DOI: 10.7860/JCDR/2023/66393.18526

Foetal Kidney Length as a Criterion for Gestational Age Estimation

DHARMESH PATEL[1], KAMLESH CHAUDHARI[2], NAINITA PATEL[3], AISHWARYA GUPTA[4], JYOTSNA GARAPATI[5]

ABSTRACT

Gestational Age (GA) is important because it helps guide prenatal care. The foetus plays a pivotal role in assessing its progress and establishing the anticipated delivery date. As GA increases, standard biometric markers like biparietal diameter, head circumference, and foetal length become less accurate, making accurate determination of Foetal Gestational Age (FGA) a significant barrier for patient care. The accuracy of Foetal Kidney Length (FKL) in predicting FGA in the third trimester has been established in several populations. The growth of foetal kidneys is linear with GA, and they are easily identifiable around 18 weeks, following the mid-trimester. The present paper discusses various related research, including the relationship between GA and the length of the foetal kidney.

Keywords: Antenatal care, Biometric markers, Delivery, Foetus, Kidney length, Pregnancy

INTRODUCTION

The GA is important in all pregnancies to provide the standard of care medical management for both mother and foetus and for epidemiological purposes. An accurate Estimated Gestational Age (EGA) and accompanying Expected Delivery Date (EDD) are crucial tools for managing pregnancy. The acquisition of this tool serves as the foundation for an impartial evaluation of foetal growth over the course of pregnancy [1].

There are various methods of estimating GA, such as dating based on the Last Menstrual Period (LMP), ultrasound-based dating, and neonatal estimates. However, FKL has been studied and shown to strongly correlate with GA in late trimesters, even in Intrauterine Growth Restriction (IUGR) foetuses. After 26 weeks of pregnancy, the reliability of Biparietal Diameter (BPD) measurement gradually declines. However, between the 12th and 26th weeks, BPD has been demonstrated to be able to anticipate GA within 6-11 days. Similar to Foetal Length (FL), Abdominal Circumference (AC), and Head Circumference (HC), it has also been noted that these measurements become less accurate after the second trimester [2-6].

The estimation of FKL was found to be more precise than the recognised foetal biometric indices (BPD, HC, FL, and AC) in assessing GA during the 24th and 38th weeks of pregnancy. At the 20th week of pregnancy, the foetal kidneys are visible in roughly 95% of cases, and they typically lie on each side of the foetal spine. Except for those that impede the urinary system, they are not affected by foetal growth defects [7].

Beyond the second trimester, several of the standard ultrasonographic markers now in use for determining GA become progressively less accurate. It is essential for obstetricians and paediatricians to accurately determine EGA, particularly in high-risk pregnancies. There are two trustworthy ways to measure the foetal kidney: transvaginal sonography, which can be performed between 14 and 17 weeks of pregnancy, and transabdominal Ultrasound Scan (USS), which can be used from 18 weeks of gestation and above. Craniocaudal length is often preferred over anteroposterior length in foetal kidney measurement because it provides a more accurate representation of the kidney's size and avoids potential variations due to the angle of ultrasound imaging. Craniocaudal length is measured along the longest axis of the kidney, minimising errors caused by the angle at which the ultrasound beam intersects the kidney. This helps ensure more consistent and reliable measurement of foetal kidney size [8].

The FKL accuracy in predicting FGA in the third trimester has been verified in different populations. The present paper discusses the studies done on the relationship between FKL and GA, as well as the accuracy of FKL in the late trimesters.

DISCUSSION

The diagnosis of foetal development problems and the timing of elective delivery depend on a correct GA, as failing to do so could result in iatrogenic preterm or postmaturity, both of which have associated perinatal morbidity and mortality. Many pregnant women who seek prenatal care are unable to pinpoint when their LMP occurred [9].

A cross-sectional study was conducted by Akintomide AO and Efanga SA, in August 2021 to October 2021, including 236 healthy pregnant women between the 20th and 34th week of gestation, to evaluate the correlation between FKL and estimated GA. They evaluated the right foetal kidney using a transabdominal approach after identifying its anatomical landmark. Additionally, HC and FL values were also assessed using routine obstetrics scan, and GA was identified from the routine parameters. They noted that FKL grew linearly with GA and demonstrated a positive connection between EGA and FKL, similar to that of the conventional routine biometry measures [10]. Furthermore, FKL is unaffected by factors that limit foetal growth and is, therefore, a reliable indicator of GA [11].

A cross-sectional study of foetal renal kidneys was carried out by Edevbie JP and Akhigbe AO in the year 2018 between May and October, including 400 pregnant women from the 20th week of gestation who had regular menses and were certain of their LMP. They used ultrasound to sonographically estimate the length of both foetuses' kidneys and compared the results with other traditional biometric approaches (BPD, HC, FL, and AC). They discovered a notable positive association between the Mean Kidney Length (MKL) in millimetres and GA in weeks [12]. However, the study found no discernible relationship between maternal height and FKL. MKL, according to some other studies, is the most reliable single indicator for forecasting GA [13-15].

In a descriptive cross-sectional study performed by Kiridi EK et al., in the year 2022 between March to August in South Nigeria, including 423 pregnant women between the 20th to 40th weeks of pregnancy, the correlation between GA and FKL in an uncomplicated pregnancy was evaluated. Right and left foetal kidneys were seen on transabdominal ultrasound. Additionally, they exemplified a statistically notable close association between maternal height and FKL and a remarkable correlation between GA and renal dimensions of the foetus. However, no statistically significant link between maternal weight and FKL was seen. Their research showed a linear rise in FKL with rising GA [16].

Abonyi EO et al., including 534 pregnant women, performed a cross-sectional study in Nigeria between 20 to 40 weeks of pregnancy to ascertain the GA using Kidney Length (KL). The lengths of the right and left kidneys, as well as their circumferences, along with other biometric indices, were calculated. Both KL increased with the increase in GA. Their research also demonstrated that, despite growth fluctuations affecting the embryonic kidney size, the transverse and anterior-posterior diameters of the foetal kidney remain essentially unaffected [17]. Their research supports the discovery by Karim SH et al., that the left-side kidney is marginally longer than the right-side [18]. The foetal length showed strong agreement and reproducibility of measurements, as evidenced by the exquisite intra- and interclass correlation coefficient mentioned in the study.

To assess the GA using FKL, Joshi BR et al., conducted a prospective cross-sectional study on 108 pregnant women between the 20th week of pregnancy and term pregnancies. The whole length of the kidney, along with the renal pelvis, was visualised in the sagittal plane, and the length of the foetal kidney was measured. They discovered a linear association between kidney growth and the late second and third trimesters. No significant difference was seen between the lengths of the right and left kidneys [19].

The intent of the study by Konje JC et al., was to ascertain the accuracy of KL measurement as a method to analyse GA between the 24th and 38th weeks of pregnancy and compare it with other biometric markers. During 24 to 38 weeks gestation, 73 pregnant women with singletons and uncomplicated pregnancies received ultrasonography for foetal biometry and KL measurements every two weeks. These measurements, based on crown-rump length dated between 8 and 10 weeks, were used to determine the pregnancies. Linear regression models for EGA were created using the biometric indicators and KL. Step-wise regression models were also built to find the best model for determining GA between 24 and 38 weeks, and the reliability of these models in determining GA was compared. They concluded that KL is a more precise method than foetal biometric indicators for predicting GA [20].

Ghaleb MM et al., included 115 pregnant women in their last trimester. The intent of the study was to determine the reliability of GA estimated by mean FKL compared to multiple growth parameters. Additionally, this study discovered a significant link between GA as determined by LMP and GA as determined by BPD, HC, AC, FL, and KL, with KL showing the most positive correlation. Additionally, this study discovered that KL and GA did not significantly differ from each other compared to other criteria [21].

Akram MS et al., conducted a cross-sectional study on 399 pregnant women carrying singletons to determine the importance of FKL for EGA. FKL calculations were made between weeks 20 and 38 of gestation, and the pregnancies were identified based on these measures. They found a positive correlation between the length of the left kidney and GA, and a statistically significant positive linear connection between the length of the right kidney (determined by femur length) and GA. Maternal age and parity status did not have any impact on how FKL calculates GA. There was no discernible variation in the GA estimate whether the right or left kidney was used for estimation. The study concluded that FKL can accurately determine GA when LMP is uncertain and other parameters cannot be used [7].

After determining the GA by LMP, Gayam S et al., conducted a one-year cross-sectional and observational study on 171 pregnant women in their last trimester. Measurements of the foetal kidney's length were made using ultrasound, and their relationships to other parameters (BPD, HC, AC, and FL) and GA were assessed. The study revealed that MKL had a better link with GA by LMP than the other parameters, with a p-value of 0.001 for each parameter [22]. [Table/Fig-1] shows the studies included [10,12,17,19,21,22-24].

A study conducted by Shaheen W et al., included 371 healthy pregnant women with healthy foetuses. Ultrasound measurements of the length of both foetal kidneys were performed along with the usual biometric measures. The study found a strong correlation between KL and GA in the late second and third trimesters, either alone or in combination with other criteria [25].

Osho ES et al., conducted a cross-sectional study in Nigeria with 470 expectant mothers in the third trimester to assess the degree of relationship between foetal kidney measures and GA. FKL, FKAPD,

Author name	Year/Place of study and No. of pregnant women	Findings	Mean Kidney Length (MKL) for different Gestational Ages (GA)
Akintomide AO and Efanga SA, [10]	2021/ Nigeria, 236 women	FKL is a reliable indicator for estimating GA	Right kidney 2.04±0.38 cm at 20 weeks of gestation to 4.57±0.26 cm at 40 weeks of gestation, left kidney from 2.10±0.37 cm at 20 weeks of gestation to 4.75±0.29 cm at 40 weeks of gestation
Edevbie JP and Akhigbe AO [12]	2018/Nigeria, 400 women	Mean left Kidney Length (KL) more then right, notable indicator for GA	Mean range of 20.87±0.75 mm to 41.41±0.07 mm from 20 to 41 weeks of gestation
Joshi BR et al., [19]	2021/Nepal, 108 women	Notable correlation amidst GA and FKL, No notable difference amidst length of left and right kidney	Mean FKL at 20-24, 25-29, 30-34 and 35-37 weeks gestation as 22.5±0.5, 26.9±0.7, 32.32±0.7 and 36.3±0.6, respectively
Abonyi EO et al., [17].	2019/Nigeria, 534 women	Left Kidney Length (KL) more than right-side; positive correlation amidst GA and FKL	Right FKL range: 2.04±0.38 cm, 4.57±0.26 cm at 20, 40 weeks of gestation; left FKL range: 2.10±0.37 cm, 4.75±0.29 cm at 20. 40 weeks of gestation, respectively
Gayam S et al., [22]	2018/India, 171 women	Mean Kidney Length (MKL) had a better link with GA by LMP	Mean kidney length (36.26-1.476) in weeks between 35 to 41 weeks of gestation
Ghaleb MM et al., [21]	2018/Egypt, 115 women	Highly significant positive correlation between gestational age and KL	Mean Kidney Length (MKL); 35.19±3.36 between 28 to 41 weeks of gestation
Chatterjee S et al., [23]	India/2015-16, 100 women	Kidney Length (KL) can be used as an individual parameter in Estimating Gestational Age (EGA), especially in later trimesters	Mean Kidney Length (MKL) was ranging from 28.00 to 40 mm between 28 to 40 weeks of gestation
Bardhan J et al., [24]	India/2015-16, 200 women	Foetal Kidney Length (FKL) shows a positive correlation with foetal Gestational Age (GA), with a linear growth rate throughout pregnancy	Mean Kidney Length (MKL) ranging from 18.15-39.15 between 18 to 39 weeks of gestation

[Table/Fig-1]: Studies on Foetal Kidney Length (FKL) and Gestational Age (GA) [10,12,17,19,21,22-24].

and transverse diameter were measured in addition to the standard biometric data. Foetal renal parameters in the third trimester had a stronger correlation with GA compared to normal biometric markers, with FKL and GA being the most closely linked among the renal variables [26].

A total of 60 pregnant women between 24 and 36 weeks of gestation participated in a study by Shivalingaiah N et al., to assess the significance of KL in EGA. Along with other biometric indicators, the length of the closer kidney was measured four times per week in the longitudinal axis. Their observations showed that KL had the lowest mean deviation from GA across all weeks, and there was a strong correlation between KL and the assigned GA in their study [27].

According to studies, FKL is more reliable than other biometric indices for measuring GA in the second half of pregnancy. In a study assessing the role of FKL in estimating GA in the late second and third trimesters, 98 singleton pregnant women had serial biometric and FKL assessments using ultrasonography at various gestational phases. They discovered that the left FKL was marginally, but significantly, longer than the right FKL at each gestational phase. FK had the lowest average error in predicting GA [15,28].

Therefore, the findings of the aforementioned research support the proposal that FKL can be employed as a crucial sonographic criterion for precise foetal gestation age prediction. However, it is crucial to keep in mind that after 30 weeks, a single ultrasound test is not sufficient for establishing GA.

CONCLUSION(S)

The anteroposterior and transverse diameters of the kidneys appear to be most affected by growth differences, while the KL is less impacted. Therefore, KL serves as an appropriate foetal biometric parameter for estimating GA. FKL can be used as an additional reliable indicator for evaluating GA in women who are not sure of their LMP.

REFERENCES

[1] Committee Opinion No 700: Methods for estimating the due date. Obstet Gynecol. 2017;129(5):e150-54. Doi: 10.1097/AOG.0000000000002046.
[2] Hadlock FP, Deter RL, Harrist RB, Park SK. Fetal biparietal diameter: A critical re-evaluation of the relation to menstrual age by means of real-time ultrasound. J Ultrasound Med. 1982;1:97-104.
[3] Hadlock FP, Deter RL, Harrist RB, Park SK. Fetal head circumference: Relation to menstrual age. AJR Am J Roentgenol. 1982;138(4):649-53.
[4] O'Brien GD, Queenan JT, Campbell S. Assessment of gestational age in the second trimester by real-time ultrasound measurement of the femur length. Am J Obstet Gynecol. 1981;139(5):540-45.
[5] Hadlock FP, Deter RL, Harrist RB, Park SK. Fetal abdominal circumference as a predictor of menstrual age. AJR Am J Roentgenol. 1982;139(2):367-70.
[6] Hadlock FP, Harrist RB, Deter RL, Park SK. Fetal femur length as a predictor of menstrual age: Sonographically measured. AJR Am J Roentgenol. 1982;138(5):875-78.
[7] Akram MS, Yousaf M, Farooqi U, Arif N, Riaz A, Khalid M, et al. Estimation of gestational age from fetal kidney length in the second and third trimester of pregnancy by ultrasonography. Saudi J Med Pharm Sci. 2019;5:222-29.
[8] Zalel Y, Lotan D, Achiron R, Mashiach S, Gamzu R. The early development of the fetal kidney- an in utero sonographic evaluation between 13 and 22 weeks' gestation. Prenat Diagn. 2002;22(11):962-65. Doi: 10.1002/pd.436.
[9] Feresu SA, Gillespie BW, Sowers MF, Johnson TR, Welch K, Harlow SD, et al. Improving the assessment of gestational age in a Zimbabwean population. Int J Gynaecol Obstet. 2002;78(1):07-18.
[10] Akintomide AO, Efanga SA. Fetal kidney length: A likely sole index for gestational age determination in late pregnancy and certain abnormalities. Niger J Med. 2022;31(2):138-43.
[11] Dash RN, Satpathy G, Shankar G, Kumar BA. Determination of gestational age by fetal kidney measurements in pregnancy. Indian J Public Health Res Dev. 2020;11(8):116-21.
[12] Edevbie JP, Akhigbe AO. Ultrasound measurement of fetal kidney length in normal pregnancy and correlation with gestational age. Niger J Clin Pract. 2018;21(8):960-96.
[13] Kansaria JJ, Parulekar SV. Nomogram for Foetal Kidney Length. Bombay Hosp J. 2009;5151(2):155-62.
[14] Seilanian Toosi F, Rezaie-Delui H. Evaluation of the normal fetal kidney length and its correlation with gestational age. Acta Med Iran. 2013;51(5):303-06.
[15] Indu K, Vinay M, Amandeep KA, Renu G. Role of fetal kidney length in estimation of gestational age. JK Sci. 2012;14(2):65-69.
[16] Kiridi EK, Oriji PC, Briggs DC, Ugwoegbu JU, Okechukwu C, Adesina AD, et al. Ultrasound measurement of foetal kidney length during healthy pregnancy: Relationship with gestational age. Ethiop J Health Sci. 2023;33(1):97-106. Doi: 10.4314/ejhs.v33i1.13.
[17] Abonyi EO, Eze CU, Agwuna KK, Onwuzu WS. Sonographic estimation of gestational age from 20 to 40 weeks by fetal kidney lengths' measurements among pregnant women in Portharcourt, Nigeria. BMC Med Imaging. 2019;19:72. Doi: 10.1186/s12880-019-0371-z.
[18] Karim SH, Mohammed NA, Aghaways IAH, Muhammed BA. Comparative ultrasonographic measurement of renal size and its correlation with age, gender, and body mass index in normal subjects in Sulaimani region. Eur Sci J. 2015;11(12):236-50.
[19] Joshi BR, Chaurasia AK, Khanal UP. Determination of gestational age by fetal kidney length measurement after the 20th week in healthy women with uncomplicated pregnancy in tertiary care centre. J Nepal Paediatr Soc. 2021;41(3):380-86.
[20] Konje JC, Abrams KR, Bell SC, Taylor DJ. Determination of gestational age after the 24th week of gestation from fetal kidney length measurements. Ultrasound Obstet Gynecol. 2002;19(6):592-97. Doi: 10.1046/j.1469-0705.2002.00704.x. PMID: 12047540.
[21] Ghaleb MM, Shokri AI, El Sokkary MS, El Shourbagy MM. Role of ultrasonographic measurement of fetal kidney length in determination of gestational age during third trimester of pregnancy. Open J Obstet Gynecol. 2021;11(03):221.
[22] Gayam S, Geethavani M, Paul S. Fetal kidney length for determining gestational age in third trimester. Obs Rev J Obstet Gynecol. 2018;4(3):49-54. Doi: 10.17511/joog.2018.i03.02.
[23] Chatterjee S, Yadav K, Prakash P, Shekhawat K. Foetal kidney length as a parameter for determination of gestational age in pregnancy by ultrasonography. International J Reprod Contracept Obstet Gynecol. 2016;5(6):1949-53.
[24] Bardhan J, Ghosh SK, Sarkar KN, Sarkar M. Fetal kidney length as a parameter for gestational age determination and its comparative evaluation with other fetal biometric indices. IAIM. 2016;3(8):36-44.
[25] Shaheen W, Gilani SA, Hasan ZU, Fatima M, Bacha R, Malik SS. Ultrasonographic evaluation of fetal kidney length as a reliable parameter for estimation of gestation age in 2nd & 3rd trimester. Int J Appl Sci Biotechnol. 2019;7(1):108-13.
[26] Osho ES, Ibitoye BO, Adetiloye VA, Adeyemi AB, Aderibigbe AS, Omisore AD. Ultrasonic determination of gestational age by assessment of fetal kidney size in the third trimester in southwest Nigeria. Int J Gynaecol Obstet. 2019;144(3):271-76. Doi: 10.1002/ijgo.12758.
[27] Shivalingaiah N, Sowmya K, Ananya R, Kanmani TR, Marimuthu P. Fetal kidney length as a parameter for determination of gestational age in pregnancy. Int J Reprod Contracept Obstet Gynecol. 2014;3:424-27.
[28] Luther N, Patnaik VVG, Puri N, Mittal A. Role of fetal kidney length in estimation of gestational age. J Anat Soc India. 2016;65:S57. Doi: 10.1016/j.jasi.2016.08.186.

PARTICULARS OF CONTRIBUTORS:

1. Resident, Department of Obstetrics and Gynaecology, Jawaharlal Nehru Medical College, Datta Meghe Institute of Higher Education and Research, Wardha, Maharashtra, India.
2. Professor, Department of Obstetrics and Gynaecology, Jawaharlal Nehru Medical College, Datta Meghe Institute of Higher Education and Research, Wardha, Maharashtra, India.
3. Resident, Department of Obstetrics and Gynaecology, Jawaharlal Nehru Medical College, Datta Meghe Institute of Higher Education and Research, Wardha, Maharashtra, India.
4. Resident, Department of Obstetrics and Gynaecology, Jawaharlal Nehru Medical College, Datta Meghe Institute of Higher Education and Research, Wardha, Maharashtra, India.
5. Resident, Department of Obstetrics and Gynaecology, Jawaharlal Nehru Medical College, Datta Meghe Institute of Higher Education and Research, Wardha, Maharashtra, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Dharmesh Patel,
Resident, Department of Obstetrics and Gynaecology, Jawaharlal Nehru Medical College, Datta Meghe Institute of Higher Education and Research,
Wardha-442005, Maharashtra, India.
E-mail: dharmesh1303@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Jul 10, 2023
- Manual Googling: Aug 05, 2023
- iThenticate Software: Sep 02, 2023 (12%)

ETYMOLOGY: Author Origin

EMENDATIONS: 6

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? No
- Was informed consent obtained from the subjects involved in the study? No
- For any images presented appropriate consent has been obtained from the subjects. No

Date of Submission: **Jul 05, 2023**
Date of Peer Review: **Jul 21, 2023**
Date of Acceptance: **Sep 04, 2023**
Date of Publishing: **Oct 01, 2023**