J Obstet Gynecol Ind Vol.53, No. 2: March/April 2003 Pg 131-133

ORIGINAL ARTICLE

The Journal of Obstetrics and Gynecology of India

Critical evaluation of various methods of estimating foetal weight by ultrasound

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Summary: This prospective study was conducted in a peripheral hospital of Kasturba Medical College; Manipal to know which sonographic method of estimation of foetal weight reliably predicts the birth weight. 100 patients were scanned thoroughly within 48 hours of delivery. Seven different models of ultrasonic weight estimation were analysed critically. It was found that the method of Hadlock2, predicted the birth weight more accurately than others. The average deviation from the actual birth weight (226gms), the percentile values of absolute error of difference were least with this method and it predicted maximum number of cases within 10% of actual birth weight (85%). Significant differences were observed between the predicted and actual birth weight in all other methods ($p<0.01$). It was concluded that this method is superior predictor of birth weight compared to other six and is a method of choice to estimate the birth weight in term pregnancies where the measurements of foetal head is inaccurate either because of engagement or moulding, as it incorporates only FL and AC measurements which is not affected by these changes.

Key words: prediction of birth weight, ultrasonography

Aims and Objectives:

In the last two decades, various models have been designed by different investigators to predict foetal weight using ultrasound. The desired outcome is achieved by measuring different foetal anthropometrical parameters. These investigators have found that an approximate estimation of foetal weight may be made by measuring Biparietal diameter (BPD), Head circumference (HC), Abdominal circumference (AC), and Femur length (FL).

Different models of ultrasound estimation of foetal weight have been proposed by Birnholz, Deter, Hadlock, Jordaan, Shepard and Warsof of which Hadlock and Shepard methods are most popular. However, these methods have not been evaluated in Indian context. A study was undertaken to analyse the accuracy of these seven methods to predict birth weight.

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Materials and Methods:

This study was conducted at Dr. T.M.A. Pai Hospital, Udupi which is a peripheral unit of Kasturba Medical College, between Janaury 2000 to June 2000. This hospital mainly caters low-risk obstetric population from low and mid socioeconomic groups in the surrounding villages. The high-risk patients like those who are having preterm labour, are usually referred to the main hospital and hence only term pregnancies (n=100) were selected for this study.

The patients studied were in between the ages of 21 and 36 years, 43 were primigravidae and reminder (57) were multigravidae and none had more than 4 pregnancies. Most of the patients could be recruited to study because either they got admitted for safe confinement because they hailed from a distant village or because they were posted for elective cesarean section.

Patients were scanned within 48 hours of delivery, using "TOSHIBA CAPASEE"(Toshiba Electronics, Japan) ultrasound scanner. A 3.5 Mhz abdominal transducer was used to obtain biparietal diameter (BPD), occipitofrontal diameter (OFD), anteroposterior and transverse abdominal diameters (AD1&AD2) and femur length (FL) in centimeters.

Head circumference (HC) was obtained using the equation:

$$HC = \pi(BPD+OFD)/2$$

Similarly abdominal circumference (AC) was calculated using the formula:

$$AC = \pi(AD1+AD2)/2$$

Average abdominal diameter was calculated by using the equation:

$$AD= (AD1+AD2)/2$$

One of the methods (Birnholz) needed corrected BPD value which was obtained by

$$Corrected\ BPD = (BPD*OFD/1.264)^{0.5}$$

Table 1 shows formulae in different methods to arrive at estimated weight by ultrasound:

Table 1

Models	Equations
Birnholz[3]	BW= (3.42928*BPD*AD^2+41.218)/1000
Deter[4]	Log_{10}(BW)= -2.014+0.211*BPD+0.057*AC-0.00403*BPD*AC
Hadlock[1]	Log_{10}(BW)= -1.5213+0.003343*AC*FL +0.001837*BPD^2+0.0458*AC+0.158*FL
Hadlock[2]	Log_{10}(BW)= -1.696+0.1938*FL+0.5281*AC-0.004*FL*AC
Jordaan[5]	Log_{10}(BW)= -1.1683+0.0377*AC+0.095*BPD-0.0015*AC*BPD
Shepard[6]	Log_{10}(BW)= -1.7492+0.166*BPD+0.046*AC-0.002646*AC*BPD
Warsof[7]	Log_{10}(BW)= -1.599+0.144*BPD+0.032*AC-0.000111*BPD^2*AC

Within 15 minutes of delivery, neonates were weighed on an electronic scale (with accuracy of ±5gms) and the actual weight of the neonate was compared with ultrasonically estimated foetal weight. The difference between the two was recorded as error in grams.

Statistical methods:

The primary objective of this study was to determine how accurately each of the methods predicted the actual observed birth weight and to compare them with each other. The accuracy of prediction was defined as the absolute difference between the predicted and observed weight. The data analysis was performed with the help of a personal computer using SSPS version 7.5 (Statistical Package for Social Sciences). As the distribution of absolute error was distinctly nongaussian, nonparametric test for paired data was performed using Wilcoxon's signed ranks method for paired data.

Descriptive statistics are shown in Table 2.

Table 2

Methods	Mean Birth Weight (gms)	St.Deviation (gms)
Birnholz[3]	3064	440
Deter[4]	2738	390
Hadlock[1]	2767	383
Hadlock[2]	2834	387
Jordaan[5]	2760	366
Shepard[6]	2714	397
Warsof[7]	2580	383
ActualWeight	2874	499

Table 2 shows that the mean birth weight in Hadlock2 method is comparable to that of mean of actual observed birth weight.

Percentile values for absolute error of difference in different methods (in grams) are shown in Table 3. It can be seen that the percentile values for error are least with Hadlock2 model.

Table 3

Models	5th	10th	25th	50th	75th	95th
Birnholz[3]	32.3	61.5	120.8	237.8	438.6	558.4
Deter[4]	15.3	26.2	66.1	163.2	283.3	597.3
Hadlock[1]	19.6	30.5	81.8	153.5	270.9	537.9
Hadlock[2]	7.3	28.9	62.8	144.1	259.9	526.8
Jordaan[5]	11.2	40.7	71.5	157.8	286.1	578.8
Shepard[6]	12.2	23.9	70.5	176.1	282.7	628.8
Warsof[7]	19.4	51.8	123.9	276.7	406.9	761.9

The overall variation from actual birth weight in each model is given in Table 4 (Absolute values are considered for analysis.) It can be seen that the variation is least in Hadlock2 model.

Table 4

Methods	Deviation from actual birth weight
Birnholz[3]	*±325gms*
Deter[4]	*±285 gms*
Hadlock[1]	*±260 gms*
Hadlock[2]	*±226 gms*
Jordaan[5]	*±280 gms*
Shepard[6]	*±295 gms*
Warsof[7]	*±386 gms*

From table 4 it is evident that the deviation is least with Hadlock2 method.

Accuracy of a method to predict birth weight within ±5% and ±10% of the actual birth weight are shown in Table 5.

Table 5

Methods	±5%	±10%
Birnholz[3]	30	55
Deter[4]	42	75
Hadlock[1]	45	78
Hadlock[2]	53	85
Jordaan[5]	46	74
Shepard[6]	41	73
Warsof[7]	28	53

It can be seen that Hadlock2 method predicted the birth weight in 85% of cases within ±10% of actual birth weight.

Table 6 shows the results of Wilcoxon's signed ranks test.

Table 6

Models	'z' values	Two tailed significance test (p value)	
Birnholz[3]	-5.869[a]	<0.01	S
Deter[4]	-4.700[b]	<0.01	S
Hadlock[1]	-3.878[b]	<0.01	S
Hadlock[2]	-1.840[b]	**>0.01**	**NS**
Jordaan[5]	-3.772[b]	<0.01	S
Shepard[6]	-5.580[b]	<0.01	S
Warsof[7]	-8.187[b]	<0.01	S

a Based on negative ranks.
b Based on positive ranks.

It is evident from Table 6 that the difference between the predicted foetal weight and the actual observed birth weight is highly significant except that of Hadlock2 and all methods under estimate birth weight except that of Birhholz's.

Discussion:

From this study it can be concluded that Hadlock's method using FL&AC is more accurate in predicting the birth weight in term foetuses. This may be due to the fact that towards the term, the head has the tendency to fix or engage and these results in error in measuring head size. The moulding of head toward the term may also contribute to this phenomenon.

In the present study, all methods except that of Birnholz underestimated the foetal weight. Even though Hadlock method using FL & AC underestimated the foetal weight; it was close to the actual observed birth weight, compared to other methods. It also could predict birth weight in maximum no. of cases within ±10% of actual birth weight.

Conclusion:

The improved weight estimates obtained using the method of Hadlock is based on the fact that FL is related linearly to crown heal length and according to Jordaan, crown heal length effects birth weight more significantly than the head size. And also it is easy to reproduce correct FL measurements, where as head measurements may be affected by variation of the shape of the head, moulding. Difficulty is also experienced in obtaining valid measurements when the head is deeply engaged in the pelvis.

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