# Comparison and Accuracy of Gestational Age Between Femur Length and Foetal Kidney Length in Third Trimester of Pregnancy

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**Abstract:-** **Accurate knowledge of gestational age is critical for obstetric provision and neonatal care. The estimation of gestational age (GA) from menstrual history is done using Naegele's rule and it is the method that is universally used. Femur is the longest bone, least movable and easily imageable from second trimester to delivery, so used as routine parameter for estimation of gestational age.**

**Additional parameters can provide a more 'universal view' of foetal development than any single measurement. So Fetal kidney length was measured by ultrasonography to determine Gestational Age.**

**The aim of study was to  measure foetal  kidney length for evaluation of gestational age by ultrasonography and to compare assessment of gestational age between Femur length and Foetal kidney length in third trimester (26-40 weeks) of pregnancy.**

**Study was conducted in Department of Anatomy, OBGY and Radiology of DYPU, Navi Mumbai.  300 normal sonographs of antenatal women of  third  trimester of pregnancy from 26-40 weeks were studied.  Femur Length (FL) and Kidney Length (FKL) of foetus  was measured by ultrasonography. Collected data was analyzed by SPSS.**

**Result showed Foetal kidney length GA was strongly correlated with Femur Length GA and LMP GA.**

**Keywords:-** *Last Menstrual Period (LMP), Gestational Age(GA).*

## I.    INTRODUCTION

The best treatment and care of pregnant women is often depending upon gestational age (GA).  An average normal gestational age, which is the length of the pregnancy, is approximately 40 weeks, with a normal range of 38-42 weeks. In 1958, Sir Ian Donald took the landmark step in implementing ultrasound (USG) for obstetric scan. [1]

Ultrasound in medicine offers vital information about fetal anatomy, physiology, growth and well-being [2]. Nowadays ultrasonographic foetal biometry is the most wide spread method used to establish gestation age and monitor its growth.[3] Ultrasonographic fetal biometry is highly reliable in first and second trimester of pregnancy but reliability of any ultrasound method greatly 2 diminishes as gestation advances . [4]

Errors in determining the exact GA may interfere with critical management decisions, such as in preterm labor as well as growth disorders that is considered the leading cause of neonatal morbidity and mortality. [5]

In most of the cases, the date of the last normal menstrual period is not known or there may be history of irregular menstrual cycles or may be on contraceptives and in such a case, estimation of GA becomes difficult, hence the estimation of GA by various parameters measured on ultrasonography will be very much useful.

In third trimester, reliability of any single ultrasound parameter is poor which is shown in many studies. [6,7] Proper assessment of the foetal well-being requires an accurate knowledge of gestational age of the foetus. Now days Ultrasound gives a more objectives evidence of gestational age. No single parameter is sufficient in giving accurate fetal age ultrasonographically.

In the present study Fetal Kidneys Length (FKL) was measured sonographically during third trimester of pregnancy. Kidney length is one of the nontraditional parameters for estimating GA under study. The correlation and significance of this parameter with gestational age assessed by Last Menstrual Period (LMP) and Femur Length which determine the accuracy of gestational age assessed by Fetal kidney length by ultrasonography method in third trimester.

➢ **Aims And Objectives :**
● To measure the Kidney Length of fetus for evaluation of gestational age by ultrasonography.
● To compare assessment of gestational age between Femur length and Foetal Kidney Length in third trimester (26-40 weeks) using first day of last menstrual period for actual period of gestation.

## II. MATERIAL AND METHODS

This prospective cross-sectional study was carried out in the Department of Anatomy and in the Department of Radiology at Dr. D.Y. Patil School of Medicine, Navi Mumbai, Maharashtra. The study was approved from the Institutional Ethical Committee. Study included 300 normal antenatal women of age group between 20-30 yrs.

➢ *Inclusion Criteria for the Study :*
● Women with regular menstrual cycle, Known LMP date, Singleton gestation, Gestational age between $26^{th}$ to $40^{th}$ weeks.
● Patients whose gestational age were confirmed by early ultrasound (<12 weeks).

➢ *Exclusion Criteria :*
● Irregular menstrual cycles, Multiple gestation, Suspected fetal anomalies, Intrauterine growth Retardation (IUGR), Oligohydramnios, Polyhydramnios, Diabetes, Hypertension

➢ *Study Procedure -*
During the study first an informed consent was taken from each the pregnant women who full fill inclusive criteria. PNDT form was obtained from all the patients. Patients Name, Age, Address, Weight of the Patient, Blood pressure, medical history of patient, date of Last Menstrual Period, Date of urine pregnancy test, Pregnancy confirmation date, GA by LMP, First trimester scanning date, Gestational age by first scanning were confirmed from patients as well as from PNDT form.

Mindray DC -7 real time ultrasound machine was used for ultrasound measurements by linear array transducer with frequency 3.5 to 5 Hz.

The subjects were scanned with a moderately distended bladder in supine position.

*Fetal Femur Length* - The transverse section of the fetal abdomen is found and the transducer should be slide caudally until the iliac bones are visualized. At this point, a cross section of the femur is usually seen.[8] Femur Length was measured in a plane where the full femoral diaphysis was seen almost parallel to the transducer. The calipers are placed along the diaphyseal shaft excluding the epiphysis.

*Foetal Kidney Length* - Both Right and Left Foetal Kidney Length was measured on the coronal or sagittal views from upper to lower pole. All Measurements were performed by single sonologist to minimize the errors.
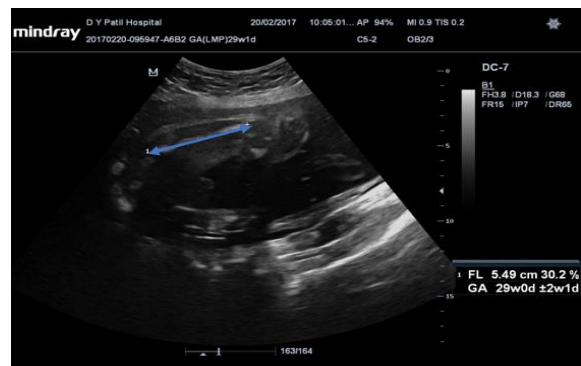

*Fig No.1: Femur Length*


*Fig No. 2 : Fetal Kidney Length*

Predictive gestational age from Femur length was assessed by Hadlock's formula. Gestational age was assessed from the USG machine, the software of which used Hadlock's formula to calculate gestational age. [9]

Collected data was entered in the SPSS software and the analysis of the data and Microsoft Word and Excel have been used to generate graphs etc.

For observation in interval of two weeks group were observed and result was obtained.

➢ *Observations :*
From 26-40 weeks, group were formed with two weeks interval. i.e., 26-28 weeks, 29-31 weeks, 32-34 weeks, 35-37 weeks, and 38-40 weeks. The mean values of Femur Length in

cm and Foetal Kidney Length in mm. along with respective Standard Deviation (SD) were calculated for each group.

*Table No. 1 :- Mean and Standard Deviation (SD) of FKL and FL in different groups of weeks.*

| GA in Weeks | Foetal Kidney Length (FKL) mm | | Femur Length (FL) cm | | P-value |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | |
| **26-28** | 27.92 | 1.30 | 5.04 | 0.36 | 0.002 |
| **29-31** | 30.27 | 2.06 | 6.54 | 0.21 | 0.001 |
| **32-34** | 33.86 | 1.32 | 6.54 | 0.21 | 0.002 |
| **35-37** | 36.02 | 1.21 | 7.10 | 0.26 | 0.000 |
| **38-40** | 38.60 | 1.23 | 7.62 | 0.16 | 0.000 |

Mean values of Foetal Kidney Length showed as gestational age (GA) increases kidney length also progresses in each group of week 27.92 mm, 30.27 mm, 33.86 mm, 36.02 mm, 38.60 mm respectively.

SD and P- value was calculated for each parameter. P-value for each parameter showed highly significant. The correlation and regression analysis has been carried out to quantify the relationship between gestational age in weeks and femur length in cm.

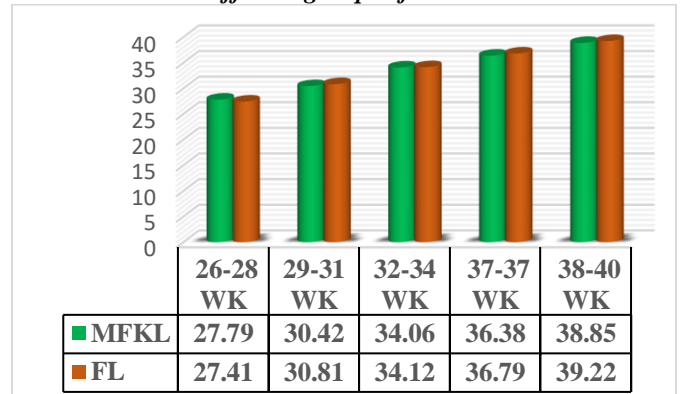*Table No. 2 :- Mean and Standard Deviation (SD) of FKL GA and FL GA and LMP GA in different groups of weeks.*

| GA in Weeks | | 26-28 | 29-31 | 32-34 | 35-37 | 38-40 |
|---|---|---|---|---|---|---|
| **FKL GA** | Mean | 27.79 | 30.42 | 34.06 | 36.38 | 38.85 |
| | SD | 1.11 | 1.18 | 1.08 | 1.00 | 0.91 |
| **FL GA** | Mean | 27.41 | 30.81 | 34.12 | 36.79 | 39.22 |
| | SD | 1.33 | 1.87 | 0.87 | 1.11 | 0.76 |
| **LMP GA** | Mean | 27.83 | 30.53 | 34.05 | 36.76 | 39.13 |
| | SD | 1.60 | 1.39 | 1.44 | 1.43 | 1.28 |
| **T– Value** | | 74.28 | 85.82 | 189.55 | 299.10 | 261.46 |
| **P– value** | | 0.002 | 0.001 | 0.000 | 0.000 | 0.000 |

Table showed the Mean and SD values of Gestational Age derived from FL, LMP GA by Naegele's rule and FKL derived from linear regression in different groups of Gestational Age.
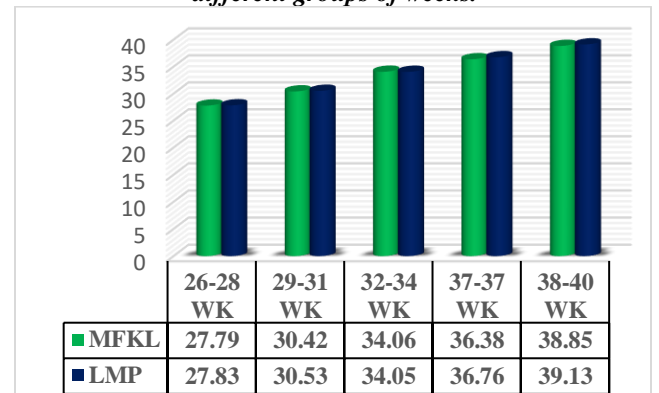
- In 26 - 28 weeks of GA, Mean Gestational Age by FL – 27.41, by LMP – 27.83, and by MFKL it was 27.79 weeks.
- In 29 - 31 weeks of GA, Mean Gestational Age by FL – 30.81, by LMP – 30.53, and by MFKL it was 30.42 weeks.
- In 32 - 34 weeks of GA, Mean Gestational Age by FL – 34.12, by LMP – 34.05, and by MFKL it was 34.06 weeks.
- In 35 - 37 weeks of GA, Mean Gestational Age of FL – 36.79, by LMP – 36.76, and by MFKL it was 36.38 weeks.
- In 38 - 40 weeks of GA, Mean Gestational Age of FL – 39.22, by LMP – 39.13 and by MFKL it was 38.85 weeks.

SD, T-value and P- value was calculated for each parameter. P-value showed highly significant.

*Graph No. 1 :- Correlation of MFKL GA and FL GA in different groups of weeks.*



| | 26-28 WK | 29-31 WK | 32-34 WK | 37-37 WK | 38-40 WK |
|---|---|---|---|---|---|
| ■ MFKL | 27.79 | 30.42 | 34.06 | 36.38 | 38.85 |
| ■ FL | 27.41 | 30.81 | 34.12 | 36.79 | 39.22 |

*Graph No. 2:- Correlation of MFKL GA and LMP GA in different groups of weeks.*



| | 26-28 WK | 29-31 WK | 32-34 WK | 37-37 WK | 38-40 WK |
|---|---|---|---|---|---|
| ■ MFKL | 27.79 | 30.42 | 34.06 | 36.38 | 38.85 |
| ■ LMP | 27.83 | 30.53 | 34.05 | 36.76 | 39.13 |

## III. RESULTS

*Table No. 3: Pearson Correlation and Linear Regression of FKL GA with FL GA and LMP GA In Third trimester.*

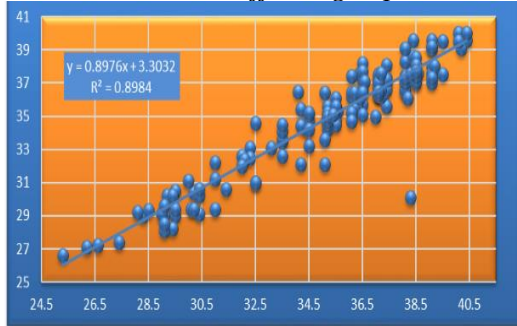| Pair | Pearson correlation (r) | $R^2$ | SE p Days |
|---|---|---|---|
| FKL GA – FL GA | 0.9478 | 0.8983 | ± 7.2 |
| FKL GA – LMP GA | 0.9692 | 0.9394 | ± 5.6 |

The table showed Pearson correlation and Linear regression between FKL GA – FL GA showed $R^2$ - 0.8983 with SE p ± 7.2 Days, and FKL GA – LMP GA showed $R^2$ - 0.9394 with SE p ± 5.6 Days.
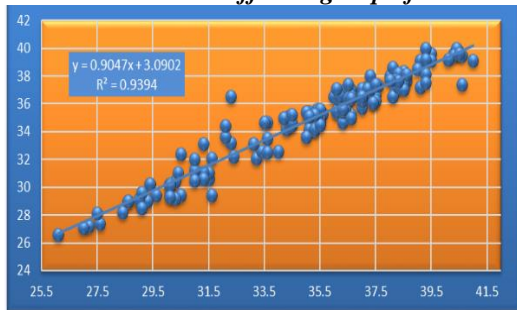
So, the Foetal Kidney Length (FKL) Gestational Age found to give more correct assessment of gestational age compare to the Femur Length (FL) assessment.

Monalisa *et al.* concluded that Linear regression equation showed kidney length could predict gestational age with an accuracy ±9.048 days.[5]

**Graph No. 3:- Correlation and Linear Regression of FKL GA and FL GA in different group of weeks**



**Graph No.4:- Correlation and Linear Regression of FKL GA and LMP GA in different group of weeks.**



## IV. DISCUSSION

The safe obstetric practice depends on the valid prediction of gestational age as it is the key for successful ante partum care and critical interpretation of antenatal diagnostic tests and successful planning of intervention. [3]

Campbell et al. demonstrated that 45% of pregnant women are uncertain of menstrual dates as a result of poor recall, irregular cycles, bleeding in early pregnancy, or oral contraceptive use within 2 months of conception. [10,11]

Sonographic biometric measurements are the most extensively used method for estimation of fetal size and gestational age. [9] Fetal biometry in the third trimester is subject to much greater individual size variations than in the second trimester. [4]

Femur Length is most commonly used ultrasound parameter and standard method of gestational age assessment as compared to other parameters like Biparietal Diameter (BPD), Abdominal Circumference (AC), and Head Circumference (HC) .

The problems with the BPD measurements after 24 weeks are those of technical problems. In cases where head is dolichocephalic of brachycephalic the measurements are not reliable. The technical problems are encountered when the head is direct occipito- posterior or direct occipito anterior and when the head has entered the maternal pelvis (which occurs around 36 weeks in most of the primigravida's). [12]

**Table No.4 :- Comparison of r- value of FL GA - LMP GA of present study with other studies.**

| Pair | Present Study | Nagesh R et al (2016) | Dr. K. Ephraim Vikram Rao (2022) |
|---|---|---|---|
| FL GA - LMP GA | 0.9478 | 0.995 | 0.965 |

The accuracy of femur length in assessment of gestational age decreased from second trimester to third trimester which was in agreement to Macgregor SN et al also quoted that Hadlock et al and Jeanty P et al found accuracy of gestational age prediction based on FL is greatest in the second trimester and least near term. [13,14]

Determining diaphyseal lengths of femur may be helpful in the diagnosis of abnormalities; shortened and abnormal long bones are seen in skeletal dysplasia's and intrauterine growth retardations. [15]

The present study found the need of fetal charts that were specific for individual population and ethnic group to determine gestational age and to improve antenatal care.

During first trimester kidneys appear as hyperechoic oval structure at both side of spine. This echogenicity progressively decreases. simultaneously with decrease echogenicity corticomedullary differentiation will appear around 14 to 15 weeks. It is always clearly seen after 18 weeks of GA. Growth of the fetal kidneys can be evaluated throughout pregnancy.

Simple sonographic method, i.e., measurement of the kidney length, can detect a diagnosis of renal abnormality as early as gestational weeks. Greater congenital anomalies of kidney, for example, infantile polycystic kidney disease, bilateral agenesis, fetal hydronephrosis etc., could be found by prenatal ultrasound observation. [14]

Gonzales J. et al.1976 studied the growth rate of the kidney both in length and width during last three months of pregnancy. This is the first study to correlate fetal kidney parameters with gestational age. Result showed that size and weight of fetal kidney increase with increase with pregnancy progresses. [16]

Bertagnoli L. et al. in 1983, 280 pregnant women were studied. Study concluded that fetal kidney measurements can be used as an additional parameter in the routine antenatal

assessment of fetal well-being and to rule out anomalies of kidney characterized by changes in kidney size.[17]

In present study we used Femur length for comparison with Foetal kidney length.

The comparative study of Foetal kidney length GA and Femur Length GA in third trimester provides validation of the performance of a retrospectively established Foetal kidney length nomogram regarding gestational age.

## V. CONCLUSION

Determination of gestational age by using Foetal Kidney Length (FKL) is more accurate and reliable method than Femur length in third trimester of pregnancy. So can be used as a tool to assist in the assessment of gestational age in third trimester.

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