ORIGINAL ARTICLE

ESTIMATION OF FETAL WEIGHT AND ITS CORRELATION WITH ACTUAL BIRTH WEIGHT BY SONOGRAPHIC MEASUREMENT OF FETAL ABDOMINAL SUBCUTANEOUS TISSUE THICKNESS (FASTT)

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ABSTRACT: OBJECTIVES: To study the correlation between fetal abdominal subcutaneous fat thickness (FASTT) and actual birth weight. **METHODS:** Fifty women with normal singleton pregnancy underwent sonography at 37-39weeks of gestation. Subcutaneous fat measurement of fetal abdomen was done at the about 2cm from the site of entry of umbilical vein into the fetal abdomen. It was then correlated with the actual fetal weight. **RESULTS:** Birth weight was divided into three groups for analytic purposes. Group I-weight less than 10th percentile, Group II-10th to 90th percentile and Group III more than 90th percentile. Subcutaneous fat had a high degree of correlation with actual birth weight. The mean subcutaneous fat thickness varied significantly as in Group I- 3.7mm, Group II-5.4mm and Group III-6.1mm (p value<0.001)with average fat thickness of newborns having birth weight between 10th-90th percentile was 5.4mm.Conclusion:-Foetal Subcutaneous fat thickness correlates well with actual birth weight and is a useful predictor of foetal growth abnormalities.
KEYWORDS: Sonography, Fetal Subcutaneous Abdominal fat thickness, Actual Fetal Weight.

INTRODUCTION: In the last two decades, various models have been designed by different investigators to predict fetal weight using ultrasound. The desired outcome is achieved by measuring different fetal anthropometrical parameters. Approximate estimation of fetal weight may be made by measuring biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC) and femur length (FL).[1,2]

The sonographic ability to predict fetal weight antenatal has been studied using a variety of different formulas that incorporate biometric measurements such as biparietal diameter, head circumference, abdominal circumference, abdominal diameter, femur length or various combinations of these measurements.[3] During first 6 months of gestation, very little subcutaneous fat is deposited. Between 24-40 weeks, skin fold thickness on the abdomen 1-2 cm lateral to the umbilicus increases from an average of 1.0 to 3.4 mm.

Total fetal fat increases from 4% of body weight at 28 weeks gestation to 14% at 40 weeks gestation. Near term approximately 75% of body fat is found in the subcutaneous adipose tissue.[4] The fetal abdominal subcutaneous tissue thickness was measured in the anterior third of the abdominal circumference by placing the cursor at the outer and inner edges of the echogenic fat line.

There was a significant positive correlation between the abdominal subcutaneous tissue thickness and birth weight.[5] subcutaneous fat can be seen antenatally and measured with ultrasound. Assessment of fetal size and growth are important aspects of antenatal care.

ORIGINAL ARTICLE

Ultrasound is the best technique to monitor fetal growth and estimate fetal weight. The fetus accumulates most of its body fat during the third trimester. Subcutaneous fat thickness had a high degree of correlation with actual birth weight. It may be helpful in predicting abnormalities in fetal growth.

Large for gestational age fetuses are noted to have an increase in subcutaneous tissue. Measurement of fetal subcutaneous fat on ultrasound is an attractive alternative to predict abnormalities in fetal growth. It may be helpful in predicting fetal weight. Growth restricted fetuses have a decrease in subcutaneous fat.

Infants with SCT less than 5 mm at 38 weeks were 5 times more likely to have birth weight <10th percentile and increased neonatal morbidity compared to infants with SCT 5 mm or more. The authors have not given the rationale for using 5 mm as cut-off.[6]

In view of above mentioned advantages of sonography it was considered worthwhile to study and evaluate the role of sonography in the measurement of subcutaneous fat thickness in fetal abdomen and its correlation with actual fetal weight.

AIMS AND OBJECTIVES: To study the role of ultrasonography in the measurement of subcutaneous fat thickness in fetal abdomen in normal term pregnancy for estimation of fetal weight and its correlation with actual birth weight.

The fetal abdominal subcutaneous tissue thickness was measured in the anterior one third of the abdominal circumference by placing the cursor at the outer and inner edges of echogenic subcutaneous fat line.[5]The estimated fetal weight was then calculated from the regression equation weight formula[6] = 0.36 x SCT + 1.284

(SCT = Subcutaneous tissue thickness) Estimated fetal weight was then further correlated with actual fetal weight at birth in coordination with the Obstetrics and Gynecology department.

MATERIAL AND METHODS: Fifty cases were included for the present study. All the cases were referred to Radiodiagnosis Department from Outdoor/Indoor Department of Obstetrics and Gynecology. Fifty cases of normal ongoing singleton pregnancies were examined at 37-39th week of gestation. The images were recorded on a multi format camera and laser printer attached to ultrasound scanner.

Patient were be subjected to transabdominal sonographic examination. Transducer of 3.5 MHz frequency was be used after applying jelly as a coupling agent for a contact between the probe and the skin surface.

The fetal abdominal subcutaneous thickness was measured in the anterior one third of the abdominal circumference by placing the cursor at the outer and inner edges of echogenic subcutaneous fat lines. The estimated fetal weight was calculated from the regression equation weight formula: =0.36 x SCT + 1.284, and then further estimated fetal weight will be correlated with actual fetal weight at birth in coordination with the Obstetrics and Gynecology Department.

OBSERVATIONS: The present study was conducted on fifty cases with normal ongoing singleton pregnancy of 37-39 weeks of gestation taken from indoor wards and outdoor patient. All the cases were examined sonographically. Fetal abdominal subcutaneous tissue thickness was measured in

ORIGINAL ARTICLE

anterior third of abdominal circumference by placing the cursor at the outer and inner edge of echogenic fat lines.

Fetal weight was calculated by using subcutaneous fat thickness as parameter which was then correlated with actual fetal birth weight. Clinical history and examination findings were recorded and ultrasound estimation of fetal weight based on standard fetal biometry parameters including femur length, biparietal diameter, abdominal circumference, head circumference were also carried out. Ultrasonographic measurements were analyzed and recorded in tabulated form.

Sr. No	Age in yrs	No. of Cases (n=50)	Percentage (%)
1	20	5	10
2	21	3	6
3	22	9	18
4	23	2	4
5	24	6	12
6	25	8	16
7	26	5	10
8	28	3	6
9	30	5	10
10	32	1	2
11	35	2	4
12	37	1	2
Table 1: Showing distribution pattern of maternal age (n=50)			

In our fifty study cases, nine(18%) cases were of 22 years of age, 8(16%) cases aged 25 years, 6(16%) cases aged 24 years, 5(10%) cases each of aged 20 years, 26 years and 28 years, 3(6%) cases aged 21 years, 2(4%) cases each aged 23 years and 35 years, 1(2%) case aged 32 and 1case (2%) of 37 year age. According to this study mean maternal age was 25.08 years.

Sr. no	No. of cases (n=50)	Gestational Age (weeks)	Percentage (%)
1	28	37 ± 5 days	56
2	22	38 ± 3 days	44
Table 2: Showing distribution pattern of Gestational age(n=50)			

In our 50 study cases, 28 (56%) cases had gestational age of 37weeks ± 5days and 22(44%) cases had gestational age of 38weeks ± 3 days.

ORIGINAL ARTICLE

Sr. No	Parity	No. of cases	Percentage
1	Nulliparous	24	48%
2	Multiparous	26	52%
Table 3: Showing distribution pattern of Parity of patients (n=50)			

In our 50 study cases, 24 (48%) women were nulliparous and 26 (52%) were multiparous in nature.

Sr. No	Age (in years)	No. of Cases (n = 50)	Percentage (%)
1	20-25	33	66
2	25-30	13	26
3	30-35	3	6
4	35-40	1	2
Table 4: Showing age range distribution in study cases (n=50)			

In our 50 study cases, thirty three (66%) cases were in the age range of 20-25 years, 13(26%) cases in the range of 25-30 years, 3(6%) cases in 30-35 years and 1(2%) case in the range of 35-40 years.

Sr. No	Percentile	No. of Cases (n=50)	Subcutaneous fat (in mm)
1	<10th	2(4%)	<4.4
2	10-90	39(78%)	4.4-5.9
3	>90	9(18%)	>5.9
Table 5: Showing Fetal Subcutaneous fat thickness (n=50)			

Foetal subcutaneous fat thickness:-The fetal abdominal subcutaneous tissue thickness ranged between 3.2-6.5mm in all fetuses with a mean measurement of 5.4 mm.[Figure 1 & 2]

Sr. No	Estimated Fetal weight (gm)	Calculated Weight(gm)	Actual Birth Weight (gm)	Sr. No	Estimated Fetal weight (gm)	Calculated Weight (gm)	Actual Birth Weight (gm)
1	2845	3192	3028	26	3348	3300	3360
2	3494	2868	3010	27	3300	3224	3250
3	3300	3480	4142	28	3090	3264	3280
4	3700	3284	3328	29	3499	3444	4089

ORIGINAL ARTICLE

5	2898	3300	3289	30	3328	3228	3200
6	3374	3552	4256	31	3499	3300	3350
7	3447	3588	4395	32	3122	3300	3200
8	3465	3480	4144	33	2846	2940	2940
9	3397	3804	4350	34	3192	3336	3400
10	3399	3588	4257	35	3411	3408	4343
11	3300	3336	3400	36	2735	2886	2800
12	2882	2930	3000	37	2670	3080	3000
13	3499	3336	3400	38	3148	3300	3000
14	3300	3480	4271	39	3090	3156	3184
15	2998	3032	3000	40	3081	3120	3000
16	3300	3120	3000	41	3097	3300	3000
17	3275	3264	3300	42	3350	3192	3000
18	3250	3284	3300	43	3475	3228	3500
19	3207	2940	3000	44	3275	3264	3270
20	2803	2796	2350	45	3325	3120	3200
21	3374	3050	3000	46	3109	3192	3130
22	2415	2436	2350	47	3525	3336	3400
23	2782	3408	4114	48	3447	3192	3202
24	3133	3264	3250	49	3300	3336	3320
25	3013	3192	3128	50	3300	3290	3100

Table 6: Showing Fetal Weight Distribution in Grams (n=50)

In our 50 study cases, the Mean Estimated birth weight was 3208.24gm. The Mean Calculated weight was 3234.80 gm. and Mean Actual Birth Weight was 3351.60 gm.

Sr. No	Percentile	No. of cases	Mean subcutaneous fat (mm)	Mean Calculated Weight (gm)	Mean actual Birth weight (gm)
1	<10th	2 (4%)	3.7	2616	2350
2	10-90th	39(78%)	5.4	3234	3351
3	>90th	9(18%)	6.1	3528	4246

Table 7: Showing Fetal Weight in Percentile (n=50)

To analyze the association between subcutaneous tissue thickness and actual birth weight, the birth weights were grouped according to the percentile. In our 50 study cases, 39 (78%) cases were in the range of 10th-90th percentile, 2(4%) cases less than 10th percentile and 9(18%) cases were more than 90th percentile.

ORIGINAL ARTICLE

According to the above table the p-value was <0.001 which was statistically significant. Mean calculated weight and mean actual birth weight in 39(78%) cases was 3234 grams and 3351 grams respectively. Mean calculated weight and mean actual birth weight in 9(18%) cases was 3528 grams and 4246 grams respectively, while in 2(4%) cases was 2616 grams and 2350 grams respectively.

Sr. No	Percentile	Gestational Age in weeks ± days	No. of cases n=50
1	<10th	37 ± 5	2(4%)
2	10-90	37-38 ± 5	39 (78%)
3	>90	38 ± 3	9 (18%)
Table 8: Showing Mean Gestational age according to the Percentile (n=50)			

For purpose of analysis, the birth weight was divided into three groups:

Group I less than 10th percentile, Group II between 10-90th percentile and Group III > 90th percentile. The gestational age at delivery did not differ significantly in the three groups (p<0.001).

The Mean gestational age was 37.24 weeks. Subcutaneous fat thickness had a high degree of correlation with the actual birth weight. The mean abdominal wall thickness in the three groups differed significantly.

It was seen that the average subcutaneous fat thickness of babies having birth weight between 10-90th percentiles was between 4.4-5.9mm. The estimated weight was calculated from the regression equation weight formula 0.36*SCT + 1.284 by using the subcutaneous tissue thickness as one of the parameter. The coefficient of determination for weight by this equation was >50%. Mean of Calculated weight was 3234.80 grams and mean of Actual Birth Weight 3351grams.

Measurement of FASTT is helpful in predicting the nutritional status in utero, hence abnormalities in the fetal growth. It may be useful in predicting fetal weight as a single parameter.

Assessment of fetal size and growth are important aspects of antenatal care. Early recognition of an abnormality coupled with appropriate surveillance and intervention will optimize perinatal outcome. It has been found that abnormalities in fetal growth are associated with changes in subcutaneous fat deposition. It is reduced in growth restricted fetuses and is increased in macrosomic fetuses. Hence it may be helpful in predicting fetal weight as a single parameter.

DISCUSSION: In the last two decades, various models have been designed by different investigators to predict fetal weight using ultrasound. The desired outcome is achieved by measuring different fetal anthropometrical parameters. Approximate estimation of fetal weight may be made by measuring biparietal diameter (BPD), Head circumference (HC) abdominal circumference (AC) and femur length.[2]

According to results, Hadlock's method using femur length and abdominal circumference was more accurate in predicting the birth weight in term fetuses. In present study, subcutaneous thickness measurement in fetal abdomen was taken as a single parameter to estimate the fetal weight. Regression equation formula used for this purpose was = 0.36 x SCT + 1.284.6.

ORIGINAL ARTICLE

Methods	Mean Birth Weight (gm)	Standard Deviation(gm)
Birnholz	3064	440
Deter et al	2738	390
Hadlock et al	2767	383
Hadlock et al	2834	387
Jordaan	2760	366
Shepard et al	2714	397
Forouzmehr et al	2875	564
Actual Weight	3351	499

Table 9: Showing comparison of Mean Birth weight and Standard Deviation in various studies

In our present study, sonography was done in women beyond 37 weeks of gestational age. For the purpose of analysis birth weight were divided into three groups i.e. <10th percentile, 10th-90th percentile and >90th percentile. It was seen that the average subcutaneous fat thickness of babies having birth weight between 10th-90th percentile was between 4.4 - 5.9 mm.

The fetal abdominal subcutaneous tissue thickness ranged between 3.2-6.5 mm in all the fetuses. The fetal abdominal subcutaneous tissue thickness was measured by the method used by Petrikovsky.[5]

According to the present study, fetal abdominal subcutaneous fat thickness measurement can be used for prediction of birth weight. Estimating fetal fat may provide additional parameter to predict the fetal weight and can improve the accuracy of the estimation of birth weight. It may also predict the fetal growth aberration associated with changes in soft tissue mass.

Dadwal et al analyzed the association between subcutaneous fat thickness and actual birth weight. The birth weight was grouped in percentiles as follows: Group I less than 10th percentile, Group II 10th-90th percentile and Group III more than 90th percentile.[6]

In our study, the gestational age at delivery did not differ significantly in the three groups (p=0.374). The subcutaneous fat thickness (mm) differed significantly in the three groups (p=0.05), as was the difference in weights among the three groups (p<0.001). It was seen that the average subcutaneous tissue thickness in babies having birth weight between 10th-90th percentile 4.4 ± 0.77 mm (95% CI, 2.89-5.91) while it was 3.4 ± 0.59 mm for babies below 10th percentile and 5.8 ± 0.71 mm for babies above 90th percentile.

Group	Percentile weight	No.	Gestation (in weeks)	Mean SCT (mm)	Mean Birth weight
1	<10th	9	38.4 ± 2.24	3.4 ± 0.59	2.09 ± 0.03
2	10th-90th	78	38.4 ± 1.24	4.4 ± 0.77	2.86 ± 0.29
3	>90th	14	37.9 ± 1.4	5.8 ± 0.77	3.71 ± 0.30
			p=0.374	P=0.001	p=0.001, 1&2, 2 &3,

Table 10: Showing correlation of abdominal wall thickness and birth weight

ORIGINAL ARTICLE

In our study, the mean age of the patients was 27.4 years and 37(36.27%) women were nulliparous. The mean actual birth weight in Kg was 2.91±0.49 and the mean estimated birth weight was 2.58±0.55. The percentage difference of mean between actual birth weight and estimated weight was 11%. The actual birth weight was within 10th percentile of estimated weight in 31(30.4%) cases and within 15% (47%) in 48 cases. It was seen that mean actual birth weight of the babies was higher than the mean estimated birth weight by 0.33 ± 0.32 Kg and this difference was statistically significant (p<0.001).

The birth weight were divided according to the percentile in three groups according to which results were statistically significant (p<0.001). Average subcutaneous tissue thickness in babies having birth weight between 10th-90th percentile was 5.402 mm. Below 10th percentile was 4.4mm and above 90th percentile was >5.9mm.The Mean estimated weight is 3208.24 gm, mean calculated weight 3234.80 gm, and mean actual birth weight 3351.60 gm.

In study conducted by Simon et al (1987), foetal weight prediction was less accurate in small and large fetuses and particularly when there were deviations from normal growth pattern. The Shepard equation (AC, BPD) performed better in intrauterine growth retarded, premature and normal term fetuses less than 4000 gm at least as far as the magnitude of the systematic error was concerned. In contrast the FL models were more accurate in large fetuses and in macrosomic fetuses in general.[10]

In 1982, William ultrasonically calculated fetal weight by a formula that utilized biparietal diameter and abdominal circumference.[8]

$$\text{Log birth weight} = \frac{1.7492 + 0.166 \times BPD + 0.046AC -}{2,646 \ (BPD \times AC)}$$

100 In a study by Hadlock et al, addition of femur length to head and abdomen measurements increases the accuracy of in utero weight estimates based on ultrasound studies.[9]

Rajeshwari GB et al conducted study on 350 women with gestational age more than 36weeks. The mean foetal Abdominal Subcutaneous Tissue Thickness (FASTT) was 6 mm ± 0.94. Mean birth weight of babies was 2986 g ± 392.8.

Number of babies weighed as average for gestational age (AGA, between 10th and 90th percentile) was 286 (81.7%), 25 babies (7.1%) were small for gestational age (SGA, < 10th percentile), 39 babies (11.2%) were large for gestational age (LGA, >90th percentile).[11]

FASTT was measured at the anterior 1/3rd of abdominal circumference by ultrasound after 36 weeks and weight of the baby measured after birth.

Forouzmehr et al, studied 300 fetuses between 37 and 42 weeks of gestation sonographically for abdominal subcutaneous tissue thickness. The mean maternal age was about 29.4±7.2 years. Thirty six percent were nulliparous. The mean gestational age was 37.7±1.9 weeks. The mean birth weight of newborns was 2875±564 gm (range: 1600-4500 gm).

The fetal abdominal subcutaneous tissue thickness ranged between 3 and 14 mm, with mean measurement of 6.7±1.8 mm. There was a significant positive correlation between the abdominal subcutaneous tissue thickness and the birth weight (r = 0.86, P < 0.001).The above study was in correlation with our study on 50 cases.[12]

ORIGINAL ARTICLE

CONCLUSION: From the study, it was concluded that the Co-efficient of the determination was more than 50%, indicating significant positive correlation between the abdominal subcutaneous fat thickness and actual birth weight. Hence measurement of fetal subcutaneous fat thickness on ultrasound is an attractive alternative method to predict abnormalities in fetal growth.

It may be helpful in predicting fetal weight as a single parameter. Subcutaneous fat thickness had a high degree of correlation with the actual birth weight as the subcutaneous thickness in mm differed significantly in the three groups ($p < 0.001$).According to the present study the results were statistically significant i.e. ($p < 0.001$).

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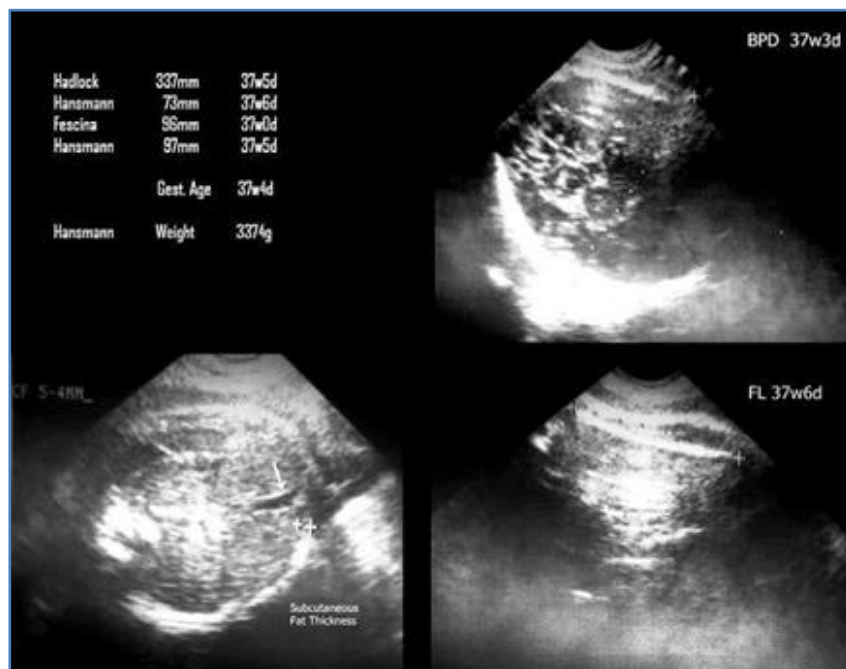
ORIGINAL ARTICLE

Figure 1. Showing Fetal Gestation age measurements by BPD (38w1d) and FL (37w6d). Fetal abdominal Fat Thickness was about 4.9mm. Approx. Fetal weight was 3325gm.
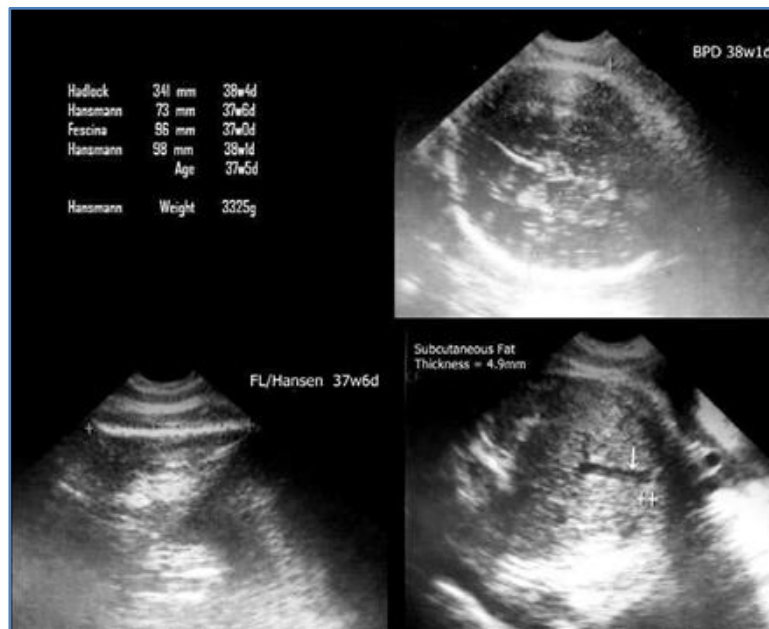
Fig. 1

Figure 2: Showing Fetal Gestation age measurements by BPD (37w3d) and FL (37w6d).Fetal abdominal Fat Thickness was about 5.4mm.Approx.Fetal weight was 3374gm.

Fig. 2

ORIGINAL ARTICLE

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