A 50-G Glucose Challenge Test: Is There Any Diagnostic Cut-Off?

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Objective: *To evaluate the diagnostic performance of 50-g glucose challenge test for diagnosis of gestational diabetes.*
Material and Method: *A retrospective study was conducted by reviewing the medical records of pregnant women who had a 50-g glucose challenge test of 140 mg/dL or higher and followed by a 100-g glucose tolerance test. Results were categorized in 10 mg/dL increments. Gestational diabetes was diagnosed using National Diabetes Data Group criteria.*
Results: *The present study included 2,226 cases from universal screening of 11,084 pregnant women. The incidence of gestational diabetes was 3.2% (351/11,084). Only 1.6% (6/374) of patients with positive screening results of less than 145 mg/dL had gestational diabetes. All of the 6 women undiagnosed by this threshold were gestational diabetes class A_1 and had at least one risk factor. Of 1,875 women, seven cases (0.4%) would be over diagnosed as gestational diabetes if 100-g glucose tolerance test was not performed after a result of 50-g glucose challenge test of $\geq$ 250 mg/dL (99.6% specificity, 85.8% negative predictive value, 12.3% sensitivity and 86.0% positive predictive value).*
Conclusion: *A 50-g glucose challenge test may be used as a diagnostic test when the value is $\geq$ 250 mg/dL. The present data suggested that the value of glucose screening of $\geq$ 145 mg/dL can be used as a threshold for a positive test in the low risk women.*

Keywords: *Gestational diabetes, Glucose challenge test, Glucose tolerance test, Diagnostic test*

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Gestational diabetes (GDM) is the most common metabolic complication affecting pregnant women. It is important to identify a pregnant woman with this complication since untreated GDM carries a significant risk of perinatal and maternal morbidity. The 50-g glucose challenge test (50-g GCT) has gained widespread acceptance as a universal screening tool for GDM[1]. A value above 130-140 mg/dL is considered positive[2-4] and is generally followed by the gold standard 100-g glucose tolerance test (100-g GTT)[5]. However, this clinical test is inconvenient, timeconsuming and requires pre-test carbohydrate priming and overnight fasting. Previous literatures have proposed that GDM can be diagnosed without the need for a 100-g GTT when 50-g GCT values are $\geq$ 180-200 mg/dL[4,6-8]. However, this proposition is still inconsistent[9,10]. Besides, it has never been supported by other reports especially when testing in different ethnic populations. The present retrospective study aimed to identify the threshold of the 50-g GCT above which GDM can be diagnosed without a need to perform the 100-g GTT and to evaluate the diagnostic performance of 50-g GCT at various cut-off values.

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Material and Method

A retrospective chart review was performed among singleton pregnant women who had a 50-g GCT of $\geq$140 mg/dL and followed by a 100-g GTT between

January 1, 2004 and June 30, 2007. The present study was approved by the Ethics Committee of Bangkok Metropolitan Administration, Bangkok Thailand. A 50-g GCT was offered to all women at the antenatal care clinic and the result of ≥ 140mg/dL is defined as positive screening. Pregnant women who did not perform the 100-g GTT after positive screening or pregnancies with incomplete data were excluded. Results of 50-g GCT were categorized in 10 mg/dL increments. GDM was diagnosed using 2 or more abnormal values referring National Diabetes Data Group (NDDG) criteria (fasting ≥ 105, one hour ≥ 190, two hours ≥ 165, and three hours ≥ 145 mg/dL).

The diagnostic performances of 50-g GCT at various cut-offs were calculated and presented as sensitivity, specificity, positive predictive value and negative predictive value. Results from GTT were used as the gold standard in diagnosis of GDM.

Results

During the present study period, the total number of pregnant women with singleton fetuses performing 50-g GCT was 11,084. Of these women, 2,323 (20.9%) had 50-g GCT values of ≥140 mg/dL. Ninety-seven cases did not proceed to 100-g GTT, leaving 2,226 cases included in the present study. Sixteen percent of these (351/2,226) were diagnosed as GDM after 100-g GTT testing. Among the 2,226 patients with abnormal screening results, the mean age was 29.1 ± 6.2 years (mean ± SD). The average gestational age at screening was 28.5 ± 4.3 weeks (mean ± SD). The range of 50-g GCT values in excluded cases was 147-185 mg/dL. Most of them (80/97) did not have 100-g GTT because of late booking. Of those, four (4.1%) were aged > 35 years and three (3.1%) had a family history of DM.

Overall, GDM was diagnosed in 351 (3.2%) of 11,084 women. Relationship between glucose screening level categorized in 10 mg/dL increments and incidence of GDM is demonstrated in Table 1. Almost all GDM women had positive screening with the results of ≥ 145 mg/dL (n = 345, 98.3%) with a sensitivity, specificity, positive predictive value, and negative predictive value of 98.3%, 19.6%, 18.6%, and 98.4% respectively. Only six pregnant women of 374 cases (1.6%) who had positive screening with the results of < 145 mg/dL were GDM. All of these six women were $GDMA_1$ and had at least one risk factor e.g. maternal age ≥ 35 years, family history of DM, or obesity (BMI ≥ 29.0 kg/m^2).

The diagnostic performance of 50-g GCT according to various cut-off values is shown in Table 2. When GCT result was above 200 mg/dL, the probability of women having GDM was only 64.5%. The false positive rate of GDM with a screening test of ≥ 200 mg/dL was 3.8% (72/1875) if 100-g GTT was not used to confirm diagnosis. The present data demonstrated that a value of 50g GCT of ≥ 320 mg/dL can be diagnosed as GDM without a false positive case (100% specificity,

Table 1. Incidence of gestational diabetes in relation to the level of glucose challenge test

Level of glucose challenge test (mg/dL)	Glucose tolerance test		Incidence of gestational diabetes (%)
	Negative (case)	Positive (case)	
140-149	670	25	3.6
150-159	463	37	7.4
160-169	312	41	11.6
170-179	182	49	21.2
180-189	118	36	23.4
190-199	58	32	35.6
200-209	27	27	50.0
210-219	24	19	44.2
220-229	5	19	79.2
230-239	3	15	83.3
240-249	6	8	57.1
≥ 250	7	43	86.0
All cases	1875	351	15.8

Table 2. Diagnostic performance of various cut-off values of glucose challenge test (GCT)

Cut-off value of GCT (mg/dL)	Sensitivity (%)	Specificity (%)	FPR (%)	PPV (%)	NPV (%)
145	98.3	19.6	80.4	18.6	98.4
150	92.9	35.7	64.3	21.3	96.4
160	82.3	60.4	39.6	28.0	94.8
170	70.7	77.1	22.9	36.6	93.3
180	56.7	86.8	13.2	44.5	91.5
190	46.4	93.1	6.9	55.6	90.3
200	37.3	96.2	3.8	64.5	89.1
210	29.6	97.6	2.4	69.8	88.1
220	24.2	98.9	1.1	80.2	87.5
230	18.8	99.1	0.9	80.5	86.7
250	12.3	99.6	0.4	86.0	85.8
300	5.4	99.9	0.1	90.5	84.9
320	5.1	100	0	100	84.9

FPR: false positive rate; PPV: positive predictive value; NPV: negative predictive value

85% negative predictive value, 5.1% sensitivity and 100% positive predictive value). However, if the cut-off at ≥ 250 mg/dL is used, only seven cases out of 1,875 women (0.4%) will be over diagnosed with 99.6% specificity, 85.8% negative predictive value, 12.3% sensitivity, and 86.0% positive predictive value.

Discussion

The incidence of GDM from the present study was 3.2% which is consistent with the previous reports ranging from 2-6.8%, depending upon the ethnicity and diagnostic criteria[2-4, 10,11]. Nahum et al[12] described that the proportion with glucose screening results above 140 mg/dL who had abnormal GTT in Asian people was 11.5%. Similarly, the present data showed that 16% of women with positive 50-g GCT were diagnosed as GDM by 100-g GTT testing.

In suggesting the use of a cut-off point for the upper limit of glucose screening in diagnosing GDM, Carpenter and Coustan[4] reported a probability of GDM of more than 95% when GCT result was above 182 mg/dL. Subsequent studies have confirmed that GCT results in the range of 180-200 mg/dL will diagnose GDM in almost 100% of cases without the need for a GTT[4,6-8]. The present results did not agree with those findings since a probability of GDM was revealed of only 64.5% when GCT result was above 200 mg/dL. These inconsistent findings may stem from the difference in ethnicity and incidence of GDM among populations.

The present data demonstrated that a 50 g GCT threshold of ≥ 250 mg/dL will diagnose GDM with very low false positive rate (0.4%). The authors suggest that this upper limit of glucose screening can diagnose GDM without further testing. The use of this approach in the diagnosis of GDM could allow for prompt initiation of therapy.

Nahum et al[12] have proposed the race-specific threshold for GCT. They recommended that GCT threshold value in Asians should be ≥ 150 mg/dL. The present data demonstrated that as high as 7.1% (25/251) of GDM cases will be missed by this threshold. Furthermore, 8% (2/25) of these were $GDMA_2$ which carried significant adverse impacts if left untreated. The present study showed that more than 98% of GDM women will be detected with the GCT results of ≥ 145 mg/dL. Only 1.6% of those with GCT between 140 and 144 mg/dL had GDM. All of them were $GDMA_1$ with at least one risk factor e.g. maternal age ≥ 35 years, family history of DM, or obesity (BMI ≥ 29.0 kg/m^2). The present findings suggested the use of ≥ 145 mg/dL for the low risk women (age < 25 years; no family history of DM; no history of GDM, macrosomia, unexplained fetal demised in prior pregnancies; normal BMI) as the threshold for a positive GCT. Nevertheless, the implication of this threshold may be limited to only a low incidence of GDM like the present study population. The present study had some limitations due to the nature of retrospective study. It is difficult to predict the results if 100-g GTT in the ninety-seven excluded cases were included for analysis. However, the suggested value of ≥ 145 mg/dL as the threshold for a positive GCT should not be altered since the lowest value of 50-g GCT in those cases was 147 mg/dL. Future research should focus on the prospective studies which determine the outcomes of pregnancy with no further testing after a value of 50-g GCT of less than 145 mg/dL. In addition, the impacts of employing the suggested cut-off of ≥ 250 mg/dL for diagnosis of GDM should also be investigated.

Conclusion

The use of GCT value of ≥ 145 mg/dL as the threshold for performing 100-g GTT will detect almost all GDM cases in a low risk population. If 50-g GCT is to be used as the diagnostic test, a threshold of ≥ 250 mg/dL should be employed.

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การตรวจคัดกรองเบาหวานโดยใช้กลูโคส 50 กรัม มีจุดตัดที่สามารถใช้ในการวินิจฉัยเบาหวานระหว่างตั้งครรภ์หรือไม่

วราลักษณ์ ยมะสมิต, สุรสิทธิ์ ชัยทองวงศ์วัฒนา, บุญชัย เอื้อไพโรจน์กิจ

วัตถุประสงค์*: เพื่อประเมินความสามารถของการตรวจคัดกรองเบาหวานโดยใช้กลูโคส 50 กรัม ที่ค่าจุดตัดต่าง ๆ ในการวินิจฉัยเบาหวานระหว่างตั้งครรภ์*

วัสดุและวิธีการ*: ทำการศึกษาแบบย้อนหลัง โดยการทบทวนบันทึกของสตรีตั้งครรภ์ที่ตรวจพบค่าการตรวจคัดกรองเบาหวานโดยใช้กลูโคส 50 กรัม ≥ 140 มก./ดล. และได้รับการตรวจโดยใช้กลูโคส 100 กรัมต่อ เพื่อวินิจฉัยเบาหวานระหว่างตั้งครรภ์ โดยใช้เกณฑ์การวินิจฉัยของ National Diabetes Data Group แบ่งค่าการตรวจคัดกรองเบาหวานโดยใช้กลูโคส 50 กรัมเป็นขั้น ๆ ขั้นละ 10 มก./ดล.*

ผลการศึกษา*: จากการคัดกรองเบาหวานในสตรีตั้งครรภ์ทุกรายจำนวน 11,084 ราย พบรายที่ค่าการตรวจคัดกรองเบาหวานโดยใช้กลูโคส 50 กรัม ≥ 140 มก./ดล.ซึ่งถูกคัดเข้าในการศึกษานี้ทั้งหมด 2,226 ราย และพบอุบัติการณ์ของเบาหวานระหว่างตั้งครรภ์ร้อยละ 3.2 (351/11,084) สำหรับสตรีตั้งครรภ์ที่การตรวจคัดกรองเป็นบวกแต่มีค่าน้อยกว่า 145 มก./ดล.นั้น มีเพียงร้อยละ 1.6 (6/374) ที่ได้รับการวินิจฉัยเบาหวานระหว่างตั้งครรภ์ ซึ่งทุกรายเป็นชนิด A_1 และมีปัจจัยเสี่ยงอย่างน้อย 1 ปัจจัย หากใช้ค่าจุดตัดที่ ≥ 250 มก./ดล.ว่าเป็นเบาหวานระหว่างตั้งครรภ์โดยไม่ทำการตรวจยืนยันด้วยกลูโคส 100 กรัม จะมีสตรีตั้งครรภ์ ร้อยละ 0.4 (7/1,875) ที่ได้รับการวินิจฉัยมากเกินจริงว่าเป็นเบาหวานระหว่างตั้งครรภ์ โดยมีค่าความจำเพาะร้อยละ 99.6, ค่าการทำนายเมื่อผลการทดสอบเป็นลบร้อยละ 85.8, ค่าความไวร้อยละ 12.3 และค่าการทำนายเมื่อผลการทดสอบเป็นบวกร้อยละ 86.0*

สรุป*: การตรวจคัดกรองเบาหวานโดยใช้กลูโคส 50 กรัมอาจใช้เป็นการทดสอบเพื่อวินิจฉัยภาวะเบาหวานระหว่างตั้งครรภ์ หากตรวจพบค่าที่ ≥ 250 มก./ดล. ข้อมูลจากการศึกษานี้พบว่า ในสตรีตั้งครรภ์ความเสี่ยงต่ำสามารถใช้ค่า ≥ 145 มก./ดล.เป็นจุดตัดของการคัดกรองเบาหวานเป็นบวก*