Estimation of Fetal Gestational Age in Second & Third Trimesters from Ultrasonographic Measurements of Different Fetal Biometric Parameters

Kuldeep Kumar[1,*], Mirza R.U. Beg[2], C.S. Ramesh Babu[3], R. K. Shrivastava[4]

[1]Lecturer, Dept. of Anatomy, Govt. of Medical College, Kannauj, Uttar Pradesh,
[2]Assistant Professor, Dept. of Anatomy, Majors D Singh Medical College, Farrukhabad,
[3]Associate Professor, Dept. of Anatomy, Mujjafar Nagar Medical College, Mujjafar Nagar,
[4]Professor & Principal, Dept. of Anatomy, Rama Medical College, Mandhana, Kanpur, UP

***Corresponding Author:**
Email: drvermakupps@yahoo.com

ABSTRACT

The study was carried out to assess fetal gestational age with the help of ultrasonographic measurements of different fetal biometric parameters [i.e. Biparietal diameter (BPD), Femur length (FL), Abdominal circumference (AC)] and Fetal kidney width (KW), in 199 women with singleton uncomplicated pregnancies attending the O.P.D for routine ultrasound fetal biometry in western Uttar Pradesh (UP). Above fetal parameters were measured biweekly, between 18 and 38 weeks of gestation. Linear regression models for estimation of gestational age were derived from above fetal biometric parameters.

The linear regression model for estimating fetal gestational age is femur length, abdominal circumference, fetal kidney width and biparietal diameter in that order with standard error of ± 3.85, ± 4.85, ± 5.81 and ± 8.75 days respectively.

Key words: *Gestational age, Biparietal diameter, Femur length, Abdominal circumference and fetal kidney width*

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INTRODUCTION

Accurate knowledge of gestational age (age of unborn baby) is key for, care, planning, critical interpretation and successful management of all pregnancies. Failure can result in iatrogenic prematurity or post maturity, both of which are associated with increased perinatal mortality and morbidity. Initially the dating of pregnancy was based on the first day of last menstrual period) in a regular 28 day menstrual cycle. But this method for dating the pregnancy is unreliable in those women who do not exactly recall their menstrual history. Since the introduction of diagnostic ultrasound, more reliable methods to date the pregnancy have been developed. In early pregnancy, these are Gestational sac diameter and volume and Crown-Rump length (CRL) measurements. In second trimester most commonly used biometric parameters for estimating gestational age are – Biparietal diameter and Femur length (Egley et al[1] 1986) and other used parameters are transverse cerebellar diameter (Chavez et al[2], Scapular measurement (Dilmen et al[3]), Fetal kidney length (Ansari et al[4]), Fetal renal volume (Fauchonet et al[5]). Fetal kidney size (Kyosun Kim et al[6] 1995), multiple fetal parameters (Hadlock et al[7] 1987).

Hence, the present study is undertaken to assess gestational age in second and third trimesters with the help of sonographic measurements of Biparietal diameter, Femur length, Head circumference & abdominal circumference.

MATERIAL AND METHOD

The study was carried out on 199 women with singleton uncomplicated pregnancies attending the O.P.D for routine ultrasound fetal biometry, in the Department of Radio diagnosis, L.L.R.M. Medical College and associated S.V.B.P. Hospital Meerut. This study includes only those uncomplicated pregnant women having single live normal fetus and those women who have multiple pregnancies and suffer from eclampsia, pre-eclampsia, chronic hypertension, Diabetes mellitus and intrauterine growth retardation were excluded from the study.

We measured four fetal biometric parameters (i.e. BPD, FL, AC and KW) by using Madison S A 8000 S E ultrasonographic machine with curvilinear probe- 3.5 to 5 MHz's. Biparietal diameter was measured maximum distance between two parietal bones at the level

of the cavum septum pellicidam, femur length from greater trochanter above to lateral condyle below (the calcified portion was measured), Abdominal circumference at the level where the umbilical vein enters the left branch of portal vein and The width of the kidney was measured in a transverse section through the abdomen, the level taken, was at the height of the renal pelvis. We have measured both kidneys per fetus in the construction of the kidney width charts. The fetal kidneys appear ultrasonically as a sonoluscent halo of tissues surrounding the somewhat more echogenic pylocalyceal sinus. The kidneys are difficult to identify prior to 17 weeks of gestation. Statistical analysis was done using linear regression equation.

RESULT

Observation table I shows Mean BPD, FL, AC and Kidney width (No of cases)

Observation table II shows that the femur length (r^2 = 99.4%) is most accurate parameter, followed by Abdominal circumference (r^2 = 99%), Kidney width (r^2 = 98.6%) and biparietal diameter (r^2 = 96.8%).

Table III shows the comparison of BPD, FL & AC of present study with Konje et al (2002) & Kansaria and Parulekar (2009).

There was a significant correlation between gestational age (weeks) and mean fetal Femur length (mm), r^2 = 0.994 or 99.4% ($p < 0.0001$), Abdominal circumference (mm), r^2= 0.99 or 99% with $p < 0.0001$), Kidney width (mm) r^2= 0.986 or 98.6% with $p < 0.0001$) and Biparietal diameter (mm), r^2= 0.968 or 96.8% with $p < 0.0001$) respectively.

Most accurate was femur length with standard error of prediction of ± 3.85 days. Accuracy of AC, KW, and BPD is ± 4.85, ± 5.81 and ±8.75 days. Other values of these parameters are given in Table II. Mean kidney width of present study also compared with study of Kim and park (1995).

Table 1: Mean BPD, FL, AC and Kidney width (No of cases =199)

S. No.	Gestational age (weeks)	No. of Cases	Mean BPD (mm±SD)	Mean FL (mm±SD)	Mean AC (mm±SD)	Mean Kidney width (mm±SD)
1	18	06	26.1±2.8	39.8±3.3	147.9±8.1	9.10±0.70
2	20	15	33.8±2.1	47.4±2.5	176.8±7.5	10.50±0.50
3	22	17	38.7±1.6	55.0±2.5	199.7±10.7	11.50±0.85
4	24	15	43.1±2.3	60.0±2.1	215.0±8.4	12.60±0.74
5	26	19	48.7±2.4	66.6±2.1	250.5±11.5	14.10±1.00
6	28	13	53.9±1.6	72.5±2.6	265.3±8.8	15.30±0.72
7	30	21	57.5±1.6	76.3±1.8	281.6±11.5	16.00±0.80
8	32	28	63.1±1.5	81.3±1.7	296.5±7.3	16.80±1.20
9	34	36	67.0±1.8	86.3±1.7	310.9±7.3	19.00±1.50
10	36	23	70.9±1.6	89.5±1.6	325.7±5.4	21.10±1.83
11	38	06	74.4±2.3	92.4±1.0	327.6±6.9	22.30±2.20

Table 2: Shows predicted values of various parameters (Independent variables like -BPD, FL, KL, KW and Dependent variables Like - Gestational age in weeks).

Parameters	Intercept (a)		Slope (b)		P value (significance)		95% confidence interval				R square	SEp
	Estimate	Standard Error	Estimate	Standard Error	Intercept (a)	Slope (b)	Intercept (a)		Slope (b)			
							Lower Bond	Upper Bond	Lower Bond	Upper Bond		
1.BPD	1.455	1.647	.377	.023	.400	.000	-2.271	5.181	0.326	.429	.968	8.75
2.F.L.	6.087	.595	.418	.011	.000	.000	4.740	7.434	.393	.442	.994	3.85
5. AC	4.978	0.783	.0.098	.0.003	.000	.000	3.20	6.75	0.091	0.106	.99	4.85
6. KW	4.611	.966	1.530	.061	.000	.000	2.427	6.796	1.392	1.668	.986	5.81

1. (A) are independent variables (BPD, FL, KL & KW).
2. (B) are dependent variables i.e. gestational age in weeks
3. SEp = Standard Error of Prediction

Table 3: Linear regression equation comparison of BPD, FL and between the present study and that of Konje et al (2002) & Kansaria and Parulekar (2009)

Param-eters	Study	Intercept		Slope		P value	r^2	
		Estimate	SE	Estimate	SE			SEp
3.BPD	Present study	1.455	1.647	.377	0.023	<.0001	96.8	8.75
	Konje et al(2002)	0.808	0.447	0.388	0.005	<.0001	88	11.16
	Kansaria and Parulekar (2009)	0.741	0.447	0.388	0.005	<.0001	90.91	10.99
2.FL	Present study	6.087	0.595	.418	0.011	<.0001	99.4	3.85
	Konje et al(2002)	5.00	0.348	0.449	0.005	<.0001	89	10.96
	Kansaria and Parulekar (2009)	3.084	0.52	0.411	0.006	<.0001	94.84	10.28
3. AC	Present study	4.978	0.783	0.098	0.003	<.0001	99.00	4.85
	Konje et al(2002)	5.493	0.452	0.97	0.002	<.0001	81.00	14.54
	Kansaria and Parulekar (2009)	3.898	0.871	0.84	0.003	<.0001	92.42	11.14
4.KW	Present study	4.611	0.966	1.53	0.061	<.0001	99.3	5.81

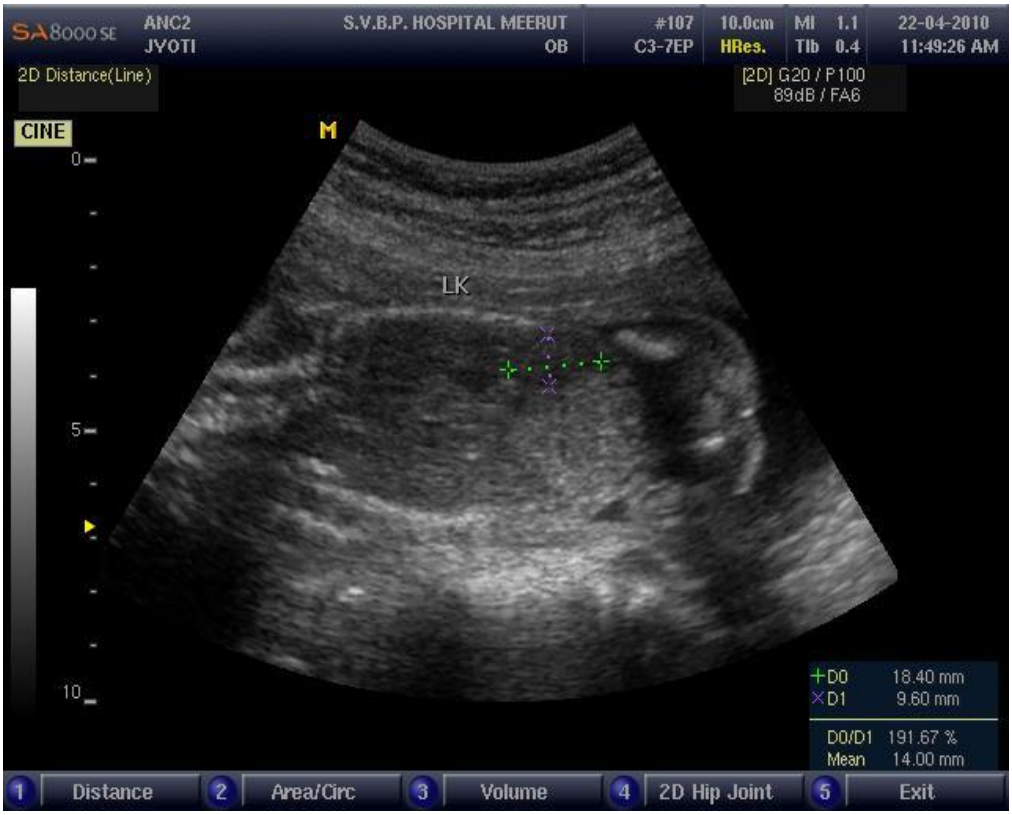

Figure 1: Ultrasonogram showing measurement of left fetal kidney width at 22 weeks of gestation is 9.60mm

Figure 2: Ultrasonogram showing measurement of left fetal kidney width at 38 weeks of gestation is 22.20mm

Figure 3: Ultrasonogram showing measurement of femur length at 24 weeks of gestation (average) is 44.8 mm (4.48cm)

Figure 4 & 5: Ultrasonograms showing measurements of BPD and AC at 24 weeks of gestation (average) is 62.80 mm (6.28cm) and 195.2mm (19.52cm) respectively

DISCUSSION

In the past many researchers worked on correct estimation of gestational age by using deferent biometric indices by ultrasound and found that the accuracy of individual parameter decreases as pregnancy advances. In our study we used four parameters to assess gestational age in second and third trimesters. Our observations show that the mean gestational age is most accurate in predicting gestational age. Our findings supported by Hadlock et. al.[7], kansaria and parulekar[8] and konje et al[9]. We compared the mean fetal FL, BPD, AC of our study with that of Konje et al[9] and Kansaria & Parulekar[8] and Mean KW with Kim and Park[6]. Table I shows different parameters of the present study (i.e. FL, BPD, AC, and KW) increase as pregnancy progresses from 18 to 38 weeks of gestation.

The data of the our study for mean fetal kidney width increases as pregnancy progresses from 18 to 38 weeks of gestation (9.10 mm, 10.50 mm, 11.50 mm, 12.60 mm, 14.10 mm, 15.30 mm, 16.00 mm, 16.80 mm, 19.00 mm, 21.10 mm, and 22.30 mm at 18, 20, 22, 24, 26, 28, 30, 32, 34, 36 and 38 gestational weeks respectively). The readings of fetal kidney width reported by Kim and Park[6] between 20 to 40 week of gestation at four weekly intervals are 1.25cm, 1.24cm, 1.58cm, 1.81cm, 1.89cm and 1.89cm respectively. Our values of mean fetal kidney width are lower than those reported by Kim and park at 20, 28 and 32 weeks and higher at 24, 36 and 38weeks of gestation. The values in our study are lower or higher as discussed above because there are significant racial, nutritional status, body build and socioeconomic differences between individuals of the present study and those of studies done by Konje et al[9], Kansaria and Parulekar[8] and Kim and Park[6].

The differences in the readings may also be attributed to number of operators (multiple v/s two skilled operators v/s one skilled operator), type of study (cross sectional v/s longitudinal), estimation of gestational age (rounded off v/s exact) and quality of ultrasound machine (older v/s newer). In our study, all sonographic measurements were performed by a single skilled and experienced sonologist, it was a random study, the ultrasound machine used was new and the patients included in the study are from western U.P. Out of Four fetal parameters (BPD, FL, AC and KW), FL and AC predicted gestational age with better precision than the model with biometric index of KW and biparietal diameter. The linear equations derived from present study have been compared with the individual variable separately with the study done by Konje et al[9], and Kansaria and Parulekar[8] (Table III) and Kim and Park. The accuracy of BPD 11.62 days by Konje et al [6] and 10.99 days by Kansaria and Parulekar[8] and 8.75 days by this study, FL 10.96day by Konje et al[9] and 10.28 days by Kansaria and Parulekar[7] and 3.85 days by this study, AC 14.54 days by Konje et al[9] and 11.44 days by Kansaria and Parulekar[8] and 4.85 days by this study. The accuracy KW is 5.81 days in present study. In present study four fetal parameters correlated well with gestational age.

CONCLUSION

Our study reveals the use of four fetal biometric parameters (BPD, FL, AC and KW) to estimate gestational age accurately and determine expected date of delivery in populations of western UP. Fetal kidney width can be used as investigational tool in determination of gestational age in late second and third trimester of pregnancy. Fetal kidney width is not affected by the discrepancy of late trimester or by fetal growth retardation. The best linear regression model for estimating fetal gestational age is femur length, abdominal circumference, Kidney width and biparietal diameter in that order, with standard error of ± 3.85, ± 4.85, ± 5.81, and ± 8.75 days respectively.

In those women who do not recall their menstrual history, Thus in these cases fetal parameters can be used as a tool for estimating fetal gestational age in second and third trimester and it can be applicable in routine practice in general population.

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