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Research Article

Abdominal Circumference Measurement by Ultrasound To Estimate Gestational Age As An Alternative Method To Last Menstrual Period Date

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ABSTRACT

This research aimed to determine the efficacy of Abdominal Circumference (AC) by ultrasound in estimating the Gestational Age (GA) compared to GA by Naegele's rule using Last menstrual period (LMP) date. 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 2067 fetuses (894 healthy women) and we had 1392 AC measurements. Data were collected prospectively and used for statistical analysis. We used Descriptive Statistics to calculate the Mean, Standard Deviation (SD), Median and Percentiles values (3rd, 5th, 10th, 50th, 90th, 95th, and 97th) for AC measurements on gestational age. We found a regression equation to estimate the GA using AC measurements. The results of the current study were compared with different studies using the Paired Differences (t-test analysis). In this study, we presented diagrams and tables for the estimation of GA using AC measurements in a group of pregnant Syrian women. These results can be useful in women who cannot recall their last menstrual period (LMP). Our criteria will provide useful references for estimating gestational age and fetal care. A larger study might be needed to include a larger sample of the population.

INTRODUCTION

Monitoring fetal growth and assessing the growth predictors has an important role in the care of pregnant women. Accurate estimation of GA gestational age and Fetal Weight (FW) are clinically important. Ultrasound is useful as an accurate method for estimating Gestational Age (GA). Different embryonic measurements can be used to date pregnancy. Accurate estimation of GA is important in for normal and pathological pregnancies management.[1,2,3] We used AC (mean gestational sac diameter) to predict the GA in pregnant women reviewing different hospitals in Damascus, Syria. Up to our Knowledge, this study is the first of its kind in Syria.

MATERIALS AND METHODS

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

2- Setting: Hospitals in Damascus.

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. 51% (455/894) of all participants were between 22-30 years old and most of them were housewives of a low socioeconomic status.

4- Inclusion criteria

- Voluntary participation with informed consent.
- A correct, accurate and reliable patient's knowledge of the first day of the LMP.
- Regular menstrual cycles (at least three previous regular menses).
- Singular alive normal fetus with a gestational age between 13-41 weeks. (3).
- 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.
- Irregular menstrual cycles.
- Multi-gestation or fetal demise.
- Oral contraceptive use (OCP) or any recent hormonal treatment (3-4 months) before current pregnancy.
- Pregnancy during lactation.
- History of previous abortion or recent delivery preceding the current pregnancy.

- Diagnosis of fetal malformations during examination or after birth.
- Presence of any medical or obstetric complication with known effect on fetal growth.
- Smoking or drug addiction.
- AC measures taken after week 41 of pregnancy.
- Pregnancies that ended in abortion preterm or post term deliveries.
- Date of delivery (vaginal or cesarean section) is inaccurate.
- Mal positioned deliveries.

6- Ultrasound examination: An ultrasound examination was made for 894 pregnant women (2067 fetuses) who were selected according to the previously explained inclusion and exclusion criteria and reviewed the hospital between February 2017 and October 2017 to determine gestational age by measuring different fetal parameters (in this study AC). We had 1392 AC measurements.

STATISTICAL ANALYSIS METHODS

The regression model of the AC was used to determine the GA 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 GA using the AC regression model. Paired – Samples T-TEST were done to test each method accuracy.

RESULT & DISCUSSION

The Embryonic Parameters have several applications in clinical practice such as estimating the gestational age, fetal weight, and fetal growth. In this study, we presented Growth Charts & Tables with the (3rd, 5th, 10th, 50th, 90th, 95th, and 97th) Percentile Values and the standard deviation of AC during the concordant pregnancy periods. We set a regression model equation that can be used to estimate the expected GA using AC measurements (mm).This equation was statistically significant (P <0.001). A strong correlation was found between the dependent variable (GA) and the independent variable (AC). We presented charts and tables that can estimate the GA (weeks) using AC measurements (mm).

We found a third degree valuable regression equation (p<0.001) that we can use to get the expected GA from AC measures (mm).

GA from AC measures (mm):

$$\hat{Y}_i = 10.285 + 0.026\,(AC)_i + 2.99 * 10^{-4}\,(AC)_i^2 + 4.01 * 10^{-7}\,(AC)_i^3$$

$\bar{r}^2 = 0.98$ Std. Err $= 1.22$

The Adjusted Coefficient of Determination $(\bar{r})^2$ of the regression model of GA (weeks) using AC measurements (mm) was 0.98. The coefficient of determination is greater than 0.75 (75%), therefore, the correlation between the dependent variable Y line (GA) and the independent variable X line (AC) is very strong (Figure 2).

The Mean Sum of Squares of regression deviations of the GA regression model using (AC) was 28947.3 and this value is significant at P <0.001.

The standard error of the Estimate (Std. Error) for the GA regression model (using AC measurements) was 1.22 (Figure 2). This value represents the effect of many factors that were not included in the regression model which affect the dependent variable Y line (GA). (Figure 2).

Figure 2 shows the expected GA (weeks) using AC measurements (mm). Based on the regression model, we also demonstrated the expected GA, the lower and upper limits of the confidence interval (Table 2).

The standard deviation (SD) of estimated the GA (weeks) from the actual GA using AC measurements (mm) were (0.8,1. 1, 1.3, 1.3, 1.5) weeks when the GA were (12-18, 18-24, 24-30, 30-36, 36-42), respectively. (Table 3)

We compared this study to many similar studies such as Kawin Kankeow, J. Kurmana vicious, ASUM, Hadlock, and PJ Schluter. We compared the correlation coefficient , the mean, standard deviation, standard Error, lower and upper limits of the confidence interval (95% Confidence Interval of the Difference), the T value, the degree of freedom df, P value and Statistical Significance.

The comparison results were: the correlation coefficients values were strong (0.9987, 0.9996, 0.9994, 0.9992, and 0.9950) and significant (0.000, 0.000, 0.000, 0.000, 0.000) between this study and the compared studies (as Kawin Kankeow, J. Kurmana vicious, ASUM, Hadlock, PJ Schluter), respectively (P <0.001) (Table 4). The mean difference in the AC measurements (mm) using the Paired-Samples T-TEST between this study and the compared studies was (5.54, 9.71, 1.52, 4.38, and 0.57) mm, respectively according to GA. The negative values indicates that the values of the compared studies were higher. There is statistical significance (P<0.001) between the current study and all the compared studies except PJ Schluter.

CONCLUSION

Many women do not recall their LMP and most pregnant women review the clinic in the first three months of pregnancy and the estimation of GA is important for the follow up and determine the Expected delivery date (EDD) for assessing growth during the rest of pregnancy and predicting the expected date of delivery (EDD). We presented diagrams and tables for the estimation of GA using AC measurements in a group of pregnant Syrian women reviewing different hospitals in Damascus, Syria according to the inclusion and exclusion criteria stated before. These results can be useful in women who cannot recall their last menstrual period (LMP). Our criteria will provide useful references for estimating gestational age and fetal care. A larger study might be needed to include a larger sample of the population. We also compared our results with similar studies abroad, and we found that our results were lower than their counterparts were. These results could help in estimating the gestational age, diagnosing fetuses who are younger than their GA, and IUGR embryos. Thus, ultrasound may be more accurate and could replace LMP method.

RECOMMENDATIONS

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

2. Using the AC by ultrasound to determine the GA especially in women who cannot recall their LMP accurately.

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TABLE AND FIGURE

Table 1: Growth chart of the MGSD measurements (mm) showing the Percentile Values and Standard deviation (SD) between 5-15 weeks of pregnancy.

GA (weeks)	Standard deviation (SD)	**MGSD (mm) Percentiles**						
		%3	**%5**	**%10**	**%50**	**%90**	**%95**	**%97**
5	3.4	2.3	3.1	4.3	8.7	13.1	14.3	15.1
6	4.6	4.6	5.7	7.4	13.3	19.2	20.9	22.0
7	6.7	7.2	8.8	11.2	19.8	28.5	30.9	32.5
8	5.5	17.6	18.9	20.9	28.0	35.0	37.0	38.3
9	6.0	23.8	25.2	27.4	35.1	42.7	44.9	46.3
10	6.0	30.4	31.8	34.0	41.6	49.3	51.5	52.9
11	5.1	35.8	37.0	38.9	45.4	52.0	53.8	55.0
12	5.3	41.4	42.7	44.6	51.3	58.1	60.0	61.2
13	6.4	48.4	50.0	52.3	60.4	68.6	70.9	72.4
14	4.5	54.0	55.1	56.7	62.5	68.3	69.9	71.0
15	5.9	66.1	67.5	69.6	77.2	84.8	87.0	88.4

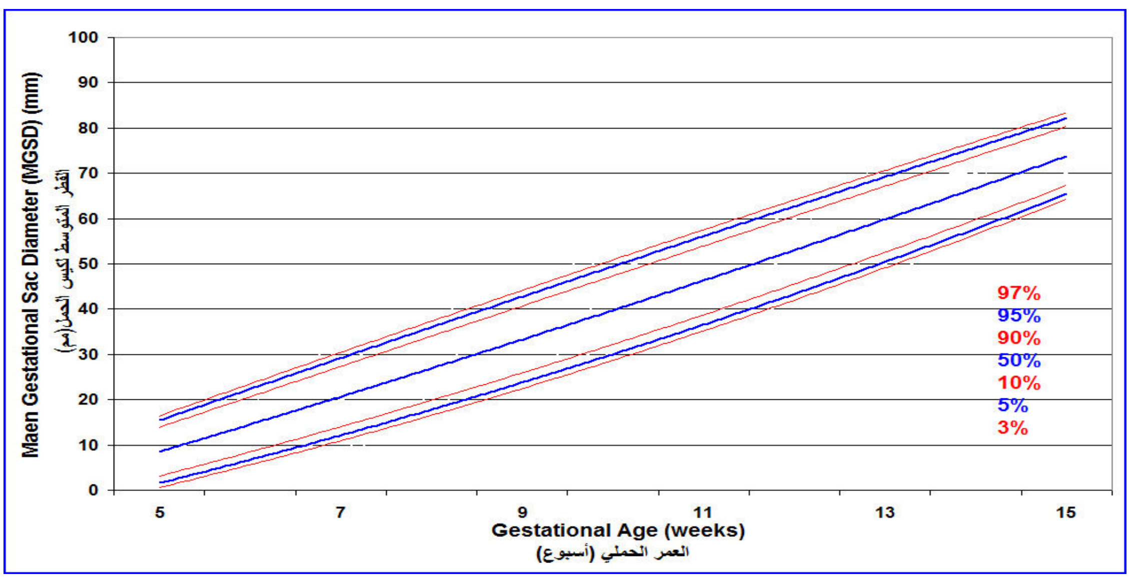

Figure 1: MGSD growth chart showing the fitted Percentile Values (3rd ،5th ،10th ،50th ،90th ،95th ،97th(of the MGSD and GA

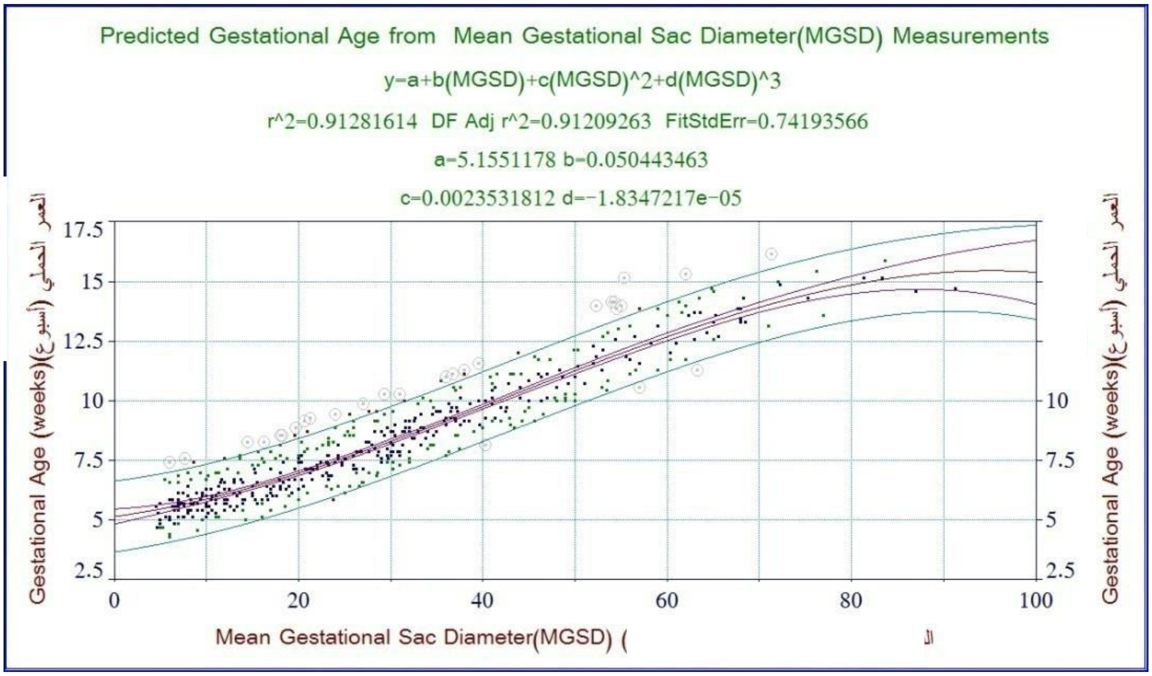

Figure 2: Predicted GA (weeks) using MGSD measurements (mm). Each point represents one fetus result.

Table 2: Expected GA (weeks) using the MGSD measurements (mm) and the lower and upper limits of both the 95% Prediction Limits and the 95% Confidence Limits based on the regression model.

95% Confidence Limits		**95%** Prediction **Limits**		$\hat{Y}_i$	**Xi**
Upper limit	**Lower limit**	**Upper limit**	**Lower limit**	**GA (weeks)**	**MGSD (mm)**
5.7	5.3	6.9	4.0	5.5	5
5.7	5.4	7.0	4.1	5.5	6
5.8	5.5	7.1	4.2	5.6	7
5.8	5.6	7.2	4.2	5.7	8
5.9	5.7	7.2	4.3	5.8	9
6.0	5.8	7.3	4.4	5.9	10
6.1	5.9	7.4	4.5	6.0	11
6.2	6.0	7.5	4.6	6.1	12
6.3	6.1	7.6	4.7	6.2	13
6.4	6.2	7.7	4.8	6.3	14

95% Confidence Limits		**95%** Prediction **Limits**		$\hat{Y}_i$	**Xi**
Upper limit	**Lower limit**	**Upper limit**	**Lower limit**	**GA (weeks)**	**MGSD (mm)**
6.5	6.3	7.8	4.9	6.4	15
6.6	6.4	8.0	5.0	6.5	16
6.7	6.5	8.1	5.1	6.6	17
6.8	6.6	8.2	5.3	6.7	18
6.9	6.7	8.3	5.4	6.8	19
7.1	6.9	8.4	5.5	7.0	20
7.2	7.0	8.5	5.6	7.1	21
7.3	7.1	8.7	5.7	7.2	22
7.4	7.2	8.8	5.9	7.3	23
7.6	7.4	8.9	6.0	7.5	24
7.7	7.5	9.1	6.1	7.6	25
7.8	7.6	9.2	6.3	7.7	26
8.0	7.8	9.3	6.4	7.9	27
8.1	7.9	9.5	6.5	8.0	28
8.2	8.1	9.6	6.7	8.1	29
8.4	8.2	9.8	6.8	8.3	30
8.5	8.3	9.9	7.0	8.4	31
8.7	8.5	10.0	7.1	8.6	32
8.8	8.6	10.2	7.3	8.7	33
9.0	8.8	10.3	7.4	8.9	34
9.1	8.9	10.5	7.6	9.0	35
9.3	9.1	10.6	7.7	9.2	36
9.4	9.2	10.8	7.9	9.3	37
9.6	9.4	10.9	8.0	9.5	38
9.7	9.5	11.1	8.2	9.6	39
9.9	9.7	11.2	8.3	9.8	40

95% Confidence Limits		**95%** Prediction **Limits**		$\hat{Y}_i$	**Xi**
Upper limit	**Lower limit**	**Upper limit**	**Lower limit**	**GA (weeks)**	**MGSD (mm)**
10.0	9.8	11.4	8.5	9.9	41
10.2	10.0	11.5	8.6	10.1	42
10.3	10.1	11.7	8.8	10.2	43
10.5	10.3	11.8	8.9	10.4	44
10.6	10.4	12.0	9.1	10.5	45
10.8	10.6	12.1	9.2	10.7	46
10.9	10.7	12.3	9.4	10.8	47
11.1	10.8	12.4	9.5	11.0	48
11.2	11.0	12.6	9.7	11.1	49
11.4	11.1	12.7	9.8	11.3	50
11.5	11.3	12.9	10.0	11.4	51
11.7	11.4	13.0	10.1	11.6	52
11.8	11.6	13.2	10.2	11.7	53
12.0	11.7	13.3	10.4	11.9	54
12.1	11.8	13.5	10.5	12.0	55
12.3	12.0	13.6	10.7	12.1	56
12.4	12.1	13.7	10.8	12.3	57
12.6	12.3	13.9	11.0	12.4	58
12.7	12.4	14.0	11.1	12.6	59
12.9	12.5	14.2	11.2	12.7	60
13.0	12.7	14.3	11.4	12.8	61
13.1	12.8	14.4	11.5	13.0	62
13.3	12.9	14.6	11.6	13.1	63
13.4	13.0	14.7	11.7	13.2	64
13.5	13.2	14.8	11.9	13.3	65
13.6	13.3	14.9	12.0	13.5	66

95% Confidence Limits		**95%** Prediction **Limits**		$\hat{Y}_i$	**Xi**
Upper limit	**Lower limit**	**Upper limit**	**Lower limit**	**GA (weeks)**	**MGSD (mm)**
13.8	13.4	15.1	12.1	13.6	67
13.9	13.5	15.2	12.2	13.7	68
14.0	13.6	15.3	12.3	13.8	69
14.1	13.7	15.4	12.5	13.9	70
14.3	13.8	15.5	12.6	14.0	71
14.4	13.9	15.6	12.7	14.1	72
14.5	14.0	15.7	12.8	14.2	73
14.6	14.1	15.8	12.9	14.3	74
14.7	14.2	15.9	13.0	14.4	75
14.8	14.2	16.0	13.0	14.5	76
14.9	14.3	16.1	13.1	14.6	77
15.0	14.4	16.2	13.2	14.7	78
15.1	14.4	16.3	13.3	14.8	79
15.2	14.5	16.4	13.4	14.9	80
15.3	14.5	16.4	13.4	14.9	81
15.4	14.6	16.5	13.5	15.0	82
15.5	14.6	16.6	13.5	15.1	83
15.6	14.6	16.7	13.6	15.1	84
15.7	14.7	16.7	13.6	15.2	85
15.8	14.7	16.8	13.7	15.2	86
15.9	14.7	16.9	13.7	15.3	87
16.0	14.7	16.9	13.7	15.3	88
16.0	14.7	17.0	13.7	15.3	89
16.1	14.6	17.0	13.7	15.4	90

Table 3: Standard Deviation (SD) of estimated the GA (weeks)

STANDARD DEVIATION	GA (WEEKS)
0.73	12 ≥
0.82	18 – 12

Table 4: Comparison between our study and reference studies:

	N	Correlation (r)	Sig.
Present Study & Tokyo[*]	9	0.998	0.000
Present Study & Hellman LF, Kobayashi M, Fillisti L[4]	6	0.997	0.000

Table 5: Comparison of Paired Differences between our study and reference studies about predicting the GA (weeks) using MGSD (mm)

Statistical significance	Sig	df	T value	Paired Differences					Comparison
				95% Confidence Interval of the Difference		Std. Error/ Mean	Std. Deviation	Mean	
				Upper	Lower				
Yes	0.000	8	7.34-	4.01-	7.69-	0.80	2.39	5.85-	Present Study & Tokyo[*]
Yes	0.001	5	7.59-	2.04-	4.13-	0.41	0.99	3.08-	Present Study & Hellman LF, Kobayashi M,and Fillisti L[4]

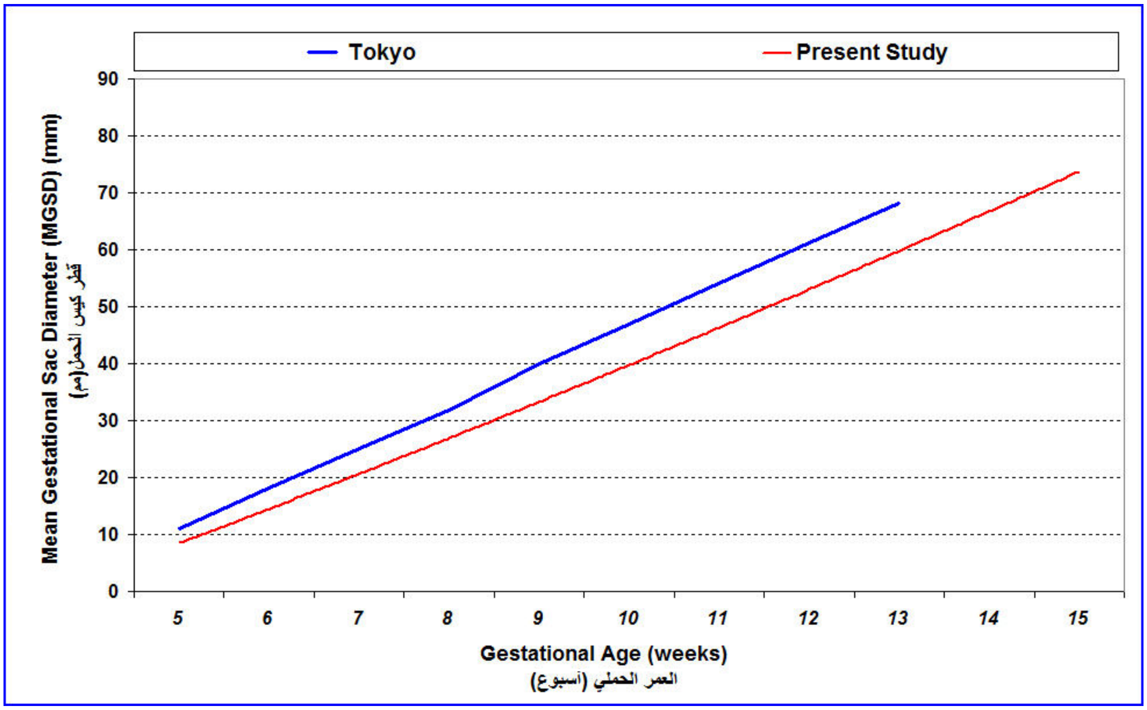

Figure 3: Comparison between GA using MGSD in our study (red line) and the GA using MGSD in reference studies (blue line)