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Original Research Article

Assessment of the suitability of fetal kidney length measurement for determining gestational age in the third trimester

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ABSTRACT

Background Obstetric sonography plays a significant role in the determination of gestational age because of its accuracy and easy reproducibility. Fetal kidney length is claiming to be more accurate in certain situations and emerging as a new parameter.
Methods: A cross-sectional study was done on 200 pregnant women from January 2023 to July 2023; third trimester ultrasonography was used to assess the mean fetal kidney length along with the fetal head circumference, femur length, abdominal circumference, and biparietal diameter. Gestational age was calculated from mean fetal kidney length using the nomogram introduced by Cohen L and from multiple biometric parameters using the nomogram by Hadlock FP. The obtained values were then compared with the actual gestational age derived from excellent dates taken as a standard.
Results: Fetal kidney length gestational age ranges between 26-40 weeks, with mean 35.5±3.2 (Mean±SD), median 35.9. The correlation of clinical gestational age with fetal kidney length is by r value 0.997. The correlation was best for clinical gestational age with fetal kidney length gestational age. At 40 weeks of clinical gestational age, there were 14 (7%) cases with a mean FKL of 40.09 mm.
Conclusions: The correlation between fetal kidney length and clinical gestational age is statistically significant. Therefore, it can be utilized as a dependable parameter for determining gestational age.

Keywords: Fetal kidney length, Gestational age, Pregnancy, Third trimester, Ultrasonography

INTRODUCTION

Accurate gestational age assessment is pivotal to quality maternity care, e.g., diagnosis of growth disorders and timing of delivery. Failure can result in iatrogenic prematurity or post maturity, both of which are associated with increased perinatal morbidity and mortality.[1] Historically, the dating of pregnancies was based on the first day of the last menstrual period (LMP) in a regular 28-day menstrual cycle.[2] Since the introduction of diagnostic ultrasound, more reliable approaches to dating pregnancies have developed. These include gestational sac diameter and volume and crown rump length measurements in the first trimester.[3] Crown rump length measurement has been described as accurately predicting gestational age to within±4.7 days.[4] In the second trimester, the most commonly used biometric indices for dating pregnancies are the fetal biparietal diameter and femur length. However, other indices, such as trans cerebellar diameter, clavicle length, and foot length, have also been used.[5] Most of these methods can predict gestational age with a high degree of accuracy in the early second trimester. However, as gestational age progresses, above mentioned methods become increasingly unreliable because of the biological variability of size in relation to age.[6] Accurate dating of pregnancies in the late second

trimester or in the third trimester therefore remains a problem, especially for women who consult late for maternity care and are uncertain of the date of their LMP.[7] There are number of parameters used to calculate gestational age, but the most commonly used by all sonologists is a composite gestational age obtained by biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL) in the second and third trimesters.[8] Even these may not provide gestational age with great accuracy owing to discrepancies in late-trimester scans and intrauterine growth restriction (IUGR). The fetal kidney has shown steady growth of 1.7mm fortnightly throughout pregnancy and is not affected by growth abnormalities.[9] By prenatal ultrasound, identification of either one or both kidneys is possible in 90% of cases in the 17th week of gestation and in 95% of cases after the 20th week. Although kidney size, as for all fetal organs, is affected by growth variations, these appear to predominantly affect only anterior-posterior and transverse diameters.[10] The length of the kidney remains largely unchanged in a small gestational-age fetus. Knowledge of these measurements may allow earlier diagnosis of a variety of renal abnormalities as well as accurate estimation of gestational age.[11] The present study intends to determine the accuracy of fetal gestational age estimation using mean fetal kidney length (FKL) and compare its efficacy with other biometric parameters and gestational age derived from the last menstrual period taken as standard criteria.

METHODS

A cross-sectional study was conducted on 200 pregnant women attending the Antenatal care clinic at ESICMC and Hospital, Gulbarga from January 2023 to July 2023. All cases with singleton pregnancies in the third trimester (28 to 40 weeks) who are sure of the dates of their last menstrual period and normal antenatal pregnant women with no associated risk factors were included in the study. Women who delivered before 28 weeks of gestation age with an unknown or inaccurate date of their last menstrual period, irregular menstrual cycles, oligohydramnios, polyhydramnios, diabetic mothers, patients with pregnancy-induced hypertension, preeclampsia, multiple gestation, fetal chromosomal abnormalities, fetal anomalies, and intrauterine growth restriction were excluded from the study. With informed written consent, a detailed clinical assessment of the patient was performed in the out-patient department, including history, general physical examination, and antenatal investigations like blood grouping and typing, a complete hemogram, serology for HIV, HbsAg, and VDRL; thyroid function test; Glucose tolerance test; urine albumin, urine sugar, and urine microscopy; and any other relevant investigations as and when needed. Following this, using third trimester ultrasonography, the mean fetal kidney length along with the fetal head circumference, femur length, abdominal circumference, and biparietal diameter were measured. The (Figure 6) Gestational age was calculated from mean fetal kidney length using the nomogram by Cohen et al and gestational age from other multiple biometric parameters using nomogram by Hadlock et al.[12,13] These values were then compared with actual gestational age derived from excellent dates taken as a standard. The ultrasonography assessment was done using a Philips 3.5 MHz probe ultrasound. Measurements were obtained in the sagittal plane when the full length of the kidney with renal pelvis was visualized. Maximum length of any single fetal kidney was measured from upper pole to lower pole at least three times, and the mean of the measurements was taken. Gestational age derived from the nomogram by Cohen et al. was used to measure mean FKL.[12]

The data was analysis was done using appropriate descriptive and inferential statistics. The categorical type of data was expressed in terms of frequencies and percentages, whereas the numeric continuous data was expressed as mean±Standard Deviation (SD). Gestational age obtained from fetal kidney length and other methods like biparietal diameter, head circumference, and abdominal circumference was expressed as a mean±SD. In order to compare the estimated gestational age by both methods with the actual age, Bland-Altman analysis was done, which is a plot of agreement after setting the limits of agreement. Karl Pearson's coefficient of correlation was also calculated between FKL and GA and other parameters like BPD, HC, AC and FL with GA. Student's t-test was used to compare the mean values of two groups. For all statistical evaluations, a p value <0.05 was considered as statistically significant. Qualitative data was also summarized using charts and diagrams. The data was analyzed using the statistical package SPSS-20.

RESULTS

In the present study, out of 200 pregnant females, 13 cases (6.5%), were <20 years 117 (58.5%) in the age group of 21-25yrs, 61 cases (30.5%) were in the age group of 26-30 years, and 9 cases (4.5%) were >30 years (Figure 1). Clinical gestational age ranges between 28-40 weeks, 35.7±3.2 (Mean ±SD), median 36.1, BPD gestational age ranges between 27-39 weeks, with mean 34.3±3.1 (Mean±SD), median 34.7; FL gestational age ranges between 27-39 weeks, with mean 34.7±3 (Mean±SD), median 35. AC Gestational age ranges between 28-39 weeks, with a mean 34.8±3.1 (Mean SD), median 35.1; HC gestational age ranges between 26-41 weeks, with a mean 34.1±3 (Mean ±SD), median 34.4 and FKL gestational age ranges between 26-40 weeks, with mean 35.5±3.2 (Mean±SD), median 35.9 (Table 1). The BPD gestational age and Clinical gestational age correlate by 99.3% in the third trimester. The (Figure 2**)** The FL gestational age and Clinical gestational age correlate by 98.9% in the third trimester. The (Figure 3**)** The AC gestational age and Clinical gestational age correlate by 99.2% in the third trimester. The (Figure 4**)** The HC gestational age and Clinical gestational age correlates by 97.3%. The correlation for FKL gestational age with BPD gestational age was (r=0.991), with FL gestational age was (r=0.988),

with AC gestational age was (r=0.986), with HC gestational age was (r=0.976) and p value <0.001. All the correlations were statistically significant (Table 2).

Table 1: Descriptive statistics of different gestational ages.

Gestational age (GA) (weeks)	Range	Mean±SD	Median
Clinical GA	28-40	35.7±3.2	36.1
BPD GA	27-39	34.3±3.1	34.7
FL GA	27-39	34.7±3.0	35.0
AC GA	28-39	34.8±3.1	35.1
HC GA	26-41	34.1±3.0	34.4
FKL GA	26-40	35.5±3.2	35.9

Table 2: Spearman correlation coefficient between fetal kidney gestational age and other gestational ages.

Correlation of fetal kidney length with GA	R value	P value
BPD GA	0.991	<0.001*
FL GA	0.988	
AC GA	0.986	
HC GA	0.976	

*significant at 5% level of significance (p<0.05)

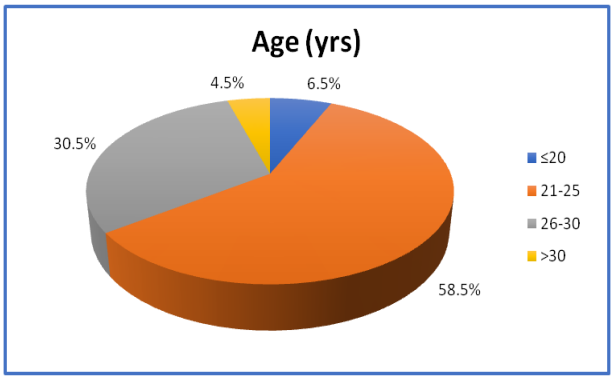

Figure 1: Distribution of cases according to age.

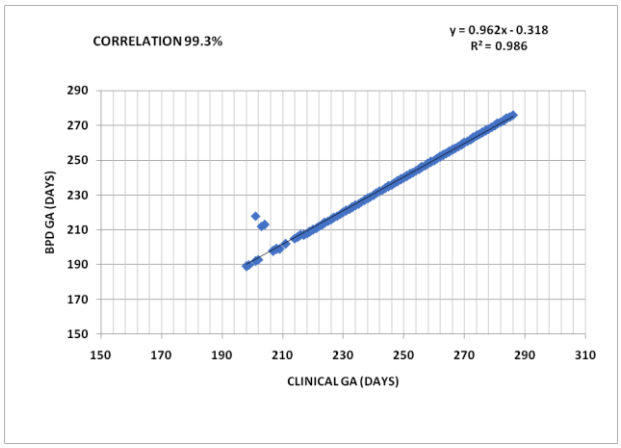

Figure 2: Spearman correlation coefficient between clinical and BPD gestational age in days.

In the present study, the number of cases at 28 weeks was 6 (3%) with the mean FKL of 28 mm; at 31 weeks, there were 15 (7.5%) cases with the mean FKL of 30.94 mm; at 35 weeks, there were 33 (16.5%) with the mean FKL of 35.10 mm; at 37 weeks, there were 30 (15%) with the mean FKL of 37.01 mm; and at 40 weeks, there were 14 (7%) with the mean FKL of 40.09 mm (Figure 5).

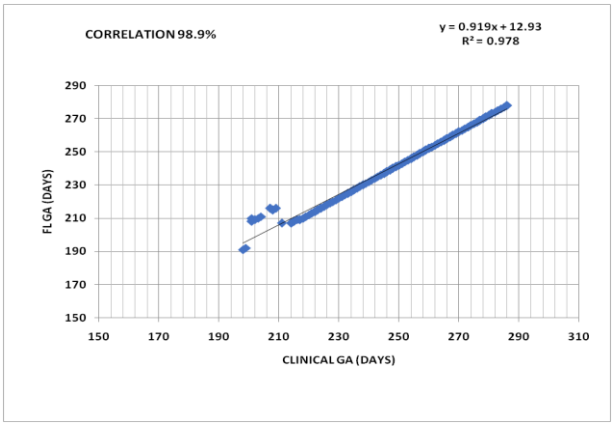

Figure 3: Spearman correlation coefficient between clinical and FL gestational age in days.

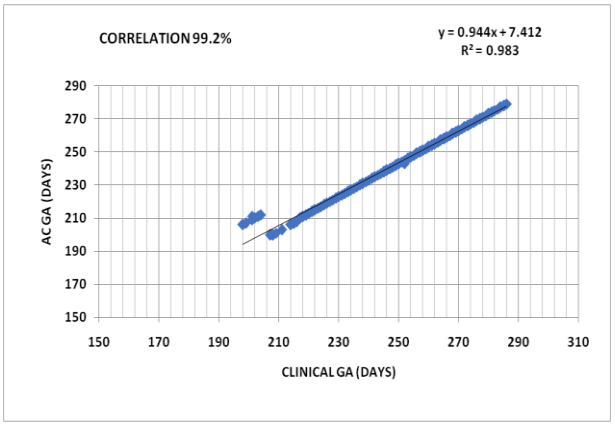

Figure 4: Spearman correlation coefficient between clinical and AC gestational age in days.

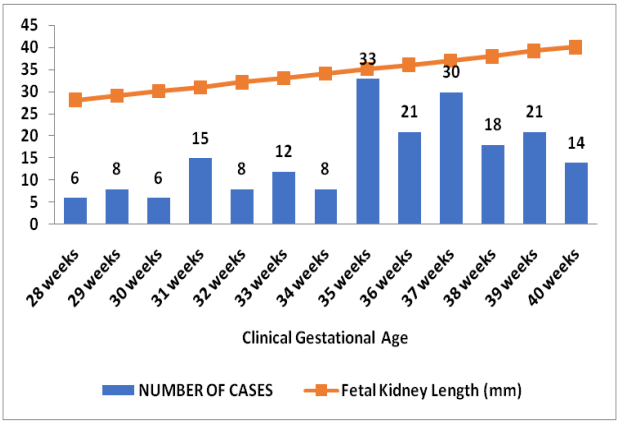

Figure 5: Mean fetal kidney length according to clinical gestational age.

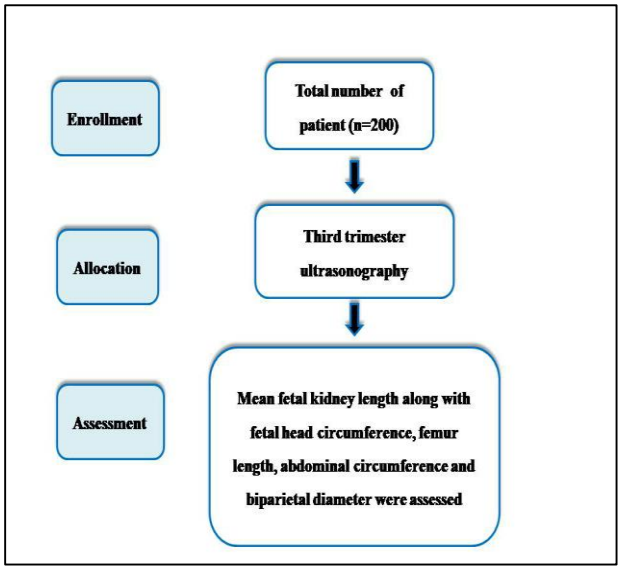

Figure 6: Consort flow chart.

DISCUSSION

The determination of gestational age is of utmost importance in prenatal care, as it guides healthcare providers in assessing fetal growth and development, making critical decisions about pregnancy management, and predicting the expected date of delivery. While various ultrasound parameters, such as crown-rump length, biparietal diameter, and femur length, have been traditionally used for estimating gestational age, recent studies have proposed fetal kidney length as an alternative parameter with potential advantages.[13]

In current study the maximum number of the patients (58.5%) were in the age group of 21 to 25 years. In our study we found that the BPD gestational age and clinical gestational age correlates by 99.3%. Karki et al in their study found that BPD was not a superior parameter to determine the gestational age in the third trimester. However, it was found that average gestational age by simple averaging of BPD, HC, FL and AC gives more accurate estimation of gestational age in both second and third trimester.[14] Since we conducted the study on third trimester patients in our study there was a positive correlation between BPD based gestational age and clinical gestational age. The BPD may get affected by presentation of fetus and presence or absence of amniotic fluid. Use of the BPD for estimating gestational age may become unreliable in patient with preterm premature rupture of the membranes.[15]

The correlation and regression analysis of FL gestational age with Clinical gestational age in the third trimester. The FL gestational age and Clinical gestational age correlates by 98.9%. Wolfson et al in his study concluded that, the biparietal diameter and femur length in late pregnancy are equal estimators of gestational age; that the femur length is a more stable estimator of gestational age when fetal growth deviates from normal; and that the femur length is technically more difficult to obtain.[16] Honarvar et al conducted the study on femur length and calculating the gestational age based on it using a different formula. The study showed the formula can be used and a positive correlation was found when assessed in pregnant women who are beyond first trimester.[17] Our study showed the positive correlation and regression analysis of AC gestational age with clinical gestational age in the third trimester.

The AC gestational age and Clinical gestational age correlates by 99.2%. We could not find much studies with regard to correlation between abdominal circumference and clinical gestational age. However, the study conducted by various authors showed that fetal abdominal circumference can be used for predicting birth weight hence to identify any possible fetal growth retardation.[18,19] In our study we found that, there is a correlation of HC gestational age with clinical gestational age in the third trimester by 97.3%. Similar study conducted by Law et al found that, head circumference is a more accurate index of the age of the fetus and its growth potential than is the biparietal diameter, and that use of the head circumference should, in consequence, replace that of the biparietal diameter in obstetric scanning.[20] The study's results demonstrated a positive correlation between fetal kidney length and gestational age, indicating that fetal kidney growth follows a predictable pattern throughout the third trimester. These findings suggest that fetal kidney length could serve as a reliable indicator of gestational age during this period, providing healthcare providers with an additional tool for accurate estimation.

The correlation of FKL gestational age with clinical gestational age in the third trimester was about 99.7%. Study conducted by Toosi et al showed that, KL measurements combination with other fetal biometric parameters could predict age of pregnancy with a better precision.[21] By incorporating fetal kidney length measurement alongside traditional parameters, healthcare providers can potentially overcome certain limitations associated with conventional methods. For instance, in cases where fetal positioning makes it challenging to obtain accurate measurements of other parameters, fetal kidney length could provide a valuable alternative.[22] Furthermore, late-term gestational age assessment may be improved, leading to more informed decisions regarding labor induction or cesarean deliveries.

In the present study the mean of various fetal biometric parameters is consistent with the study conducted by Shivalingaiah et al.[23] The r value in present study for correlation of FKL GA with BPD GA is 0.991, that with FL GA is 0.988, with AC GA 0.986, with HC GA is 0.976. All are statistically significant with p value of <0.001. The r value in Peter et al study for correlation of FKL GA with BPD GA is 0.943, that with FL GA is 0.945, with AC GA 0.943, with HC GA is 0.946.[24] All are statistically significant with p value of <0.001. The r value in Yusuf et al study for correlation of FKL GA with BPD GA is 0.632,

that with FL GA is 0.692, with AC GA 0.871, with HC GA is 0.861. All are statistically significant with p value of <0.001.[25]

CONCLUSION

The present study concludes that fetal kidney length correlates well with gestational age. FKL increases linearly with gestational age. There is a good correlation between gestational age derived from FKL and gestational age established from biometric indices like BPD, HC, AC, and FL. The FKL in millimeters collaborates nicely with gestational age in weeks and can be used as an individual parameter in estimating gestational age, especially in later trimesters. FKL can be combined with the other four biometric indices to give a fair estimation of gestational age where dates are uncertain and the women present late for ultrasound biometry dating. Therefore, FKL can be routinely incorporated into ultrasound examinations along with other parameters for optimal obstetrical outcomes.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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