

Study of fetal kidney size by ultrasonography at different gestational age

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Abstract

Normal fetal kidney dimensions are necessary to diagnose fetal kidney abnormalities. The maximum fetal renal growth occurs during 26-34 weeks gestation. Fetal kidney length correlates well with gestational age. Aim of the present study is to measure fetal kidney size at 30 and 38 weeks of gestation in singleton pregnancy. No statistically significant difference was found in the mean parameters of right and left kidney at a particular gestational age ($p \geq 0.05$) in this study. The mean length in mm of fetal kidneys was slightly longer than the approximate gestational age in weeks.

Keywords: Fetal kidney, Ultrasound, Gestational age.

Introduction

The kidneys, one of the vital organs of body, are part of the urinary system. It excrete metabolic waste products, has role in maintaining blood pressure and blood glucose level and also act as endocrine tissue liberating Kinins, 1, 25-dihydroxycholecalciferol, erythropoietin and renin. Measurement of the kidney length, by sonography can diagnose renal abnormality. Kidney can be visualized early at 14 weeks of gestation. As the pregnancy progresses, the increase in the perinephric fat with increased echogenicity separate the kidney from its surrounding soft tissues & allow its visibility easier.¹ During 26-34 weeks gestation the fetal renal growth is maximum.² In the third trimester 60% of the nephrons develop and the increase in nephron numbers stops by 36 weeks of gestation.³ Accurate measurements also may be helpful in determination of gestational Age.¹ An often quoted "Rule of Thumb" is that renal length in millimeters approximates gestational age in weeks from 24 to 40 weeks.⁴

Materials and Methods

The present study was conducted after obtaining clearance from Ethical Committee of the Institution from October 2011 to August 2013 in the Department of Anatomy Kalinga Institute of Medical Sciences, KIIT University, Patia, Bhubaneswar, Odisha, India. It was done in collaboration with the Department of Radiodiagnosis, Pradyumna Bal Memorial Hospital, KIMS, KIIT campus-5. Singleton 172 antenatal cases from eastern Odisha were included for the study. Two gestational age, at 30 and 38 Weeks of Gestation were included for the study, as the "Rule of Thumb" includes 24 to 40 weeks of gestational age and most of the booked patients at antenatal clinics of gynae & obstetrics units were referred for ultrasonographic evaluation at these weeks. Gestational age of fetus was

calculated from the last menstrual period as mentioned by the patient.

Fetal Renal Measurements: The measurements of both kidneys were performed in the phase of Fetal Apnea. Ill-defined Adrenal or renal borders, abnormal renal morphology, and renal pelvic dilatation greater than 4 mm in anteroposterior diameter were excluded.

For measurement of the kidney length, the fetus was scanned in the transverse plane until the kidneys were visualized just below the stomach. The probe was then rotated through 90° to outline the longitudinal axis of the kidneys to take the length pole to pole (Fig. 5 & 6). The transducer was then rotated 90° to the longitudinal axis and the Transverse Section was obtained at the level of the renal hilum. Thickness & Width were measured in axial plane perpendicular to each other from outer to outer margin of the frozen image. Maximum thickness (Antero-Posterior diameter) was measured from ventral to dorsal surface and Width (Transverse diameter) was measured from lateral to medial border of the kidney images (Fig 5 & 6). The renal volume (cm³) was calculated (ellipsoid formula) as: $0.523 \times \text{Length (in cm)} \times \text{Width (in cm)} \times \text{Depth (in cm)}$

Results

Statistical analysis of measurements fetal kidney parameters in 172 singleton antenatal cases were taken. Out of which 56 cases were 30 weeks gestation and 116 cases were 38 weeks gestation.

The comparison of parameters of right and left kidneys between 30 and 38 weeks of gestation by Independent Sample 't' test is furnished in Table 1. The mean values of different parameters of right and left kidney are plotted graphically in Fig. 1 and Fig. 2 respectively. It is clearly revealed that at 38 weeks the parameters were higher than parameters at 30 weeks and the difference was statistically significant. Further

analysis was done to see the difference between the parameters of right and left kidneys at a particular gestational age through paired sample 't' test. The results are depicted in Table 2 and graphically represented in Fig. 3 and Fig. 4 for 30 weeks and 38 weeks of gestation respectively. It was revealed that at 30 weeks of gestation the mean length, breadth, thickness and volume of right kidney were 32.4 ± 5.2 mm, 17.8 ± 3 mm, 20.3 ± 4 mm and 6.3 ± 2.7 cm³ respectively. At 30 weeks of gestation the mean length, breadth, thickness and volume of left kidney were 33.3 ± 4 mm, 17.7 ± 2.9 mm, 19.8 ± 3.4 mm and 6.4 ± 2.3 cm³ respectively. The difference between the mean

parameters of right and left fetal kidney at 30 weeks of gestation was not statistically significant ($p \geq 0.05$). At 38 weeks of gestation the mean length, breadth, thickness and volume of right kidney were 39.7 ± 4.9 mm, 21.1 ± 3.5 mm, 23.5 ± 4 mm and 11 ± 7.3 cm³ respectively. At 38 weeks of gestation the mean length, breadth, thickness and volume of left kidney were 39.1 ± 4.9 mm, 20.6 ± 3 mm, 22.7 ± 4.9 mm and 9.8 ± 2.8 cm³ respectively. The difference between the mean parameters of right and left fetal kidney at 38 weeks of gestation was not statistically significant ($p \geq 0.05$). Hence, there was no difference in the mean parameters of right and left kidney at a particular gestational age.

Table 1: Comparison of parameters of kidney between 30 weeks and 38 weeks

Parameters	Foetal Age	Statistic			Std. Deviation Mean	t value	p value
		Mean	95% Confidence Interval for Mean				
			Lower Bound	Upper Bound			
Length Right Kidney	30 weeks	32.443	31.063	33.822	5.151	-8.950	0.000
	38 weeks	39.743	38.834	40.653	4.946		
Breadth Right Kidney	30 weeks	17.754	16.963	18.544	2.953	-6.231	0.000
	38 weeks	21.113	20.474	21.752	3.473		
Thickness Right Kidney	30 weeks	20.305	19.229	21.382	4.019	-4.896	0.000
	38 weeks	23.511	22.771	24.252	4.027		
Volume Right Kidney	30 weeks	6.271	5.549	6.993	2.696	-4.683	0.000
	38 weeks	11.003	9.658	12.349	7.316		
Length Left Kidney	30 weeks	33.307	32.226	34.388	4.038	-7.726	0.000
	38 weeks	39.150	38.247	40.053	4.913		
Breadth Left Kidney	30 weeks	17.689	16.895	18.484	2.967	-6.018	0.000
	38 weeks	20.645	20.085	21.204	3.042		
Thickness Left Kidney	30 weeks	19.770	18.855	20.684	3.415	-4.071	0.000
	38 weeks	22.723	21.826	23.620	4.879		
Volume Left Kidney	30 weeks	6.355	5.730	6.980	2.334	-7.953	0.000
	38 weeks	9.768	9.258	10.277	2.770		

Table 2. Comparison of parameters of left and right kidney at same gestational age (30 weeks and 38 weeks)

Foetal Age	Pair	Parameters	Mean	N	Std. Deviation	Std. Error Mean	t value	p value
30 weeks	Pair 1	Length Right Kidney	32.443	56	5.151	0.688	-1.621	0.111
		Length Left Kidney	33.307	56	4.038	0.540		
	Pair 2	Breadth Right Kidney	17.754	56	2.953	0.395	0.208	0.836
		Breadth Left Kidney	17.689	56	2.967	0.396		
	Pair 3	Thickness Right Kidney	20.305	56	4.019	0.537	1.041	0.302
		Thickness Left Kidney	19.770	56	3.415	0.456		
	Pair 4	Volume Right Kidney	6.271	56	2.696	0.360	-0.433	0.667
		Volume Left Kidney	6.355	56	2.334	0.312		
38 weeks	Pair 1	Length Right Kidney	39.743	116	4.946	0.459	1.284	0.202
		Length Left Kidney	39.150	116	4.913	0.456		
	Pair 2	Breadth Right Kidney	21.113	116	3.473	0.322	1.326	0.188
		Breadth Left Kidney	20.645	116	3.042	0.282		
	Pair 3	Thickness Right Kidney	23.511	116	4.027	0.374	1.627	0.107
		Thickness Left Kidney	22.723	116	4.879	0.453		
	Pair 4	Volume Right Kidney	11.003	116	7.316	0.679	1.822	0.071
		Volume Left Kidney	9.768	116	2.770	0.257		

Table 3. Comparison of fetal kidney length in present study and other studies

	Present Study		J.J. Kansaria (2009)	Nahid Yusuf (2007)	J.C. Konje (2002)	S.M. Ansari (1997)
	Right kidney	Left kidney				
Kidney length at 30 weeks (mm)	32.443±5.2	33.307±4.0	29.03±1.32	31.4±1.4	30.9±3.2	32±5
Kidney length at 38 weeks (mm)	39.743±4.9	39.150±4.9	36.25±1.70	37±1.4	40.1±2.4	37±7.4

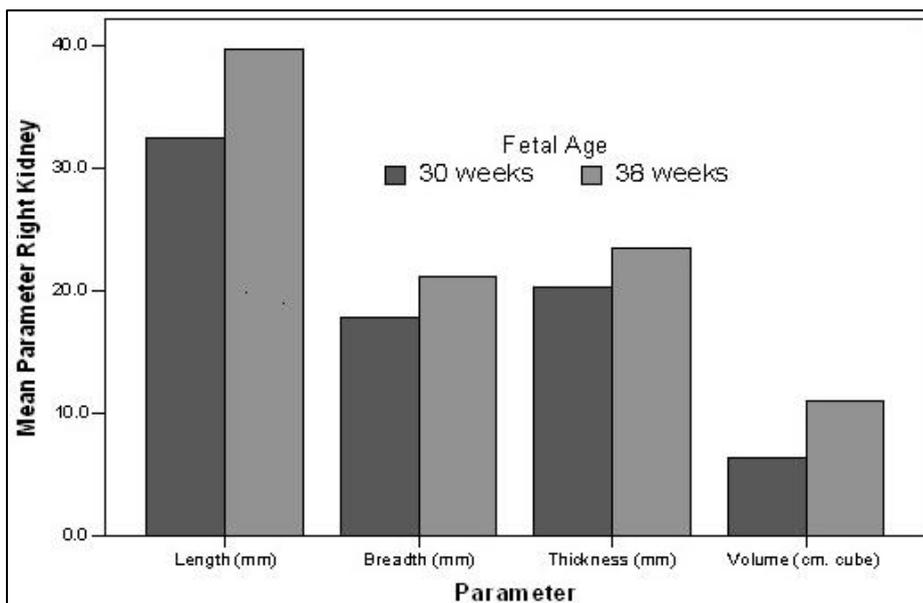


Fig. 1: Parameters (USG) of right kidney by fetal age

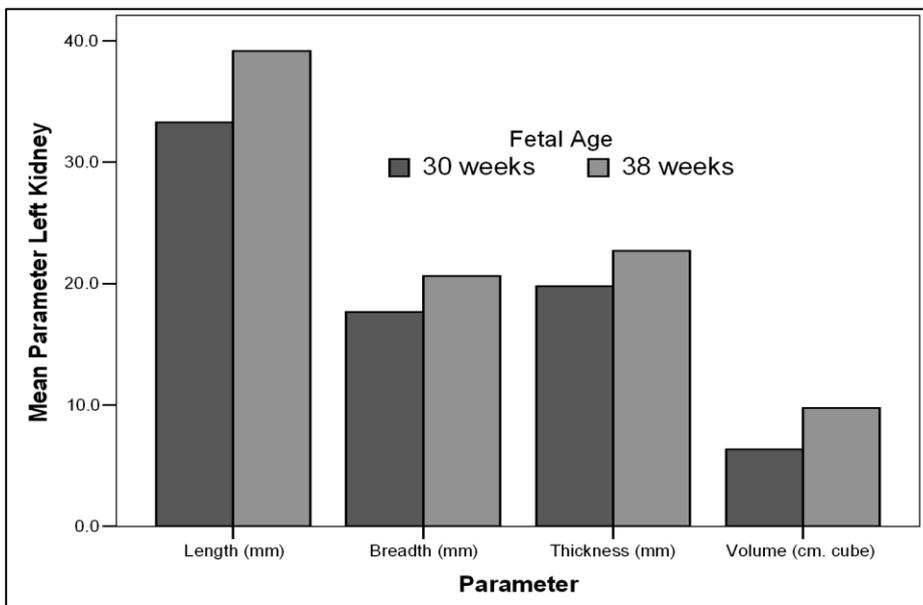


Fig. 2: Parameters (USG) of left kidney by fetal age

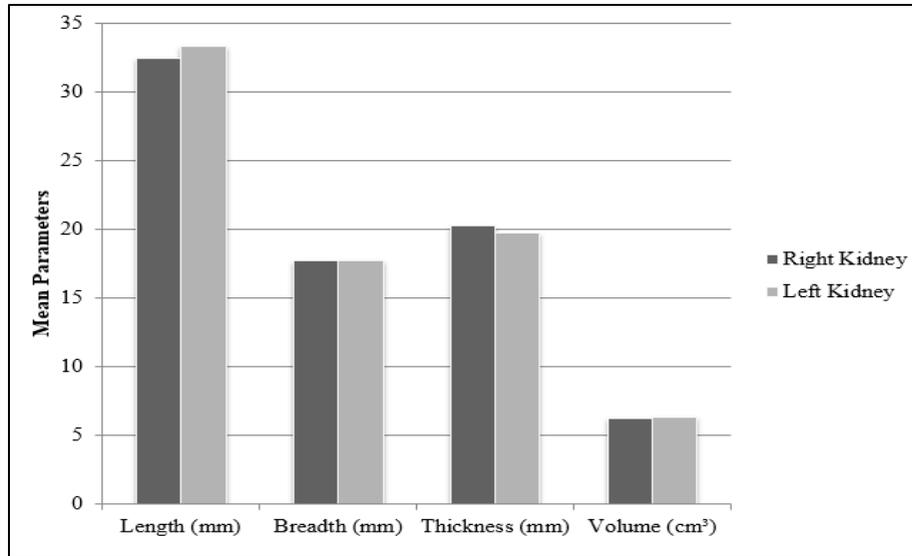


Fig. 3: Comparison between mean parameters of foetal right and left kidney at 30 weeks by USG

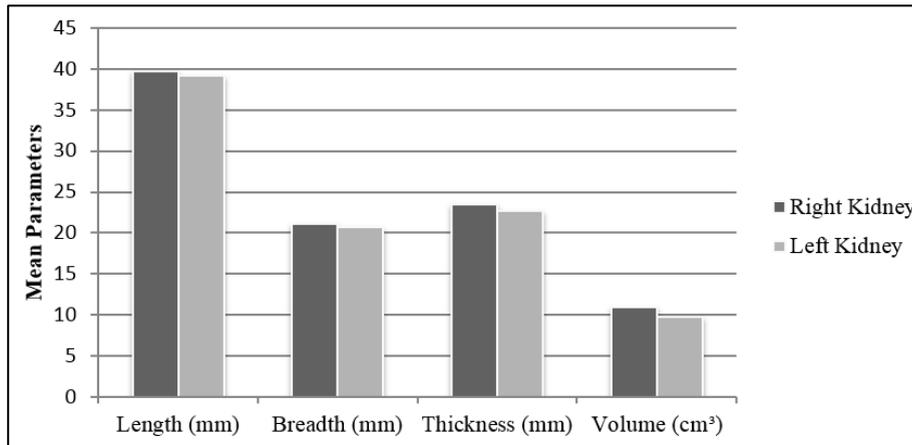


Fig. 4: Comparison between mean parameters of foetal right and left kidney at 38 weeks by USG

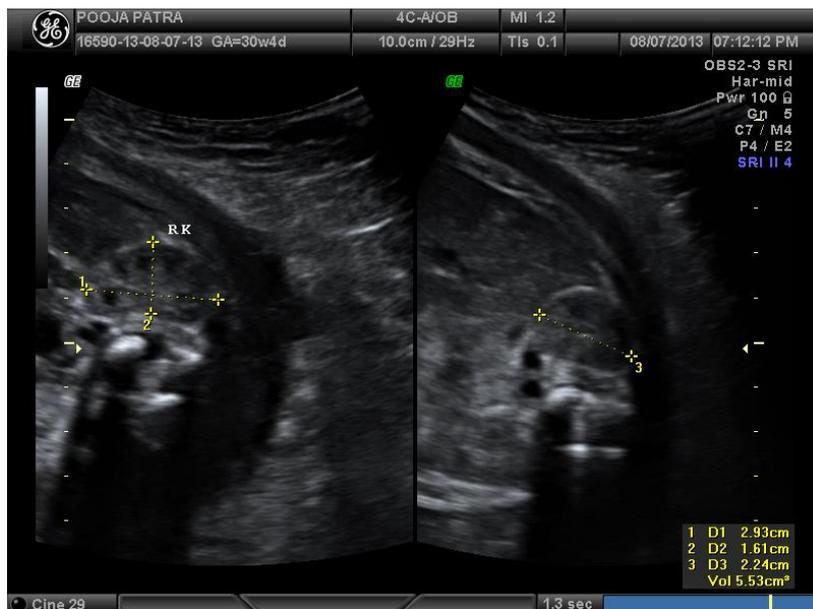


Fig. 5: Showing ultrasonographic measurements of fetal right kidney at 30 weeks

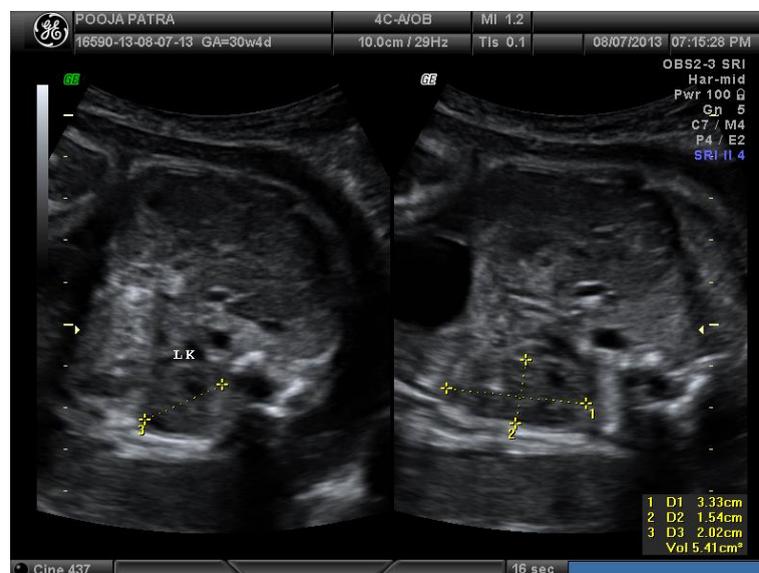


Fig. 6: Showing ultrasonographic measurements of fetal left kidney at 30 weeks

Discussion

Normal dimensions of fetal kidneys is helpful in order to diagnose abnormalities.⁵ Measurement of the kidney length, by sonography can diagnose renal abnormality as early as 14 weeks of gestation. As the pregnancy progresses, the increase in the perinephric fat with increased echogenicity separate the kidney from its surrounding soft tissues & allow its visibility easier.¹ By 30 weeks, the sufficient perirenal fat surrounding and accentuating the normal sonolucent renal parenchyma make identification relatively simple.⁶

Gestation of 26-34 weeks is the period during which maximum fetal renal growth occurred.² Major increase in kidney length, i.e. 26.2 mm has been noticed in second trimester while the measurement in 13 week was 6.3 mm and 9.6 mm in last trimester and at 37 week of gestation, the length of kidney was 42.1 mm.⁷ Sixty per cent of the nephrons develop in the third trimester and that increase in nephron numbers stops by 36 weeks of gestation.³ The renal length does not change significantly from 35 weeks of gestational age until term.

According to the study by Dinkel et al (1986), pathology of kidney is better expressed in its volume than in its length.⁸ Renal pelvic dilatation is a common sonographic finding in early pregnancy to diagnosis fetal kidney's anomalies.⁹ Along with this measuring their size can help in determination of gestational age, especially in cases where the date of the mother's last menstruation is unknown, and routine methods show contradictory results.^{5,8,10}

In the present study there was no statistically significant difference between the measurements of the left and right kidneys ($p \geq 0.05$) (Fig 1 & Fig 2). Similar result is also reported by many authors.^{1,10-12} The mean length of fetal kidneys in the present study was 32.9mm at 30 weeks and 39.5mm at 38 weeks which was similar

to the study by Ansari SM et al (1997),¹¹ Nahid Yusuf et al (2007),¹² Konje J. C. et al (2002),¹⁰ but greater than those reported by J. J. Kansaria et al (2009)⁶ (Table 3). The mean length of fetal kidneys in this study was smaller than that reported by Cohen et al (1991),¹ H.A.M. Damen – Eliasa (2005).⁹

Konje et al (2002) mentioned that kidney length between 24 and 38 weeks of pregnancy was a more accurate technique for determining GA than other fetal biometric parameters such as BPD, HC, FL and AC.¹⁰ Kidney length can estimate the age of pregnancy, when the fetal head is too low and BPD and/or HC measurements are unfeasible. As the differences between the left and right kidney length is insignificant, measuring only one kidney in difficult cases does not affect the GA estimation.¹⁰

Another study in India by Kansaria et al (2009) demonstrated that by measuring kidney length, pregnancies could be dated within 9.17 days.⁶ Many authors, in their study did not find significant difference in kidney length between normal and growth restricted fetuses, but they observed decreased kidney volume (29% less) in foetuses with intrauterine growth restriction than that of normally grown foetuses, which may be due to impaired nephrogenesis as a result of decreased renal perfusion.^{3,14,15}

But Indu Kaul et al (2012).¹⁶ found in their study the mean Left fetal kidney length was slightly but significantly longer than the mean Right at each gestational period, which was also observed by Fitzsimons RB et al,¹⁷ Duval JM et al¹⁸ and Sampaio FJ et al,¹⁹ as mentioned by Indu Kaul et al.

The left kidney volume is more than the right one from VI to IX lunar month. Nevertheless, in X lunar month the right fetal kidney has bigger average volume than left one.¹⁰ In this study also the volume of left kidney is more than right at 30 weeks of gestation and

the volume of right kidney is more than left at 38 weeks of gestation. Philippe Jeanty et al (1982) also found the mean difference in both kidney volumes was 17%.²⁰

Many studies have found a very strong correlation between Fetal Kidney Length and Gestation Age.^{1,10,12,13,16} B O Verburg et al (2007) found all fetal growth parameters were positively associated with Fetal Kidney Volume.¹³

Conclusion

In this study, the observed mean dimensions of right kidney at 30 weeks of gestation were length 32.4 ± 5.2 mm, breadth 17.8 ± 2.9 mm, thickness 20.3 ± 4 mm and volume 6.3 ± 2.7 cm³ and that of left kidney were length 33.3 ± 4 mm, breadth 17.7 ± 2.9 mm, thickness 19.8 ± 3.4 mm and volume 6.4 ± 2.3 cm³. At 38 weeks of gestation, the mean measurements of right kidney were length 39.7 ± 4.9 mm, breadth 21.1 ± 3.5 mm, thickness 23.5 ± 4 mm and volume 11 ± 7.3 cm³ and the mean measurements of left kidney were length 39.2 ± 4.9 mm, breadth 20.7 ± 3 mm, thickness 22.7 ± 4.9 mm and volume 9.8 ± 2.8 cm³. An often quoted rule-of thumb is that "renal length in mm approximates gestational age in weeks". In this study the mean length in mm of fetal kidneys were slightly longer than the approximate gestational age in weeks. No difference in measurements between right and left kidney was found.

Interest of Conflict: None

References

- Cohen HL, Cooper J, Eisenberg P, Mandel FS, Gross BR, Goldman MA, Barzel E, Rawlinson KF. Normal length of foetal kidney: Sonographic study in 397 obstetric patients. *American Journal of Roentgenology*. 1991;157:545-548.
- Konje J. C., Bell SC, Morton JJ, de Chazal R, Taylor DJ. Human foetal kidney morphometry during gestation and the relationship between weight, kidney morphometry and plasma active renin concentration at birth. *Clin Sci (Lond)*. 1996;91(2):169-175.
- Konje J. C., C.I. Okaro, S. C. Bell, R. De Chazal and D. J. Taylor. A cross-sectional study of changes in foetal renal size with gestation in appropriate- and small-for-gestational-age fetuses. *Ultrasound Obstet. Gynecol*. 1997;9:22-26.
- Bertagnoli L, Lalatta F, Gallicchio MD et al. Qualitative characterization of the growth of fetal kidney. *J. Clin. Ultrasound*. 1983;11(7):349-56.
- Slobodan V, Dakovic-Bjelakovic M, Cukuranovic R, Krivokuca D. The Average Volume of Fetal Kidney during Different Periods of Gestation. *Acta Medica Medianae*. 2005;Vol:44:47-50.
- Kansaria J. J., SV Parulekar. Nomogram for Foetal Kidney Length. *Bombay Hospital Journal*, 2009;51(2):155-62.
- Farhat A, Javed M, Ali H, Wazir F. Comparative Study of Manual and Ultrasonographic Measurement of Foetal Renal Length. *Gomal Journal of Medical Sciences*. 2012;Vol. 10, No. 1:27-31.
- Dinkel E., M. Ertel, M. Dittrich, H. Peters, M. Berres and H. Schulte-Wissermann. Kidney size in childhood. Sonographical growth charts for kidney length and volume. *Pediatr Radiol*. 1985;15(1):38-43.
- Damen- Eliasa H.A.M., R.H. Stigtera, C. P. Westers, G.H.A. Vissera Growth and size charts of the foetal kidney and the renal pelvis, chapter-3 igitur-archive.library.uu.nl/dissertations/2005-0106-151942/c2.pdf.
- Konje J. C., K. R. Abrams, S. C. Bell and D. J. Taylor Determination of gestational age after the 24th week of gestation from fetal kidney length measurements. *Ultrasound Obstet Gynecol*. 2002;19:592-597.
- 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. *Australas Radiol*. 1997;41(1):3-5.
- Nahid Y, Moslem F, Haque JA. Fetal Kidney Length: Can be a New Parameter for Determination of Gestational Age in 3rd Trimester. *TAJ* 2007; Vol 20, No 2:147-1.
- Verburg B O, J. J. M. Geelhoed, E A P Steegers, A Hofman, H A Moll, J C M Witteman, and V W V Jaddoe. Foetal kidney volume and its association with growth and blood flow in foetal life: The Generation R Study. *Kidney Int*. 2007;72(6):754-761.
- Jeannette B, Olree M, Kaatee R, et al. Renal Volume Measurements: Accuracy and Repeatability of US Compared with that of MR Imaging. *Radiology*. 1999;211(3):623-628.
- Mohamed El B M, Ibrahim M A, Siam S, Seksaka MA. Foetal Renal Volume and Fetal Doppler in Normal and Growth Restricted Fetuses: Is there a Correlation? *Gynecol Obstet*. 2012; 2, 2. doi: 10.4172/2161-0932.1000118
- Indu K, Menia V, Anand A K, Gupta R. Role of Foetal Kidney Length in Estimation of Gestational Age. *J K Science*. 2012; Vol. 14 No. 2:65-69.
- Fitzsimons RB. Kidney length in the newborn measured by ultrasound. *Acta Paediatr Scand* 1983;72:885-87.
- Duval JM, Milon J, Langella B et al. Ultrasonographic anatomy and physiology of the fetal kidney. *Anat Clin*. 1985;7(2):107-23.
- Sampaio FJ, Mandarim-de-Lacerda CA, Prates JC. Allometric study of renal growth in human fetuses. *Surg Radiol Anat*. 1989;11(1):29-31.
- Jeanty P, Dramaix-Wilmet M, N. Elkhazen, Regemorter H V. Measurement of Fetal Kidney Growth on Ultrasound. *Radiology*. 1982;144:159-162.

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