



## Original Article

## Correlation of Sonographic Gestational Age with Fetal Kidney Length in Normal Pregnancy

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## ABSTRACT

Precise evaluation of gestational age is essential for quality maternity care. Ultrasonography is the most readily available and reliable method to establish gestational age. This study aims to use the length of the fetal kidney as a reliable parameter to measure gestational age in late second and third trimesters. **Objective:** To determine the relationship between fetal kidney length and gestational age in weeks during the late 2nd and 3rd trimester of normal pregnancy. **Methods:** It was a prospective cross-sectional study conducted on 105 singleton normal pregnant females between 24th and 40th weeks of gestation who came to the obstetrics and gynecology department at a private sector hospital in Kharian, Pakistan. The duration of the study was four months. Bi-parietal diameter, femur length, and fetal kidney lengths were measured. Statistical analyses were applied using SPSS version 22.0. **Results:** A moderately significant positive correlation was identified between different gestational age measuring parameters and fetal kidney length. The correlation was significant at the level of 0.01. The correlational values of GA according to LMP with FKLL and FKLR were ( $r = .85^{**}$ ) and ( $r = .87^{**}$ ) respectively. GA with BPD indicates a moderately significant positive correlation with FKLL and FKLR ( $r = .94^{**}$ ) and ( $r = .94^{**}$ ). GA with FL also shows a moderately significant positive correlation with FKLL and FKLR ( $r = .83^{**}$ ) and ( $r = .83^{**}$ ), respectively. **Conclusion:** In conclusion, fetal kidney length in millimeters correlates well with gestational age in weeks and shows linear growth with gestational age throughout pregnancy. Gestational age estimated from fetal kidney length gives improved dating of fetal age.

## INTRODUCTION

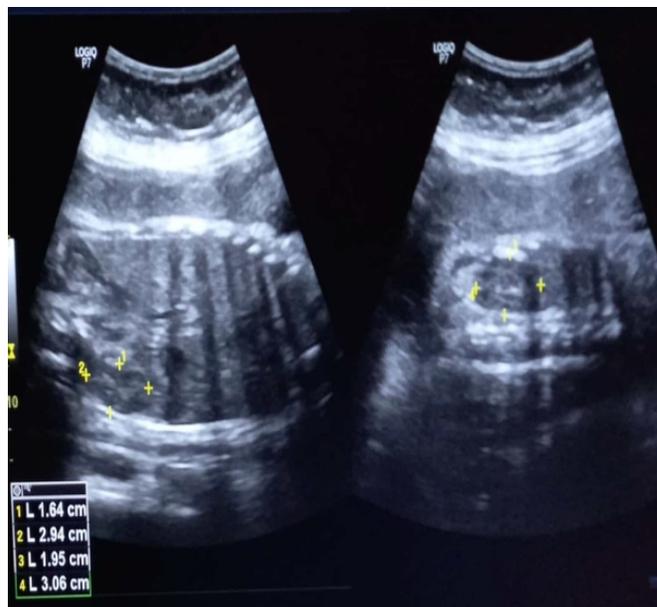
Accurate estimation of gestational age is essential for assuring fetal well-being and management of pregnancies [1]. Estimating the delivery date, especially for those who present late for maternal care and those uncertain about their LMP, always remained a challenge [2]. If the gestation age is not measured accurately, it can result in fetal premature birth or post-maturity, increasing the chances of fetal morbidity and mortality [3]. In the first trimester, the date of pregnancy is determined by the first day of the previous menstrual cycle, the diameter of the gestational sac, and the crown lump length. The most common parameters used to determine pregnancy dates in the second trimester are the fetal Bi-parietal diameter, femur length, head circumference, and abdominal circumference, with an accuracy of +/-10 to 14 days [4,5].

Many of these parameters can predict gestational age with great precision. However, as gestational age increases, these parameters become more and more unreliable due to physical size variations of organs. They can also be affected in certain medical conditions like oligohydromnios, polyhydromnios, breech presentation, IUGR, etc [6,7]. They show discrepancies from the expected average gestational age [8,9]. Therefore, accurate pregnancy dating remained a challenge in the late 2nd or 3rd trimester. It requires a valuable parameter that can independently predict gestational age accurately [10,11]. Other non-traditional parameters being studied to measure gestational age include trans cerebellar diameter, the transverse diameter of the colon, amniotic fluid volume, hard palate width, and fetal sacral length [12]. The fetal

kidney is one parameter to measure the fetus's gestational age in the second and third trimesters [13,14]. The renal length of the fetus showed a fortnightly growth rate of 1.7mm with gestational age during pregnancy [15]. Fetal kidneys are easy to visualize after the 18th week of gestation. In the early stage before 17th week, kidneys are just homogeneous structures except at the central collecting structure. Lately, one can easily differentiate between renal parenchyma, collecting structures, adrenal glands, cortex, medulla, and renal pelvis [16]. Fetal kidneys are seen in the transverse plane as two circular structures along both sides of the spine. While longitudinally, they appear as two small bean-shaped structures in the paravertebral region. Fetal kidney length correlated with gestational age, and its linear progression with gestational age has been demonstrated on MRI. After 24 week of gestation FKL is more accurate way of measuring gestational age than FL, BPD, AC, and HC [17,18]. High-risk pregnancies like hypertension, diabetes mellitus, IUGR, oligohydramnios, polyhydramnios, and placental abnormalities affects BPD, FL, HC and AC [19]. Length of fetal kidney in millimeters approximates fetal gestational age in weeks [20]. This growth of the fetal kidneys remains unaffected by abnormalities; therefore, it can effectively measure gestational age as an adjunct to other routinely used parameters [21,22].

## METHODS

A prospective cross-sectional study was conducted at a private sector hospital's obstetrics and gynecology department in Kharian, Pakistan. The sample size for this study was selected using a convenient sampling technique. One hundred five females with singleton normal pregnancies between 24 to 40 weeks of gestational age who were sure about their LMP were included in the study. Females with pregnancies below the 24th week of gestation, multiple pregnancies, diabetes mellitus, hypertension, oligohydromnios and polyhydromnios were excluded from the study. GE Logic P7 Ultrasound Machine with a 3.5MHz frequency convex transducer was used for scanning the fetus. Fetal kidneys were visualized in a transverse plan below the stomach level. Then the probe was rotated to 90 degrees to image the kidneys' longitudinal axis in the left and right paravertebral region. Kidney length was measured from the lower to upper pole, excluding the adrenal gland. All participants gave written consent. Data was analyzed using SPSS version 22.



**Figure 1:** Fetal right and left Kidney measured from one pole to another at 30th weeks of gestation 29.4(right), 30.6(left)

## RESULTS

The study included one hundred five females with gestational age between 24 to 40 weeks of normal pregnancy. All of the participant's age range from 22-40 years. Out of 105 subjects, 15 were between 25-29 weeks of gestation, 44 were between 30-34 weeks, and 46 were between 35-39 weeks. There were 22.9% (24) primigravida and 77.1% (81) multigravida subjects. The mean value of gestational age according to LMP, BPD, FL, FKLL, and FKLR was 33.56 weeks, 32.68 weeks, 32.66 weeks, 32.61 weeks, and 32.38 weeks respectively with a standard deviation of 3.14, 3.29, 3.18, 3.42, and 3.42 respectively. A moderately significant positive correlation was identified between different gestational age measuring parameters and fetal kidney length. The correlational values of GA according to LMP and GA with BPD, GA with FL, FKLL and FKLR were ( $r = .87^{**}$ ), ( $r = .75^{**}$ ), ( $r = .85^{**}$ ) and ( $r = .87^{**}$ ) respectively significant at 0.01. GA with BPD indicates a moderately significant positive correlation with FKLL and FKLR ( $r = .94^{**}$ ) and ( $r = .94^{**}$ ) significant at 0.01. GA with FL also shows a moderately significant positive correlation with FKLL and FKLR ( $r = .83^{**}$ ) and ( $r = .83^{**}$ ), respectively significant at 0.01, as shown in Table 1.

| Parameters              | R     | P value |
|-------------------------|-------|---------|
| GA with LMP*GA with BPD | .87** | 0.01    |
| GA with LMP*GA with FL  | .75** | 0.01    |
| GA with LMP* FKLL       | .85** | 0.01    |
| GA with LMP* FKLR       | .87** | 0.01    |
| GA with BPD* FKLL       | .94** | 0.01    |
| GA with BPD* FKLR       | .94** | 0.01    |

|                  |       |      |
|------------------|-------|------|
| GA with FL* FKLL | .83** | 0.01 |
| GA with FL* FKLR | .83** | 0.01 |

BPD= Bi parietal diameter, FL=Femur Length, FKLL=Length of fetal left kidney, FKLR=Length of Fetal right kidney, GA= Gestational age

**Table 1:** Correlation between GA with LMP, GA with BPD, GA with FL, FKLL and FKLR

The simple linear regression model shows a strong positive linear relationship between gestational age with LMP and BPD, FL, FKLL, and FKLR, as shown in Table 2.

| Independent Variables | A    | B     | P    | R <sup>2</sup> | Sum of Error |
|-----------------------|------|-------|------|----------------|--------------|
| BPD                   | 3.89 | 0.363 | 0.00 | 0.774          | 0.00         |
| FL                    | 13.7 | 0.310 | 0.00 | 0.633          | 0.00         |
| FKLL                  | 7.46 | 0.792 | 0.00 | 0.726          | 0.00         |
| FKLR                  | 7.43 | 0.796 | 0.00 | 0.762          | 0.00         |

BPD=Bi parietal diameter, FL=Femur Length, FKLL=Length of fetal left kidney, FKLR=Length of Fetal right kidney, GA=Gestational age

**Table 2:** Simple Linear regression between Gestational Age with LMP and BPD, FL, FKLL and FKLR

The overall growth of fetal right and left kidney length with their standard deviation according to gestational age is shown in Table 3.

| GA weeks |      | FKLL (mm) | FKLR (mm) |
|----------|------|-----------|-----------|
| 25-29    | Mean | 28.0133   | 27.4533   |
|          | N    | 15        | 15        |
|          | Sd   | 2.05804   | 1.95553   |
| 30-34    | Mean | 31.9636   | 31.8023   |
|          | N    | 44        | 44        |
|          | Sd   | 2.36418   | 1.91839   |
| 35-39    | Mean | 35.5391   | 35.5283   |
|          | N    | 46        | 46        |
|          | Sd   | 1.95885   | 2.14628   |
| Total    | Mean | 32.9657   | 32.8133   |
|          | N    | 105       | 105       |
|          | Sd   | 3.38125   | 3.44470   |

FKLL= Length of Fetal left kidney, FKLR= Length of Fetal right kidney

**Table 3:** Distribution of cases based on gestational age with right and left kidney length

## DISCUSSION

Ultrasound is an easily available modality that can image various organs in utero, allowing adequate estimation of the fetal GA. This study was conducted on 105 pregnant females to determine the relationship between the length of the fetal right and left kidney and gestational age between 24-40 weeks. Fetal kidney length shows a statistically significant positive correlation with weeks of gestation. FKL gives reliable estimate of gestational age. Mean value of fetal left kidney was 32.61 mm and mean length of fetal right kidney was 32.38 mm. The left kidney correlation coefficient was slightly lower than from the right kidney. The best correlation coefficient was found between LMP and BPD derived gestational age. The correlation coefficient values of GA according to LMP with

FKLL and FKLR were ( $r= 0.85^{**}$ ) and ( $r= 0.87^{**}$ ). A previous study conducted by Sanjib Kumar Das et al. 2018 showed a significant positive correlation between the length of fetal kidneys and gestational age according to LMP with a correlation coefficient ( $r=0.907$ ) which is slightly higher than our study [1]. The correlation coefficient values of GA according to BPD with FKLL and FKLR were ( $r= 0.94^{**}$ ) and ( $r= 0.94^{**}$ ). The correlation coefficient values of GA according to FL with FKLL and FKLR were ( $r= 0.83^{**}$ ) and ( $r= 0.83^{**}$ ). A previous study conducted by Jayati Bardhan et al. 2016 showed a significant positive correlation between the length of fetal kidneys and sonographic gestational age with a correlation coefficient ( $r=0.99$ ) which is slightly higher than our study A simple linear regression model shows a positive relationship between gestational age according to LMP and FKLL, FKLR with a determination coefficient of 0.72 and 0.76, respectively. The regression equation used to estimate gestational age with BPD, FL, FKLL, and FKLR was  $Y = \alpha + \beta(x)$ . The regression model with GA according to BPD as an independent variable showed a regression equation as: GA according to LMP =  $3.89 + 0.36$  (BPD). The regression model with GA according to FL as an independent variable showed a regression equation as: GA according to LMP =  $13.7 + 0.31$  (FL). The regression model with GA according to FKLL as an independent variable showed a regression equation as: GA according to LMP =  $7.46 + 0.79$  (FKLL). The regression model with GA according to FKLR as an independent variable showed a regression equation as: GA according to LMP =  $7.43 + 0.79$  (FKLR). A previous study conducted by Mahmoud Mohamed Ghaleb et al. 2021 found a positive linear relationship between gestational age according to LMP and FKLL, FKLR with determination coefficients of 0.67, 0.86 respectively which are in accordance with our study [13]. FKL may be a more helpful method in cases when other traditionally used parameters are difficult to obtain and show considerable differences with GA. Because the GA is still traditionally determined, in some places, by LMP, the chances of error increase, necessitating the use of USG investigation as the only measuring tool for GA determination.

## CONCLUSION

This study concludes that length of the fetal right and left kidney in millimeters shows linear progression with gestational age in weeks. It gives reliable estimation of gestation age without using any software. Ultrasonography is readily available and the safest modality to use during pregnancy which can be used to measure length of fetal kidneys accurately. Gestational age estimated from fetal kidney length gives improved dating of fetal age.

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