Fetal Kidney Length: A Useful Parameter For Ultrasonographic Gestational Age Calculation

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Abstract: <u>Background & Objective</u>: As the technology used in sonography has become more advanced accurate estimation of gestational age (GA) has become more demanding to plan treatments in pregnancy. Fetal kidney length (FKL) alone or its combination with other biometric parameters can be used in GA calculation more precisely in IInd&IIIrd trimester. <u>Methodology:</u> Two hundred three healthy pregnant females of IInd&IIIrd trimester were analyzed for GA calculation via FKL, Bi parietal diameter (BPD) and femur length (FL) using various lenear regression models. <u>Results:</u> Fetal kidney could be seen easily sonographically at 16[th]wk of gestation. FL was the most accurate single parameter (SE $\pm$ 7.95 days) followed by FKL $\pm$ 9.56days; BPD was the least accurate $\pm$ 9.86 days. GA can be calculated most accurately by combining FKL with FL and BPD with SE $\pm$ 7.12 days. <u>Conclusion:</u> FKL is easy to measure in IInd and IIIrd trimester and more accurate than BPD for GA estimation. So FKL could be used alone or easily incorporated into the model for dating pregnancies after 16th wk of gestation, in particular when measurements of BPD and FL are difficult. [Agarwal S NJIRM 2016; 7(1):55-58]

Key Words: Gestational age (GA), Fetal kidney length (FKL), Femur length (FL), Biparietal diameter (BPD).

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Introduction: An accurate age of fetus plays a pivotal role in obstetric care. Uncertain dates and no assigned ultrasound date in early trimester poses a dilemma in management decision leading to iatrogenic pre or post maturities.[1]

In routine ultrasonography the ultrasonologist measures the bipariental diameter (BPD), head circumference (HC), abdominal circumference (AC) and femur length (FL) in estimating the gestational age (GA) and estimated date of delivery.[2]

However as the pregnancy advances these parameters become increasingly unreliable in prediction of GA. Therefore accurate estimation of GA in late 2nd and 3rd trimester still remains problem.[3]

Fetal kidney has been shown a steady growth of 1.7 mm fortnightly[4] 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.[2,3]

Fetal kidney is easy to identify and measure[5,6] but has not been studied extensively as a biometric index for gestational age estimation, although ultrasound textbooks often have tables, of different dimensions.[7]
Hence the purpose of our study is to evaluate the accuracy of FKL measurement for GA estimation alone and along with BPD and FL.

Material and Methods: The study was conducted in the Department of Radiology, RMCH and at Ganesh diagnostic, Bareilly on pregnant women who came for ultrasonography with a single live fetus in the 2nd and 3rd trimester. Only those fetuses were included in the study in whom the kidney was clearly visualized and no abnormal renal morphology and other fetal anomalies were observed. Two hundred three pregnant women were screened for KL, BPD and FL.

The length of both kidneys were measured from outer to outer margin using a gray scale real time ultrasonographic scanner, medisonsonoace X-8, 3.5MHz sector transducer was used. The method described by Konje et al[7]was followed i.e., the fetus was scanned in transverse plane until the kidney were visualized just below the stomach. The probe was rotated through 90[0] to outline the longitudinal axis of the kidney during apnea.

The data thus compiled was analyzed using computer software MS Excel and SPSS 14.0 version software. At each GA FKL and other biometric indices were reported as mean standard deviation (SD). Correlation between GA and FKL as well as correlation between GA and other parametric indices were calculated and assessed by using Pearson's product moment correlation coefficient. To predict GA by using FKL measurements and other biometric indices, multiple linear regression analysis was performed using linear mixed model approach taking GA as dependent variable and fetal biometric indices as independent variables. New models were constructed by including BPD, FL and average of left and right kidney in various combinations. Determination of best model was based on Akaike information criterion (AIC), $r^2$and

standard error (SE) of prediction. For each model the SE of prediction in days was calculated.

Table 1: Regression Models of Relationship between KL,BDP and FL

Parameters	Equation	AIC	r^2	SE(days)
KL	GA = 3.9636+ 0.8705*KL	1852.04	90.6	±9.562
KL,FL	GA = 4.7349+0.3923*KL+0.2427*FL	1655.32	94.4	±7.324
KL,BPD,FL	GA = 3.261+0.0884*KL+0.2525*BPD+0.0910*FL	1635.67	97.01	±7.122
BPD	GA= 2.888+ 0.3601*BPD	1935.36	96.4	±9.864
FL	GA = 6.7381+ 0.4173*FL	1886.14	92.2	±7.947
KL,BPD	GA = 2.750+0.1339*KL+0.3089*BPD	1608.54	96.6	±7.231
FL,BPD	GA = 3.405+0.101*FL+0.278*BPD	1667.32	96.9	±7.442

Results: In our study earliest age at which fetal kidney could be seen sonographically was found to be the 16th week of gestation and mean KL is 14.3 ± 1mm.

Table 1 shows – When GA was calculated on basis of FL, KL and BPD individually the SE was±7.95 days, ± 9.56days and ± 9.86 days with coefficient of determination (r^2) 92.2, 90.6 and 96.4 respectively. When KL was clubbed with BPD and FL, SE was reduced to ± 7.12 days with r^2 = 97.01.
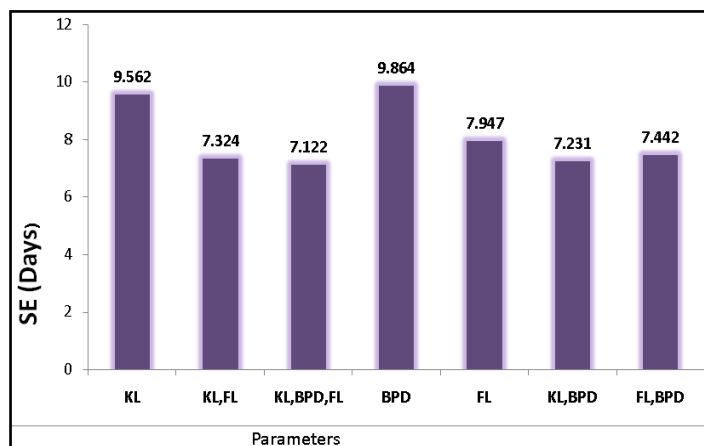
Discussion: The biometric indices used in second trimester continue to be used in third trimester despite substantial evidence indicating that the standard deviation for these measurements widens with advancing gestation and therefore were likely to be more inaccurate as the GA progress.[3]

In the present study we evaluated the accuracy of FKL as an individual biometric parameter in comparison to FL and BPD and also compared its accuracy with combinations with FL and BPD.

In all the cases, both the kidneys were visualized with alittle manipulation of transducer position and angle insonation relative to kidney plan which allowed easy identificationof both kidneys[3].This is in agreement with Konje et al[7]who also found that both kidneys could be identified easily.

Duval et al[8]however encountered difficulty in imaging kidneys in breach presentation and in vertex presentations with back facing laterally or posteriorly and in the study conducted by Cohen et al[9] only the border of near kidney could be measured unless fetus was prone with its back facing the transducer.

In our study, the earliest age at which fetal kidney could be visualized sonographically was found to be at 16th week of gestation and mean KL was 14.3 ± 1mm,which is almost comparable with the findings of Kumar et al[10]in which the earliest age at which fetal kidney was seen was at 18th week of gestation with mean kidney length 12 ± 1.31mm.

In our study while comparing the regression models of relationship between FL, KL and BPD the S.E in estimating GA varied with ± 7.94 days, ± 9.52 days and ± 9.86 days respectively. FL was found to be the most accurate and BPD was the most inaccurate single biometric index for estimating GA. S.E of KL lies in between FL and BPD and is closely followed by BPD.

Similar findings were observed by kumaret al[10] in which FL was the most accurate single parameter with SE of ± 3.85 days. KL with SE of ± 8.4 days is closely followed by BPD with SE of ± 8.75 days. The most inaccurate single biometric index was BPD for the GA estimation.
In the studies done by Konjeet al[7] and Gupta et al[2] BPD was also found to be the most inaccurate individual biometric index with SE of ± 11.62 days and ± 10.69 days respectively. These findings supported our observations that BPD as an individual parameter was most unreliable in GA estimation.

However, FKL was found to be the most accurate single biometric index with S.E of ± 10.29 days and ± 10.45 days in the studies by Konjeet al[7] and Gupta et al[2] respectively. This is in contrast with our study in which FL was the most reliable individual biometric parameter. As observed with the above studies including the present study, FKL predicted GA with better precision than the model with biometric index of BPD. This provides an advantage where BPD cannot be accurately

measured because either the fetal head is too long or correct plane for measurement cannot be obtained.

In these circumstances FKL can be used as an individual biometric index to estimate GA.[10] Kansaria and Parulekaret al[11]andKaul et al[3] have also reported that the FKL is the most accurate single parameter for estimating GA. Therefore FKL measurement can be introduced as a measure for estimating GA where BPD and FL are unreliable[10].

The present study further shows that the models obtained by combining different parameters were more accurate than individual biometric parameters for GA estimation: The best regression model after combining KL, BPD and FL comes out in the order of KL + BPD+ FL> KL +BPD>KL+FL>FL+BPD with SE of $\pm$ 7.12 days, $\pm$ 7.23 days, $\pm$ 7.32 days and 7.44 days respectively.

As evident from results that after combining KL with BPD and FL, the predictability of GA estimation has improved as compared to either parameters alone.

These findings are in accordance with the findings of Kaulet al[3] in which the combination of FL+KL+BPD with SE of + 7.59 days had improved accuracy than FKL with SE of $\pm$ 8.56 days.

The combination of FKL with FL and BPD also gave best predictability in the study by Konje et al[7] with S.E of $\pm$ 8.67 days as compared to other combination and with any individual biometric indices.

Similar results were observed in the study done by Gupta et al[2] in which combination of KL + FL + BPD scored least SE with $\pm$ 7.22 days as compared to combination of KL+FL & KL and BPD as individual parameter.

Hadlock FP et al[12] also conformed that combinations were significantly better that those using any single parameter.

The above studies supported the findings of our study that when KL is combined with FL and BPD it gave least SE in GA estimation.

The combination of the measurement of FKL with other biometric indices improvedpredictability.This could be explained on the basis that length of kidney remains largely unchanged in small – for gestational age fetuses[13,14].

Growth variation in the fetus affects all organs including the kidney but only in the AP and transverse diameter, not in the length[5,6].

The present study reveals that KL can be used in the estimation of GA in combination with FL + BPD for better prediction and where dates are uncertain and the women present late for ultrasound biometric dating.

Conclusion: Both the kidney can be easily visualized on ultrasonography in late IInd and IIIrd trimester and can be easily and accurately measured. So fetal kidney length can be used as investigational tool alone and with other parameters in the determination of gestational age in late IInd and IIIrd trimester of pregnancy.

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