



SONOGRAPHIC ASSESMENT OF GESTATIONAL AGE BY THE FETAL KIDNEY LENGTH AND VOLUME AFTER 18 WEEKS OF GESTATION IN LOCAL POPULATION IN NORTH- WESTERN AHMEDABAD.

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ABSTRACT

Introduction: Ultrasonography is widely used in determination of GA from 2nd trimester onwards apart from routine parameters used for GA estimation like BPD, HC, and AC and FL, FKL is emerging as a useful parameter in estimation of GA more reliably. **Objective:** to define how precisely FKL measurement by USG can determine GA from 18 weeks onwards, to create baseline reference values of FKL in local population in north-western Ahmedabad from 18 weeks onwards to see population-specific variations. **Material and Methods:** A Cross-Sectional - observational study was conducted on 200 antenatal women in the second and third trimester with normal singleton pregnancies using SAMSUNG HS50 ultrasound machine. **Results:** The result suggests a positive linear relationship of GA with fetal kidney length. However, no correlation of GA with volume was noted. **Conclusion:** FKL measurement can be used as a reliable ultrasonographic parameter for estimating the GA in the 2nd and 3rd trimester and correlation increases when used with other parameters. Population-specific baseline reference values for north-west Ahmedabad of FKLs for the estimation of GA should be adopted rather than relying on the Caucasians values as universal patterns.

KEYWORDS : Fetal kidney length (FKL), Gestational age (GA), Biparietal diameter (BPD), Head Circumference (HC), Abdominal Circumference (AC), Femoral Length (FL).

INTRODUCTION

Assessment of accurate GA is very important for a gynaecologist for maternity care - to rule out growth disorders and for timing of delivery to decrease perinatal morbidity and mortality. Fetal biometry by USG is the most widely used method to establish GA due to its safety, reliability and reproducibility. Routine parameters from second trimester onwards used for GA determination are biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL)^{1,12}. To increase accuracy, growth-adjusted sonographic age and taking averages can be used. But studies show that with advanced pregnancy these parameters become unreliable in the accurate prediction of GA due to their limitations. Accurate GA assessment remains a challenge, particularly for a patient coming late for a treatment and unsure of their LMP^{2,13,14}. Few less commonly used sonographic parameters for the estimation of GA include transverse cerebellar diameter, fetal kidney length (KL), fetal foot length, placental grading, and amniotic fluid volume. The fetal kidney is easy to identify and measure in the second and third trimesters when conventional parameters become gradually unreliable in the estimation of GA and there is a positive correlation between GA and fetal kidney length (FKL) but has been studied less as a biometric index for GA estimation^{3,5}.

The goal of this study is to prove that measuring foetal kidney length and volume as an additional morphological marker of foetal growth with less variability is valid. Because these measurements are simple, they can be incorporated in the model for dating pregnancies after 20 weeks of pregnancy, especially when biparietal diameter and head circumference measurements are challenging^{4,16}.

OBJECTIVE:

- To define how precisely 'foetal kidney length' measurement by USG can determine GA from 18 weeks onwards^{1,5,17}.
- To create baseline reference values of fetal kidney lengths

in local population in north-western Ahmedabad from 18 weeks onwards to see population-specific variations⁶.

MATERIALS AND METHODS

- A Cross-Sectional - observational study was carried out on 200 antenatal patients in GA of 19-39 weeks attending the antenatal clinic, referred for ultrasonography at department of Radiology, Dr. M.K. SHAH Medical college and Research centre Ahmedabad from Dec'22- March 23.
- Ultrasound was performed on HS50 (SAMSUNG) ultrasound machine.
- PNDT [Prenatal Diagnostic Technique] form - form F was filled and after taking all relevant clinical history, correct LMP was confirmed. After taking due consent, USG was performed with patient in supine position.
- In all the patients - BPD, AC, HC, FL, fetal heart rate, fetal weight, AFI and placental position. Fetal kidney length and volume measurements were taken and recorded. The fetuses were scanned in the transverse plane until the kidneys were visualized just below the stomach, then the probe was rotated 90° to outline the longitudinal axis of the kidneys.

Inclusion Criteria

Normal single intrauterine pregnancies of 19-39 weeks who were sure about their LMP or have first-trimester ultrasound confirmation of GA and giving consent.

Exclusion Criteria

- Women who are not sure about their LMP.
- Multiple gestations.
- Congenital anomalies.

Ethical Clearance

Since the study was done on pregnant women, ethical clearance was obtained from the institutional Ethical Review committee.

RESULTS AND DISCUSSION

- Fetal kidney length and volume were measured in a cross-sectional population of 200 pregnant women with uncomplicated pregnancy with GAs ranging from 19 to 39 weeks. A statistically significant linear relationship has been established in these patients which correlates with clinical GA. In the present study, FKL correlate well with GA with a correlation coefficient of 0.97.

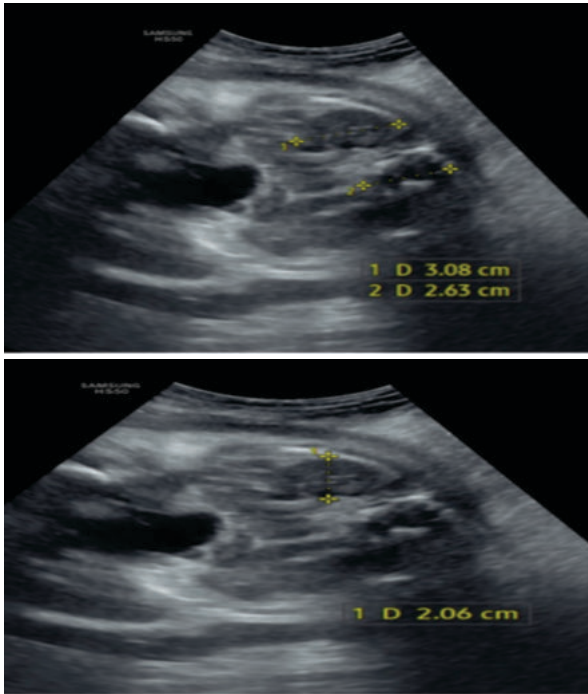


Image 1 & 2 : Fetal kidney size in coronal plane

Table - 1 Right And Left Mean Fetal Kidney Length At Different GA Among The Study Participants

GA In Weeks	Frequency	Right Kidney Mean Length (in mm)	Left Kidney Mean Length (in mm)
18	6	14.5	16
19	8	20.6	20
20	5	21.6	22
21	9	24.8	24
22	8	25.5	25
23	7	27	25
24	9	27.8	26
25	7	29	27
26	8	29.3	28
27	9	28.8	29
28	12	28.6	31
29	11	29.9	33
30	12	32.7	34
31	13	33.8	35
32	14	34.3	35
33	13	35.5	36
34	13	35.4	37
35	10	36.5	38
36	6	37.3	38
37	6	38	38
38	6	37.7	38
39	5	38.2	38
40	3	39.7	39
n	200		
Correlation coefficient		0.963595383	0.970945339

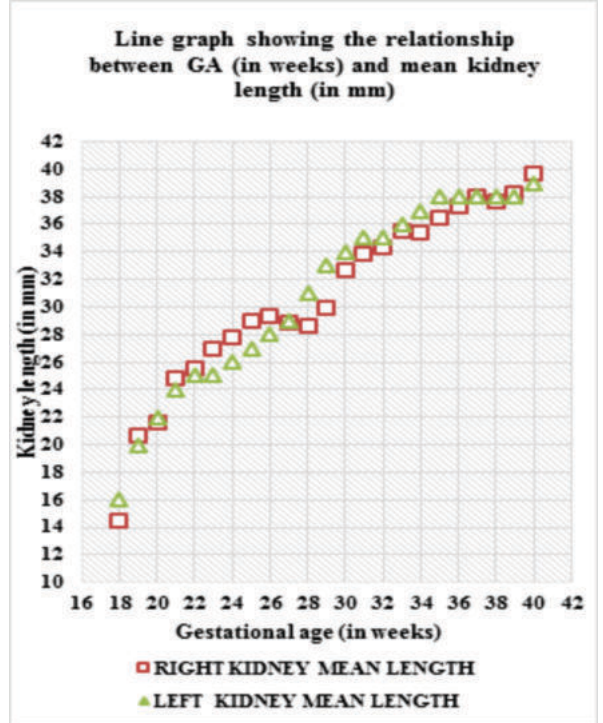


Chart-1

Table - 2 Right And Left Mean Fetal Kidney Volume At Different GA Among The Study Participants

GA in Weeks	Frequency	Right Kidney Volume	Right Kidney Mean Size
18	6	690.015	14.5*8.5*10
19	8	2337.5338	20.6*13.6*16
20	5	1590.096	21.6*10.2*14
21	9	2086.1811	24.8*10.7*15
22	8	2528.4196	25.5*12*16
23	7	3015.2224	27*12.5*17
24	9	4080.6626	27.8*15*19
25	7	4316.8271	29*14.8*19
26	8	4748.9229	29.3*15.5*20
27	9	4987.0178	28.8*15.8*21
28	12	5416.0639	28.6*16.5*22
29	11	5870.3727	29.9*17.5*21
30	12	7554.3167	32.7*20.25*22
31	13	9004.5136	33.8*21*24
32	14	8976.176	34.3*21.36*23
33	13	9385.0574	35.5*20.6*24
34	13	11374.449	35.4*23.15*26
35	10	11110.576	36.5*22.6*26
36	6	14632.749	37.3*26*29
37	6	12618.613	38*22.5*28
38	6	13062.138	37.7*24*29
39	5	15012.34	38.2*24.8*30
40	3	14834.756	39.7*23.7*30
n	200		

Table - 3 Right And Left Mean Fetal Kidney Volume At Different GA Among The Study Participants

GA in Weeks	Frequency	Left Kidney Volume	Left Kidney Mean Size
18	6	1249.022222	16*11.8*13
19	8	2763.330833	20*15.25*17
20	5	2547.796	22*14.4*15
21	9	3232.339259	24*15.33*17
22	8	3688.976667	25*16*17
23	7	3421.179524	25*16*116

24	9	3822.426667	26*16.7*17
25	7	4536.477619	27*18*18
26	8	6025.594583	28*20*20
27	9	7340.854815	29*21*23
28	12	9351.094444	31*22.8*25
29	11	9623.338788	33*22.3*25
30	12	9853.276389	34*21.7*25
31	13	9777.597692	35*21.5*25
32	14	10200.4769	35*21.5*26
33	13	10019.94128	36*21.5*25
34	13	11835.94821	37*22.7*27
35	10	12215.28033	38*22.6*27
36	6	12879.40778	38*23.5*28
37	6	13279.06	38*23.7*28
38	6	14292.23333	38*25*28
39	5	14109.48533	38*24.4*29
40	3	14861.96889	39*24*30
n	200		

Line graph showing the relationship between GA (in weeks) and mean kidney volume (in cc)

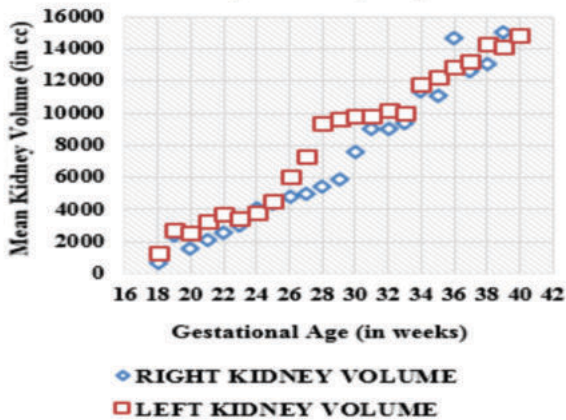


Chart - 2

- Although kidney size may change by growth variations, which affect anterior-posterior and transverse diameters predominantly. The Kidney length remains unaffected in IUGR fetuses.
- No evident difficulty in the imaging of kidney in vertex presentation with the back facing laterally or posteriorly. With advancing pregnancy, an increased echogenicity from increasing perinephric fat makes them more visible by allowing easier separation of the kidney from surrounding soft tissue. This provides an obvious advantage where there is difficulty in measuring BPD, HC due to engaged head or small AC due to IUGR. In such circumstances, FKL can be used on its own to estimate GA accurately.

The present study showed that FKL increases linearly with GA from 20.6 ± 0.60 mm at 19 weeks to 39.7 ± 0.15 mm at 39 weeks.

The present study hence validates the recommendation that FKL can be used as an important sonographic parameter for accurate prediction of fetal gestation age. In our study there is Foetal kidney length tends to show a strong correlation with gestational age up to 30 weeks beyond which the accuracy of correlation defers. However, no significant correlation established with gestational age and fetal kidney volume^{7,18}. Our reference charts for size and volume of the fetal kidney may be useful to diagnostic renal pathology. Accurate estimation of gestational age and early diagnosis of variety of renal abnormalities are few advantages that measurement of these parameters can provide⁸.

Limitation

Fetal kidney length is not routinely measured in fetal biometry. So, this study was done to demonstrate the accuracy of GA measured by FKL with that of Hadlock-based average GA. Further studies with a large sample size may be required to corroborate our findings and to establish FKL as accurate and more reliable parameters in the estimation of GA in second and third trimesters^{9,19}.

Technical error or maternal obesity may sometimes result in poor scans and prevent identification of fetal kidneys, especially during early gestation where the fetal adrenal and renal parenchyma have identical homogeneous patterns and closer to term this point is further obscured by the echogenic nature of lower ribs. This probably explains the slightly different results in different studies¹⁰.

Statistical Analysis

Data was entered into Microsoft excel data sheet and was analysed using SPSS 22 version software.

Categorical data was represented in the form of Frequencies and proportions. Continuous data was represented as mean and standard deviation. Independent t test was used as test of significance to identify the mean difference between two quantitative variables.

Pearson correlation was done to find the correlation between two quantitative variables^{11,20}.

CONCLUSIONS

- Fetal kidney length measurement can be used as a reliable ultrasonographic parameter for estimating the gestational age in the 2nd and 3rd trimester and correlation increases when used with other parameters.
- Population specific baseline reference values for northwest ahmedabad of FKLs for the estimation of FGA should be adopted rather than relying on the Caucasians values as universal patterns.

Fetal kidney length increase with an increase in GA and show an excellent correlation coefficient which suggests good agreement and reproducibility of measurements and is not affected by the discrepancy of the late trimester. This study concludes that FKL show a strong correlation with fetal GA, with a steady growth rate throughout pregnancy.

Obstetric care begins with determining gestational age, which has the least variability in early pregnancy. This current study was planned to provide an overview of fetal kidney length and volume as a useful adjunct parameter for better determination of gestational age.

REFERENCES:

1. Papageorghiou AT, Kemp B, Stones W, Ohuma EO, Kennedy SH, Purwar M, Salomon LJ, Altman DG, Noble JA, Bertino E, Gravett MG, Pang R, Cheikh Ismail L, Barros FC, Lambert A, Jaffer YA, Victora CG, Bhutta ZA, Villar J; International Fetal and Newborn Growth Consortium for the 21st Century (INTERGROWTH-21st). Ultrasound-based gestational-age estimation in late pregnancy. *Ultrasound Obstet Gynecol.* 2016 Dec;48(6):719-726. doi: 10.1002/uog.15894. PMID: 26924421; PMCID: PMC6680349.
2. Sonographic Assessment of Fetal Growth Abnormalities Michelle P Debbink, Shannon L. Son, Paula J. Woodward, and Anne M. Kennedy, *RadioGraphics* 2021; 41:1: 268-288.
3. Singh A, Singh G, Gupta K. Estimation of Gestational Age by Using Fetal Kidney Length and Transcerebellar Diameter in Comparison with Other Biometric Indices. *Donald School J Ultrasound Obstet Gynecol* 2021; 15(1):4-9.
4. Kiridi EK, Oriji PC, Briggs DC, Ugwoegbu JU, Okechukwu C, Adesina AD, Ubom AE, Bosroti PY, Addah AO, Abasi IJ. Ultrasound Measurement of Foetal Kidney Length during Healthy Pregnancy: Relationship with Gestational Age. *Ethiop J Health Sci.* 2023 Jan;33(1):97-106. doi: 10.4314/ejhs.v33i1.13. PMID: 36890924; PMCID: PMC9987282.
5. Ugur MG, Mustafa A, Ozcan HC, Tepe NB, Kurt H, Akcil E, Gunduz R. Fetal kidney length as a useful adjunct parameter for better determination of gestational age. *Saudi Med J.* 2016 May;37(5):533-7. doi: 10.15537/smj.2016.5.14225. PMID: 27146616; PMCID: PMC4880653.
6. Abonyi, E.O., Eze, C.U., Agwuna, K.K. et al. Sonographic estimation of gestational age from 20 to 40 weeks by fetal kidney lengths' measurements

- among pregnant women in Portharcourt, Nigeria. *BMC Med Imaging* 19, 72 (2019). <https://doi.org/10.1186/s12880-019-0371-z>.
7. 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 Aug 22;19(1):72. doi: 10.1186/s12880-019-0371-z. PMID: 31438870; PMCID: PMC6704576.
 8. Martha G. Menchaca, Kiara Tulla, Manpreet Samra, Jaspreet Samra, Ivo Tzvetanov, Suman Setty, Kidney Volume Growth and Kidney Function of En Bloc Pediatric Kidney Transplants: A Case Series, *Kidney Medicine*, 10.1016/j.xkme.2023.100616, 5, 5, (100616), (2023).
 9. Singh A, Singh G, Gupta K. Estimation of Gestational Age by Using Fetal Kidney Length and Transcerebellar Diameter in Comparison with Other Biometric Indices. *Donald School J Ultrasound Obstet Gynecol* 2021; 15(1): 4–9.
 10. Lee YQ, Lumbers ER, Oldmeadow C, Collins CE, Johnson V, Keogh L, Sutherland K, Gordon A, Smith R, Rae KM, Pringle KG. The relationship between maternal adiposity during pregnancy and fetal kidney development and kidney function in infants: the Gomerol gaaynggal study. *Physiol Rep*. 2019 Sep;7(17):e14227. doi: 10.14814/phy2.14227. PMID: 31515958; PMCID: PMC6742895.
 11. Kumari Vasantha NS, Madhusudhana R. Intrathecal Bupivacaine with Neostigmine and Bupivacaine with Normal Saline for Postoperative Analgesia: A Cost-effective Additive. *Anesth Essays Res*. 2018 Apr-Jun;12(2):328-332. doi: 10.4103/aer.AER_184_17. PMID: 29962592; PMCID: PMC6020563.
 12. Jabaz D, Abed M. Sonography 2nd Trimester Assessment, Protocols, and Interpretation. [Updated 2023 May 22]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK570574>.
 13. Olaleye OA, Olatunji OO, Jimoh KO, Olaleye AO. Ultrasound Measurement of Placental Thickness: A Reliable Estimation of Gestational Age in Normal Singleton Pregnancies in Nigerian Women. *J West Afr Coll Surg*. 2022 Jan-Mar;12(1):17-22. doi: 10.4103/jwas.jwas_72_22. Epub 2022 Aug 23. PMID: 36203931; PMCID: PMC9531736.
 14. Lee, L.H., Bradburn, E., Craik, R. et al. Machine learning for accurate estimation of fetal gestational age based on ultrasound images. *npj Digit. Med*. 6, 36 (2023). <https://doi.org/10.1038/s41746-023-00774-2>.
 15. Ugur MG, Mustafa A, Ozcan HC, Tepe NB, Kurt H, Akcil E, Gunduz R. Fetal kidney length as a useful adjunct parameter for better determination of gestational age. *Saudi Med J*. 2016 May;37(5):533-7. doi: 10.15537/smj.2016.5.14225. PMID: 27146616; PMCID: PMC4880653.
 16. Salomon LJ, Alfirevic Z, da Silva Costa F, Deter RL, Figueras F, Ghi T, Glanc P, Khalil A, Lee W, Napolitano R, Papageorghiou AT, Sotiriadis A, Stirnemann J, Toi A, Yeo G. ISUOG Practice Guidelines: ultrasound assessment of fetal biometry and growth. *Ultrasound Obstet Gynecol* 2019; 53: 715–723.
 17. Joshi BR, Chaurasia AK and 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. *Austin J Radiol*. 2021; 8(1): 1121.
 18. Peter, M., Nayak, A. K., Giri, P.P., & Jain, M. K. (2017). Fetal kidney length as a parameter for determination of gestational age from 20th week to term in healthy women with uncomplicated pregnancy. *International Journal of Research in Medical Sciences*, 5(5), 1869–1873. <https://doi.org/10.18203/2320-6012.ijrms20171808>.
 19. Joshi BR, Chaurasia AK and 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. *Austin J Radiol*. 2021; 8(1): 1121.
 20. Hazra A, Gogtay N. Biostatistics Series Module 4: Comparing Groups - Categorical Variables. *Indian J Dermatol*. 2016 Jul-Aug;61(4):385-92. doi: 10.4103/0019-5154.185700. PMID: 27512183; PMCID: PMC4966396.