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The Use Of Abdominal Aorta Length In The Fetuses' After 34 Weeks Of Gestation For Calculating Gestation Age Among Primigravida Healthy Women

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Abstract: Aim of the stud; To verify the correlation between abdominal Aorta Length in the fetus and gestational in weeks between 34- 40 weeks
Type of study; Case Control
Methods; a healthy pregnant women were chosen who's age between 15-40 years all are primigravida and conceived within 3 months of marriage. They were between 34- 40 weeks in gestation. Their last menstrual period was know and recorded in addition all were scheduled for ultrasound examination for measurement of the abdominal aorta length, femoral length and biparietal diameter.
Result; a highly significant correlation was found between abdominal aorta and biparietal diameter and femoral length . In addition a highly significant correlation was found between gestational age calculated by their LMP and abdominal aorta. In addition a highly significant correlation was found between gestational age and abdominal aorta length. A non linear exponential equation was constructed with lowest mean of sum of squares=1, and coefficient of correlation= 0.97 between abdominal aorta length and gestational age in weeks. From this equation a reference table built which contains value for the abdominal aorta between 34- 40 weeks for 1,2.5,5,10,90,95, and 99 centiles. After the building of this table further 35 women were taken for assessment of this table. Only 2 were miss calculated, the Kappa Cohen coefficient=0.93
Conclusion; a table by which the gestational age can be calculated between 34-40 weeks by measuring the abdominal aorta. However under no circumstances this table may be used apart from assessment applications. Further studies are required to verify its accuracy

Keyword; gestational age, abdominal aorta length, calculation of the fetal gestation

1. INTRODUCTION

It goes without saying that the calculation of gestational age after 34 weeks by ultrasound has still large standard deviation and remains unreliable[1]. Coupled with this is that most of the obstetrical procedures like external cephalic version, induction of labor in premature rupture of the membranes all occur after 34 weeks and needs accurate gestational age estimation[2]. In the literatures there exist a wide varieties from different researchers to bypass this problem[3]. Some of those include the measurement of hypothalamus size, kidney size and even

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transverse colon caliber [4]. Unfortunately no method of the above mentioned has clinical significance or has been adopted till writing this paper[5] . Accordingly we have suggested the length of the aorta portion in the abdominal fetus till the bifurcation into the common Iliac arteries as a reasonable biometric variable which correlates well with the gestational age. It is well known that the aorta length in the abdomen is proportional to the fetal size whether with fetus with normal growth or retarded. So the aim of this study is to evaluate the Abdominal aorta length as reasonable biometric parameter for calculation of gestational age.

2. PATIENTS AND METHODS

Setting

The study was conducted in AL Yarmook teaching hospital in Baghdad and lasted about 1 year from June 2018 up to June 2019. During this period a total of 59 healthy primigravida pregnant women we selected to participate in the study after 34 weeks of gestation as guided by their last menstrual period date. The study was approved by the local committee in the hospital and since it doesn't involve any invasive procedure or interference the board approval was obtained. In addition all women who participated in the study have accepted to enter the study by taking their verbal consent.

Methods

All patients who have participated in this study were healthy primigravida 15- 40 years in whom the exact date of last menstrual period was well known and conceived within 3 months after marriage and known to have regular cycles before marriage. Preeclampsia was excluded by measuring the blood pressure and a sample sent to the lab for protein urea. Diabetes was excluded from measuring random blood sugar and their readings should not bypass 135 mg/dl or 7.3 mmol/L at any time. Multiple gestations was excluded during ultrasound estimation of the abdominal aorta. Intrauterine growth restriction, placenta previa and oligo hydramnios were all excluded at the initial visit between 34- 40 weeks of gestation. During this visit and after taking the patient approval the aorta length was measured from the diaphragm till the bifurcation as detailed below. In addition the biparietal diameter, femoral length were also measured and all recorded in excel data sheet for further analysis. The gestational age at visit was measured from the date of the last menstrual history in weeks and days and stored with other data. At the end of the study a total of 59 primigravida women were scanned and subject to further analysis.

In addition to the initial 59 women chosen initially for the study another 35 women were taken after the end of the study to verify the accuracy of gestational age all between 34- 40 weeks. For each gestational age 5 women were chosen for abdominal aorta length for each gestational age 34- 40 weeks. Only 2 patients were under dated. One at 36 week diagnosed as 35 weeks, while the other at 38 weeks were diagnosed as 37 weeks by table.

Measurement of the abdominal aorta

all patient were examined with real time B- mode U/S examination using the samsung premium ultrasound system WS80 with Elite , convex probe(3 to 5 MHZ, CA1-7A) , the recorded time of examination was not more than ten MN , , patient usually in supine position , the routine obstetrical U/S examination was done , then additionally the operator searched for coronal plan in fetus (usually in longitudinal lie ,weather breech or cephalic presentation) to identified full length of fetal abdominal aorta from the level of diaphragm to the level of aortic bifurcation measured in MM as seen in fig (1) & (2)

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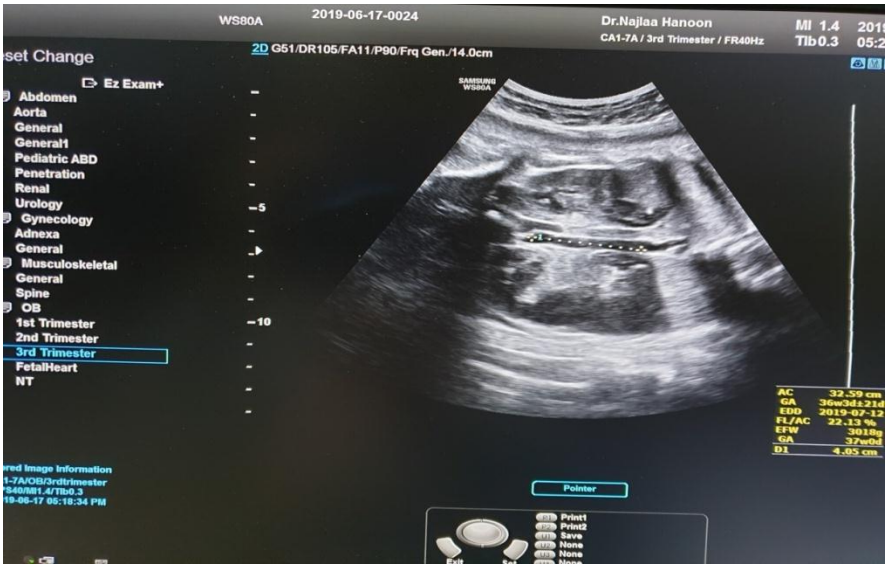

Figure (1) : fetal abdominal aortic length (40.5 mm) , fetal gestational age from the LMP (35 weeks & 5 days) & by FL (36 weeks & 2 days)

Figure (2) : fetal abdominal aortic length (50.9 mm) , fetal gestational age from LMP (38 weeks &1day) & by FL (37 weeks & 3 days)

Statistical analysis

Since the demographic criteria taken in this study is few and only include age, it was expressed as mean and standard deviation. In addition the aorta length was analyzed for normal distribution criteria as it is the main variable in taken in this study. In addition to the mean and standard deviation the kutosis, skewness and normality of distribution was assessed by Shapiro- Wilk test. Results showed that it is rejected for normality. In addition a surface mesh plot was constructed in which the aorta length was assigned to the Z axis in one side while the biparietal diameter and femoral length were assigned to X and Y axes. The partial coefficient of correlation was calculated and found to be significantly correlated. Accordingly we can consider the abdominal aortal length as an independent biometric

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variable which can be used alone for calculation of the gestational age. Next a non linear equation of the exponential associated was built in which the abdominal aorta was expressed as independent factor while gestational age in days as dependent factor with plotting of the equation. Results should a significant degree of associated between the 2 variables. Finally to build an easy reference table which can be used to calculate the gestation age from the abdominal aorta tables with left column from 34 to 40 weeks was constructed and in each gestational age the 1,5, 10, 90, 95, and 99 centiles of the abdominal aorta length was given for each gestational age. The following soft wares were used in this paper MedCalc, Statsdirect, Minitab and curve expert for building the equation between abdominal aorta length and the gestational age in weeks. Inter Rater table was built was calculation of the Kappa- Cohen coefficient was done by statdirect.

3. RESULTS

Starting with results the only demographic criteria taken from women participated in this study are maternal age and their fetuses abdominal Aortal length were measured bellow. As shown in table 1 the range of maternal age for women taken in this study was between15 years to 40. All were healthy and primigravida free from any high risk pregnancy situation. In addition the normal distribution of the maternal age criteria were given and showing normal distribution with W=0.9 by Shapiro Wilk test

Table 1;Summary statistics of the maternal age distribution criteria

Sample size	59
Lowest value	15.0000
Highest value	40.0000
Arithmetic mean	27.0339
Standard deviation	5.7863
Coefficient of Skewness	0.01239 (P=0.9668)
Coefficient of Kurtosis	-0.4950 (P=0.3940)
Shapiro-Wilk test for Normal distribution	W=0.9874 accept Normality (P=0.8015)

In addition to the maternal age the second biometric variable which is the main denominator upon which this study was conducted is the abdominal aorta length.

Table 2; The criteria of the abdominal aorta distribution is given in millimeter

Sample size	59
Lowest value	36.0000
Highest value	62.0000
Arithmetic mean	44.5203
Standard deviation	6.5662
Coefficient of Skewness	0.9367 (P=0.0050)
Coefficient of Kurtosis	0.2309 (P=0.5587)
Shapiro Wilk Test for Normal distribution	D=0.1410 Accept Normality (P=0.52)

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Possibly the most important finding of this table is not only the normal distribution in addition to the range, mean and standard deviation which will be the main determinant of gestational age

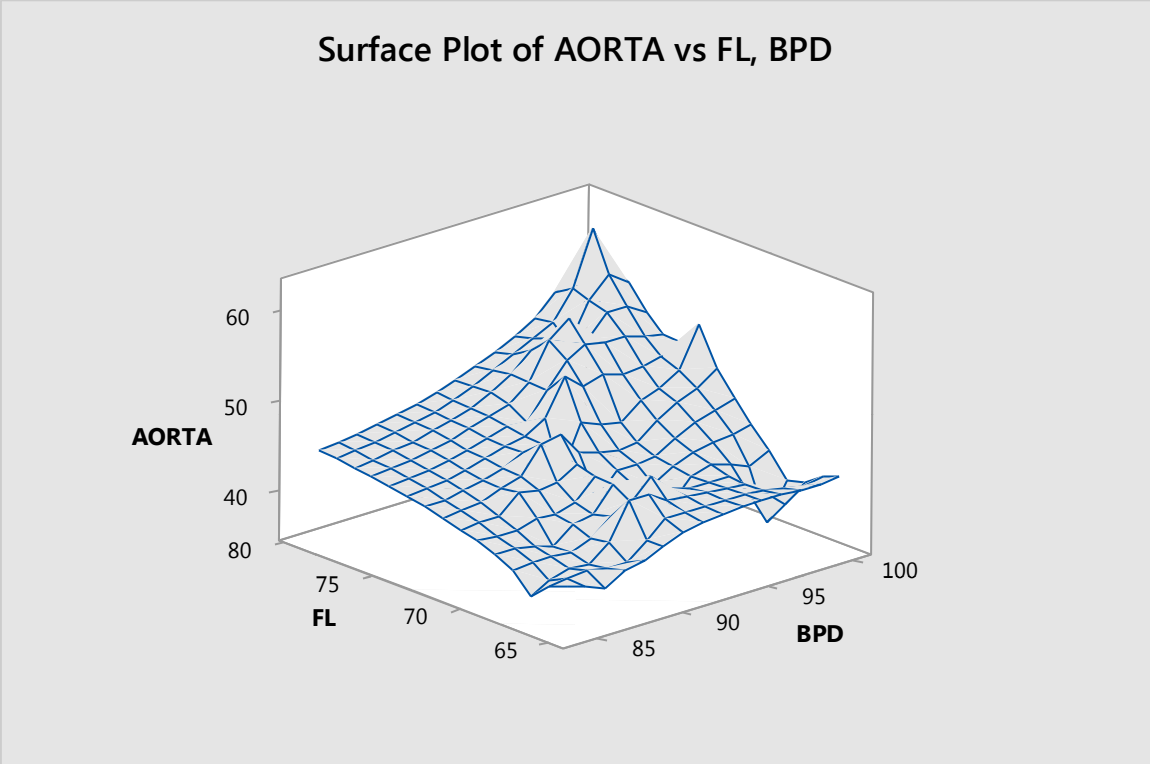

Figure 3; a surface mesh plot showing the correlation between aorta length and the biparietal diameter and femoral length with highly significant correlation between abdominal aorta versus biparietal diameter and femoral length ; P value =0.0002

The mesh plot is strong key master key to conclude that abdominal aorta is directly proportional to the biometric characteristic used for gestational aging namely the biparietal diameter and the femoral length accordingly with the gestational age itself. The highly significant association indicates highly significantly association with gestational age, P=0.0002. Accordingly it is expected that building a model which correlates the gestational age and abdominal aorta length will show also a significant correlation as shown in the next graph.

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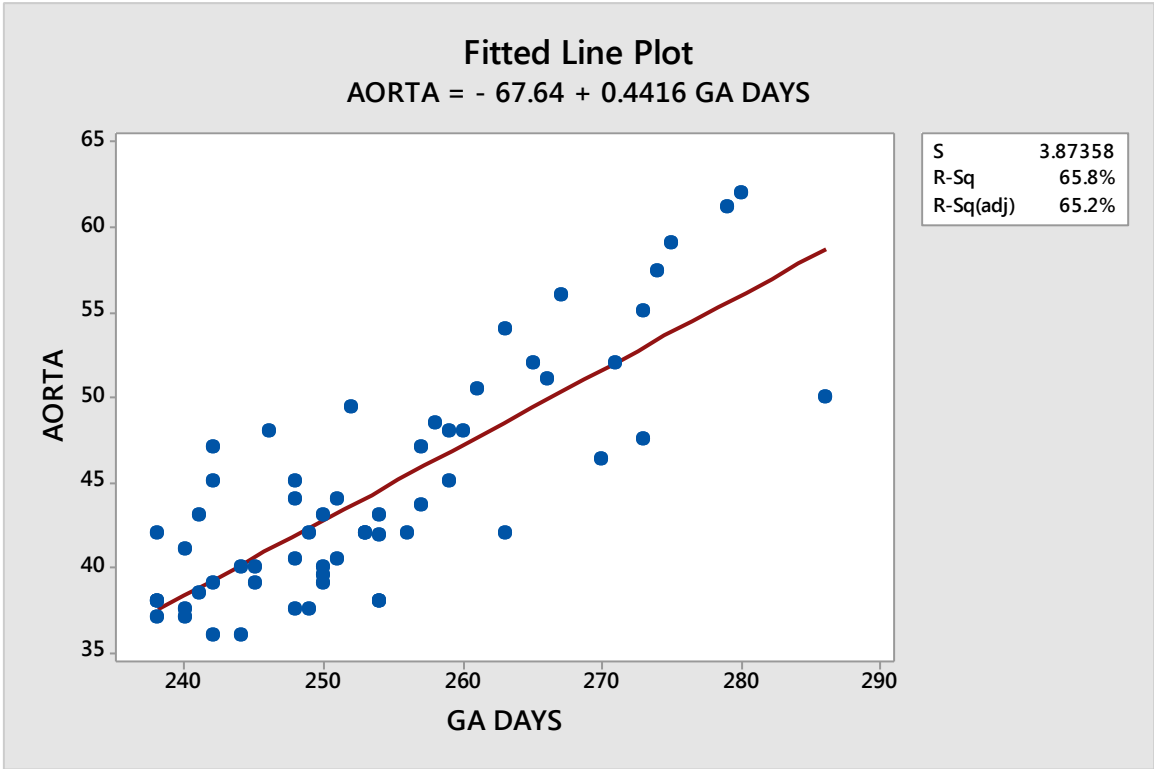

Figure 4; a highly significant correlation is present between gestational age in days in the X axis and abdominal aorta length in millimeter from 34-40 weeks of the fetus in Y axis
r= 65%; P<0.0001

Since this curve shows a highly significant correlation is present between gestational age in days and abdominal aorta length in millimeter then a non linear formula was constructed from the software with can build up 360 model and then choose the models with lower mean sum of the square.

Bellow is the model which has lowest mean sum of squares as 1.05 and correlation coefficient as 0.9. the model is the ***exponential association*** model. And from this equation the table below was constructed with contains the 1,5,10, 90, 95 and 99 centiles value are shown for each gestational age from 34 to 40 weeks. Any fetus who should lie in any gestational age should have abdominal aorta length between 5-95 centiles or lying within 2 standard deviations. Those fetuses above 2 standard deviation or 95 centile should cross to the next centile. Otherwise if lower than 5 centile should cross to next lower gestational age.

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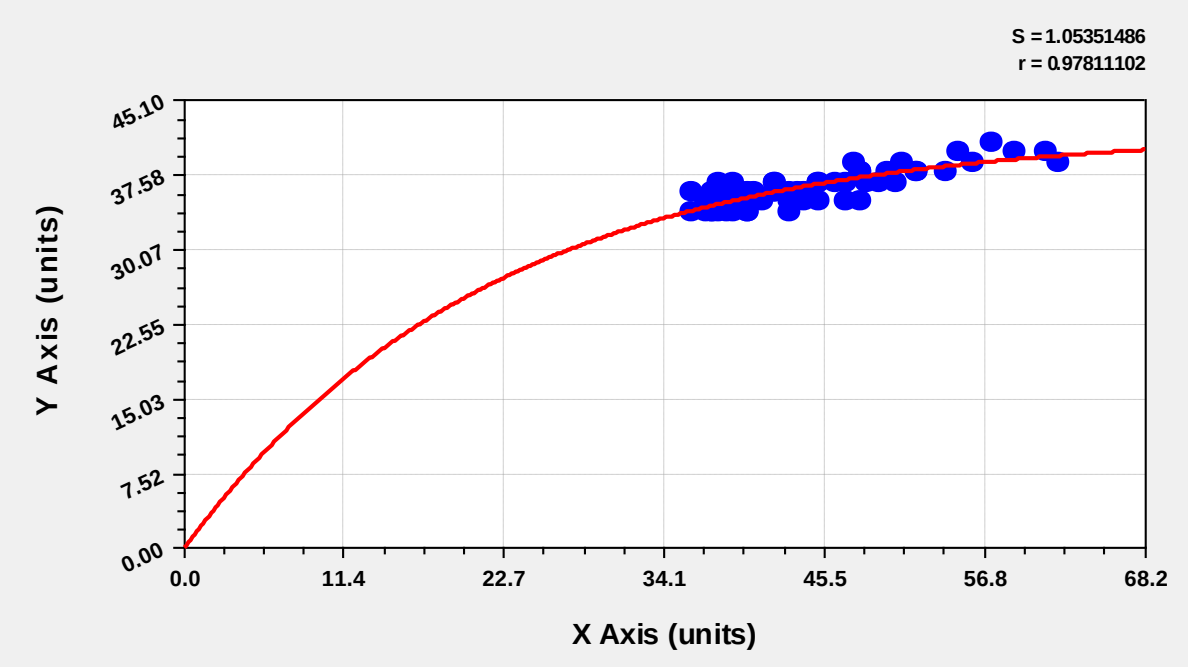

Figure 5; the typical non linear equation between abdominal aorta length in millimeters units in the X axis and gestational age in weeks in the Y axis is shown with coefficient of the formula mean sum of the squares and coefficient of correlation Exponential

Association: y=a(1-exp*(-b*x))*

Coefficient Data:

a =41.917

b =0.046

Table 3; abdominal aorta length in the form centiles versus gestational age 34- 40 weeks given as 1, 5, 10, 90, 95 and 99 corresponding values Centiles of the abdominal aorta length

Age variable	Centiles of AORTA length in millimeter					
GA_code	0.01	0.05	0.10	0.90	0.95	0.99
34	35.5218	35.9989	36.2532	38.0476	38.3019	38.7790
35	37.5748	38.1545	38.4635	40.6436	40.9527	41.5323
36	39.8110	40.5747	40.9818	43.8539	44.2610	45.0247
37	42.2346	43.2650	43.8143	47.6896	48.2389	49.2692
38	44.8501	46.2313	46.9676	52.1622	52.8985	54.2797
39	47.6619	49.4793	50.4482	57.2835	58.2524	60.0698
40	50.6745	53.0150	54.2628	56.0655	59.3132	62.6538

It may be noted that the first row of gestational age in which the abdominal aorta length appears should be the true gestational age and the corresponding gestational age the fetus has as far as it is with 5- 95 centiles. Otherwise should the row contains the reading outside this rage then move forward or backward with regard to the gestational age in weeks should be done.

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Table 4; the inter rater table for the next 35 women taken for assessment of the table constructed above is given. One women at 36 classified as 35 and other at 38 classified as 37- Kappa Cohen= 0.93

Gestational age in weeks		As assessed by last menstrual period LMP						
		34	35	36	37	38	39	40
assessed by Aorta length Measured by ultrasound	34	5	0	0	0	0	0	0
	35	0	5	0	0	0	0	0
	36	0	1	4	0	0	0	0
	37	0	0	0	5	0	0	0
	38	0	0	0	1	4	0	0
	39	0	0	0	0	0	5	0
	40	0	0	0	0	0	0	5

Kappa Cohen = 0.93327

Legend showing the interpretation of the Kappa - Cohen value

Kappa		Strength of agreement
< 0.2		Poor
> 0.2 □ 0.4		Fair
> 0.4 □ 0.6		Moderate
> 0.6 □ 0.8		Good
> 0.8 □ 1		Very good

In addition to the initial 59 patient taken to the study- another 35 were taken after construction of the tables to verify its accuracy. Out od 35 patient 2 were misclassified one at 36 week was lower than 2 standard deviation while other at 38 gestational age. The Kappa Cohen coefficient was 0.93 which signify excellent inter rater measurement of gestational age between last menstrual period and the aorta length for assessment of gestational age.

4. DISCUSSION

As a matter of fact the most important word to be started with writing the discussion of this paper is that the authors shall be such acknowledged from any reader of this article as this topic is not only new in Journals simply no such article with same title exist in literature. So we hope as well as we are expecting from our reader the difficulty on writing a paper like this.

The inaccuracy of ultrasound in estimating fetal gestational age after 34 weeks of gestation is not only well known among ultrasonographer as well as the Obstetricians rather this mal assessment may lead to serious fetal outcome from wrongly timed interference as explained by Molin et al [6]. In this long and comprehensive metanalysis which gives the ultimate conclusion in any clinical problem has found that the disparity caused by mal estimation of gestational age assessed by ultrasound has extreme and profound effect on the fetal outcome. Gardosi [7] et all has proposed the use of fetal growth charts since 1992 to detect early fetal

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complication associated with late poor fetal gestational aging by ultrasound. Di Fabrizio [8] et al has suggested the use of other method rather than ultrasound in predicting spontaneous preterm labor as measurement of placental alpha micro globulin -1 in the cervico- vaginal canal due to the poor results compared to those dependent on ultrasound measurements. As a matter of fact the inaccuracy of ultrasound measurements of the gestational age is still vague and obscure. For example Ashwal [9] has found little impact of amniotic fluid index in fetal gestational aging by ultrasound in the third trimester. In other words the amount of liquor has little impact in the fetal aging by ultrasound in late pregnancy. Janas [10] has reached the same conclusion while his study was done on growth retarded infant with oligohydraminous also found the amount of liquor has little impact on late fetal gestational aging by ultrasound.

The poor correlation between fetal gestational aging and ultrasound in later pregnancy has pushed many obstetrician all over the world to undertake auxiliary methods to overcome this problem. For example Mongelli [11] has suggested since 1995 the introduction of maternal demographic criteria to improve fetal gestation calculation and reducing the false positive estimations. Some has suggested using the hypothalamus size as assess by ultrasound for gestational aging, Duthie [12] et al. Yet the method didn't populate among researchers as the hypothalamic size is affected by the normal physiological activities of the fetus. Mete [13] et al has suggested the use of kidney size as a biological marker for gestational aging. Despite this idea was first published more than 20 years ago no reference tables, chart or any practical method was introduced to evaluate its efficiency. Tongpraser[14] has suggested the use of liver size as a reliable method to evaluate the fetal gestational age and despite this idea was introduced some 10 years ago no reference charts or tables has been offered for clinical assessment. In brief we don't want to review all the alternatives to the biparietal diameter and femoral length rather to discuss hardy the rational behind using the aorta length from the diaphragm down to the bifurcation of the aorta , an idea which has no references in the literature to aid us in discussion.

The rational behind this idea in general is that vascular tree especially big sized arteries and veins can't out grow or under grow the fetal size lying in. example the limbs are small in asymmetrical intrauterine growth restriction, according the brachial artery and femoral arteries should matches exactly the lengths of limbs irrespective of growth state like growth retarded or large for date or even adequate for gestational age. Hence the abdominal aorta length is an excellent biomarker for the growth state of the fetus. That is exactly the rational behind this paper. And indeed all the results in previous sections shows this. First of all the aorta is a biomarker structure is normally distributed as shown by basic demographic criteria as assessed by Shapiro Wilk test. Secondly we have constructed a surface mesh plot between the abdominal aorta as dependent variable while the x and y axis were assigned to the to the biepariетal diameter and femoral length. The surface plot shows a direct proportional relationship with both BPD and FL versus the aorta length with partial coefficient of correlation 0.49 and P value = 0.0002. Sine this highly significant correlation was found between the abdominal aorta and the usual biometric variables used for estimation of the gestational age namely biparietal diameter and femoral length were found and assessed nothing left except building the model which connects the gestational age with abdominal aorta length with gestational age. For this process we used the (Curve Finder) icon in the software a function which can build in few seconds more than 360 forms of equation and express only the ones with lowest mean of the sum squares. The exponentional model which has a typical sigmoid shape typical of all biological structures growth was chosen and from this equation the table which have different centiles from 34 weeks up to 40 weeks was build. The fetus is considered in a particular gestational age when its measurement for aorta length lies within 2 standard deviations, otherwise if more than 2 standard deviation should cross to

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the next gestational age or if the aorta less than 2 standard deviation should be downed to lower gestational age.

At last we have collected 35 extra women for estimation of the accuracy of the tables by Kappa Cohen inter rater observation methods. The Kappa Cohen was equal to 0.93 which mean excellent association between gestational age calculated by the LMP and the formula and its related table. One fetus at 36 week was lower than 2 standard deviation and calculated as 35 weeks another at 38 calculated as 37. Anyhow those 2 fetuses out of 35 and nothing can be said unless further testing or re- construction of similar paper which shall identify the accuracy of the concept. It is not recommended at this moment such tables except for evaluation purposes. We hope to listen from other colleagues all over the world and to provide help either with reconstructing this paper or similar to identify the reproducibility and accuracy of aorta length in calculating gestational age and until then those tables are not recommended except for evaluation purpose only.

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