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ORIGINAL ARTICLE

A single test procedure to diagnose gestational diabetes mellitus

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Abstract Universal screening for gestational diabetes mellitus (GDM), detects more cases and improves maternal and offspring prognosis. Of all the screening tests, World Health Organization (WHO) procedure is simple and cost effective; the only disadvantage is that the pregnant woman has to come in the fasting state to undergo oral glucose tolerance test (OGTT). Hence, we undertook a study to elucidate a test that is casual and reliable to diagnose GDM. A total of 800 pregnant women underwent 75-g glucose challenge test (GCT) irrespective of the time of the last meal and their 2-h plasma glucose (PG) was estimated. They also underwent a 2-h 75-g OGTT recommended by WHO after 72 h. There was no statistically significant difference in the glycemic profile between GCT and WHO OGTT in the diagnosis of GDM. In conclusion, GCT performed irrespective of the last meal timing is a patient-friendly approach and causes least disturbance in the pregnant woman's routine activities.

Keywords Gestational diabetes mellitus (GDM) · 2-h 75-g oral glucose tolerance test (OGTT) · 2-h 75-g oral glucose challenge test (GCT) · American Diabetes Association (ADA) · World Health Organization (WHO)

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Introduction

Gestational diabetes mellitus (GDM) is defined as carbohydrate intolerance of variable severity with onset or first recognition during pregnancy [1]. GDM is not only associated with increasing pregnancy morbidity but also increases the likelihood of subsequent diabetes in the mother. As such GDM has implications beyond the index pregnancy, identifying two generations at risk of future diabetes [2]. Hence, detection and care of women with GDM becomes necessary in the strategy for the primary prevention of diabetes [3]. American Diabetes Association (ADA) recommends selective screening to detect GDM. This policy may not be applicable for population belonging to the ethnic group with high prevalence of GDM [4]. Further, compared to selective screening recommended by ADA, universal screening for GDM detects more cases and improves maternal and offspring prognosis [5].

The 2-h 75-g oral glucose tolerance test (OGTT) recommended by World Health Organization (WHO) for diagnosis of GDM is simple and cost effective. The only drawback in this procedure is that the pregnant woman has to come to the antenatal clinic or laboratory in the fasting state for assessing glucose tolerance. For the successful implementation of universal screening, a test has to be casual and reliable. Hence we undertook a study to evaluate, whether a 2-h 75-g oral glucose challenge test (GCT) performed in a non-fasting state, is as efficacious as 2-h fasting 75-g OGTT recommended by WHO in detecting GDM. Our aim was to validate a test which is able to diagnose GDM and exclude NGT with least inconvenience to a pregnant woman.

Subjects, materials and methods

The study population was from pregnant women attending the antenatal clinic of the Institute of Obstetrics and Gynecology, Chennai, India. A total of 1,106 consecutive pregnant women were explained about the study procedure and 862 of them gave their consent to participate in the study. Complete history regarding menstrual cycle, previous obstetric history and family history of these women were taken. They underwent a thorough clinical examination. The inclusion criterion was women with gestational age between 16 and 32 weeks. Pregestational diabetic women were excluded.

They were subjected to 75-g GCT irrespective of time of the last meal. Venous samples were collected at 2 h after GCT. All of them were advised to follow a diet containing atleast 150 g carbohydrate daily and usual activity for atleast 3 days and come to the antenatal clinic after an overnight fasting of 10–12 h. They underwent 2-h 75-g OGTT recommended by WHO. Plasma glucose (PG) was estimated by GOD–POD method in the central laboratory of the institute. Women with a 2-h PG value of $\geq$140 mg/dl were diagnosed as GDM. Ultrasound examination was performed in all GDM women to assess the fetal development.

Paired *t* test was employed to examine the difference of PG values between the WHO OGTT and GCT values in all GDM women. Mc Nemar Test was used to assess the difference in the detection of GDM and NGT cases using the two techniques of WHO OGTT and GCT. The Bland and Altman plot was used to compare the two methods in diagnosing GDM. Analysis was two tailed and $P < 0.05$ was considered statistically significant. Statistical analysis was performed using SPSS version 10 package.

Results

Out of 862 women who were included in the study, 800 completed the study procedure and were available for analysis. Among 800 pregnant women, 87 (10.89%) were diagnosed as GDM by WHO criteria. The mean age of the GDM women was 32.5 ± 2.56 years and that of the women with normal glucose tolerance (NGT) was 26.6 ± 4.13 years. There was a statistically significant difference in age between GDM and NGT women ($P < 0.05$).

Among the GDM women, 35.6% were primigravida and among the NGT women 56.2% were primigravida. Prevalence of GDM also increased with multigravidae ($P < 0.05$).

BMI $\geq$30 was observed in 31% of the GDM women and 11.1% of the NGT women ($P < 0.05$). Positive family history of diabetes was documented in 44 (50.6%) GDM women and 99 (14%) NGT women. Incidence of GDM in patients with positive family history of diabetes was 43.6% and was found to be statistically significant ($P < 0.05$).

Out of the 87 GDM women, 7 (8%) were diagnosed between 16 and 20 weeks, 17 (19.5%) between 21 and 24 weeks, 49 (56.3%) between 25 and 28 weeks and 14 (16.1%) between 29 and 32 weeks' gestation. Though the usual recommendation for GDM screening is between 24 and 28 weeks of gestation [6], we detected 27.6% of them with GDM prior to this recommended period of screening.

The Bland Altman plot, utilized for comparison of two methods (WHO OGTT and GCT) of measurement of the 2 h PG is shown in Fig. 1. The average of the 2 h PG value by the two methods is plotted on the *x*-axis and the difference (WHO OGTT–GCT) on the *y*-axis. The middle vertical line represents the mean difference across all measures, and the top and bottom lines represent differences of $\geq$+1.96 greater and $\geq$−1.96, respectively. With two methods that show excellent agreement, the mean difference will be near zero, and very few points will fall outside the upper and lower boundary limits. In our study, this plot shows that the mean difference (WHO OGTT–GCT) is near zero (−0.6), and that all the points fall within the +1.96 and −1.96 mg/dl boundary limits. There was no statistically significant difference ($P > 0.05$) in the glycemic profile between GCT and WHO OGTT in the detection of GDM.

The observation in this study was that all women diagnosed as GDM by 75-g GCT irrespective of the last meal timings also satisfied the diagnostic criteria of 75-g OGTT recommended by WHO (Table 1). It was found that there was no statistically significant difference ($P > 0.05$) between the PG levels of GCT and WHO OGTT performed in the GDM and the NGT pregnant women. Results of the Mc Nemar test also confirms that there was no statistically

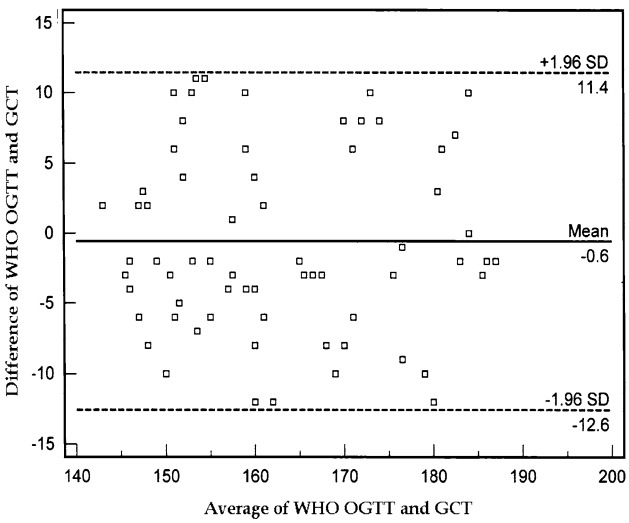

Fig. 1 Bland and Altman plot comparing WHO OGTT and GCT for measuring the 2-h PG in the diagnosis of GDM

Table 1 Agreement between WHO OGTT and GCT

	WHO OGTT		Total
	+GDM	− GDM	
GCT			
+ GDM	87	0	87
− GDM	0	713	713
Total	87	713	800

Sensitivity 100%, Specificity 100%

significant difference between the two tests in identifying GDM women ($P = 1$).

Discussion

Women with a history of GDM are at an increased risk of future diabetes predominantly type 2 diabetes as are their children [2]. Thus GDM women are an ideal group for the primary prevention of diabetes [3]. This implies that universal screening for detection and care of women with GDM may be considered as mandatory, and for this we need a simple and acceptable test procedure.

The importance of any screening procedure is not only to identify women with GDM but also to exclude NGT women. ADA recommends 50 g of oral glucose for screening without regard to time of the last meal and the PG of ≥140 mg/dl 1 h after the glucose load as a positive screen test [6]. In them, the diagnosis of GDM needs confirmation by 100 g OGTT. This two-step procedure is cumbersome and also the phenomenon of no show occurs since the woman has to visit the antenatal clinic twice [7–9]. However, the one-step procedure of WHO serves the dual purpose of both screening and diagnosis of GDM [7]. But the disadvantage with this procedure is that the pregnant woman has to come to the antenatal clinic or laboratory in a fasting state. In this context a procedure that does not impose any restriction would be ideal for universal screening. The test performed should be able to diagnose GDM, as they walk into the antenatal clinic or laboratory irrespective of their last meal timings.

A normal glucose tolerant woman would be able to maintain euglycemia despite glucose challenge due to adequate insulin response. Whereas in a woman with GDM who has impaired insulin secretion [10], her glycemic level increases with a meal and with glucose challenge, the glycemic excursion is expected to exaggerate. This cascading effect is advantageous as this would not result in false positive diagnosis of GDM. Performing the test procedure in the non-fasting state is rational as glucose concentrations during the glucose tolerance are affected little by the time since the last meal [11].

In our study, we estimated the 2-h PG after 75-g GCT without regard to the time of the last meal just like 50-g ADA screening procedure [6]. They also underwent WHO OGTT with overnight fasting. We found non-fasting GCT identified women with GDM similar to that of OGTT. Plasma glucose for each subject in non-fasting GCT and OGTT varied, but yet all the values were found to be above the diagnostic criteria of 2-h PG ≥140 mg/dl. At the same time, women who were diagnosed to be NGT by non-fasting GCT were found to have NGT by OGTT too. Their plasma glucose also varied but was ≤140 mg/dl. Thus this procedure assumes clinical relevance, as Pettitt et al. [12] also observed that WHO criteria based on the glucose concentration 2 h after 75 g of load administered to non-fasting women correctly identified subjects with GDM. The non-fasting 2 h post-75 g glucose concentration strongly predicts adverse outcome for the mother and her offspring [13].

The 75 g of glucose challenge though larger than the 50 g recommended by ADA, the difference in the glycemic load is not expected to result in a higher glycemic excursion in NGT subjects [12]. Further, ADA also permits both 100 and 75 g OGTT for diagnosis of GDM. Though the glucose loads are different, the cut off values (FPG ≥95 mg/dl, 1-h PG ≥180 mg/dl, 2-h PG ≥155 mg/dl) for diagnosis of GDM are the same implying that the quantity of glucose load has little influence on the PG levels in a normal person, whereas in a metabolically deranged state like GDM, both 50 and 75 g glucose load would unmask the glucose intolerance. The advantage of 75-g GCT is that there is no necessity to repeat OGTT; however, for 50-g glucose challenge it is.

Conclusion

Universal screening for glucose intolerance during pregnancy is recommended in ethnically vulnerable population with increased risk of developing GDM. The 75-g GCT performed irrespective of the last meal timing is a patient-friendly approach. Diagnosis of GDM may be established or excluded by this simple procedure. Women found to have NGT in the first visit may need to undergo GCT in the subsequent visits of all trimesters. This one-step diagnostic procedure is easy to perform, cost effective and causes least disturbance in a pregnant woman's routine activities.

References

1. Metzger B, Coustan DR (1998) Summary and recommendations of the fourth international workshop—conference on gestational diabetes mellitus. Diabetes Care 21(Suppl 2):B161–B167

2. Dornhost A, Rossi M (1998) Risk and prevention of type 2 diabetes in women with gestational diabetes. Diabetes Care 21(Suppl 2):B43–B49
3. Girling J, Dornhorst A (2003) Pregnancy and diabetes mellitus. In: Pickup JC, Williams G (eds) Textbook of diabetes, 3rd edn. Blackwell publishing company, Oxford, pp 65–66
4. Beischer NA, Oats JN, Henry OA et al (1991) Incidence and severity of gestational diabetes mellitus according to country of birth in women living in Australia. Diabetes 40(Suppl 2):35–38
5. Cosson E, Benchimol M, Carbillon L et al (2006) Universal rather than selective screening for gestational diabetes mellitus may improve fetal outcomes. Diabetes Metab 32(2):140–146
6. Gestational Diabetes Mellitus (2002) American Diabetes Association: clinical practice recommendations 2002. Diabetes care 25(Suppl 1):S94–96
7. Seshiah V, Balaji V, Balaji MS et al (2005) One step procedure for screening and diagnosis of gestational diabetes mellitus. J Obstet Gynecol Ind 55(6):525–529
8. Magee S, Walden CE, Bendedetti TJ et al (1993) Influence of diagnostic criteria on the incidence of gestational diabetes and perinatal morbidity. JAMA 269:609–615
9. de Aguiar LG, de Matos HJ, de Brito Gomes M (2001) Could fasting plasma glucose be used for screening high-risk outpatients for gestational diabetes mellitus? Diabetes Care 24:954–955
10. Kühl C, Hornnes PJ, Andersen O (1985) Etiology and pathophysiology of gestational diabetes mellitus. Diabetes 34(Suppl 2):66–70
11. Gough WW, Shack MJ, Bennett PH, Burch TA, Miller M (1970) Evaluation of glucose in the Pima Indians by longitudinal studies (abstract). Diabetes 19(Suppl 1):388
12. Pettitt DJ, Bennett PH, Hanson RL, Narayan KM, Knowler WC (1994) Comparison of World Health Organization and National Diabetes Data Group procedures to detect abnormalities of glucose tolerance during pregnancy. Diabetes Care 17(11):1264–1268
13. Pettitt DJ, Bennett PH, Saad MF, Charles MA, Nelson RG, Knowler WC (1991) Abnormal glucose tolerance during pregnancy in Pima Indian women: log term effects on the offspring. Diabetes 40(suppl 2):126–130