

Assessment of Fetal Kidney Length as a Parameter for Detection of Gestational Age at the Third Trimester of Pregnancy

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ABSTRACT

Background: the accurate knowledge of gestational age is a keystone in an obstetrician's ability to successfully manage the antepartum care of a patient and is of critical importance in ante-natal test and successful planning of appropriate therapy or intervention. Failure can result in iatrogenic prematurity which is associated with increased perinatal morbidity and mortality. **Objectives:** the aim of this study is to evaluate the accuracy of fetal kidney length in estimation of gestational age in normal singleton pregnancies.

Patients and Methods: observational study, the study was conducted at the antenatal outpatient clinics of Obstetrics and Gynecology at Alzahraa University hospitals and Ahmed Maher Teaching hospital in the period between December 2017 and December 2018. Approval from Ethical Committee at Al Zahraa University was taken. This study included 120 asymptomatic, pregnant women, with singleton pregnancy (30 cases at each gestational age 32, 34, 36 & 38 weeks gestation). **Results:** the study shows that fetal kidney length is a good indicator of gestational age and can be used alone due to its accuracy in comparison to other measurements (BPD, FL & AC) that may be changed in the third trimester. There was a significant difference between right and left kidney length through different age of gestation (The Lt KL measurement was larger than the measurement Rt KL). Gestational age in weeks is nearly equal to MKL. **Conclusion:** fetal kidney length correlates well with gestational age, so it can be concluded that kidney dimensions can be helpful in determining the gestational age when menstrual dates are uncertain.

Keywords: Fetal Kidney Length, Gestational Age, Third Trimester of Pregnancy.

INTRODUCTION

Precise knowledge of gestational age is the cornerstone of the obstetrician's ability to successfully manage prenatal care and is critical to prenatal testing and successful planning for appropriate treatment or intervention. Failure can lead to prematurity, which is associated with increased perinatal morbidity and mortality⁽¹⁾.

Even if the date of menstruation is true, the time of ovulation, fertilization and implantation cannot be known. Women may undergo several "waves" of vesicle growth during the normal menstrual cycle, which may mean ovulation inconsistency during any given cycle. Sperm may remain for 5 to 7 days in the female reproductive system, so the "known" pregnancy date is not fully reliable. Recent studies suggest that the duration of ovulation to implantation can vary by 11 days, which may affect fetal size and growth⁽²⁾.

Even in women who are certain of menstrual dating, delayed ovulation is an important cause of perceived prolonged pregnancy and is more likely to occur than early ovulation. Some authors have suggested that 282 days should be used instead of 280 to improve dating accuracy, since it is more likely that women will ovulate later rather than earlier than predicted. All of these factors seems to make it difficult to accurately predict gestational age based on menstrual history⁽²⁾.

Further, factors such as menstrual abnormalities, lactational amenorrhea, oral contraceptive failure, bleeding in early pregnancy and chronic anovulation may interfere with accurate calculation of GA from the date of LMP⁽³⁾. An accurate GA is of importance in cases where early

termination is necessary as soon as the fetus becomes mature e.g., pre-eclampsia, chronic renal disease, severe intrauterine growth retardation (IUGR), diabetes, placenta praevia centralis and where mothers are Rh -ve. Accurate GA estimation is also necessary where certain tests need to be performed for example amniotic fluid and serum assays, chorionic villus sampling and to plan fetal therapies. A recent trend can also be included in this list, where women want an elective cesarean section on a certain date e.g., 11.11.11 or 12.12.12 or the New Year day and also the date suggested by the astrologer. A sudden increase in operation rates were witnessed on these dates⁽⁴⁾.

Ultrasonic measurement of fetal biometry: Crown rump length (CRL), Biparietal diameter (BPD), Femur length (FL), Abdominal circumference (AC) & Head circumference (HC) are considered to be reliable when they are performed in first & early 2nd trimester (<24 weeks). Currently there is no single fetal measurement used for accurate estimation of gestational age in the 3rd trimester especially in women who booked late & unsure about their LMPs⁽⁵⁾. However, as gestational age progresses, they become increasingly unreliable because of the biological variability of size in relation to age, so accurate dating of pregnancies in the late second trimester or in the third trimester remains a problem, especially in women who consult late for maternity care and are uncertain of the date of their LMP⁽¹⁾.

Recent studies have indicated that fetal kidney length (KL) correlates well with gestational age. The conclusion of these studies indicates that the fetal kidney length could be used in the gestational age estimation where dates are uncertain or women come

for ultrasound fetal biometry dating in the third trimester itself ⁽⁶⁾.

Several longitudinal studies have been performed in the western countries concerning sonographic measurement of fetal kidney length. Initially these were done for diagnosis of renal malformation in utero & later on they were to find out the correlation between the fetal kidney length and the gestational age ⁽⁵⁾.

The use of all four biometric indices is recommended for all pregnancies beyond 20 weeks for reduction of variabilities. In second trimester BPD, HC, AC and FL can predict GA with fair accuracy ($\pm 10-14$ days). As pregnancy advances these parameters become increasingly unreliable in estimation of GA ⁽⁴⁾.

Fetal kidney has been shown a steady growth of 1.7 mm fortnightly throughout pregnancy and is unaffected by growth abnormalities. Various studies have reported that fetal kidney length (FKL) strongly correlates with the gestational age in late trimester. Fetal kidney is easy to identify and measure but has not been studied extensively as a biometric index for gestational age estimation, although ultrasound textbooks often have tables, of different dimensions ⁽⁷⁾.

Although fetal biometry measurements help an accurate gestational age estimation in the early second trimester, the biological diversity of size lead to change in accuracy of these parameters as the age of fetus advanced and a true dating in late second or third trimester is difficult. So, some studies focused on the association of kidney size in a normal fetus with gestational age ⁽⁸⁾.

AIM OF THE WORK

The aim of this study is to evaluate the accuracy of fetal kidney length in estimation of gestational age in normal singleton pregnancies.

PATIENTS AND METHODS

Study design: Observational study.

Settings:

The study was conducted at the outpatient clinics of Obstetrics and Gynecology at Alzahraa University hospitals and Ahmed Maher teaching hospital in the period between December 2017 and December 2018. **Approval from Ethical Committee at Al Zahraa University was taken.**

Study Population:

This study included 120 asymptomatic, pregnant women, with singleton pregnancy (30 cases at each gestational age 32, 34, 36 & 38 weeks gestation), calculated from first day of last menstrual period (LMP), cases were recruited from the antenatal outpatient clinic.

The exclusion criteria included the following:

- Anomalous fetus especially fetal kidney anomalies.
- IUGR.

- Uncertain gestational age.
- Multiple pregnancies.
- Patients with high risk pregnancies such as preeclampsia, fetal growth restriction (FGR), macrosomia, DM, oligohydramnios, and polyhydramnios.

- Gross maternal obesity (Class II & Class III):

BMI is the ratio between weight to the squared height (Kg/m^2) of a case, used to easily approximate body fat percentage and stratify people into categories as follows:

- Under weight (BMI 18.5 Kg/m^2),
- Normal weight (BMI 18.5-24.9 Kg/m^2),
- Class I obesity-over weight (BMI 25.0-29.9 Kg/m^2),
- Class II obesity –obesity (BMI 30.0-39.9 Kg/m^2) and
- Class III obesity-extreme obesity (BMI 40 Kg/m^2).

Methods:

The nature and aim of work were fully discussed to all women who agreed to participate in the study. Informed consent was obtained from each case.

Every woman was subjected to:

A) Detailed History taking with more concern about:

- **Personal history:** name, age, sex, occupation, etc.
- **Menstrual and obstetric history:** Date of LMP, expected date of delivery and gestational age, etc.

- **Past History:** of other diseases like hypertension, diabetes mellitus liver or renal diseases, collagen diseases or any other condition that may affect fetal growth.

- Expected date of delivery was calculated according to Naegle's formula:

$$\text{EDD} = \text{LMP} + 7 \text{ days} - 3 \text{ months} + 1 \text{ year}$$

Naegle's rule is a standard way of calculating the due date for a pregnancy. The rule estimates the expected date of delivery (EDD) by adding one year, subtracting three months, and adding seven days to the first day of a woman's last menstrual period (LMP). The result is approximately 280 days (40 weeks) from the start of the last menstrual period. Another method is by adding 9 months and 7 days to the first day of the last menstrual period.

Then though clinical examination was done including:

- General examination especially:
 - Measurement of weight, height and body mass index (BMI).
 - Assessment of vital signs (pulse and blood pressure, etc).
 - Abdominal examination was done: (fundal level, lie and presentation of the fetus, auscultation of fetal heart rate (FHR), presence of scar of previous operations).

Investigations: All cases were subjected to the following:

- Routine laboratory investigations including: Complete blood picture (CBC), Random blood sugar (RBS) & urine analysis.

- All cases were subjected to transabdominal ultrasound examination for assessment of: Fetal number, fetal biometry {biparietal diameter (BPD), Femur length (FL), abdominal circumference (AC) & amniotic fluid index (AFI) & kidney length.

The Equipment:

The ultrasound equipment used was LOGIQ V5 with transabdominal probe 3.75 MHZ in the ultrasound unit at the obstetrics and Gynecology

department of Al-Zahraa University and LOGIQ P7 in Ahmed Maher Teaching Hospital.

Statistical analysis:

Recorded data were analyzed using the statistical package for social sciences, version 20.0 (SPSS Inc, Chicago, Illinois, USA). Probability (P-value): P-value >0.05 was considered insignificant, P-value <0.05 was considered significant, P-value <0.001 was considered as highly significant.

RESULTS

Table (1): Comparison between the four studied groups regarding all data

		Group I (32 wks)	Group II (34 wks)	Group III (36 wks)	Group IV (38 wks)	P-value
		No. = 30	No. = 30	No. = 30	No. = 30	
Age (years)	Mean ± SD	26.47 ± 3.29	26.10 ± 3.35	26.23 ± 4.07	25.60 ± 3.78	0.822•
	Range	20 – 34	19 – 33	19 – 34	19 – 32	
Parity	Median	2 (0-4)	2 (0-4)	2 (0-4)	2 (0-4)	0.939*
Weight (kg)	Mean ± SD	78.20 ± 5.25	79.77 ± 4.60	82.53 ± 3.10	82.67 ± 4.06	0.000•
	Range	70 – 90	70 – 85	75 – 90	70 – 88	
Height (cm)	Mean ± SD	155.13 ± 7.24	156.97 ± 3.35	156.97 ± 3.35	156.40 ± 3.77	0.447•
	Range	130 – 164	150 – 164	150 – 164	150 – 164	
BMI	Mean ± SD	32.83 ± 5.24	32.48 ± 1.95	33.56 ± 2.14	33.84 ± 2.08	0.321•
	Range	27.89 – 50.12	27.34 – 35.42	29.3 – 38.02	28.4 – 37.59	
SBP	Mean ± SD	112.00 ± 4.07	107.33 ± 10.15	109.00 ± 8.03	108.00 ± 9.61	0.143•
	Range	110 – 120	90 – 130	90 – 120	90 – 130	
DBP	Mean ± SD	69.00 ± 8.45	68.67 ± 9.00	68.00 ± 8.47	67.00 ± 15.12	0.892•
	Range	60 – 80	60 – 80	60 – 80	0 – 80	
Hb%	Mean ± SD	11.18 ± 0.68	10.98 ± 0.74	10.92 ± 0.81	11.18 ± 0.90	0.466•
	Range	10.3 – 12.8	9.6 – 12.4	9.6 – 12.5	9.6 – 12.4	
RBS	Mean ± SD	79.23 ± 4.12	77.97 ± 5.05	80.23 ± 4.90	80.83 ± 5.74	0.134•
	Range	70 – 84	70 – 85	70 – 90	70 – 92	
FL (mm)	Mean ± SD	64.19 ± 3.75	65.21 ± 1.88	71.30 ± 1.15	72.30 ± 1.02	0.000•
	Range	61 – 70.3	63 – 70.1	68 – 73	71 – 74	
AC (mm)	Mean ± SD	29.00 ± 0.83	29.80 ± 0.71	32.32 ± 0.85	32.83 ± 0.79	0.000•
	Range	27 – 30	29 – 31	31 – 35	31 – 34	
AFI (cm)	Mean ± SD	17.05 ± 1.38	17.40 ± 1.48	17.23 ± 1.52	17.49 ± 1.38	0.653•
	Range	15 – 20	15 – 20	15 – 20	15 – 20	
Rt.kl (mm)	Mean ± SD	31.20 ± 0.54	33.08 ± 0.46	35.89 ± 0.42	36.94 ± 0.75	0.000•
	Range	30.5 – 32.1	32.3 – 34.3	35 – 36.8	34.4 – 37.8	
lt.kl (mm)	Mean ± SD	31.95 ± 0.49	33.80 ± 0.34	36.48 ± 0.32	37.64 ± 0.52	0.000•
	Range	31.3 – 33.5	33.2 – 34.8	36 – 37.3	36.3 – 38.5	
Mkl (mm)	Mean ± SD	31.57 ± 0.49	33.43 ± 0.34	36.15 ± 0.33	37.35 ± 0.49	0.000•
	Range	30.9 – 32.8	32.95 – 34.5	35.5 – 37.05	36.1 – 38.1	

P-value > 0.05: Non significant; P-value < 0.05: Significant; P-value < 0.01: Highly significant, *: Chi-square test; •: One Way ANOVA test.

No significant difference in the four groups as regards Age, Parity, height, BMI, BP, Hb% and level of Random blood sugar (RBS).

Table (2): Mean Right Kidney Length, Left Kidney Length & combined kidney length compared with gestational age

Gestational age (weeks)	Number of patients	Rt KL± SD (mm)	Lt KL± SD (mm)	P-value	MKL± SD (mm)
32	30	31.20± 0.54	31.95± 0.49	0.000	31.57±0.49
34	30	33.08±0.46	33.80± 0.34	0.000	33.43± 0.34
36	30	35.89±0.42	36.48± 0.32	0.000	36.15± 0.33
38	30	36.94±0.75	37.6± 40.52	0.000	37.35± 0.49

The left kidney length is significantly higher than the Right KL across the different weeks of gestation.

Table (3): Relation between various indices and Mkl at 36 weeks of gestation

	Group III (36 wks)	
	Mkl (mm)	
	r	P-value
Age (years)	0.463*	0.010
Weight (kg)	-0.203	0.283
Height (cm)	0.191	0.312
BMI (kg/m ²)	-0.211	0.264
SBP	0.105	0.582
DBP	0.221	0.240
Hb%	-0.062	0.746
RBS	-0.382*	0.037
BPD (mm)	-0.504**	0.005
FL (mm)	0.168	0.375
AC (mm)	-0.169	0.372
AFI (cm)	0.024	0.898

There was a strong positive correlation between MKL and Age, BPD and RBS at 36 weeks of gestation.

Table (4): Comparison between Rt kl & Lt kl at different gestational ages

		Group I (32 wks)	Group II (34 wks)	Group III (36 wks)	Group IV (38 wks)
		No. = 30	No. = 30	No. = 30	No. = 30
Rt.kl (mm)	Mean ± SD	31.20 ± 0.54	33.08 ± 0.46	35.89 ± 0.42	36.94 ± 0.75
	Range	30.5 – 32.1	32.3 – 34.3	35 – 36.8	34.4 – 37.8
Lt.kl (mm)	Mean ± SD	31.95 ± 0.49	33.80 ± 0.34	36.48 ± 0.32	37.64 ± 0.52
	Range	31.3 – 33.5	33.2 – 34.8	36 – 37.3	36.3 – 38.5
P-value		<0.001	<0.001	<0.001	<0.001

There was a statistically difference between Rt and Lt kidney length in all gestational age groups.

DISCUSSION

The first and most important duty of the obstetrician is the date of conception as soon as possible during the prenatal period. Accurate estimates of gestational age are essential for the management of all pregnancies, particularly high-risk pregnancies (5). Previous studies have concluded that embryonic kidney length can be used to accurately date of pregnancy even in difficult situations (head injury, IUGR for fetus, macromia, deformity, etc.).

The biometric indices used in second trimester continue to be used in third trimester despite substantial evidence indicating that the standard deviation for these measurements widens

with advancing gestation and therefore were likely to be more inaccurate as the GA progress (3).

During the early stages of pregnancy, gestational age can be determined accurately by gestational sac diameter and volume, foetal crown – rump length (9) and much later with the help of biparietal diameter and femur length measurements (10). However, when women book late and in particularly those who are uncertain of their last menstrual period, it is often difficult to date pregnancies.

Various parameters have been studied for dating pregnancies which include floating particles in the amniotic fluid (11), transcoelomic diameter (12),

transcerebellar diameter ⁽¹²⁾ and ossification centres of the long bones ⁽¹³⁾.

By abdominal ultrasound in transverse section, both kidneys appear as hypo echogenic oval retroperitoneal structure with no distinctive borders at the second trimester ⁽⁵⁾. Depending on fetal position and model of ultrasound machine, 90% of fetal kidneys are identified by week 20 ⁽⁶⁾.

In the present study we evaluated the accuracy of fetal kidney length as an individual parameter for determination of gestational age.

The present study involved 4 groups, at different gestational ages as follows:

The first group contained 30 singleton pregnant women at 32 weeks gestation, the second group contained 30 singleton pregnant women at 34 weeks gestation, the third group contained 30 singleton pregnant women at 34 weeks gestation and the fourth group contained 36 singleton pregnant women at 38 weeks gestation.

All cases at each group underwent detailed medical history, examination and Transabdominal ultrasound to assess Foetal biometry (BPD, FL, AFI & AC) and kidney length measurement for both right and left kidneys.

The mean age of women under study was 26.10 Years (ranging from 19-34 years), the parity of women was ranging from 0 to 4 pregnancies.

In the current study there was no relation between FKL and age of patient, Parity, weight, BP, BMI, and other indices at 34 weeks of gestation, while at 32 weeks there was inverse relation between age and MKL. At 36 weeks of gestation, there was direct relation between age and MKL and inverse relation between BPD and RBS with the M KL.

At 38 weeks of gestation there was inverse relation between SBP and Mean KL.

Cohen *et al.* ⁽¹⁴⁾ found that there was no correlation between fetal kidney length and mother's height.

Edevbie & Akhigbe ⁽¹⁵⁾ proved that there is a weak positive correlation between maternal weight and maternal age that suggests maternal body habitus may significantly affect the correctness of GA determination using the LMP predicted on Naegel's rule.

In our study, the mean foetal kidney length has increased from 31.57 mm at 32 weeks of gestation to 37.35 mm at 38 weeks of gestation.

The linear increase in fetal kidney length in millimeters as the gestational age increased in weeks in the current study agreed with **Aremu** ⁽¹⁶⁾.

In agreement with **Edevbie & Akhigbe** ⁽¹⁵⁾, who observed significant differences in length between both kidneys, in favor of the left kidney.

Also, **Seilianian & Delui** ⁽¹⁷⁾ found that left kidney length is slightly & significantly higher than the right kidney length.

In the current study there was significant difference between measurement of right and left kidneys (left kidney length was significantly higher than the Right Kidney length).

In contrast to **Konje *et al.*** ⁽¹⁾ and **Kansaria** ⁽⁶⁾ found no significant difference between the right and left kidney lengths. These investigators carried out their measurements in fewer participants (70 and 73 participants, respectively), compared with 120 participants in the present study.

The research by **Kansaria and Parulekar** ⁽⁶⁾ was a longitudinal study in which consecutive measurements were done at 2 weekly intervals in each participant (in an Asian population), against the observational approach in the present study in which measurements were taken in each participant at just one visit (in an African population).

Although **Ahmadi *et al.*** ⁽¹⁸⁾ found no difference between RKL and LKL ($P = 0.843$) in an examination of 557 fetuses, they found mean right kidney width longer than the mean left kidney width ($P = 0.004$).

The variation in observations regarding right and left kidney lengths in the present study compared with other differing previous studies may be due to genetic and socioeconomic factors.

This study provides an obvious advantage where there is difficulty in measuring BPD, HC due to engaged head or small AC due to IUGR.

Both kidneys were visualized with a little manipulation of transducer position and angle insonation relative to kidney plan which allowed easy identification of both kidneys.

In agreement with **Konje *et al.*** ⁽¹⁾ in which study involved measurements of both kidneys.

CONCLUSION

Fetal kidney length correlates well with gestational age, so it can be concluded that kidney dimensions can be helpful in determining the gestational age when menstrual dates are uncertain. Both kidneys can be easily visualized on ultrasonography in third trimester and can be easily and accurately measured with difference between measurement of right and left kidney. Lt KL measurement is significantly higher than Rt KL throughout gestation, so due to this difference both right and Left kidneys should be measured, measurement of one kidney can't replace the other. Mean KL measurement is helpful for detection of gestational age.

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