

STUDY OF ACCURACY OF COMMONLY USED FETAL PARAMETERS FOR ESTIMATION OF GESTATIONAL AGE

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ABSTRACT

Estimation of the gestational age by sonographic measurements of fetal parameters is usually done by measuring mean sac diameter (MSD), Crown-rump length (CRL), biparietal diameter (BPD), head circumference (HC), femoral length (FL) and abdominal circumference (AC) depending on the trimester of pregnancy. This is a prospective study to see the correlation of different fetal parameters in estimating the gestational age. A total of 71 normal women were taken and ultrasonogram was done to take MSD and CRL in 1st trimester and BPD, HC, FL and AC in 2nd and 3rd trimester. Gestational age was calculated by MSD using Rempen normogram and Hadlock normograms were used for the rest of fetal parameters. Gestational age by LMP was also calculated at the same time. Correlation of different fetal parameters in estimating gestational age in different trimesters was done by Pearson correlation. Pearson correlation showed that the CRL was the best fetal parameter (correlation coefficient of 0.909) in the first trimester. The correlation of MSD and average gestational age by MSD and CRL was with correlation coefficients of 0.778 and 0.888 respectively. Thus the averaging of gestational age in 1st trimester decreases the accuracy in the gestational age estimation. Correlation of gestational age by BPD, HC, FL and AC and their average in 2nd trimester showed that the best correlation was by AC and the least correlation by BPD in this study. It is in contrary to other studies which could be due to chance finding or bias because of prospective study. Pearson correlation calculated in 3rd trimester showed HC and FL were better parameters than BPD and AC. Average gestational age by simple averaging of BPD, HC, FL and AC gives more accurate estimation of gestational age in both 2nd and 3rd trimester.

Key Words: Ultrasonogram, Fetal parameters, Gestational age.

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INTRODUCTION

Conception occurs approximately two weeks after last menstrual period (LMP) in women with regular 28 days cycles however gestational age is calculated from the first day of the last menstrual period. Ultrasonography has evolved as a promising modality in evaluation of gestational age. It now provides information about fetal age, growth and development. Professor Ian Donald was the pioneer who described measurements of BPD in 1961 for estimation of gestational age.¹ Then gestational sac diameter was described in assessment of gestational age in 1969 by Hellman and Kobayashi.² Later on measurement of different body parts of fetus was tried for studying gestational age. The size of variety of fetal body parts depends upon the gestational age. Thus gradually measurements of crown-rump length (CRL), Abdominal Circumference (AC), Femoral length (FL), Head Circumference (HC) are introduced. Though normograms of thoracic circumference, binocular diameter, tibial length, trans-cerebellar diameter, etc. are available, 6 parameters (MSD and CRL in 1st trimester and BPD, HC, FL and AC in 2nd and 3rd trimester) are the most commonly used measurements. These are considered enough for routine assessment of fetal growth.

In every scan, every parameter may not be available due to different reasons. Availability of fetal parameters for estimation of gestational age depends on the trimester scanned, fetal position and abnormality if any in fetus. Fetal ascites or omphalocele can cause inaccurate measurement of AC. Skeletal dysplasia can be the source of error in estimating gestational age by FL. Hydrocephalus or microcephaly can give faulty measurements of BPD or HC.

Therefore, we may have to rely on fewer than available fetal parameters. At times, question of the reliability of the single or fewer parameters for gestational age estimation may arise. Therefore the study was carried out at BP Koirala Institute of Health Sciences, Dharan to determine the correlating fetal parameter in different trimesters of pregnancy.

MATERIALS AND METHODS

Normal pregnant women who visited the antenatal clinic of BP Koirala Institute of Health Sciences (BPKIHS) were enrolled in the study. This is a prospective study conducted in the department of Radio-diagnosis in coordination with the department of obstetrics and gynecology in 2002-2003. A total of 88 pregnant women were included in the study who received antenatal care and had normal delivery at BPKIHS Hospital. All the ultrasonograms were performed by a Radiologist using high resolution real time ultrasound system, Siemens Versa Pro with linear and convex probes of 3.5-7.5 MHz transducer. The measurements of the fetal parameters e.g. MSD, CRL, BPD, HC, FL and AC were taken in millimeters using electronic calipers in accordance with standard methods depending on the trimester scanned.

In 1st trimester, measurements were taken in 6-12 weeks. Measurements of 2nd and 3rd trimesters of same pregnant women were taken at around 18th and 32nd weeks which were the appropriate time for anomaly detection also. Average gestational age was also calculated by simple averaging of gestational ages by different fetal parameters in each trimester. The gestational age (GA) was calculated by Rempen (for MSD) and Hadlock (for CRL, BPD, HC, FL and AC) normogram tables and by known LMP in pregnant women with regular cycle. After compiling all those informations, data were analyzed and correlated using Pearson correlation.

RESULTS

Out of 88 pregnant women included in this study, a total of 71 normal pregnant women without fetal abnormality completed all the follow up scans as per dates allocated. The correlation of the gestational ages by MSD (Rempen), CRL (Hadlock) and the average gestational age with the gestational age by LMP was evaluated by Pearson Correlation. GA by MSD with Rempens table showed significant correlation (Correlation coefficient-0.778) (Table-I). Pearson correlation also showed that the GA by CRL with Hadlock normogram was strongly correlated with GA by LMP with correlation coefficient of 0.909.

Table I : Pearson Correlation of GA by different fetal parameters with GA by LMP in 1st Trimester

		AVG GA by MSD + CRL in days	GA by MSD in days (I)	GA by CRL in days (I)	GA by LMP in days (I)
Pearson Correlation	AVG GA by MSD+CRL in days	1.000	.897**	.982**	.888**
	GA by MSD in days (I)	.897**	1.000	.844**	.778**
	GA by CRL in days (I)	.982**	.844**	1.000	.909**
	GA by LMP in days (I)	.888**	.778**	.909**	1.000
Sig. (2-tailed)	AVG GA by MSD+CRL in days	.000	.000	.000	.000
	GA by MSD in days (I)	.000	.	.000	.000
	GA by CRL in days (I)	.000	.000	.	.000
	GA by LMP in days (I)	.000	.000	.000	.

AVG GA = Average gestational age in 1st Trimester.

** Correlation is significant at the 0.01 level (2 tailed)

Table II: Pearson correlation of GA by different fetal parameters with GA by LMP in 2nd Trimester

		GA BPD in days (II)	GA by HC in days (II)	GA by FL in days (II)	GA by AC in days (II)	AVGA 2	GA by LMP in days (II)
Pearson Correlation	GA BPD in days	1.000	.8389	.753**	.744**	.902**	.435**
	GA by HC in days	.833**	1.000	.745**	.906**	.906**	.511**
	GA by FL in days	.753**	.745**	1.000	.744**	.903**	.504**
	GA by AC in days	.744**	.693**	.744**	1.000	.861**	.553**
	AVGA2	.902**	.906**	.905**	.861**	1.000	.554**
	GA by LMP in days	.435**	.511**	.504	.553	.554**	1.000
Sig. (2-tailed)	GA BPD in days	.000	.000	.000	.000	.000	.000
	GA by HC in days	.000	.000	.000	.000	.000	.000
	GA by FL in days	.000	.000	.000	.000	.000	.000
	GA by AC in days	.000	.000	.000	.000	.000	.000
	AVGA2	.000	.000	.000	.000	.000	.000
	GA by LMP in days	.000	.000	.000	.000	.000	.000

** Correlation is significant at the 0.01 level (2-tailed).

AVGA 2 = Average gestational age in 2nd Trimester.

Table III: Pearson correlation of GA by different fetal parameters with GA by LMP in 3rd Trimester

		GA BPD in days	GA by HC in days	GA by FL in days	GA by AC in days	AVG A3	GA LMP3
Pearson Correlation	GA BPD in days	1.000	.703**	.397**	.497**	.807**	.313**
	GA by HC in days	.703**	1.000	.549**	.489**	.837**	.318**
	GA by FL in days	.397**	.549**	1.000	.713**	.795**	.340**
	GA by AC in days	.497**	.489**	.713**	1.000	.821**	.252*
	AVGA3	.807**	.837**	.795**	.821**	1.000	.366**
	GA by LMP in days	.313**	.318**	.340**	.252*	.366**	1.000
Sig. (2-tailed)	GA BPD in days	.000	.001	.000	.000	.000	.008
	GA by HC in days	.000	.000	.000	.000	.000	.007
	GA by FL in days	.001	.000	.000	.000	.000	.004
	GA by AC in days	.000	.000	.000	.000	.000	.034
	AVGA3	.008	.000	.000	.000	.000	.002
	GA by LMP in days	.007	.004	.034	.002	.002	.000

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

AVGA 3 = Average gestational age in 3rd Trimester.

Average GA by MSD and CRL also correlated with GA by LMP which showed correlation coefficient of only 0.888.

In second trimester, Pearson correlation showed the nearest correlation of GA by AC (Hadlock table) with GA by LMP with correlation coefficient of 0.553 (Table II). The least correlation occurred in GA by BPD (Hadlock). Second nearest correlation seen in GA by HC (Hadlock).

Applying Pearson correlation in 3rd trimester, GA by FL showed the nearest correlation with GA by LMP which was significant at the 0.01 level (2 tailed)

(Table III). The least correlation was of GA by AC (Hadlock). The 2nd nearest correlation was seen in GA by HC (Hadlock).

DISCUSSION

Gestational age (GA) used to be assessed by history, abdominal palpation and symphyseofundal height which are still valuable tools for clinical assessment of gestational age.³ Since the introduction of sonographic measurements of biparietal diameter by Ian Donald, different fetal parameters were introduced for estimation of gestational age. Study of accuracy of gestational age estimation was done in many studies and compared with the then present normograms. The present study also evaluated the correlation of different fetal parameters in terms of accuracy in normal pregnant women of eastern Nepal.

Crown-rump length (CRL) has been considered the 'gold standard' for estimation of gestational age from the very beginning which was confirmed by H. Robinson, van de Velde EH et al and FP Hadlock et al.^{4,5,6} In this study gestational age by CRL was comparable with findings of previous studies. Gestational age in 1st trimester by Mean Sac Diameter (MSD) was less accurate than by CRL alone.⁷ Average GA by MSD & CRL was also less correlated than that of gestational age by CRL. However it was greater than that of gestational age by MSD. This suggests that if CRL is used for gestational age estimation in 1st trimester, this should be used alone.

In 2nd trimester, on Pearson correlation, GA by AC, HC and FL showed good correlation with GA calculated by LMP (correlation coefficient of 0.553, 0.511 and 0.505 respectively). Surprisingly gestational age (GA) by AC showed the best correlation and BPD (correlation coefficient 0.435) showed the least correlation with GA by LMP.

In Hadlock et al showed GA by HC as the most accurate parameter in almost all age group except in 30-36 weeks.⁸ In Benson and Doubilet's study in, BPD and HC were the most accurate predictors of gestational age and AC was the least accurate predictor in second trimester.⁹ In the present study, though the difference in correlation was small among different parameters, there is difference in findings compared to other studies i.e. the best correlation with AC and the least correlation with BPD. Technical error in plane selection, bias due to prospective study or chance finding as in 30-36 weeks group in Hadlock study may be the possible factors contributing such results. Therefore further more elaborate study is indicated in second trimester.

As in Hadlock and W J Ott studies, accuracy of estimating GA was increased by averaging the GA by different parameters.^{8,10}

In 3rd trimester, Pearson correlation showed the least correlation compared to first and second trimester. Estimation of gestational age was shown to be the most accurate by FL measurement. HC was the second most accurate parameter. Gestational age by AC showed the least correlation (correlation coefficient of 0.252). Doubilet and Benson's study showed no significant difference in accuracy among BPD, HC and FL.⁹ However FL was the most accurate parameter followed by HC or BPD in estimating GA. AC was the least accurate parameter in their study. Our findings in 3rd trimester were comparable with the study of Hadlock and Doubilet and Benson. Average GA showed better correlation than GA derived from any individual fetal parameters.

In conclusion, CRL in 1st trimester is found to be the best fetal parameter for estimation of gestational age. This study

showed that the average gestational age if calculated combining gestational age by CRL and MSD will decrease the accuracy. Average gestational age calculated by simple averaging of 4 parameters e.g. BPD, HC, FL and AC gives more accurate estimation of gestational age in 2nd and 3rd trimester. FL and HC are the better fetal parameters than BPD and AC in 3rd trimester.

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