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Estimation of Gestational Age According to Crown-Rump Length in Nepalese Population: A Comparison with Previously Published Nomograms

Background/Objective: This study was performed to construct an institution specific crown-rump length (CRL) nomogram and to compare its ability to predict gestational age with previously published nomograms.

Patients and Methods: A regression model was developed for estimation of gestational age using CRL measurements of 123 singleton fetuses in the Nepalese population. Measurements were obtained by placing the calipers of the ultrasound machine from the crown to the rump. The appropriateness of previously established CRL nomograms for predicting the gestational age was assessed in the Nepalese population to determine comparability between nomograms.

Results: CRL corresponds to Robinson's nomogram up to 9 weeks of gestational age. There is a deficiency of 2mm at 10 weeks, 5 mm at 11 weeks and 8 mm at 12 weeks.

Conclusion: CRL measurements are used as a reliable method for estimation of the gestational age as well as a baseline for comparing gestational ages later. CRL corresponds to Robinson's nomogram up to 9 weeks gestational age. There is a deficiency of 2-8 mm from 10-12 weeks gestational age. Difference with the established nomograms may be due to ethnic differences of the fetal development. After 12 weeks, CRL measurement is unreliable due to flexion of the fetus.

Keywords: Ultrasound, Gestational Age, Nomogram, Crown-Rump Length

Introduction

Gestational age (GA) is defined as the conceptual age plus two weeks. By convention, pregnancies are dated beginning from the first day of LMP. In women with a regular 28-day cycle, conception occurs approximately 2 weeks after LMP. In these women, GA and menstrual age are the same. Accurate knowledge of GA is important for the following reasons:

1- The timings of chorionic villous sampling in the first trimester, genetic amniocentesis in the second trimester, and elective induction or cesarean delivery in the third trimester are all based on GA.

2- The differentiation between term and pre-term labor and characterization of a fetus as postdate depend on GA.

3- Knowledge of GA is critical in distinguishing normal from pathological fetal development. Midgut herniation is normal up to 11 or 12 weeks of gestation but signifies omphalocele thereafter.

4- The normal size of a variety of fetal body parts depends on GA.

5- The levels of maternal serum alpha-fetoprotein, human chorionic gonadotropin and estriol depend on GA

6- Estimation of fetal weight alone or in relation to GA may influence

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obstetric management decisions concerning the timing and route of delivery.¹

Sonographic determination of GA is becoming increasingly important. Many parameters may be used for establishing GA. The crown-rump length (CRL) is a reliable parameter for estimating gestational age in the first trimester.² The purpose of this study was to construct an institution specific CRL model and to compare its ability in predicting gestational age with previously published nomograms.

Patients and Methods

This study was performed on 123 participants who came to the Department of Radiology and Imaging of Tribhuvan Hospital for ultrasonography from January to December, 2007. Measurements were obtained by placing the calipers of the ultrasound machine from the crown to the rump of the fetuses (Fig.1). Only fetuses with a known gestational age based on the last menstrual period were included. A regression model was constructed by using recorded CRL measurements (Table 1). The measurements were achieved with a commercially available, curvilinear array real time, B-mode ultrasound, equipped with a 3.5 MHz

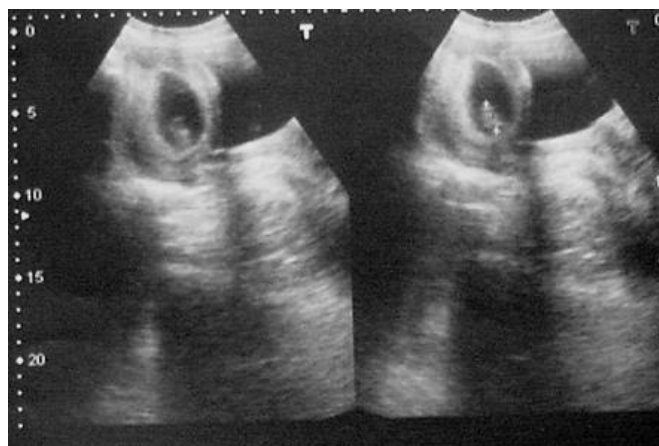


Fig. 1. Technique of CRL measurement. The longest length of the embryo is measured.

Table 1. Important Percentile Values of CRL in Different Gestational Weeks

GA (wks)	No. of Patients	CRL Percentiles		
		5	50	95
7	9	9	9	29
8	9	11	12	12
9	18	11	16	64
10	18	10	17.5	37
11	15	36	39	48
12	18	38	48	58
13	24	52	59	71
14	12	52	62	75

Table 2. Regression Model for Predicting Fetal CRL Parameters from Gestational Age

Regression Model	R ²
$CRL = -39.60 + 7.01GA$	0.56
$CRL = 109.27 - 25.34GA + 1.70GA^2$	0.82
$CRL = 59.91 - 9.34GA + 0.0GA^2 - 0.059GA^3$	0.83

Table 3. Regression Model for Predicting Fetal Gestational Age from CRL Parameters

Regression Model	R ²
$GA = 8.26 + 0.08CRL$	0.56

transducer (Sonace 8800 Medison and Aloka SSD-1000 machines). The procedure was explained to the participants and it was performed in the supine position with hips and knees in extension. The probe was held with the right hand and the same observer performed all the measurements in millimeters. Specific methods regarding imaging criteria, caliper placement, and averaging of at least two measurements for each were followed. To decrease the inter-observer variability, a single radiologist performed the measurements. To decrease the intra-observer variability the average value of the two measurements was used. The inclusion criteria included:

- 1- Certain date of the first day of the last normal menstrual period
- 2- Regular menstrual cycles (26–30 days) prior to pregnancy
- 3- Diagnosis of pregnancy by pelvic examination and urine pregnancy test

The exclusion criteria included:

1. Multiple gestations
2. Maternal complications—hypertension, abnormal glucose tolerance test, diabetes mellitus, isoimmunization

3. Patients treated for infertility

SPSS 11 for windows was used for data analysis. Separate linear regression models were fit based on the GA (Table 2). The regression model for the mean was best fit by allowing a first-degree polynomial equation for GA of the form: $y = a + bx$ where a is the intercept and corresponds to that value of y where $x = 0$ and b is the slope of the curve and describes the rate of change of y for a given x. In diagnostic ultra-

TABLE 4. Comparison of CRL in Correlation with GA in Different Studies⁵⁻⁷

Predicted GA (weeks)	CRL 50 th Percentile [mm]								
	Current study	Robinson	Hadlock	Tokyo	Rempen	Osaka	Daya	Hansman	Nelson
7	-	10	10	-	9	9	8	11	-
8	16	16	16	14	17	13	15	13	10
9	23	22	23	21	25	20	23	18	22
10	30	32	32	29	34	30	31	26	32
11	37	42	42	37	43	41	41	36	44
12	44	52	54	46	54	53	53	47	56
13	-	66	68	57	67	65	70	60	66

sound, one rarely needs to go beyond a third order or cubic relationship.

To develop the CRL regression model, quadratic and cubic linear regression models for the mean and SD were fit based on the GA. The number of CRL measurements varies for each gestational week. There is more variability in CRL measurements with the increase of gestational age (Table 3). Differences of the performance in the prediction of GA between our model and the previously published nomograms were compared. The GA was assessed for each given CRL measurement. Comparison of the predicted GA for each CRL measurement for this model versus other nomograms were performed. The other published nomograms were of Robinson, Hadlock, Tokyo, Rempen, Osaka, Daya, Hansman and Nelson (Table 4).

Results

There were 123 singleton fetuses who met the inclusion criteria for this study. CRL measurements for gestational ages from 7 to 14 weeks were available. By using the regression model (Table 2), the predicted



Fig. 2. Technique of CRL measurement. The measurement is made from the head to the outer edge of the rump.

CRL for the 5th, 50th and 95th centiles were calculated for each GA. Since the R² numbers were similar for quadratic and cubic models, the quadratic model was used. Higher GA values suggest less variability in CRL measurements. Significant p value (0.001) for coefficients were observed. The measurement for each GA percentile was compared with data from other nomograms.³⁻⁷

Discussion

The estimated date of delivery is usually based on the patient's recalling of the first day of LMP. This may be inaccurate because of the variability in the length of menstrual cycles, faulty memory, or early pregnancy bleeding. Knowing the LMP date is critically important in clinical obstetrics, primarily because it can significantly affect obstetric management decisions and the neonatal outcome. By defining an acceptable period of 38-42 weeks for normal delivery, this knowledge should preclude the possibility of iatrogenic premature delivery in patients undergoing elective cesarean delivery. In patients with premature labor, knowledge of LMP will influence the use of tocolytic agents, the use of steroids to induce fetal lung maturity, the timing of amniocentesis for evaluating fetal lung maturity, and the type of institution in which delivery should take place. Precise knowledge of the menstrual age should also help the obstetrician avoid post-date pregnancy and its attendant risks to the fetus. Finally, knowledge of the menstrual age helps the sonologist recognize the growth-retarded or macrosomic fetus, since the normal range of values for fetal growth parameters varies with the menstrual age.³

With significant improvements in ultrasound

equipment in the early 1970s, it was not surprising that attention was directed to the fetus itself and its measurement as a means of assessing GA. The first ultrasound measurement of the fetal CRL was reported by Robinson.⁷ Crown-rump length (CRL) in the first trimester is the most accurate method of assessing gestational age, except when there is incontrovertible evidence of the time of ovulation and conception (e.g. in an in-vitro fertilization pregnancy). By the end of the first trimester, the biparietal diameter (BPD) becomes more accurate than CRL due to errors associated with fetal flexion.

According to Table 4, CRL corresponds to Robinson's nomogram up to 9 weeks of gestational age. There is a deficiency of 2mm at 10 weeks, 5 mm at 11 weeks and 8 mm at 12 weeks gestational age.

CRL corresponds to Robinson's nomogram up to 9 weeks of gestational age. There is a deficiency of 2 mm at 10 weeks, 5 mm at 11 weeks and 8 mm at 12 weeks gestational age. A significant correlation was present between this study and Robinson's study ($r=0.996$; p value <0.001).

The differences with other nomograms may be due to the differences in sample size, unselected population, recent technological advancements in ultrasound and ethnic population variation. The best parameter for estimating gestational age is a fetal dimension, which (1) rapidly grows, (2) has a small biologic variation for a particular week of gestation, and (3) can be measured with a high degree of reproducibility.⁸

Peterson showed that the gender difference was discernible from 8 weeks onward, with an average difference of 2 mm between boy and girl fetuses. He

concluded that the difference in size between genders had a genetic rather than a hormonal mechanism.⁹

Finally, we concluded that;

1- High degree of positive correlations between CRL and GA were present.

2- Earlier flattening of later growth starting from 9 weeks was present. This earlier flattening of growth may be a characteristic of the Nepalese population.

3- There is a need to have a separate nomogram for the Nepalese population.

4- A nomogram specific for Nepalese population should be developed with a larger sample size based on CRL parameters in the first trimester.

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