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Original Research Article

Estimation of Foetal Weight at Term Pregnancy by Clinical and Ultrasonographic Methods

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Abstract: Assessment of fetal weight is essential in detecting any disturbances in fetal growth like intrauterine growth restriction and macrosomia, both having increased risk for perinatal morbidity and mortality and it could help in the management of labour preventing of some of these complications. Many clinical as well as ultrasound methods have been used to estimate the fetal growth and the birth weight in utero. Total of 120 patients were selected for the study with single viable fetus with reliable date and without any complications, duly getting their consent. Clinical examination was done and estimated fetal weight calculated clinically using Johnson's formula and Insler's Formula. All the patients were then subjected to ultrasonography where BPD, AC, FL and thigh circumference measurements were obtained. According to the measurements fetal weight was estimated using Vintzileos and Hadlock formula. Estimated fetal weight is compared to the weight of the baby taken within an hour of delivery and comparative analysis was done. In all the weight groups estimated fetal weight by Vintzileos formula is close to the actual weight. Percentile values for absolute error are least with Vintzileos formula highest and with Johnson's formula. 89.1% of predictors were within 10% of error with Vintzileo's formula as compared with 65.5, 32.7, 26.4 by Hadlock, SFH x AG, Johnson's formula respectively. Vintzileos formula which included BPD, AC, FL, and thigh circumference is more accurate than Hadlock formula which included only BPD, AC and FL. Its inclusion in routine ultrasound is strongly recommended to improve the birth weight estimates.
Keywords: Estimation of fetal weight, Clinical and Ultrasonographic formulae, Ultrasound parameters.

INTRODUCTION

Assessment of fetal weight, an important factor in determining the survival of fetus is essential in detecting any disturbances in fetal growth like intrauterine growth restriction and macrosomia. Both are at increased risk for perinatal morbidity and mortality. Hence an accurate estimation of birth weight could help in the management of labour preventing of some of these complications. Many clinical as well as ultrasound methods have been used to estimate the fetal growth and the birth weight in utero.

OBJECTIVES

The purpose of this study was to compare the accuracy of various clinical and ultrasonographic estimation of fetal birth weight with the actual neonatal birth weight in order to select a suitable method.

CLINICAL METHODS

Many workers have attempted birth weight prediction by clinical methods like the following;

- Andreas [21] determined fetal length and maturity by taking x-ray at standard distances and standard positions.
- Johnson *et al.* [1] correlation of uterine fundal height with fetal weight.
- Insler and Bernsteins [2] correlation with symphysio fundal height (SFH) and abdominal girth (AG).
- Dawn's formula [22] correlation of uterine volume with fetal weight.

The conventional method of abdominal palpation of the fundus of uterus is highly inaccurate especially at the upper and lower ranges of expected size for dates [3].

These clinical methods are liable to significant margin of errors and not helpful in case of maternal obesity, multiple gestations, malpresentations, abnormal liquor volume, in growth retarded and growth accelerated fetus.

ULTRASONOGRAPHIC METHODS

Obstetric Ultrasonography utilizing many fetal parameters such as BPD, HC, AC, and FL is better when compared with clinical methods and is more reproducible. Sonographic assessment of fetal growth for the estimation of fetal weight (EFW) is now a standard practice in obstetrical decision making like planning the mode of delivery and management of labor. The utility of Ultrasonography spans over three decades now, with various formulae incorporating different fetal parameters.

After the report of Fetal Biparietal diameter by Donald and Brown in 1961, many authors like Willocks *et al*. [4], Thomson *et al*. [20], Kohorn [5] suggested various formulae for fetal weight estimation utilizing this single fetal parameter. Some authors like Campbell and Wilkin [6], Higginbottom *et al*. [7], Poll and Kasby [18], also devised fetal weight formulae utilizing abdominal circumference as single parameter. But these did not yield significantly better results than those obtained by conventional inspection and palpation.

Then came the utilization of two parameters, both Biparietal diameter and abdominal circumference by few authors like Warsof *et al*. [19] , Hadlock and Harrist [8], Timor-Tritsch [9], Shepard and associates [10].

The limiting factors in these formulae were

- Inclusion of only BPD and AC rather than HC, AC and or FL. Changes in the head shape as dolicocephaly or brachycephaly can significantly change the true estimates of fetal birth weight and cephalic size by BPD.
- Utilization of same formula for all fetuses regardless of gestational age and growth status. The contribution to birth weight by head size and body size at different intervals in pregnancy is variable.

Hadlock *et al*. [8] has shown improved weight estimates obtained with models of multiple parameters like HC, AC and femur length. The rationale behind the use of femur length is based on the fact that femur length is related linearly to crown heel length.

A number of articles have described techniques for estimating fetal weight that utilize various combinations of ultrasonically derived measurements. These methods often require the use of complex mathematical equations to convert the data measured into estimated weights. They are all based on the principle that fetal area or volume measurements corresponds to the Weight mass = Volume & Density.

The fetal weight depends not only on head and body dimensions but also on extremities dimensions hence it is ideal to investigate the role of extremities as well. Formulae incorporating thigh circumference measurement may be proven most useful in predicting fetal weight when growth abnormalities are present. Pediatric experience has shown that thigh circumference is one of the parameters that reflects soft tissue mass.

In the study by Vintzileos *et al*. [11], has shown fetal weight estimation by incorporating the thigh circumference measurement along with the other parameters with better results.

However, the accuracy of EFW is compromised by significant intra- and interobserver variability, and many of the existing formulae are generally inaccurate at the extremes of fetal weight.

Our study aims at determining usefulness of various clinical and recent ultrasonographic formulae incorporating multiple parameters especially Hadlock formula and Vintzileos formula in accurate prediction of birth weight.

MATERIALS AND METHODS

It was a prospective study 120 patients performed in the Department of radiology and imaging with referral from Department of obstetrics and gynecology at SREE BALAJI MEDICAL COLLEGE AND HOSPITAL, CHENNAI. The study population included was antenatal patients attending the antenatal clinic and subsequently admitted in our hospital for delivery. Only those antenatal mothers with single viable fetus with reliable date and without any complications are selected, duly getting their consent. All cases of multiple pregnancies, complicated pregnancies, chromosomal and structural anomalies are excluded.

All the selected patients in their 38-40 weeks gestations are examined both clinically as well as ultrasonographically within a week prior to delivery.

Clinically the fundal height is measured for calculating with the help of measuring tape marked in centimeters, from upper border of symphysis pubis to the marking of fundus. By careful examination station of vertex was determined.

Johnson's formula: Fetal weight in gms = {fundal height in cms – n} x k

m = 12 when station of fetal head is above the level of ischial spines.

n = 11 when the presenting part is at or below the ischial spine.

K = constant – 155

Insler's Formula

Abdominal girth is measured in cms at the level of the umbilicus. According to this formula Fetal weight in grams = Symphysiofundal height in cms X Abdominal Girth in cms.

After clinical examination patient is subjected to ultrasonography.

Ultrasonographic evaluation was done examination was done in all patients using SIEMENS 2000 S 3.5 MHz convex array transducer. All the required parameters Biparietal diameter (BPD), Head circumference (HC), abdominal circumference (AC), femur length (FL) and TC (thigh circumference) were measured in centimeters for the estimation of fetal weight, utilizing both Hadlock as well as Vintzileos formulae. All patients were examined at or near term. 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.

Within half an hour of delivery neonates were weighed on weighing scale and actual weight of the neonate was taken for comparison. Thigh circumference of the neonate was measured at the middle of the thigh using measuring tape. This is compared with ultrasonically measured thigh circumferences.

Finally statistical analysis of the estimated fetal weight by clinical methods (Johnson formula and Insler's Formula), ultrasound methods (Hadlock formula which includes BPD, AC, FL, Vintzileo's formula which includes thigh circumference along with BPD, FL, AC) are compared with actual birth weight.

RESULTS AND ANALYSIS

Of all the 120 patients analysed, 65 were primigravida and 55 were multigravida. Mean birth weight for all the 120 patients studied was 2820 Gms and the mean gestational age was 38.2 weeks. In overall 110 cases Vintzileos formula is closest to actual birth weight. Table-1.

All these patients were categorized into four groups according to their birth weight. (Table-2).

In all the above categories Vintzileos formula predicted the birth weight closest to actual birth weight (Table-2A to Table-2D).

It can be seen that percentile values for error are least with Vintzileos model as the mean birth weight and standard deviation observed with Vintzileos method are closest to actual mean birth weight and standard deviation (Table-3).

In all the weight groups Vintzileos formula is more accurate in predicting the actual birth weight than Hadlock, SFH x AG & Johnson formula (Table-4).

Table-1: Mean and standard deviation in overall weight groups (n = 120)

	Mean	SD
Actual Birth weight	2822	538
SFH x AG	3199	651
Johnson's method	3227	593
Hadlock	3013	543
Vintzileos	2711	529

Table-2: Distribution of patients according the birth weight

Group	Number (N = 120)	Percentage (%)
Group I < 2500 gms	43	36
Group II 2501 – 3000 gms	36	30
Group III 3001 – 3500 gms	32	27
Group IV > 3500 gms	9	7

Table-2A: Mean and SD in weight group <2500gms

Weight Group	<2500	
Number	N=43	
Statistics	Mean	SD
Actual Birth weight	2253	189
SFH x AG	2477	317
Johnson's method	2639	291
Hadlock	2600	215
Vintzileos	2183	205

Table-2B: Mean and Standard Deviation in weight group <2501 – 3000

Weight Group	**2501 – 3000 GMS**	
Number	**N=36**	
Statistics	**Mean**	**SD**
Actual Birth weight	2804	149
SFH x AG	3007	235
Johnson's method	3257	343
Hadlock	3151	304
Vintzileos	2660	214

Table-2C: Mean and Standard Deviation in weight group 3001 – 3500

Weight Group	**3001 - 3500 GMS**	
Number	**N=32**	
Statistics	**Mean**	**SD**
Actual Birth weight	3303	139
SFH x AG	3484	218
Johnson's method	3737	248
Hadlock	3684	410
Vintzileos	3184	191

Table-2D: Mean and Standard Deviation in weight group > 3500

Weight Group	**3001 - 3500 GMS**	
Number	**N=9**	
Statistics	**Mean**	**SD**
Actual Birth weight	3869	278
SFH x AG	3896	666
Johnson's method	4072	606
Hadlock	4028	440
Vintzileos	3726	247

Table-3: Percentile Values for Absolute Error of Difference

Percentile Statistics	**Percentile Values for Absolute Error of Difference**					
	5^{th} percentile	**10^{th} percentile**	**25^{th} percentile**	**50^{th} percentile**	**75^{th} percentile**	**95^{th} percentile**
SFH x AG	33.1	50.3	150	200	300	609.1
Johnson's	58.25	100	250	372.5	517.5	972.25
Hadlock	51.7	74.3	187	320.5	527.25	914.95
Vintzileos	7.1	18.3	59	108	174.25	358.95

Table-4: Deviation from Actual Birth Weights GroupWise

Weight Group	**< 2500**	**2501 - 3000**	**3001 - 3500**	**> 3500**
Number	**N=43**	**N=36**	**N=32**	**N=9**
SFH x AG	±356	±360	±394	±373
Johnson’s	±388	±456	±441	±371
Hadlock	±237	±223	±220	±360
Vintzileos	±101	±156	±136	±173

AVERAGE OF THIGH CIRCUMFERENCE
FL/TC

Prenatal (by USG)(in cm)	**Post natal (actual) (in cm)**
12 -14	12.8 – 13.8

Table-5: Relation between femur length and thigh circumference

Mean	0.458
SD	0.106
95% confidence interval	0.28 – 0.63

Values > 0.63 may suggest asymmetric IUGR.

DISCUSSION

In our study of 120 patients 54.55% (n=65) were primi gravida and 45.45% (n=55) were multigravida. In our study the predicted fetal weight was calculated by clinical and Ultrasound methods within seven days of delivery of which 75% of deliveries occurred within four days of fetal weight estimation. All these patients were categorized into four groups (< 2500 Gms, 2501-3000 gms, 3001-3500 gms, and > 3500 gms.) according to their fetal birth weight. In all the weight groups estimated fetal weight by Vintzileos formula is close to the actual birth weight

In our study mean of actual birth weight is 2822 Gms. This inference is very nearer to that of Vintzileos formula with least percentage error. The mean of actual birth weight in the study with Vintzileos formula was 2711 Gms.

Percentile values for absolute error are least with Vintzileos formula and highest with Johnson's formula. 89.1% of predictors were within 10% of error with Vintzileo's formula as compared with 65.5, 32.7, 26.4 by Hadlock, SFH x AG, Johnson's formula respectively.

In all weight groups our study showed an error of 132 Gms with reference to Vintzileos formula, an error of 238 Gms with Hadlock formula, an error of 384 gms with Insler's method SFH x AG and 421 gms with Johnson's formula.

Vintzileos formula has predicted 90% of cases within 300gms whereas Hadlock, SFH x AG and Johnson's formula predicted 80.9%, 40.9% and 40% within 300gms respectively.

In weight group < 2500 Gms Vintzileos formula is better than Hadlock, SFH x AG and Johnson's formula.

In weight group 2500 – 3000 Gms Vintzileos is comparable to Hadlock but better than SFH and Johnson.

In weight group 3001 – 3500 Gms Vintzileos is better than Hadlock, SFH x AG and Johnson formula.

In weight group > 3500 Gms all are comparable. This might be due to sample size.

In this study, percentage of cases with estimated fetal weight within 5% and 10% of actual birth weight when thigh circumference was included was 58.2 and 89.1% and with Hadlock formula it was 25.5 and 65.5% respectively.

In this study there was a good correlation between prenatal and postnatal thigh circumference estimates and ultrasound can fairly reproduce the actual thigh circumference.

CONCLUSION

Vintzileos formula which included BPD, AC, FL, and thigh circumference is more accurate than Hadlock formula which included only BPD, AC and FL.

Hadlock formula is comparable to Vintzileos formula in weight group 2501 – 3000 Gms.

Estimation of fetal weight clinically has a significant margin of error.

Good correlation was found between prenatal and postnatal thigh circumference estimates & ultrasound can fairly reproduce the actual thigh circumference and its inclusion in routine ultrasound is strongly recommended to improve the birth estimates.

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