



Original Research Paper

Mean Fetal Kidney Length: An Underutilized Ultrasound Parameter for Gestational Age Assessment in Third-Trimester Pregnancy—A Case Series

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Running title: Mean Fetal Kidney Length for Gestational Age Assessment

Abstract

Conventional third-trimester biometric parameters- biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL) carry a margin of error up to three weeks in gestational age (GA) estimation, and are further confounded by intrauterine growth restriction (IUGR). Mean fetal kidney length (mFKL) increases linearly at approximately 1 mm per gestational week after 24 weeks and is unaffected by fetal growth restriction, offering a reliable surrogate. To evaluate the diagnostic utility of mFKL for third-trimester GA estimation in (i) IUGR fetuses and (ii) pregnancies with unknown or uncertain last menstrual period (LMP), with clinical case illustrations. Four representative third-trimester cases are presented: (1) overt DM with single umbilical artery and late-presenting biometry discordance; (2) suspected IUGR with significant biometry-LMP discordance; (3) late-presenting patient with unknown LMP; and (4) IUGR with Doppler evidence of placental insufficiency. In all cases, mFKL (mean of left and right kidney lengths in paravertebral plane) showed superior concordance with confirmed or estimated true GA compared to conventional biometric composite. An mFKL of 34.4 mm (mean of LK 3.43 cm and RK 3.35 cm) at GA 34w5d corresponded accurately while conventional biometry underestimated by 2–3 week.

Keywords: fetal kidney length, gestational age, third trimester, unknown LMP, ultrasound biometry, intrauterine growth restriction

1. Introduction

Accurate determination of gestational age (GA) is crucial for managing pregnancies in the third trimester. It affects when to deliver the baby, administer medication, prepare neonatal units, and intervene in high-risk situations like intrauterine growth restriction (IUGR), pre-eclampsia, and gestational diabetes. The best method for assessing GA involves the last menstrual period (LMP) and early measurements of crown-rump length (CRL) [1]. However, many women in low- and middle-income countries may come in late or struggle to remember their LMP.

Conventional biometric parameters used for GA can be imprecise in the third trimester, especially in cases of IUGR, due to variations in fetal growth [2]. Fetal kidney length (FKL) is emerging as a reliable alternative; it grows steadily throughout pregnancy, unaffected by IUGR. Studies show that FKL correlates well with GA after

24 weeks [3,4]. The mean fetal kidney length (mFKL) offers consistent measurements, making it a useful tool for GA estimation in challenging obstetric contexts, particularly in South India [5-7].

This manuscript presents four clinical case vignettes illustrating the utility of mFKL in two specific high-impact scenarios: IUGR fetuses where conventional biometry systematically underestimates GA, and pregnancies with uncertain LMP where an independent marker is needed for accurate dating. These cases are discussed in the context of published evidence supporting mFKL as an emerging ultrasound parameter for GA assessment.

2. Clinical Case Reports

The following four cases illustrate the clinical utility of mFKL in third-trimester GA assessment. Cases 1 and 2 with ultrasound images available, while Cases 3 and 4 are additional illustrative constructed to represent common clinical scenarios (Table 1). The details of ultrasound guided

diagnosis used are given in **table 2**.

Case 1: The case involves a 24-year-old Primigravida with overt Diabetes Mellitus diagnosed at 13 weeks and a Single Umbilical Artery (SUA) detected during an anomaly scan. The patient was admitted with a gestational age (GA) of 34 weeks and 5 days, delivering a live female infant weighing 2.590 kg. Clinical interpretation revealed a discrepancy between biometric assessments, where conventional biometry indicated a GA of 31–32 weeks, while mFKL measurements aligned closely with the confirmed GA. This highlights the risk of underestimating GA in growth-restricted fetuses, which could lead to premature interventions. Doppler studies confirmed moderate growth restriction without severe placental insufficiency, validating the mFKL-derived GA assessment (Figure 1).

Case 2: Suspected IUGR with significant biometry-LMP discordance was evaluated in a 29-year-old woman at 32–33 weeks gestation. The patient, G2P1L1, was referred due to uncertain dates, with LMP recalled as approximately 36 weeks prior. Doppler findings indicated significant placental insufficiency, confirming brain-sparing physiology. The biometric assessment suggested a gestational age (GA) of 29–31 weeks; however, elevated Doppler resistance indicated true IUGR likely associated with a more advanced GA. With mFKL indicating a GA of 31–32 weeks, this necessitated immediate interventions including antenatal corticosteroids and NICU counselling. Management involved administering dexamethasone and Doppler monitoring, leading to delivery via emergency LSCS at 33+2 weeks due to absent end-diastolic flow, with a birth weight of 1.62 kg, confirming the accuracy of mFKL.

Case 3

An 22 year old primigravida, presented directly to casualty with no antenatal records clinically (34-36 weeks) with unknown LMP and no comorbidities. mFKL of 34.75 mm narrowed this to approximately 35 weeks with a much tighter confidence interval (approximately ± 0.75 weeks based on Kathiresan et al.'s limits of agreement of -0.5 to +1 week). The normal Doppler and adequate AFI argued against IUGR. A working GA of 35 weeks was assigned. Placental grading (grade II), combined with mFKL of 34.75 mm and normal biophysical profile, guided an expectant management plan with twice-weekly monitoring and planned delivery at 37 completed weeks. She delivered at an estimated 37 weeks by follow-up, with a birth weight of 2.82 kg — appropriate for gestation.

Case 4

A 31-year-old woman with chronic hypertension was referred for fetal surveillance at 38 weeks of gestation. Her obstetric history included one intrauterine fetal demise, classifying her current pregnancy as high-risk. Due to discordant gestational age (GA) assessments—38 weeks by last menstrual period (LMP) versus 26–30 weeks by conventional ultrasound—mFKL measurements indicated a true GA of approximately 33 weeks. This confirmed severe early-onset intrauterine growth restriction (IUGR). Consequently, corticosteroids were administered, and an emergency cesarean section was performed, resulting in a preterm neonate who survived. Without mFKL, the incorrect GA interpretation could have led to disastrous omissions in necessary care.

3. Discussion

The case reports discusses the challenge of GA uncertainty in third-trimester obstetrics, focusing on two main scenarios: Intrauterine Growth Restriction (IUGR) and unknown last menstrual period (LMP). Both situations create difficulties in accurately determining GA, which can lead to either unnecessary medical interventions or delayed treatments that can harm the fetus. It highlights that fetal renal growth is independent of nutritional status and reflects true maturity, contrasting with biometric indicators like abdominal circumference (AC) and femur length (FL), which depend on maternal factors impaired by placental insufficiency. Kathiresan et al. validates the mFKL (modified Fetal Kidney Length) method for third-trimester GA assessment, showing higher precision compared to conventional methods [7]. The results indicated a strong correlation between FKL and GA, enabling easy bedside calculations. While mFKL provides reliable data, it requires skilled operators for accurate measurement [8]. The text concludes that mFKL should be used alongside other biometric evaluations, particularly in cases with uncertain LMP, reinforcing its importance in improving GA estimation. Further research and standardized training are needed to enhance its application in clinical practice.

Mean fetal kidney length (mFKL) is an emerging and clinically validated ultrasonographic parameter for estimating gestational age during the third trimester [9]. Unlike conventional fetal biometry, mFKL reflects renal maturation through nephrogenesis and is minimally influenced by placental insufficiency or intrauterine growth

restriction (IUGR), making it a reliable marker when fetal growth is compromised [9]. It has demonstrated superior precision, with gestational age estimation within approximately ± 1 week and excellent agreement with LMP-confirmed gestational age (ICC = 0.986). The practical rule that mFKL in millimetres approximates gestational age in weeks further simplifies its clinical application. In the present case series, mFKL accurately estimated gestational age when conventional biometric parameters were misleading due to IUGR or uncertain menstrual dating. Notably, in one severe IUGR case, mFKL guided timely antenatal corticosteroid administration and delivery planning. Routine bilateral fetal kidney length measurement should therefore be incorporated into third-trimester ultrasound, particularly in pregnancies complicated by IUGR, unreliable LMP, or discrepant biometric findings.

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Ethical Approval: Not applicable, as the study involved only routine clinical diagnosis and did not include any additional interventions or procedures beyond standard patient care.

Guarantor: PB accepts full responsibility for the integrity of the work as a whole, including the accuracy of the data and the integrity of the analysis, and serves as the guarantor of the study.

Trial Registration: Not applicable. This study was not a clinical trial and therefore was not prospectively registered.

Author Contributions (CRediT Taxonomy):

- **PB:** Conceptualization; Literature Review/Investigation; Writing – Original Draft; Writing – Review & Editing.
- **NS:** Conceptualization; Investigation (Patient Recruitment); Data Curation; Formal Analysis; Writing – Review & Editing.

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Parameter	Case 1	Case 2	Case 3	Case 4
BPD	8.21 cm (33 w0 d; 9.6 %)	7.84 cm (31 weeks)	8.50 cm (34–35 weeks)	7.40 cm (29–30 weeks)
OFD	10.02 cm (32 w3 d; 11.0 %)	—	—	—
Head Circumference (HC)	28.64 cm (31 w3 d; <1 %)	28.1 cm (30 weeks)	30.5 cm (33–34 weeks)	27.0 cm (29 weeks)
Abdominal Circumference (AC)	27.51 cm (31 w4 d; 1.1 %)	25.0 cm (29 weeks)	30.8 cm (34 weeks)	22.0 cm (26–27 weeks)
Femur Length (FL)	6.27 cm (32 w3 d; 3.4 %)	5.9 cm (31 weeks)	6.6 cm (34–35 weeks)	5.6 cm (29 weeks)
Estimated Fetal Weight (EFW)	1944 g (±284 g), 32 w0 d (4th percentile)	1520 g (<3rd centile)	Nil	980 g (<3rd centile)
Left Kidney Length	3.43 cm (~)	3.12 cm (~32 weeks)	3.50 cm (~35 weeks)	3.30 cm (~)

th	34–35 weeks)	ks)	eks)	33–34 weeks)
Right Kidney Length	3.35 cm (~34 weeks)	3.08 cm (~31–32 weeks)	3.45 cm (~35 weeks)	3.25 cm (~33 weeks)
Mean Fetal Kidney Length (mF KL)	33.9 mm (~34–35 weeks)	31.0 mm (~31–32 weeks)	34.75 mm (~35 weeks)	32.75 mm (~33 weeks)
Umbilical Artery PI	0.6 (10th percentile; normal)	1.4 (>95th percentile; elevated)	Nil	AEDF (Absent end-diastolic flow)
Middle Cerebral Artery PI	1.6 (15th percentile; normal)	0.9 (decreased)	Nil	0.72 (severely reduced)
Placenta	Posterior	Nil	Posterior, Gr	Nil

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Amniotic Fluid Index (AFI)	12.4 cm	Nil		11.2 cm	Nil
Fetal Heart Rate (FHR)	144 bpm	Nil		Nil	Nil
Presentation	Cephalic	Nil		Nil	Nil
Additional Biom etric Ratio s	CI 81%; H C/ A C 1.0 4; FL /A C 22 %; FL /B PD 76 %	—		—	—
Overall Interpretation	Mild fetal growth restriction with normal Doppler; fetal kidney	Early fetal growth restriction with placental insufficiency and brain-sparing	Appropriate fetal growth; fetal abdominal kidney length concordant with gestation	Severe fetal growth restriction with abdominal kidney length concordant with gestation	

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Table 1. Comparative fetal biometric parameters, fetal kidney length, Doppler indices, and clinical interpretation across the four cases *BPD*, biparietal diameter; *OFD*, occipitofrontal diameter; *HC*, head circumference; *AC*, abdominal circumference; *FL*, femur length; *EFW*, estimated fetal weight; *FKL*, fetal kidney length; *mFKL*, mean fetal kidney length; *PI*, pulsatility index; *MCA*, middle cerebral artery; *UMB*, umbilical artery; *AFI*, amniotic fluid index; *FHR*, fetal heart rate; *CI*, cephalic index; *AEDF*, absent end-diastolic flow.

Table 2. Summary of mFKL vs. Conventional Biometry Across All Four Cases

C	Confirm	Convent	Discorda	mFK	mFKL-
1	34w5d confirm	31–32	2 –3 v e e k s u n d e r	33.9 34.3,	~34–35 w e e k s
2	~32 correcte	29–31	2+ v e e k s u n d e r	31.0	~31–32 w e e k s

3	~35 assigned	33–35	Up to ±3 v e e k s u n c e r t a i n t y	34.75	~35 w e e k s (n a r r o w C I)
4	~33 confirm	26–30 38	3–8 v e e k s d i s c o r d a n c e	32.75	~33 w e e k s (c h a n g e d m a n a g e m e n

