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"A NOVEL ATTEMPT IN ESTIMATION OF FETAL WEIGHT USING NEW SOFT TISSUE MEASUREMENTS"

Radiodiagnosis

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ABSTRACT

Background: The Accurate estimation of fetal weight is important in modern obstetrics. Currently, Hadlock's formula is used widely for fetal weight estimation, which includes BPD, AC, FL and HC. The correct plane of measurement of various standard parameters is difficult to obtain especially in third trimester. Hence soft tissue thicknesses of the fetus are tested for correlation with birth weight in this study.

Materials & Methods: A prospective observational study conducted among 90 pregnant females referred for Ultrasound examination in the third trimester with an interval from the ultrasound scan to delivery of ≤7 days from 2019 to 2020.

Results: The measurements of abdominal, fetal mid-thigh and mid-arm soft tissue thicknesses correlated well with birth weight in a high statistically significant positive linear relationship. A new regression model developed out of the soft tissue thicknesses(FASTT, FMASTT, FTSTT) correlates better than the Hadlock's model and Sujitkumar Hiwale et al model (For Indian population) based on BPD, HC, AC and FL

Conclusion: Ultrasound measurement of soft tissue thickness may prove to be a strong predictor of fetal weight essential for sonographic assessment of pregnancy. They are easy and simple hence fetal soft tissue thickness measurements, both two- and three-dimensional, may prove to be a diagnostic parameter that has as small an error rate as possible, is quick to use and reproducible by different examiners.

KEYWORDS

Estimated fetal weight, Fetal abdominal soft tissue thickness, Fetal mid-arm soft tissue thickness, Fetal mid-thigh soft tissue thickness, Birth weight.

INTRODUCTION:

The estimated fetal weight (EFW) is considered a part of standard routine ante partum surveillance over the past two decades. Newborns under both the ends of birth weight spectrum are at increased risk of perinatal complications. In contrast to developed countries high rate of perinatal mortality is still a major concern in developing countries [1]. Categorization of fetuses into small and large for gestational age will help us prepare to attend the due complications resulting from low birth weight and macrosomia thereby leading to successful labour management and newborn care thereby perinatal mortality rates may decrease [2].

The estimated fetal weight guides the management of high risk pregnancies like breech presentation, vaginal birth after cesarean section and pregnancy associated with diabetes. Currently, Hadlock's formula is used widely for fetal weight estimation, which includes BPD, AC, FL and HC. Even though more efficacious than clinical methods the error with sonographic weight estimation appears to be high at both the ends of weight scale spectrum. In situations such as late trimesters when head gets engaged in the pelvic cavity it is difficult to visualise the head in symmetry and abdominal circumference could not be obtained in a proper section due to compression. Hence there exists a need for an appropriate formula for accurately predicting EFW in all categories of weight. [3]

In our study soft tissue measurements at the abdominal, mid-arm and mid-thigh level are measured and their correlation with birth weight is tested as fetal fat deposition is altered at the earliest before skeletal measurements in both small for age and macrosomic babies.

MATERIALS AND METHODS:

STUDY DESIGN:

After getting institutional ethical committee approval **a** prospective observational study was conducted at Department of Radio Diagnosis, Government Stanley Medical College, Chennai during the study period of June 2019 to June 2020.

SAMPLE SIZE AND STUDY POPULATION: The study was conducted among 90 pregnant females after obtaining written and informed consent from participant.

INCLUSION CRITERIA:

Antenatal women referred for Ultrasound examinations in the third trimester and an interval from the ultrasound scan to delivery of ≤7 days.

EXCLUSION CRITERIA:

Pregnancies with Intrauterine death, Major structural or chromosomal anomalies, multiple pregnancy, Oligohydramnios & Severe Polyhydramnios, Transverse lie and breech presentation are excluded from the study

TECHNIQUES OF MEASUREMENT:

All examinations were performed on the Mindray DC-60 ultrasound equipment using a convex 3.5 MHz transducer. Conventional sonographic measurements BPD(mm),HC(mm),AC(mm) ,FL(mm) and the estimated fetal weight(EFW) in grams by Hadlock's model are obtained followed by soft tissue measurements of fetus such as Fetal Abdominal Soft Tissue Thickness (FASTT)mm, Fetal Mid Arm Soft Tissue Thickness(FMASTT)mm and Fetal Mid Thigh Soft Tissue Thickness (FTSTT)mm

FASTT is measured by ultrasound measurement of subcutaneous tissue at the anterior abdominal wall at any point within one fourth of the abdominal circumference from the umbilical cord insertion in the midline between the outer and inner margin of echogenic subcutaneous tissue(Fig 5).

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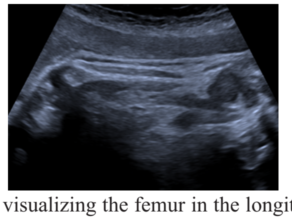
Figure 5: Measurement Technique Of Abdominal Soft Tissue Thickness

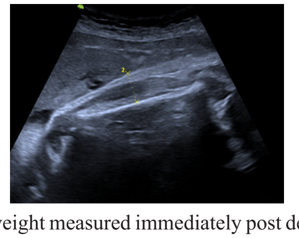
FMASTT involved the visualization of the humerus in the longitudinal section in the saggital plane as obtained by visualizing the condyle in its largest dimension and freezing the image, and then measuring the distance between the outer surface of the arm and the outer surface of the humerus, perpendicular to the bone, in its middle part (Fig 6).

Figure 6: Measurement Technique Of Mid-Arm Soft Tissue Thickness



FTSTT involved visualizing the femur in the longitudinal section in the coronal plane by visualizing the head and neck and freezing the image, and then measuring the distance between the outer surface of the thigh and the outer surface of the femur, perpendicular to the bone, in its middle part (Fig 7).

Figure 7: Measurement Technique Of Mid-Thigh Soft Tissue Thickness



The actual fetal weight measured immediately post delivery is entered in grams.

STATISTICAL ANALYSIS AND RESULTS:

After collecting, the data are compiled and entered in Microsoft Excel Sheet. Analysis is done using Statistical software SPSS version 16. The test is considered Significant if $p<0.05$, at 95% Confidence Interval. Correlation is estimated by using Pearson's correlation. Regression analysis of various factors is done by linear regression

Figure1: Birth weight distribution of the study population

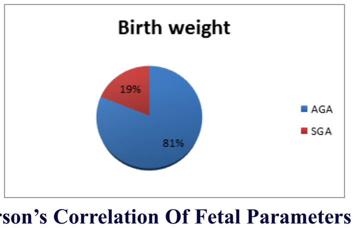


Table 1: Pearson's Correlation Of Fetal Parameters With Actual Birth Weight

PARAMETER	r value	p value
BPD	0.409	0.0005
HC	0.308	0.0007
AC	0.665	0.0011
FL	0.426	0.0006
FASTT	0.729	0.0004
FMASTT	0.869	0.0005
FTSTT	0.875	0.0008

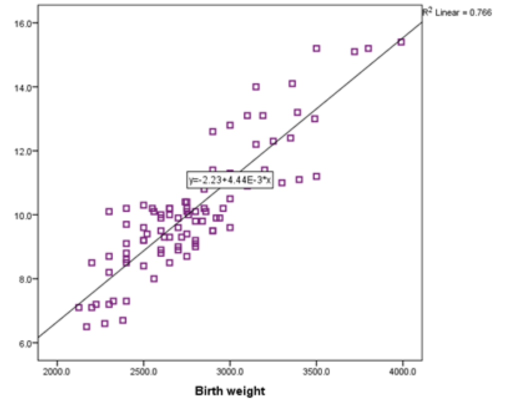


Figure 2: Scatter Plot Between FHSTT And Birth Weight

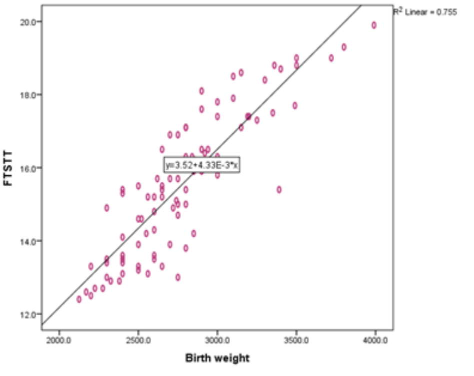


Figure 3: Scatter Plot Between FTSTT And Birth Weight

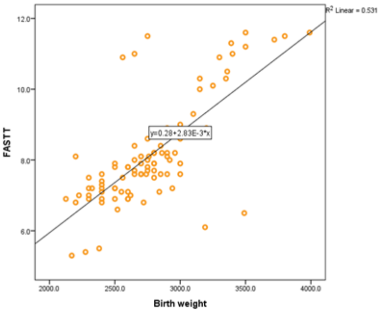


Figure 4: Scatter Plot Between FTSTT And Birth Weight

Table 2: Multiple Regression Analysis With Birth Weight and soft tissue thicknesses

Model	Unstandardized Coefficients		Standardized Coefficients	t	p-value	95% C.I	
	B	Std. Error	Beta			LB	UB
(Constant)	3.046	.020		151.885	0.0008 **	3.006	3.086
FMASTT	.011	.002	.354	4.841	0.0009 **	.006	.015
FTSTT	.014	.002	.468	6.958	0.0001 **	.010	.018
FASTT	.008	.002	.208	3.886	0.0004 **	.004	.012
** Highly Statistical Significance at p < 0.01 level							
PROPOSED NEW MODEL: LogBW = 3.046+0.11FHSTT+0.014FTSTT+0.008FASTT and R square is 0.866							

Table 3: Pearson's Correlation Between Birth Weight And Proposed New Model, EFW Hadlock and Indian population based model

		Proposed New model	EFW hadlock	Indian population based model (Sujitkumar hiwale et al)
Birth weight	r-value	0.932	0.762	0.791
	p-value	0.0005 **	0.0008 **	0.0017 **

DISCUSSION:

A prospective observational study on 90 pregnant women was done to determine the role of soft tissue measurements of fetus with actual birth weight and also to create new regression models based on them. Pearson's Correlation showed a high statistically significant positive linear relationship between FASTT and Birth weight with r-value=0.729 p=0.004<0.01 similar to previous study conducted by ***Forouzumer et al*** [5] who demonstrated a strong positive correlation between fetal abdominal soft tissue thickness in the third trimester of pregnancy and fetal weight (r = 0.86, p < 0.001). In our study Pearson's Correlation showed a high statistically significant positive linear correlation between the mid-arm soft tissue thickness and Birth weight with r-value=0.869, p=0.0005<0.01. ***Al-Hilli et al*** [6] demonstrated in her study that humeral soft tissue thickness is a more sensitive parameter, but less specific than Hadlock formula. It also has a higher negative predictive value than the standard formula.

Hoffbauer and co-workers[7] were among the first to include fetal thigh diameter in a weight formula. They draw the conclusion that circumference measurements of fetal thigh could be made in a reliable manner and could be used to detect changes in the soft tissue mass and possibly improve fetal weight estimation. In our study foetal. The correlation between foetal mid-thigh soft tissue thickness and actual birth weight in our study is 0.875, p=0.0008<0.01.

All the standard four parameters (BPD, HC, AC and FL) utilised for estimating fetal weight by Hadlock model showed a high statistically significant correlation tested by Pearson's correlation method with actual birth weight of the baby. AC had the highest correlation (r-0.665; p-0.0005) among the four. FL had the second highest correlation followed by BPD. HC is the least correlating parameter of the four.

This is very similar to **Mojgan Kalantari et al** [9] in which there was significant linear correlation between the above said parameters with birth weight . AC had the highest correlation with R value of 0.67, p<0.001 with statistical significance. FL had the next best correlation value similar to our study R: 0.66, p<0.001. BPD also had linear significant correlation but lesser than the AC and FL R: 0.59, p<0.001.Similar level of correlation is obtained in our study.

Multiple regression analysis with Birth weight using soft tissue measurements of fetal abdominal, mid-thigh and mid-arm thicknesses was done. It revealed that all the variables were equally influencing (p=0.0005 < 0.01) which is highly statistical significant in the prediction of birth weight and from the above model the following equation is generated for the birth weight prediction

New model:
Log BW = 3.046+0.11FHSTT+0.014FTSTT+0.008FASTT.

Correlation by Pearson's method between Birth weight and the regression model generated in our study as well as EFW-Hadlock and a model created for Indian population by ***Sujitkumar Hiwale et al*** [2] was analysed. Indian based model had better correlation than the Hadlock's model since it was created originally based on Western population. As a number of factors, including population characteristics, are known to impact fetal growth Hadlock's model showed less correlation as compared to Indian based model. It is very important to use appropriate models for fetal weight estimation.

Indian population based model using BPD, HC, AC and FL (log10(EFW)=2.3870211110+0.0074323216(HC)+0.0186555940(AC)+0.0013463735(BPD×FL)+0.0004519715 (HC×FL)

Hadlock model using BPD, HC, AC and FL (Log10 weight = 1.3596 - 0.00386 AC x FL + 0.0064 HC + 0.00061BPD x AC + 0.0424 AC + 0.174 FL)

Multiple regression model developed using combinations of soft tissue measurements showed significant highly positive linear correlation with actual birth weight than the existing Hadlock and Indian based model by ***Sujitkumar Hiwale et al*** [2] based on BPD, HC , AC and FL. This gives us the inference that these measurements can be brought in to current use for prediction equations after large scale studies. When used in addition to the existing parameters these may be helpful in improving the accuracy by reducing the error rate.

LIMITATIONS

Small sample size from a single center is an important limitations of our study..Variation in the measurement of soft tissues thicknesses as against changes in rotational position of limbs is another limitation that cannot be avoided.

CONCLUSION

Ultrasound measurement of soft tissue thickness in various areas of the body may prove to be a strong predictor of fetal weight essential for sonographic assessment of pregnancy that has as small an error rate as possible, is easy, simple, quick to use and reproducible by different examiners. It can be used as an alternative method when the correct plane of standard measurements are not possible. It needs to be revalidated in future.

Abbrevations:

AC- Abdominal circumference, AGA- Appropriate for gestational age, SGA- Small for gestational age, BPD- Biparietal diameter, EFW- Estimated fetal weight, FASTT- Fetal abdominal soft tissue thickness, FMASTT- Fetal mid-arm soft tissue thickness, FL- Femur length, FTSTT- Fetal mid-thigh soft tissue thickness, HC- Head circumference.

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