Original Research Article

CORRELATION OF GESTATIONAL AGE WITH FERAL RENAL LENGTH IN THIRD TRIMESTER PREGNANCY IN A JA GROUP OF HOSPITAL, GWALIOR

Dr. Rajesh Baghel[1] (Associated Professor), Dr. Pooja Meena[2] (Resident) & Dr. Akshara Gupta[3] (Professor & Head)

Department of Radio-diagnosis, GRMC and JAH Gwalior, 474001, Madhya Pradesh, India[1,2&3]

Corresponding Author: Dr. Pooja Meena

Abstract:
Aim and objective: Our aim of the study was to determine the role of foetal kidney length to predict gestational age at third trimester.
Material and Methods: We were conducted a prospective, observational study between the duration of January 2021 to June 2022. In our study, we were enrolled 140 pregnant women who having third trimester of pregnancy. We were observed kidney length, femur length, HC, AC and BPD during our study.
Result: Among 140 patients, Multigravida patients were highly observed compared to primigravidae. We observed that gestational age with last menstrual period was highly significantly positively correlated with mean kidney length (r=0.958) compared to right kidney length, left kidney length, MKL, femur length , BPD , AC ,HC and weight. Based on mean kidney length, we were predicted (r2=91%) equation to determine gestational age at third trimester.
Conclusion: Foetal kidney length can be utilised as an additional criterion for estimating gestational age in the third trimester since the results of the current study have demonstrated a substantial link between renal length and gestational age, particularly in the third trimester.

1. INTRODUCTION

To date the pregnancy as early as feasible during the antenatal period is the fundamental and most important duty of an obstetrician. In high-risk pregnancies, such as those with severe preeclampsia, persistent hypertension, severe IUGR, central placenta previa, and sensitised Rh-negative mothers, early termination may occasionally be required as soon as the foetus reaches maturity. [1] Knowing the precise gestational age (GA) of the foetus is crucial for obstetricians to analyse the foetus' progress and determine the anticipated delivery date. If an exact GA is not known, macrosomia and foetal growth retardation may go unnoticed. Previously, the GA was frequently determined using the patient's medical history and clinical symptoms. Gestational Age estimation is also a precondition to interpret certain tests[2] (amniotic fluid assay, serum assay, chorionic villus sampling) and to plan timing of various forms of foetal therapy.

Traditionally, the length of a pregnancy is measured in terms of 40 weeks, or 280 days, measured from the first day of the last menstrual period (LMP).[3] This is equivalent to 9 calendar months and 7 days. The flaw in this approach is that it doesn't account for the fact that every cycle and person ovulates at a different time in relation to their menstrual cycle. 18 % of pregnant women reported significant disparities in menstruation and ultrasound dates, and approximately 10-15% of pregnant women are unable to provide their accurate LMP. [4] Only 71 percent of women, according to Anderson et al research, will disclose their precise LMP. [5] Furthermore, irregular menstruation, lactational amenorrhea, oral contraceptive failure, early pregnancy bleeding, chronic anovulation[6], multiple gestations, IUGR, diabetic pregnancy, maternal size, variations in foetal lie and engagement, and inter and intra-observer measurement variation[7] can all complicate determining gestational age.

Sir Ian Donald made history by introducing ultrasonography (USG) for obstetric exams in 1958. The GA was initially calculated using biparietal diameter (BPD) in the third trimester. Since then, other more factors have been included, with the typical ones being head circumference (HC), abdominal circumference (AC), and femur length (FL), biparietal diameter (BPD).

Ultrasonographic foetal biometry is the most widely used method to establish gestational age.[8] Crown Lump Length (CRL), Biparietal Diameter (BPD), Head Circumference (HC), Abdominal Circumference (AC), and Femur Length (FL) are some of the most commonly used sonographic biometric parameters. CRL measurements are accurate to within 5-7 days of gestational age, however they can only be utilised in the first trimester. [9] In the early second trimester, BPD, FL, HC, and AC can predict gestational age with reasonable accuracy (10-11 days, 10-20 days, 10-14 days, and 10-14 days, respectively). [9] However, as the pregnancy progresses, these measures become less useful in predicting gestational age. [10] It could be attributed to biological variability in foetal growth.[11,12] A single foetal measurement cannot yet reliably compute third trimester gestational age. [1] Because of this, it is still difficult to estimate gestational age accurately in the late second and third trimesters, especially for women who booked late and were unclear of their LMPs.[13]

Transverse cerebellar diameter, foetal foot length, epiphyseal ossification centres, amniotic fluid volume, and placental grading are a few non-traditional sonographic parameters being studied for estimating gestational age,[14] but none of these parameters has been demonstrated to correlate with an accurate GA in the third trimester.

Foetal kidney length (FKL) initially used to diagnose renal abnormality in utero and later used to correlate it with gestational age. Its linear increase during gestation has also been seen on MRI,[1,15,16] and it is significantly connected with gestational age. After the 24th week of gestation, it is a more reliable way of estimating gestational age than BPD, FL, HC and AC.[15,17]

2. MATERIAL AND METHODS

The present study is a prospective comparative study conducted in Department of radio diagnostics. The study was conducted on 140 singleton uncomplicated pregnancies in their third trimester (28-40 weak) who were sure of their last menstrual period. After measurement of conventional parameter, FKL was measured, and correlation was obtained with GA and its efficacy was compared with other parameters.

Study participants:

Patients with uncomplicated pregnancies in their third trimester will be considered for the study. After clinical evaluation, once a patient satisfied the inclusion and exclusion criteria for this study will be subjected to USG.

Inclusion Criteria –
Patients with uncomplicated pregnancies in their third trimester are referred to and then presented to the radiology department for sonographic evaluation.

Exclusion Criteria –
Not willing consent, Oligohydramnios or polyhydramnios,>90th percentile or < 10th percentile of estimated fetal weight as per last menstrual period ,Dilated renal pelvis (> 4 mm) ,Chromosomal and congenital anomalies, Abnormal renal morphology (nephromegaly, agenesis, hypoplasia, cyst, polycystic kidney, hydronephrosis etc.),Obscured adrenal and renal borders or margins ,Multiple pregnancies, Gross maternal obesity, Gestational diabetes mellitus and Preeclampsia were excluded from our study.

Method: USG:
Technique and equipment: The sonography was performed using transducer probe of frequency ranging from 3.5-5.0 MHz on ESAOTE ultrasound machine.

Procedure:
- To validate the gestational age, a complete history of LMP, regularity of flow, recent use of OCP, date of urine pregnancy test, earliest scan, and date of quickening was acquired. A routine prenatal examination was performed on the registered mothers. Height, weight and blood pressure of the women were all measured. An obstetric examination was performed, and symphysiofundal height was assessed. A regular investigation was conducted in accordance with hospital practise.
- The women had conventional ultrasonography foetal biometry and foetal kidney length measurements performed on them. These measures were used to determine the gestational age. The accuracy of foetal kidney length measurement was compared to other foetal biometric markers (BPD, HC, AC, FL) in determining gestational age.
- Informed written consent was taken from all involved patients in study.
- The length of the foetal kidney is measured bipolarly with a grayscale real-time ultrasonographic scanner equipped with a 3.5 ~ 5.0 MHz transducer. When the complete length of the kidney including renal pelvis is seen, measurements are taken in the sagittal plane.

Observation and results
We enrolled 140 patients, all of whom had third trimester pregnancy. These patients were prospectively enrolled between January 2021 and June 2022 at our institute. We selected 140 patients based on exclusion as well as inclusion criteria. Overall mean age of the study was 25.55 ± 4.65 years. Out of 140 patients, 40% were pregnant women who had an age group of 21-25 years. 15%, 27.9%, and 17.1% were observed respectively in the age group as $\leq$ 20years, 26–30 years, and 31–35 years. In our study population, two types of gravidae were observed. 1) Multigravidae (62.9%) and 2) Primigravidae (37.1%). Overall mean gestational age was 34.17 ± 3.42(weeks) at last menstrual period.

Overall USG Doppler indices parameter of foetal kidney length of variable like Right kidney length, left kidney length, MKL, femur length, BPD, AC and HC. (Table1)

According to our data population, we observed that gestational age with last menstrual period was highly significantly positively correlated with right kidney length (r =

0.903), left kidney length (r = 0.913),MKL (r = 0.958), femur length (r = 0.936) , BPD (r = 0.855), AC (r = 0.822) ,HC(r = 0.868) and weight (r = 0.937).(Table :2)

Regression equation for gestational age

The dependent variable (gestational age with last menstrual period) was found to be significantly related to the independent variables (BPD, RKL, AC, HC, FL, MKL, LKL). We were observed that our model highly significant between individual parameter (BPD, RKL, AC, HC, FL, MKL, LKL) with gestational age with last menstrual period. BPD, RKL, AC, HC, FL, MKL and LKL of each model with gestational age with last menstrual period respectively explained as 73.1%, 81.5%, 67.5%, 87% , 91.8% and 83.3%. Among all these variables, mean kidney length with GA with last MP highly explained our model for estimation for gestational age. (Table :2)

Age with femur Length

We were observed femur length was not significantly affected with different age group. (F=2.010, p=0.115) (Table :3)

RKL and LKL

According to pair sampled t-test analysis, we were not observed significant difference between right kidney length and left kidney length. (p=0.315) (Table :4)

Femur Length with Parity

According to our analysis, primigravidae or multi-gravidae was not significantly effect on femur length. (p=0.222) (Table :5)

Table1: Descriptive statistics of GA and biometric parameter

	Minimum	Maximum	Mean	Std. Deviation
RKL	27.9	42.0	35.430	3.5891
LKL	28.1	44.0	35.471	3.6114
MKL	28.00	41.55	35.1924	3.57411
FL	52.0	75.8	64.439	6.4577
BPD	68.1	99.5	84.086	6.7510
AC	224.0	360.0	299.243	30.0297
HC	235.0	353.0	286.814	29.2091

Table 2: Pearson correlations coefficient for relation between gestational age (LMP) with biometric indices and kidney length

Correlations											
		Age	GA by LMP	RKL	LKL	MKL	FL	BPD	AC	HC	Weight
Pearson Correlation	Age	1									
	GA by LMP	.025	1								
	RKL	.056	.903**	1							
	LKL	.060	.913**	.991**	1						
	MKL	.036	.958**	.938**	.942**	1					

	FL	-.003	.936**	.897**	.900**	.920**	1			
	BPD	.092	.855**	.817**	.813**	.842**	.833**	1		
	AC	.080	.822**	.793**	.788**	.828**	.833**	.765**	1	
	HC	.083	.868**	.882**	.878**	.853**	.852**	.911**	.783**	1
	Weight	.051	.937**	.894**	.895**	.920**	.938**	.883**	.920**	.908**	1

**. Correlation is significant at the 0.01 level (2-tailed).

Table 3: linear regression analysis of foetal biometric parameters

	R^2	P	Predict formula	Standard error of estimate
FL	87%	<0.0001	(0.50 * FL) + 2.26	1.204
BPD	73.1%	<0.0001	(0.43 * BPD) + (-2.21)	1.778
HC	75.3%	<0.0001	(0.10 * HC) + 5.07	1.705
AC	67.5%	<0.0001	(0.09 * AC) + 6.20	1.954
Right kidney length	81.5%	<0.0001	(0.86 * RKL) + 3.73	1.474
Left kidney length	83.3%	<0.0001	(0.86 * RKL) + 3.54	1.400
Mean Kidney Length	91.8%	<0.0001	(0.92 * RKL) + 1.95	0.984

Table 4: Paired sample statistics of fetal right and left kidney

	RKL	LKL	t	p-value
Pair	35.43±3.59	35.47±3.61	-1.01	0.315

Table 5:

	RKL	LKL	t	p-value
Femur	35.43±3.59	35.47±3.61	-1.01	0.315

3. DISCUSSION:

A non-invasive, secure, and helpful investigation in the antepartum monitoring of the foetus is diagnostic ultrasound. It was not until the late 1950s that Ian Donald became the first person to employ ultrasonography in obstetrics. In 1960, Stuart Campbell made history by using ultrasound to identify anencephaly, a congenital condition.

Seoys et al. [21] reported the first study on the relationship between sonography measured normal foetal kidney length and gestational age. The findings of the study by Bertagnoli et al. [19] supported the use of measurements of the foetal kidney as an additional criterion in regular assessments of the health of the foetus as well as for the exclusion of renal abnormalities through size change.

For the evaluation of GA, the first-trimester USG is a very helpful and repeatable technique. The two criteria used to evaluate GA in the first trimester are the crown-rump length and

mean gestational sac diameter. The yolk sac and the extremities should never be included in the crown-to-rump measurement. From 8 to 12 weeks of gestation, it is helpful. [22] At the mid-trimester scan, if GA has not already been discovered at a dating or first-trimester scan, it should be. The following sonographic parameters are employed throughout the second and third trimesters of pregnancy: BPD, HC, AC, or FL. [23,24]

A number of research have been conducted in the past to evaluate the variability in FKL's capacity to determine gestational age. They discovered a linear link between the weeks of gestation and the length of the foetal kidney, measured in millimetres. The goal of our study was to identify any variations in the Indian population.

Growth differences have an impact on foetal kidney size just like they do on other organs. However, they will only have an impact on the kidney's antero-posterior and transverse diameters. Variations in growth do not impact the length of the foetal kidney.

We advise including renal length in the traditional techniques for GA estimate because the current study emphasises its use as a potentially accurate parameter for GA assessment.

According to the most recent research The mean kidney length (35.19–3.56) in weeks was discovered to be more closely related to LMP derived GA than other numerous parameters (BPD,HC,AC,FL). It also demonstrated MKL best correlation (r = 0.958) with GA by LMP than the other parameters HC(r=0.868), FL(r = 0.936), AC(r = 0.822), BPD(r = 0.855) with P value = 0.000 for all the parameters. This outcome is found to be comparable to that of the Konje et al. 2002 study. [15] We also discovered that as gestational age increased, the mean length of the foetal kidney increased linearly.(Table :6)

According to Mahasset et al [25], there is a significant association between gestational age as measured by BPD, FL, AC, and the sum of the three, and renal length. Hansari et al [20] also found an excellent correlation between gestational age and FKL, Lawson et al [18], Fong, and Ryan [26] also reported that measurements of FKL in mm are approximately the same as gestational age in weeks. Scott et al. [27] reported similar outcomes. In a study including 102 expectant mothers, Nahid Yusuf et al. [1] found a substantial association between several measures, with a correlation coefficient of r = 0.99 for foetal kidney length and gestational age and a P value of 0.01 for this relationship. Konje et al research's indicates [15] A prospective two-operator study (cross-sectional) conducted on 73 pregnant women revealed a correlation coefficient for MKL and GA of 0.93 with a P value of 0.002 for both variables.(Table :7)

Ghaleb et al. 2021 [15] claim that the mean kidney length and femur length were equally highly significant in explaining the model for estimating gestational age. Our investigation found that a highly significant model for explaining gestational age was the mean kidney length.(Table :8)

In this study, we used individual variables including BPD, RKL, AC, HC, FL, MKL, and LKL to predict gestational age. The outcomes of our anticipated formula matched those of Ghaleb MM et al 2021 [15] expected formula from. Additionally, we saw that MKL had a lower standard error estimation value among all variables. We could therefore conclude that MKL is the most accurate predictor of gestational age for whom women forget the date of their last period.(Table :9)

Table 6: Relationship between age with femur length

| | N | Mean | Std. Deviation | 95% Confidence Interval for Mean | | F value | p-value |
				Lower Bound	Upper Bound		
≤ 20	21	63.562	7.0204	60.366	66.758	2.010	0.1150
21-25	56	65.300	6.8114	63.476	67.124		
26-30	39	62.662	6.5206	60.548	64.775		
31-35	24	66.088	4.1562	64.332	67.843		
Total	140	64.439	6.4577	63.360	65.518		

Table 7: Different study of correlation coefficient

Study Name	r value
Konje et al[15]	0.93
Cohen et al[16]	0.82
Nahid yusuf et al[1]	0.990
Gayam S et al[28]	0.991
Gloor et al[22]	0.90
Present Study	0.958

Table 8: Linear regression analysis of fetal biometric parameters

	R^2(Our Study)	R^2(Ghaleb MM etal,2021)[29]	P
FL	87%	92%	<0.0001
BPD	73.1%	58%	<0.0001
HC	75.3%	65%	<0.0001
AC	67.5%	68%	<0.0001
Right kidney length	81.5%	86%	<0.0001
Left kidney length	83.3%	67%	<0.0001
Mean Kidney Length	91.8%	91%	<0.0001

Table 9:

	P	Predict formula (Our Study)	Predict formula (Ghaleb MM etal,2021)[29]
FL	<0.0001	(0.50 * FL) + 2.26	(0.47 * FL) + 2.94

BPD	<0.0001	(0.43 * BPD) + (-2.21)	(0.49 * BPD) + −7.4
HC	<0.0001	(0.10 * HC) + 5.07	(0.1 * HC) + 4.77
AC	<0.0001	(0.09 * AC) + 6.20	(0.08 * AC) + 10.27
Right kidney length	<0.0001	(0.86 * RKL) + 3.73	(0.81 * RKL) + 7.08
Left kidney length	<0.0001	(0.86 * RKL) + 3.54	(0.68 * LKL) + 11.86
Mean Kidney Length	<0.0001	(0.92 * RKL) + 1.95	(0.92 * MKL) + 3.38

Figure 1: Fetal kidney length measurement sonographic evaluation.

4. CONCLUSION

- For optimal obstetric treatment, estimating gestational age is crucial. High-resolution real-time ultrasound has significantly increased our ability to visualise the numerous foetal organs. It is said that the renal length in mm and the gestational age in weeks are relatively close.
- Renal length is the most suitable measure among others to predict gestational age, particularly in the third trimester. Numerous studies have demonstrated that foetal kidney length can be a reliable indicator of gestational age in the third trimester.
- This study indicates that the measurement of the foetal kidney length is a trustworthy ultrasonographic parameter for reliably determining gestational age in the third trimester and notes that the correlation increased when used in conjunction with other parameters.

- Fetal kidney length can be utilised as an additional criterion for estimating gestational age in the third trimester since the results of the current study have demonstrated a substantial link between renal length and gestational age, particularly in the third trimester.

5. REFERENCE:

1. Yusuf, N., Moslem, F., & Haque, J. Fetal Kidney Length: Can be a New Parameter for Determination of Gestational Age in 3rd Trimester. TAJ: Journal Of Teachers Association, 2009;20(2), 147-150.
2. Pernoll ML, et al. Normal pregnancy and prenatal care. In: Decherney AH, Pernoll ML, editors. Current Obstetric and Gynecologic Diagnosis and Treatment. 8thed. Fast Norwalk. Appleton and Lange; 1994; 183–201.
3. Grannum P, Bracken M, Silverman R, Hobbins JC.Assessment of fetal kidney size in normal gestation by comparison of ratio of kidney circumference to abdominal circumference. Am J Obstet Gynecol. 1980 Jan 15;136 (2):249-54.
4. Geirsson RT, Busby-Earle RM. Certain dates may not provide a reliable estimate of gestational age. Br J Obstet Gynaecol. 1991 Jan;98(1):108-9.
5. Andersen HF, Johnson TR Jr, Flora JD Jr, Barclay ML.Gestational age assessment. II. Prediction from combined clinical observations. Am J Obstet Gynecol. 1981 Aug 1;140 (7):770-4.
6. Grudzinskas JG. Assessment of fetal wellbeing in early pregnancy. In: Edmonds D, editor. Dewhurst's Textbook of Obstetrics and Gynaecology for postgraduates. 6th ed.Blackwell science Ltd.; 1999; 133–8.
7. Hadlock FP, et al. Determination of fetal age. In: Athey PA, Hadlock FP, editors. Ultrasound in Obstetrics and Gynaecology. 2nd Ed. New Delhi: B.I. Churchill Livingstone Pvt. Ltd.; 1985; 22–37.
8. Otto C, Platt LD. Fetal growth and development. Obstet Gynecol Clin North Am. 1991 Dec; 18 (4): 907-31.
9. MacGregor SN, et al. Assessment of gestational age by ultrasound. Globlibr women's med. 2008.
10. Benson CB, Doubilet PM. Sonographic prediction of gestational age: accuracy of second- and third-trimester fetal measurements. AJR Am J Roentgenol. 1991 Dec;157(6): 1275- 7. 881.
11. Reece EA, Goldstein I, Pilu G, Hobbins JC. Fetal cerebellar growth unaffected by intrauterine growth retardation: a new parameter for prenatal diagnosis. Am J Obstet Gynecol. 1987 Sep;157(3):632-8.
12. Hill LM, Guzick D, Fries J, et al. The transverse cerebellar diameter in estimating gestational age in the large for gestational age fetus. Obstet Gynecol. 1990 Jun; 75 (6):981-5.
13. Sagi J, Vagman I, David MP, et al. Fetal kidney size related to gestational age. GynecolObstet Invest. 1987;23(1):1-4.
14. Gottlieb AG, Galan HL. Nontraditional sonographic pearls in estimating gestational age. SeminPerinatol. 2008 Jun;32(3):154-60.
15. Konje JC, Abrams KR, Bell SC, Taylor DJ.Determination of gestational age after the 24th week of gestation from fetal kidney length measurements. Ultrasound Obstet Gynecol. 2002 Jun;19(6):592-7.

16. Cohen HL, et al. Normal length of fetal kidneys:sonographic study in 397 obstetric patients. AJR Am J Roentgenol 1991 Sep; 157(3):545–8.
17. Cannie M, et al. Prenatal Magnetic Resonance Imaging Demonstrates Linear Growth of the Human Fetal Kidneys during Gestation. J Urol 2007; 178:1570-74.
18. Lawson TL, Foley WD, Berland LL, Clark KE. "Ultrasonic evaluation of fetal kidneys", Radiology, (1981); January; 138 (1); 153-6.
19. Bertagnoli L, Lalatta F, Gallicchio R, Fantuzzi M, Rusca M, Zorzoli A, Deter RL."Quantitative characterization of the growth of the fetal kidney", Journal of Clinical Ultrasound, September(1983); 11 (7); 349-56.
20. Ansari SM, Saha K, Paul AK, Mia SR, Sohel A, Karim."Ultrasonographic study of 793 fetuses; measurement of normal fetal kidney length in Bangladesh", Australian Radiology, February(1997); 41 (1); 3-5.
21. SeoYS,etal. Normal size of fetal kidneys: Sonographic Measurements.KoreanJObstetGynecol2003;46(3):537- 4119.
22. Gloor JM, Breckle RJ, Gehrking WC, Rosenquist RG, Mulholland TA, Bergstralh EJ, et al. Fetal renal growth evaluated by prenatal ultrasound examination. Mayo Clin Proc 1997;72:124-9.
23. Kaul I, Menia V, Anand AK, Gupta R. Role of fetal kidney length in estimation of gestational age. JK Sci 2012;14:65-9.
24. Schlesinger A, Hedlund G, Pierson WP, Null DM. Normal standards for kidney length in premature infants:Determination with US. Radiology 1987;164:127-9.
25. Mahesset, et al .Fetal kidney length and gestational age. American Journal of roentology.1999Vol157;545-48.
26. Fong KW,et al. Fetal urogenital tract. In: Rumarck CM, Wilson SR, Carbonean JW, editors. Diagnostic ultrasound. Volume II. 2nd ed. New York: Mosby Year book Inc; 1998; 1069–92.
27. Scott JE, Wright B, Wilson G, et al. Measuring the fetal kidney with ultrasonography. Br J Urol. 1995 Dec;76 (6): 769-74.
28. Gayam S, Geethavani M, Paul S. Fetal kidney length for determining gestational age in third trimester. Obs Rev: J Obstet Gynecol. 2018;4:49-54.
29. Ghaleb, M. , Shokri, A. , Sokkary, M. and Shourbagy, M. (2021) Role of Ultrasonographic Measurement of Fetal Kidney Length in Determination of Gestational Age during Third Trimester of Pregnancy. Open Journal of Obstetrics and Gynecology, 11, 221-232.