ORIGINAL ARTICLE

Correlation between Fetal Kidney Length and Gestational Age on Ultrasound during Second and Third Trimester

MAHREEN TARIQ[1], MUHAMMAD NAWAZ ANJUM[2], USMAN SHAHID[3], SYED AMIR GILANI[4], MUHAMMAD ARSALAN OMER[5],HIFSA RIASAT[6]

[1,6]Deptt of Diagnostic Radiology,The University of Lahore.
[2]Head, Radiology Research Section,The University of Lahore.
[3]Head,Usman Diagnostic Center, Sheikhupura
[4]Dean, Faculty of Allied Health Sciences,TheUniversity of Lahore.
[5]Deptt.Of Radiology, DHQ Hospital, Sheikhupura
Correspondence to Dr. Muhammad Arsalan Omer, Email: dr.arslan14@gmail.com, Contact: 03214321557

ABSTRACT

Background: Exact evaluation of gestational age is essential to provide maternity quality care. Determining the fetus GA is a great challenge particularly during late trimester. With the progression of pregnancy, BPD, AC, HC and FL can be used but these parameters could be incorrect. The measurement of fetal kidney length has high prognostic values that can be utilized as an addition parameter.
Aim: To find the correlation between fetal kidney length on ultrasonography and gestational age in females presenting during second and third trimester.
Methodology: It was a cross-sectional, analytical study in which 400 pregnant females visiting Usman Diagnostic Center, Sheikhupura were included. Data was collected through questionnaire, which was entered and statistically analyzed using SPSS 21.0. Pearson's correlation was calculated to measure relationship between gestational age and fetal kidney length.
Results: Results showed that mean age of pregnant females was 26.49+3.989 years. A significant correlation between fetal kidney length and gestational age by LMP, BPD, FL, AC& HC was observed. The mean kidneys length during 18-24 weeks gestational age by USG was 21.557+2.0476 and during 25-37 weeks was 31.851+3.3801. The result was found statistically significant (P=0.000).
Conclusion: Study concluded that fetal kidney length is the most accurate parameter for the estimation of gestational age. It is strongly correlated with the gestational age during second and third trimesters.
Keywords: Fetal kidney length, gestational age, ultrasound, second and third trimester

INTRODUCTION

The kidneys, human body vital organs are the urinary system part that release metabolite waste products, play an important role in maintaining blood sugar and BP (blood pressure) levels, and also work like endocrine tissue liberating the Kinins, erythropoietin, rennin and 1,25-dihydroxycholecalciferol.[1] Fetal kidneys natural development is important for neonatal better outcome as well as knowledge regarding fetal kidney dimensions normal range, adrenal gland and renal pelvis is significant for recognition of anomalies.[2] Gestational age (GA) accurate assessment is necessary in the prenatal medicine for the prediction of labor dating and fetal health. Mistakes in deciding the accurate GA could meddle with serious management decisions, for example, during preterm labor and growth problem which is believed a major cause for neonatal mortality and morbidity.[3,4] In emerging states, antenatal care delayed booking remains a normal practice in pregnant females. Majority of traditional ultrasound indicators utilized for the assessment of GA become more varying beyond second trimester.[5] The obstetrician first and major responsibility is to date the pregnancy failure that can cause iatrogenic pre- or post-maturity of the fetus causing perinatal mortality and morbidity.[6]

Several techniques are available for the measurement of GA; during the 1st trimester delayed menstrual period &diameter/gestational sac (GS) volumes are adopted. With the progression of pregnancy, other parameters for example, biparietal diameter (BPD), abdominal circumference (AC), head circumference (HC) and femur length (FL) can be used. The parameters could be incorrect during delayed pregnancy, particularly when pregnant female is unable to remember her last menses period (LMP). Also, there is an important fact that SD (standard deviation) regarding these indicators are broaden when the pregnancy is progressed, and even it will be worse if head is very low or a clear plan cannot be achieved, that collectively will mislead HC and BPD measurement. Hence, other parameters are required which can provide a correct GA and can effortlessly be measures.[7,8]

Exact evaluation of GA is essential to provide maternity quality care. Most extensively utilized technique is ultrasound (US) fetal biometry to determine GA.[9] Determining the fetus GA is a great challenge, particularly during late trimester to treat pregnant females appropriately. Ultrasonographic parameters such as BPD, FL, AC and HC during 2nd and 3rd trimesters are very unreliable to assess the pregnancy date. Fetal kidney length (FKL) has been investigated and demonstrated to significantly correlate with GA during delayed trimesters even during intrauterine retardation fetuses.[10] Formulae for various dating have been demonstrated in literature more than past thirty years utilizing fetal biometric measurements by ultrasound.[11]

Received on
Accepted on

In the pregnancy dating, error of estimation could be due to late ovulation caused by oligo-ovulation or hormone treatment. The diagnostic ultrasound development has unlocked new probabilities for dating more confident evaluation. During first trimester GA can be evaluated through ultrasonographic measurement for diameter, GS volume and length of crown-rump.[12,13]

Normal antenatal FKL correct assessment plays an important role, hence, normal measurements determination helps in timely identification, improves fetal safety and makes reduction in elevated prenatal mortality and morbidity.[14]A study conducted by Toosi and colleagues supported FKL as a precise parameter during late pregnancy.[15] One more research carried out in India by Kansaria and coworkers confirmed that utilization of FKL enhanced the dating labor.[16] A study showed correlation between FKL onultrasound (0.997) while the GA was (P=0.000).[4] In a study Cohen et al. showed the association between FKL on ultrasonography and GA was r=0.82 (P-value <0.05).[17] Also, it was found that association between FKL on ultrasonography and GA was r=0.94 (P-value <0.0002).[18]

Generally, significant majority of pregnant women present during the late trimester and mostly unbooked. Also, they bias in remembering correct last dates of menses that make confusion. The measurement of FKL has high prognostic values that can be utilized as an addition parameter. This along with several other routine biometric indices (FL, BPD, AC, HC) will be useful to assess the correct gestational age in the fetuses who are vulnerable to growth retardation. Therefore, adding it to other routinely utilized parameters will provide gestational age better estimation. The objective of the study is to find the correlation between fetal kidney length on ultrasonography and gestational age in females presenting during second and third trimester.

MATERIAL METHODS

It was a cross-sectional analytical study in which 400 pregnant females aged 18-45 years with gestational age 18-37 weeks on LMP visiting Usman Diagnostic Center, Sheikhupura were included. Purposive sampling technique was used. Written informed consent was taken from all the participants. Demographic details were obtained including name, age, gestational age (on LMP), gestational age (a/c to ultrasound), FKL, HC, BPD, FL, AC. Then females were underwent ultrasonography for assessment of fetal kidney length by expert sonologist with ultrasound diagnostic scanner Toshiba Nimio XG with a 3.75MHz convex array transducer. Data was collected through questionnaire, which was entered and statistically analyzed using SPSS 21.0. Quantitative variables were described as mean and SD. Qualitative variables were described as frequency and percentage. Pearson's correlation was calculated to measure relationship between gestational age and fetal kidney length. A P-value ≤0.05 was taken as significant.

RESULTS

Table-1 exhibits that among 400 pregnant females, 340 (85%) were 18-30 years old and only 60 (15.0%) were 31-45 years old.

Figure-2 depicts that mean age + SD of pregnant females was 26.49+3.989 years whilemean gestational age according to LMP (weeks), BPD (mm), FL (mm), AC (mm), HC (mm), gestational age (according to BPD, FL, AC, HC), right fetal kidney length (mm), left fetal kidney length (mm), mean fetal kidneys length (mm) and mean gestational age according to FKL (mm) were 29.022+5.4856, 29.076+5.4716, 71.693+14.5894, 54.943+14.1861, 247.947+59.1698,29.076+5.4716, 28.968+5.4915, 29.347+5.5092, 29.123+5.4942, 29.123+5.4942, respectively.

Table-2 demonstrates a significant correlation between fetal kidney length and gestational age by LMP, BPD, FL, AC& HC.

Table-3 highlights that mean right kidney length during 18-24 weeks gestational age by LMP was 21.538+2.4078 and during 25-37 weeks was 31.681+3.3900 during second and third trimesters. The result was found statistically significant (P=0.000). The mean right kidney length during 18-24 weeks gestational age by USG was 21.418+2.0706 and during 25-37 weeks was 31.689+3.3876. The result was found statistically significant (P=0.000). Similarly, the mean right kidney length during 18-24 weeks gestational age by FKL was 21.418+2.0706 and during 25-37 weeks was 31.689+3.3876. The result was found statistically significant (P=0.000).

Result shows that mean left kidney length during 18-24 weeks gestational age by LMP was 21.874+2.3807 and during 25-37 weeks was 32.076+3.3879 during second and third trimesters. The result was found statistically significant (P=0.000). The mean left kidney length during 18-24 weeks gestational age by USG was 21.752+2.0287 and during 25-37 weeks was 32.085+3.3859. The result was found statistically significant (P=0.000). Likewise, mean left kidney length during 18-24 weeks gestational age by FKL was 21.752+2.0287 and during 25-37 weeks was 32.085+3.3859. The result was found statistically significant (P=0.000).

Table-1: Frequency distribution of age wise pregnant females

	Frequency	Percentage (%)
18-30 years	340	85.0
31-45 years	60	15.0
Total	400	100.0

Figure-1: Mean of age and gestational age

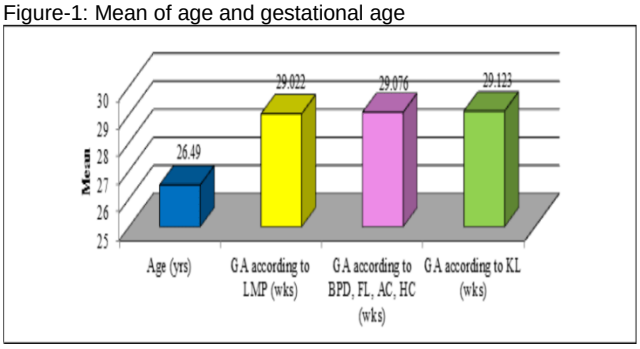

Table-3 describes that mean kidneys length during 18-24 weeks gestational age by LMP was 21.678+2.3914 and during 25-37 weeks was 31.842+3.3824 during second

and third trimesters. The result was found statistically significant (P=0.000). Likewise, the mean kidneys length during 18-24 weeks gestational age by USG was 21.557+2.0476 and during 25-37 weeks was 31.851+3.3801. The result was found statistically significant (P=0.000). The mean kidneys length during 18-24 weeks gestational age by FKL was 21.557+2.0476 and during 25-37 weeks was 31.851+3.3801. The result was found statistically significant (P=0.000).

Table-2: Correlation between gestational age and fetal kidney length

	Control Variables	Right kidney length	Left kidney length	Mean kidney length
Right KL	Correlation	1.000	.951	.985
	Significance (2-tailed)	.	.000	.000
	Df	0	397	397
Left KL	Correlation	.951	1.000	.969
	Significance (2-tailed)	.000	.	.000
	Df	397	0	397
Right KL	Correlation	1.000	.924	.977
	Significance (2-tailed)	.	.000	.000
	Df	0	397	397
Left KL	Correlation	.924	1.000	.952
	Significance (2-tailed)	.000	.	.000
	Df	397	0	397
Right KL	Correlation	1.000	-.076	.
	Significance (2-tailed)	.	.131	.
	Df	0	397	397
Left KL	Correlation	-.076	1.000	.
	Significance (2-tailed)	.131	.	.
	Df	397	0	397

Table-3: Mean fetal kidney length during second and third trimesters

	GA by LMP		GA by USG		GA by FKL	
	18-24 wks	25-37 wks	18-24 wks	25-37 wks	18-24 wks	25-37 wks
Right kidney length						
N	107	293	106	294	106	294
Mean	21.538	31.681	21.418	31.689	21.418	31.689
Std. deviation	2.4078	3.3900	2.0706	3.3876	2.0706	3.3876
Std. Error Mean	.2328	.1980	.2011	.1976	.2011	.1976
P-value	0.000		0.000		0.000	
Left kidney length						
N	107	293	106	294	106	294
Mean	21.874	32.076	21.752	32.085	21.752	32.085
Std. deviation	2.3807	3.3879	2.0287	3.3859	2.0287	3.3859
Std. Error Mean	.2302	.1979	.1970	.1975	.1970	.1975
P-value	0.000		0.000		0.000	
Mean kidneys length						
N	107	293	106	294	106	294
Mean	21.678	31.842	21.557	31.851	21.557	31.851
Std. deviation	2.3914	3.3824	2.0476	3.3801	2.0476	3.3801
Std. Error Mean	.2312	.1976	.1989	.1971	.1989	.1971
P-value	0.000		0.000		0.000	

DISCUSSION

Fetal kidney length is most precise technique for the determination of gestational age than fetal biometric indicators such as head circumferences, abdominal circumference, biparietal diameter and femur length during second and third trimester. Keeping in mind the significance of fetal kidney length, current study was carried out to assess the correlation between fetal kidney length and gestational age on ultrasound during second and third trimester. To acquire appropriate outcomes, 400 pregnant females were included in the study and found that most of the women were in their best reproductive years as 85.0% pregnant females were 18-30 years old and only 15.0% were 31-45 years old. The findings of our study are comparable but exhibited better scenario than a study undertaken by Halliru (2016) who reported that majority (68.1%) of the pregnant women were 18-30 years old and 31.9% were 31-45 years old[19].

Study further highlighted that mean age of the pregnant females was 26.49+3.989 years while mean gestational age according to LMP (weeks), BPD (mm), FL (mm), AC (mm), HC (mm), gestational age (according to BPD, FL, AC, HC), right fetal kidney length (mm), left fetal kidney length (mm), mean fetal kidneys length (mm) and mean gestational age according to FKL(mm) were 29.022+5.4856, 29.076+5.4716, 71.693+14.5894, 54.943+14.1861, 247.947+59.1698, 29.076+5.4716, 28.968+5.4915, 29.347+5.5092, 29.123+5.4942, 29.123+5.4942, respectively. But the results of a similar study undertaken by Ugur and coworkers (2016) showed that mean GA depending upon last menstrual period and

early US was 31.98±4.29 weeks. Fetal biometry mean indicators including BPD was 31.97±4.35 weeks, head circumference 31.98±4.32 weeks, femur length 31.76± 4.36 weeks and abdominal circumference 31.62±4.75 weeks while mean fetal kidney length measurement was 35.66±6.61mm.[8] A recent study carried out by Shaheen and associates (2019) indicated that mean right kidney length of fetuses was 33.2841+3.47501 and mean left kidney length was 33.3673+3.46742 while the mean gestational age was 33.1898+3.52883 weeks.[20]

Study further disclosed that mean right kidney length during 18-24 weeks gestational age by USG was 21.418+2.0706 and during 25-37 weeks was 31.689+3.3876. Likewise mean left kidney length during 18-24 weeks gestational age by USG was 21.752+2.0287 and during 25-37 weeks was 32.085+3.3859. As far as mean kidneys length is concerned, study divulged that mean kidneys length during 18-24 weeks gestational age by USG was 21.557+2.0476 and during 25-37 weeks was 31.851+3.3801. A similar study undertaken by Modi (2017) confirmed that mean kidneys length at 24 weeks was 21.84 and at 36 weeks was 38.93.[21] Likewise, Ananya (2013) demonstrated that mean kidney length at 24 weeks was 23.87+0.27 and at 36 weeks was 35.76+0.21.[22] Gupta and coworkers (2013) observed during study that mean fetal kidneys length was 30.7mm at 27 weeks while 39.4mm at 38 weeks.[23] Similarly, Kiran et al. (2019) reported in the study that mean fetal FKL was 26.02±0.25mm at twenty six week and 42.5±0.7mm at forty week of pregnancy.[24]

When the correlation between fetal kidney length and gestational age was assessed, study showed a significant correlation between fetal kidney length and gestational age by LMP, BPD, FL, AC& HC. The results of a study performed by Ugur and coworkers (2016) exhibited similar scenario who reported a very strong positive correlation (P=0.001) between fetal kidney length gestational age.[8] A study performed by Shaheen and associates (2019) reported a significant correlation between GA as per femur length, left kidney and right kidney. Results showed a strong correlation between GA and right kidney length according to femur length (P=0.000).[20]A recent study done by Muthaian et al. (2019) found a positive correlation between all parameter and gestational age. The correlation between fetal kidney length and gestational age was observed highly significant (P <0.001).[25] Describing the importance of fetal kidney length, study performed by Al-Mlah and assistant (2019) reported that FKL well correlates with GA, hence kidney measurement can be useful in the determination of gestational age when the menstrual dates are doubtful[26] while Abo-Donia and Shalaby (2019) elucidated in their study that mean fetal kidney length could be utilized as a novel single indicator to determine the gestational age during 2nd and 3rd trimesters.[27] The findings of our study were compared with several other similar studies and found that FKL measurement is a reliable USG parameter for accurate estimation of gestational age during 2nd and 3rd trimesters.

CONCLUSION

Study concluded that fetal kidney length is the most accurate parameter for the estimation of gestational age. It is strongly correlated with the gestational age during second and third trimesters.

REFERENCES

1. Purohit K, Purohit A, Kabiraj S, Srivastava RK. Study of fetal kidney size by ultrasonography at different gestational age. Indian journal of clinical anatomy and physiology. 2018; 5(3): 331-6.
2. Van Vuuren S, Damen-Elias H, Stigter R, Van der Doef R, Goldschmeding R, De Jong T, et al. Size and volume charts of fetal kidney, renal pelvis and adrenal gland. Ultrasound in obstetrics and gynecology. 2012; 40(6): 659-64.
3. Kinney MV, Lawn JE, Howson CP, Belizan J. 15 million preterm births annually: what has changed this year? Reproductive health. 2012; 9: 28.
4. Howson CP, Kinney MV, McDougall L, Lawn JE. Born too soon: preterm birth matters. Reproductive health. 2013; 10(1): S1.
5. Edevbie JP, Akhigbe AO. Ultrasound measurement of fetal kidney length in normal pregnancy and correlation with gestational age. Nigerian journal of clinical practice. 2018; 21(8): 960-6.
6. Shivalingaiah N, Sowmya K, Ananya R, Kanmani TR, Marimuthu P. Fetal kidney length as a parameter for determination of gestational age in pregnancy. International journal of reproduction, contraception, obstetrics and gynecology. 2014; 3: 424-7.
7. Kaul I, Menia V, Anand AK, Gupta R. Role of fetal kidney length in estimation of gestational age. JK science. 2012; 14(2): 65-9.
8. Ugur MG, Mustafa A, Ozcan HC, Tepe NB, Kurt H, Akcil E, et al. Fetal kidney length as a useful adjunct parameter for better determination of gestational age. Saudi medical journal. 2016; 37(5): 533-7.
9. Peter M, Nayak AK, Giri PP, Jain MK. 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. 2017; 5: 1869-73.
10. Chatterjee S, Yadav K, Prakash P, Shekhawat K. Foetal kidney length as a parameter for determination of gestational age in pregnancy by ultrasonography. International journal of reproduction, contraception, obstetrics and gynecology. 2016; 5: 1949-52.
11. Bailey C, Carnell J, Vahidnia F, Shah S, Stone M, Adams M, et al. Accuracy of emergency physicians using ultrasound measurement of crown-rump length to estimate gestational age in pregnant females. American journal of emergency medicine. 2012; 30(8): 1627-9.
12. Adam M, Tamboul JY, Yousef M, Sulieman A. The normal fetal kidney measurement in third trimester in normal pregnant Sudanese ladies. Journal of American science. 2013; 9(12): 794-7.
13. Toosi FS, Rezaie-Delui H. Evaluation of the normal fetal kidney length and its correlation with gestational age. ActaMedicaIranica. 2013; 51(5): 303-6.
14. Kansaria J, Parulekar S. Nomogram for foetal kidney length. Bombay hospital journal. 2009; 51(2): 155-62.
15. Cohen HL, Cooper J, Eisenberg P, Mandel FS, Gross BR, Goldman MA, et al. Normal length of fetal kidneys: sonographic study in 397 obstetric patients. American journal of roentgenology. 1991; 157(3): 545-8.
16. 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; 19(6): 592-7.
17. Halliru MA. Sonographic estimation of gestational age using fetal kidney length in Aminu Kano Teaching Hospital Kano,

Nigeria. Kano, Nigeria: Aminu Kano Teaching Hospital; 2016.
18. 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. International journal of applied sciences and biotechnology. 2019; 7(1): 108-113.
19. Modi V. Evaluation of fetal gestational age by assessment of fetal renal length: a comparative study. International journal of contemporary medical research. 2017; 4(8): 1796-8.
20. Ananya R. Fetal kidney length as a parameter for determination of gestational age in pregnancy. Bengaluru, Karnataka: Rajiv Gandhi University of Health Sciences; 2013.
21. Gupta DP, Gupta HP, Zaidi Z, Saxena DK, Gupta RP. Accuracy in estimation of gestational age in third trimester by fetal kidney length in Indian women. Indian journal of clinical practice. 2013; 24(5): 459-463.
22. Kiran L, Aneesh MM, Thulaseedharan A. Fetal kidney length in estimation of gestation age by sonography. International journal of contemporary medicine surgery and radiology. 2019; 4(3): C79-81.
23. Muthaian E, Selvaraj K. Accuracy of the fetal kidney length measurement by ultrasonography in the determination of the gestational age in pregnancy. National journal of clinical anatomy. 2019; 8(1): 18-21.
24. Al-Mlah S, Nasef A, El-Masry HAM. Assessment of fetal kidney length as a parameter for detection of gestational age at the third trimester of pregnancy. Egyptian journal of hospital medicine. 2019; 75(5): 2839-44.
25. Abo-Donia MEA, Shalaby IE. Determination of gestational age by ultrasonographic measurement of fetal kidney length during third trimester of pregnancy. Journal of medicine in scientific research. 2019; 2: 148-51.