Original Article

Comparison Between Fetal Abdominal Subcutaneous Tissue Thickness and Abdominal Circumference to Predict Large for Gestational Age Neonate in Gestational Diabetes

Smitha Mohan; M.D., P Pallavee; M.S., Rupal Samal; M.D.

Department of Obstetrics & Gynecology, Mahatma Gandhi Medical College & Re-search Institute, Sri Balaji Vidyapeeth (Deemed-to-be-University), Pondicherry, India

Received January 2024; Revised and accepted March 2024

Abstract

Objective: Increased subcutaneous fat deposition in abdomen in large for gestational age (LGA) fetuses of mothers with gestational diabetes mellitus can be measured by fetal abdominal subcutaneous tissue thickness (FASTT) using ultrasound. The current study aimed to evaluate the correlation between FASTT and birth weight and compare FASTT and abdominal circumference (AC) for prediction of LGA babies in gestational diabetes.

Materials and methods: 150 term GDM women were enrolled into the study. FASTT was measured weekly. Birth weight was measured immediately after delivery and categorized into SGA, AGA and LGA according to International growth charts. The last FASTT and AC values were recorded for analysis. Correlation statistics was used to determine the relation between FASTT with birth weight and ROC curves were used to compare FASTT and AC for prediction of LGA fetuses.

Results: There was weak positive correlation between FASTT and birth weight with Pearson's co-efficient (r) of 0.375. The cut-off value for FASTT to predict LGA fetuses obtained by ROC curve was ≥8.05 mm with sensitivity and specificity of 68.8% and 68.7%. The mean values of FASTT for small for gestational age (SGA), appropriate for gestational age (AGA) and LGA fetuses were significantly different. AUC for FASTT was 0.692 and for AC was 0.755.

Conclusion: FASTT had a positive but weak correlation with birth weight. The utility of FASTT as a screening tool may not be impressive. FASTT can discriminate between SGA, AGA and LGA fetuses. AC is a better predictor than FASTT for LGA neonates.

Keywords: Fetal Abdominal Subcutaneous Tissue Thickness; Birth Weight; Abdominal Circumference; Large For Gestational Age; Gestational Diabetes Mellitus

Introduction

Gestational diabetes mellitus (GDM) is the onset or first recognition of glucose intolerance of variable degree during pregnancy. It is one of the most prevalent metabolic complications that affect pregnant women. The prevalence of GDM in India varies from 3.8% to 21% according to studies conducted in different geographical locations of the

Correspondence:
Dr. P Pallavee
Email: drppallavee@gmail.com

country using different diagnostic methods (1, 2). Indian women are eleven times more likely to develop GDM and this is a worrying trend because it is associated with adverse pregnancy outcomes. One such fetal complication is large for gestational age (LGA) baby which complicates 15-45% of diabetic pregnancies (3). In simple words, a fetus is considered to be LGA when there is undue intrauterine fetal growth which leads to a birth weight that is greater than 90th percentile for the gestational age.

Macrosomic fetuses have the uncommon tendency of subcutaneous fat deposition in the medial abdominal and interscapular areas. Ultrasound estimation of fetal fat may be vital in detecting defects in fetal growth. Therefore, the measurement of fetal abdominal subcutaneous tissue thickness (FASTT) may have immense potential in predicting LGA infants in diabetic pregnant women and eventually help in better clinical management of these pregnancies. The current study aimed to determine the correlation between FASTT and birth weights (BW) and to compare FASTT with abdominal circumference (AC) which is the present standardfor the prediction of LGA neonate in term GDM.

Materials and methods

This hospital based prospective observational study was conducted after obtaining approval from Institutional Human Ethics Committee (CTRI Registration No.: REF/2019/07/026972). A purposive sampling was done to choose the study participants, and accordingly 150 term pregnant women with GDM were enrolled into the study over a period of 18 months from March 2019 to August 2020 after obtaining informed written consent from the participants. The inclusion criterion was all singleton term pregnancies with GDM. The exclusion criteria were major congenital abnormalities in fetus, difficult ultrasound examination where measurements could not be taken, hypertensive disorders, pre-gestational diabetes mellitus, fetal malpresentation and previous caesarean section. The sonographic measurement was performed by LOGIC GE S-7 ultrasound unit, 2-5 MHz wide band convex, curved array transducer by single consultant who had been certified in obstetric ultrasound. Fetal abdominal subcutaneous tissue thickness (FASTT), bi-parietal diameter (BPD), head circumference (HC), abdominal circumference (AC), femur length (FL) and estimated fetal weight (EFW) were measured. Fetal abdominal subcutaneous tissue thickness (FASTT) was measured in millimeters at anterior third of abdominal circumference by placing the cursor at outer and inner edges of the echogenic subcutaneous fat line as shown in Figure 1. The measurements were repeated every week and the last measurement before delivery was taken into consideration for analysis.

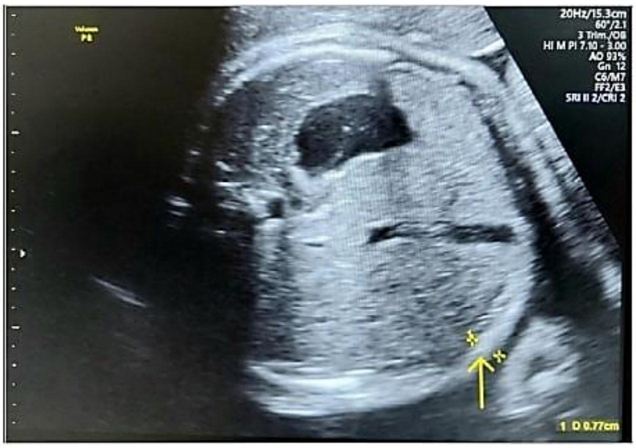

Figure 1: FASTT measurement (indicated by arrow)

The birth weight of neonate was measured immediately after birth using electronic weighing machine, model BS-250 with accuracy 20 gram. Neonates were classified as small for gestational age (SGA), appropriate for gestational age (AGA) and large for gestational age (LGA) based on international standardized growth chart for female and male neonates used in our Institute.

Large for gestational age neonate was taken as neonate with birth weight more than 90th centile for the gestational age, small for gestational age neonates were those with birth weights below 10th centile and appropriate for gestational age neonates had birth weights between 10-90th centile based on growth charts followed in our hospital.

The age, parity, body mass index, and gestational age at diagnosis of GDM were recorded. The ultrasonographic fetal parameters as mentioned above were also recorded. Obstetric outcomes noted included gestational age at delivery, onset of labor, and mode of delivery. Neonatal outcomes recorded included the Apgar score at 5 mins, the birth weight, admissions to the neonatal intensive care unit (NICU), and complications such as shoulder dystocia, hypoglycemia, hyperbilirubinemia and respiratory distress.

All the data was collected using a pre-designed data collection proforma and entered into Excel sheet.

Sample size was calculated based on the following formula:

$$n \geq \frac{Z^2_{1-\alpha/2} \times p(1-p)}{d^2}$$

Using an estimated proportion (p) of 0.25 and an estimated error (d) of 0.07, a total of 147 women were estimated to be required for the study. This number was rounded off to 150.

Data was expressed as mean ± standard deviation. The group means were evaluated using one-way analysis of variance and Tukey*post hoc* test. Pearson's correlation was calculated between FASTT and the birth weight. Receiver operator characteristic (ROC) curves were drawn for FASTT as well as the abdominal circumference in cms and the areas under curves (AUCs) compared. Statistical analysis was done using Epi data version 2.2.2.186. All statistical analysis was considered significant if p-value < 0.01.

Results

A total of 150 antenatal women, who fulfilled the inclusion and exclusion criteria were included in the study. The average maternal age was 28 years. 48% (72/150) were primipara. The average body mass index (BMI) was 22.9 kg/m^2. The mean gestational age at diagnosis of GDM was at 29.2 weeks. Majority of women (39.3%) delivered between 38 to 39 weeks. Only 13.3% went on to deliver beyond 40 weeks. The mean abdominal circumference (AC) was 33.42 ± 1.55 cm with 95% confidence interval (CI) of 33.17-33.67. The mean FASTT value was 7.7 ± 1.86 mm (95% CI, 7.4-8.). Most of the women (69.3%) were on medical nutrition therapy alone. Out of 150 cases, 49.3% cases went into spontaneous labour whereas, 50.7% cases were induced. Total of 47.3% women had normal vaginal delivery, 6 (4%) had instrumental delivery and the rest 48.7% underwent lower segment caesarean section. Majority of neonates were appropriate for gestational age (86.7%). The proportion of LGA neonates in our study was 10.7% and only 2.6% were small for gestational age. Most of the neonates (80.7%) had birth weights between 2500-3500 gram. The mean birth weight was 3107 grams. Out of 150 neonates delivered, 142 (94.7%) had Apgar score of >7 at 5 minutes. Eight (5.3%) neonates had Apgar ≤7 at 5 minutes. 38 neonates were admitted to neonatal intensive care unit (NICU). 112 neonates did not require NICU admission. Twenty-eight per cent neonates had complications. The most common complication was hyperbilirubinemia (17.3%) followed by respiratory distress (3.3%) and hypoglycaemia (2.7%). Only 1 LGA neonate had shoulder dystocia. Table 1 demonstrates the demographic characteristics and clinical data for the sample population chosen.

Table 1: Demography and clinical data of all patients

Variables	Value
Age in years (Mean ± SD)	28 ± 5
Primipara n (%)	72 (48%)
BMI in kg/m^2 (Mean ± SD)	22.9 ± 6.4
Gestational age in weeks at diagnosis of GDM (Mean ± SD)	29.2 ± 1.8
Gestational age in weeks at delivery (Mean ± SD)	38.5 ± 1.3
AC in cms (Mean ± SD)	33.42 ± 1.55
FASTT in mm (Mean ± SD)	7.7 ± 1.86
Management modalities for GDM:	
1. Medical Nutrition therapy only n (%)	104 (69.3%)
2. Oral hypoglycaemic agents (OHAs) n (%)	18 (12%)
3. Insulin n (%)	21 (14%)
4. OHA + Insulin n (%)	7 (4.7%)
Mode of delivery n (%):	
1. NVD	71 (47.3)
2. Instrumental	6 (4)
3. LSCS	73 (48.7)
Birth weight n (%):	
< 10th centile (SGA)	4 (2.6)
10th to 90th centile (AGA)	130 (86.7)
> 90th centile (LGA)	16 (10.7)
Birth weight in gms (Mean ± SD)	3107 ± 421
Apgar scores n (%)	
1. > 7 at 5 minutes	142 (94.7)
2. ≤ at 5 minutes	8 (5.3)
NICU admission n (%)	
1. Required	38 (25.3)
2. Not required	112 (74.7)

There was a weak positive correlation between FASTT and birth weight with a Pearson's co-efficient (r) of 0.375 (Table 2). Figure 2 demonstrates the scatter plot of the correlation between FASTT and the birth weight. As can be seen, there was a lot of scatter. Multiple comparisons were carried out for the LGA, AGA and SGA groups, with respect to their FASTT values. There was statistically significant difference in the mean FASTT value for SGA, AGA and LGA groups (F=9.789, p=0.000) as shown in Table 3.

Table 2: Correlation between FASTT and Birth Weight

		FASTT(mm)	Birth Weight(grams)
FASTT (mm)	Pearson Correlation	1	0.375**
	Sig. (2-tailed)		0.000
	N	150	150
Birth Weight (grams)	Pearson Correlation	0.375**	1
	Sig. (2-tailed)	0.000	
	N	150	150

**Correlation is significant at the 0.01 level (2-tailed).

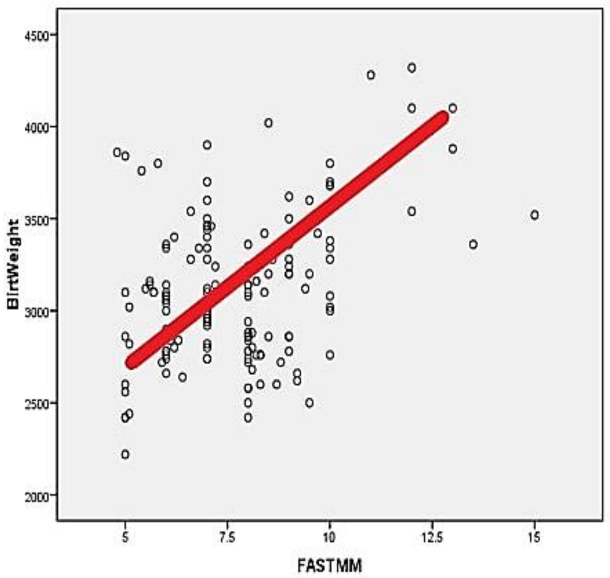

Figure 2: Scatter plot showing correlation between FASTT and birth weight

A Tukey post hoc test (Table 4) revealed that FASTT was significantly higher in AGA neonates (7.59 ± 1.63 mm, p=0.024) and LGA neonates (9.182±14 mm, p=0.000) when compared to SGA group (5.22 ± 0.45 mm).

By obtaining the co-ordinates of the receiver operating characteristics curve (ROC), a cut off value for FASTT of 8.05 mm had maximum sensitivity and specificity of 68.8 % and 68.7% respectively for predicting LGA neonate. Thus its utility as a screening tool for this purpose may be rather limited. Areas under the ROC curves for AC (cm) and FASTT (mm) were 0.755 and 0.692 respectively (Figure 3) indicating that AC had greater diagnostic accuracy than FASTT.

Discussion

Gestational diabetes mellitus is one of the most prevalent medical complications that affect women during pregnancy. Hyperglycaemia leading to macrosomia or large for gestational age (LGA) neonate is an expected complication which can lead to shoulder dystocia, increased risk of instrumental delivery, perineal tears, and higher chances of caesarean section, postpartum haemorrhage and fetal birth injuries. Hence there is a need to diagnose LGA baby antenatally in order to manage labour and delivery efficiently, thereby, preventing maternal and fetal complications during childbirth (4).

This study was designed to find out whether there is any correlation between FASTT and birth weight and to compare it with abdominal circumference for prediction of large for gestational age neonate in gestational diabetes. In our study FASTT was measured in 150 term GDM women, and was weakly correlated with birth weight. The mean birth weight was 3107 gram and the proportion of large for gestational age was 10.7%. There was a positive correlation between FASTT and birth weight which was statistically significant with a Pearson co-efficient (r) of 0.375.

We also found that FASTT was able to discriminate between small for gestational age (SGA), appropriate for gestational age (AGA) and large for gestational age (LGA). The FASTT values were significantly higher in LGA than in SGA and AGA and it also showed higher values in AGA than SGA.

Table 3: FASTT and multiple comparisons

		Sum of Squares	Df	Mean Square	F	Sig.
FASTT (mm)	Between Groups	60.841	2	30.420	9.789	0.000
	Within Groups	456.798	147	3.107		
	Total	517.639	149			

Table 4: Post hoc Test

Dependent Variable	(I) SGA AGALGA	(J) SGA AGALGA	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Lower Bound
FASTT (mm)	1	2	-2.367*	0.895	0.024	-4.49	-0.25
		3	-3.950*	0.985	0.000	-6.28	-1.62
	2	1	2.367*	0.895	0.024	0.25	4.49
		3	-1.583*	0.467	0.003	-2.69	-0.48
	3	1	3.950*	0.985	0.000	1.62	6.28
		2	1.583*	0.467	0.003	0.48	2.69

*The mean difference is significant at the 0.05 level.

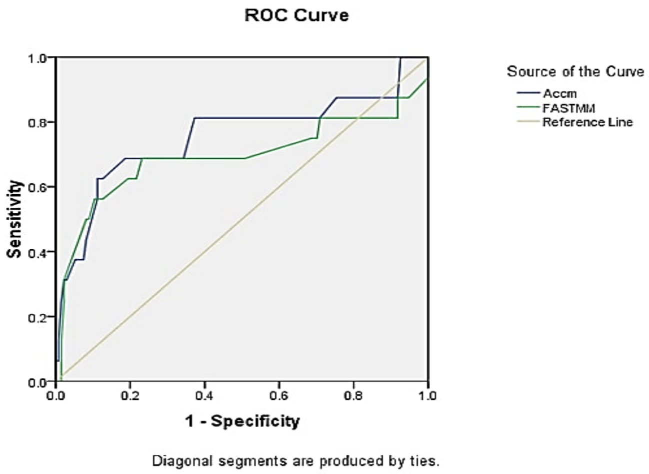

Figure 3: ROC curve comparing FASTT and AC for predicting LGA

Using the ROC curve and taking the best sensitivity and specificity, a FASTT cut off value of more than 8.05mm predicted LGA baby with a sensitivity of 68.8% and specificity of 68.7%. On comparing FASTT with abdominal circumference we found that abdominal circumference fared better than FASTT in predicting large for gestational age in GDM.

As the prevalence of GDM is increasing, it becomes imperative to be able to predict large for gestational age fetus early for judicious planning of safe delivery for both mother and baby. In our study we found FASTT as a simple ultrasound tool which showed a positive correlation with birth weight. It was fairly comparableto abdominal circumference > 90^{th} percentile in prediction of LGA and can be used in situations where AC measurement is difficult to obtain. FASTT values were significantly different between LGA, AGA and SGA. Use of FASTT to discriminate between restricted growth, normal and macrosomia should be explored further in larger population. Further research to find the usefulness of FASTT in predicting mode of delivery can improve the readiness of obstetric units for operative interventions and minimize intrapartum complications. In our study the rather low sensitivity suggests that the utility of FASTT as a screening tool for LGA in GDM mothers may be limited. Future studies can be directed to evaluate the combined use of FASTT, EFW and AC in a multimodal prediction model for LGA in GDM to achieve higher precision.

Third-trimester FASTT values in 125 diabetic women were studied in a prospective cohort study conducted by Higgins et al (5). They concluded that FASTT value ≥ 5.6mm at 36-39 weeks or AC > 90^{th} centile when measured together with AC was a better predictor than AC alone, for macrosomia. Another similar prospective cohort study (6) concluded that anterior abdominal wall thickness (AAWT) was significantly higher in LGA and its sensitivity was better than AC in determining LGA in third trimester. Kuttanet al. (7) conducted a study on 100 GDM pregnant women between 30 to 35 weeks of gestation.They concluded that there was a significant correlation between FASTT and subscapular subcutaneous tissue thickness with BW and that it can be used to predict LGA.Yet another hospital based prospective study (8) was conducted in this regard in GDM women between 31-37 weeks of gestation. The authors concluded that subscapular subcutaneous tissue thickness (SSSTT) and FASTT strongly correlated with birth weight ($r=0.666; p<0.001$) and that a cut off value of 5.45mm and 5.15 mm respectively was highly accurate in predicting macrosomia in the neonates of GDM mother. Finally, Aksoy et al. (9) conducted a cross sectional study between 26 and 28 weeks of gestation. They concluded that AAWT can be used to evaluate fetal growth in GDM women.

The strengths of our study included its prospective nature and the fact that we recruited a homogenous population of women with GDM. Further, all the ultrasound measurements were done by a single experienced consultant using the same ultrasound machine. Weekly fetal biometry and FASTT were measured by ultrasound, and the last value measured before delivery was taken into consideration to reduce the time period between USG and delivery.

Our study does have the following limitations. Firstly, we have studied FASTT in term GDM, and its value as an early clinical marker for LGA. However, it needs to be explored further to change clinical management strategies for better pregnancy outcome. Secondly, we have tried to study the value of FASTT for prediction of LGA alone and not for other complications of GDM. Further, we did not study the effect of combining FASTT and AC for prediction of LGA in GDM.

Conclusion

We conclude that there is a weak positive correlation between FASTT and birth weight. FASTT could detect growth abnormalities. There was significant difference between the mean values of FASTT of small for gestational age, appropriate for gestational age and large for gestational age groups. However, FASTT value ≥ 8.05mm can predict large for gestational age with maximum sensitivity and specificity of 68.8 % and 68.7% respectively, which admittedly are not too impressive for a diagnostic screening test.AC was a better predictor than FASTT to predict LGA.Thus,FASTT is a simple ultrasound tool which correlates positively with birth weight, albeit weakly. It can detect fetal growth abnormalities in gestational diabetes but is less accurate than abdominal circumference to predict large for gestational age. Hence, the search for better screening tools for the purpose of predicting large for gestational age babies in GDM mothers is far from over.

Conflict of Interests

Authors declare no conflict of interests.

Acknowledgments

None.

References

1. Ministry of health and family welfare government of India. Diagnosis and management of Gestational Diabetes Mellitus Technical and Operational Guidelines. 2018. https://nhm.gov.in/New_Updates_2018/NHM_Components/RMNCH_MH_Guidelines/Gestational-Diabetes-Mellitus.pdf.
2. Seshiah V, Sahay BK, Das AK, Shah S, Banerjee S, Rao PV, et al. Gestational diabetes mellitus - Indian guidelines. J Indian Med Assoc 2009; 107(11):799-802.
3. Kc K, Shakya S, Zhang H. Gestational diabetes mellitus and macrosomia: a literature review. Ann Nutr Metab. 2015; 66(2):14-20.
4. Bhat RG, Nathan A, R A, Vasudeva A, Adiga P, Bhat PV, et al. Correlation of fetal abdominal subcutaneous tissue thickness by ultrasound to predict birth weight. J Clin Diagn Res. 2014; 8(4):OC09-11.
5. Higgins MF, Russell NM, Mulcahy CH, Coffey M, Foley ME, McAuliffe FM. Fetal anterior abdominal wall thickness in diabetic pregnancy. Eur J Obstet Gynecol Reprod Biol. 2008; 140(1):43-7.
6. Lertvutivivat S, Sunsaneevithayakul P, Ruangvutilert P, Boriboonhirunsarn D. Fetal anterior abdominal wall thickness between gestational diabetes and normal pregnant women. Taiwan J Obstet Gynecol. 2020; 59(5):669-74.
7. Kuttan K, George ANR, Ramachandran L. Correlational study of birth weight to sonographic measurement of umbilical cord thickness, fetal abdominal and shoulder pad thickness in overt and gestational diabetes mellitus. Indian J Obstet Gynecol Res. 2019; 6(1):20-3.
8. Rauf KER, Adarsh KM, Acharya D, Ahmed K. Measurement of fetal abdominal and subscapular subcutaneous soft tissue thickness to predict macrosomia in pregnancies affected by gestational diabetes. IOSR-JDMS. 2020; 19(2):32-40.
9. Aksoy H, Aksoy Ü, Yücel B, Özyurt SS, Aydın T, Babayiğit MA. Fetal anterior abdominal wall thickness may be an early ultrasonographic sign of gestational diabetes mellitus. J Matern Fetal Neonatal Med. 2016; 29(12):2028-32.

Citation: Mohan S, Pallavee P, Samal R. **Comparison Between Fetal Abdominal Subcutaneous Tissue Thickness and Abdominal Circumference to Predict Large for Gestational Age Neonate in Gestational Diabetes.** J Family Reprod Health 2024; 18(1): 30-5.