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ORIGINAL ARTICLE

Fetal Kidney Length as a parameter for determination of Gestational Age in Second Trimester of Pregnancy

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ABSTRACT

Objective: To evaluate application and accuracy of foetal kidney length measurement in determining the gestational age of foetus in second trimester of pregnancy.

Design: Prospective study.

Methods: The present study evaluated the role of Foetal Kidney Length in determining the gestation age with the study population of 101 pregnant women with single ton uncomplicated pregnancies who attended the outdoor patient department of Radiology at the MMIMSR, Ambala for routine ultrasound foetal biometrics like Bi-parietal Diameter (BPD), Abdominal Circumference (AC), Femur Length (FL),Head Circumference (HC). Foetal kidney lengths (FKL) were measured in second (20-24 weeks) trimester.

Results: Kidney Length predictedgestational age with precision when combined with other foetal biometrics – BPD, AC, HC, FL.

Conclusion: Foetal Kidney length when combined with other foetal parameters increases the efficacy of gestational age

Key words: Gestational age, Foetal Kidney Length, Pregnancy

Introduction

Accurate Gestational Age (GA) estimation is very important to anobstetrician for diagnosis of growth disorders, inassessment of wrong dates or forgotten dates and timing of delivery either by induction or caesarean section. It isparticularly important in high risk pregnancies. Wherein some cases early termination may become necessaryas soon as foetus becomes mature. GA estimation is also a prerequisite to interpret certain tests and to plantiming of various forms of foetal therapy. Failure inestimating GA accurately can result in unnecessaryinduction, dysfunctional labour, operative delivery, iatrogenic prematurity or postmaturity, false interpretationof tests and delay or failure of foetal therapy, therebyincreasing perinatal morbidity and mortality. GA hastraditionally been estimated from the date of first day of last menstrual period (LMP). The fallacy in this method is that the time of ovulation in relation to the menstrual cycle varies greatly both from cycle to cycle and individual to individual. About 10-45% of pregnant women cannot provide useful information about their LMP and 18% of women with certain menstrual dates have significant differences between menstrual and ultrasonography dating [1].

Since the introduction of diagnostic ultrasound, more reliable methods to date the pregnancy have been developed. In the first term, these are gestational sac diameter and volume and crown rump length (CRL) measurement [2]. In the second trimester, the most commonly used biometric indices for dating pregnancies are biparietal diameter (BPD) and femur length (FL) [3] and other used parameters are transverse cerebellar diameter, [4] scapular measurement, [5] foetal kidney length, [6] and foetal renal volume [7]. Foetal kidney is easy to identify and measure in the late second and third trimesters and there is a strong correlation between gestational age and foetal kidney length [8].

Hence, the present study is undertaken to evaluate the reliability of Foetal Kidney Length for estimation of gestational age (GA) in second trimester (20-24 weeks) and also to find out the effect on gestational age if measured by Foetal Kidney alone or when it is combined

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with other biometric indices such as BPD ,FL, AC and HC.

Materials and Methods

The study was carried out, after obtaining informed consent, on 101 women with singleton uncomplicated pregnancies attending the outdoor patient department (OPD) for routine ultrasound foetal biometry, in the Department of Radio diagnosis, MMIMSR Medical College, Mullana, Ambala. This study included only those uncomplicatedpregnant women having single live normal foetus and those women who had multiple pregnancies and suffered from eclampsia, pre-eclampsia and chronic hypertension, diabetes mellitus and intrauterine growth retardation were excluded from the study.

The selective foetal biometric indices (BPD, FL, HC, and AC) were measured along with Foetal Kidney Lengths (FKL) by using Ultrasound machine HD-11xE (Philips Medical systems, USA) with convex array transducer in the second trimester between 20-24 weeks. The maximum renal length was measured from the upper pole to lower pole of both the kidneys in the longitudinal section of the foetus in the sagittal plane. The data was then analysed using software SPSS Version 21. To predict GA by using FKL alone and by other foetal biometric indices, Univariate and multivariate Linear Regression analysis was performed based on Ultrasonography. GA was taken as dependent variable whereas foetal biometrics indices as independent variables.

New models were constructed including BPD, HC, FL, AC& KL (average) in various combinations.The best model was determined based on Akaike Information Criterion (AIC), r^2 (Coefficient of Determination) & Std. Error of Estimate in days was also calculated. The Left Kidney length and the Right Kidney Length were compared between 20-24 weeks of gestation based on USG. Its significance was assessed by usage of paired T-test. Also, the coefficient of correlation between Gestational age (according to USG)and foetal biometric parameters including MKL was also calculated.

Results

The study involved 101 women with singleton uncomplicated pregnancies in between 20-24 weeks of gestation. 9 women out of 101 could not remember their date of Last Menstrual Period (LMP), however reported of regular cycles. These womenunderwent standard ultrasoundfoetal biometrics and kidney length measurement. During the study it wasobserved that FKL roughly corresponds to theage of gestation with left kidney slightly longer than right.

Table 1 shows that significant difference exists between the Left & Right Kidney Length at 21 weeks of gestation with p value less than 0.0005 and same for 22& 23 weeks of gestation when calculated according to USG.

Table 1 : Comparing LKL with RKL at different period of gestation in weeks according to USG

	LK (mm)	RK (mm)	Difference (mm)	Paired T Test	KL
GA weeks	Mean ± SD	Mean ± SD			Mean ± SD
20	19.87 ± 2.27	19.13 ± 2.33	-0.746	0.6131	19.5 ± 2.19
21	20.22 ± 2.14	19.65 ± 1.96	-0.567	0.0306	19.94 ± 1.94
22	22.02 ± 5.79	21.05 ± 4.79	-0.971	0.0113	21.54 ± 5.24
23	22.41 ± 3.02	21.36 ± 2.51	-1.045	0.0009	21.89 ± 2.75
24	22.84 ± 2.5	22.14 ± 2.48	-0.700	0.3644	22.49 ± 2.31

LK - Left Kidney Length, RK - Right Kidney Length, KL - Mean of Left Kidney Length & Right Kidney Lengths.

Table 2 : Univariate Regression on GA according to USG

	R Square	Std. Error of the Estimate	Regression Equation	P value	correlation coefficient
BPD	.655	5.156	77.4 + 1.43 * BPD2	.000	0.809
HC	.738	4.491	49.15 + 0.54 * HC2	.000	0.859
FL	.657	5.137	93.71 + 1.58 * FL2	.000	0.811
AC	.658	5.133	71.24 + 0.48 * AC2	.000	0.811
KL	.114	8.259	133.5 + 0.89 * MKL2	.001	0.337

BPD - Biparietal Diameter, HC - Head Circumference, FL- Femur Length, AC - Abdominal Circumference, KL - Average of LK & RK

Table 3 : Multivariate regression on GA on USG

	Residual sum of squares	AIC	Regression Equation	R Square	Std. Error of the Estimate
KL, BPD	2473.728	135.5198996	72.68 + 0.39 * MKL + 1.36 * BPD	.675	5.024
KL,HC	1971.540	126.4536334	48.23 + 0.16 * MKL + 0.53 * HC	.741	4.485
KL,FL	2549.521	136.7257159	90.64 + 0.25 * MKL + 1.52 * FL	.665	5.101
KL,AC	2593.392	137.4073887	70.4 + 0.12 * MKL + 0.47 * AC	.660	5.144
KL,HC,BPD	1438.433	115.8573576	46.5 + 0.16 * MKL + 0.35 * HC + 0.68 * BPD	.811	3.851
KL,HC,FL	1475.035	116.8613338	55.07 + 0.09 * MKL + 0.35 * HC + 0.74 * FL	.806	3.900
KL,HC,AC	1516.522	117.9696045	45.38 + 0.03 * MKL + 0.36 * HC + 0.22 * AC	.801	3.954
KL,HC,BPD,FL	1179.826	109.9387755	52.06 + 0.1 * MKL + 0.26 * HC + 0.53 * BPD + 0.56 * FL	.845	3.506
KL,HC,BPD,AC	1149.535	108.899578	44.44 + 0.05 * MKL + 0.24 * HC + 0.58 * BPD + 0.18 * AC	.849	3.460
KL,HC,BPD,AC,FL	984.886	104.7230482	49.3 + 0.02 * MKL + 0.18 * HC + 0.47 * BPD + 0.46 * FL + 0.15 * AC	.871	3.220

KL- Average of Left and right kidney acc to Usg, BPD- Biparietal Diameter, HC- Head Circumference, FL- Femur Length, AC- Abdominal Circumference, AIC- Akaike Inforamation Criterion

Table 2 shows that when individual variables were analysed separately based on USG,the Head Circumference (HC) was the most accurate parameter with standard error of estimate (4.491) followed by AC with standard error of estimate (5.133). MKL was the most inaccurate parameter with std error of estimate (8.259) in second trimester according to USG.

Table 3 Shows multivariate regression analysis of GA based on USG. The derived model of GA prediction by combination of various Foetal Biometrics Indices based on USG shows accuracy of precision of Gestational Age estimation is best when MKL is combined with other gold standard parameters (BPD, HC, AC,FL) with SE of estimation of just 3.22 days.

Discussion

Accurate dating of pregnancy is a challenge for obstetrician till the present day especially in women with unreliable menstrual history. Failure to date the pregnancy accurately can result in the iatrogenic prematurity or post maturity, both of which can cause increased peri natal mortality and morbidity. Earlier the gestational age was calculated by knowing the first day of last menstrual period in a regular (28 days cycle) or by physical examination. These methods of dating pregnancy are not considered to be reliable anymore. Women with certain clinical conditions like oligohydramnios, polyhydramnios and women who could not exactly remember their LMP, these methods were associated with erroneous estimation of gestational age. Introduction of diagnostic ultrasound has taken obstetrics to the new horizons to the fact that gestational age could now be calculated with more accuracy thus resulting considerable decrease in perinatal morbidity and mortality [9].

Gestational age is calculated with precision by measuring ultrasonic foetal parameters like BPD, AC, HC and FL in 2nd trimester. In certain circumstances these parameters may not be reliable like femur length in achondroplasia, similarly BPD and HC becomes unreliable in altered skull growth like macrocephaly, microcephaly etc. [6,10]

Taking into consideration the disparities of the scan, various non-traditional methods are under study. Foetal kidney length is one such non-traditional parameter which is easy to measure and correlates well with gestational age especially in unbooked women. More over kidney length is one such parameter which is not affected by growth variations. However in practice, all these are not common methods of dating pregnancies. There is therefore a need to investigate a method of dating pregnancies that is simple, easy to define and reproducible. Although kidney size, as for all foetal organs, is affected by growth variations, these appear to predominantly affect only the anterior–posterior and transverse diameters [11].

The present study evaluated the role of foetal kidney length measurement in the estimation of gestational age alone and when combined with and compared with that of routinely used gold standard parameters like BPD,FL,AC and HC in second trimester 20-24 weeks. In all the cases the foetal kidney length was easily visualised with a little manipulation of transducer position and angle insonation relative to kidney plane, which is in agreement with Konje et al. [12]

Foetal parameters like BPD, FL, AC and HC were measured in 101 cases along with both kidney lengths in 2nd trimester. 92 women out of 101 were sure of their LMP.

The left kidney length when compared with that of right kidney by using paired T test showed a significant variation between the left & right kidneys with p value <0.0005 (Table 1). It was also observed that the left kidney length was significantly longer than the right kidney in the 2nd trimester (Table 1).These findings were in agreement to the studies done earlier which also found that the left kidney was longer than the right [3].

All four biometric indices were measured in 101 cases along with both KL.There was increase in Foetal Kidney Length as the gestation increases indicating significant correlation between gestational age and mean foetal Kidney Length. [13]

In our study the equations derived from linear regression analysis when the individual biometric parameters (variables) were analysed separately. The most accurate parameter was HC with a standard error (SE) of 4.491, whereas it was highest for MKL with the SE of 8.259 days (Table 2).

We also found thatthe derived models of GA prediction by combination of various biometric indices showed that the estimation of the best GA can be achieved by combining AC, BPD, FL and HC with a SE of 3.460 days and the accuracy of precision of estimation of gestational age increases when MKL (Mean Kidney Length) is combined to the above model with SE of prediction of just 3.22 days.

Conclusion

Hence it is concluded that although there is a strong correlation between the Kidney Length and gestational age. In this study however FKL was not found to be reliableparameter when used alone for estimation of gestational age between 20-24 weeks but its accuracy increases only when it is combined with the other four gold standard parameters. Therefore, foetal kidney length can be used as a tool for estimating foetal gestational age in the second trimester only when used along with the other parameters.

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