TITLE:
"UMBILICAL CORD THICKNESS", THE PROMISING DARK HORSE FOR FETAL WEIGHT ESTIMATION: A COMPARATIVE STUDY

INTRODUCTION:

Fetal weight is one of the most conspicuous factors to determine the fetal well being in utero. Its estimation is extremely helpful in clinical decisions regarding termination, specially for patients with co-morbidities. [1] Knowledge of Estimated Fetal Weight (EFW) can prevent perinatal complications, unnecessary instrumentations, and improve the outcome. While macrosomia is associated with an increased risk for a number of perinatal complications like prolonged labour, shoulder dystocia, brachial palsy, facial nerve palsy, fracture of clavicle and humerus, perinatal mortality and birth asphyxia [2-3]; Low birth weight is an important determinant of infant mortality and is associated with an increased risk of neonatal infections, and metabolic abnormalities in adult life.

For a long time, researchers have been putting efforts to scale this mammoth task, but with limited success. We do have a variety of imaging techniques available, each having its fair share of challenges. Till date, a gold standard method has not been developed. Hence, this study was conceived for a comparative analysis and determining the most effective modality of fetal weight estimation.

AIMS AND OBJECTIVES:

1. Comparison of newer methods with the conventional methods for estimating fetal weight and to develop a prediction model using tests of significance.
2. Comparison of newer methods for estimation of fetal weight with the actual birth weight of the baby.

MATERIALS AND METHODS:

- A prospective observational study was undertaken in the Department of Obstetrics and Gynecology in collaboration with the Department of Radiology at PGIMSR-ESI Hospital, Basaidarapur for a period of one year. A total of 190 subjects were enrolled by randomly selecting successive patients with singleton pregnancies attending antenatal OPDs and expected to deliver in 24-48 hours. Patients with congenital aberrations, and multifetal gestations were excluded from the study. After an informed consent, a comprehensive history, and general examination, a per-abdomen examination was performed and the following measurements were taken using a non-elastic metric tape:

- **Symphysio-Fundal Height (SFH)**

  It was measured from top of pubic symphysis to the top of fundus in a straight line.

- **Abdominal Girth (AG)**

  It was measured at the level of the umbilicus encircling the abdomen.

  Estimation of fetal weight was done using the following:

  Johnson's formula:

  Fetal weight(gms) = 155* (fundal height-X)

  X= 11 at +1, 12 at 0 and 13 at -1 station

Dare's formula:

Fetal weight (gm)= fundal height * abdominal girth

The subjects were then taken up for ultrasonographic evaluation by 2-D probe, after appropriate technical adjustments on Toshiba Xario Platinum 200 machine, and the following parameters were measured:

- **Biparietal Diameter (BPD):**

The Biparietal Diameter was measured by Ultrasound in transverse section of the skull at the level of visualisation of cavum septum pellucidum, thalamus, from outer table of the skull to the inner table.

- **Head Circumference (HC)**

It was measured in same transverse section of the skull as BPD measuring around the entire outer table of the skull.

- **Abdominal Circumference (AC)**

It was measured in a transverse section of the fetal abdomen, to include the umbilical vein, spine and gastric bubble along the outer edge of the skin layer.

- **Femur Length (FL)**

Femur length was measured when the limb was parallel to the probe to avoid its foreshortening. The shaft of femur bone was measured excluding the distal femoral diaphysis from one blunt end to other blunt end.

Hadlock's formula was used for fetal weight:

Log 10 (wt)= 1.326- 0.00326(AC)(FL) + 0.0107 (HC) + 0.438(AC) + 0.158(FL)

- **Cord Circumference (CC):**

Measurements were performed by marking the outer edges of the umbilical cord near its insertion in the fetal abdomen and measured by tracing along the outer border of the cord (as shown in Figure 1). The measured value was then used in a simple regression equation to calculate estimated weight.

The equation used was: Fetal wt(gm)= C^2 + 35* C (cm)

RESULTS:

The analysis revealed a young population with 86.8% in the age group of 21-30 years; and 48.4% belonging to lower middle socioeconomic class. The study population had preponderance of nulliparous women. Dating was confirmed using first trimester ultrasound. 74% of the study subjects delivered vaginally. The distribution of actual weight was mainly in the normal weight category, with 68%; and a total of 27.36% patients having some associated high risk factor, mandating a treatment. The mean weight was 2796.3 +/- 497.22 grams. It was affected by factors like maternal BMI, amount of liquor, maternal abdominal girth, with a p-value< 0.05. All the methods of fetal weight estimation had a positive linear regression equation with the actual baby

weight. Linear equations were computed and Mean Percentage Error was determined for each method.

Mean Percentage Error (MPE) was calculated by the formula:

$$MPE = \left\{ \frac{\text{Actual weight} - \text{Estimated Weight}}{\text{Actual Weight}} \right\} \times 100$$

The MPE was inversely correlated to the accuracy of the method; i.e. higher MPE was associated with a lower accuracy to predict weight and vice versa.

The ascending order of MPE for different methods is as follows: ***Hadlock's<Cord circumference<Johnson's<Dare's.***

The Hadlock's method has the lowest MPE and Dare's method has the highest MPE; therefore, Hadlock's method is the most accurate and Dare's method is the least accurate for measuring estimated fetal weight.

A prediction model developed using regression analysis of all variables is as shown in Table 1.

The estimated weight was found to be significantly dependent on the following factors:

Period of gestation, Symphysio-fundal height, Maternal Abdominal Girth, Hypertension, Amount of liquor, Presence of fetal growth restriction, Maternal BMI, Umbilical cord circumference, Biparietal Diameter, Head Circumference, Fetal Abdominal Circumference, and Femur Length with a p-value<0.05.

The presence of oligohydramnios increased the mean percentage error in clinical methods, but it did not affect the ultrasonographic methods. The station of head also affected the estimation by Dare's method, but other modalities were not affected. Abdominal edema did not affect measurements in any method including the clinical methods.

The cord circumference and Hadlock's method had comparable sensitivity and specificity, while the clinical methods had the lowest sensitivity and specificity. The combination of newer methods to the conventional biometry greatly improved the estimation of fetal weight. This has also been highlighted in Table 2.

DISCUSSION:

This was one of the pioneer studies from the Indian Subcontinent to estimate fetal weight using umbilical cord thickness, a parameter well recognised, yet under-utilised. Hence, there are major advantages and strengths of the study. All measurements were taken by a single observer, thus removing the possibility of an inter-observer bias. The learning curve for the novel method is gradual, and time required for measurement does not exceed greatly.

A total of 190 patients were a part of the study, thus increasing the accuracy of results and reducing the error. Through this research, the workers aim to determine the single best parameter for fetal weight estimation near term. This study also helps to detect growth disorders (SGA and LGA babies) more readily by using a multi-modality approach. All the subjects enrolled in the study delivered in 24-48 hours after measurements, thus leaving little room for post-test variations in weight. Appropriate statistical tests were used to develop a prediction model for fetal weight. The new method for fetal weight

estimation can also be used in presence of gross congenital anomalies of the cranium or abdomen.

In this study, a comparison was done among 3 different approaches to fetal weight estimation:

The clinical methods used the already established formulae by Johnson and Dare [4] to estimate fetal weight. It uses minimal resources, gives an estimate in no time, and is specially useful in day-to-day practice of Obstetrics, emergencies and in low resource settings. This study recognized a mean error in Johnson's and Dare's formula as 564.94 grams +/- 290.64 grams; and 618.69 grams +/- 304.56 grams. These values are quite high, and hence these methods can be prone to providing false estimates of fetal weight. The error in Johnson's formula was slightly lower, and the error in Dare's formula was slightly higher than the respective errors in a similar study from India, with values of 261 and 672 grams respectively. [5]

The 2-D estimates use the well-established and widely used formula for ultrasonographic fetal weight estimation; i.e. Hadlock's formula. [6,7]The Mean error was 156.74 gms +/- 74.16 gms. The Mean Percentage error was 5.71%. This was found to be more reliable than the clinical modalities, with more consistent results. here ultrasound has become a routine investigation for fetal well being. However, as opposed to the present study, in a Randomised Controlled trial by Hendrix et al, the values derived from clinical and ultrasound techniques were comparable with no one method being superior to the other. [8]

The Hadlock's method also has one major challenge in visualisation of fetal bony cranium near term, especially with an engaged head, abnormal presentation, or head shape; and since it uses 2 cranial parameters- fetal Biparietal Diameter (BPD) and Head Circumference (HC), it is prone to underestimation of fetal weight. Also, the only soft tissue parameter used here is the fetal Abdominal Circumference (AC); hence, it might not subsist as the most accurate measurement of fetal weight, particularly in acute insults or fetal growth disorders.

The new modality used in this study was cord circumference. The value of cord circumference has been underestimated for determination of EFW. The mean error was higher than the Hadlock's method at 223.48 +/- 157.18 grams. The mean percentage error using this method was 8.29 +/- 11.07%. But when the hadlock's method was combined with the cord circumference method, there was a significant improvement in the MPE, without undue prolongation of the diagnostic time, thereby proving it to be a promising tool for assesment of EFW.

In a recent study by Al Heshimi, the researchers observed a significant correlation between cord circumference and fetal weight. The relationship was described by a linear regression equation in a similar fashion as the current study. However, they did not evaluate the difference in error with conventional biometry, as opposed to our study. [9]

Thus, it is safe to say that the combination of Hadlock's and cord circumference methods provide with the most accurate results for estimated fetal weight. The results are consistent even at extremes of weight and in growth disorders. This method can also be used in various abdominal wall defects, and in presence of cranial malformations. However, this study does have its lacunae as all the patients enrolled in the study were successive admissions in the labour rooms/OPDs of a tertiary care centre, hence, this can depict a falsely high rate of co-morbidities among antenatal females; thus not representing the general population completely. Besides, it requires good machinery, software for various calculations, and may not be available at lower rungs of the healthcare ladder.

CONCLUSION:

With this knowledge, this study considered the application of different methods of fetal weight estimation in three different settings in our existent healthcare system:

In resource limited settings, like primary health care centres, clinical estimate by the healthcare provider being the only available modality, the training of the provider is important for quality control and reduction in error percentage.

In secondary and tertiary care centres, that have access to ultrasound machine, but with limited machinery and manpower, the Hadlock's method can be combined with cord circumference method, to improve the sensitivity; and/or the cord circumference method can be used as a fairly reliable, easy to measure and less time consuming screening tool in suspected fetal growth disorders.

Thus, more such trials need to join the bandwagon of improvement in the speciality of Obstetrics and Gynaecology, to continue moving forward towards the goal of Happy Mother and Healthy Baby!

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METHOD USED	MEAN ERROR	MEAN % ERROR	REGRESSION EQUATION
CLINICAL (JOHNSON'S AND DARE'S)	564.94 g & 618.6 g Respectively	22.69% & 23.36%	Y= 0.4116X + 2191 Y= 0.8035X + 1133.1 respectively
2-D HADLOCK'S	156.64 g	5.71%	Y= 0.8031X + 550.45
CORD CIRCUMFERENCE	223.48 g	8.29%	Y=1.0048X + 151.53

Table 1: Showing mean errors and correlation by different modalities: the maximum mean percentage error is seen in the clinical methods, followed by the Cord Circumference method, and then the Hadlock's method.

METHOD USED		SENSITIVITY		SPECIFICITY
Cord circumference + Hadlock's		**94.6%**		**88.7%**
Hadlock's method		**91.7%**		**84.4%**
Cord circumference method		**91.2%**		**82.6%**

Johnson's method		**58.3%**		**32.7%**
Dare's method		**83.3%**		**53.7%**

Table 2: Comparative analysis of the combination of newer and conventional parameters: the sensitivity of clinical methods viz. Johnson's and Dare's method is not appreciably high, whereas the sensitivity and specificity of Hadlock's and Cord Circumference method is comparable. However, with the combined use of both the modalities, a definite improvement can be seen in the sensitivity and specificity for fetal weight estimation.