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Research Article

PREDICTIVE ANALYSIS OF MATERNAL SUBCUTANEOUS FAT THICKNESS FOR THE RISK OF DEVELOPMENT OF GESTATIONAL DIABETES MALLITUS

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ABSTRACT

Introduction: In recent years the prevalence of gestational diabetes mellitus is remarkably increased. Obesity is the most important risk factor for GDM. Abdominal obesity is associated with insulin resistance and metabolic syndrome. Maternal abdominal subcutaneous fat thickness is highly correlated with obesity and can be measured by ultrasonography. This study was done to find correlation between maternal ASCFT and development of GDM and to find a cut-off value of ASCFT for prediction of risk of developing GDM.
Material and method: This was a prospective observational study. 200 women included in the study were classified as normal (n=181) and with GDM (n=19) on the basis of DIPSI. Abdominal subcutaneous fat thickness was measured by ultrasonography. Data were evaluated statistically.
Results: Mean age of the women who developed GDM (27.47 ± 2.14 years) was significantly more. Receiver-operating characteristic curve analysis showed ASCFT above 15.2 mm predicted GDM with 100% sensitivity and 91.78% specificity and the risk of developing GDM was significantly high [odd ratio-117 (95% CI 14.9262-917.1130, p <0.0001)].
Conclusion: Measurement of abdominal subcutaneous fat thickness by ultrasonography at 16 -18 weeks may help to identify women at risk of developing GDM at 24-28 weeks.

INTRODUCTION

Gestational diabetes mellitus (GDM), is the most common metabolic disorder of pregnancy and is defined as any degree of dysglycaemia that occurs for the first time or is first detected during pregnancy, irrespective of treatment with diet or insulin.[1] Recent studies have shown that the risk of developing type 2 diabetes mellitus and metabolic syndrome with the advanced age is increased in patients with a history of GDM.[2] Metabolic syndrome is correlated with insulin resistance, abdominal obesity, hypertension, and atherogenic dyslipidemia. Abdominal obesity and insulin resistance are responsible for the central role in the pathogenesis of Metabolic syndrome.[3] Abdominal obesity seems to be more strongly linked to metabolic disease compared with body mass index (BMI) and anthropometric measures of abdominal obesity [e.g., waist circumference (WC) and waist-to-hip ratio (WHR)].[4]

With the increasing prevalence of obesity and diabetes mellitus there is parallel increase in prevalence of gestational diabetes.[5] In Asia, the prevalence of GDM ranges from 0.7 to 51.0%.[6] In India the prevalence of gestational diabetes varies from 3.8% in Kashmir,[7] to as high as 41% in Lucknow.[8] This vast disparity in prevalence rates may be due to differences in ethinicity[9], diagnostic criteria[10], screening strategies[11], and population characteristics[12].

We are using diagnostic test for GDM as recommended by Diabetes in Pregnancy Study group of India (DIPSI) where plasma glucose is evaluated after two hours of ingestion of 75 g anhydrous glucose in 250 – 300 ml of water irrespective of meal timings. A 2-hours plasma glucose ≥ 140 mg/dl is taken as GDM.[13]

Women with GDM are at increases risk of pre-eclampsia, eclampsia, infectious disease, and the birth rate of large for gestational age foetuses. There is increased perinatal morbidity due to increased risk of infantile respiratory distress syndrome, metabolic disorders, and hyperbilirubinemia in fetuses[5]. Women are also at risk of developing diabetes after delivery.[14]
The age of a mother, her pre-pregnancy body mass index (BMI), the amount of obesity, family history, and weight gain during pregnancy are major risk factors for GDM, but among these, obesity is the most serious risk factor[15]. Various biochemical biomarkers like adiponectin, follistatin-like-3

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(FSTL3) and sex hormone-binding globulin (SHBG), have been used for early prediction of GDM.[16]One of the most limiting factors in using these tests to predict GDM is cost. Pre-pregnancy BMI is used most frequently to assess the risk of pregnancy complications. One of the drawbacks of using BMI is that it depends on pre-pregnancy weight which a woman may not remember so recently maternal abdominal subcutaneous fat thickness (ASCFT) is used to complement the use of BMI to assess risk for GDM. ASCFT is highly correlated with obesity and can be measured by ultrasonography. Measurement of abdominal subcutaneous fat by ultrasound is an easy, quick, non-invasive and cost-effective method. It also avoids the use of ionizing radiation.[17]This study was done to find correlation between maternal ASCFT and development of GDM and to find a cut-off value of ASCFT for predictionofrisk of developing GDM.

MATERIAL AND METHODS

This was a hospital based prospective observational study conducted in the Department of Obstetrics and Gynaecology. 200 women with singleton live pregnancy between 16 -18 weeks of gestation and willing to participate in the study were included after obtaining written informed consent. Women with type 1 or type 2 diabetes prior to pregnancy or with a previous history of GDM, hypertension were excluded. Pre-pregnancy BMI was calculated for all women. Ultrasonography was done to assess foetal well-being and rule out congenital malformation. Maternal abdominal subcutaneous thickness was measured from the subcutaneous fat layer to the outer border of the rectus abdominus muscle at the level of the linea alba. Three measurements were taken for subcutaneous thickness for each woman and mean subcutaneous thickness was determined. All women included in the study underwent DIPSI test (2 hours sugar after 75 gm of anhydrous glucose)between 24to 28 weeks of gestation. GDM was diagnosed when plasma glucose levels were above 140 mg/dl.

All data were entered into MS excel sheet and analyzed. To determine the cut-off value for predicting GDMa receiver operating characteristic (ROC) curve analysis was conducted, with the area under the curve (AUC), sensitivity, and specificity calculated. A logistic regression analysis was done to calculate the odds ratio for the ASCFT-mediated risk of GDM. A p value 0.05 was considered to be statistically significant.

RESULTS

Out of 200 women screened, 19 (9.5%) were screened positive for GDM and 181 (90.5%) were screened negative for GDM. Mean age of the women who developed GDM (27.47 ± 2.14 years) was significantly more than mean age of the women who did not developed GDM (23.81 ± 2.69 years) (p – 0.0000). Mean BMI and ASCFT were significantly more in women who developed GDM (28.42 ± 3.06 kg/m² and 17.75 ± 1.82 mm respectively). (Table 1)

Table 1 Age, BMI and ASCFT differences in women with or without GDM

Variables	Total (n=200)	Control (n=181)	GDM (n=19)	P value
Age (year)	24.17 ± 2.86	23.81 ± 2.69	27.47 ± 2.14	0.0000
BMI (kg/m²)	22.84 ± 2.93	22.25 ± 2.22	28.42 ± 3.06	0.0000
ASCFT (mm)	12.47 ± 3.13	11.92 ± 2.70	17.75 ± 1.82	<0.001

To find an effective cut-off value for predicting GDM by BMI and ASCFT, a ROC curve analysis was conducted which showed that pre-pregnancy BMI above 25 kg/m² (AUC=0.984) predicted GDM with a sensitivity of 100% and specificity of93.4% and Youden index of 0.93.ROC curve analysis for ASCFT showed that ASCFT above 15.2 mm(AUC=0.970) predicted GDM with a sensitivity of 100% and specificity of85.6 and Youden index of 0.86.There was no significant difference in the diagnostic performance of BMI (Kg/m²) and SCFT (mm) in prediction of GDM (DeLong's Test p = 0.157). (Table 2 and Fig 1)

Table 2 Receiver operating characteristic prediction curve analysis of variables

Predictor	AUROC	Sensitivity %	Specificity %	Youden Index	P value
BMI (Kg/m²)	0.984	100%	93.4%	0.93	<0.001
ASCFT (mm)	0.970	100%	85.6%	0.86	<0.001

AUROC: Area under ROC curve, BMI: body mass index.,ASCFT:abdominal subcutaneous fat thickness

Figure 1 ROC for prediction of GDM by BMI & SCFT

Increased abdominal SCFT was significantly associated with increased risk of developing GDM. Using 15.2 mm cut -off value for ASCFT, the odd ratio of GDM in 200 women screened was 117 (95% CI 14.9262-917.1130, p <0.0001). (Table 3)

Table 3 Association of ASCFT with risk of GDM

ASCFT	GDM		Odd Ratio, 95%CI	P value
	Yes (n=19)	No (n=181)		
<15.2 mm	1	157	117.75(15.022-922.956)	<0.0001
≥15.2 mm	18	24		

DISCUSSION

Depending on population sample and diagnostic criteria used, prevalence of GDM ranges from 1 to 20 per cent.[18] The incidence of GDM is increasing due to increase in maternal age and obesity among mothers with increase in the GDM related complications.[17] Therefore there is a need to predict the risk of GDM at an early gestational age so that appropriate measures can be taken to prevent GDM. This study was done to measure abdominal subcutaneous fat thickness by ultrasonography at 16 to 18 weeks and to use it to predict GDM at 24-28 weeks.

In our study, out of 200 women screened for GDM 9.5% women were found to be positive. The prevalence of GDM in our study was lower than prevalence observed by Kansu-Celik H *et al* (20%)[2] and Yang SH *et al* (12%)[17]

In our study mean age of the women (24.17 ± 2.86 years) was lower than mean age of the women observed by Moon Sook Hwang (32.14 ± 4.11 years)[19],and Martin A M *et al* (31.7± 5.0 years)[20]. This may be due to practice of early marriage which is still prevalent in our state. Mean age of the women was significantly more in women with GDM than without GDM. (p 0.0000). Our results were consistent with results of Kansu-Celik H *et al*[2]. Mean BMI and Mean SCFT of the women in our study were lower than Mean BMI and SCFT observed by Yang SH *et al*,[17] Martin A M *et al*[20] and De Souza *et al*[21]. There was significant difference in mean SCFT and BMI in women with GDM and without GDM and our results were in line with results observed by Kansu-Celik H *et al*[2], Yang SH *et al*[17] and D'Ambrosi F *et al*[22].

In present study, ROC curve analysis showed that pre-pregnancy BMI above 25 kg/m² (AUC=0.984) predicted GDM with a sensitivity of 100% and specificity of 93.4% withYouden index of 0.93.ROC curve analysis for ASCFT showed that ASCFT above 15.2 mm (AUC=0.970) predicted GDM with a sensitivity of 100% and specificity of 85.6 with Youden index of 0.86.Kansu-Celik H *et al*[2] in their study observed that BMI above 25.75 kg/m^2 predicted GDM with a sensitivity of 78.2%, a specificity of 40.9% and SAT (abdominal subcutaneous adipose tissue) thickness above 16.75 mm had a sensitivity of 71.7%, a specificity of 57.1%. Yang SH *et al*[17] in their study observed that BMI above 21.8 kg/m² (AUC=0.71) predicted GDM with a sensitivity and specificity of 80.49% and 57.19%, respectively with a Youden index of 0.377 and ASCFT above 2.4 cm (AUC= 0.90) predicted GDM with sensitivity and specificity of75.61% and 91.78%, respectively with a Youden index of 0.674.

The role of SAT in the development of GDM is not exactly clear. some recent studies demonstrated that subcutaneous adiposity is associated with insulin resistance[23,24].A recent study revealed that increased biological activity in the SAT of pregnant women was associated with inflammation. The secretion of inflammatory agents, for example, leptin, adiponectin, and retinol-binding protein-4, was detected higher in subcutaneous tissue than in visceral adipocytes[25]. In addition, it was shown that increased inflammation and cytokines produced by fat tissue induce insulin resistance that leads to the development of diabetes mellitus[21, 26]. In our study at a cut-off value of 15.2 mm for ASCFT, the risk of developing GDM was significantly high [odd ratio-117 (95% CI 14.9262-917.1130, p <0.0001)]. Our results were consistent with results of Yang SH *et al*[17], Kennedy NJ *et al*[27], Kosus *et al*[28].All of them in their respective studies observed increase in the risk of GDM with increase in SCFT. In a retrospective cohort study by Suresh *et al*[29], it was observed that the median SAT was 18.2 mm and for every 5 mm increase in SAT, the odds ratio for developing GDM was 1.40 (95% CI: 1.22–1.61, $p < 0.001$).Our results were in contrast with the results of De Souza *et al*[21] and D'Ambrosi F *et al*[22].They reported that visceral adipose thickness, but not subcutaneous adipose thickness, was significantly and independently associated with GDM. The difference in the thickness of subcutaneous fat in different studies shows that SAT thickness changes during pregnancy from women to women and it may be due to differences in socioeconomic status, physical activity, and diets between nationalities[2,30].

CONCLUSION

Ultrasonographic measurement of ASCFT is a reliable, quick and cost-effective method and we found that ultrasonographic ASCFT measurement at 16 -18 weeks of pregnancy predicted GDM with 100% sensitivity and 91.78% specificity therefore measurement of ASCFT by ultrasonography may be helpful in predicting risk of GDM in pregnancy. During antenatal checkup, women with increased ASCFT can be counselled about the risk of developing GDM, diet modification and exercises so as to prevent GDM in later pregnancy.

Conflicts of interest: NIL

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