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Pregnancy Outcomes in Women With 1-Hour Glucose Challenge Test 200 mg/dL

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Abstract

Objective—Many protocols diagnose gestational diabetes mellitus (GDM) solely on a 1-hour glucose challenge test (GCT) 200 mg/dL. However, pregnancy outcomes in these women compared with women diagnosed with a 3-hour glucose tolerance test (GTT) has not been adequately evaluated. We hypothesize that a 1-hour GCT 200 mg/dL is associated with worse pregnancy outcomes compared to a GCT 135–199 with positive GTT.

Study Design—Retrospective cohort of singleton pregnancies complicated by GDM. Maternal outcomes included A2DM, preeclampsia, primary cesarean, and failed trial of labor after cesarean. Perinatal outcomes were large/small for gestational age, shoulder dystocia, and birth injury. Groups were compared with t-test and chi-squared test, and logistic regression to adjust for confounders.

Results—602 women diagnosed with GDM by 1-hour GCT 135–199 and confirmatory 3-hour GTT (<200 group) and 225 women diagnosed with 1-hour GCT 200 alone (200) were included. The 200 group had a higher incidence of preeclampsia (16.4% versus 10.6%) and shoulder dystocia (3.1% versus 1.0%). Adjusted ORs and 95% CIs were 1.80 (1.10–2.94) and 5.10 (1.25–20.76) respectively.

Conclusion—Preeclampsia and shoulder dystocia are more frequent in women with GCT 200 mg/dL than those with a positive GTT following a GCT of 135–199 mg/dL.

Keywords

gestational diabetes; shoulder dystocia; preeclampsia; birth injury

Introduction

Gestational diabetes mellitus (GDM), defined as glucose intolerance with onset or first recognition during pregnancy,¹ affects up to 6% of pregnancies in the United States.^{2,3} Its incidence is only expected to rise with the growing obesity epidemic.² Recent studies have

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exposed the detrimental effects of GDM on both mother and neonate and have also demonstrated the benefits of effective treatment.^{4,5}

ACOG endorses the two-step screening protocol for diagnosis of gestational diabetes which entails a 50 gram, 1-hour oral glucose challenge test (GCT) during weeks 24–28 of gestation followed by a 100-gram, 3-hour oral glucose tolerance test (GTT) if the 1-hour GCT is abnormal.^{2,6} Many institutions and practitioners use a threshold of 200 mg/dL on the 1-hour GCT without confirmatory 3-hour GTT as diagnostic of GDM, mirroring the criteria for diagnosis of diabetes in the non-pregnant population.⁶ Previous studies raised concern for overdiagnosis of GDM based solely on 1-hour GCT testing. In one analysis, 19% of patients diagnosed with GDM on 1-hour GCT 200 mg/dL had normal 3-hour GTT values,⁷ while another study estimated the positive predictive value of 1-hour GCT 200 mg/dL to be only 54%.⁸ It is also unclear if this subset of patients has worse pregnancy outcomes.

We conducted this study to investigate the association of a GCT 200 mg /dL with adverse pregnancy outcomes. Our hypothesis was that women with a 1-hour GCT of 200 mg/dL have worse pregnancy outcomes compared to women diagnosed with GDM with GCT of 135–199 mg/dL and a positive 3-hour GTT.

Materials and Methods

We performed a retrospective cohort study of all singleton pregnancies complicated by GDM at the University of Alabama at Birmingham from 2007–2012. Approval was obtained from the University of Alabama at Birmingham Institutional Review Board for Human Use prior to initiation of this study. The patient medical records were abstracted by physicians and entered into a database by trained research personnel.

At our institution, all women are screened for gestational diabetes with a 1-hour GCT. Women with a GCT value between 135–199 mg/dL undergo a 3-hour GTT and are diagnosed with GDM according to the Carpenter-Coustan criteria (at least two values elevated above the following thresholds: fasting 95 mg/dL, 1-hour 180 mg/dL, 2-hour 155 mg/dL, and 3-hour 140 mg/dL).¹⁰ Women with a GCT 200 mg/dL are diagnosed with GDM without a 3-hour GTT. For this analysis, our exposure group was women with GDM diagnosed with a GCT 200 mg/dL and women with GDM with a GCT 135–199 mg/dL served as the reference group. After diagnosis, target blood glucose levels were a fasting blood sugar <95 mg/dL and two hour postprandial blood glucose levels <120 mg/dL. All women diagnosed with GDM (regardless of criteria used) were initially started on an American Diabetic Association diet after counseling by the diabetic educator and given a glucometer to measure blood glucose levels at home. Blood glucose logs were reviewed in clinic every 1–2 weeks. If more than half of blood glucose levels were over target, they were transitioned to glyburide with dosage titrated accordingly. If patients reached the maximum dose of glyburide (20 mg/day), they were transitioned to an insulin regimen of NPH and regular insulin.

Women were excluded for major medical comorbidities (with exception of chronic hypertension) such as sickle cell disease, systemic lupus erythematosus, renal disease, and significant maternal cardiac disease. Women with chronic steroid use and pregnancies complicated by fetal anomalies were also excluded. We included women with chronic hypertension as it is frequently a comorbidity of GDM. Maternal outcomes of interest were need for oral hypoglycemic medications or insulin (A2DM), and rates of preeclampsia, primary cesarean delivery, and failed trial of labor after cesarean (TOLAC). Neonatal outcomes examined were macrosomia, large for gestational age (LGA, defined as >90th percentile on Alexander growth curve),¹¹ small for gestational age (SGA, defined as <10th percentile on Alexander growth curve),¹¹ shoulder dystocia, and birth injury (including brachial plexus injury, cephalohematoma, subarachnoid, hemorrhage, clavicular fracture, and humerus fracture). Shoulder dystocia was documented by the delivering physician and was defined as inability to deliver the anterior fetal shoulder with routine delivery maneuvers. The primary pediatrician documented brachial plexus injury, and both temporary and permanent injuries were included in analysis.

Groups were compared with Student's t-test and chi-squared tests as appropriate. Multivariable logistic regression models for the outcomes of interest were then developed to better estimate the effect of GCT ≥ 200 mg/dL while adjusting of potentially confounding effects. Clinically relevant covariates for initial inclusion in multivariable statistical models were selected using results of the stratified analyses, and factors were removed in a backward step-wise fashion, based on significant changes in the exposure adjusted odds ratio or significant differences between hierarchical models using likelihood ratio test. Confounding variables considered in the analysis included maternal age, obesity, parity, race, hypertension, and tobacco use. A p-value < 0.05 was considered significant. All analyses were performed using Stata version 11.1 (College Station, TX).

Results

Eight hundred ninety-five women at our institution were diagnosed with GDM between 2007 and 2012, and had documented laboratory testing. Of these, 37 women were excluded for maternal medical morbidities and 31 women were excluded for pregnancies complicated by fetal anomalies, leaving 827 women for analysis. Of these 827 women, 602 women were diagnosed with GDM via the two-step approach using the Carpenter and Coustan criteria and 225 women (25% of gestational diabetics) were diagnosed with GDM solely with 1-hour GCT ≥ 200 mg/dL.

The demographic characteristics of the cohort are detailed in Table 1. In addition to the expected differences in gestational age at diagnosis and 1-hour GCT values, those with GCT ≥ 200 mg/dL were also more likely to be smokers and be married. Race, pre-pregnancy body mass index, and prevalence of chronic hypertension were similar between the groups.

Table 2 displays the primary maternal outcomes. Rates of A2DM, insulin use and primary cesarean were similar in the GCT ≥ 200 mg/dL group and the GCT <200 mg/dL group. Preeclampsia was significantly more frequent in the group with GCT ≥ 200 mg/dL after

adjusting for maternal age and obesity (adjusted odds ratio (AOR) 1.80, 95% confidence interval (CI) 1.10–2.94).

Neonatal outcomes are displayed in Table 3. Women with GCT ≥ 200 mg/dL were more likely to have delivery complicated by shoulder dystocia, and the higher incidence persisted even after adjusting for obesity (AOR 5.10, 95% CI 1.25–20.76). Although the difference in rates of macrosomia and LGA infants between the groups was not significant, the rates were higher in those with GCT ≥ 200 mg/dL. Birth injury remained similar between groups, even with the increased incidence of shoulder dystocia in the ≥ 200 mg/dL group, although due to the rarity of birth injury, the power to detect a difference in this outcome was only 20%.

Discussion

We found that women diagnosed with GDM after GCT ≥ 200 mg/dL had a higher incidence of preeclampsia and shoulder dystocia compared to women diagnosed with GDM after GCT 135–199 mg/dL with positive 3-hour GTT. Other outcomes including cesarean delivery, macrosomia, LGA, and birth injury were more frequent in those with GCT ≥ 200 mg/dL although the differences did not attain statistical significance. These findings suggest that women with a GCT ≥ 200 mg/dL should be treated as though they have GDM. A GCT ≥ 200 mg/dL may indicate worse glucose intolerance than counterparts with GCT 135–199 mg/dL. It is less likely that these patients represent undiagnosed pregestational diabetes as there were no differences in GDM in a prior pregnancy or obesity between the groups, and the number of patients requiring insulin during the affected pregnancy was similar between diagnosis groups.

The majority of prior studies examining the GCT cutoff of 200 mg/dL have focused on correlation to the 3-hour GTT, leading some to conclude that a GCT cutoff of 200 mg/dL may lead to over-diagnosis of GDM, and therefore, treatment of low-risk women. Lanni and Barrett investigated 1,972 patients with GCT >140 mg/dL who subsequently underwent 3-hour GTT. Thirty-one percent ($n=614$) were diagnosed with GDM based on Carpenter-Coustan criteria. The positive predictive value of a GCT ≥ 200 mg/dL was 54%. The authors concluded that GCT alone leads to overdiagnosis of GDM.⁸ Shivvers and colleagues studied 59 women with GCT ≥ 200 , all of whom subsequently completed 3-hour GTT. Nineteen percent of these women ($n=11$) had normal 3-hour GTT. Postnatally, there was greater incidence of LGA in those with 2-step diagnosis than those with GCT ≥ 200 mg/dL and normal 3-hour GTT, again leading to the conclusion that GCT ≥ 200 mg/dL leads to overdiagnosis of GDM with no improvement in preventing LGA gestations.⁷

Conversely, Friedman et al investigated the incidence of a positive 3-hour GTT by 1-hour GCT in African American women. Out of 307 patients, 8 had GCT ≥ 200 mg/dL and all 8 had at least 2 abnormal values on 3-hour GTT, though this study is limited based on sample size and inclusion of only African American women.¹² Korucuoglu et al also found a positive correlation with increasing 1-hour GCT and adverse neonatal outcomes. Women with GCT ≥ 180 mg/dL ($n=152$) had increased incidence of macrosomia and LGA infants and higher rates of neonatal hospitalization for hyperbilirubinemia and hypoglycemia than women with GCT <180 mg/dL. These authors concluded that these women should be

considered as having GDM and receive treatment.¹³ Our study confirms findings that patients with highly elevated 1-hour GCT are at increased risk for adverse perinatal outcomes.

The weakness of our study was that those diagnosed with GCT ≥ 200 mg/dL did not also have a 3-hour GTT performed. It would have been noteworthy to observe if those women did have elevated 3-hour readings. This has been explored before in previous studies, but in small numbers. However, our analysis did demonstrate increases in preeclampsia and shoulder dystocia, solely based on GCT. Perhaps, the 3-hour GTT could provide further stratification as to which patients need more aggressive management of GDM. However, our study confirms the findings of Figueroa et al that an elevated 1-hour is associated with adverse outcomes, regardless of GCT status.¹⁴ Also, our study is a retrospective study and likely underpowered to demonstrate statistical differences in the adverse outcomes that occurred more frequently in the exposure group.

The strengths of our study include the large number of women with GDM (n=827) and the significant number of patients who had GCT ≥ 200 mg/dL (n=225). These patients were treated uniformly according to screening and intervention protocols by specialists in Maternal-Fetal Medicine. Our data collection included detailed information regarding each patient's diagnosis of GDM, and only subjects with documented glucose challenge and glucose tolerance tests were included in the analysis, minimizing misclassification bias.

Overall, our analysis suggests the subset of women with GCT ≥ 200 mg/dL may represent GDM of a greater severity that are at increased risk of adverse outcomes such as preeclampsia and shoulder dystocia. These findings also support the use of a GCT ≥ 200 in diagnosis of GDM without subsequent 3-hour GTT.

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Abbreviations

A2DM	A2 diabetes mellitus
ACOG	American College of Obstetrics and Gynecology
AOR	adjusted odds ratio
CI	confidence interval
GCT	glucose challenge test
GDM	gestational diabetes mellitus
GTT	glucose tolerance test
LGA	large for gestational age
NPH	neutral protamine Hagedorn
SGA	small for gestational age

TOLAC trial of labor after cesarean**References**

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Table 1

Baseline characteristics stratified by 1-hour glucose challenge test (GCT)

	1-hr GCT 135–199 (n=602)	1-hr GCT 200 (n=225)	p-value
Mean age (yr)	29.1 ± 6.0	29.4 ± 5.8	0.56
Race n (%) *			0.88
Black	262/549 (47.7)	95/208 (45.7)	
White	77/549 (14.0)	31/208 (14.9)	
Hispanic	182/549 (33.2)	74/208 (35.6)	
Asian	7/549 (1.3)	3/208 (1.4)	
Pacific Islander	2/549 (0.36)	1/208 (0.48)	
Other	19/549 (3.5)	4/208 (1.9)	
Married n (%) *	174/516 (33.7)	74/196 (37.8)	0.02
High School Education or greater n (%) *	199/339 (58.7)	71/130 (54.6)	0.74
Smoker n (%)	96 (16.0)	42 (18.8)	0.04
Body Mass Index ≥ 30 kg/m ² n (%) *	281/519 (54.1)	115/197 (58.4)	0.31
Mean gestational age at time of glucose testing (weeks)	27.3 ± 3.4	26.3 ± 2.8	<0.01
Mean 1-hr GCT ± SD (mg/dL)	165 ± 17	221 ± 23	<0.01
History of gestational diabetes n (%)	73 (12.1)	25 (11.1)	0.69
Prior macrosomic infant n (%)	63 (10.5)	18 (8.0)	0.29
Prior preterm delivery <37 weeks n (%)	109 (18.1)	42 (18.6)	0.86
Chronic hypertension n (%)	72 (11.9)	22 (9.8)	0.67

* Denominators shown where there was missing/incomplete data

Table 2

Maternal outcomes by 1-hour glucose challenge test (GCT)

	1-hr GCT 135–199 (n=602) n (%)	1-hr GCT 200 (n=225) n (%)	p-value	AOR (95% CI)
A2 diabetes mellitus	226 (37.5)	99 (44.0)	0.09	1.28 (0.91–1.81) *
Require Insulin	25 (4.2)	12 (5.3)	0.48	-
Preeclampsia	64 (10.6)	37 (16.4)	0.02	1.80 (1.10–2.94) †
Primary Cesarean	134 (22.3)	65 (29.0)	0.07	1.44 (0.95–2.18) *
Failed trial of labor after cesarean[‡]	337 (55.9)	135 (60.0)	0.74	1.10 (0.38–3.15) †

* Adjusted for obesity

† Adjusted for maternal age, obesity

‡ Total number of patients undergoing trial of labor after cesarean: n=63 for 1-hour GCT 135–199 and n=18 for GCT 200

Table 3

Neonatal outcomes by 1-hour glucose tolerance test (GCT)

	1-hr GCT 135–199 (n=602) n (%)	1-hr GCT >200 (n=225) n (%)	p-value	AOR (95% CI)
Macrosomia	72 (12.0)	37 (16.4)	0.09	1.49 (0.93–2.37) *
LGA [†]	79 (13.1)	41 (18.2)	0.06	1.56 (0.99–2.44)
SGA [‡]	45 (7.5)	16 (7.1)	0.86	0.93 (0.50–1.72)
Shoulder dystocia	6 (1.0)	7 (3.1)	0.03	5.10 (1.25–20.76) *
Birth Injury	8 (1.3)	6 (2.7)	0.19	2.0 (0.70–5.71) [§]

* Adjusted for obesity

[†]LGA – large for gestational age[‡]SGA – small for gestational age[§]Relative risk