Scientific Research Publishing

Open Journal of Obstetrics and Gynecology, 2020, 10, 1513-1524
https://www.scirp.org/journal/ojog
ISSN Online: 2160-8806
ISSN Print: 2160-8792

The Relation of Fetal Colon Diameter with Estimation of Gestational Age

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How to cite this paper: Haidar, I.A., Al Sakka, K., Abou-Tok, A. and Roumieh, M. (2020) The Relation of Fetal Colon Diameter with Estimation of Gestational Age. *Open Journal of Obstetrics and Gynecology*, **10**, 1513-1524.
https://doi.org/10.4236/ojog.2020.10110137

Received: October 23, 2020
Accepted: November 6, 2020
Published: November 9, 2020

Abstract

Background: Conventional ultrasound dating is not very accurate after 34 weeks of gestation and has standard deviation of about 2 weeks. **Objective:** Verify whether fetal colon diameter can be used as a tool for estimating gestational age (GA) of fetuses between 34 to 40 weeks. **Materials and Methods:** This was a prospective cross-sectional study conducted at Obstetrics and Gynecology University Hospital, Damascus, Syria, during the period from September 2019-September 2020. The study enrolled 395 women with uncomplicated singleton pregnancies at 34 - 40 weeks of gestation. Fetal bi-parietal diameter, head circumference, abdominal circumference, and femoral lengths were assessed by ultrasound. In addition, descending colon diameter was assessed at the level of colonic haustra. The correlation between GA and colon diameter was assessed by the Pearson correlation test. **Results:** Significant correlation between fetal colon diameter and gestational age was observed $P < 0.0001$ ($r = 0.852$). In addition, a highly significant correlation between colon diameter and bi-parietal diameter, femoral length, head circumference and abdominal circumference were found with P values < 0.0001. The correlation between gestational age at 3rd trimester and colon diameter was significantly stronger than the correlation between gestational age and bi-parietal diameter, head circumference, and abdominal circumference. Whereas, no significant difference was found when comparing colon diameter and femoral lengths ($P = 0.089$). **Conclusion:** The present study suggested that colon diameter can be used for predicting third trimester gestational age.

Keywords

Colon Diameter, Fetal Colon, Gestational Age, Ultrasound

1. Introduction

The gestational age of all pregnant women must be calculated for safe antenatal

evaluation throughout the remainder of the pregnancy for both mother and fetus.

The accurate estimation of pregnancy dates is important for the mother, who wants to know when to expect the birth of her baby, and for her health care providers, so they may choose the times at which to perform various screening tests and assessments, such as serum screening, assessment of maturity, and induction of labor for postdate pregnancies [1].

Prior to the widespread use of ultrasound, clinicians relied on a combination of history and physical examination to clinically determine gestational age. Ultrasound imaging provided an advanced obstetric practice by enabling relatively detailed evaluation of the fetus, including accurate estimation of gestational age when performed before 22 weeks of pregnancy. This information is invaluable because most diagnostic and management decisions during pregnancy are strongly influenced by the development of the fetus, which is closely related to the age of the fetus. The first trimester of pregnancy is the best time to determine the gestational age with ultrasound. As pregnancy progresses into the third trimester, the accuracy of the biometric measurements typically used to determine gestational age declines due to major biological changes. After 34 weeks of pregnancy, there is a standard deviation of ±2 weeks in determining the gestational age. Therefore, a new ultrasound index must be found, as despite the presence of other indices of gestational age in the last trimester, they are imprecise when taken for the first time, due to the large biological changes in the size of the fetus [2].

The first ultrasound imaging of the fetus colon was done in 1983 by Zilanti and Fernandez, in which the relationship between fetal colon diameter and gestational age was established [3].

In 1987, Goldestein *et al.* suggested that gradient augmentation of the fetal colon diameter could be used to estimate gestational age, especially in the third trimester of pregnancy, as it is considered an independent indicator [4]. In 2015, Helen and Dadgar demonstrated that there is a good linear relationship between fetal colon diameter and gestational age, and fetal colon diameter can be used as an independent biometric measurement to determine gestational age [5].

Recently, researchers have shown interest in using fetal colon diameter in some studies, not only to determine gestational age in the third trimester but also to diagnose small and large for gestational age fetuses 36 weeks and over.

The aim of this study was to determine whether fetal colon diameter can be used as an independent parameter for estimating gestational age in the third trimester.

2. Materials and Methods

This prospective cross-sectional study was conducted at Obstetrics and Gynecology University Hospital, Damascus from September 2019 and September 2020. During this period, 395 pregnant women aged 14 to 45 years and between 34 to 40 weeks of pregnancy were included. Written informed consent was ob-

tained from all of the women before the study. The study group consisted of pregnant women who fulfilled the following criteria:

1) History of regular menses with a known date of the beginning of the last menstrual period, or crl < 12 weeks.

2) Clinically and sonographically normal singleton fetus.

Exclusion criteria included:

Fetal anomalies, multiple pregnancies, polyhydramnios, oligohydraminos, macrosomia, hypertension, gestational diabetes, and malpresentation.

Each patient was scanned only once during the study by a single experienced sonographer using a trans-abdominal 3.5 - 5.0-MHz curvilinear transducer.

The fetal colon was identified sonographically by its peripheral location and characteristic haustral folds. The maximum internal diameter of the fetal descending colon was measured in the parasagittal plane [6]. Each measurement was repeated three times in each fetus and the largest diameter was recorded.

The colon of the fetus is viewed through a cross-section at the level of the periphery of the fetus's abdomen [7], then the probe is changed in successive maneuvers where the transverse colon is identified by its anatomical position below the liver by an axial section from right to left and by a Sagittal side section. The transverse colon is followed by the descending colon [8]. The measurement of fetal colon diameter was followed by biometric measurements like bi-parietal diameter, head circumference, abdominal circumference and femur length. Once these measurements were made, these women were followed up till their delivery.

3. Statistical Analysis

Statistical analysis was performed using the *Statistical Package for the Social Sciences* (SPSS) (version 20) as well as Excel 2010. Predictive value less than 0.05 was considered statistically significant. All data are presented as mean ± SD for continuous variables. The mean and 95% confidence interval were calculated for the colon diameters according to the gestational age. Pearson's correlation coefficient was used to study the correlation between gestational age and each of the biometric parameters. Also, it was used in order to study the correlation between colon diameter and other biometric measurements.

Fisher-z-transformation test was used to compare the strength of association with gestational age between colon diameter and the rest of biometric measurements.

4. Results

The study included 395 pregnant women with a mean maternal age of 26.9 ± 6.17 years (range, 14 - 45 years). The mean gestational age of all pregnant women was 37.4 ± 1.88 weeks (range, 34 - 40 weeks). Maternal age, gestational age and parity characteristics are shown in **Table 1**.

The mean bi-parietal diameter was 89.8 ± 6.37 mm (range, 35 - 99.2 mm). The mean head circumference was 314.3 ± 15.8 mm (range, 228 - 350 mm). The

mean abdominal circumference was 330.3 ± 21.7 mm (range, 230 - 370 mm). The mean femur length was 71.45 ± 3.71 mm (range, 58 - 79.7 mm). The mean colon diameter was 12.53 ± 2.6 mm, with a range of 6 - 18.8 mm.

Table 2 shows the mean values of bi-parietal diameter, head circumference, abdominal circumference, and femur length according to gestational age.

Table 3 shows the mean values of colon diameter according to gestational age.

Table 4 shows the different colon diameter values in millimeter and their corresponding gestational age in weeks and days.

Table 5 and Figure 1 show the linear correlation between colon diameter and gestational age.

Table 1. Maternal age, gestational age, and parity characteristics of women.

Characteristics	Patients (n)	Percent (%)
Maternal age (years)		
<20	36	9.1%
20 - 25	117	29.6%
26 - 30	135	34.2%
>30	107	27.1%
Gestational age (weeks)		
34 - 35	44	11.1%
35 - 36	50	12.7%
36 - 37	57	14.4%
37 - 38	61	15.4%
38 - 39	64	16.3%
39 - 40	65	16.4%
40	54	13.7%
Parity		
Nulliparous	88	22.3%
Multiparous	307	77.7%

Table 2. Mean values of biometric measurements according to gestational age.

GA (weeks)	N (patients)	bi-parietal diameter (mm)	head circumference (mm)	abdominal circumference (mm)	femoral length (mm)
34 - 35	44	86.1 ± 2.6	300.85 ± 18.8	305 ± 12.1	66.8 ± 2
35 - 36	50	87.4 ± 3.9	303.6 ± 9.39	309.2 ± 15.5	67.1 ± 2.6
36 - 37	57	88.01 ± 7.39	306.56 ± 10.4	321.5 ± 11.1	69.7 ± 1.77
37 - 38	61	88.25 ± 8.7	308.7 ± 17.5	328.3 ± 18.1	71.45 ± 2.45
38 - 39	64	91.34 ± 4.05	321.9 ± 8.75	338.9 ± 12.13	72.92 ± 1.41
39 - 40	65	91.77 ± 7.06	323.4 ± 8.9	347.7 ± 16.6	74.5 ± 1.74
40	54	93.45 ± 2.47	324 ± 16.1	350.8 ± 14.8	75.7 ± 2.38

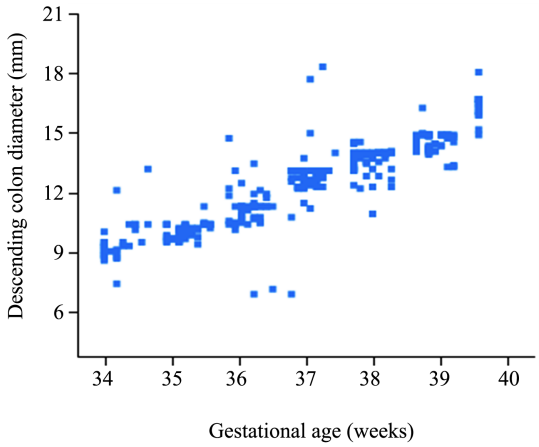

Figure 1. Pearson's correlation between gestational age and colon diameter.

Table 3. Mean values of colon diameter according to gestational age.

GA (weeks)	N	colon diameter (mm)	CI 95%
34 - 35	44	9.07 ± 1.14	8.74 - 9.4
35 - 36	50	9.59 ± 0.41	9.48 - 9.7
36 - 37	57	10.77 ± 1.26	10.44 - 11.1
37 - 38	61	12.7 ± 1.49	12.33 - 13.07
38 - 39	64	13.5 ± 0.73	13.32 - 13.68
39 - 40	65	14.6 ± 0.61	14.45 - 15.11
40	54	17.1 ± 1.8	16.62 - 17.58

Table 4. The different colon diameter values in millimeter and their corresponding gestational age in weeks and days.

GA	Corresponding colon diameter						
	+0	+1	+2	+3	+4	+5	+6
34 weeks	8.5	8.6	8.7	8.9	9.1	9.17	9.3
35 weeks	9.2	9.37	9.45	9.61	9.68	9.75	10.1
36 weeks	10.33	10.46	10.5	10.6	10.75	10.75	10.82
37 weeks	12	12.3	12.41	12.5	12.7	12.73	13.1
38 weeks	13.17	13.2	13.3	13.45	13.5	13.76	13.94
39 weeks	14.3	15.4	14.53	14.62	14.76	14.8	14.9
40 weeks	15.4	15.93	16.35	17.1	17.5	18.1	18.3

Table 5. Correlation coefficient between colon diameter and gestational age.

Parameter	Coefficient of correlation	P value
GA versus Colon diameter	0.852	<0.0001

A statistically significant positive linear correlation was found between gestational age and fetal colon diameter.

The correlation equation between colon diameter and gestational age is: GA (weeks) = 29.29 + (0.643 × the maximum diameter of the descending colon in mm).

We studied the correlation between gestational age and each of the other biometric parameters as shown in Table 6 and Figure 2. A statistically significant positive linear correlation was found between gestational age and bi-parietal diameter (r = 0.338), head circumference (r = 0.482), abdominal circumference (r = 0.722), and femur length (r = 0.809).

Table 7 and Figure 3 show the correlation between colon diameter and the other biometric parameters. A statistically significant positive linear correlation was found between colon diameter and bi-parietal diameter (r = 0.303) P < 0.0001, head circumference (r = 0.419) P < 0.0001, abdominal circumference (r = 0.659) P < 0.0001, and femur length (r = 0.785) P < 0.0001.

We compared the strength of correlation with gestational age between colon diameter and other biometric measurements separately using Fisher-z-transformation test as shown in Table 8. The statistical analysis showed that the correlation between gestational age and colon diameter is stronger than the correlation between gestational age and bi-parietals diameter, head circumference, and abdomen circumference (P < 0.05). Whereas, the difference was not statistically significant when comparing with femur length (P = 0.089).

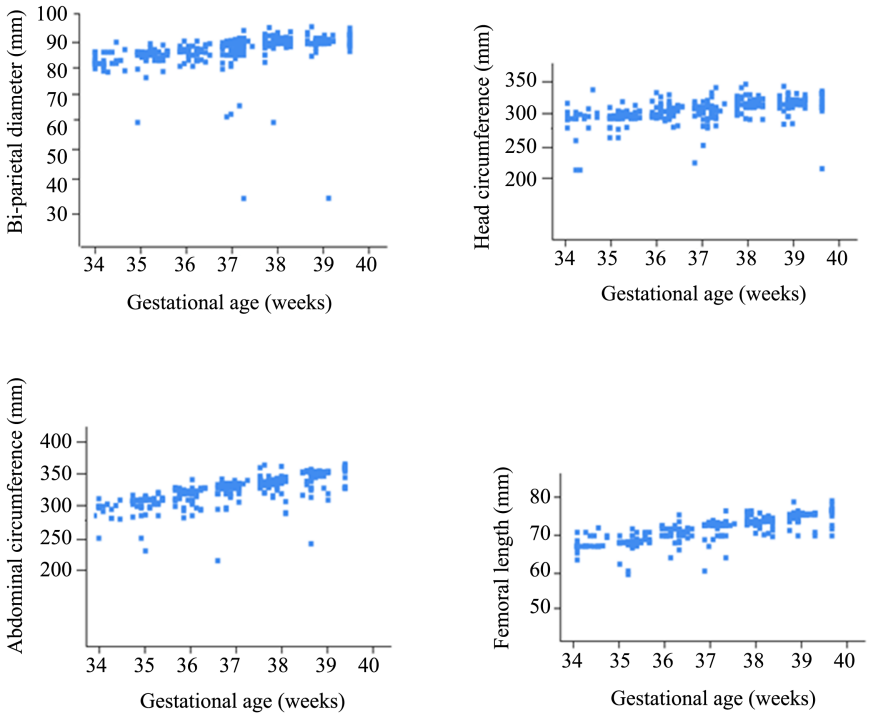

Figure 2. Pearson's correlation between gestational age and bi-parietal diameter, head circumference, abdominal circumference, and femur length.

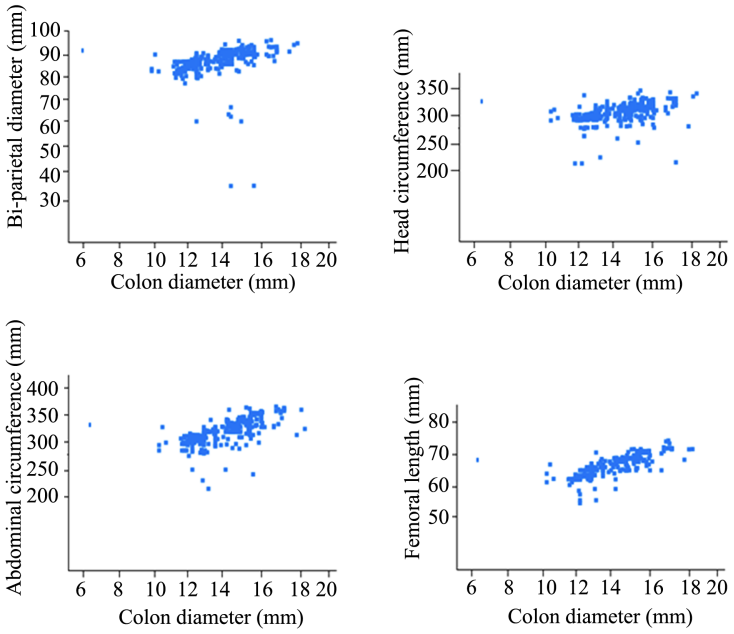

Figure 3. Pearson's correlation between colon diameter and bi-parietal diameter, head circumference, abdominal circumference, and femur length.

Table 6. Correlation coefficients between gestational age and bi-parietal diameter, head circumference, abdominal circumference and femur length.

Parameters	Coefficient of correlation	P value
GA versus bi-parietal diameter	0.338	<0.0001
GA versus head circumference	0.482	<0.0001
GA versus abdominal circumference	0.722	<0.0001
GA versus femoral length	0.809	<0.0001

Table 7. Correlation coefficients between colon diameter and bi-parietal diameter, head circumference, abdominal circumference and femoral length.

Parameters	Coefficient of correlation	P value
Colon diameter versus bi-parietal diameter	0.338	<0.0001
Colon diameter versus head circumference	0.482	<0.0001
Colon diameter versus abdominal circumference	0.722	<0.0001
Colon diameter versus femoral length	0.809	<0.0001

Table 8. Comparison the strength of correlation with gestational age between colon diameter and the other biometric measurements.

Correlation	Coefficient of correlation	Fisher-Z-Transformation	P value
Correlation between GA and colon diameter	0.852	-	
Correlation between GA and bi-parietal diameter	0.338	11.11	<0.0001
Correlation between GA and head circumference	0.482	8.99	<0.0001
Correlation between GA and abdominal circumference	0.722	4.28	<0.0001
Correlation between GA and femur length	0.809	1.7	0.089

5. Discussion

One of the most important goals of prenatal care is to have a healthy, mature baby. To achieve this goal, determining the gestational age is of particular importance. Accurate estimation of gestational age allows the diagnosis of normal and abnormal growth of the fetus and determines the need for prenatal interventions such as chorionic villus sampling and amniocentesis, screening tests, interpretation of biochemical results, how to deal with pregnancy complications (pre-eclampsia and early rupture of membranes), determining the time of cesarean delivery, premature labor and the need to suppress labor, the need for corticosteroids, and mother transfer to a hospital equipped with a neonatal intensive care unit.

It is not unusual in our daily clinical practice to find patients visiting OPDs in the last trimester without known last menstrual period and a dating ultrasound done in the first trimester.

During the 6th week of fetal development, the endodermal epithelium of the gut tube proliferates and completely occludes the lumen. Over the next 2 weeks, however, it vacuolates and recanalizes [9]. Congenital stenosis or duplication of the fetal colon may result from incomplete recanalization, resulting in intestinal obstruction [9]. Abnormal rotation and fixation of the fetal primary intestinal loop may result in a variety of malformations, including compression or volvulus of the intestine [9].

It is common for many women to be referred to an ultrasound unit for suspicion of expanding the intestine of the fetus, so one of the aims of this study was to develop a table of reference values for the normal descending colon diameter of fetuses in the 3rd trimester of pregnancy among Syrian women.

This study included 395 singleton pregnant women (88 nulliparous, 307 parous), with a regular menstrual cycle and accurate knowledge of the last menstrual period at a gestation age between 34 - 40 weeks.

The mean maximum diameter of the fetuses descending colon at 34 - 40 weeks of gestation was 12.53 mm (range 6 - 18.8 mm). The mean colon diameter at 34 weeks of gestation was 9.07 mm (95% CI: 8.74 - 9.4), and at 40 weeks it was 17.1 mm (95% CI: 16.62 - 17.58). We observed variation in colon diameter at each gestational age, the main result of this study was the presence of a statistically significant positive correlation between the third trimester gestational age and the maximum diameter of the fetal descending colon ($r = 0.852$, $P < 0.0001$).

The regression equation for gestational age as a function of colon diameter was derived as: GA (weeks) = 29.29 + (0.643 × the maximum diameter of the descending colon in mm).

One of the first studies of the correlation between colon diameter and gestational age was the study of Goldestein *et al.* [4] in 1987, that study included 289 pregnant women with uncomplicated singleton pregnancies between 16 and 40 weeks of gestation. They found a statistically significant correlation between the transverse colon diameter (not descending as in our study) and gestational age (r

= 0.859, P < 0.0001).

Also in 1987, the study of Nyberg *et al.* [10] included 130 pregnant women in the second and third trimesters of pregnancy. They found a statistically significant positive linear correlation between colon diameter and gestational age (r = 0.82, P < 0.05). In this study, the colon diameter gradually increased from 4-6 mm at the 22nd week of pregnancy to 10-18 mm at term.

In 2003, Zalel *et al.* [11] conducted a study of 379 pregnant women with uncomplicated singleton pregnancies between 16 and 40 weeks of gestation. The minimum and maximum diameter of the descending colon were measured by ultrasound. They found a statistically significant linear correlation between the maximum diameter of the descending colon and gestational age (r = 0.848, P < 0.0001). In this study, the mean maximum diameter of the descending colon at 34 weeks of gestation was 8.1 mm, it was 18 mm at term.

In 2013, Akram *et al.* [6] conducted a study including 220 pregnant women with uncomplicated singleton pregnancies between 34 and 40 weeks of gestation. They found a statistically significant positive linear correlation between colon diameter and gestational age in days (r = 0.99, P < 0.0001). In this study, the mean maximum diameter of the descending colon at 34 weeks of gestation was 9 mm and it was 18 mm at term.

In 2015, Sahebghalam *et al.* [5] conducted a study including 100 pregnant women with uncomplicated singleton pregnancies, and a statistically significant positive linear correlation was found between colon diameter and gestational age (r = 0.935, P < 0.0001). The mean maximum diameter of the descending colon at term was 17.9 mm.

In 2016, Arora *et al.* [12] conducted a study including 100 pregnant women with uncomplicated singleton pregnancies between 32 and 40 weeks of gestation. They found a statistically significant positive linear correlation between colon diameter and gestational age (r = 0.582, P < 0.0001). The mean maximum diameter of the descending colon at term was 18.6 mm. The regression equation for gestational age as a function of colon diameter was derived as: GA (weeks) = 28.61 + (0.629 × the maximum diameter of the descending colon in mm).

Our study showed a correlation between the maximum diameter of the fetal descending colon in the late third trimester and the other biometric measurements (bi-parietal diameter r = 0.303, P < 0.0001), (head circumference r = 0.419, P < 0.0001), (abdominal circumference r = 0.65, P < 0.0001), and (femur length r = 0.785, P < 0.0001).

Our results are consistent with Akram *et al.*, they found a statistically significant correlation between colon diameter and the four biometric measurements most commonly used at the clinical practice level (bi-parietal diameter r = 0.99), (head circumference r = 0.987), (Abdominal circumference r = 0.99), and (femur length r = 0.985).

Arora *et al.* also showed a strong correlation between colon diameter and femur length (r = 0.632).

Our study showed a correlation between conventional biometric parameters

(bi-parietal diameter, head circumference, abdominal circumference, and femur length) in the late third trimester of pregnancy and gestational age.

In order to determine the best biometric measurement for estimating gestational age, we compared the correlation between gestational age and colon diameter with the correlation between gestational age and each of the biometric parameters. We found that the correlation between gestational age and colon diameter is stronger than the correlation between gestational age and bi-parietal diameter, head circumference, abdominal circumference, and femur length. Whereas, the difference was not statistically significant when comparing colon diameter and femur length (P = 0.089).

There is a lack of studies that compared the correlation of colon diameter with gestational age and the correlation of other biometric parameters with gestational age in the third trimester of pregnancy.

Arora *et al.* found that the correlation between femur length and gestational age (r = 0.725) was higher than the correlation between colon diameter and gestational age (r = 0.528).

We extracted a table of reference values for the normal descending colon diameter of fetuses in the late third trimester of pregnancy in Syrian women (Table 5).

6. Conclusions

There is a statistically significant positive linear correlation between the maximum diameter of the fetal descending colon in the third trimester of pregnancy and gestational age (r = 0.852, P < 0.0001).

The regression equation was extracted: GA (weeks) = 29.29 + (0.643 × the maximum diameter of the descending colon in mm).

There is a statistically significant correlation between conventional biometric measurements (bi-parietal diameter, head circumference, abdominal circumference, and femur length) and gestational age in the third trimester of pregnancy.

Colon diameter was significantly correlated with bi-parietal diameter (r = 0.303 P < 0.0001), head circumference (r = 0.419 P < 0.0001), abdominal circumference (r = 0.659 P < 0.0001), and femur length (r = 0.785 P < 0.0001).

Correlation between gestational age and colon diameter is stronger than the correlation between gestational age and bi-parietal diameter, head circumference, and abdominal circumference.

A table of reference values for the normal colon diameter in the third trimester of pregnancy in Syrian women has been drawn up.

7. Recommendations

This study may be the first of its kind in Syria that evaluated the role of colon diameter in determining the gestational age in the late third trimester of pregnancy. We recommend that this study data (such as the equation for the regression correlation between colon diameter and gestational age and the table of

normal values) to be a base for further research and studies in the future in order to adopt this measurement as a main tool in estimating the gestational age of women who present between 34 - 40 weeks of pregnancy without ultrasound evaluation in the first trimester.

Ethical Approval

Department of Obstetrics and Gynecology and the Damascus University deanship ethical approval was taken.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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