Correlation of Ultrasound Biometric Indices and Renal Length with Gestational Age among Pregnant Women

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ABSTRACT

BACKGROUND
Accurate gestational age assessment is of great importance in obstetric practice. Ultrasound is an accurate and useful modality for the assessment of gestational age which can greatly impact obstetric management and improve antepartum care. We wanted to evaluate the association of foetal biometric indices and kidney length with gestational age.

METHODS
The present study was conducted over a period of 18 months among 266 women in the age group of 18-32 years with uncomplicated pregnancy who underwent ultrasound evaluation in the Department of Obstetrics and Gynaecology. Routine foetal parameters were obtained along with detailed clinical history.

RESULTS
There was no correlation between foetal KL and mother's height, weight, BMI, parity, or occupation. A significant correlation was found between gestational age and kidney length ($r=0.84$, $p<0.001$).

CONCLUSIONS
Kidney length is easy to identify and measure. Routine foetal biometric with FRL results in accurate estimation of gestational age. Hence, it can be incorporated in routine antenatal ultrasound in general population.

KEYWORDS
Ultrasound Biometric Indices, Renal Length, Gestational Age

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BACKGROUND

Estimation of gestational age (GA) is crucial during antenatal care as the exact determination of GA is critical in management decision. Traditionally the duration of pregnancy is calculated in terms of 9 months and 7 days or 40 weeks or 280 days from the first day of last menstrual period (LMP) in a regular 28-day menstrual cycle. However, there is evidence that about 30% of women forget their accurate LMP or misunderstand early pregnancy bleeding as normal menstrual cycle.[1] Sometimes when the menstrual cycles are irregular or when pregnancy occurs during lactation, amenorrhea miscalculation of gestational age can occur. In developing countries, where maternal and foetal deaths are still endemic, ultrasound has played a major role in reducing maternal and foetal mortality and morbidity. The last two decades have seen a tremendous progress in application of ultrasound as a diagnostic modality revolutionizing the management towards better care. 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. During first trimester of GA may be estimated by gestational sac and crown rump length measurement.[2,3] Foetal biometric indices like biparietal diameter (BPD), femur length (FL) trans-cerebellar diameter (TCD), clavicle length (CL), foot length, and head circumference (HC) have increased the accuracy of assessment of GA. Although these biometric indices are useful during early trimester, its accuracy decreases with increase in GA. Hence, lately association of renal size with that of gestational age is considered. Therefore, the present study was conducted to determine the association of foetal kidney length with GA.

METHODS

The present study was a cross sectional study conducted at GSL medical college, Rajahmundry for a period of 18 months from January 2016 to June 30th 2017. We have included 266 pregnant women between 26-40th week of gestation with uncomplicated pregnancy after obtaining their written informed consent. After obtaining the detailed clinical history, ultrasound evaluation was performed to obtain routine foetal parameters i.e. BPD, HC, abdominal circumference, FL and additionally foetal renal length. For foetal renal length assessment, measurements were taken in the sagittal plane, when full length of kidney with renal pelvis is visualized. Data entered in excel sheet was analysed using SPSS software. Results were expressed in terms of Descriptive statistics and Pearson correlation was used to analyse the data.

RESULTS

Around 145 women were included in the present study of which, 12 were excluded because of unclear renal border. Among the study subjects, single kidney with clear borders were imaged adequately and measured. The age of the study subjects is between 18-32 years, mean weight, height and BMI of the women were in the range of 46– 86 kg, 130-170 cm and 19.32-28.30 respectively.

Gestational Age in Weeks	Mean Kidney Length ± (SD) mm
25	24.9 (0.5)
26	26.4 (0.7)
27	27.3 (0.8)
28	29.0 (0.8)
29	30.7 (1.4)
30	31.5 (1.1)
31	32.5 (1.4)
32	33.5 (1.3)
33	34.2 (1.6)
34	35.4 (1.1)
35	36.5 (1.1)
36	37.3 (0.8)
37	38.4 (1.0)
38	39.4 (1.1)
39	40.6 (1.3)
40	41.6 (0.9)

Table 1. Changes in Foetal Kidney Length with Gestation

Pair	Pearson Correlation	p Value
EGA vs. BPD GA	0.826	<0.001**
EGA vs. HC GA	0.833	<0.001**
EGA vs. AC GA	0.822	<0.001**
EGA vs. FL GA	0.838	<0.001**
EGA vs. FRL GA	0.846	<0.001**

Table 2. Correlation Co-Efficient of EGA with GA of BPD GA, HC, AC, FL and FRL

Parameter	Equation	AIC	r^2	SE (Days)
FRL	GA = 6.696 + 0.782*KL	1880.07	60.1	10.126
FRL, FL	GA = 5.568 + 0.0501*KL + 0.187*FL	1569.43	86.6	7.428
FRL, FL, BPD	GA = 3.01 + 0.321*KL + 0.146*FL + 0.098*BPD	1592.67	82.3	7.246
FRL, FL, AC	GA = 4.562 + 0.211*KL + 0.149*FL + 0.037*AC	1369.86	79.9	7.933
FRL, FL, HC	GA = 2.957+ 0.285*KL + 0.177*FL + 0.026*HC	1532.42	82.1	7.126
FRL, FL, AC, HC, BPD	GA=2.216+ 0.134*KL + 0.128 FL + 0.018*HC + 0.040*AC +0.046*BPD	1296.36	88.2	5.844

Table 3. Linear Regression Model Equations Defining the Relationship between Gestational Age with Foetal Biometric Parameters FRL, FL, HC, BPD and AC

No correlation was found between foetal KL and mother's Height, Weight, BMI, Parity, and Occupation. There was increase in mean kidney length from 25.2mm to 42mm with increase in gestational age, which was also proved by Pearson correlation test, where we found the maximum correlation for gestational age and kidney length (r- 0.84). Significant correlation was found between the Gestational age (days) and kidney length (mm) ($r=0.84$, $p<0.001$).

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, FRL was derived in the present study. Above table shows that when GA was calculated by KL alone the SE was ±10.12 days, foetal FL was added to KL and calculation done the SE was reduced to ± 7.43 days. When all the five parameters were included in the calculation the accuracy increased and the SE was only ±5.8 days. Thus, it was observed that

calculation by regression model relationship between GA with KL the coefficient of determination corresponding to this parameter was r^2 = 60.5%, When all the five parameters were included the accuracy improved and the coefficient was r^2 = 88.2% corresponding to SE of only ±5.84 days.

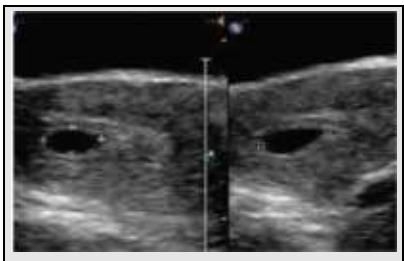

Image 1. Gestational Sac Measurement

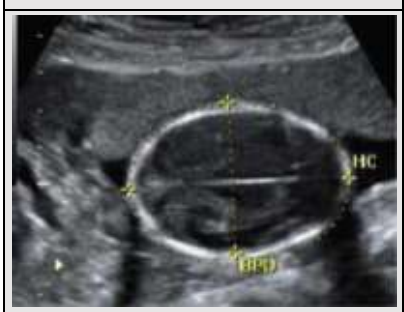

Image 2. Plane for BPD and HC

Image 3. Plane for AC

Image 4. Femur Length Measurement

Image 5. Plane for Trans Cerebellar Diameter Measurement

DISCUSSION

With advancing gestational age renal outline becomes more distinctive due to increased deposition of echogenic perinephric fat. Renal outline delineation may be cumbersome in case of maternal obesity and as well as due to obscuration from lower ribs and adrenal glands[4]. The foetal renal parameter is correlated with routinely used foetal biometric parameters i.e. BPD, HC, AC and FL. The relation of FRL GA with other parameters also showed statistically significant results with Pearson coefficient (r) 0.826 for BPD, 0.833 for HC, 0.820 for AC and 0.838 for FL with all of them showing p value <0.001. Among the four parameters strongest correlation was observed with FRL and followed by FL and least with AC. Many studies have been conducted to assess the variability in gestational age determination from FRL. In the present study, this linear relationship has been established and correlating well with estimated gestational age. Also a significant correlation demonstrated with other 4 foetal parameters with high correlation coefficient. The mean foetal renal length has increased from 25.1 mm at 25 weeks of gestation to 43 mm at 40 weeks of gestation. Many authors reported, no correlation was found between FRL and mother's age, height, weight and parity.[5] In present study the observations we found is no correlation between foetal kidney length and mother's height, weight, BMI, parity, occupation. In our study, when FRL was used for calculating GA values were with SE ± 10.12 days, which is in accordance with the values calculated by Konje et al[6] and DP Gupta[7] of SE - 10.29 and 10.45 days respectively. When all four parameters (HC, BPD, AC, FL) were incorporated the accuracy was SE of 5.8 days, which differed slightly from values obtained by Konje et al[6] of SE of 9.45 days and similar to the study by Dpgupta.[7] When FKL was combined with other four indices the accuracy increased to SE-5.8 days. Though FRL can be used as a single parameter in estimation of GA, very accurate results can be obtained by using all five biometric indices. Ansari et al[8] also reported similar correlation of foetal kidney length with gestational age in Bangladesh population. The mean FRL values of the present study were higher when compared to this study. Kiran Pandey et al studied foetal parameters of kidney lengths, kidney circumference, BPD, FL, AC, HC compared and correlated them with gestational age. They found a correlation coefficient of r=0.84 and 0.86, between gestational age and kidney length, kidney circumference respectively.[9] The correlation coefficient values between gestational age and foetal renal length of our study are same as this study. In present study FRL was the most accurate single parameter for the estimation of GA closely followed by FL and HC. AC was the most inaccurate parameter for estimation of GA. These findings were consistent with the findings of Konje et al[6] and Kaul et al.[10]

Measurements of foetal kidney length showed good correlation with gestational age with correlation coefficient (r) 0.947 and p<0.001. When all the four parameters were combined (BPD, HC AC, FL) the gestational age could be predicted within ±7.66 days. 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).[11] The present study shows less correlation coefficient between foetal renal length and gestational age (r-0.845) but shows standard error of 5.6 days, which is more accurate in prediction of the gestational age when all the foetal biometric indices are combined. In the present study, renal length shows linear correlation with

gestational age between 25-40 weeks. Both the Ruchi Saxena[12] and Manasvi et al[13] study showed that foetal renal length corresponds to gestational age in weeks, but in our study renal length corresponds to weeks only in 25 to 30 weeks of gestation. As the gestation age increases the renal length is more than corresponding gestation in our study, which is similar to many other studies. This variability is focus for evaluation in future studies.

CONCLUSIONS

Kidney length is easy to identify and measure. Routine foetal biometric with FRL results in accurate estimation of gestational age. Hence, it can be incorporated in routine antenatal ultrasound in general population.

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