



Research Article

Ultrasonographic evaluation of fetal kidney length as a reliable parameter for estimation of gestation age in 2nd & 3rd trimester

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Abstract

The fetal Kidney length can be used in estimation of gestational age. In late 2nd and 3rd trimester both kidneys can be visualized easily and can be measured accurately. In late 2nd and 3rd trimester the fetal kidney length can be used as an investigational tool alone or may be in addition of other parameter in estimation of gestational age. The most commonly used parameters used by sonologist can predict gestational age in 1st and 2nd trimester. But as pregnancy advances, the accuracy of these parameters decreased. The length of fetal kidneys in mm collaborates very nicely with gestational age in weeks

Objective: To evaluate that fetal kidney length is a reliable parameter for gestational age estimation in 2nd and in 3rd trimester of pregnancy.

Methods: 371 healthy, pregnant females with a normal fetus were included in this study. A standard 2nd and 3rd trimester ultrasound examination was done. In addition to the standard biometric parameters, both fetal kidneys length were also measured. The collected data was subjected to statistical analysis.

Results: This study finding confirmed that fetal kidney length can be used as standard parameters alone or in addition with other routine parameters for estimation of gestational age in late 2nd and 3rd trimester. The Pearson correlation coefficient $r=0.988$ which showed a strong correlation with kidney length and gestational age and p value is (0.00)

Conclusion: Fetal kidney length estimates gestational age as accurate as other standard traditional parameters. It is more accurate in late 2nd & 3rd trimesters of pregnancy when other parameters are not much reliable. It is easy to detect and measure.

Keywords: Gestational age; fetal kidney length; femur length; Biparietal diameter

Introduction

The accurate knowledge of gestational age is very important for obstetrician as well as mother (Kaul *et al.*, 2012). Estimation of gestational age is also very helpful to categorize the fetus in normal fetus (normal for gestational

age), small for gestational age, large for gestational age. The first & most important duty of an obstetrician is to date the pregnancy as early as possible during the antenatal period. An accurate estimation of gestational age is fundamental to the management of all pregnancies, especially high-risk

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pregnancies (chronic hypertension, severe preeclampsia, central placenta previa, severe IUGR, sensitized Rh-negative mother etc.) where in some times early termination may become compulsory as soon as fetus becomes mature (Kaul et al., 2012; Yusuf et al., 2007). Any inaccurate estimation of gestational age may lead to perinatal morbidity and mortality due to iatrogenic pre- or post-maturity (Kansaria and Parulekar, 2009).

There are many parameters to measure gestational age. Some parameters are pre-nataly and some are post-nataly. Pre-nataly, the date of the last menstrual period (LMP) and abdominal ultrasound scan are commonly used. Post-nataly, examination of the anterior vascular capsule of the lens, physical and neurological assessment is most commonly used (Opara, 2009).

As the technology advanced in sonography, the accuracy in estimation of fetal age has become more demanding. Due to advancement in medical technology the expectation of people have increased and they expect exact estimation to plan for their pregnancy (Gupta et al., 2013).

Various non-traditional sonographic parameters for calculation of GA are being studied like transverse cerebellar diameter (TCD), fetal foot length, scapular measurements, fetal renal volume, fetal kidney length, epiphyseal ossification centers, amniotic fluid volume and placental grading (Toosi and Rezaie-Delui, 2013; Gottlieb and Galan, 2008).

Many researches show that fetal kidney length is very accurate assessment of gestational age estimation than bi parietal diameter (BPD), femur length (FL), head circumference (HC) and abdominal circumference (AC) after 24th week of gestation.⁸ Fetal kidney has been shown a steady growth of 1.7mm fortnightly throughout pregnancy and is unaffected by growth abnormalities (Konje et al., 2002).

Methodology

Study was conducted at Gilani ultrasound centre, Ferozpur road, Lahore Pakistan. 371 female with a history of regular menstrual cycles, known date of last menstrual period and

previous live normal neonates in multipara and having singleton pregnancy without any maternal complications or fetal anomalies were included in the study.

All pregnant women with any maternal complication e.g. hypertension, pre-eclampsia, maternal diabetes, central placenta previa, cases of oligohydramnios or polyhydramnios were excluded from study.

Fetal Complications such as twins pregnancy, severe IUGR, chromosomal, congenital abnormalities, dilated renal pelvis (>4mm) were also excluded from study. Toshiba Xario with 3-5MHZ curvilinear probe was used. Transabdominal scan was performed on every included woman whose gestational age was confirmed by early ultrasound scan and by her LMP. Scan was performed in supine position. Data was recorded on predesigned questionnaire forms and data collection sheets. These were then tranformed to EXCEL. SPSS 21 version was used. Regression analysis between the values of fetal right and left kidney was used. A normogram of these values was made using the available data and it was compared with previous studies using t test. P value of 0.5 was considered as significant.

Results

A total 371 pregnant females between 18 to 40 years of age regardless of parity were examined with ultrasound BPD, FL and length of fetal both kidneys were measured. The present study showed strong correlation between mean fetal kidney length and gestational age. Mean length of both kidneys were presented in millimeters (mm) with 95% confidence interval. There was no association between gestationl age, maternal weight, height, parity or socioeconomic status.

Table 1 shows Gestational age estimated from FL, Rt and Lf kidney, range, mean and standard deviation.

Table 2 shows Strong correlation between gestational age according to FL, right and left kidney. The Pearson correlation coefficient r= 0.988 which shows a strong relation between right kidney length and gestational age according to FL (p value=0.000).

Table 1: Gestational age estimated from FL, Rt. Kidney and Lt. Kidney

	N	Range	Minimum	Maximum	Mean	Std. Deviation
Gestational Age according to FL	371	108.00	170.00	278.00	232.3315	24.69863
Right Kidney	371	16.10	24.50	40.60	33.2841	3.47501
Left Kidney	371	16.00	24.80	40.80	33.3673	3.46742
GA_Weeks	371	15.43	24.29	39.71	33.1898	3.52883

Table 2: Correlation Gestational Age according to FL.

Right Kidney	Pearson Correlation	.988**	Left Kidney	Pearson Correlation	.988**
	P value	.000		P value	.000
**. Correlation is significant at the 0.01 level (2-tailed).					

Table 3 shows the equations derived from the linear regression analysis considering individual variables separately. The most accurate were the left and right kidney lengths of the fetus with standard error of 0.53 weeks while the less accurate was femur length with standard error of 1.788 weeks respectively

Table 4 Shows grouped length of length of right and left kidney ** GA according to FL. This table shows the

average progression in the right and left kidney lengths of the fetus (mm) with their standard deviations according to the gestational age (weeks).

The scatter plot analysis shown in Fig. 1 and 2 show a correlation of gestational age estimated from FL with left kidney (Fig. 1) and a linear relationship between GA according to FL (weeks) and left kidney length of fetus (Fig. 2).

Table 3: Linear Regression Equation: association between gestational age (weeks) and various other indices i.e. FL, FKL-L, FKL-R, BPD

Parameters	Intercept		Slope		P value	R ²	SE
	Estimate	SE	Estimate	SE			
Right kidney length	0.982	0.261	0.973	0.008	0.000	0.977	0.53047
Left kidney length	1.140	0.261	0.971	.008	0.000	0.977	0.53173
Femur length	-5.167	0.877	2.086	0.026	0.000	0.945	1.78864
Biparietal diameter	5.961	0.772	2.296	0.023	0.000	0.964	1.57282

Table 4: GA according to FL, Rt & Lt kidney in weeks

GA in weeks		Right Kidney	Left Kidney
24.000---29.0	Mean	27.2456	27.3526
	N	57	57
	Std. Deviation	1.18534	1.16988
	Minimum	24.50	24.80
	Maximum	30.00	30.00
29.000---34.0	Mean	31.9118	31.9890
	N	127	127
	Std. Deviation	1.34351	1.33239
	Minimum	29.40	29.50
	Maximum	34.70	34.70
34.000---39.0	Mean	35.9040	35.9807
	N	177	177
	Std. Deviation	1.31829	1.32029
	Minimum	33.50	33.50
	Maximum	40.60	40.80
39.000---40.00	Mean	38.7600	38.9000
	N	10	10
	Std. Deviation	1.62426	1.60139

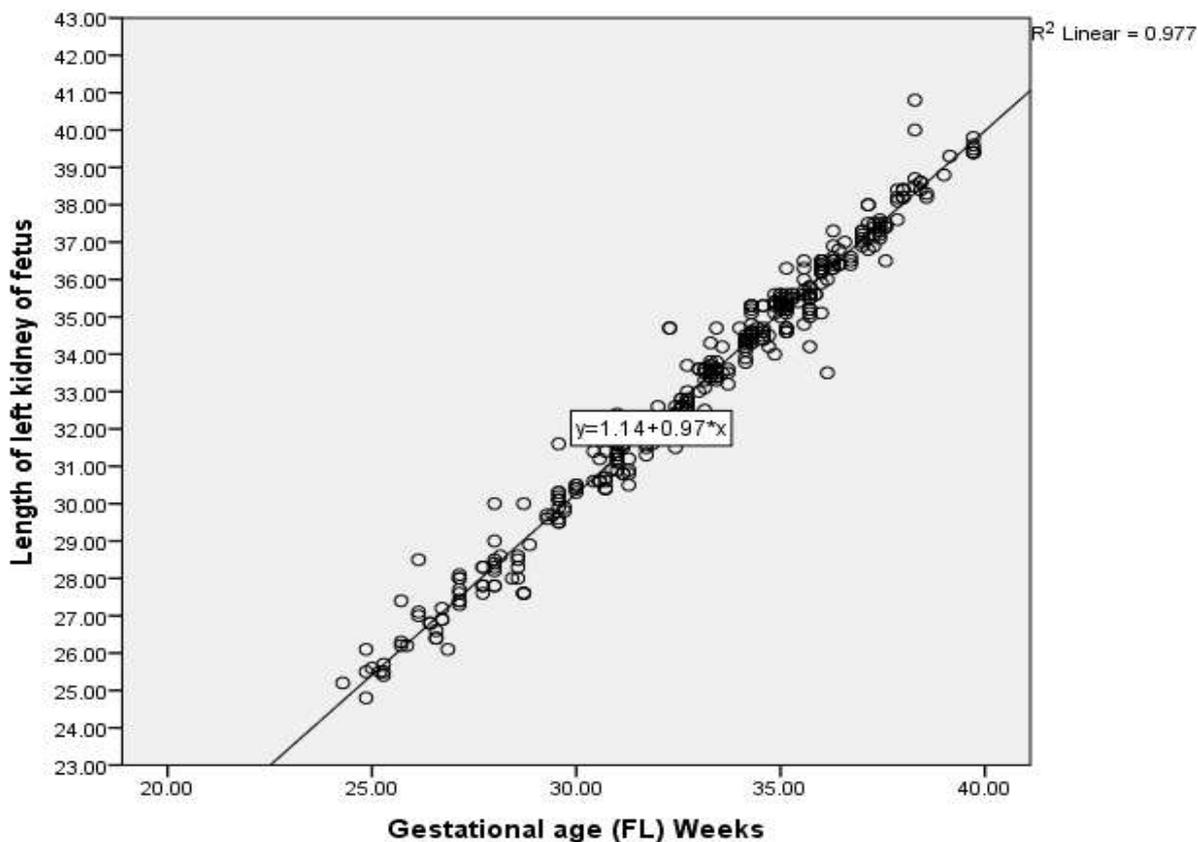


Fig. 1: Scatter plot showed correlation of gestational age estimated from FL with left kidney

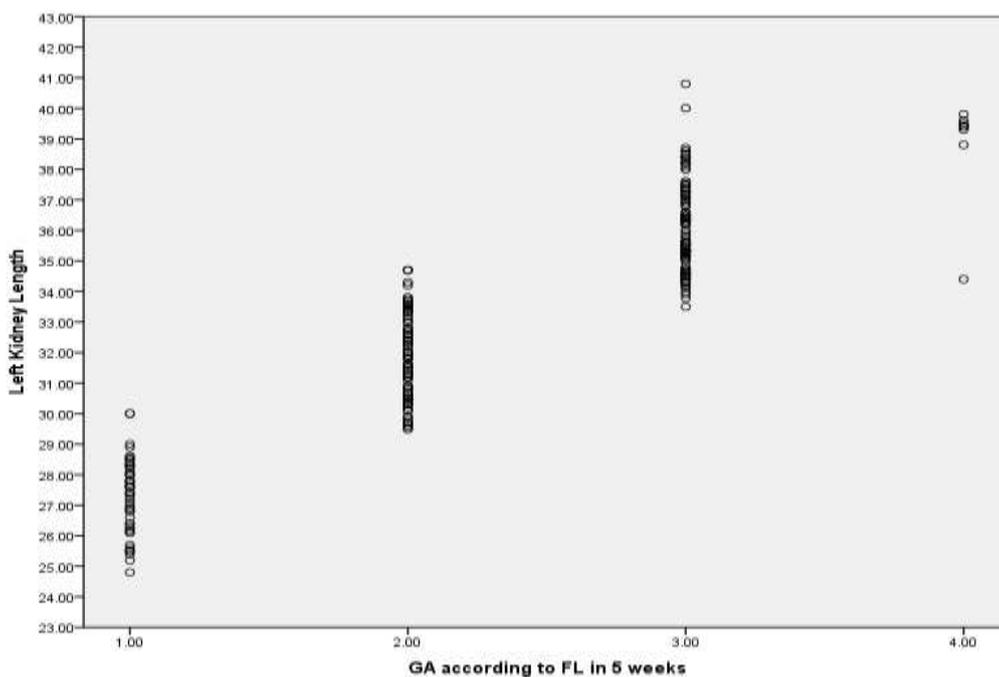


Fig. 2: Scatter plot shows a linear relationship between GA according to FL (weeks) and left kidney length of fetus

The mean femur length from 24 to 40 weeks increased was 232.33 ± 24.69 mm. GA was calculated by FL alone by regression model. Average length of left kidney was found to be 33.36 ± 3.46 mm.

Table 1 has shown that the range of gestational age according to FL is 108.00 days with mean and standard deviation of 232.33 ± 24.69 days. Range of right kidney length is 16.10 mm with mean 33.28 ± 3.47 mm. Average

length of left kidney is found to be 33.36 ± 3.46 mm with range of 16.00 mm. Gestational age is found in the range of 15.43 weeks with an average of 33.18 ± 3.52 weeks respectively.

Table 2, Pearson correlation shows a strong correlation between right and left kidneys length of fetuses and gestational age as the P value is 0.000 which is much smaller than the level of significance ($\alpha=0.05$).

Table 3 shows that Gestational age in weeks and length of left and right kidney of fetus has shown that 57 of 371 participants have gestational age 24.000---28.999 weeks with an average of left kidney length 27.352 ± 1.169 mm and 27.245 ± 1.185 mm of right kidney. 127 participants at gestational age of 29.000---33.999 weeks have an average length of right kidney 31.911 ± 1.343 mm and that of left kidney is 31.989 ± 1.33 mm. 177 participant females with gestational age in the range 34.000---38.999 weeks have an average length of right kidney of the fetus 35.904 ± 1.31 mm and that of left kidney 35.980 ± 1.32 mm. 10 of the females having gestational age in the range 39.000---43.000 weeks have their fetal right and left kidney length 38.760 ± 1.62 mm and 38.900 ± 1.60 mm respectively.

Summary report of gestational age has shown that among 371 participant females, the overall average length of the fetal right kidney is 33.284 ± 3.47 mm and that of left kidney of fetus is 33.367 ± 3.46 mm respectively.

Discussion

The standard fetal biometric parameters used for estimation of GA during 2nd and 3rd trimesters despite the fact that as with advancing gestational age the accuracy of these parameters decreased. We evaluated the role of length of fetal kidneys for estimation of gestational age. The main aim of the study was to measure the length of normal length of fetal kidneys sonographically in the all cases of study during late 2nd and 3rd trimester of pregnancy. We compared its accuracy with other standard biometric parameter.

Our measurements were at 27 weeks 27.6mm, at 30 weeks 30.4mm, at 34 weeks 34.7mm and at 38 weeks it was 39.3mm. Gupta *et al.* (2013) had also found strong correlation between FKL and GA. They also found length of FK 28.6mm at 27 weeks, 30.85mm at 30 weeks, 33.45 mm at 34 weeks and 39.45 mm at 38 weeks.

Rehman *et al.* (2008) also reported the mean of fetal kidney length at 34 weeks it was 34.30mm and at 38 weeks was 37.30mm. Jayati Bardhan *et al.* (2016) also reported that fetal kidney length has strong correlation with gestational age of fetus and throughout pregnancy has steady growth rate.

JJ Kansaria (2009) in his study between 22 to 38 weeks of pregnancy found that mean kidney length increased at 24

weeks of gestation 23.87mm and at 38 weeks of gestation to 36.25.

There are number of factors that effect on readings of fetal kidney length i.e numbers of operators for example multiple versus double or single skilled operator, Skilled or non skilled operator, quality of ultrasound machine(newer vs older), study type (longitudinal vs cross sectional), and estimation of gestational age (exact or rounded off).

In our study a single skilled and well experienced sonologist performed all the sonographic measurements. The present study was non random study and new Toshiba machine was used.

The study population was from Lahore division, Pakistan. The length of fetal kidney better predict the gestational age than the biometric index model of FL. In all cases, with little manipulation in the position of the transducer both kidneys were easily visualized. Also, by angle insonation relative to the plane of kidney both fetal kidneys could be easily identified, which is in agreement with Gupta *et al.* (2013).

In present study, fetal kidney length showed strong correlation with gestational age and the correlation coefficient showed 98.8% association between gestational according to FL and both kidneys of fetuses and $P < 0.0001$. For estimation of gestational age regression model with fetal kidney length was ($R^2=0.97$). Regression model for the right and left kidney length and GA-FL is statistically significant (p-value = 0.000).

Left kidney length = $1.135 + 0.139(\text{gestational age according to FL})$

Left kidney length = $1.140 + 0.971(\text{gestational age (weeks)})$

Right kidney length = $0.982 + 0.973(\text{gestational age (weeks)})$

Ugur *et al.* (2016) calculated regression model for fetal renal length to estimate to gestational age was ($R^2=0.896$) and conclude that fetal kidney length is a practicable parameter for gestational age estimation with very high predictive value and by using FKL with other biometric indices gives better estimate of gestational age.

Yusuf *et al.* (2007) investigated fetal kidney length after 30 weeks of pregnancy and found excellent correlation between gestational age as calculated by FL, AC, BPD and HC ($p < 0.001$) and mean fetal kidney length.

Another study conducted by Sunipa Chatterjee *et al.* (2017) in Rajasthan, india stated that fetal kidney length is much reliable parameter in dating labor that it can be used as individual parameter, especially when other parameters are not effective and much reliable.

Moreover, Ahmadi *et al.* (2015) investigated fetal kidney length in 557 fetuses between 26 to 39 weeks of gestational age and predicted that even when exact date of LMP is not

confirmed by female then the fetal kidney length can be used as parameter for estimation of gestational age. The study showed strong correlation between gestational age and fetal kidney length.

Conclusion

Fetal kidney is easy to identify and to calculate its length due to lack of intestinal gases. Fetal kidney length is therefore a reliable parameter for the determination of gestational age in second and third trimesters of pregnancy. In the late second and third trimester fetal kidney length is the most perfect and accurate parameter than other traditional parameters. Fetal kidney length can be used as an individual parameter for gestational age estimation. It could prove to be a valuable tool in cases where other established biometric indices are difficult to obtain show gross discrepancies with each other or with GA. The length of fetal kidney in mm collaborates very nicely with gestational age in weeks.

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