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A study of fetal biometry using fetal kidney length post 20 weeks gestation

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Abstract
Obstetric Sonography was performed in 100 pregnant women attending to OPD to evaluate the efficacy of fetal kidney length (FKL) as a measure to estimate gestational age. Only patient with known LMP, previous history of normal menstrual cycle and with exclusion criteria were included in the study. Fetal biometry evaluation includes BPD, HC, AC, FL, and FKL. FKL was correlated with other fetal biometric parameters and clinical gestational age. The correlation was found to be significant. Nomogram of the FKL shows that there is a linear relationship between the kidney growth and the gestational age. So FKL can be used as a reliable parameter for determination of gestational age. FKL is reasonably a precise parameter for estimating gestational age (GA). Measurement of FKL will prove significant when other biometric parameters failed to be measured in certain situations like engaged/fixed head and when head is not in correct plane. Hence, FKL can be used as a reliable parameter for determination of gestational age.

Keywords: Fetal kidney length, gestation age, fetal biometry

Introduction
When mankind took first tentative steps to cure themselves of disease, diagnostics had always remained a challenge. So, it is till recent times that a host of diagnostic techniques has invaded the field of medicine. Among these the discovery of ultrasound plays a very crucial role [1].
Tremendous progress in application of ultrasound as a diagnostic modality revolutionized the management towards better care in the last two decades. This is particularly due to its non-invasive and non-ionizing nature besides its cost effectiveness leading to wider acceptability. The exemplary safety record of diagnostic ultrasound is probably an important reason that it has become so widely used [1].
Fetal biometry is a methodology devoted to the measurement of the several fetal anatomical parts and their growth pattern which helps in assessing gestational age and fetal well being [2]. Accurate gestational age assessment is crucial for deciding management options.

Knowledge of gestational age is important
i) To plan time and route delivery.
ii) To schedule invasive procedure such as chorionic villus sampling and amniocentesis in cases of need. Many important clinical decisions are influenced by the gestational age.

Ultrasound imaging has attained a universal status as it is safe for the women, the fetus and the sonologist with no reported risk of ionizing radiations as in other imaging modalities [3, 4, 5, 6, 7].
Since the introduction of diagnostic ultrasound, more reliable approaches to the dating of pregnancies have developed. These include gestational sac diameter (GSD), volume (GSV) and crown rump length (CRL) measurement in the first trimester [8].
Crown rump length measurement has been described to predict gestational age accurately to within ± 4.7 days [8]. In the second trimester, most commonly used biometric indices for dating pregnancies are the fetal biparietal diameter (BPD) and femur length (FL) [9, 10]. However, other indices such as transcerebellar diameter (TCD), clavicle length and foot length, have also been used. Most of these methods can predict gestational age with a high degree of accuracy in the early second trimester.
However, as gestational age progresses, they become increasingly unreliable because of the biological variability of size in relation to age [10]. Accurate dating of pregnancies in the late second trimester or in the third trimester therefore remains a problem, especially in women with

late booking and with uncertain last menstrual period (LMP) [11]. Using all the above parameters this error can be reduced by 25% to 30% [12]. There are conditions like oligohydromnios, multiple gestation, breech presentation and intrauterine growth restriction (IUGR) that can alter the shape of the fetal skull, abdomen, femur length, which inturn can result in dilemma of determining gestational age [13, 14].

The present study is undertaken to validate the fetal kidney length (FKL) measurement as an additional morphological parameter of fetal growth with less variability. This measurement is easy to take and can therefore be easily incorporated as another modality for dating pregnancies particularly when measurements of bi- parietal diameter and head circumference (HC) are difficultdue to postural variations.

The fetal kidney length can hence be used as a valuable and easy diagnostic tool that will accurately predict the estimated date of delivery without being affected by the factors causing discrepancy.

Since it is not routine parameter for gestational age (GA) measurement, we have therefore undertaken this study to evaluate its potential value in assessing fetal gestational age in our antenatal population.

Materials and Methods

Pregnant women with uncomplicated pregnancy more than 20 wk attending antenatal Outpatient department.

Method of collection of data

Sample size: 100.

Inclusion criteria

Only singleton pregnancy with complete visualization of at least one fetal kidney.

Booked antenatal cases at Narayana medical college and hospital between 20wks and term gestation.

Women who had reliable last menstrual period with H/O regular menstrual cycles.

Exclusion criteria

Before 20 wks of gestation
Unknown or inaccurate date of last menstrual period
Irregular menstrual cycles
Oligohydramnios
Polyhydramnios
Diabetic mothers
Pregnancy induced hypertension.
Preeclampsia
Fetal anomalies
Multiple gestation
IUGR

Examination method

All the statutory requirements under PNDT act were followed and form F was obtained from all the patients. All the relevant clinical history was obtained and the correct LMP was confirmed. Transabdominal ultrasonography was performed with patient in supine position. Good acoustics coupling was obtained using synthetic ultrasound gel

Ultrasonography is done using Siemens Sonoline or Philips HD 7 ultra sound scanner using a 3.5-12MHz transducers, images were recorded in the thermal films using the digital camera

In all the patients following parameters were obtained, they are BPD, HC, AC, FL, Fetal heart rate, estimated fetal weight, AFI and placental position. Plane used for measuring BPD and HC should include the third ventricle and thalami. Cavum septum pellucidum must be visible in the anterior portion of the brain and the tentorial hiatus must be visible in the posterior portion of the brain. The cursors are positioned in outer edge of near calvarial wall to inner edge of far calvarial wall for BPD

For HC the cursors are positioned on the outer edge of inner calvarial wall & the outer edge of far calvarial wall. AC was taken in the plane showing the umbilical vein perpendicular to fetal spine and stomach bubble.

The FL was obtained by aligning the transducer to the long axis of the diaphysis. Measurement cursors are placed at the junction of cartilaginous epiphysis of the bone and the thin bright reflection of the cartilaginous epiphysis should not be included.

Fetal kidney length was obtained in the sagittal plane, when full length of the kidney with renal pelvis is visualized, maximum length of any one single kidney is measured from upper pole to lower pole at least thrice and mean of the measurements are taken.

Statistical analysis

Descriptive statistical analysis has been carried out in the present study. Results on continuous measurements are presented on mean SD (minimum-maximum) and results on categorical measurements are presented in number (%). Significance is assessed at 5% level of significance. Pearson correlation has been performed to find the relationship between variables. LOESS plot using PROC LOESS from SAS has been used to plot the nomogram for relationship between fetal kidney GA with other variables.

Results

Out of 100 patients included in the study, 35(35%) were in the age group of 20-25 yrs, 53 (53%) were in the age group 25-30 yrs, 12(12%) in the age group of >30 yrs.

Out of 100 patients in the study population age ranged between 20 to 34yrs with mean age of 26.23±3.379 yrs in the second trimester. Mean age in third trimester is 26.25±3.8, with age ranging from 20 to 36 yrs.

The trimester distribution of the 100 pregnant women included in the study is as follows: 48(48%) pregnant women were in second trimester, 52(52%) pregnant women were in third trimester.

The correlation was best for FKGA versus FL (r: 0.778) and least for FKGA versus AC (r: 0.488). All the correlations were statistically significant.

The correlation was best for CGA versus HC (r: 0.832) and least for CGA versus AC (r: 0.499). All the correlations were statistically significant.

The correlation was best for FK GA versus AC (r: 0.876) and least for BPD (r: 0.808). All the correlation were statistically significant.

The correlation was best for CGA versus FL(r: 0.959) and least for CGA versus BPD(r: 0.931). All the correlations were statistically significant.

The correlation was best for FK GA versus CGA(r: 0.965) and least for FK GA versus AC(r: 0.955). All the correlations were statistically significant.

Table 1: Correlation Co-efficient of CGA with BPD, HC, AC, FL and FK GA in 2&3 trimesters

Pair	Pearson Correlation	P value
CGA Vs BPD	0.987	< 0.0001
CGA Vs HC	0.989	< 0.0001
CGA Vs AC	0.965	< 0.0001
CGA Vs FL	0.989	< 0.0001
CGA Vs FK GA	0.973	< 0.0001

The correlation was best for CGA versus HC and FL (r: 0.989) and least for CGA versus
AC (r: 0.965). All the correlations were statistically significant.

Table 2: Mean fetal kidney length according to Gestational age in present study

Clinical GA (WKS)	N	FKL MEAN (mm)
20	9	20.8±0.6
21	9	21.1±1.36
22	11	21.73±0.78
23	9	23.78±2.48
24	5	24.4±0.89
25	4	24.75±2.36
26	1	27
27	2	27.1
28	3	28±1
29	2	28.5±0.7
30	4	32±2.4
31	4	32.5±1.73
32	2	33±2.82
33	3	35.67±2.08
34	4	37.25±3.77
35	7	36.14±1.34
36	9	38.33±2.8
37	5	39.4±2.1
38	7	39.14±2.11

Kidney length increases linearly. It is 20mm at 20 wks and 39 mm at 38 wks.

Table 3: Probable gestational age for FKL of 19 to 43mm

Fetal Kidney Length (mm)	N	Fetal kidney GA (weeks)			
		Mean	Std. Deviation	Minimum	Max
19	2	19.00	.00	19.00	19.00
20	4	19.50	.00	19.50	19.50
21	13	20.23	.35	19.50	21.20
22	10	22.21	.33	22.00	23.00
23	5	22.40	.00	22.40	22.40
24	5	23.20	.00	23.20	23.20
25	6	24.20	.00	24.20	24.20
27	2	25.30	.14	25.20	25.40
28	4	26.23	.05	26.20	26.30
29	3	27.80	1.04	27.20	29.00
30	1	30.40	.	30.40	30.40
31	3	30.00	1.21	29.30	31.40
34	5	31.16	2.09	29.30	34.40
35	8	32.99	.83	31.40	34.50
36	4	34.50	.00	34.50	34.50
37	5	35.40	.00	35.40	35.40
38	5	33.78	3.37	29.30	36.20
39	2	38.10	.00	38.10	38.10
40	4	38.30	.00	38.30	38.30
41	6	39.00	.00	39.00	39.00
42	1	39.30	.	39.30	39.30
43	2	39.50	.00	39.50	39.50

Discussion

This prospective study conducted in of 100 healthy pregnant women, attending OPD. Ultrasonic measurement of fetal kidney length was taken between 20 wks and term gestation along with other fetal parameters to find a correlation between them and gestational age.

A linear relationship was found between fetal kidney growth measured in mm and the gestational age in second (20 wks to 28 wks) and third trimesters (29 wks to term). The relationship between fetal kidney length and gestational age is statistically significant.

Many studies have been conducted to assess the variability in gestational age determination with FKL. In the present study positive correlation has been established in second and third trimesters and is showing a strong linear relationship with clinical gestational age.

This study demonstrated that by measuring fetal kidney length, pregnancies could be dated accurately with r=0.979 in those booking late or in those who had forgotten their last menstrual period and presented late for booking. Even if in normal pregnancy where other fetal biometric parameters can't be assessed due to postural variations, confinement during lactational amenorrohea, and irregular cycles. So it should be included in the routine armamentarium for fetal gestational age assessment.

The range of mean fetal kidney length was from 20mm at 20 weeks to max of 42mm at 38 weeks gestation, along with standard deviation and their 95%confidence interval. According to our study the fetal kidney lengths in mm are almost equal to the weeks at a particular gestational age i.e. at 20 weeks of gestation the fetal kidney length was 20mm. It is also evident from this study that as the gestational age increases, the length of fetal kidney also increases.

The study of Lawson *et al* using articulated arm scanning, showed measurement of 32 mm at 30 weeks and measurement of 42-43 mm at term, which are closer to our measurements.

Mean fetal kidney length in present study is 29.53±7.59 mm as in present study sample is between 20 wks to term where as in Ugur *et al* sample is between 24 wks to term (35.66±6.61 mm).

Fetal kidney length constantly increases by about 1.7mm fortnightly throughout the pregnancy and unchanged by growth disorders, which makes using it more reliable parameter in complicated pregnancies.

FKL has also been measured to estimate mean gestational age in different ethinic groups. FKL is not independent of ethinic origin of patient. Nomo gram for FKL can be developed for different ethinic races to estimate gestational age for a particular ethinic population. In our study, all the patients were of Indian origin and the nomogram for predicting gestational age from FKL was obtained.

A number of observed errors and technical errors can occur in obtaining the FKL measurements; the major source of errors may be due to uncertainity of end points and skewed off-axis images of the kidneys. The fetal adrenal gland is relatively large, and except in near term infants, it is difficult to separate it from the kidney, due to the lack of peri renal fat and a similar echo pattern. This may result apparent increase in the length of kidney because of the addition of fetal kidney and adrenal measurement. These possible errors were not evaluated in this study. Not withstanding the above possible technical and observer errors, the measurements taken in the present study were reasonably accurate.

Conclusion

- FKL is reasonably a precise parameter for estimating GA.
- Measurement of FKL will prove significant when other biometric parameters failed to be measured in certain situations like engaged/fixed head and when head is not in correct plane.
- Hence, FKL can be used as a reliable parameter for determination of gestational age

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