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To Estimate the Gestational Age of Fetus by using Fetal Kidney Length in Second Trimesters

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Abstract

Background: The waste products of metabolism and extra water are eliminated by the kidneys. The kidneys are reddish-brown when they are fresh. The average dimensions of a kidney are 3 cm in the anteroposterior direction, 6 cm in width, and 11 cm in length. The left kidney may be 1.5 cm longer than the right.

Objective: The objective of the study is to determine the gestational age of fetuses based on fetal kidney length.

Material and Methods: This study was conducted on 96 normal sonographs of pregnant women in 2nd trimesters in the Department of Anatomy, in collaboration with Obstetrics & Gynecology and Radiology of Index Medical College Hospital & Research Centre, Malwanchal University, Indore. This study was carried out for a period of 2 and a half years (from July 2021 to December 2023).

Observation & Result: From this study, we calculated the mean value and standard deviation of fetal kidney length in group A (18-21) is 18.54±2.55, and group B (22-25) is 19.71±2.22 weeks. The mean and standard deviation of fetal kidney Width in group A (18-21) is 11.81±2.16, and in group B is 14.18±2.89 weeks. The mean and standard deviation of fetal kidney Thickness in group A (18-21) is 9.81±2.37, and in group B is 11.37±1.66 weeks.

Conclusion: From this study, we conclude that FKL is a good and accurate indicator for the measurement of GA, especially in the second trimester. FKL correlated very strongly with GA compared to other parameters. Hence in the second trimester, FKL can be used for better prediction of GA.

Keywords: Fetal kidney length (FKL), Gestational Age (GA), Fetal kidney Width (FKW), Fetal kidney Thickness (FKT)

1. Introduction

The waste products of metabolism and extra water are eliminated by the kidneys. The kidneys are reddish-brown when they are fresh. The average dimensions of a kidney are 3 cm in the anteroposterior direction, 6 cm in width, and 11 cm in length. The left kidney may be 1.5 cm longer than the right. It weighs 135 g for women and 150 g for men on average [1, 2]. The kidneys begin to grow early in the fifth week and begin to function in the ninth week of gestational age. It develops through three successive embryonic stages pronephric kidney, mesonephric kidney, and metanephric kidney. It develops from two sources: the collecting part is formed by the metanephric diverticulum (ureteric bud), and the secretory part is formed by the metanephric mass of the intermediate mesoderm (metanephrogenic blastema) [3, 4]. The measurement of the fetal biparietal diameter and fetal kidney parameters allow for accurate assessment throughout the second trimester [5]. In obstetrical examinations, ultrasound has become an essential tool. Determining the fetal gestational age, growth, and aberrant patterns with accuracy aids in determining whether or not early intervention is required in high-risk pregnancies. [6]. Fetal biometry measurements using ultrasound (CRL, BPD, FL) are thought to be trustworthy when done in the first and early second trimesters [7, 8]. Hemodynamic alterations associated with preterm delivery are anticipated to be particularly dangerous for the immature preterm kidney with ongoing nephrogenesis [9, 10]. To diagnose and treat prenatal renal abnormalities such as Wilm's tumor, multicystic renal dysplasia, and hydronephrosis, as well as to provide genetic counseling, it is crucial to comprehend the normal developmental morphology of the kidneys. Among all the biometric indices, fetal kidney characteristics provide the most reliable estimate of gestational age [11, 12]. Preeclampsia, maternal dystrophia, and hyperuricemia can all lead to fetal growth restriction (FGR) [13]. It is strongly suggested that a poor intrauterine environment contributes to the development of hypertension and chronic kidney disease later in life. In chronic kidney disease, risk increases by 70% in cases of low birth weight [14]. A major risk factor for hypertension and the poor prognoses of certain kidney disorders is low birth weight [15]. In cases of pre-eclampsia, chronic renal disease, severe intrauterine growth retarder (IUGR), diabetes, placenta praevia centralis, and Rh-negative women, a precise gestational age determination is essential when an early termination is necessary as soon as the fetus reaches maturity [16]. Numerous studies have also conclusively shown that smoking by a pregnant mother during pregnancy has numerous detrimental consequences on the developing fetus. During the second and early third trimesters, the fetal kidney exposed to smoke was larger and thicker than the unexposed kidney; however, later on, the kidneys became proportionately thinner in terms of both length and width [17].

2. Materials and Methods

This study was conducted on 96 normal sonographs of pregnant women in 2nd trimesters in the Department of

Anatomy, in collaboration with Obstetrics & Gynecology and Radiology of Index Medical College Hospital & Research Centre, Malwanchal University, Indore. This study was carried out for a period of 2 and a half years (from July 2021 to December 2023). The history of the patient was collected from the OBGY department of Index Medical College Hospital & Research Centre, Malwanchal University, Indore. After approval from the institutional ethical committee for biomedical and Health Research Index Medical College Indore. Patients were divided into two groups based on the gestation age of fetuses. In group-A (18-21) GA of fetuses and group-B (22-25) weeks of GA of fetuses. Group-A was subdivided into A1(18), A2(19), A3(20), and A4(21) weeks of GA. Group -B was subdivided into B1(22), B2(23), B3(24), and B4(25) weeks of GA. The length of the kidney was recorded by USG. The Data was analyzed using SPSS software version 27. Statistical test of Significance (t-test will be applied wherever found necessary. (p<0.05 was considered statistically significant).

3. Observation and Result

TABLE 1: SHOWING MEAN, STD, MINIMUM, MAXIMUM OF LENGTH, WIDTH, AND THICKNESS OF FETAL KIDNEY

Parameters/GA	Length		Width		Thickness	
	Mean ± SD	Min-Max	Mean ± SD	Min-Max	Mean ± SD	Min-Max
Group A (18-21) weeks	18.54±2.55	11.9-23.7	11.81±2.16	8.90-19	9.81±2.37	0.90-19.90
A1 (18)	18.6±5.21	11.9-23.7	12.0±1.42	11.1-14.1	9.6±2.02	7.2-11.9
A2 (19)	17.2±1.34	16.2-18.1	10±1.55	8.9-11.1	8.8±0.07	8.8-8.7
A3 (20)	19.1±2.63	14.9-22.5	11.6±2.36	9.9-19	10.0±2.77	8-19.9
A4 (21)	18.3±2.01	14.9-21.9	12.1±2.16	8.9-18.5	9.3±2.12	0.9-11.1
Group B (22-25)	19.71±2.22	14.9-24.2	14.18±2.89	10-20.50	11.37±1.66	8-15.80
B1 (22)	19.2±1.98	16.5-23	13.8±2.70	10-20	11±1.56	8-14.2
B2 (23)	19.1±2.34	14.9-22.5	13.9±3.01	10.8-20.5	11.3±1.70	9.5-15.8
B3 (24)	20.2±1.61	3.2-4.8	14.1±2.49	17.5-24.2	11.7±1.48	11.1-18.8
B4 (25)	23.4±0.77	4.5-4.8	17.6±3.46	22.4-24.1	12.7±2.22	12.5-20.1

TABLE 2: SHOWING CORRELATION BETWEEN SE, R-VALUE, R2, AND P- VALUE WITH LENGTH, WIDTH, AND THICKNESS OF FETAL KIDNEY

Parameters		SE	R-value	R2	P-value
Length	Group-A	0.38	0.959	0.919	<0.0001
	Group-B	0.3			
Width	Group-A	0.32	0.872	0.76	
	Group-B	0.39			
Thickness	Group-A	0.35	0.885	0.783	
	Group-B	0.22			

TABLE 3: SHOWS PEARSON'S CORRELATION BETWEEN FETAL GENERAL PARAMETERS AND FETAL KIDNEY LENGTH, WIDTH, AND THICKNESS

Parameter	FKL	FKW	FKT
BPD	0.958	0.871	0.886
HC	0.972	0.879	0.891
AC	0.973	0.876	0.896
FL	0.965	0.877	0.884

The gestational age of the fetuses in this study ranged from 18 to 25 weeks. Patients were divided into two groups based on the gestation age of fetuses. Group A (18-21) weeks and Group B (22-25) weeks. The mean and standard deviation of fetal kidney length in group A is 18.54±2.55mm. The mean and standard deviation of fetal kidney length are 18.6±5.21, 17.2±1.34, 19.1±2.63, and 18.3±2.01 mm at subgroups A1, A2, A3, and A4 respectively. The mean and standard deviation of fetal kidney length in group B (22-25) is 19.71±2.22 mm. The mean and standard deviation of fetal kidney length is 19.2±1.98, 19.1±2.34, 20.2±1.61 and 23.4±0.77 mm at subgroups B1, B2, B3, and B4 respectively. The values of the length of the kidney about gestational age in weeks were calculated by the best-fit regression formula: Y =−3.66542+ 1.083147 × GA in weeks (mm). Pearson's correlation between the length of the kidney and the gestation age of the fetuses was r = 0.959 and p-values <0. 0001. The mean and standard deviation of fetal kidney Width in group A (18-21) is 11.81±2.16 mm. The mean and standard

deviation of fetal kidney Width is 12.0±1.42, 10±1.55, 11.6±2.36 and 12.1±2.16mm in groups A1, A2, A3, and A4 respectively. The mean and standard deviation of fetal kidney length in group B (22-25) is 14.18±2.89mm. The mean and standard deviation of fetal kidney Width are 13.8±2.70, 13.9±3.01, 14.1±2.49 and 17.6±3.46 mm at subgroups B1, B2, B3, and B4 respectively. The values of the width of the kidney about gestational age in weeks were calculated by the best-fit regression formula: Y =−2.52077+ 0.750826 × GA in weeks (mm). Pearson's correlation between the width of the kidney and the gestation age of the fetuses was r = 0.872 and p-values <0.0001. The mean and standard deviation of fetal kidney Thickness in group A (18-21) is 9.81±2.37 mm. The mean and standard deviation of fetal kidney Thickness is 9.6±2.02, 8.8±0.07, 10.0±2.77 and 9.3±2.12 mm in subgroups A1, A2, A3, and A4 respectively. The mean and standard deviation of fetal kidney Width in group B is 11.37±1.66 mm. The mean and standard deviation of fetal kidney Thickness is 11±1.56, 11.3±1.70, 11.7±1.48 and 12.7±2.22 mm at subgroups B1, B2, B3, and B4 respectively. The values of the thickness of the kidney about gestational age in weeks were calculated by the best-fit regression formula: Y =−1.35093+ 0.57106 × GA in weeks (mm). Pearson's correlation between the thickness of the kidney and the gestation age of the fetuses was r = 0.885 and p-values <0. 0001.

4. Discussion

TABLE 4: SHOWING COMPARISON BETWEEN THE PRESENT STUDY AND THE PREVIOUS STUDY

Gestational Age	Authors (FKL) (mm)						
	Manal M.S. ElMeligy, *et al.* (2018)	**Joshi BR *et al.* (2021)**	**Chiddarwar *et al.* (2022)**	**Umesh Khana *et al.* (2022)**	**Mahima *et al.* (2023)**	**Bob-Manuel *et al.* (2023)**	**Present study**
Group-A (18-21) Wks	18.31	21.01	21.31	21.1	20.33	20.15	18.54
Group-B (22-25) Wks	24.02	23.94	23.5	23.94	23.9	23.46	19.71

In the present study, we found that the mean value of fetal kidney length is 18.54 mm and 19.71 mm in group A and B respectively. Whereas the mean value of fetal kidney width is 11.81 mm and 14.18 mm in group A and group B respectively. The mean value of fetal kidney thickness is 9.81 mm and 11.37 mm in group A and group B respectively.

In Group A our finding is strongly similar to the study conducted by Manal M.S. El-Meligy, *et al*. [18]. whereas our finding is lesser than the study conducted by Joshi BR *et al*. [19], Chiddarwar *et al*. [20], Umesh Khana *et al*. [21], Mahima *et al*. [22], Bob-Manuel *et al*. [23]. In Group B our finding is smaller than the study conducted by Manal M.S. El-Meligy, *et al*. [18], Joshi BR *et al*. [19], Chiddarwar *et al*. [20], Umesh Khana *et al*. [21], Mahima *et al*. [22], Bob-Manuel *et al*. [23].

In Group A, our finding of the mean fetal kidney width is 11.81mm. Whereas the mean fetal kidney width was 12.01mm in the study conducted by Enefia K. *et al*. (2023) [24]. So, our finding is quite similar to previous findings. In Group B, our finding of the mean fetal kidney width is 14.18 whereas, the mean value of fetal kidney width was 15.53mm observed by Enefia K. *et al*. (2023) [24]. So, our finding is smaller than the previous finding.

In Group A our finding of the mean fetal kidney thickness is 9.81mm. Whereas mean fetal kidney thickness was 13.51mm in the study conducted by Enefia K. *et al*. (2023) [24]. So, our finding is smaller than the previous finding. In Group B, our finding of mean fetal kidney thickness is 11.37mm, and the mean value of fetal kidney thickness was 16.86mm observed by Enefia K. *et al*. (2023) [24]. So, our finding is smaller than the previous finding.

5. Conclusion

The initiation of USG in clinical practice has improved patient evaluation, early diagnosis, treatment, monitoring, and prognosis of many clinical conditions. It is a good tool for estimating GA and evaluating growth and abnormalities associated with the fetal kidneys. From this study, we conclude that FKL is a good and accurate indicator for the measurement of GA, especially in the second trimester. FKL correlated very strongly with GA compared to other parameters. Hence in the second trimester, FKL can be used for better prediction of GA. Even fetal kidney width and fetal kidney thickness are highly significant with gestational age. So, it also helps to accurately measurement of fetal gestational age based on fetal kidney width and thickness.

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