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Original Research Article

Fetal kidney length as a parameter for determination of gestational age from 20th week to term in healthy women with uncomplicated pregnancy

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ABSTRACT

Background: Accurate assessment of gestational age is pivotal to give quality maternity care. Ultrasonographic fetal biometry is the most widespread method used to establish GA. Sonographic biometric parameters commonly used are Crown rump Length (CRL), Biparietal diameter (BPD), Head circumference (HC), Abdominal circumference (AC) and Femur length (FL). Fetal Kidney Length (FKL) is one of nontraditional parameter and more accurate method of GA estimation than BPD, FL, HC and AC after 24th week of gestation. This study evaluates role of FKL in estimation of GA and compared its accuracy with other established biometric indices.
Methods: Present study is a cross sectional study and includes healthy women who were certain of their LMP with prior regular menstrual cycles with uncomplicated pregnancy between 20 weeks of gestation to term. Maximum length of anyone single fetal kidney is measured from upper pole to lower pole at least thrice and mean of the measurements was taken. The data has been analyzed in SPSS-21 version and Microsoft word, excel have been used to generate graphs, tables etc.
Results: Linear regression equation showed kidney length could predict gestational age with an accuracy ±9.048 days and predictability when combined with other biometric indices was ±8.299 days.
Conclusions: The study shows good correlation between gestational age derived from FKL and gestational age from established biometric indices like BPD, HC, AC, and FL.FKL can be combined with the other four biometric indices to give a fair estimation of gestational age.

Keywords: Gestational age, Kidney length, Ultrasonography

INTRODUCTION

The first and foremost duty of an obstetrician is to date the pregnancy failing which can result in iatrogenic prematurity or post maturity of fetus leading to perinatal morbidity and mortality. The last two decades have seen a tremendous progress in application of ultrasound as a diagnostic modality to establish GA. Various sonographic biometric parameters commonly used are Crown rump Length (CRL), Biparietal diameter (BPD), Head circumference (HC), Abdominal circumference (AC) and Femur length (FL).

Conditions like oligohydramnios, multiple gestation, breech presentation, polyhydramnios and intrauterine growth restriction (IUGR) can affect the BPD, AC, FL measurements. As the pregnancy advances these parameters become increasingly unreliable in prediction of GA.[1] Therefore accurate estimation of GA in late 2nd and

3rd trimester still remains a problem. Various nontraditional sonographic parameters for estimating GA are being studied like transverse cerebellar diameter, fetal foot length, epiphyseal ossification centers, amniotic fluid volume. Placental grading and fetal kidney length. Fetal Kidney Length is strongly correlated to GA and is more accurate method of GA estimation than BPD, FL, HC and AC after 24th week of gestation.[2-4] In this study we sonographically measured FKL, evaluated its role in estimation of GA and compared its accuracy with other established biometric indices.

METHODS

The present clinical study is a cross sectional study carried out on pregnant women in the second and third trimester of pregnancy. The study was done in the Department of Obstetrics and Gynecology S.C.B. Medical College, Cuttack, Odisha, India after obtaining clearance by the Institutional Ethical Committee.

- Sample size: 200 participants.
- Period of Study: September 2013- September 2015.

Inclusion criteria

- Healthy women who were certain of their LMP and had prior regular menstrual cycles with uncomplicated pregnancy between 20 weeks of gestation to term were selected for the study.

Exclusion criteria

- Before 20 weeks of gestational age.
- Unknown or inaccurate date of last menstrual period.
- Oligohydramnios.
- Polyhydramnios.
- Diabetic mother.
- Pregnancy induced hypertension.
- Pre-eclampsia
- Multiple gestations.
- Fetal chromosomal abnormalities

Examination Method

All relevant clinical history was obtained. LMP of the patient was noted, EDD calculated by Naegle's rule. Previous reliable menstrual history was ascertained. Gestational age at the time of admission was found out from LMP which was confirmed by early USG (<24weeks) if available.

An ultrasonography was performed in the ultrasound clinic in the department of obstetrics and gynecology, SCB MCH, Cuttack, using VOLUSON P8 scanner with a 3.5 MHZ convex probe. In all the patients following parameters were obtained. They are BPD, HC, AC, FL, FKL, Fetal heart rate, estimated fetal weight, AFI and placental grade, placental position.

For any measurement to be included in the study, the adrenal glands had to be clearly identified and excluded from the measurements. Fetal kidney length was obtained in the sagittal plane, when full length of kidney with renal pelvis is visualized. Maximum length of anyone single fetal kidney is measured from upper pole to lower pole at least thrice and mean of the measurements was taken.

Statistical analysis

The data has been analyzed in SPSS-21 version and Microsoft word, excel have been used to generate graphs, tables etc. Percentage, Regression analysis and Pearson correlation coefficient has been applied as required. Descriptive statistical analysis has been carried out in the present study. Results on continuous measurement are presented on mean±SD (Min-Max) and results on categorical measurements are presented in number (%).

Gestational age obtained using fetal kidney length was compared with gestational age obtained from individual parameters such as biparietal diameter, head circumference, abdominal circumference and femoral length and correlation among these parameters was assessed by using the Pearson's correlation coefficient.

RESULTS

The gestational age is that which is calculated from LMP on the day of examination. The fetal kidney length has increased from 22.5 mm at 24 weeks of gestation to 38.5 mm at 41 weeks.

Table 1: Changes in fetal kidney length with gestational age (in weeks) in the study.

Gestational age (in weeks)	Number of cases (n)	Fetal kidney length (±SD in mm)
24	2	22.5±0.07
25	4	25±0.2
26	5	26.2±0.10
28	4	28±0.08
29	6	29.1±0.075
30	4	30.2±0.09
31	14	31.4±0.13
32	7	31.2±0.04
33	11	32.5±0.16
34	7	33.2±0.04
35	32	34.5±0.13
36	21	35.7±0.13
37	30	36.0±0.09
38	18	37.3±0.07
39	17	37.6±0.13
40	12	37.9±0.13
41	2	38.5±0.21

Table 2: correlation of FKL GA WITH BPD GA, HC GA, AC GA, FL GA.

Parameters	r	P value
BPD GA	0.943	<0.001
HC GA	0.945	<0.001
AC GA	0.943	<0.001
FL GA	0.946	<0.001

This Table 2 shows relationship of gestational age from kidney length with gestational age from BPD, HC, AC, FL which was highly significant (p<0.001).

This Table 3 shows the equations derived from linear regression analysis when the individual variables were considered separately. The fetal kidney length can predict gestational age to within ± 9.048 days.

Table 4: regression models of relationship between GA with parameters FKL, BPD, FL, AC, HC.

Parameters	Regression equation	R^2	S.E in Days
FKL	GA = 3.694 +70.12 FKL	0.896	9.048
FKL, FL	GA = 3.953 +61.08 FKL+4.659FL	0.900	8.895
FKL, FL, AC	GA =5.07+49.26FKL+2.89FL+1.71AC	0.909	8.486
FKL, FL, AC, HC	GA=6.193+49.74FKL+3.11FL+1.74AC-0.167HC	0.909	8.496
FL, AC, HC, BPD	GA = 1.427+7.105FL+13.59BPD-0.63HC+2.807AC	0.875	7.666
FKL, FL, AC, HC, BPD	GA = -3.196+44.11FKL+1.59FL+1.34AC-0.258HC+6.42BPD	0.913	8.299

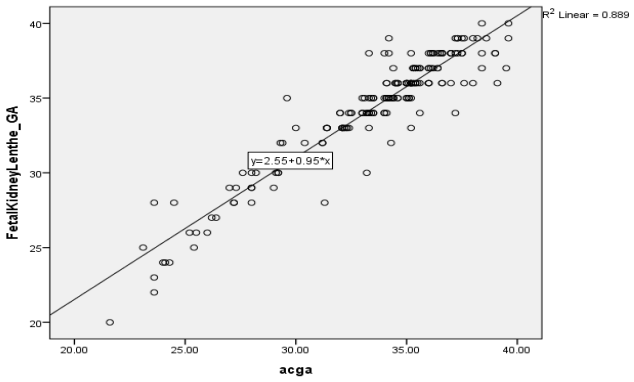

Figure 1: Correlation between AC GA and fetal kidney length GA.

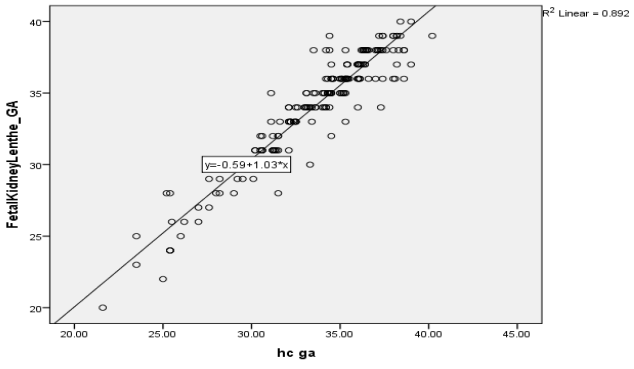

Figure 2: Correlation between HC GA and fetal kidney length GA.

Accuracy of estimation of GA by FKL alone was calculated and it was compared with the values obtained when FKL was combined with FL, FKL with FL and AC, FKL with FL, AC, and HC. All these values were compared with values obtained when all five parameters i.e. KL, FL, AC, HC, BPD were used. Present study shows when all the four parameters were combined (BPD, HC AC, FL) the gestational age could be predicted within ±7.66 days. When FKL was combined with other four indices (BPD, HC, AC, FL) the gestational age was found to be predicted with an accuracy of ± 8.299 days.

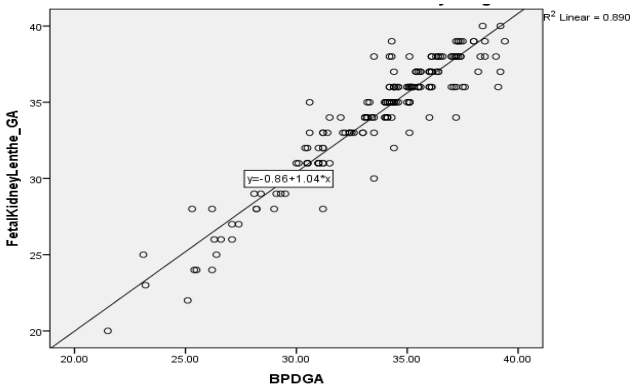

Figure 3: Correlation between BPD GA and fetal kidney length GA.

DISCUSSION

In the absence of reliable menstrual history there is no accurate alternative method of predicting the expected date of confinement. With the advent of high resolution real time ultrasound, the ability to image various organs in utero has dramatically improved. Ultrasonography fails in accurate determination of fetal age in the third trimester due to a large variability in the biometric parameter readings. Women booked late in pregnancy and in particularly those who are uncertain of their last menstrual period, it is often difficult to date pregnancies. There is therefore a need to

investigate a method of dating pregnancies that is simple, easy to define and reproducible. Fetal kidney length is one such parameter.

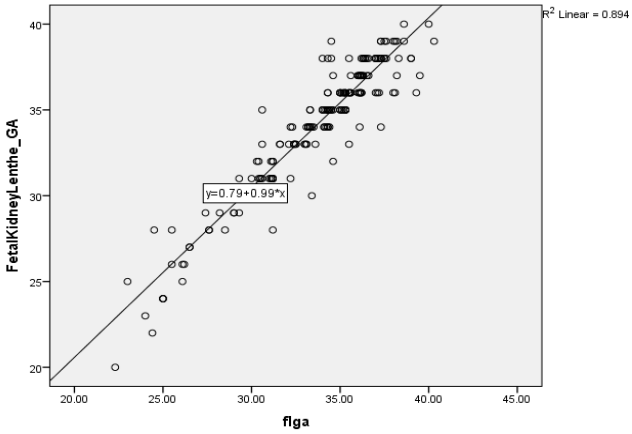

Figure 4: Correlation between FL GA and fetal kidney length GA.

The appearance of fetal kidney changes with advancing gestational age. As pregnancy advances, increased echogenicity from increasing perinephric fat is said to make them more visible by allowing easier separation of the kidney from its surrounding soft tissue.[5] Technical error or maternal obesity may result in poor scans and prevent identification of fetal kidneys especially during early gestation where the fetal adrenal and renal parenchyma have very similar homogenous patterns and closer to term this point is further obscured by echogenic nature of lower ribs.[4,6] This probably explains the slightly different results in different studies.[7] By overcoming all these obstacles, if renal length can be measured properly, it would be a good parameter to assess the gestational age of the fetus. The present study is an attempt to find whether fetal kidney length can be used as an independent parameter to calculate the gestational age like the other established biometric indices (BPD, HC, FL, AC) and accuracy to which gestational age can be calculated if kidney length is added to the four routine biometric parameters. An often quoted rule of thumb is that "renal length in mm approximates gestational age in weeks".

In present study it was found that length of the kidney increases linearly with gestational age from 22.5±0.07mm at 24 weeks to 37.3±0.07 mm at 38 weeks. As this study is a cross sectional study it is appropriate for comparing renal size at a known gestational age with reference data. They are not suitable for judging the appropriateness of growth of kidneys across time. The values of fetal kidney length at different gestational ages was similar to that of Kansaria, Parulekar (23.87±1.17mm at 24 weeks and 36.25±1.70mm at 38 weeks) but lower than those reported by Konje et al (24.2±1.2mm at 24 weeks and 40.1±2.4mm at 38 weeks).[8,9] Various reasons might explain these differences like multiple vs two skilled operators vs one skilled operator, type of study (cross sectional vs longitudinal),estimation of gestational age (rounded vs exact),quality of ultrasound machine (new vs old),racial differences. In this study, all sonographic were performed by single sonologist, it was a cross sectional study, gestational ages were rounded off to nearest single figure, ultrasound machine was new, patients are from South East Asia with body built different from western world. In the present study, we have correlated gestational age from fetal kidney length with gestational age derived from standard measured parameters like BPD, FL, HC, AC and it demonstrated that strong correlation($p<0.001$) exists between them. Similar correlation was found by Nahid Yusuf et al in their study.[10] The study shows correlation of gestational age from LMP with gestational age derived from biometric indices BPD, HC, AC, FL, and FKL.

Measurements of fetal kidney length showed good correlation with gestational age with correlation coefficient (r) 0.947 and $p<0.001$. Similarly, Cohen et al concluded that kidney length correlates well with gestational age.[4] Kaul et al also have suggested that fetal kidney length as the most accurate single parameter for estimating gestational age because of the good correlation.[11] Linear regression equations defining the relationship between gestational age from LMP and the various biometric indices used for gestational age estimation i.e. BPD, HC, AC, HC, FKL was derived in the present study. The most accurate was AC with a SE of 6.943 days and most inaccurate was HC with a SE of 12.098 days. In study by Konje et al the most accurate was the FKL with SE of 10.29 days and most inaccurate was AC with SE of 14.54 days.[9] Kansaria et al found most accurate variable to be FKL with SE of 9.17 days and most inaccurate was AC with a SE of 11.14 days.[8]

In present study when all the four parameters were combined (BPD, HC AC, FL) the gestational age could be predicted within ±7.66 days. Konje et al in their study showed that accuracy of calculating gestational age when the standard biometric indices were combined was ±9.45days.[9] When FKL was combined with other four indices (BPD,HC,AC,FL) in this study the gestational age was found to be predicted with an accuracy of ±8.299 days which is in accordance with study of Konje et al (± 8.4 days).[9] This study demonstrates that by measuring kidney length, pregnancies can be dated with a standard error (SE) of 9.048 days in those booking late or those who have forgotten their LMP and presented late for booking. The linear equation derived from present study for individual parameters has been compared with study done by Konje et al and Kansaria and Parulekar.[8,9] The fetal kidney length varied with a standard error (SE) of 10.29 days in study by Konje et al, 9.17 days by Kansaria and Parulekar and 9.048 days in the present study.[8,17] Though FKL can be used as a single parameter in estimation of gestational age accurate results can be obtained by using all five biometric indices (BPD, HC, AC, FL, FKL).

CONCLUSION

Fetal kidney length fulfills the need of the hour, as an investigational tool that will accurately predict the estimated date of confinement without being affected by

discrepancy of difficulty in dating in later trimesters. Although kidney size, as for all fetal organs, is affected by growth variations, these appear to predominantly affect only anterior-posterior and transverse diameters. In India, where routine antenatal registration is not a very common phenomenon, particularly in the rural area and where illiteracy makes it difficult to elicit proper menstrual history, it is very imperative that accurate dating is available. Manipulations of the transducer position and angle of insonation relative to kidney plane will allow easy identification of the kidneys. From present study, we can see FKL increases linearly with gestational age. There is a good correlation between gestational age derived from FKL and gestational age from established biometric indices like BPD, HC, AC, and FL. The FKL in mm collaborates nicely with GA in weeks. This parameter alone can predict the gestational age. FKL can be combined with the other four biometric indices to give a fair estimation of gestational age. Hopefully, the results will demonstrate its applicability in routine practice.

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