J Obstet Gynecol India Vol. 57, No. 4 : July/August 2007 Pg 316-319

ORIGINAL ARTICLE

The Journal of Obstetrics and Gynecology of India

Role of fetal thigh circumference in estimation of birth weight by ultrasound

Hebbar *Shripad*, Varalakshmi *N*.

Department of Obstetrics and Gynecology, Kasturba Medical College, Manipal, Udupi District

OBJECTIVE(S): To evaluate the accuracy and usefulness of predicting birth weight by measuring fetal thigh circumference by ultrasound.

METHOD(S): In 110 pregnant women, fetuses without structural or chromosomal anomalies were studied prospectively and cross-sectionally. Thigh circumference (TC) was determined at the mid level of the thigh. Biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL) were measured using standard techniques. Fetal weights were estimated within a week prior to delivery. Estimates of birth weights obtained by various ultrasound birth weight formulas in different weight categories were statistically analysed and compared with each other and also with estimates obtained by clinical methods.

RESULTS: Estimated fetal birth weight using TC correlated well with actual birth weight in all birth weight categories and was superior to clinical and birth weight formulas using BPD, HC, AC and FL measurements.

CONCLUSION(S): There was a good correlation between ultrasound measurement and actual postnatal measurement of thigh circumference ($r2=0.89$, $p<0.01$). Thigh circumference measurement was simple and there was better accuracy when it was combined along with BPD, HC, AC and FL measurements.

Keywords: estimated birth weight, thigh circumference

Introduction

As far as independent extrauterine existence and optimum survival of fetus is concerned birth weight is undoubtedly one of the most significant determinants of neonatal survival. It has become increasingly important especially for the prevention of prematurity, evaluation of pelvic disproportion before induction of labor and detection of intrauterine growth restriction (IUGR).

A lot of work has been done to find out accurate methods of estimation of fetal size and weight in utero. They include clinical and ultrasound estimations. Clinical methods include models incorporating height of the uterus and girth of the abdomen measured at the level of umbilicus. But they are subjected to significant margin of error and are not useful in malpresentations, maternal obesity, multifetal pregnancy, polyhydramnios and oligoamnios. Ultrasound uses many fetal parameters such as BPD, HC, AC, FL and is better when compared with clinical methods and is more reproducible. However many standard ultrasound fetal birth weight models do not incorporate thigh measurements which may prove most useful in predicting fetal weight when growth abnormalities are present. Pediatric experience has shown that thigh circumference (TC) is one of the parameters that reflects soft tissue mass. Our study aims at determining usefulness of incorporating fetal thigh circumference measurements in ultrasound fetal weight estimation formulas in accurate prediction of birthweight.

Paper received on 13/07/2005; accepted on 25/05/2007

Correspondence :
Dr. Shripad Hebbar
Shrigandha, 1-71-C, Budnar,
Opposite to MGM College
Kunjibettu, Udupi, Udupi District, Karnataka
Tel. 0820-2531228 Email : drshripadhebbar@yahoo.co.in

Methods

This is a prospective study of 110 antenatal women who attended our obstetric unit. All women were examined at or

near term. The fetal weight was estimated within a week prior to the delivery. If the delivery did not occur within a week of the ultrasound examination, the estimations were repeated and these repeat estimations were taken into consideration. Clinical estimation of fetal weight was done for comparative analysis using Johnson's and Insler's formula in all these women.

Ultrasonic measurements were made with linear array real time ultrasound equipped with a 3.5 MHz transducer. Ultrasound measurements of BPD, HC, AC, FL and TC were done. Only measurement of TC will be described as others have been standardized in obstetric ultrasound practice.

Measurement of TC

First whole length of femur from greater trochanter to the distal metaphysis was imaged. Transducer was then rotated by 90^0 to obtain a cross sectional profile of the middle of the thigh at a position that the bone profile was as round as possible and the boundary of the thigh profile well defined. TC was determined with elliptical approximation three times and the average was taken as the final measurement.

Within half an hour of delivery, neonates were weighed on weighing scale and actual weight of the neonate was compared with clinical and ultrasound estimated fetal weight. TC of the neonate was measured at the middle of the thigh using measuring tape for comparison with ultrasound measurements.

Results

Of 110 women examined, 55% were primigravidas and 45% multigravidas. Thirty-nine (36%) neonates weighed less than 2500g, 33 (30%), between 2501 and 3000g, 30 (27%) between 3001 and 3500g, and 8 (7%) weighed more than 3500g.

Table 1 shows the actual birth weight versus predicted birth weight in different weight categories. Up to 3500g, Vintzileos proved better than all methods and this difference was statistically significant. However in weight group >3500g, Vintzileos was comparable to Insler, Johnson and Hadlock. This may be due to small sample size.

Formulae	Methods	Parameters
Johnson (1957)[1]	Symphysiofundal height (SFH)	BW=(SFH-N)* 155 N=12 when station of fetal head is above the level of ischial spines (or) N=11 if presenting part is at or below the level of spines
Insler and Bernsteins (1967)[2]	SFH and Abdominal girth(AG)	BW(Birthweight) = SFH * AG
Hadlock et al (1985) [3]	BPD, AC and FL	Log10 (BW) = -15213 + 0.003343*AC*FL+ 0.001837* BDD^2 +0.0458 *AC +0.158*FL
Vintzileos et al (1987) 4	BP, AC, FL and Thigh circumference (TC)	Log10 (BW) =1.897 +0.015*AC + 0.057 * BPD + 0.054* FL + 0.011*TC

Table 1. Comparative analysis of birth weights in different weight groups.

Methods	≤ 2500 n=39	2501-3000 n=33	3001-3500 n=30	>3500 n=8	Overall n=110
Actual Birthweight	2253	2804	3303	3869	2822
Insler[2]	2477	3007	3484	3896	3194
Johnson[1]	2639	3257	3737	4072	3227
Hadlock[3]	2600	3151	3684	4028	3013
Vintzileos[6]	2183	2660	3184	3726	2711

It can be seen from Table 2 that Vintzileos model was closest to the actual birth weight in all weight categories.

Table 2. Mean of difference from actual birth weight in different weight categories.

Methods	<2500gms	2501-3000gms	3001-3500gms	>3500gms
Insler[2]	±356	±360	±394	±360
Johnson[1]	±388	±456	±441	±371
Hadlock[3]	±237	±223	±220	±373
Vintzileos[4]	±101	±156	±136	±173

From Table 3, it can be seen that percentile values for error are least with Vintzileos model

From Table 4, it can be inferred that Vintzileos model is superior to all other models in its ability to predict the estimated birth weight nearest to actual birth weight

Table 3. Percentile Values for Absolute Error of Difference.

Method	5th percentile	10th percentile	25th percentile	50th percentile	75th percentile	95th percentile
Insler[2]	33	50	150	200	300	609
Johnson[1]	58	100	250	373	518	972
Hadlock[3]	52	74	187	321	528	915
Vintzileos[4]	7	18	59	108	174	359

Table 4. Ability of each method to predict expected birth weight within 10% in different weight categories.

Method	≤ 2500gms	2501-3000gms	3001-3500gms	>3500gms
Insler[2]	26%	27%	50%	25%
Johnson[1]	10%	30%	33%	63%
Hadlock[3]	51%	70%	77%	75%
Vintzileos[4]	95%	73%	96%	88%

Table 5. shows statistical analysis using McNemar Chi-Square test for two independent variables.

Table 5. Results of McNemar Chi-square tests in evaluating two methods to predict birth weight within 10% in different weight categories.

Method	Chi-square	P value	Inference
Birth weight up to 2500 grams (n=39)			
Vintzileos vs Insler	15.2	<0.05	Vintzileos is better than Insler
Vintzileos vs Johnson	32.9	<0.05	Vintzileos is better than Johnson
Vintzileos vs Hadlock	25.1	<0.05	Vintzileos is better than Hadlock
Birth weight up to 2501-3000 grams (n=33)			
Vintzileos vs Insler	0.06	>0.05	Vintzileos is better than Insler
Vintzileos vs Johnson	9.4	<0.05	Vintzileos is better thanJohnson
Vintzileos vs Hadlock	9.3	<0.05	Vintzileos is better than Hadlock
Birth weight up to 3001 to 3500 grams (n=30)			
Vintzileos vs Insler	15.2	<0.05	Vintzileos is better than Insler
Vintzileos vs Johnson	32.9	<0.05	Vintzileos is better than Johnson
Vintzileos vs Hadlock	25.1	<0.05	Vintzileos is better than Hadlock
Birth weight above 3500 grams (n=8)			
Vintzileos vs Insler	0.01	>0.05	Vintzileos is comparable to Hadlock, Insler
Vintzileos vs Johnson	1.5	>0.05	and Johnson formula. This may be due to small sample size in this group.
Vintzileos vs Hadlock	1.4	>0.05	

From Table 5, it can be understood that Vintzileos method incorporating thigh circumference provides a better model in predicting birth weight by ultrasound.

There was a good correlation between ultrasound measurement and actual postnatal measurements of thigh circumference in the present study ($r2=0.89$, $p<0.01$).

Discussion

The results of this study clearly indicate that fetal TC measurements add to the accuracy of birth weight estimation in obstetric practice. Measurements of TC provide a potentially straight forward method for assessing the deposition of muscle and fat in the growing fetus. This parameter is preferred over diameter measurements as it is less sensitive to changes in shape. Anatomical studies have proved that the correct plane for TC is located at the middle of the thigh. Ultrasound measurement of fetal thigh circumference is uniformly reproducible within 4% error and is comparable to other fetal parameters in variability. Vintzileos et al [4] in 1985 measured the TC at the same plane used in our study but the TC was calculated from diameter or measured directly using a map measurer.

Formulas incorporating TC measurements may be proven most useful in predicting fetal weight when growth abnormalities are present. Fetal growth aberrations are associated with changes in the soft tissue mass which is decreased in IUGR. Pediatric experience has shown that TC is one of the parameters that reflect soft tissues mass [5]. Recently imaging fetal limb volume by 3D ultrasound has proved that fetal thigh measurements facilitate accurate prediction of birth weight[6,7]. Thus it can be inferred that TC measurements using ultrasound add to obstetrician's ability to predict intrauterine growth abnormalities.

References

1. Johnson RW. Calculations in estimating fetal weight. Am J Obstet Gynecol 1957; 74: 929-30.
2. Insler V, Bernstein D, Rikover M et al. Estimation of fetal weight in utero by simple external palpation. Am J Obstet Gynecol 1967; 98: 292-3.
3. Hadlock FP, Harrist RB, Sharman RS et al. Estimation of fetal weight with the use of head, body, and femur measurements - a prospective study. Am J Obstet Gynecol 1985; 151: 333-7.
4. Vintzileos AM, Campbell WA, Rodis JF et al. Fetal weight estimation formulas with head, abdominal, femur, and thigh circumference measurements. Am J Obstet Gynecol 1987; 157: 410-4.
5. Mattoo GM, Bhat IA, Shah GN et al. Maximum thigh circumference as an indicator of birth weight. Indian J Matern Child Health 1991; 2: 42.
6. Song TB, Moore TR, Lee JI et al. Fetal weight prediction by thigh volume measurement with three-dimensional ultrasonography. Obstet Gynecol 2002; 96: 157-61.
7. Lee W, Deter RL, Ebersole JD et al. Birth weight prediction by three-dimensional ultrasonography: fractional limb volume. J Ultrasound Med 2001; 20: 1283-92.