

Ultrasound Measurement of Fetal Kidney Length in Normal Pregnancy and its Correlation with Gestational Age

Sapana Koirala,¹ Kapil Adhikari,¹ Karun Devkota¹

¹Department of Radio Diagnosis and Imaging, BPKIHS, Dharan.

ABSTRACT

Background: To establish a nomogram of fetal kidney length for a normal pregnancy from 20 to 41 weeks of gestational age.

Methods: A prospective cross-sectional study was carried out in the Department of radio-diagnosis and imaging BPKIHS, Dharan. 400 kidneys of 200 fetuses between the gestational age 20 to 41 weeks were scanned. Renal measurement was performed by ultrasonography.

Results: Analysis was performed on data obtained from 200 normal fetuses. Size charts for right, left and mean fetal kidney length with standard deviation were presented for each weeks of gestation from 20 weeks to 41 weeks. The difference in renal length between right and left side was statistically not significant. There was significant correlation between gestational age and fetal kidney length ($r=0.947$, $p=0.001$).

Conclusions: Fetal kidney length can be used as an adjunct parameter for estimation of gestation age.

Keywords: Fetal kidney; gestational age; ultrasound

INTRODUCTION

Fetal kidney is easy to identify and measure in the second and in the third trimesters. Fetal kidney growth is constant, increases ≈ 1.7 mm fortnightly throughout pregnancy and unchanged by growth disorders.¹

Accurate estimation of gestational age is required to assess the fetal growth and to calculate expected date of delivery. The most accurate way to estimate GA is by measuring fetal CRL.² As gestation advances, ultrasound biometry becomes less accurate for estimating gestational age.³ Fetal kidney can be evaluated as an alternate parameter as which can reduce the errors in estimating gestational age, especially in late second and third trimester.

The objectives of the study were to derive nomogram for estimating the gestational age of the fetus from ultrasonographically measured fetal kidney length in Nepalese population and to determine a correlation between the fetal kidney length and the gestational age from 20 to 41 weeks.

METHODS

A hospital based cross sectional prospective study was

conducted in the Department of Radiodiagnosis and Imaging at BPKIHS, Dharan over a period of one year from 25 September 2020 to 24 September 2021 after taking ethical approval from local institutional review committee. The patients were explained the procedure and its purpose, prior to scanning. Informed consent was obtained for the study from the enrolled patients.

Women with singleton uncomplicated pregnancy at the gestational age 20 weeks or more with gestational age verified by sonographic measurement of the crown-rump length in first trimester were included in the study. Women with multiple pregnancy, diabetes, hypertension, oligohydrominos, polyhydramnios, intrauterine growth restriction, chronic renal diseases and fetal anomalies were excluded from the study.

200 consecutive women were included in the study. All examination was performed by using a Mindray DC- 8 ultrasonographic machine with curvilinear probe 3-5Mhz. The maximum renal length was measured from the upper to lower pole of the kidney in a longitudinal section with fetus in the sagittal plane. Both FKLs were measured from the outer edge of the upper pole to the outer edge of the lower pole as described by Bertagnoli et al.⁴

Correspondence: Dr Sapana Koirala, BP Koirala Institute of Health Sciences, Dharan. Email: ksapana11@gmail.com, Phone: +9779852062477.

Means and standard deviations of the right kidney length(RKL), left kidney length (LKL) and mean kidney length (MKL) for consecutive gestational ages (GA) were calculated. To compare mean values between the measurements of the right and left kidneys, a paired Student t test was applied.

Pearson correlation coefficient was used to detect linear relationship between gestational age and fetal kidney length. Linear regression models for estimation of gestational age is derived from mean kidney length.

All analyses were performed using the Statistical Package for Social Sciences Version 22.0 and p value <0.05 was accepted as significant.

RESULTS

A total of 200 pregnant women and 400 fetal kidneys were examined. The age range of participants was 17-39 years, with a mean age of 26 ± 0.5 years.

Mean RKL, LKL, and MKL with their respective standard

deviations at specific gestational age from 20 weeks to 41 weeks are shown in table no 1. There was a progressive increase in RKL, LKL, and MKL in millimeters as the GA increased in weeks. The MKL increased from a value of 20.16 ± 0.97 mm at 20 weeks to 42.25 ± 0.71 mm at 41 weeks of gestation.

Right and left kidney lengths were compared by using the paired t-test. There was no significant difference in right and left kidney length in all gestational age as shown in the table 2.

There was a significant positive correlation between the gestational age and kidney lengths (Pearson coefficient for RKL was 0.98 , LKL was 0.98 and MKL was 0.98 with P value <.01)

By linear regression analysis regression equation was calculated for estimating the gestational age by using MKL.

$$\text{Gestational age} = 2+0.854 \times \text{MKL}$$

Table 1. Right, left and mean fetal kidney length (in milimeters) from 20 to 41 weeks gestational age.

GA (in weeks)	Number of cases	RKL	Std. Deviation	LKL	Std. Deviation	MKL	Std. Deviation
20	14.00	20.15	.97	20.18	.97	20.16	.97
21	15.00	21.56	1.01	21.56	1.01	21.56	1.01
22	9.00	23.28	.97	23.28	.97	23.28	.97
23	15.00	24.75	1.06	24.76	1.05	24.75	1.06
24	14.00	26.34	1.04	26.34	1.01	26.34	1.03
25	9.00	27.66	1.30	27.73	1.32	27.69	1.30
26	13.00	29.04	1.20	29.05	1.20	29.05	1.20
27	6.00	30.20	1.09	30.20	1.09	30.20	1.09
28	6.00	31.43	1.30	31.43	1.30	31.43	1.30
29	4.00	32.53	1.30	32.53	1.30	32.53	1.30
30	14.00	33.71	.76	33.70	.78	33.71	.77
31	11.00	34.85	1.13	34.85	1.14	34.85	1.13
32	6.00	35.72	1.23	35.72	1.23	35.72	1.23
33	4.00	37.05	1.52	37.07	1.54	37.06	1.53
34	11.00	37.72	1.29	37.71	1.27	37.71	1.28
35	6.00	38.48	1.61	38.73	1.71	38.61	1.65
36	10.00	39.45	1.41	39.48	1.43	39.46	1.42
37	10.00	40.20	1.50	40.20	1.50	40.20	1.50
38	10.00	41.02	1.37	41.02	1.37	41.02	1.37
39	7.00	41.60	1.31	41.64	1.33	41.62	1.32
40	4.00	42.28	1.06	42.22	1.10	42.25	1.08
41	2.00	42.50	.71	42.50	.71	42.50	.71

Table 2. Correlation of right and left kidney length.

GA (in weeks)	Number of cases	RKL (Mean)	LKL (Mean)	Difference	P value
20	14.00	20.15	20.18	.03	0.1
21	15.00	21.56	21.56	.00	N/A
22	9.00	23.28	23.28	.00	N/A
23	15.00	24.75	24.76	.01	0.1
24	14.00	26.34	26.34	.00	N/A
25	9.00	27.66	27.73	.07	0.3
26	13.00	29.04	29.05	.01	0.3
27	6.00	30.20	30.20	.00	N/A
28	6.00	31.43	31.43	.00	N/A
29	4.00	32.53	32.53	.00	N/A
30	14.00	33.71	33.70	.01	0.5
31	11.00	34.85	34.85	.00	N/A
32	6.00	35.72	35.72	.00	N/A
33	4.00	37.05	37.07	.02	0.4
34	11.00	37.72	37.71	-.01	0.8
35	6.00	38.48	38.73	.25	0.2
36	10.00	39.45	39.48	.03	0.2
37	10.00	40.20	40.20	.00	N/A
38	10.00	41.02	41.02	.00	N/A
39	7.00	41.60	41.64	.04	0.2
40	4.00	42.28	42.22	.06	0.4
41	2.00	42.50	42.50	.00	N/A



Figure 1. Ultrasound of fetal kidney length measured from outer to outer margin with fetus in sagittal plane.

DISCUSSION

Congenital abnormalities of the genitourinary tract are the most common sonographically identified malformations, with an incidence of 1 to 4 in 1000 pregnancies.⁵ Some of these anomalies can be detected in utero by sonographic method. A knowledge of normal fetal length is useful in

the early diagnosis of abnormality in a fetal kidney and helps to detect abnormal renal development.

Accurate ultrasonographic evaluation of the fetal kidney is not complete until approximately 15 to 17 weeks of gestation due to the relatively small size and the lack of perirenal fat.⁶ Accurate evaluation of the fetal kidneys is possible in a large percentage of cases after 20 weeks of gestation.⁷ In our study, we measured kidney length from 20 weeks of gestation and were able to identify and measure both kidneys in all cases.

Our values of mean kidney length were within the 10th to 90th centiles values noted in the study by Barbosa et al.⁸ In the study, serial weekly sonographic evaluation of fetal kidneys of 115 participants were done from first trimester until delivery and the 10th, 50th and 90th centiles of fetal kidney measurements were calculated. Our values of fetal kidney length were slightly less than 50th centile values of the study.

We compared the mean fetal kidney length of our study with the study by Joshi et al.⁹ Our values of mean fetal kidney length were higher than those reported in the study. The differences in the values can be attributed to the difference in method of estimating gestational age (LMP vs first trimester CRL), technique of measurement, quality of ultrasound equipment, frequency of measurements and data analysis.

Our values of fetal kidney lengths were higher than reported in the study by Ansari et al.¹⁰ The study was performed in 793 fetuses between 16 to 40 weeks of gestation. In the study, average kidney value at full term was 3.95 cm compared to our value of 4.2 cm. The difference could be attributed to improvement in quality of ultrasound equipment.

There was no statistically significant difference between the right and left kidney length. Similar findings was observed in other studies.^{1,11,12}

In our study, we found that the mean length of fetal kidney linearly increased with gestational age with strong correlation between fetal kidney length & gestational age. We found a very strong correlation between FKL and GA. The correlation coefficient (r = 0.98) observed in our study was similar to the study by Joshi et al. and was higher as compared to study by Konje et al. (r = 0.91), Cohen et al. (r = 0.82), and similar to Kumar et al. (r=0.98).^{9,11,13,14} So, taken in conjunction with BPD, FL, HC & AC, kidney length could well be used as an alternative parameter for determination of gestational age.

For this study, a possible limitation was the lack of evaluation of intra- and inter-observer variabilities of fetal kidney measurements. However, in a study by S.H. van Vuuren et al., it was demonstrated that fetal kidneys can be measured accurately and with a high level of intra- and inter-observer agreement, ensuring reproducibility of the method.¹⁵

CONCLUSIONS

This study has been able to establish a nomogram for mean right and left fetal kidney length per week, between 20 to 41 weeks of gestation with MKL of 20.87 ± 0.75 mm and 41.41 ± 0.07 mm at 20 and 41 weeks, respectively. Knowledge of these values are useful in assessment of normal kidney growth and development and for diagnosis of renal abnormalities. The study shows that the kidney length correlates well with gestational age. So, it can be concluded that fetal kidney length may be helpful in estimation of gestational age when the date of conception is uncertain.

CONFLICT OF INTEREST

The authors declare no conflict of interest

REFERENCES

1. Witzani L, Brugger PC, Hörmann M, Kasprian G, Csapone-Balassy C, Prayer D. Normal renal development investigated with fetal MRI. *European journal of radiology*. 2006 Feb 1;57(2):294-302. [\[Article\]](#)
2. American College of Obstetricians and Gynecologists. Committee opinion no 700: methods for estimating the due date. *Obstet Gynecol*. 2017 May;129(5):e150-4. [\[Article\]](#)
3. Deb S, Mohammed MS, Dhingra U, Dutta A, Ali SM, Dixit P, et al. Performance of late pregnancy biometry for gestational age dating in low-income and middle-income countries: a prospective, multicountry, population-based cohort study from the WHO Alliance for Maternal and Newborn Health Improvement (AMANHI) Study Group. *The Lancet Global Health*. 2020 Apr 1;8(4):e545-54. [\[Article\]](#)
4. Bertagnoli L, Lalatta F, Gallicchio R, Fantuzzi M, Rusca M, Zorzoli A, et al. Quantitative characterization of the growth of the fetal kidney. *Journal of clinical ultrasound*. 1983 Sep;11(7):349-56. [\[Article\]](#)
5. Grandjean H, Larroque D, Levi S. The performance of routine ultrasonographic screening of pregnancies in the Eurofetus Study. *American journal of obstetrics and gynecology*. 1999 Aug 1;181(2):446-54. PMID: 10454699 [\[Article\]](#)
6. Shin JS, Seo YS, Kim JH, Park KH. Nomogram of fetal renal growth expressed in length and parenchymal area derived from ultrasound images. *The Journal of urology*. 2007 Nov;178(5):2150- [\[Article\]](#)
7. Gloor JM, Breckle RJ, Gehrking WC, Rosenquist RG, Mulholland TA, Bergstrahl EJ, Ramin KD, Ogburn Jr PL. Fetal renal growth evaluated by prenatal ultrasound examination. In *Mayo clinic proceedings* 1997 Feb 1 (Vol. 72, No. 2, pp. 124-129). Elsevier. [\[Article\]](#)
8. Barbosa RM, Souza RT, Silveira C, Andrade KC, Almeida CM, Bortoleto AG, Oliveira PF, Cecatti JG. Reference ranges for ultrasound measurements of fetal kidneys in a cohort of low-risk pregnant women. *Archives of Gynecology and Obstetrics*. 2019 Feb;299(2):585-91. [\[Article\]](#)
9. 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. *Journal of Nepal Paediatric Society*. 2021;41(3):184-90. [\[Article\]](#)
10. Ansari SM, Saha M, Paul AK, Mia SR, Sohel A, Karim R. Ultrasonographic study of 793 fetuses: measurement of normal foetal kidney lengths in Bangladesh. *Australasian radiology*. 1997 Feb;41(1):3-5. [\[Article\]](#)
11. Konje JC, Abrams KR, Bell SC, Taylor DJ. Determination of gestational age after the 24th week of gestation from fetal kidney length measurements. *Ultrasound in Obstetrics and Gynecology: The Official Journal of the International Society of Ultrasound in Obstetrics and Gynecology*. 2002 Jun;19(6):592-7. [\[Article\]](#)
12. Kansaria JJ, Parulekar SV. Nomogram for foetal kidney length. *Bombay Hospital Journal*. 2009;51(2):155-62. [\[Download PDF\]](#)
13. Cohen HL, Cooper J, Eisenberg P, Mandel FS, Gross BR, Goldman MA, Barzel E, Rawlinson KF. Normal length of fetal kidneys: sonographic study in 397 obstetric patients. *AJR. American journal of roentgenology*. 1991 Sep;157(3):545-8.
14. Kumar K, Lalwani R, Babu R, Aneja S, Malik A. Ultrasonographic estimation of fetal gestational age by fetal kidney length. *Journal of the Anatomical society of India*. 2013 Jun 1;62(1):33-6. [\[Article\]](#)
15. Van Vuuren SH, Damen-Elias HA, Stigter RH et al (2012) Size and volume charts of fetal kidney, renal pelvis and adrenal gland. *Ultrasound Obstet Gynecol* 40(6):659–664. [\[Article\]](#)