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Original research article

EVALUATION OF FETAL KIDNEY LENGTH MEASUREMENT IN ESTIMATION OF GESTATIONAL AGE IN SECOND HALF OF PREGNANCY

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Abstract

Background: Accurate gestation age assessment is essential to avoid iatrogenic prematurity or post maturity; both being associated with increased perinatal morbidity and mortality. Ultrasound parameters like BPD, FL are more accurate for GA estimation from early second trimester. However, as the GA progresses, they become unreliable because of biological variability. FKL is not affected by growth variations. Therefore, the present study is to evaluate its role in estimating the GA and its linear correlation with GA.

Aim: To evaluate the role of FKL in estimating GA and its linear correlation with GA.

Methods: This is a prospective study conducted in the Obstetrics and Gynaecology department, at Mamata General Hospital, Khammam from October 2022 to September 2023, with a sample size of 50 antenatal women who were beyond 24 weeks.

Results: When all the parameters were compared to clinical gestational age, least standard deviation for FKL was 0.43 at 26 and 29 weeks, for BPD was 0.73 at 26 weeks, for HC was 0.25 at 26 weeks, for AC was 0.7 at 26 and 29 weeks and for FL was 0.1 at 26 weeks. All the parameters were significant in estimating GA in both second and third trimesters but more accurate in second trimester. The FKL showed linear correlation with increasing gestational age, thus showing correlation of clinical GA best with FKL (r=0.953) in our study.

Conclusion: FKL closely approximates GA and increases in linear correlation in the late second and third trimester.

Clinical Significance: Since FKL is not affected by growth and has linear correlation with gestational age, it would a valuable tool singly or along with other parameters to as a better than average parameter to asses gestational age of fetus.

Keywords: Gestational age, fetal kidney length, growth variations, ultrasonography.

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Introduction

Accurate assessment of gestational age is crucial for delivering high-quality maternity care. Inaccuracies in this process can lead to iatrogenic preterm birth or prolonged pregnancy, both of which are linked to increased perinatal morbidity and mortality. Obstetric sonography is integral in determining intrauterine gestational age accurately. Before the widespread use of sonography, the estimation of pregnancy duration was based on the first day of the last menstrual period (LMP) for women with a regular 28-day cycle, uterine size examination (e.g., McDonald's rule), and radiographic assessment of ossification centers and dental development. However, these methods are fraught with high variability [1].

Understanding gestational age is crucial for several reasons [1]: It helps in planning for spontaneous or elective delivery within a full-term pregnancy timeframe (38 to 42 weeks), scheduling invasive procedures such as chorionic villus sampling and amniocentesis, assessing fetal growth, and influencing management decisions in the presence of fetal anomalies. Thus, gestational age impacts critical clinical decisions.

The last two decades have seen tremendous advancements in the application of ultrasound as a diagnostic tool, revolutionizing management and care due to its non-invasive, non-ionizing nature, cost-effectiveness, and excellent safety record [2]. It is the primary responsibility of an obstetrician to ascertain the pregnancy duration as early as possible, especially in high-risk pregnancies, such as cases of severe preeclampsia, chronic hypertension, significant intrauterine growth restriction (IUGR), central placenta previa, and sensitized Rh-negative mothers. In some of these cases, early delivery may be necessary as soon as the fetus reaches maturity [3]. Estimation of gestational age is also a prerequisite for interpreting specific tests (e.g., amniotic fluid assay, serum assay, chorionic villus sampling) and planning various fetal therapies.

Traditionally, pregnancy duration is counted as 9 calendar months and 7 days, or 40 weeks or 280 days from the first day of the LMP [4]. The error in this method is the variation in ovulation timing from one cycle to another and from one individual to another. Approximately 10-15% of pregnant women cannot accurately recall their LMP, and 18% show significant discrepancies between menstrual and ultrasound estimations [5]. Konje *et al.* [6] found that only 71% of women accurately recall their LMP. Furthermore, factors such as menstrual irregularities, lactational amenorrhea, contraceptive failure, early pregnancy bleeding, chronic anovulation, multiple gestations, IUGR, diabetic pregnancies, maternal size, variation in fetal position, and measurement discrepancies can affect the precise calculation of gestational age [7].

Ultrasound has become an indispensable tool in obstetric examinations and in accurately estimating fetal gestational age. In the first trimester, measurements of gestational sac diameter and crown-rump length are more reliable. In the second trimester, the biparietal diameter (BPD) and femur length (FL) are commonly used. These measurements more accurately predict gestational age early in the second trimester but become increasingly unreliable as gestation progresses due to biological size variability relative to age [8].

Measurements like BPD, abdominal circumference (AC), head circumference (HC), and FL are affected by conditions such as breech and transverse presentations, oligohydramnios, multiple gestations, deep engagement of the head, IUGR, dolichocephalic skull, achondroplasia, phocomelia, fetal hepatosplenomegaly, and

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anencephaly, which render gestational age estimation by these parameters less accurate [9]. While fetal kidney size is also influenced by growth variations, it is primarily the anteroposterior and transverse diameters that are affected. The kidney length remains unaffected by growth variations. Past studies have shown a linear correlation between fetal kidney length and gestational age. The present study is undertaken to evaluate the role of fetal kidney length as a parameter for estimating gestational age in the second half of pregnancy and to compare its effectiveness in estimation with other commonly used parameters like BPD, FL, HC, and AC.

Materials and Methods

A one year study was undertaken in the department of Obstetrics and Gynecology, at Mamata General Hospital, Khammam from October 2021 to September 2022. A total of 50 antenatal cases were considered who gave consent for the study.

Procedure: Pregnant women with singleton pregnancy who were reliably sure of the date of their last menstrual period were selected for the study. The patients were evaluated as per the history, general physical examination, antenatal examination and routine antenatal investigations. Following this, using ultrasound mean kidney length along with fetal head circumference, biparietal diameter, abdominal circumference and femur length were measured. These values were then compared with actual gestational age derived from excellent dates taken as standard. Comparison has been made between the accuracy of fetal kidney length measurement and other fetal biometric parameters (BPD, HC, AC, FL) in the determination of gestational age. The length of fetal kidney is a bipolar measurement using gray scale real time ultrasonographic scanner with 3.5-5.0 MHz transducer. Measurements were obtained in the sagittal plane, when full length of kidney with renal pelvis is visualized.

Inclusion Criteria

- Women with singleton pregnancies.
- Women with gestational age > 24 weeks

Exclusion Criteria

- Women with IUGR, Oligohydramnios, Polyhydramnios, suspected fetal anomalies.
- Women with medical disorders.

Statistical Analysis

Linear regression models for estimation of gestational age are derived from the biometric indices and kidney length. Comparisons have been made between the accuracy of these models in the determination of gestational age. Pearson correlation has been performed to find the relationship between variables. Tatistical significance was considered to be achieved at P-values < 0.05.

Results

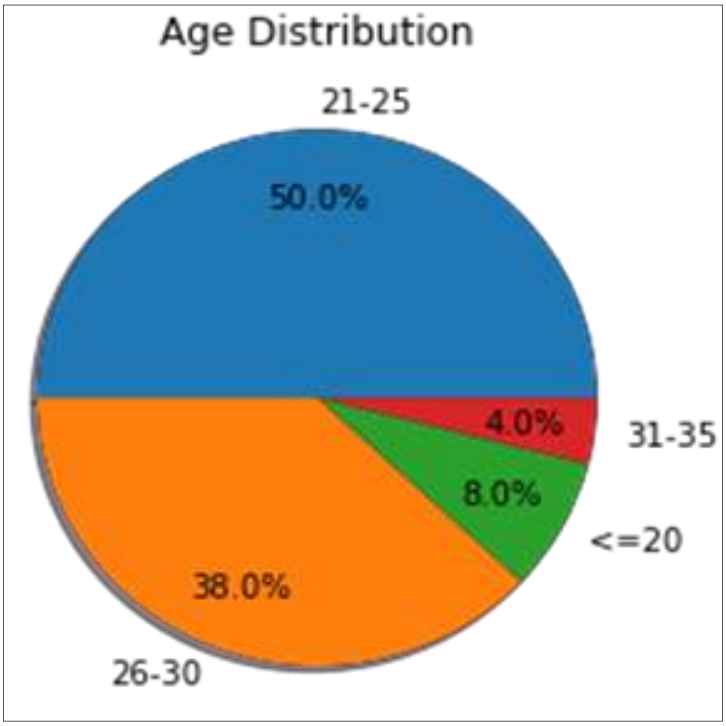

Fig 1: Age distribution of cases

The age distribution of the cases shows a concentration in the younger age groups. The majority of women, accounting for 50%, fell within the age group of 21 to 25 years. This was followed by 38% of women in the age group of 26 to 30 years. A smaller percentage, 8%, were women below 21 years of age. Finally, only 4% of the cases involved women who were above 30 years old (Figure 1).

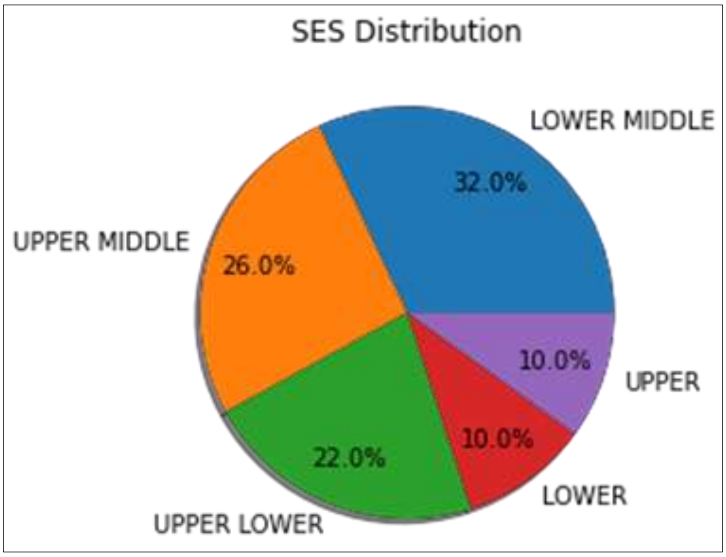

Fig 2: Socio Economic Distribution of cases

In a study of 50 cases, the socio-economic distribution of the cases was as follows: The

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largest proportion, 32%, belonged to the lower middle class. This was followed by 26% of the cases associated with the upper middle class. The upper lower class comprised 22% of the cases. The remaining cases were evenly split between the upper and lower classes, with each accounting for 10% of the total cases.

Table 1: Trimester distribution of cases

Trimester	No of Cases	Percentage
Ill Trimester	39	78%
II Trimester	11	22%

Among the cases studied, there was a notable disparity in the distribution across pregnancy trimesters. A smaller portion, 22% of the cases, occurred during the second trimester. In contrast, the majority of cases, comprising 78%, were reported in the third trimester.

Table 2: Mean fetal kidney length at various gestational ages

Gestational age in weeks	FKL mean	FKL std.	Confidence interval
25	24.45	-	-
26	26.4	0.43	25.98 to 26.82
27	21.62	0.73	26.89 to 28.34
28	28.4	-	-
29	29.92	0.43	29.49 to 30.35
30	30.04	1.29	28.75 to 31.33
31	32.16	0.69	31.48 to 32.84
32	31.47	0.92	30.55 to 32.38
34	34.53	1.38	33.15 to 35.9
35	34.28	1.64	32.65 to 35.92
36	36.26	1.42	34.85 to 37.67
37	37.91	0.83	37.09 to 38.74
39	38.75	-	-

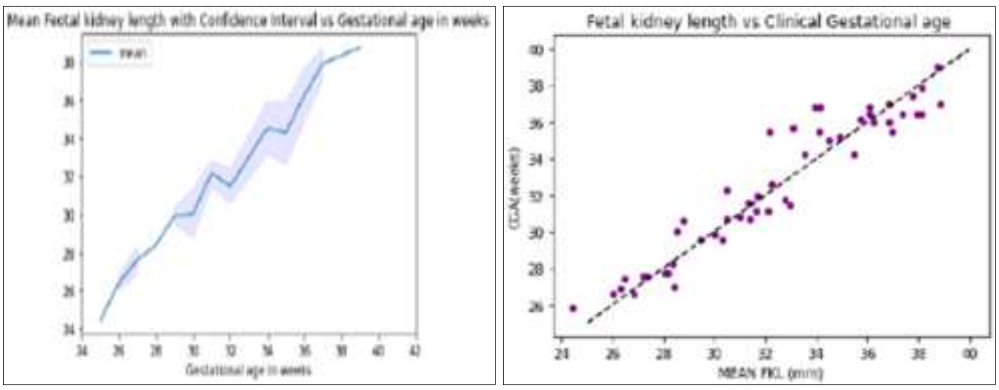

Fig 3:

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The table 2 presents a summary of femur-knee length (FKL) data across various gestational weeks, detailing the average lengths (mean) and their variability (standard deviation) where available. It also includes the confidence intervals for certain gestational ages, indicating the range within which the true average FKL is likely to fall.

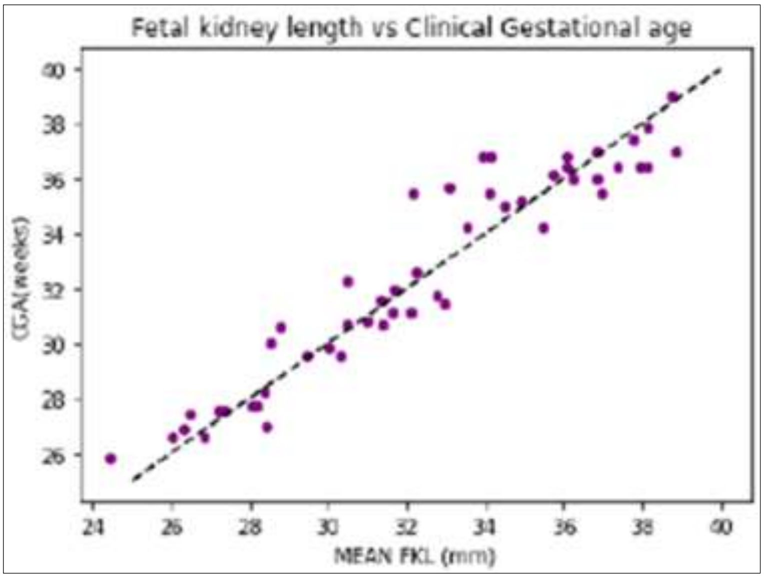

Fig 4: Biparietal diameter at various gestational age

The scatter plot suggests a strong positive correlation between two variables, as indicated by the trend of the data points and the upward slope of the line of best fit. While the majority of data points are closely aligned with this trend, indicating a consistent relationship, there are a few outliers that deviate from the pattern. The absence of axis labels and scales on the graph, however, prevents specific interpretations of the variables and their units. Overall, the graph indicates that as one variable increases, so does the other, with a few exceptions.

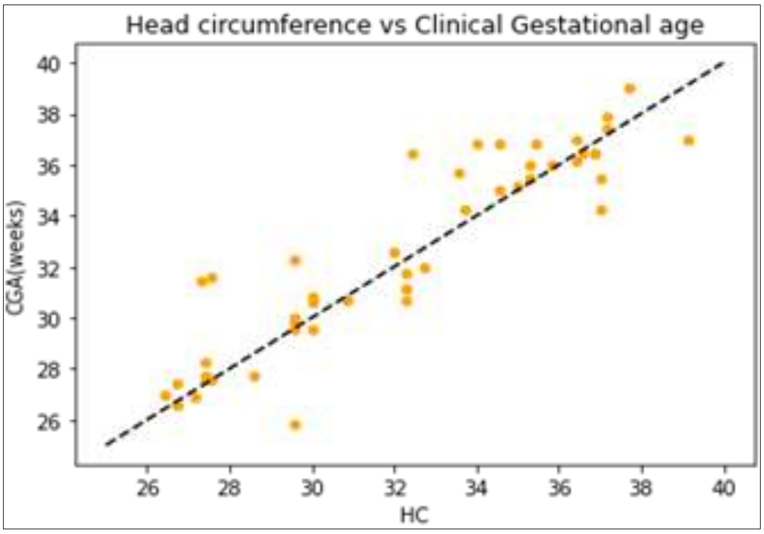

Fig 5: Head circumference at various Gestational age

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This scatter plot figure 5 features data points and a dashed regression line, indicating a positive linear relationship between two variables. The data points generally cluster around the line of best fit, suggesting a strong correlation. Despite the clear trend, some points stray from the line, highlighting variations not captured by the linear model. The plot lacks axis titles and scale, precluding specific interpretations about the data's nature and the precise relationship's strength. However, the pattern implies that as one variable increases, the other tends to increase as well, with occasional exceptions to this trend.

Table 3: FKL vs. BPD at various Gestational ages

Gestational age in weeks	FKL mean	FKL std.	BPD mean	BPD std.
25	24.45	-	26.57	-
26	26 4	0 43	26.9	0 73
27	27 62	0 73	27.79	0 97
28	28 4	-	29.14	-
29	29.92	0.43	29.52	1.21
30	30.04	1.29	30.86	1.82
31	32.16	0 69	3149	1.36
32	31 47	-	31.38	1 67
34	34 53	138	34.14	1 21
35	34 28	164	34.07	186
36	36.26	1.42	35.59	0.81
37	37.91	0.83	36.93	1.11
39	38.75	-	37.71	-

The table 3 presents means measurements for femur-knee length (FKL) and biparietal diameter (BPD) across various gestational weeks, along with the standard deviations for these measurements when available. The data shows a general trend of increasing mean values for both FKL and BPD as gestational age progresses, indicative of fetal growth.

Discussion

High-resolution real-time ultrasonography has significantly improved the imaging of fetal organs in utero, offering a valuable tool in prenatal care. However, it’s precision in determining fetal age wanes during the third trimester due to considerable variability in biometric measurements. Fetal growth rates can vary widely, influenced by genetic and other factors, which complicates the estimation of gestational age based on size measurements [10].

For women who initiate prenatal care later in pregnancy or for those uncertain of their last menstrual period, estimating the gestational age becomes more difficult. Consequently, there is a pressing need for a method that is simple, easy to administer, and consistent. The age distribution of the cases reveals a predominance of younger women, with half of the cases occurring in the 21 to 25-year age bracket. This trend

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suggests that younger women are either more likely to be part of the study population or more susceptible to the condition being studied (Figure 1). Studies have shown that maternal age can be a significant factor in various pregnancy outcomes, affecting both the mother and the fetus [11].

The socio-economic distribution highlights that a substantial number of cases (32%) belong to the lower middle class, which may reflect the accessibility of the study to this socio-economic group or indicate a higher prevalence of the condition among them. The upper middle class follows this with 26% of cases, and the upper lower class with 22%. The balanced distribution of the remaining cases between the upper and lower classes suggests that the condition being studied does not disproportionately affect one economic class over another [12].

When looking at pregnancy trimesters, a vast majority (78%) of cases occur in the third trimester, which could imply a heightened vulnerability or the emergence of detectable symptoms of the condition being studied during this stage of pregnancy. The second trimester accounts for only 22% of cases, which could suggest a different pattern of occurrence or detection of the condition in the earlier stages of pregnancy [13].

The FKL data presented in table 2 indicates that as gestational week's increase, so does the mean FKL, which is consistent with expected fetal growth patterns. However, the standard deviations and provided confidence intervals reflect some variability in fetal sizes, which could be relevant for assessing the accuracy of FKL as a measure for gestational age [14].

The scatter plot analysis suggests a strong positive correlation between two variables (Figure 4). Despite the lack of axis labels and scale which limits a detailed interpretation, the general trend implies a consistent and strong relationship, albeit with some outliers. These outliers highlight that while there is a general trend, individual cases may deviate due to factors not captured by the linear model.

Table 3 extends the analysis to include BPD measurements, which, like FKL, also show a trend of increasing mean values with gestational age. This consistency between FKL and BPD measurements reinforces the reliability of ultrasound biometry as a method for monitoring fetal growth [15].

In conclusion, the study presents comprehensive data across multiple variables, demonstrating the multifaceted approach required for thorough prenatal assessment. The consistency in fetal growth measurements through FKL and BPD, alongside the socio-economic and age distributions, offers insight into the factors that may influence the condition being studied. These findings underscore the importance of considering a broad range of factors when interpreting medical data and its implications for patient care. Future research should continue to explore the interplay between these variables to further refine the management of pregnancy and improve outcomes for both mothers and their babies.

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