Original Research Article

Role of mean fetal kidney length as an additional parameter in late trimester for accurate estimation of gestational age relative to other biometrics indices

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ABSTRACT

Background: As biometric indices are difficult to obtain or show gross discrepancies with each other or with gestational age in the late trimester, so for accurate dating additional parameter is required. Fetal kidney length is easy to measure and appear reliable in previous studies.
Methods: Well dated 121 antenatal women from 28 to 40 weeks of gestation with no obstetric or medical risk factors were recruited and kidney length is assessed in longitudinal scan and maximum length is taken. fetal kidney length derived gestational age compared with other biometrics indices gestational age.
Results: Mean kidney length showed significant correlation (r=0.899, p<0.001 value) with increasing gestational age. Mean kidney length dated pregnancy within ±8.5 days.
Conclusions: Fetal kidney length measurement correlated well with other routinely used parameters for the estimation of gestational age and can be used as an accurate parameter to date pregnancy in the late trimester.

Keywords: Gestational age, Late trimester, Mean kidney length

INTRODUCTION

Accurate dating of pregnancy is critically important for pregnancy management from the first trimester to delivery and is particularly necessary for determining viability in premature labor and post-dates deliveries.[1] The NMR is 28 per 1000 live births in 2013. A systematic analysis of global, regional, national causes of child mortality in 2013 identified preterm birth complications and infections to be the two major causes of neonatal deaths in India.[2] It is particularly important in high-risk pregnancies (severe preeclampsia, chronic hypertension, severe IUGR, central placenta previa, sensitized Rh-negative mother, etc) where in some cases early termination may become necessary and prerequisite to interpret certain tests (amniotic fluid assay, serum assay, chorionic villus sampling) and to plan the timing of various forms of fetal therapy.[3]

The estimated date of delivery (EDD) commonly known as 'due date' has traditionally been calculated from this by adding 280 days to the LMP date, or through Naegele's rule: subtracting 3 from the month and adding 7 days. this practice assumes a regular menstrual cycle of 28 days, with ovulation occurring on the 14th day after the beginning of the menstrual cycle.[4] So, this method of dating a pregnancy is inaccurate where there is not a reliable recollection of LMP, or if menstrual cycles are short, long, or irregular. the certainty of LMP has been reported as low as 32%.[5] the estimated date of delivery calculation based on last menstrual period has its own set of limitations leading to false calculations like vague

menstrual history, pregnancy during lactational amenorrhea, first trimester bleeding per vagina.[6]

The development of diagnostic ultrasound has opened new possibilities for reliable assessment of dating. GA can be estimated in the first trimester by ultrasonic measurement of diameter and volume of gestational sac as well as crown-rump length (CRL) (Bailey et al, Sahota et al, Karki et al, Lobo et al). Also, other biometric indices such as fetal biparietal diameter (BPD), femur length (FL) trans-cerebellar diameter (TCD), clavicle length (CL), foot length, and head circumference (HC) are used for GA estimation during different pregnancy trimesters Lobo et al.[7] Most of these methods can predict gestational age with accuracy. However, these methods are not reliable in late trimester of pregnancy. Even the composite gestational age prediction in the third trimester does not give with great accuracy the actual gestational age, taking into consideration the discrepancies of late trimester scan and the possibility of growth retardation.[8]

Cohen et al conclude that kidney length correlates well with gestational age. Their conclusions agree with those of this study that kidney length could be used in the estimation of gestational age in pregnancies where dates are uncertain and the women present late for ultrasound biometry dating.[9]

Konje et al concludes that kidney length is a more accurate method of determining gestational age than the fetal biometric indices of biparietal diameter, head circumference, femur length and abdominal circumference between 24- and 38-weeks' gestation. When combined with biparietal diameter, head circumference, femur length, the precision of dating is improved by 2 days.[10]

Recent studies show that it is the most accurate single parameter for estimating gestational age than other biometric indices in late 2nd and 3rd trimester.[8]

In this longitudinal study, authors are going to compare mean fetal renal length in the estimation of gestational age and their correlation with other sonography measured biometrics indices.

METHODS

Present study is hospital-based and cross-sectional study to be conducted in the department of obstetrics and gynecology, SMS Medical College and Hospitals, Jaipur from April 2018 onwards for one year or till the desired sample size is reached for data collection and two months for data analysis and compilation.

Fetal kidney length was compared with gestational age derived from LMP and Cohen et al nomogram or first-trimester scan date if LMP or actual delivery date is not available. Fetal kidney length also compared with other studies i.e., Sagi et al, Kansaria et al, Bertagnoli et al, Ahmedi et al, and Chatterjee et al.[8,9,11,12,14]

Inclusion criteria

All women with singleton live pregnancy in their third trimester and willing to participate in the study. Women who are sure of their LMP and having regular periods were included in this study.

Exclusion criteria

Exclusion criteria of this study were suspected IUGR fetus, anomalous fetus, women with associated medical disorders (DM, HT, and thyroid dysfunction).

Institutional review board and ethical committee approval were taken before the study.

The study would comprise of pregnant women attending ANC clinic in Mahila Chikitsalya, SMS Medical College, Jaipur. The Sample size is calculated at 95% confidence levels assuming a standard deviation of 56 mm at 36 weeks gestational age, mean kidney length reference as found in seed article. At the absolute allowable error (precision) of 0.1 mm in kidney length, 121 patients are required as a sample size for study purposes.

Method of collection of data

Routine third-trimester pregnant patients attending to the department of obstetrics and gynecology in Mahila Chikitsalya hospital associated with SMS Medical College, Jaipur, Rajasthan, India were study and follows. the same patient will be evaluated as per history, general physical examination, and routine antenatal investigation. Following this using third-trimester ultrasonography, mean fetal kidney length along with fetal head circumference, femur length, abdominal circumference, and biparietal diameter will be measured. gestational age calculated from mean kidney length using nomogram by Cohen et al and from other biometrics indices using by Hadlock et al. these values are then compared with actual dates taken as a standard. USG assessment was done on machine of frequency probe.

Statistical analysis

Data was analyzed for the statistical significance using the intraclass correlation coefficient (r) significance found by student t-test. A p-value of <0.05 considered significant. Linear and multiple regression equations were formulated.

RESULTS

A total number of 121 patient was selected for the study. Maximum kidney length is measured in a longitudinal scan of each kidney then mean kidney length is used to calculate the gestational age. The kidney which is

proximal to the transducer was measured (Figure 1 and Figure 2).

Figure 1: Right kidney length measured in longitudinal scan.

Figure 2: Left kidney length measured in longitudinal scan.

Similarly, biometric indices BPD, FL, and AC are measured then their corresponding clinical gestational age is calculated and compared with gestational age by fetal kidney length.

The cases were in the age group of 18 to 37 years maximum number of cases are in middle age group (20-29 years) (Table 1). And minimal in the elderly age group (>35 years).

Table 1: Frequency distribution of the cases according to their age in years.

Age distribution	No. of cases	Percentage
<19 years	4	3.3
19-29 years	94	77.68
30-34 years	21	17.35
>35 years	2	1.6

A maximum number of cases i.e., 17 (14%) of women belonged to 39 weeks of gestation. The minimal number of cases belong to 41 weeks 1 (0.008%). The number of cases in each gestational age was randomly selected.

It was observed that mean fetal kidney length increased linearly with an increase in gestational age. Mean kidney length is 27.33±1.53 mm at 28 weeks and 41±1.00 mm at 42 weeks of gestational age (Table 2).

Table 2: Mean fetal kidney length at various gestational ages.

Gestational age in weeks	Mean fetal kidney length	SD	C.I.
28	27.33	1.53	-3.128 to 4.461
29	30.20	0.84	-2.239 to -0.1611
30	30.88	1.36	-2.009 to 0.2588
31	31.33	1.37	-1.767 to 1.1
32	33.40	0.89	-2.511 to -0.2894
33	34.90	0.99	-2.611 to -1.189
34	35.00	1.94	-2.489 to 0.4885
35	35.45	2.11	-1.875 to 0.9663
36	35.14	1.35	-0.3869 to 2.101
37	37.00	1.10	-1.15 to 1.15
38	39.70	2.36	-3.388 to -0.0122
39	39.59	2.29	-1.767 to 0.5907
40	41.00	1.69	-2.413 to 0.4131
41	43.00	0.00	
42	41.00	1.00	-1.484 to 3.484

Mean fetal kidney length has almost corresponded with gestational age. In this study, minimal fetal kidney length was 27.33 mm at 28 weeks and maximum length 43 mm at 41weeks Table 2.

The correlation for CGA vs BPD, AC, and FL was significant (correlation coefficient r: 0.846, 0.859, 0.899 respectively). the correlation was best for CGA versus FKL (r=0.935, p<0.001value, Table 3).

Table 3: The association between CGA and fetal kidney length derived gestational age.

	CGA versus FKL GA	P value
Karl Pearson correlation	0.935	P<0.001

And least for CGA vs BPD (r: 0.846, Table 4).

Table 4: The association between CGA and BPD derived gestational age.

	CGA versus BPD GA	P value
Karl Pearson correlation	0.846	P<0.001

All the correlations were statistically significant.

In this study, it has shown that fetal kidney length dates pregnancy with the accuracy of ±8.5 days compares to BPD ±10.5 days, FL by ±10.5 days, AC by ±9.5 days. Hense proves that fetal kidney length can be used to date

the pregnancy in the last trimester in addition to other parameters.

DISCUSSION

This study was done to find out that fetal kidney length can be used as a biometric parameter in late trimester in the Indian population and to measure the normal length of fetal kidneys sonographically during the late trimester of pregnancies in all the cases of this study. The range of mean kidney length was 27.33 at 28 weeks and maximum at 41 weeks i.e., 43 mm. In this study, we found that mean fetal kidney length almost corresponds with

gestational age that is it is 27.33 at 28 weeks, 30.88 at 30 weeks, and 39.59 at 39 weeks. This study is also found that mean kidney length is linearly increasing with each gestational age, and there were significant differences in mean kidney length that corresponds to gestational weeks. Accordingly, standard deviation and 95% confidence interval is calculated (Table 5).

This study values closely correlate with Sagi et al study who assessed fetal renal anatomy in 660 normal fetuses, establishing fetal gestational age, as well as the assessment of normal renal morphology in routine obstetric ultrasound assessment (Table 6).[11]

Table 5: Mean and standard deviation of gestational age derived from various indices compared with clinical gestational age.

Gestational age in weeks	BPD		AC		FL		KL	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
28	69.67	1.53	231.67	13.65	69.67	1.53	27.33	1.53
29	73.40	3.78	242.00	19.40	73.40	3.78	30.20	0.84
30	76.00	3.85	265.88	10.38	76.00	3.85	30.88	1.36
31	79.17	4.67	263.00	19.91	79.17	4.67	31.33	1.37
32	77.80	3.27	282.40	16.32	77.80	3.27	33.40	0.89
33	79.90	2.02	288.80	13.88	79.90	2.02	34.90	0.99
34	82.67	3.84	300.22	19.89	82.67	3.84	35.00	1.94
35	85.36	3.07	315.64	13.21	85.36	3.07	35.45	2.11
36	84.29	2.43	306.14	11.94	84.29	2.43	35.14	1.35
37	86.83	2.56	309.83	10.57	86.83	2.56	37.00	1.10
38	86.20	4.13	322.90	21.34	86.20	4.13	39.70	2.36
39	86.65	5.02	317.12	25.26	86.65	5.02	39.59	2.29
40	88.00	3.42	331.38	15.72	88.00	3.42	41.00	1.69
41	89.00	0.00	344.00	0.00	89.00	0.00	43.00	0.00

Table 6: Comparison between the mean fetal kidney length of the study with that of the other studies.

Gestational age in weeks	In this present study	Sagi et al[11]	Kansaria et al[8]	Cohen et al[9]	Bertagnoli et al[14]	Ahmedi et al
28	27.33	27.8	26.9	34	27.2	32.27
30	30.88	30.5	29	38	28.8	35.23
32	33.40	33.3	30.8	41	30.4	37.41
34	35.0	36.0	32.5	42	34.0	39.70
36	35.14	38.2	34.2	42	34.0	40.81
38	39.7	40.3	36.2	44	36.0	42.45

Table 7: Regression equation application between FKL/BPD/AC/FL versus CGA.

FKL	Intercept estimate	Intercept SE	Slope estimate	Slope SE	P value	R^2	Sep (days)
Present study	2.6	0.12	0.11	0.036	0.001	87	8.54
Kansaria et al[8]	2.9	0.42	0.83	0.014	<0.0001	97	9.17
Konje et al[10]	3.8	0.38	0.85	0.012	<0.0001	90	10.29
Saxena et al[15]	3.0	0.34	0.99	0.099	<0.0001	98	2.81

Indian studies closely matched from our studies are Kansaria et al (28 to 30 weeks), studied 70 women of regular menstrual cycle, fetal biometry is assessed at 2 weekly intervals between 22 weeks and 38 weeks of gestation was performed to measure fetal kidney parameters and BPD, FL, AC, head circumference (HC).[10] Study concludes that foetal kidney length grows at the rate of 1.7 mm fortnightly and pregnancies could be dated within 9.17 days.[8] Similarly, our study concludes that pregnancy is dated within ±8.5 days of the standard error of prediction by mean kidney length of the women having regular menstrual cycles. It is well correlated with 10.29 days in Konje study.[10]

This study also shows that compare to other biometric indices fetal kidney length is relatively more accurate as the standard error of prediction that gestational age can be calculated from fetal kidney length with a difference of ±8.5 days. it has shown that BPD dates pregnancy with the accuracy of ±10.5 days, FL by ±10.5 days, AC by ±9.5 days (Table 6).

Other Indian studies we suggest are Chatterjee et al (28 to 38 weeks) studied 100 pregnant women with known dates of different parity and ages for the period of one year (2015 to 2016) conclude that kidney length can be used as an individual parameter in estimating gestational age, especially in later trimesters, where biometric indices may not be much reliable.[12]

Similarly, Monalisa et al (28 to 31 weeks) studied 200 pregnant women with known dates of different parity and ages for the period of two years (2013 to 2015) conclude FKL can be combined with the other four biometric indices to give a fair estimation of gestational age.[13] kidney length could predict gestational age with an accuracy ±9.048 days and predictability when combined with other biometric indices was ±8.299 days.[13]
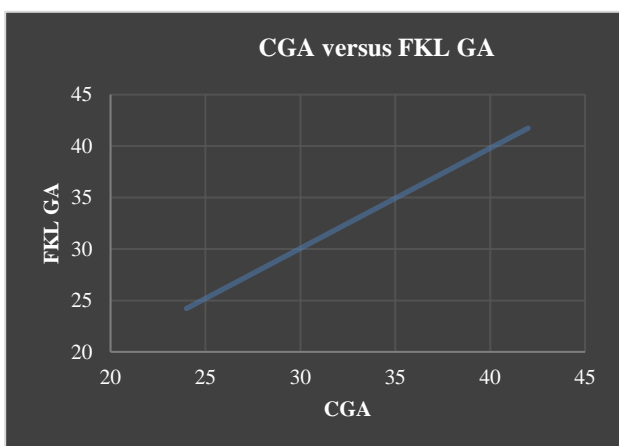

Figure 3: The correlation of 93.5% (r=0.935) between CGA GA and FKL in both trimesters (Konje et al 0.8824, Cohen et al 0.91, Chatterjee et al 989, Bardhan et al 0.99) and least for CGA versus BPD (r=0.846).

Mean kidney length also correlates with Bertagnoli et al at 28 to 36 weeks.[14] Who studied 280 pregnant women of 22 to 40 weeks gestations. The relationships of the A-P diameter and length to menstrual age were determined in cross-sectional and longitudinal studies of kidney growth. The results obtained confirmed that measurements of the fetal kidney can be used as an additional parameter in the routine assessment of fetal wellbeing and to rule out kidney malformations characterized by changes in kidney size.[14]
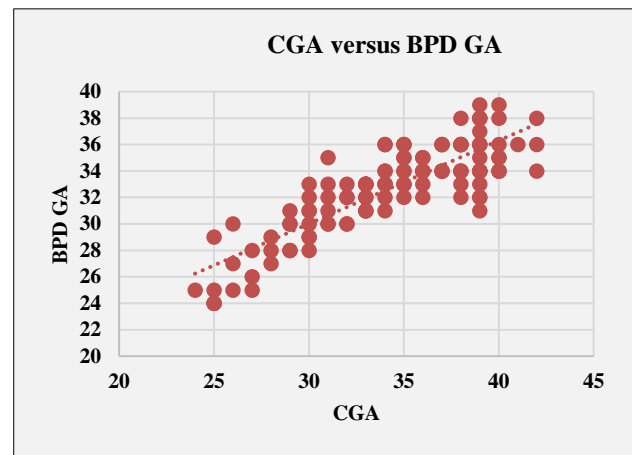

Figure 4: The correlation of 84.6% (r=0.846) between CGA GA and BPD in both trimesters. (Konje r=0.792, Bardhan J et al r=0.99).

Thus, this study suggests 30 weeks was 30.88±1.36 mm, in Kansaria 29.03±1.32 mm, in Saxena et al. 29.67±0.51 mm, and Konje it is 30.9±3.2 mm. In this study mean kidney length at 38 weeks was 39.7±2.36 mm in Kansaria 36.25±1.70 mm, in Saxena et al, 37.54±0.54 mm and Konje study 40±2.4 mm.[15]

The correlation for CGA versus BPD, AC, and FL was almost similar (correlation coefficient r=0.846, 0.859, 0.899 respectively). the correlation was best for CGA versus FKL (r=0.935, p<0.001value, Figure 3).

All the correlations were statistically significant.

According to this study, fetal kidney length in mm are almost equal to the weeks at a particular gestational age with approx. ±8.5 days of the standard error of prediction. this is similar to study done by Bertagnoli et al, Sagi et al, Konje et al and shows their measurement is almost equal to our study.

CONCLUSION

The present study hence validates the recommendation that fetal kidney length can be used as an important sonographic parameter in late trimester for accurate prediction of fetal Gestational age in the Indian population.

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