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Comparison Study between Fetal Kidney Length and Transcerebellar Diameter to Determine Gestational age in the Third Trimester

Ahmed Mounir Ahmed El-Saeed [1*]; Walaa Mohammed El-Bassioune [2]; Abdelrahman Ali Hassan Emam [2]

[1] Department of Obstetrics and Gynecology, EL-Sinblawin General Hospital, Ministry of Health, Egypt.
[2] Department of Obstetrics and Gynecology, Faculty of Medicine, Al-Azhar University, Damietta, Egypt.

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ABSTRACT

Introduction and Aim: An accurate determination of gestational age (GA) is crucial to the management of all pregnancies, particularly high-risk pregnancies. This study aimed to comparing between the accuracy of ultrasonographic fetal kidney length and Transcerebellar diameter in GA determination in third trimester.

Patients and methods: The study was a cross sectional one, carried out at the department of Obstetrics and Gynecology, Damietta Faculty of Medicine, Al-Azhar University, Damietta, Egypt. The study had been performed between January 2021 and January 2022. All were submitted to a detailed history, routine antenatal investigations, general and obstetrical examination. Then, measurements of all fetal biometric parameters were recorded using a real- time, grayscale, 3.5–5.0 MHz curvilinear array transducer. Results were compared to the gestational age determined by last menstrual period.

Results: The patient age ranged between 18 and 37 years, their weight ranged between 55 and 109 kg, while gravidity ranged between 1 and 5 and parity ranged between 0 and 4. The GA as determined by last menstrual period (LMP) was ranged between 28 and 40 weeks. The calculated GA by different measurements were also included and they were around the same measurements as determined by LMP. This was confirmed by the absent statistically significant difference between GA by LMP and any of calculated gestational age by any method. The mean fetal kidney length is more accurate in determination of gestational age than transcerebellar diameter (96.3% vs 89.8%) and both were significantly correlated with other calculated gestational ages.

Conclusion: The length of the fetal kidney length proportionately correlated with fetal gestation age with powerful correlation coefficient. Fetal kidney length is found to be more accurate in GA determination than transcerebellar diameter (TCD).

Keywords: Fetal Kidney; Transcerebellar diameter; Gestational Age; Third Trimester.

* Corresponding author
Email: ahmedmounir@domazhermedicine.edu.eg

INTRODUCTION

During the antenatal period, the obstetrician is responsible for dating the pregnancy as early as possible. An accurate determination of the gestational age (GA) is of utmost importance to the management of all gestations, especially when high-risk factors are expected [1].

The calculation of the last menstrual period (LMP) to estimate expected date of the delivery (EDD) becomes very difficult in different situations (e.g., with irregular menstrual cycle, inaccurate reporting of LMP or even the inability to remember it, pregnancy during lactational amenorrhea, and early bleeding in pregnancy that conceals the LMP [2].

From 24 to 36 weeks of gestation, the symphysio-fundal height could be used for GA determination, as the height (in centimeters) approximates to the number of weeks. However, it could be affected by many factors (e.g., multiple gestations, intrauterine growth restriction (IUGR), diabetes with pregnancy, maternal obesity, abnormal fetal lie & engagement and finally observer variations (inter and intra). The ultrasonic fetal biometry (e.g., crown rump length (CRL), biparietal diameter (BPD), fetal length (FL)) are recognized as reliable determinants of gestational age when they are carried out before <24 weeks of gestation [3]. However, there is no single fetal measurement, which could be used for precise determination of the gestational age in the third trimester. The kidney length measured by the ultrasound can reach the diagnosis of renal abnormalities. In addition, the kidney can be visualized early in gestation (at 14th week). As the pregnancy advances, the perinephric fat accumulation is associated with an increased echogenicity separating the kidney from surrounding soft tissues and permits easy visibility [4].

Fetal kidney showed a steady growth throughout pregnancy and is unaffected by any growth deviations. In the third trimester, 60% of the nephrons develops. The continuous increase in the number of nephrons stops by 36th week of gestation. In modern obstetrics, sonographic fetal parameters could represent the cornerstone of gestational age (GA) estimation. It is an important issue in management of complicated pregnancies related to fetal growth. On of reliable predictors of gestational age is the transverse cerebellar diameter (TCD). Its importance relies on its use as the standard to compare other fetal parameters, particularly when GA can't be estimated by the LMP**.** TCD is also considered a reliable predictor for GA in third trimester. Another crucial issue is that, despite their dependability, it had some limitations and pitfalls. So, there a need for an additional reliable parameter is always present. This suggested parameter must be relatively easy with accurate estimation of GA [5].

This study aimed to compare between the accuracy of fetal kidney length by ultrasonography and TCD in the estimation of gestational age in the third trimester.

PATIENTS AND METHODS

This was a cross sectional study, carried out at the department of obstetrics and gynecology, Damietta Faculty of Medicine, Al-Azhar University, Damietta, Egypt. It was approved by the local research and ethics committee and an informed consent was signed by each participant. The study had been performed between January 2021 and January 2022.

The sample size (N) was determined by the Fisher's formula -8 [6], given as N = (Z/D)2P (1 − P), where Z represented the standard normal deviation (with a value of 1.96) and 95% confidence level (CI)), D denotes the degree of desired accuracy (0.05), and P the proportion in the target population estimated to have a particular characteristic (50% for this study). With these values, the required minimum sample size for this study was 384.

Inclusion criteria: Pregnant women who are sure of their LMP with previous regular cycles and uncomplicated pregnancy with singleton fetus between 28 and 40 weeks of gestation were included in the study.

Exclusion criteria included the following: pregnancy-induced diabetes or hyper-tension, polyhydramnios, oligo-hydramnios, fetal abnormalities, multiple gestations, complicated pregnancy, and indistinct adrenal or renal borders.

All were submitted to a detailed history, routine antenatal investigations, general and obstetrical examination. Then, measurements of all fetal biometric parameters were obtained using a real- time, grayscale, 3.5–5.0 MHz curvilinear array transducer. Gestational age in weeks was determined from the patient's LMP using Naegele's rule, while the estimated GA was determined from the Hadlock's chart of predicted fetal measurements at specific menstrual weeks for BPD, HC, FL, and AC, using well-defined reference points. The CGA (calculated Gestational Age) in weeks, was derived as a mean value of the measured indices (BPD, HC, FL, and AC), was similarly documented in the worksheet. Each recorded measurement was done thrice and the average was computed and documented as the average value.

Fetal kidney length: A suitable transverse fetal plane was first recognized at the level of the heart four chambers. Then, a continuous transverse scanning was carried out in a cephalon-caudal direction until visualization of the fetal kidneys. The probe was then directed by 90° to obtain the longitudinal axis of individual kidney on the side of the midline tubular anechoic abdominal aorta. The image showing both superior and inferior outer poles of each kidney (in the longitudinal axis) was obtained and frozen on the screen. Kidney length was then measured by electronic calibers from the superior outer pole to the inferior outer pole. Three measurements were recorded per kidney to minimize intraobserver error, and the mean value in millimeters was documented in a worksheet. We measured right kidney length, left kidney length and extracted Mean kidney length

(RT+LT/2). Care was taken to exclude the adrenal glands (AGs) from the measurements.

Gestational age was calculated from the mean fetal kidney length (FKL) measuring nomogram. This value was then compared with actual GA derived from the sure LMP.

Transcerebellar diameter (TCD): at transthalamic transverse view of fetal intracranial anatomy through the posterior fossa that was include visualization of midline thalamus, cerebellar hemisphere and cistern magna. Measurements was obtained by placing on screen calipers of ultrasound machines at the outer margins of cerebellum.

Statistical analysis: The collected data were documented, coded, and fed to an excel sheet. Then, transferred to the analysis software package (statistical package for social sciences; SPSS version 16; SPSS Inc, Chicago, USA). Date of categorical type were expressed as number and percentages, and the association was tested by Chi square test or any equivalent according to the number of cases. Numerical data, however, were tested for normality by Kolmogorov Smirnove test. Normally distributed data were expressed as arithmetic mean (for central tendency) and standard deviation (for dispersion). However, median and interquartile range were computed for abnormally distributed data. Groups compared by the Student "t" test. Spearman's correlation coefficient (*r*) was calculated to determine the correlation between non parametric variables. P <0.05 was considered statistically significant.

RESULTS

Table (1) presented patient's age, weight, height, body mass index, gravity and parity. The patient age ranged between 18 and 37 years, their weight ranged between 55 and 109 kg, while gravidity ranged between 1 and 5 and parity ranged between 0 and 4. Table (2) presented gestational age as determined by LMP and it was ranged between 28 and 40 weeks. The calculated GA by different measurements were also included and they were around the same measurements as determined by LMP. This was confirmed in table (3), as there was no a statistically significant difference between GA by LMP and any of calculated gestational age by any method. The mean fetal kidney length was significantly correlation with other measurements (table 4). The correlation was proportional and powerful. Predicted GA by mean length of both fetal kidneys and TCD did not significantly differ than that determined by LMP (table 5). In addition, there was a statistically significant positive correlation between GA by LMP (w) and BPD GA, HC GA, AC GA, FL GA, TCD, and mean fetal kidney length (Table 5). Transcranial Doppler was positively and significantly correlated with gestational age by LMP, BPD, HC, AC, FL, TCD, and mean fetal kidney measurements and gestational age predicted by these measures. The mean fetal kidney length is more accurate in determination of gestational age than transcerebellar diameter (96.3% vs 89.8%).

Table (1): Age, anthropometric measurements, gravidity and parity among studied sample

Variable (n=384)	Mean ±SD	Range
Age (years)	25.60±5.06	18-37
Weight (kg)	79.38±12.83	55-109
Height (cm)	163.78±4.37	154-175
BMI (kg/m^2)	29.62±4.90	21.60-39.50
Gravidity	2.53±1.20	1-5
Parity	1.24±1.04	0-4

Table (2): Gestational age by LMP and calculated GA by different measurements

Variable	Mean ±SD	Range
Gestational age (w) by LMP	34.13±4.16	(28w-40.0w)
BPD GA (w)	34±3.13	27.71w-39.28w
HC GA (w)	34.14±3.27	27.85w – 39.57w
AC GA (w)	34.11±3.18	27.28w – 39w
FL GA (w)	34.30±3.28	27.85w – 39.80w
TCD (w)	34.31±3.51	28w – 40.71w
Mean fetal kidney length (w)	34.12±3.40	28w – 40.28w

Table (3): Comparing the calculated GA with LMP GA

Variable (n=384)	Mean ±SD	Range	t. test	P. value
LMP GA	34.13±4.16	3.28w-40.57w		
BPD GA (w)	34±3.13	27.71w-39.28w	0.239	0.625
HC GA (w)	34.14±3.27	27.85w – 39.57w	0.001	0.970
AC GA (w)	34.11±3.18	27.28w – 39w	0.006	0.940
FL GA (w)	34.30±3.28	27.85w – 39.80w	0.395	0.530
TCD (w)	34.31±3.51	28w – 40.71w	0.420	0.517
Mean fetal kidney length (w)	34.12±3.40	28w – 40.28w	0.00	0.971

Table (4): Correlation between mean fetal kidney length and the studied variables

	Mean fetal kidney length (mm)	
	r	P value
GA LMP (w)	0.843	<0.001*
BPD (mm)	0.986	<0.001*
BPD GA (w)	0.983	<0.001*
HC (mm)	0.991	<0.001*
HC GA (W)	0.987	<0.001*
AC (mm)	0.986	<0.001*
AC GA (W)	0.986	<0.001*
FL (mm)	0.989	<0.001*
FL GA (W)	0.929	<0.001*
TCD (mm)	0.987	<0.001*
TCD (w)	0.984	<0.001*

Table (5): Correlation (Degree of association) between LMP GA and the calculated and predicted GA

With	GA by LMP (w)	
	R	P value
BPD GA (w)	0.844	<0.001*
HC GA (w)	0.849	<0.001*
AC GA (w)	0.850	<0.001*
FL GA (w)	0.815	<0.001*
TCD (w)	0.855	<0.001*
Mean fetal kidney length (w)	0.840	<0.001*

DISCUSSION

This study compared between the accuracy of ultrasound determined fetal kidney length and transcerebellar diameter in estimating gestational age in third trimester. The current study showed that there was a statistically significant positive correlation between mean fetal kidney length and GA LMP. This agrees with Abdelrazek and Shalaby [7] who aimed to estimate gestational age and the reduction of the fetal and maternal morbidity and mortality as much as possible. It was a prospective clinical study to evaluate the gestational age at the third trimester using fetal kidney length by ultrasound (FKL US) measurement. They found that there is a strong significant correlation between the average kidney length and gestational age. The gestational age using FKL as single measurement with SE of 6.4 days may introduce a new helpful method for determination of gestational age in women with forgotten or inaccurate LMP. This agrees also with Ugur *et al.* [3] who aimed to address the validity of FKL and amniotic fluid index (AFI) in the prediction of labor dating. It was a prospective clinical study included 180 pregnant women, who were followed up in the outpatient clinic at Gaziantep University (Turkey). They found a strong positive correlation between FKL and GA, that could be used as an eligible parameter in the dating of labor. There was a very strong positive correlation between GA and FKL. This coincides also with Edevbie and Akhigbe [8] who found that, there was strongly positive significant correlation between mean FKL in millimeters and GA by the LMP in weeks (r = 0.997, P = 0.000). This is the approximate result of Peter *et al.* [1] who estimate FKL as a parameter from 20th weeks to term with r 0.974 and P value less than 0.001. In study done by Shiraz Akram *et al.* [9] mentioned that measurements of FKL yielded a good correlation with the gestational age (r) 0.939. This agrees also with Abonyi *et al.* [10] who aimed to create baseline reference values of FKL in Nigerian women as prior studies showed population specific variations. This study included 534 pregnant women between 20 and 40 weeks of gestation. They found that FKL increases with increase in FGA, reflecting a positive proportional correlation between FKL and FGA. FKL could be considered as a good predictor of FGA at the third trimester.

Our results showed that there was a statistically significant positive correlation between mean FKL and biparietal diameter (BPD), BPD and GA, head circumference (HC) and GA, abdominal circumference (AC) and GA, femoral length (FL), and GA and between all previous parameters and TCD. This agrees with Edevbie and Akhigbe [8] who found a strong positive significant correlation between MKL in millimeters and GA in weeks as predicted by BPD, HC, FL and AC.

The strong positive correlation between MKL in millimeters and GA in weeks as predicted by BPD, HC, FL, and AC in this study supports the findings of other researches [11,12]. Aremu [13] from Nigeria found strong correlation between FKL and estimated GA by LMP (r = 0.997). Joylene *et al.* [14] also found a high strong positive correlation (*r* = 0.860) between MKL and

GA in an examination of the third-trimester participants. Konje *et al*. [15] and others [12] reported MKL as the most accurate single predictor of GA as found in the current study. The increasing unreliability of BPD in GA determination beyond early second trimester has earlier been reported by O'Brien *et al*. [16] and may be due to fetal skull engagement and molding that occurs with most vertex-presenting intrauterine fetuses as pregnancy progresses toward term, when it becomes difficult to obtain the standard plane for BPD measurement.

The current study showed that there was a statistically significant positive correlation between GA by LMP and BPD GA, HC GA, AC, GA, FL GA, TCD, and Mean FKL. This agrees with Ashmawy *et al*. [17] who reported a statistically significant positive correlation between GA by LMP (w) and BPD, HC, AC and FL. This also agrees with Uger *et al*. [18] who aimed to determine the validity of FKL and amniotic fluid index (AFI) in labor dating. Their prospective study included 180 pregnant women followed up in the outpatient clinic at the Department of Obstetrics and Gynecology, Gaziantep University, Turkey, between January 2014 and January 2015. The gestational age (GA) was estimated by early fetal ultrasound measures and last menstrual period. Routine fetal biometric parameters, fetal kidney length, and amniotic fluid index were measured. There was a very strong positive correlation between GA and BPD (r=0.975, p=0.001), HC (r = 0.974, p=0.001), FL (r=0.967, p=0.001), and AC (r=0.852, p=0.001).

This study shows that there was no statistically significant difference in comparing the calculated Ga with LMP GA. The current study showed that there was a statistically significant positive correlation between TCD and GA by LMP (w). Bansal *et al*. [19] in their study involving 650 pregnant patients, found TCD equivalent to GA of fetus. The Karl Pearson correlation coefficient between GA & TCD was 0.972305 with p-value of <0.001 (highly significant). Sharma *et al*. [20] conducted a prospective study showed TCD was correlated with GA by LMP. This revealed significant correlation between TCD and GA by LMP In normal pregnancies, GA predicted by all parameters was within normal range. In IUGR pregnancies all parameters including BPD, HC & FL were showing disparity of > 3 weeks except TCD which in both groups were nearer to GA.

This study showed that there was a statistically significant positive correlation between TCD and BPD GA, HC GA, AC GA, FL GA, and mean fetal kidney length. This agrees with Ashmawy *et al*. [17] who found that there was a statistically significant positive correlation between TCD and Mean fetal kidney length. This coincides also with Edevbie and Akhigbe [8] who found that, there was positive significant correlation between TCD and BPD GA, HC GA, AC GA, FL GA, and Mean fetal kidney length.

The current study showed that the mean fetal kidney length is more accurate in determination of gestational age than Transcerebellar diameter. This is supported by Konje *et al*. [15] who stated that between 24 and 38 weeks of gestation, FKL is a more accurate method of determining FGA than the biometric indices of TCD, BPD, HC, FL and AC. This may also explain why both FKLs correlated weakly albeit positively with other biometric parameters whose efficacy decreases as gestation increases towards term.

Different independent past examinations have shown a strong relationship with the gestational age in the third trimester. Gestational age assurance is one of the best strides in the administration of the timing of pregnancy and subsequent diminishing in perinatal mortality due to preterm conveyances [4]. Fetal Kidney Length is emphatically associated to GA and is considered more exact technique for GA estimation than TCD, BPD, FL and HC after 20th week stretch of incubation [5, 21]. Kaul *et al*. [11] also have suggested that fetal kidney length as the most accurate single parameter for estimating gestational age because of the good correlation.

In study done by Shiraz Akram *et al*. [9] mentioned that measurements of fetal kidney length (FKL) manifest good association with gestational age. Bardhan *et al*. [22] concluded that Pearson's correlation coefficient value of 0.99 and regression coefficient or slope 1.0 noted between gestational age and fetal kidney length with a significance P< 0.001 and Fetal kidney length shows a constructive association with fetal gestational age. As well as previously reported results from Seilanian Toosi and Rezaie-Delui [23] and Shivalinhaiah *et al*. [24]. All these studies with narrow zone of variation confirm the best correlation of FKL and gestational age and make the idea of usage of FKL as a single parameter more near to be used.

This matched with the results of various studies, such as Peter *et al*. [1], with correlation coefficient r of 0.896, and as well as previously reported results from Uger *et al*. [18] (r = 0.947). Despite all studies confirming the functional relation between gestational age by date and gestational age by FKL and high possibility of use of kidney length as a new parameter (either solo or part of other parameters), there is some variation of correlation coefficient. Moreover, this could be explained by the variable generation of US machine used (new or old), degree of experience of the US operator, single or multiple US operators included in same study, as well as the design of the study (restrict studies of noncomplicated pregnancies vs. studies with complicated pregnancies).

In conclusion, fetal kidney length increases with increase in FGA and shows excellent correlation coefficient which suggests good agreement and reproducibility of measurements. Fetal kidney length is more accurate in determination of GA than Transcerebellar diameter (TCD).

Conflict of interest: none

Financial disclosure: none

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