Screening for Gestational Diabetes Mellitus And Abnormal Carbohydrate Metabolism by The Glucose Challenge Test in Early Pregnancy

Dr Salvatore F SFAMENI FRANZCOG [1], Dr Peter WEIN FRANZCOG [2], Dr Andrew CC NGU FRANZCOG [1]

[1] Department of Obstetrics and Gynaecology, The Northern Hospital, Melbourne, Victoria, Australia.

[2] Department of Obstetrics, Freemason's Hospital, Melbourne, Victoria, Australia.

Email : ssfameni@bigpond.net.au

Abstract

INTRODUCTION: Gestational diabetes mellitus is currently diagnosed by the glucose tolerance test in the third trimester. The detection of pre-pregnancy abnormalities including impaired carbohydrate metabolism during pregnancy present diagnostic difficulties. The 75-gram glucose challenge test in early pregnancy is effective in screening for the full range of abnormalities of carbohydrate metabolism encountered during pregnancy.

METHODS: A prospective study involving 1,500 consecutive antenatal patients attending a community hospital. All patients were administered a 75-gram glucose challenge test in early pregnancy and a 75-gram 2-hour oral glucose tolerance test to diagnose gestational diabetes mellitus. Statistical analysis determined the plasma glucose cut-off value for a positive glucose challenge test that necessitates further investigation and treatment.

RESULTS: The glucose challenge test ≥6.5mmol/L (117mg/dL) with a sensitivity of 78.7% (95% CI 71.6-84.7) and specificity of 61.4% (95% CI 58.7-64.0) was selected as the cut-off level for screening in early pregnancy. A GCT value ≥10.0mmol/L (180mg/dL) in 2.5% of the population was an indication for an immediate glucose tolerance test.

CONCLUSIONS: The glucose challenge test in early pregnancy was effective in screening for gestational diabetes mellitus and when ≥6.5mmol/L (117mg/dL) selected a group for glucose tolerance testing in the third trimester. A result ≥10.0mmol/L (180mg/dL) facilitated the detection of pre-pregnancy abnormalities of carbohydrate metabolism including diabetes mellitus. Further testing based on risk- factors is recommended to exclude a false-negative glucose challenge test. Patients with a high false-positive result indicative of underlying impaired glucose tolerance require dietary advice and blood glucose monitoring in order to improve pregnancy outcome.

Objectives

Gestational diabetes mellitus (GDM) is detected by a 75 gram oral glucose tolerance test (GTT) in the 3rd trimester and previous screening by the glucose challenge test (GCT) is now not currently recommended. Pre-pregnancy diabetes mellitus can be looked for with a fasting blood glucose level or HbA1c at the first antenatal visit although this is not a cost effective strategy. Screening for GDM can also be undertaken in early pregnancy by a 75 gram glucose challenge test given in the non-fasting state.(1) This selects a group for a GTT in the 3rd trimester and also in early pregnancy for those that screen high to detect pre-pregnancy diabetes mellitus. As the early pregnancy GCT is not influenced by the diabetogenic hormones of late pregnancy, the optimal plasma glucose cut-off value for the GCT with its sensitivity and specificity when given at this time was evaluated in our study.

Methods

Our study was carried out at The Northern Hospital, a level 2 community hospital in Victoria, Australia over an 18 month period with 1,500 consecutive antenatal patients receiving an early pregnancy non-fasting 75 gram GCT and subsequently a 75 gram 2-hour GTT. The diagnosis of GDM was based on the ADIPS criteria in place at the time with a fasting plasma glucose ≥5.5mmol/L (99mg/dL) and/or a 2 hour ≥8.0mmol/L (144mg/dL) fulfilling the diagnostic requirements for GDM.(2)

Statistical analysis was performed using the MedCalc Software package version 12.2.1.0. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and 95% confidence intervals (CI) for different cut-off values of the GCT were calculated. The Receiver Operating Characteristic (ROC) curve for the range of GCT values was constructed in order to establish the performance of the GCT at this time. The GCT cut-off value to be taken as a positive result in early pregnancy was selected.

Results

The diagnosis of GDM was confirmed in 164 patients for a prevalence of 10.9% of the study population. In 18 patients the diagnosis of GDM was established before 20 weeks gestation as a result of a very high GCT. The range of the GCT values for the population extended from 2.9 to 18.5mmol/L (52 to 333mg/dL) and a sample of the cut-off values is displayed in Table 1.

The ROC curve is displayed in Figure 1 with the area under the ROC curve (AUC) of 0.784 (95% CI 0.762-0.805) indicating a favourable performance for the GCT in early pregnancy (p < 0.0001). The highest Youden index occurred at a GCT value ≥7.3mmol/L (131mg/dL) with a sensitivity of 69.5% (95% CI 61.9-76.5) and specificity of 75.2% (95% CI 72.8-77.5). However, the GCT ≥6.5mmol/L (117mg/dL) was selected as the preferred value for the purpose of population screening with a sensitivity of 78.7% (95% CI 71.6-84.7%) and specificity of 61.4% (95% CI 58.7-64.0). At this level 645 patients (43.0%) screened positive with the GCT ≥6.5mmol/L (117mg/dL).

The distribution curve for the population was analysed and the mean blood glucose level was found to be 6.4mmol/L with a SD 1.7mmol/L so that a plasma glucose value of 9.8mmol/L being the mean+2SD, would represent a level that would include 97.5% of the population.
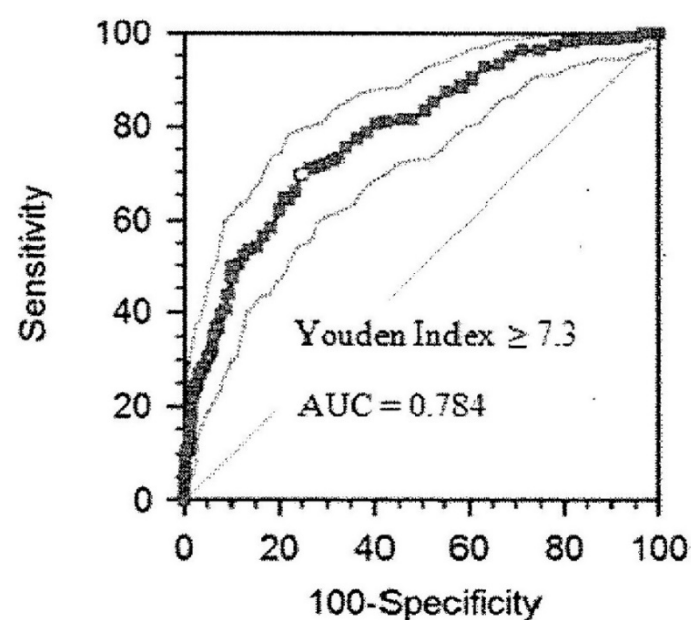

Figure 1. ROC Curve of GCT's

Table 1. List of glucose challenge test plasma glucose cut-off values (mmol/L) with corresponding sensitivity, specificity, PPV, NPV and 95% CI.

Criterion (mmol/L)	Sensitivity %	95% CI	Specificity %	95% CI	PPV %	95% CI	NPV %	95% CI
≥6.0	83.54	77.0 - 88.9	49.25	46.5 - 52.0	16.8	14.3 - 19.6	96.1	94.3 - 97.4
≥6.1	81.71	74.9 - 87.3	52.10	49.4 - 54.8	17.3	14.7 - 20.2	95.9	94.2 - 97.2
≥6.2	81.71	74.9 - 87.3	54.27	51.6 - 57.0	18.0	15.3 - 20.9	96.0	94.4 - 97.3
≥6.3	81.10	74.3 - 86.8	57.41	54.7 - 60.1	18.9	16.1 - 22.0	96.1	94.5 - 97.3
≥6.4	80.49	73.6 - 86.3	59.28	56.6 - 61.9	19.5	16.6 - 22.7	96.1	94.6 - 97.3
≥6.5	78.66	71.6 - 84.7	61.38	58.7 - 64.0	20.0	17.0 - 23.3	95.9	94.4 - 97.1
≥6.6	77.44	70.3 - 83.6	63.55	60.9 - 66.1	20.7	17.5 - 24.1	95.8	94.3 - 97.0
≥6.7	75.61	68.3 - 82.0	65.72	63.1 - 68.3	21.3	18.0 - 24.9	95.6	94.1 - 96.9
≥6.8	73.17	65.7 - 79.8	67.37	64.8 - 69.9	21.6	18.2 - 25.2	95.3	93.8 - 96.6
≥6.9	72.56	65.1 - 79.2	68.71	66.1 - 71.2	22.2	18.7 - 25.9	95.3	93.8 - 96.6
≥7.0	71.95	64.4 - 78.7	70.21	67.7 - 72.7	22.9	19.3 - 26.7	95.3	93.8 - 96.6
≥7.1	71.34	63.8 - 78.1	71.56	69.1 - 74.0	23.5	19.9 - 27.5	95.3	93.8 - 96.5
≥7.2	70.73	63.1 - 77.6	73.28	70.8 - 75.6	24.5	20.7 - 28.7	95.3	93.8 - 96.5
≥7.3 *	69.51	61.9 - 76.5	75.22	72.8 - 77.5	25.6	21.6 - 29.9	95.3	93.8 - 96.5
≥7.4	65.85	58.1 - 73.1	76.35	74.0 - 78.6	25.5	21.4 - 29.9	94.8	93.3 - 96.0
≥7.5	64.63	56.8 - 71.9	77.77	75.4 - 80.0	26.3	22.1 - 30.9	94.7	93.2 - 96.0
≥7.6	64.63	56.8 - 71.9	78.74	76.4 - 80.9	27.2	22.8 - 31.9	94.8	93.3 - 96.0
≥7.7	62.20	54.3 - 69.6	79.94	77.7 - 82.1	27.6	23.1 - 32.4	94.5	93.0 - 95.8
≥7.8	58.54	50.6 - 66.2	81.59	79.4 - 83.6	28.1	23.4 - 33.2	94.1	92.6 - 95.4
≥7.9	56.71	48.8 - 64.4	83.23	81.1 - 85.2	29.3	24.4 - 34.7	94.0	92.5 - 95.3
≥8.0	54.27	46.3 - 62.1	84.58	82.5 - 86.5	30.2	25.0 - 35.8	93.8	92.3 - 95.1

Conclusion

The glucose challenge test in early pregnancy was effective in screening for gestational diabetes mellitus. A GCT ≥6.5mmol/L (117mg/dL) selects a group for glucose tolerance testing in the third trimester and immediately when ≥10.0mmol/L (180mg/dL) to detect pre-pregnancy abnormalities of carbohydrate metabolism.

STOP Testing for GDM at 28 weeks gestation.

STOP Testing for diabetes mellitus in early pregnancy by fasting blood glucose & HbA1c.

START Screening for GDM with non-fasting 75 gram GCT at booking visit.

START Test for GDM at 28 weeks gestation when GCT ≥6.5mmol/L (117mg/dL)

START Testing pre-existing diabetes mellitus immediately when GCT ≥10.0mmol/L (180mg/dL).

References

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