ORIGINAL RESEARCH ARTICLE

ULTRASONOGRAPHIC ESTIMATION OF GESTATIONAL AGE USING FETAL KIDNEY LENGTH

ABSTRACT

Background: The obstetric management of a pregnancy depends on the knowledge of an accurate gestational age particularly in unregistered case. **Aim:** The aim of the study is determine how accurately fetal kidney length (FKL) could estimate gestational age (GA) using ultrasonography. **Materials and Methods:** The study involved 200 participants with 20 to 40 weeks pregnancies, referred to the Radiology Department of Image Diagnostic Center, Rumuola Port Harcourt for obstetric ultrasound scan, within a three-month period. The left and right fetal kidney lengths were measured and data obtained were analyzed using SPSS version 23.0. Linear regression equations were deduced. **Results**: There was a strong positive correlation between gestational age (GA) and right kidney length (RKL) ($r = .998$, $p < 0.01$) and left kidney length (LKL) ($r = .998$, $p < 0.01$). Regression formulae used for predicting GA using right and left FKL was 9.9494(RKL) + 0.3058, and 9.9404(LKL) + 0.3468, respectively. **Conclusion**: FKL proved to be a reliable predictor of gestational age of pregnancies in the second and third trimesters.

Keywords: Fetal Kidney Length. Gestational Age Estimation, Ultrasonography

INTRODUCTION

Precise knowledge of gestational age (GA) is relevant for better antenatal care, planning, and successful management of all pregnancies. In high-risk pregnancies like preeclampsia,

intrauterine growth retardation, gestational diabetes mellitus, and termination of pregnancy is planned considering the GA [1]. Failure in accurate estimation of GA can result in iatrogenic prematurity or postmaturity, both of which are associated with increased perinatal mortality and morbidity [2].

The application of ultrasonography has played a vital role in the estimation of GA and has become an integral part of obstetric practice [3]. Sonographic estimations of GAs could be derived from mathematical expressions based on fetal measurements which serve as indirect indicators of gestational ages. Regression equations on the relationship between fetal biometric parameters have been developed by numerous authors and have proven early antenatal ultrasound to be an objective and accurate means of establishing GA [2, 4, 5, 6, 7, 8]. These biometric parameters includes gestational sac (GS), crown rump length (CRL), biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), femur length (FL) and fetal kidney length (FKL).

Fetal kidney is easily identified and measured during late second and third trimesters of pregnancy and there has been a strong correlation between gestational age and FKL [9, 10, 11]. However, there is limited literature that possibly suggests the relevance of FKL in the estimation of gestational age in a Southern Nigerian population, hence this study.

MATERIALS AND METHODS

From January to March 2023, 200 consecutive pregnant women ranging between 20-40 weeks of gestation who were certain of their last menstrual period referred to the antenatal clinic of the Obstetrics and Gynaecology Department of Image Diagnostic Center Port Harcourt and satisfied the inclusion criteria were sonographically examined. As part of the study's inclusion criteria, only healthy women with uncomplicated singleton pregnancy between 20-40 weeks of gestation and with knowledge of their last menstrual period (LMP) were selected. Excluded from the study were patients with twin gestation, known fetal anomaly, oligo-hydramnios or polyhydramnios and patients in labour.

The maximum kidney length was measured from the upper to lower pole of the kidney in a longitudinal section of the fetus in the sagittal plane. Measurements were obtained for both sides

and in a sagittal plane, when full length of kidney with renal pelvis was visualized. Examinations were performed using high resolution real time digital ultrasound scanner (DP-50 by Shenzhen Mindray Biomedical Electronics Co. Ltd. China, 2011) with 3.5MHz frequency convex transducer. All measurements were taken in centimeters (cm).

Data was analyzed using Statistical Package for social Sciences (SPSS) version 23.0. Both descriptive and inferential statistics were applied. The means of both right (RKL) and left kidney length (LKL) were expressed in form of tables. Significant differences between right (RKL) and left kidney length (LKL) were done using paired samples t-test, and correlation between GA and kidney lengths were performed using Pearson's correlation. Finally, linear regression equations were obtained. Level of significance was set at 0.05.

RESULTS

The gestational age of the fetuses studied ranged from 20 to 40 weeks; thus, covering both the second and third trimesters. Majority (126) of the fetuses were in the third trimester making up about 74.3% of the study population; while about (74) fetuses were in the late second trimester corresponding to 25.7% of the study population respectively.

Mean fetal left and right kidney lengths among the (200) fetuses at the different gestational ages documented is illustrated in table 1. The mean fetal kidney length for the both kidneys (Right and Left) ranged from 1.89mm and 1.90mm at 20 weeks of gestation to 4.10mm and 4.10mm at 40 weeks of gestation respectively, indicating a weekly increase of 0.1mm from one successive gestational age to another. There was no statistically significant difference between the measurements of the right and left kidneys.

There was a strong positive correlation between gestational age (GA) and right kidney length (RKL) ($r = .998$, $p < 0.01$) and left kidney length (LKL) ($r = .998$, $p < 0.01$). Using linear regression analysis to deduce equations, the formula used for predicting GA using RKL was GA = 9.9494(RKL) + 0.3058, while the formula used for predicting GA using LKL was GA = 9.9404(LKL) + 0.3468 with both sharing a prediction accuracy of 99.6%.

Table 1: Descriptive statistics of gestational age, right and left kidney length of all subjects

Parameter	N	Mean	SEM	SD	Min	Max	CI (95.0%)
GA (weeks)	200	30.28	0.42	5.96	20	40	0.83
RKL (cm)	200	3.01	0.04	0.6	1.89	4.1	0.08
LKL (cm)	200	3.01	0.04	0.6	1.9	4.1	0.08

GA = Gestational age, RKL = Right kidney length, LKL = Left kidney length, CI = Confidence interval, SEM = Standard Error of Mean, SD = Standard deviation, Min = Minimum, Max = Maximum, N = Number of subjects

Table 2: Differences between Right and Left Kidney Length

Parameters	Mean	SD	Paired Samples Test			
			T	df	p < 0.05	Inference
RKL (cm)	3.01	0.60	0.994	199	0.322	Not Significant
LKL (cm)	3.01	0.60				
N				200		

GA = Gestational age, RKL = Right kidney length, LKL = Left kidney length, df = Degree of Freedom

Table 3: Pearson's correlation between gestational age and kidney length

Parameters		GA	RKL	LKL
GA	**Pearson Correlation**	1	.998**	.998**
	Sig. (2-tailed)		0.000	0.000
RKL	**Pearson Correlation**	.998**	1	.999**
	Sig. (2-tailed)	0.000		0.000
	N		200	

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

Table 4. Descriptive Statistics of right and left mean kidney length (mm) for gestational age (weeks)

N	GA (weeks)	Mean RKL (cm)	Mean LKL (cm)	N	GA (weeks)	Mean RKL (cm)	Mean LKL (cm)
10	20	1.98 ± 0.06	1.98 ± 0.06	6	31	3.10 ± 0.02	3.10 ± 0.01
8	21	2.06 ± 0.04	2.06 ± 0.03	12	32	3.16 ± 0.06	3.16 ± 0.06
8	22	2.16 ± 0.05	2.16 ± 0.05	6	33	3.30 ± 0.03	3.29 ± 0.03
7	23	2.28 ± 0.03	2.28 ± 0.03	14	34	3.40 ± 0.02	3.41 ± 0.06
10	24	2.40 ± 0.02	2.39 ± 0.02	14	35	3.49 ± 0.04	3.49 ± 0.03
10	25	2.49 ± 0.03	2.49 ± 0.04	14	36	3.59 ± 0.02	3.59 ± 0.02
13	26	2.60 ± 0.03	2.60 ± 0.03	8	37	3.69 ± 0.01	3.69 ± 0.01
6	27	2.72 ± 0.05	2.72 ± 0.05	12	38	3.79 ± 0.03	3.78 ± 0.03
8	28	2.79 ± 0.02	2.79 ± 0.01	4	39	3.89 ± 0.01	3.88 ± 0.02
10	29	2.88 ± 0.02	2.88 ± 0.02	10	40	3.96 ± 0.09	3.95 ± 0.08
10	30	2.99 ± 0.02	2.98 ± 0.02				

Figure 1: Relationship between mean Right Kidney Length and Gestational Age

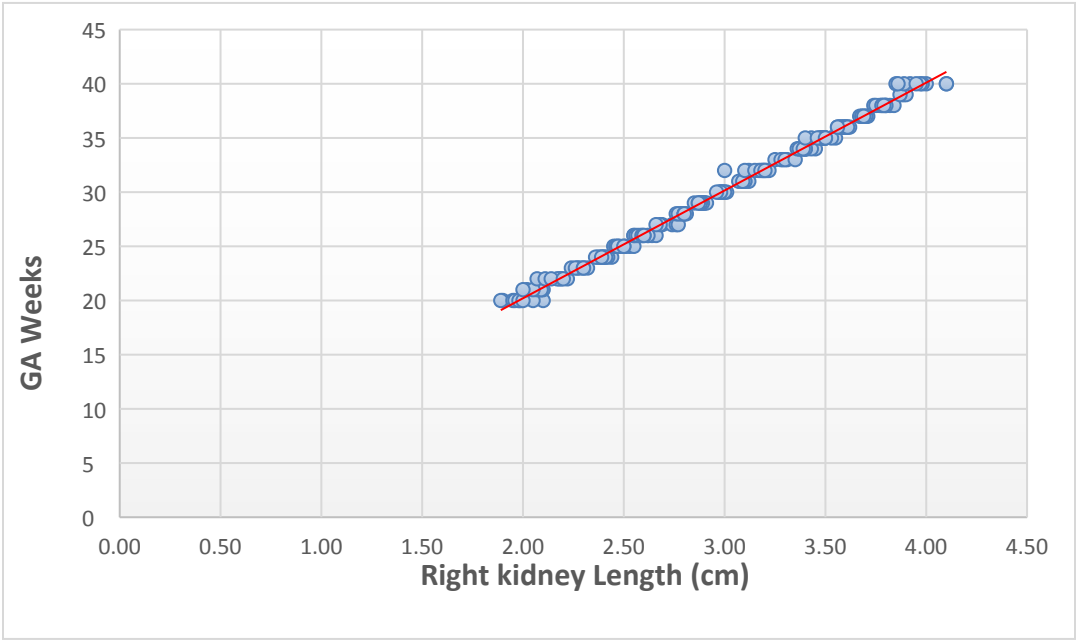
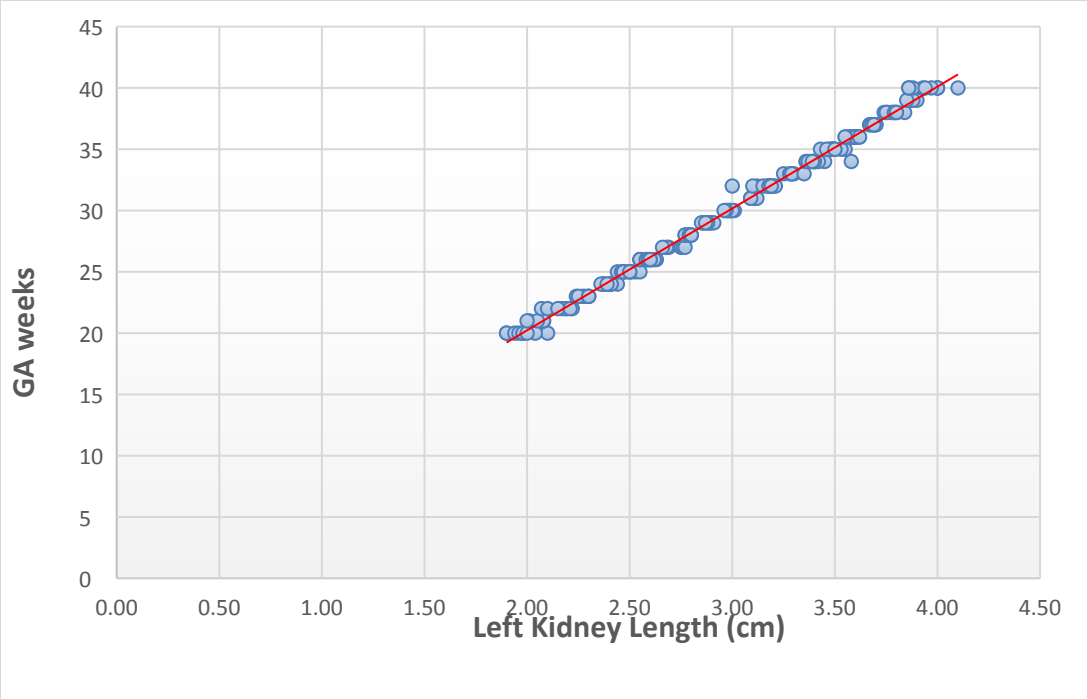


Figure 2: Relationship between mean Left Kidney Length and Gestational Age



DISCUSSIONS

Several studies have been done earlier to assess the variability in gestational age determination from fetal kidney length [9, 10, 11]. They found that there is a linear relationship between the fetal kidney length (FKL) and the gestational age (GA). This study was done to find out any difference in Nigerian population. It will be beneficial in patients who forgot their date of LMP, and do not have dating scan done in first trimester and coming for antenatal check-up late.

Both Ghaleb *et al*. [10] and Mustapha *et al*. [11] reported from their studies that there was no significant difference between the right and left kidney lengths which is in agreement with this current study. In comparison with a study done by Kumar *et al*. [2] using an Indian population, the mean FKL in this present study as observed from 20th to 24th week of gestation was much higher but became lesser as from the 26th to 40th week of gestation. This could be best explained that there are racial and geographical differences that could be attributed to the gestational changes that occur during fetal development.

There was a positive strong correlation between gestational age (GA) and right kidney length (RKL) ($r = .998$, $p = 0.000$) and left kidney length (LKL) ($r = .998$, $p = 0.000$) in this current

study. In concordance with related studies, Ghaleb et al. [10] also reported a strong correlation between GA and RKL (r = 0.932, p = 0.000) and LKL (r = 0.784, p = 0.000), while Ugur et al. [12], there was a very strong positive correlation between GA and FKL (r = 0.947, p = 0.001).

Linear regression analyses aimed at deducing formulae for predicting gestational age using both right and left FKL were done in this present study. In comparison with a related study done by Ghaleb et al. [10], predicting GA using RKL (in millimetres) was (0.81 * RKL) + 7.08 while that of LKL (in millimetres) was (0.68 * LKL) + 11.86. This present study showed that there was a prediction accuracy of 99.6% when predicting gestational age from fetal kidney length for both sides. Ugur et al. [12] deduced regression model for fetal renal length to estimate to gestational age and was shown to have an accuracy of 89.6% and concluded that fetal kidney length was a strong predictor for gestational age estimation. Furthermore, a related study by Ghaleb et al. [10] revealed a prediction accuracy with a R-squared value of 0.951 (at p = 0.000), which was in close concordance with this present study. In line with similar studies done by Konje et al. [13] and Kaul et al. [14], they showed from their results that fetal kidney length was the most reliable predictor of gestational age in comparison with other fetal biometric parameters.

CONCLUSION

In conclusion, fetal kidney length by ultrasound is a reliable method for gestational age estimation during pregnancy. With a constant increase, FKL has shown a strong correlation with GA in third trimester pregnancy. Consequently, it is essential for health care providers to incorporate fetal kidney length by ultrasound in their routine practice for accurate and timely gestational age estimation.

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