

Original Article

Role of Fetal Kidney Length in Estimation of Gestational Age : Second Trimester *versus* Third Trimester

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This study aims to evaluate the reliability of Fetal Kidney Length (FKL) measurement in determining the Gestational Age (GA) of the fetus in second and third trimester to compare its accuracy with other fetal biometric indices like Bi-parietal Diameter (BPD), Femur Length (FL), Head Circumference (HC) and to study the change in efficacy of GA by combining the FKL with other fetal biometric indices.

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Key words : Fetal Kidney Length, Gestational Age, Femur Length, Bi-parietal Diameter, Head Circumference.

An accurate estimation of Gestational Age (GA) plays a vital role in excellence maternal care such as to observe the growth of developing fetus and to plan the delivery date. Any wrong estimation possibly will result in perinatal morbidity and mortality attributable to iatrogenic pre- or post maturity¹.

GA is the time elapsed since the first day of the Last normal Menstrual Period (LMP) and is approximately 280 days or 40 weeks².

An exact knowledge of GA of fetus plays a fundamental role in obstetrics care for diagnosis of growth disorders, especially in case of wrong dates or forgotten dates and also to plan the delivery either by induction or caesarean section. Above all it is important in complicated pregnancies like severe Preeclampsia, hypertension, severe IUGR, central placenta previa, sensitized Rh- negative mother etc. where early termination may become necessary once the fetus achieves maturity³.

About 30% of women however, do not remember their correct LMP or misinterpret early pregnancy bleeding as normal menses. Inaccurate estimation in pregnancy dating may occur because of delayed ovulation due to hormone therapy or improper-ovulation¹. Even if menstrual history is correct, the exact time of ovulation, fertilization and implantation is not known exactly.

Since the introduction of diagnostic ultrasound, more reliable methods to date the pregnancy have been developed. In the first trimester, these are gestational sac diameter and volume and Crown Rump Length (CRL) measurement⁴⁻⁶. Estimation of GA in the second and third trimester is accomplished by measuring multiple parameters like Bi-parietal Diameter (BPD), Head Circumference (HC), Abdominal Circumference (AC) and

Editor's Comment :

■ This study showed that Fetal Kidney Length can be used as an alternative and additional method for estimation of gestational age especially in rural communities of India where accurate menstrual history is difficult to obtain. Also, in women who present in late trimester where other parameters like BPD & HC are difficult to measure due to descent of fetal head in the pelvis.

Femur Length (FL) and some other non-traditional parameters that have been used to estimate the GA are transverse cerebellar diameter, foot length, antero-posterior thigh diameter and Fetal Kidney Length (FKL)⁴. FKL is one such non-traditional parameter under study for estimating GA. It correlates well with GA, this has been demonstrated on MRI as well^{3,4}.

Hence, the present study is undertaken to evaluate the reliability of FKL for estimation of GA in second trimester and third trimester and to compare its accuracy with that of other gold standard fetal biometric indices such as BPD, FL, AC and HC also to find out the change in efficacy of gestation age if measured alone by FKL or when combined with other standard biometric indices.

MATERIALS AND METHODS

The study was carried on women with singleton uncomplicated pregnancies attending the Outdoor Patient Department (OPD) for routine ultrasound fetal biometry using two dimensional ultrasonography. This was a prospective study for 18 months, commenced after the approval of ethical and research committee. Women with multiple pregnancies or women with known pregnancy complications like eclampsia, pre-eclampsia, gestational diabetes, polyhydramnios, oligohydramnios etc. were excluded from the study.

Fetus with pre-diagnosed chromosomal abnormalities, congenital anomalies and intrauterine growth retardation were excluded from the study.

The selective fetal biometric indices (BPD, FL, HC, AC) were measured along with FKL by using Ultrasound

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machine HD-11x E (Philips Medical Systems, USA) With convex array transducer in the second and third trimesters. The maximum renal length was measured from the upper pole to lower pole of both the kidneys in the longitudinal section of the fetus in the sagittal plane. The data was then analyzed using software SPSS Version 21. To predict GA by using FKL alone and by other fetal biometric indices, univariate and multivariate linear regression analysis was performed based on the ultrasonography. GA was taken as dependent variable whereas fetal biometric indices as an independent variables.

New models were constructed included BPD, HC, FL, AC and KL (average) in various combinations. Determination of the best model was based on Akaike Information Criterion (AIC), r² (Coefficient of Determination) and SE (standard Error of Estimation in days) was also calculated. The left kidney and the right kidney length were compared between 20-24 weeks and 34-38 weeks based on ultra-sonogram, its significance was assessed by usage of paired T-test. The coefficient of correlation between GA according to USG and fetal biometric parameters including Mean Kidney Length (MKL) was also calculated.

RESULTS

The present study evaluated the role of FKL measurement in the estimation of gestational age alone and when combined with and compared with that of routinely used gold standard parameters like (BPD, FL, AC and HC) in second trimester 20-24 weeks and in third trimester 34- 38 weeks . In all the cases the FKL was easily visualized with little manipulation of transducer position and angle insonation relative to kidney plane.

The youngest women in the study was 18 years old and the oldest was 42 years .503 women were enrolled and underwent fetal biometric ultrasound in the second trimester and out of which only 424 women came for third trimester follow up ultrasound ,79 women dropped out of study in the third trimester due to certain reasons (Table 1).

Table 2 shows that the left kidney and right kidney lengths based on ultrasound showed slight but significant variation in 2nd trimester when compared using paired sample T test with P value <0.0005. The left kidney length was longer than the right.

The MKL estimated by ultrasound increased with increase in gestation with mean of 18.87±1.60 mm in 20 weeks to 23.03±1.89 mm in 24 weeks (Table 3).

The Univariate regression shows that the

standard error of BPD is lowest so the BPD is the most accurate in predicting GA with standard error of 2.709 days followed by AC, HC, FL and MKL (Table 4).

Table 5 model shows that accuracy of precision for GA estimation is best when kidney length is combined with BPD, HC,FL and AC showed standard error of just 2.025 days.

The left and right kidneys showed significant variation with p value <0.0005 by using paired sample T test. The left kidney was seen longer than the right. (Table 6).

The MKL increased with the advancement of gestation in third trimester with mean of 33.75±0.9 mm in 34 weeks to 38.25±1.32 weeks at 38 weeks of gestation (Table 7).

The standard error AC is lowest so AC is the most accurate in predicting GA with SE of 2.589 days followed by HC, BPD, FL and KL (Table 8).

Table 9 model derived from regression equation shows accuracy of estimation is best when kidney length is combined with standard fetal parameters with standard error SE of just 2.063 days.

Table 1 — Frequency distribution table of the cases, age range and trimester

Trimester	Age Distribution	Number of Cases
Second	18-42	503
Third	18-42	424

Table 2 — Gestational Age according to USG in second trimester and its relation with the Kidney Length

GA weeks	LK Mean±SD(mm)	FK Mean±SD(mm)	Difference	P value
20	19.19 ± 1.57	18.55 ± 1.69	0.638	<0.0005
21	19.84 ± 1.22	19.28 ± 1.23	0.558	<0.0005
22	20.39 ± 1.5	19.77 ± 1.56	0.618	<0.0005
23	21.33 ± 1.44	20.92 ± 1.39	0.404	<0.0005
24	23.33 ± 1.86	22.72 ± 1.99	0.610	<0.0005

Table 3 — Gestational Age according to USG in second trimester and its correlation with Mean Kidney Length (MKL) in second trimester

Gestational Age in Weeks	Sample size	Mean Kidney Length (MKL)	
		Mean+SD(mm)	Median(mm)
20	115	18.87 ± 1.60	18.55
21	121	19.56 ± 1.19	19.45
22	145	20.08 ± 1.49	20.05
23	83	21.12 ± 1.38	20.75
24	39	23.03 ± 1.89	22.5

Table 4 — Univariate Regression on GA on USG in second trimester

Parameters	R ² Coefficient of determination	STD Error of Estimate (days)	Regression Equation	P value	Correction coefficient (r)
BPD	0.895	2.709	56.8+1.83*BPD	<0.0005	0.947
HC	0.881	2.888	61.29+0.48*HC	<0.0005	0.939
FL	0.876	2.940	83.52+1.84*FL	<0.0005	0.935
AC	0.884	2.840	57.72+0.55*AC	<0.0005	0.94
MKL	0.326	6.858	101.64+2.59*MKL	<0.0005	0.575

Table 5 — Multivariate regression on GA on USG in Second trimester

Parameters	Residual sum of squares	AIC	Regression Equation	R square	STD Error of the Estimate
MKL, BPD	3607.820	150.5980498	55+0.25*MKL+1.77*BPD	0.897	2.686
MKL,HC	4092.816	155.6375594	59.18+0.27*MKL+0.46*HC	0.883	2.861
MKL,FL	4113.141	155.8354936	78.79+0.42*MKL+1.74*FL	0.882	2.868
MKL,AC	3907.266	153.783836	55.15+0.34*MKL+0.52*AC	0.888	2.795
MKL,AC,BPD	2225.098	133.2876457	51.49+0.11*MKL+0.27*AC+0.99*BPD	0.936	2.112
MKL,BPD,FL	2810.390	142.6180482	63.65+0.21*MKL+1.04*BPD+0.81*FL	0.920	2.373
MKL,HC,BPD,	3049.668	145.8827562	55.04+0.17*MKL+0.2*HC+1.05*BPD	0.913	2.472
MKL,BPD,HC,AC	2119.817	133.3509737	51.9+0.09*MKL+0.1*HC+0.7*5BPD+0.24*AC	0.939	2.063
MKL,BPD,FL,AC	2071.020	132.4204773	56.39+0.12*MKL+0.77*BPD+0.4*FL+0.22*AC	0.941	2.039
FL,HC, BPD,AC	2050.486	132.0223501	56.27+0.67*BPD+0.06*HC+0.31*FL+0.22*AC	0.941	2.029
MKL,HC,BPD,AC,FL	2038.757	133.7931379	55.64+0.1*MKL+0.06*HC+0.66*BPD+0.32*FL+0.21*AC	0.942	2.025

Table 6 — Gestational Age according to USG in third trimester and its relation with Kidney Length

GA weeks acc to USG	LK Mean±SD(mm)	RK Mean±SD(mm)	Difference	P value
34	34.15 ± 0.98	33.35 ± 0.96	0.796	<0.0005
35	35.17 ± 1.13	34.29 ± 0.92	0.885	<0.0005
36	35.93 ± 1.00	35.09 ± 1.01	0.844	<0.0005
37	37.43 ± 1.28	36.05 ± 1.07	0.933	<0.0005
38	38.84 ± 1.39	37.65 ± 1.32	1.194	<0.0005

Table 7 — Gestational age accordingly to USG and its correlation with Mean Kidney Length (MKL) in Third Trimester

Gestational Age in Weeks	Sample size	Mean Kidney Length	
		Mean±SD(mm)	Median(mm)
34	93	33.75 ± 0.9	33.6
35	101	34.73 ± 0.98	34.7
36	127	35.51 ± 0.96	35.3
37	69	36.97 ± 1.13	36.7
38	34	38.25 ± 1.32	38.28

DISCUSSION

GA is calculated with precision by measuring ultrasonic fetal parameters like BPD, AC, HC and FL in 2nd trimester. However, these parameters are not reliable in the late trimester of pregnancy where growth discrepancies are obvious. In certain circumstances these parameters may not be reliable like femur length in achondroplasia, similarly BPD and HC becomes unreliable in altered skull growth like microcephaly, macrocephaly etc. These two parameters are also difficult to measure in the late third trimester when the head descends deep down the pelvic cavity^{4,7}.

Taking into consideration the disparities of the third trimester scan, various non-traditional methods are under study. FKL is one such non-traditional parameter which is easy to measure and correlates well with GA especially in unbooked women who presents late in the third trimester itself. Although all fetal organs are affected by growth variations and in fetal kidney, these

Table 8 — Univariate Regression on GA on USG in third trimester

Para-meters	R Square	STD Error of Estimate (days)	Regression Equation	P value	Correlation Coefficient (R)
BPD	0.879	2.946	-50.31+3.36*BPD	<0.0005	0.741
HC	0.882	2.910	-91.85+1.09*HC	<0.0005	0.729
FL	0.831	3.481	32.21+3.16*FL	<0.0005	0.728
AC	0.907	2.589	20.08+0.72*AC	<0.0005	0.746
KL	0.613	5.272	110.84+3.98*MKL	<0.0005	0.655

appear to predominantly affect the anterior-posterior and transverse diameters but FKL is not affected by growth variations. However, in practice all these are not common methods of dating pregnancies^{8,10,11}.

The present study evaluated the role of FKL measurement in the estimation of GA alone and was combined and compared with that of routinely used gold parameters like BPD, FL, AC and HC in second trimester (24-28 weeks) and third trimester (34-38

Table 9 — Multivariate Regression on GA on USG in Third trimester

Parameters	Residual sum of squares	AIC	Regression Equation	R square	STD Error of the Estimate (Days)
MKL,BPD	3192.796	145.7152729	-38.97+0.95*MKL+2.86*BPD	0.895	2.754
MKL,HC	3232.245	146.2059072	-75.82+0.83*MKL+0.94*HC	0.893	2.771
MKL,FL	4592.601	160.2409235	33.14+1.04*MKL+2.62*FL	0.849	3.303
MKL,AC	2662.128	138.4525886	21.03+0.59*MKL+0.65*AC	0.912	2.515
MKL,AC, BPD	2014.776	129.3203907	-16.45+0.43*MKL+0.4*AC+1.36*BPD	0.934	2.190
MKL,AC,FL	2302.466	134.6533009	15.06+0.36*MKL+0.5*AC+0.9*FL	0.924	2.341
MKL,HC,AC	2345.425	135.3919066	-23.59+0.49*MKL+0.38*HC+0.43*AC	0.923	2.363
MKL,HC,BPD,AC	1871.919	128.3819304	-42.92+0.37*MKL+0.26*HC+1.2*BPD+0.28*AC	0.938	2.114
MKL,BPD,FL,AC	1872.271	128.3894422	-14.91+0.3*MKL+1.16*BPD+0.59*FL+0.34*AC	0.938	2.114
FL,HC,BPD,AC	1813.209	127.1087000	-39.12+1.08*BPD+0.22*HC+0.55*FL+0.26*AC	0.940	2.080
MKL,HC,BPD,AC,FL	1779.444	128.3576727	-37.02+0.28*MKL+0.22*HC+1.06*BPD+0.49*FL+0.25*AC	0.941	2.063

weeks). In all the cases the FKL was easily visualized with a little manipulation of transducer position and angle insonation relative to kidney plane which is in agreement with Konje, *et al* and Luther, *et al*^{5,10}.

Fetal parameters like BPD, FL, AC and HC were measured in 503 cases along with both kidney lengths in 2nd and 3rd trimester. 480 women were sure of their LMP (Table 1).

The study showed that the left kidney was significantly longer than the right kidney in both trimesters (Tables 2,3,6) These findings were in agreement to the studies done earlier which also found that the left kidney was longer than the right⁵.

This study revealed a strong correlation of GA with KL and that MKL increased linearly with the advancement of GA in both trimester (Tables 2,6). These findings were supported by the studies done earlier^{12,13}.

The study also found that accuracy of GA estimation is best when MKL is added to routinely used parameters (BPD, HC, AC and FL) in both trimesters on multivariate regression models (Tables 5,9). The results obtained were in agreement with the studies done by Gupta, *et al*¹³⁻¹⁵. Whereas AC was the best parameter in the third trimester; this result was in concordance with the study done by Toosi, *et al*¹.

This study evaluated that KL when combined with the routinely used parameters estimated the GA with more precision in both the trimesters but however the accuracy of prediction of GA was more in the third trimester and therefore KL can be incorporated in models where other parameters are unreliable or difficult to obtain¹⁴⁻¹⁹.

Additionally, FKL is easy to measure and is least affected by the discrepancy of the third trimester and is therefore is useful parameter even in fetuses with growth retardation. Moreover, it can be used as an alternative and additional parameter for estimation of GA particularly in rural communities of India where illiteracy rate is higher and accurate menstrual history is difficult to obtain. As early antenatal check-ups is not a routine practice in such communities FKL can therefore, be used in women who presents in late trimester where other parameters are difficult to measure especially (BPD & HC) due to descent of foetal head in the pelvis. KL does not get affected by the discrepancy of late trimester or growth retardation where the foetal parameters can get affected which is predominantly seen in undernourished women who belong to the low socio-economic strata.

However, a further research is warranted to find the reliability and correlation of FKL in the estimation of gestational age between the nourished and the undernourished women.

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