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Original Research Article

Measurement of Fetal Kidney Length as a Parameter for Gestational Age in Singleton Pregnancy and its Comparative Evaluation with other Fetal Biometric Indices

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Abstract

Aim: Measurement of fetal kidney length as a parameter for gestational age in singleton pregnancy and its comparative evaluation with other fetal biometric indices

Methods: This prospective observational study was carried out in the Department of Radio diagnosis, IGIMS, Patna, India. 100 women aged between 18 to 35 years with normal singleton pregnancies whose gestational age were confirmed by early ultrasound, were included in this study. Ultrasound was performed on Samsung HS 50 using curvilinear transducer. Ultrasound was conducted by two radiologists with ample experience and under defined scanning parameters. All cases were scanned twice by ultrasound. Radiologist one determined the average gestational age using Hadlock's formula from foetal biometric indices viz, abdominal circumference, head circumference, femur length, bi parietal diameter, as well as carried out foetal anomaly scan of all cases.

Results: There was a positive correlation between mean kidney length and gestational age as predicted by BPD, FL, AC and HC ($P< 0.001$). The correlation between gestational age and mean fetal kidney length is highly significant with Pearson's correlation coefficient value of 0.98 and significance being $P< 0.001$ as shown in Table 1 also illustrates an extremely strong correlation with other variables as well like with AC ($r = 0.911$), HC ($r = 0.985$), BPD ($r = 0.980$) and FL ($r = 0.988$). Scatter plots were drawn between gestational age (independent variable) and with all the dependent fetal biometric indices, to depict the best fit line, linear regression equation, its slope and intercept. Regression coefficient or slope of kidney length is 1.1, abdominal circumference 1.05, head circumference 0.88, femur length 0.23, and bi parietal diameter 0.25 with respect to fetal gestational age**.**

Conclusion: Fetal kidney length shows a strong correlation with fetal gestational age, with a steady growth rate throughout pregnancy irrespective of underlying medical condition like intrauterine growth retardation.

Keywords: fetal kidney length, singleton pregnancy, biometric indices.

Introduction

Precise assessment of the gestational age (GA) is essential in prenatal medicine to predict fetal health and labor dating. Errors in determining the exact GA may interfere with critical management decisions, such as in preterm labor as well as growth disorders that is considered the leading cause of neonatal morbidity and mortality [1].

Last menstrual period (LMP) has been a reliable predictor in estimating GA, but many pregnant women cannot recall the exact date of their LMP. Garg et al., suggests that 30% of women cannot recall the exact date of LMP [2].

In the first trimester, the mean gestational sac diameter and crown-rump length (CRL) are reliable measurements for this purpose [3]. In the second trimester, biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), femur length (FL), and trans-cerebellar diameter4 are feasible useful parameters. We studied the correlation between GA and fetal kidney length (FKL), also the correlation between amniotic fluid index (AFI) and GA depending on the fact that amniotic fluid is secreted abundantly from kidneys after the second trimester.

Material and methods

This prospective observational study was carried out in the Department of radio diagnosis, IGIMS, Patna, India, after taking the approval of the protocol review committee and institutional ethics committee.

Methodology

100 women aged between 18 to 35 years with normal singleton pregnancies whose gestational age were confirmed by early ultrasound, were included in this study. Ultrasound was performed on Samsung HS 50 using curvilinear transducer. Ultrasound was conducted by two radiologists with ample experience and under defined scanning parameters. All cases were scanned twice by ultrasound. Radiologist one determined the average gestational age using Hadlock's formula from foetal biometric indices viz, abdominal circumference, head circumference, femur length, bi parietal diameter, as well as carried out foetal anomaly scan of all cases. Radiologist two measured the renal length. Both were unaware of the study. Oligohydramnios or polyhydramnios, >90th percentile or < 10th percentile of estimated fetal weight as per last were excluded from this study.

Renal pelvic dilation up to 10 mm can be seen in normal fetus with no evidence of obstruction and vesico ureteric reflux; however more than 4 mm renal pelvic dilatation were excluded to avoid false positive and spuriously high renal length estimation [4]. Renal evaluation by ultrasound is difficult in first and second trimester, as there is an obscured renal margin, however it being a limitation factor in previous studies, all women with gestational age more than equal to 18 weeks were included in the study. Moving the probe caudally in transverse section just below the level for abdominal circumference measurement, kidneys are identified. Once kidneys are located probe was rotated longitudinally till full length of kidney was identified for its length calculation. Length was determined for both left and right kidney. The average of their length in millimeter was recorded as final measurement. The fetal kidney was measured from outer-to-outer margin [5].

Statistical analysis

Analysis was done using statistical package for social science (SPSS 25.0). Pearson's correlation and regression coefficient was calculated between gestational age and renal length as well as between gestational age and other fetal biometric indices. P value <0.05 was taken as significant.

Results

Kidney length gives a reliable estimate of fetal gestational age. We noticed that the

renal length in millimeters at any given gestational age corresponds to the gestational age of the fetus. It can be of immense significance in gestational age determination without use of any software. Kidney shows a uniform increase in its length approximately by 1.8 mm every fortnightly. Both right and left kidneys were measured, and its average was used for computation of renal length. Those cases where either of the kidneys was not adequately visualized were excluded from the study. In the present study mean fetal kidney length was 31.6 ± 5.8 mm with a range from 18.1 mm to 39.3 mm. We calculated Pearson's correlation coefficient between gestational ages determined by Hadlock formula with the fetal kidney length (**Table 1**). There was a positive correlation between mean kidney length and gestational age as predicted by BPD, FL, AC and HC (P< 0.001). The correlation between gestational age and mean fetal kidney length is highly significant with Pearson's correlation coefficient value of 0.98 and significance being P< 0.001 as shown in Table 1also illustrates an extremely strong correlation with other variables as well like with AC (r = 0.911), HC (r = 0.985), BPD (r = 0.980) and FL (r = 0.988). Scatter plots were drawn between gestational age (independent variable) and with all the dependent fetal biometric indices, to depict the best fit line, linear regression equation, its slope and intercept

Table 1: Correlation of gestational age with that of kidney length, abdominal circumference, head circumference, bi-parietal diameter and femur length

Correlations						
Variables	**Test statistics**	**AC**	**HC**	**BPD**	**Femur length**	**Kidney length**
Gestational age	Pearson Correlation	0.911**	.985**	.980**	.988**	.989**
	Sig. (2-tailed)	<0.001	<0.001	<0.001	<0.001	<0.001
	Number of subjects	100	100	100	100	100

** Correlation is significant at the 0.05 level (2-tailed).

Regression coefficient or slope of kidney length is 1.1, abdominal circumference 1.05, head circumference 0.88, femur length 0.23, and bi parietal diameter 0.25 with respect to fetal gestational age**.**

Table 2: Fetal kidney length (mean ± 2SD) predicted by gestational age calculated on the basis of linear regression equation y= 0.16 + 1(x), where y is kidney length in mm, x is gestational age in weeks, 0.16 is the intercept and 1 is the regression coefficient and standard deviation (SD) is 6.6.

Gestational age (weeks)	**Fetal kidney length (mm)**		
	Mean - 2SD	**Mean**	**Mean + 2SD**
18	5.16	18.16	31.16
19	6.16	19.16	32.16
20	7.16	20.16	33.16
21	8.16	21.16	34.16
22	9.16	22.16	35.16
23	10.16	23.16	36.16

24	11.16	24.16	37.16
25	12.16	25.16	38.16
26	13.16	26.16	39.16
27	14.16	27.16	40.16
28	15.16	28.16	41.16
29	16.16	29.16	42.16
30	17.16	30.16	43.16
31	18.16	31.16	44.16
32	19.16	32.16	45.16
33	20.16	33.16	46.16
34	21.16	34.16	47.16
35	22.16	35.16	48.16
36	23.16	36.16	49.16
37	24.16	37.16	50.16
38	25.16	38.16	51.16
39	26.16	39.16	52.16

Discussion

Estimation of an accurate gestational age is of utmost significance with varied clinical implications. It has been emphasized since long for a fetal biometric index, which is not formula based, accurate, easy to calculate with hassle free interpretation and reproducible. Fetal growth variation affects all the organs including the anterio-posterior and transverse dimensions of kidney; however, its length more or less remains constant [6,7]. Even though on most of the cases the length of both the kidneys were almost similar, we preferred taking their average length into account for ruling out discrepancies due to right and left side length variation. The renal length in the present study showed a positive Pearson's correlation coefficient value of 0.98 and regression coefficient of 1.1 with that of gestational age determined by taking all other fetal biometric indices into account. This study shall prove its worth in cases of engaged fetal head, where it is difficult to measure fetal bi parietal diameter and head circumference as well as in cases of intrauterine growth retardation, macrosomia and malformation where abdominal circumference measurement gives false values. In above enlisted clinical scenarios measurement of fetal kidney length shall give an accurate, hassle free, estimation of fetal gestational age. We compared the intercept and regression coefficient (slope) between previous and present study as illustrated in Table-3. The present showed a positive Pearson's correlation and regression coefficient between kidney length and gestational age as compared to previous studies.

It may be due better quality of ultrasound machines with better resolution, observer bias. In future an average gestational can be computed taking all biometric indices into account including kidney length. With advancing gestational age renal outline becomes more distinctive due to increased deposition of echogenic perinephric fat [8]. Renal outline delineation may be cumbersome in case of maternal obesity and as well as due to obscuration from lower ribs and adrenal glands [9,10].

Table 3: Comparison of intercept and regression coefficient of linear regression equation of kidney length and gestational age between present and past studies.

Study	Intercept estimate	Slope estimate	P value	R2
Present study	0.16	1.1	<0.001	0.98
Nahid Yusuf, et al.[11]	(intercept and slope not calculated) Pearson's correlation = 0.99		<0.001	0.99
Kansaria andParulaker[12]	2.964	0.832	<0.001	0.90
Konje, et al.[13]	3.821	0.858	<0.001	0.97
Kuldeep Kumar, Rakhi Lalwani [14]	9.577	0.652	<0.001	0.97

Conclusion

Fetal kidney length shows a strong correlation with fetal gestational age, with a steady growth rate throughout pregnancy irrespective of underlying medical condition like intrauterine growth retardation. This study shall prove its worth in cases of engaged fetal head, where it is difficult to measure fetal bi parietal diameter and head circumference as well as in cases of intrauterine growth retardation, macrosomia and malformation where abdominal circumference measurement gives false values.

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