



Evaluation of Normal Foetal Kidney Length by Ultrasonography and its Correlation with Foetal Gestational Age- A Study in Chhattisgarh State of India

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Abstract

Background: An accurate baseline of the lengths of normal fetal kidneys is necessary to diagnose fetal abnormalities associated with abnormal kidney size. Accurate measurements also may be helpful in determinations of gestational age, particularly when the mother's last menstrual period is unknown and routine methods used to determine gestational age give conflicting results. Present study was conducted to evaluate the normal fetal kidney length by ultrasonography method and also to see accuracy of fetal kidney length in determining the gestational age of the fetus in the population of Chhattisgarh state of India.

Materials and Methods: There were 380 pregnant females, between 20 weeks to 38 weeks gestation with their age ranging from 18-35 years. The maximum fetal kidney length of left kidney was measured from the upper to lower pole of the kidney in a longitudinal section of the fetus in the sagittal plane. **Results:** The correlation of fetal kidney length was maximum between 35 to 38 weeks of gestation i.e. 0.991 and minimum between 20 to 24 weeks of gestation i.e. 0.928. **Conclusion:** Fetal kidney length is more accurate for determination of gestational age especially in later weeks of pregnancy.

Keywords: Gestational age, Fetal kidney length, Biparietal diameter

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Introduction

Gestational age can be determined prior to birth or at birth. Before birth, we can use ultrasound to measure the size of the baby's head, abdomen, and thigh bone. This helps to determine how well the baby is growing in the womb. For estimation of gestational age and to evaluate the fetal development, the study of fetal biometry is most used. In the first trimester, these are gestational sac diameter and volume and crown

length measurements. In the second and third trimester the most used biometric indices for dating pregnancy are Biparietal diameter, Head circumference, Abdominal circumference, and Femur length, besides these, Fetal biometry the Fetal kidney length is also being studied by many researchers.^[1] An accurate baseline of the lengths of normal fetal kidneys is necessary to diagnose fetal abnormalities associated with abnormal kidney size. Accurate measurements also may be helpful in determinations of gestational age, particularly when the mother's

last menstrual period is unknown and routine methods used to determine gestational age give conflicting results. [2] Fetal kidney is easy to identify and measured in the late second and in the third trimesters and there is a strong correlation between gestational age and fetal kidney length. The fetal kidney is somewhat difficult to identify prior to 17 weeks of gestation. However, one or both kidneys are identified in 90% of cases from 17 to 22 weeks of gestation. Initially they appear as hypoechogenic oval structures in the posterior mid abdomen. As the kidney mature the pelvicalyceal system becomes more apparent.[3] During the third trimester of pregnancy fetal kidneys are clearly defined due to increased echogenicity from increasing perinephric fat by allowing easier separation of the kidney from its surrounding soft tissue. First accurate ultrasound examination with data of last menstrual period can provide accurate estimated due date (EDD) in first trimester. During second trimester, the crown rump length is not a reliable estimate of the gestational age. [4, 5] In many clinical setup, women have first antenatal care late in pregnancy or even at the time of delivery.[6, 7] Such situations make estimation of gestational age more difficult especially in absence of accurate last menstrual period dates. [8] In these circumstances, the clinician must depend on the ultrasonographic measures of gestational age estimation. [9, 10] However, the accuracy of these measurements is not universally established when used in isolation. [11, 12] We have conducted the present study at Pandit Jawaharlal Nehru Medical College and Dr. B.R.Ambedkar Hospital, Raipur Chhattisgarh to evaluate the normal fetal kidney length by ultrasonography method and also see accuracy of fetal kidney length in determining the gestational age of the fetus in the population of Chhattisgarh state of India.

Materials and Methods

There were 380 pregnant females, between 20 weeks to 38 weeks gestation with their age ranging from 18-35 years. Uncomplicated pregnant women having single live, normal fetus and only singleton fetus with complete visualization of at least one kidney were included in the study. The patients who were sure of the dates of their last menstrual period

with regular menstrual cycle were also included in the study. Before 18 weeks of gestation age, unknown or inaccurate date of last menstrual period, irregular menstrual cycles, Oligohydramnios, Polyhydramnios, Diabetic mother, Eclampsia, Preeclampsia, Twin pregnancy, Fetal chromosomal abnormalities, Fetal anomalies, Intrauterine growth retardation, Anemia and patient with Fetal kidney abnormalities were excluded from the study. Informed consent was obtained for the study from the enrolled patients. All examination was performed by using a SeimenssonolineG50 ultrasonographic machine with curvilinear probe 3.5Mhz. The patients were explained the procedure and its purposes, prior to scanning. The anatomical plane chosen for measurement of various fetal parameters was obtained by placing the transducer over abdomen in the middle sagittal section. The fetal head was then looked for the lie of the fetus then placing the transducer over parasagittal plane to define other fetal parts. The maximum fetal kidney length was measured from the upper to lower pole of the kidney in a longitudinal section of the fetus in the sagittal plane (**Figure- 1**). The fetal kidney appears ultrasonically as a sonolucent halo of tissues surrounding the somewhat more echogenic pyelocalyceal sinus. After confirming the lie, axial section was obtained perpendicular to the spine, adjusting the position of patient, tilting the scanning arm for best result. A series of axial scans through the kidneys was performed at 3 mm intervals. To obtain a coronal or sagittal view, the scanning arm was turned 90 to the plane of the axial scans. As the differences between measurements of the left and the right kidney were minimal, measurement of one side kidney was reliable. Thus, in the present study single (left) kidney was measured.



Figure- 1: Measurement of Fetal Kidney Length

Results

We observed a total of 158 cases in 2nd trimester i.e. ranging from 20 to 27 weeks and 220 cases were in 3rd trimester of pregnancy. Mean of Biparietal Diameter, Femur Length and Foetal Kidney Length observed was 73.1, 56.2 and 31.1 respectively. The standard deviation and standard error of mean for fetal kidney length specially during later weeks of pregnancy was least. At term fetal kidney length was more accurate for dating pregnancy (Table -1). Fetal kidney length was increased linearly with corresponding gestational age from a mean of 20.1 mm at 20 weeks to 41.5 mm at 38 weeks of pregnancy. We found fetal kidney length was highly positively correlated with gestational age. The correlation between fetal kidney length and gestational age was statistically significant (P=0.000). This correlation was consequently increasing according to gestational age from 20 to 38 weeks of gestation. We also observed that the correlation was maximum between 35 to 38 weeks of gestation i.e. 0.991 and minimum between 20 to 24 weeks of gestation i.e. 0.928. All the fetal biometric indices had a *p* value <0.05 in our study and were statistically highly significant. According to above observation FKL is more accurate for determination of gestational age specially in later week of pregnancy (Table- 2).

Table- 1: Mean of Various Parameters

Gestational age in weeks	BPD(mm)	FKL(mm)
20	46.70	20.1
21	51	23
22	57	23.7
23	62.40	24.1
24	64	25.1
25	68	26.1
26	69.5	27.8
27	71.5	28.7
28	72.2	29.1
29	72.8	30
30	76.3	31.1
31	78.9	33.5
32	80.5	34.5
33	81.4	35
34	82.1	37.8
35	85.7	38.7
36	89.3	39.6
37	89.8	40.9
38	91.5	41.5
Mean	73.1	31.1
SD	12.8	6.6
SE	0.63	0.32

Table- 2: Correlation between Fetal Kidney Length with Gestational Age

Gestational age in weeks	Mean FKL (mm)	r	r2	P
20	20.1	0.928	0.860	0.023
21	23			
22	23.7			
23	24.1			
24	25.1	0.972	0.944	0.006
25	26.1			
26	27.8			
27	28.7			
28	29.1			
29	30			
30	31.1	0.972	0.945	0.006
31	33.5			
32	34.5			
33	35			
34	37.8			
35	38.7	0.991	0.983	0.009
36	39.6			
37	40.9			
38	41.5			
Total	31.1	0.995	0.990	0.000

Discussion

The search for a single fetal parameter for determination of fetal gestational age is an object of interest of late. In last 10 years, the quality of ultrasound has increased enormously, and this has opened up new improved techniques. Many studies have been done on various fetal parameters and its relation to gestational age determination. In spite of using high-quality real-time ultrasound machine, imaging the exact renal borders may be difficult especially in early weeks of gestation. Also, the large fetal adrenals may make it difficult to delineate the anterior margins of the kidneys. [4, 13] Hence in our study the kidney length estimation has been done after 19 weeks as it is more technically feasible. In the past, studies were done to rule out anomalies of the urinary tract by measuring the kidney length. Further it was also found useful for gestational age assessment in normal cases. In the present study the maximum number of cases out of total 380 normal pregnant female were found in the maternal age group between 24 -26 years i.e. 116 cases (30.5%), and minimum cases were in the age group of 33 – 35 years i.e. 17 cases (4.4%). The mean value for fetal kidney length for each gestational age was compared with western standard Shin J Set et al., [5, 14] showed the maximum difference of ±5mm in 35 weeks. We compared the mean of fetal kidney length of

our study with that of Kuldeep et al, Konje et al.,^[1] and Kansaria et al.,^[3] and Parulekar et al.,^[14] The data of present study for mean fetal kidney length increased linearly as pregnancy progresses from 20th week to 38th week of gestation in the present study.

The reading of fetal kidney length reported by Kuldeep et al⁽¹⁾ between 18th week to 38th week of gestation at two weekly intervals were 12± 1.31 mm, 15.3± 2.1 mm, 19.3 ±1.7 mm, 21.6 ±1.7 mm, 26.3 ±1.1 mm, 29.8± 2.2 mm, 34.3± 1.2 mm, 36.2± 0.7 mm, 37.2± 1.0 mm, 38.9 ±1.5 mm, 40.4 ±1.7 mm respectively.

The reading of fetal kidney length reported by Konje et al.,^[4] between 24 weeks and 38 weeks of gestation at two weekly intervals were 24.2 ± 1.2 mm, 26.3 ± 1.9 mm, 29 ± 2.2 mm, 30.9 ± 3.2 mm, 33.2 ±4.5 mm, 35.0 ± 3.6 mm, 38.2 ± 4.2 mm, and 40.1 ± 2.4 mm, and that of Kansaria and Parulekar^[1] were 23.87 ± 1.17 mm, 25.23 ± 1.18 mm, 26.98 ± 1.06 mm, 29.03 ± 1.32 mm, 30.8 ± 1.53 mm, 32.51 ± 1.38 mm, 34.26 ± 1.41 mm, 36.25 ± 1.70, respectively.^[1]

In our study the fetal kidney length at different gestational age were higher than those reported by Kuldeep et al.,^[1] from the 20th week of gestation to the 38th week of gestation except at 28, 30, 32, and 34 weeks. At 30th and 32nd week of gestation, reading of our study were lower than those reported by Kuldeep et al and but at 28 and 34 weeks of gestation values of our study were near about like those reported by Kuldeep et al.,^[1] Values of our study of mean fetal kidney length were higher than those reported by Kansaria et al.,^[3] from 24 weeks of gestation to 38 weeks of gestation. The fetal kidney length of our study at different gestational ages were higher than those reported by Konje et al.,^[15] from 24 to 38 weeks of gestation except at 28 weeks of gestation, our values were near about similar to those reported by Konje et al.,^[15] Our values of mean fetal kidney length were higher than those reported by Yusuf et al¹⁵ from 32nd weeks of gestation to 38th weeks of gestation (Our reading were 34.5 mm, 37.8 mm, 39.6 mm and 41.5 mm and readings reported by Yusuf et al were 32.0mm, 34.2 mm, 35.9 mm and 37.0mm at 32 weeks, 34 weeks, 36 weeks and 38 weeks of gestation, respectively).The differences in reading is due to there are significant regional, racial and socioeconomic differences between individuals of our study and

those of studies done by Kuldeep et al.,^[1] and Yusuf et al.,^[16]. In the present study, we have correlated fetal kidney length with gestational age and the study demonstrated that the fetal kidney length was correlated with gestational age significantly ($r = 0.995$). We found that the coefficient of correlation (r) of BPD, varying between ($r = 0.987$ to 0.947), FL, varying between ($r = 0.921$ to 0.977), FKL, varying between ($r = 0.928$ to 0.991) showed a high degree of linear relationship with gestational age. The correlation coefficient observed in our study was higher as compared to ($r=0.82$), Gloor et al.,^[17] ($r=0.90$) and Schlesinger et al.,^[18] ($r=0.859$). Correlation coefficients between GA and other biometric indices were also higher as compared to previous studies. (for FL $r=0.987$, for BPD $r=0.980$ found in our study). In present study, it was observed that calculation by regression model relationship between Gestational age and Fetal kidney length the coefficient of determination corresponding to this parameter was $r^2= 0.990$, which was observed in our study was higher as compared to J.J. Kansaria et al.,^[3] ($r^2= 97.67, 94.84, 90.91$ for FKL). A number of reasons could explain these differences. These include number of sonologists, type of study (longitudinal vs. cross-sectional), quality of ultrasonography machine, characteristics of subjects and observer bias (non-blind vs. blind study). A study regarding the fetal kidney length was done by Sampaio and Aragao et al on 240 kidneys of 120 human fetuses ranging in age from 10 to 34 weeks post conception. They showed that growth curve of kidney length correlated well with gestational age. The observation of this study was consistent with the findings of the above studies which showed that fetal kidney length could be used as a measure of gestational age.^[19] A previous study regarding the fetal kidney lengths carried out in Bangladesh by Ansari et al.,^[20] They found an excellent correlation between gestational age and fetal kidney. In that study he showed that the average kidney length of 29 mm at 29 weeks and 39.5 mm at 40 weeks, which was also in good agreement with the present study. Sagi et al.,^[21] assessed fetal kidney anatomy in 660 apparently normal fetuses. A correlation of fetal kidney length and gestational age was presented. They found a linear progression of fetal kidney length

which produce a growth curve similar to that seen with BPD. [21] There are variations in the correlation factors are due to anthropometric differences in underlying population. [22] It is recommended to have a national algorithm specific to sub populations of India for more accurate gestational age estimation through sonographic measurements.

Conclusion

It can be concluded from the study that Fetal Kidney Length increases linearly with corresponding gestational age from a mean of 20.1 mm at 20 weeks of gestation to 41.5 mm at 38 weeks of gestation. Correlation between Fetal kidney length and gestational age is consequently increasing according to gestation age from 20th week to 38th week. Correlation is maximum between 35 to 38 weeks of gestation i.e. 0.991. The comparisons conclude that, out of the mean value of all parameters, the minimum discrepancy was found in fetal kidney length, for the prediction of gestational age. Fetal kidney length may be an effective means of assessing fetal status especially later week of gestation.

Limitations of the Study

Inclusion of early (12wk) and late (24wk) second trimester data in the analysis would have added more value to the predicative ability of the fetal kidney length. Evaluation of the combination of these parameters rather than isolated correlates would have added to the accuracy of these parameters in gestational age estimation.

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