

THE GLUCOSE CHALLENGE TEST: A SCREENING TEST FOR GESTATIONAL DIABETES MELLITUS

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ABSTRACT

The 50g glucose challenge test (GCT) was evaluated as a method to screen for gestational diabetes in 540 low-risk pregnant women to establish its sensitivity and specificity, as well as to establish a relevant threshold plasma glucose value above which a diagnostic 75g oral glucose tolerance test (OGTT) would be indicated. If a threshold of 140 mg/dl is used, the diagnostic yield would be 28.5%. At a threshold of 130 mg/dl, the diagnostic yield fell to 25.4%; the sensitivity rose to 87.7% and the specificity declined to 67.1%. There was progressive increase in diagnostic sensitivity when the GCT was performed after 24 weeks without significant decrease in specificity. In low-risk populations, a 50g GCT should be performed between 24-28 weeks gestation.

Keywords: screening, low-risk population, 50g glucose challenge test, threshold value, sensitivity and specificity

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INTRODUCTION

The incidence of gestational diabetes has been estimated at between 3% to 12%, and varies with the population studied and diagnostic criteria used⁽¹⁾. Maternal hyperglycaemia affects foetal development adversely and perinatal morbidity may rise in proportion to the severity of maternal hyperglycaemia. Conversely, if normoglycaemia is achieved in pregnant diabetics, most of the adverse effects on the foetus may be eliminated. In such circumstances, outcome is determined by the quality of antenatal care provided, rather than the presence of diabetes per se⁽²⁾. Consequently, early screening and diagnosis, which permit early initiation of appropriate therapy are encouraged.

Many different forms of screening for diabetes mellitus are available. These methods have been designed with the aim of developing a cheap and sensitive test which is acceptable to the pregnant woman and easily applied for screening of the entire population.

In Singapore, we have traditionally screened for gestational diabetes mellitus with historical and obstetric risk factors⁽³⁾. However, like others⁽⁴⁻⁶⁾, we have found this to be of low sensitivity and specificity. The 50g glucose challenge test (50g GCT) has been proposed as a screening test for all preg-

nant women^(4,7,8). We evaluated the 50g GCT^(4,5,7), as an additional method to screen for gestational diabetes in pregnant women who had no historical or obstetric risk factors (ie the low risk population). We also attempted to evaluate its sensitivity and specificity, as well as to establish a relevant threshold plasma glucose value above which a diagnostic 75g oral glucose tolerance test would be indicated.

PATIENTS AND METHODS

Five hundred and forty pregnant women attending the antenatal clinic in the National University Hospital, Singapore were recruited at their booking visit. Informed consent was obtained. These women had neither obstetric nor historical risk factors for developing gestational diabetes mellitus⁽³⁾. Women with any historical or obstetric risk factors were not recruited into the study, but had a routine diagnostic 75g oral glucose tolerance test performed at booking.

Details of the women's age, parity, past obstetric history and race, as well as best gestational age assessment at time of the glucose challenge test were obtained. Venous blood was drawn for a random plasma glucose estimation, following which a 50g glucose drink was administered. After a 60 min interval during which the patient rested without smoking or eating, a second specimen of blood was drawn. Plasma glucose levels (PGL) were determined in the laboratory by the glucose oxidase method.

Patients whose 1 hour plasma glucose level was ≥ 120 mg/dl after the 50g GCT were recalled within a week for a formal 75g glucose tolerance test. Using the WHO criteria, diagnosis of gestational diabetes was made if the second hour plasma glucose level at the 75g OGTT was ≥ 140 mg/dl⁽⁹⁾.

The data were collated and the sensitivity and specificity of the GCT as a screening test was analysed. Data obtained when different threshold values (≥ 120 mg/dl, ≥ 130 mg/dl and ≥ 140 mg/dl) were used as a cut off level for performing a 75g glucose tolerance test were compared.

RESULTS

Of the 540 women recruited for the GCT, 504 (93.3%) completed the project and data derived from these patients were used for analysis. Thirty-six patients were excluded from the analysis after the GCT had been carried out, either because they delivered soon thereafter or because they failed to comply with 2 or more requests that they attend a 75g OGTT.

The distribution of 1 hour-post-50g glucose challenge blood sugar levels in our study population is depicted in Fig 1. The distribution of test values in women with normal OGTT without disease extends above the abscissa; the distribution in those diagnosed to have gestational diabetes based on a 2 hour plasma

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Fig 1 - Distribution of 1 hour plasma glucose levels with 50g GCT

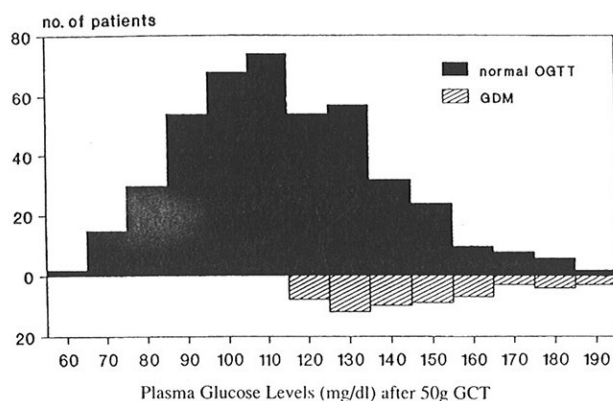
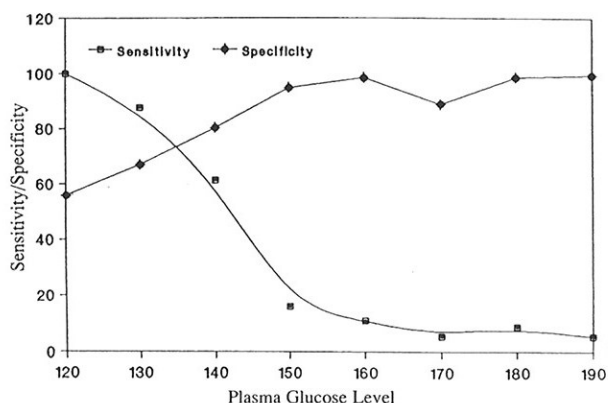


Fig 2 - Screening test thresholds: Changes in sensitivity and specificity



glucose value ≥ 140 mg/dl on the 75g OGTT, extends below the abscissa. There is substantial overlap in screening test results between the 2 groups.

There were 254 GCTs where the 1 hour plasma glucose level was ≥ 120 mg/dl. These patients were recalled for a 75g OGTT, of whom 57 (22.4%) had gestational diabetes. The diagnostic yield of gestational diabetes among patients using different screening test values is depicted in Table I. If a threshold of 140mg/dl is used, the diagnostic yield would be 28.5% (35 positive OGTTs of a total of 123 performed in patients with a 1 hour GCT plasma glucose level of 140mg/dl) with sensitivity and specificity of 61.4% and 80.3% respectively. At the median threshold value of 130mg/dl the diagnostic yield fell to 25.4% (50 positive OGTTs of 197 performed); the sensitivity rose to 87.7% and the specificity declined to 67.1%. The effect of choosing different test thresholds is seen in Fig 2.

When the value of ≥ 130 mg/dl was used, 7(12.3%) of 57 patients who would otherwise have been diagnosed to have gestational diabetes (at a threshold of ≥ 120 mg/dl) would have been missed. However, in all these seven patients, good blood sugar control within a normal range of 80mg/dl to 120mg/dl was achieved with dietary restriction alone. At 6 weeks post delivery, the repeat oral glucose tolerance tests in all seven patients were normal. At a threshold of ≥ 140 mg/dl, 22 (38.6%) of 57 patients who would otherwise have been treated as gestational diabetics would not have been picked up. Only one of these women required low dose of insulin to maintain euglycaemia throughout pregnancy, and in all these patients, the 6-week postnatal 75g OGTTs were normal.

Table II reveals the percentage of patients who required a

Table I - Frequency of Gestational Diabetes Mellitus in groups with different GCT results

GCT 1hr PGL (mg%)	% with + 75g OGTT	Sensitivity (%)	Specificity (%)
≥ 140	28.5% (35/123)	61.4	80.3
≥ 130	25.4% (50/197)	87.7	67.1
≥ 120	22.4% (57/254)	100	39.1

Table II - Proportion of patients with different 1 hour post Glucose Challenge Test plasma glucose values at Different Gestations

Gestation (weeks)	Total GCT n=504	No. of patients (%) with 1 hr post glucose challenge PGL		
		≥ 120 mg%	≥ 130 mg%	≥ 140 mg%
<24	283	62 (22)	42 (15)	37 (13)
24-28	74	20 (27)	10 (14)	9 (12)
≥ 29	147	41 (28)	22 (15)	11 (7)
Total	504	123 (24)	74 (15)	57 (11)

Table III - Sensitivity and Specificity of the GCT* when used to screen for Gestational Diabetes Mellitus at different gestational ages

Gestational age (wks)	Sensitivity (%)	Specificity (%)
<24	76.9	67.3
24-28	90.9	68.3
>28	100.0	66.7

* using 1 hr post GCT value of ≥ 130 mg/dl as threshold for performing 75g OGTT to diagnose Gestational Diabetes Mellitus

75g OGTT to be performed because of 1 hour post glucose challenge level of 120mg%, 130mg% and 140mg% respectively, at different gestational ages. The proportion of patients subsequently requiring a 75g OGTT do not appear to vary at the different gestational ages. However, the results in Table III demonstrate a progressive increase in diagnostic sensitivity when the GCT was performed after 24 weeks gestation (between 24 and 28 weeks and after 28 weeks) without significant decrease in specificity.

DISCUSSION

Since there are clear benefits to be derived by treating pregnant diabetics, effective screening of all pregnant women for gestational diabetes is ideal. However, traditional screening criteria using historical and obstetric risk factors have been shown to be both insensitive and of low specificity⁽⁴⁻⁶⁾. During the same period, 1194 antenatal 75g OGTTs were performed on patients with one or more historical or obstetric risk factors⁽³⁾; 28.9% gave a positive OGTT for gestational diabetes and 71.1% were normal by WHO criteria (using a 2 hour plasma glucose level of ≥ 140 mg% on the 75g OGTT as diagnostic of gestational diabetes mellitus⁽⁹⁾) (Table IV). Our study showed that using the 50g GCT as a screening method, an additional 57 "normal"/low risk pregnant women (11.2% of the study population of 504 women) were found to have gestational diabetes. These women would otherwise have been

Table IV - Results of 75g OGTT performed in the presence of one or more historical or clinical risk factors

Total	Normal ($<140\text{mg/dl}$)	+ OGTT	
		Impaired ($140\text{-}200\text{mg/dl}$)	Abnormal ($>200\text{mg/dl}$)
1194	850	286	58
% of total	71.2%	24%	4.9%

missed using historical/obstetric features alone as screening tests. These results are comparable to those of other studies^(4,5).

The 50g GCT has been well documented, especially in the American literature^(4,7). Its advocates claim that it is easy to administer, and can be performed as part of the routine antenatal haematological investigations of a pregnant patient on booking at the antenatal clinic. The Second International Workshop Conference⁽⁸⁾ recommended that all pregnant women be screened for glucose intolerance with a 50g glucose challenge test performed at 24-28 week, and that a 1 hour plasma glucose level of 140mg/dl should be used as the threshold for further testing with a 3 hour 100g glucose tolerance test.

Much work has been done to define a plasma glucose screening value that is most efficient in identifying gestational diabetics^(4,5,7,10,11). O' Sullivan et al⁽⁴⁾ recommend that at a threshold blood glucose level of 130mg/dl , (converted to plasma glucose level of 143mg/dl to compare with the more modern glucose oxidase derived plasma values today) women should be subjected to a 3 hour 100g OGTT. They reported 79% sensitivity and 87% specificity using this value. Carpenter and Coustan⁽⁷⁾, in a study limited to gravidae more than 24 years old have shown that lowering the threshold from 143mg/dl to 135mg/dl would detect an additional 16% of diabetics, while requiring only another 6% of the screened population to undergo an OGTT. Thus, threshold values have been lowered to increase the sensitivity of the GCT, at the expense of some loss on specificity, and these observations are also reflected in our study. However, it remains clear that because of the overlap in distribution of 1 hour post glucose challenge levels between normal patients and those who were eventually diagnosed to have gestational diabetes, there can be no one single cut off threshold value that can be used as a positive screen value (Fig 1) with absolute sensitivity and specificity (Fig 2).

In this study, while lowering the threshold from $\geq 140\text{mg/dl}$ in this population to $\geq 130\text{mg/dl}$ would detect an additional 6% of diabetics, an additional 15% of the screened population would have to undergo an OGTT. At least seven gestational diabetics would not have been picked up at a threshold of 130mg/dl . Whether or not all 7 patients would have had as good an outcome had they not had the close antenatal care given to our diabetic population is open to question. The infants of all 7 patients had birthweights less than 3.8kg and

there was no significant perinatal morbidity. As the screening test is a discovery test in this low risk population, and the diagnosis of gestational diabetes leads to closer antenatal and intrapartum monitoring, and some alteration in diet, without, in the majority of cases, the need for insulin and its possible side effects, and the end point is a good perinatal outcome, we feel justified in lowering the threshold value of the GCT in our population to $\geq 130\text{mg/dl}$.

There is no consensus regarding the optimal time for screening. A balance has to be found between screening at a time when the anti-insulin effect of pregnancy is maximal, and the need to diagnose the condition early enough so that treatment and monitoring may be initiated as early as possible, with clear advantages for both foetus and mother. We have found that the pick up rate (screen positive) for the GCT was similar regardless of gestation (Table II). However, the diagnostic sensitivity was increased when the GCT was performed after 24 weeks gestation as compared to earlier gestations, with no marked decrease in specificity (Table III).

CONCLUSION

The glucose challenge test when performed on a low risk population appears to be an acceptable screening test in our population. With the 50g glucose load, there were neither complaints of nausea nor vomiting. This type of screening helped overcome low sensitivity rates associated with historical or obstetric risk factor screening. As the GCT is more sensitive after 24 weeks, we propose that in low risk populations, screening should be performed between 24-28 weeks gestation. A threshold of $\geq 130\text{mg/dl}$ should be used because of improved sensitivity and specificity. However, those with risk factors for gestational diabetes should however continue to have a diagnostic 75 OGTT at booking.

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