	0.9857	P<0.0001
Head circumference versus colon Caliber	0.9872	P<0.0001
Abdominal circumference versus colon caliber	0.9903	P<0.0001

Evidently from table 1 that colon caliber is proportionally and significantly associated with the 4 most common parameters used commonly for gestational age dating worldwide by ultrasound routine scan. While in table 2 the mean of colon caliber at each gestational age starting from 34 to 40 weeks is given with multiple pair wise comparison done by one way ANOVA test using Student-Newman Keuls test.

**Table 2:** mean colon caliber and Student-Newman-Keuls test for all pairwise comparisons

Group / gestational age in weeks	Number	Mean in mm	Different (P<0.05) from others
(1) 34	30	9.0000±0.371	(2)(3)(4)(5)(6)(7)
(2) 35	30	11.0000±0.371	(1)(3)(4)(5)(6)(7)
(3) 36	30	12.0000±0.371	(1)(2)(4)(5)(6)(7)
(4) 37	30	14.0000±0.371	(1)(2)(3)(5)(6)(7)
(5) 38	30	15.0000±0.371	(1)(2)(3)(4)(6)(7)
(6) 39	30	17.0000±0.371	(1)(2)(3)(4)(5)(7)
(7) 40	40	18.0000±0.320	(1)(2)(3)(4)(5)(6)

Apparently table 2 shows that for each gestational age 34, 35, 36, 37, 38, 38, 39 and 40 weeks the mean of colon caliber is significantly different from the precede or subsequent value. Based on the above facts it may be justifiable to construct a formula which calculate gestational age directly from colon caliber in millimeters. While the characteristics of this formula are given in table 3 and figure 4. Apparently that both slope and coefficient of correlation were highly significant indicating good predictor capability of this equation in estimating gestational age from colon caliber alone.



**Figure 4:** which show a regression line between gestational ages which may be calculated in days via measuring the colon caliber in millimeter with the characteristics of the formula constructed. Gestational age (days) = 196.0344 + 4.5956\* Colon caliber (millimeter).

**Table 3:** characteristics of the Regression Equation

Gestational age (days) = 196.0344 + 4.5956* Colon caliber (millimeter)			Coefficient of correlation = 0.998		
Parameter	Coefficient	Std. Error	95% CI	t	P
Intercept	196.0344	0.6269	194.7989 to 197.2700	312.7161	<0.0001
Slope	4.5956	0.04399	4.5089 to 4.6823	104.4584	<0.0001

**Table 4:** the different colon caliber values in millimeter and their corresponding gestational age in weeks and days

Gestational age	Corresponding Colon Caliber						
	+0	+1	+2	+3	+4	+5	+6
34 weeks	9.13	9.34	9.56	9.78	10.02	10.21	10.43
35 weeks	10.65	10.87	11.09	11.30	11.52	11.74	11.96
36 weeks	12.17	12.39	12.61	12.83	13.04	13.26	13.48
37 weeks	13.70	13.91	14.13	14.35	14.57	14.78	15.00
38 weeks	15.22	15.44	15.65	15.87	16.09	16.31	16.53
39 weeks	16.74	16.96	17.18	17.40	17.61	17.83	18.05
40 weeks	18.27	18.48	18.70	18.92	19.2	19.32	19.40

It is well known fact that most doctors hate mathematics and statistics. So to facilitate the calculation of gestational age by requesting colon caliber from any ultrasound department, table 4 will give immediate result.

In order to verify the overall accuracy of the equation constructed, we have used Kappa Cohen coefficient to verify its overall accuracy. This coefficient is calculated from the number of agreement and disagreement between gestational age calculated by the formula and by the standard method used. Kappa Cohen coefficient for this formula is 0.71. As shown below this indicates good agreement between the dating by equation and last menstrual period. Kappa Cohen coefficient is interpreted as: 1) 0- 0.20 as poor agreement, 2) 0.2- 0.4 as fair agreement, 3) 0.4- 0.6 as moderate agreement, 4) 0.6- 0.8 as good agreement and, 5) 0.8-1 as excellent agreement.

## DISCUSSION

As far as the main result obtained in this study, colon caliber diameter was found to be significantly associated with gestational age, bi-parietal diameter and femoral length, Figure 2 which shows colon caliber diameter as surface plot against bi-parietal diameter and femoral length. As far as the inaccuracy of ultrasound scan in the third trimester, many researchers have explained the cause. Neufeld et al [6] in his study involving 319 women found that variation of the femoral length accounts for major inaccuracy in estimation of gestational age in the third trimester. Beigi et al [7] has found similar finding in his study in Tehran University. In his study involving 15,594 women living in Tehran city scanned in the third trimester for gestational age found that femoral length false measurement in the fetus accounts for major inaccuracy of ultrasound dating. Pierce et al [8] in his study have suggested that maternal height may affect fetal biometry. He suggested that maternal height may affect seriously the fetal biometric measurement in the third trimester. The growing uterus in the maternal abdomen has less space to expand in short women and this may affect fetal biometry. In order to improve accuracy of gestational age measurement in the third trimester, many researchers have used other biometric parameters. Roberts et al [9] have used fetal liver volume as a predictor of gestational age. He suggested through evaluation of 98 pregnant women that fetal liver size correlate with the gestational age in the third trimester. He found also that fetal liver size correlate well with the small for date and large for date fetuses. However, he didn't develop an

equation to predict gestational age from the fetal liver size. Kansaria et al [10] have suggested that fetal kidney correlate well with the gestational age throughout the second and third trimesters. In his paper he has put a table from 24 to 38 weeks and the corresponding fetal kidney size. Alexandros et al [11] have found that thalamus volume as assessed by ultrasound scan correlate well with gestational age. He has developed nonlinear equation to calculate gestational age directly from measurement of the thalamus volume in fetal head. However, measurement of thalamic volume is rather more difficult than other biometric variables. This may explain why this formula didn't gain popularity in clinical practice. Martin et al [12, 13, and 14] in three different papers published in American Journal of Obstetrics and Gynecology have stressed on the importance of transcerebellar diameter as an independent biometric parameter which correlates well with gestational age. He has developed nonlinear formula for direct calculation of gestational age from this biometric diameter. He stressed that this biometric parameter correlate well with gestational age even with twin pregnancy. However, the difficulty in measuring transcerebellar diameter has limited the popularity of this equation in the practice. Gardeil [15] et al has used fat thickness in the fetal abdominal wall as a reliable predictor of gestational age. He has constructed table which predict gestational age in weeks directly from measuring the abdominal wall fat thickness. However, no further studied to evaluate his table were published. Finally de Carvalho et al [5] have published a paper in which colon caliber was used as an auxiliary method to assess gestational age between 37 to 40 weeks. She found that colon caliber correlate well with adequate and small for date fetuses. Upon her study, our study protocol was based. Instead we have chosen women with well documented last menstrual period date between 34 and 40 weeks. It has been found in this study that the significant association between colon caliber in one hand, and bi-parietal diameter on the other hand as shown in the surface plot in figure 2. Consequently a linear formula connecting gestational age with colon caliber has been developed, and easy table has been constructed. The fact that only one study is published in the last ten years about colon caliber in pregnancy dating make it very difficult to compare this study with others. Another drawback is the most biometric parameters like head circumference, fetal weight are not linearly associated with gestational age add another obstacle to the exact interpretation and assessment of the results obtained in this study. In addition as far as measuring colon caliber it requires some time and experience add another factor to

the difficulty in assessing this method. We hope that routine measurement of fetal colon caliber in the transverse colon become a routine practice through which gestational age is evaluated and compared to the standard, otherwise this method become valueless. So our final conclusion with regard to this study that a formula and easy use table may be used to date a pregnancy once fetal colon caliber is measured provided that gestational age between 34- 40 weeks. In case that such formula gives reasonable results a contact may be established with ultrasound manufacturing companies, in such a way that the formula can be incorporated into the device so assessment of gestational age is made easy form direct measurement of the colon caliber. However for the time being extreme caution should be practiced in using this formula as its accuracy in real world of obstetrical practice has not been determined yet. Accordingly further studies are required to define its role in pregnancy dating and other obstetrics related problems.

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