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Cut-off Value of 50-g Glucose Challenge Test for The Diagnosis of Gestational Diabetes Mellitus

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ABSTRACT

Objective: To determine the cut-off value of 50-g glucose challenge test (GCT) for the diagnosis of gestational diabetes mellitus (GDM) among Thai pregnant women.

Materials and Methods: A study was conducted at the Department of Obstetrics and Gynecology, Faculty of Medicine Siriraj Hospital. Data of 816 pregnant women who were at risk for GDM with abnormal 50-g GCT results (≥140 mg/dL) before 20 weeks of gestation were included. All women received 100-g oral glucose tolerance test (OGTT) for GDM diagnosis. This approach was repeated during 24-28 weeks of gestation among those with normal 100-g OGTT results. Medical records were reviewed for data collection. Positive predictive values for GDM diagnosis were estimated at different cut-off levels of 50-g GCT, using 10 mg/dL increment interval.

Results: Mean age was 32.4±5.1 years, and mean gestational age when 50-g GCT was initially performed was 10.1±5.9 weeks of gestation. GDM was diagnosed in 290 cases (35.5%) and mean gestational age at diagnosis was 19.1±10.3 weeks. The positive predictive values for GDM diagnosis increased with 50-g GCT values. Of 19 and 13 women whose 50-g GCT values were ≥230 and ≥240 mg/dL, 90.5% and 100% were diagnosed with GDM, respectively.

Conclusion: 50-g GCT before 20 weeks of gestation could be applied and used for diagnosis of GDM using appropriate cut-off value.

Keywords: 50-g glucose challenge test, gestational diabetes mellitus

Introduction

Gestational diabetes mellitus (GDM) is defined as carbohydrate intolerance of variable severity which is first recognized during pregnancy and may or may not resolve after pregnancy(1-4). GDM is associated with an increased incidence of maternal and perinatal morbidity, including cesarean delivery, preeclampsia, macrosomia, birth injury, shoulder dystocia, hypoglycemia, polycythemia, and bilirubinemia, and higher risk for obesity and diabetes later in life(4-6). The HAPO study reported significant associations between adverse outcomes and higher maternal glucose levels, even within a non-diabetic range and impaired glucose tolerance in pregnancy or GDM was associated with

increased maternal and fetal risk[5]. Untreated GDM have been shown to significantly increase the risks for perinatal morbidity in all disease severity levels[7]. Early diagnosis and appropriate treatment of GDM, consisting of blood glucose control alone or with special obstetric care, not only reduce these complications but might also improve the woman's health-related quality of life[8-10].

Screening for GDM is controversial. Recommendations vary widely about whether to screen, how to screen, an optimal approach to screening and diagnosis as well as treatment benefits. Various screening programs have been proposed and utilized by many groups of experts for the detection of GDM. However, there is still no consensus on the most appropriate screening and diagnostic scheme[1-4,11].

According to Siriraj Hospital guideline, similar to majority of the hospitals in Thailand, a risk factor-based selective screening approach consisting of a 50-g glucose challenge test (GCT) as a screening test and 100-g oral glucose tolerance test (OGTT) as a confirmatory test was utilized for GDM screening and diagnosis[12].

Although GCT is only a screening test, it is not clear if OGTT is always necessary when the GCT result is highly elevated, where the likelihood of GDM should also be high. An objective of this study was to determine the positive predictive values (PPV) for GDM diagnosis at different cut-off value of 50-g GCT among high-risk pregnant women attending antenatal clinic at Siriraj Hospital, in order to validate whether GTT is warranted if the GCT result exceeds a certain level.

Materials and Methods

The study was conducted at the Department of Obstetrics and Gynecology, Faculty of Medicine Siriraj Hospital, after the approval from Siriraj Institutional Review Board (SIRB). Clinical and laboratory data of 816 pregnant women who were at risk for GDM and had abnormal 50-g GCT results (≥140 mg/dL) before 20 weeks of gestation were retrieved. Those with preexisting diabetes, and other endocrinopathies were excluded. Risk factors for GDM include maternal age ≥ 30 years, family history of diabetes, obesity (defined as pre-pregnancy body mass index (BMI) ≥27 kg/m^2), previous history of GDM, fetal macrosomia (>4,000 g), unexplained congenital anomalies, unexplained fetal death, and coexisting hypertension.

All women received 100-g OGTT for GDM diagnosis within 2 weeks of abnormal 50-g GCT, using the National Diabetes Data Group (NDDG) cut-off values, according to the institutional guideline[11]. This 2-step approach was repeated at 24-28 weeks of gestation if initial results were normal. When the diagnosis of GDM was made, pregnant women were classified into class A1 and A2 according to their fasting and 2-hour postprandial blood glucose level in consistent with Siriraj Hospital guideline[12]. Pregnant women were counseled and treated individually following the treatment guideline as appropriate.

Various baseline clinical data were extracted from medical records, including age, parity, pre-pregnancy BMI, gestational age at initial tests and diagnosis of GDM, risk factors of GDM, and classification of GDM. Descriptive statistics including mean, standard deviation (SD), number, and percentage were used to describe various characteristics as appropriate. Positive predictive value (PPV) for GDM diagnosis was calculated at different cut-off value of initial 50-g GCT results, using 10 mg/dL increment. Relationship between different risk factors, GDM classification and cut-off level were also examined.

Results

A total of 816 pregnant women who were at risk for GDM and had abnormal 50-g GCT were enrolled. Table 1 showed baseline characteristics of the study population. Mean age was 32.4±5.1 years old and majority were parous (56.7%). Mean pre-pregnancy BMI was 22.9±4.5 kg/m^2 and mean total weight gain was 12.7±5.3 kg. Mean gestational age when 50-g GCT was performed and mean gestational age of GDM diagnosis were 10.1±5.9 and 19.1±10.3 weeks of gestation, respectively. Most of them were finally diagnosed as GDM in the first trimester (46.9%)

Table 2 revealed GDM risk factors in the study

population. The 3 most common risk factors were maternal age ≥ 30 years, history of diabetes in the first degree relatives, and obesity (pre-pregnancy BMI ≥ 27 kg/m^2).

GDM was diagnosed in 290 cases (35.3%) among the study population. Predicive values of GDM diagnosis were examined at different GCT cut-off level, using 10 mg/dL increment. The results were demnstrated in Table 3. The predictive values increased as the cut-off values increased and reached 90.5% and 100% at GCT ≥ 230 and ≥ 240 mg/dL, respectively. However, there was no definite cut-off level for the diagnosis of GDM A1 or A2. Detailed data exploration revealed that among women whose GCT was between 230-239 mg/dL, 1 case could have been diagnosed 9 weeks earlier, and among those whose GCT was ≥ 240 mg/dL, one case could have been diagnosed 12 weeks earlier using GCT alone. (These 2 cases were diagnosed during their second screening).

The predictive values of GDM diagnosis were further stratified by common risk factors and the results were shown in Table 4. Among those with family history of DM, the predictive value was almost 90% and 100% at ≥ 210 and ≥ 230 mg/dL cut-off, respectively. Among obese women, the predictive values reached 90% and 100% at the cut-offs at ≥ 200 and ≥ 220 mg/dL, respectively. Among women of ≥ 30 years, the predictive values were comparable to overall results.

Table 1. Baseline characteristic of study population (N=816)

Characteristics	
Age (years)	32.4 ± 5.1
Pre-pregnancy BMI (kg/m^2)	22.9 ± 4.5
Nulliparous	353 (43.3%)
Mean gestational age at initial 50-g GCT (weeks of gestation)	10.0 ± 5.9
Mean gestational age when GDM was diagnosed (weeks of gestation)	19.1 ± 10.3

Datapresented as mean + SD or n (%)

Table 2. Risk factors of GDM in the study population (N=816)

Risk factors of GDM	N (%)
Age ≥ 30 years	634 (77.7%)
Familial history of diabetes	411 (50.4%)
Obesity (pre-pregnancy BMI ≥ 27 kg/m^2)	148 (18.1%)
History of fetal macrosomia	18 (2.2%)
Previous history of GDM	13 (1.6%)
Coexisting hypertension	13 (1.6%)
Previous history of unexplained congenital anomalies	5 (0.6%)
Previous history of unexplained fetal death	3 (0.4%)

Table 3. Diagnosis of GDM according to different cut-off level of 50-g GCT results

50-g GCT cut-off level (mg/dL)	Total cases	GDM Diagnosis N (%)		
		GDM	GDM A1	GDM A2
≥140	816	290 (35.5)	269 (33.0)	21 (2.6)
≥150	604	242 (40.1)	222 (36.8)	20 (3.3)
≥160	416	197 (47.4)	177 (42.5)	20 (4.8)
≥170	277	153 (55.2)	133 (48.0)	20 (7.2)
≥180	179	106 (59.2)	86 (48.0)	20 (11.2)
≥190	113	78 (69.0)	58 (51.3)	20 (17.7)
≥200	72	55 (76.4)	36 (50.0)	19 (26.4)
≥210	52	42 (80.8)	24 (46.2)	18 (34.6)
≥220	38	33 (86.8)	18 (47.4)	15 (39.5)
≥230	21	19 (90.5)	8 (38.1)	11 (52.4)
≥240	13	13 (100.0)	4 (30.8)	9 (69.2)

Table 4. Diagnosis of GDM according to different cut-off level of 50-g GCT results, stratified by common risk factors

50-g GCT cut-off level (mg/dL)	GDM Diagnosis N (%)		
	Family history (N=411)	Age ≥ 30 years (N=634)	Obesity (N=148)
≥140	161 (39.2)	234 (36.9)	67 (45.3)
≥150	136 (44.9)	194 (41.5)	58 (50.0)
≥160	115 (51.8)	155 (48.6)	50 (63.3)
≥170	90 (59.2)	121 (57.9)	37 (67.3)
≥180	67 (63.8)	80 (60.6)	32 (78.0)
≥190	48 (72.7)	60 (69.0)	26 (81.3)
≥200	35 (81.4)	42 (76.4)	21 (91.3)
≥210	25 (89.3)	33 (80.5)	15 (93.8)
≥220	18 (94.7)	26 (86.7)	10 (100.0)
≥230	10 (100.0)	14 (87.5)	6 (100.0)
≥240	6 (100.0)	10 (100.0)	5 (100.0)

Discussion

Effective early identification of high-risk women for the development of GDM is likely to minimize associated adverse pregnancy outcomes by appropriate dietary advice and/or pharmacological interventions. Untreated GDM have been shown to significantly increase the risks for perinatal morbidity in all disease severity levels[7]. Previous studies have demonstrated the benefits of early diagnosis and appropriate treatment of GDM in reducing obstetric complications and improving the woman's quality of life[8-10].

The HAPO study reported risk of adverse maternal, fetal, and neonatal outcomes continuously increased as a function of maternal glucose level, even within range previously considered normal for pregnancy[5]. Following this, the International Association of Diabetes in Pregnancy Study Group (IADPSG) have recommended a simplified one-step approach with a 75-g, 2-hour GTT to early identify pregnant women with overt diabetes[2]. However, there is still limited evidence that the use of IADPSG recommendations will lead to significant improvement in maternal and neonatal outcomes[4].

The results of this study revealed that the risk of GDM increased with increased 50-g GCT values as expected. The PPVs of 50-g GCT in GDM diagnosis were 90.5% and reached 100% at the cut-off value of ≥ 230 and ≥ 240 mg/dL, respectively. However, these women with relatively high 50-g GCT results were not always in GDM class A2 or undiagnosed pre-pregnancy diabetes. The chance of being GDM A2 increased to more than 50% after ≥ 230 mg/dL cut-off level. Stratified by common risk factors, PPVs have reached 90% and 100% at lower cut-off values among those with family history of DM (at ≥ 210 and ≥ 230 mg/dL cut-off, respectively), and among obese women (at ≥ 200 and ≥ 220 mg/dL cut-off, respectively).

Although many authorities still recommend the use of OGTT for the diagnosis of GDM,[3,4] previous studies had investigated whether the 50-g GCT could possibly be used as diagnostic test[13-15]. However, the results were inconsistent. A study in USA investigated the predictive value of 50-g GCT for the diagnosis of GDM among high-risk pregnant women and reported low PPV of 63% at the cut-off level of ≥ 260 mg/dL, and concluded that it is inappropriate for GDM to be diagnosed based on 50-g GCT[13]. Another study in Thailand, using universal screening, reported 86% PPV at the cut-off value of ≥ 250 mg/dL and suggested that 50-g GCT may be used as a diagnostic test at such cut-off level[15]. A study in Australia reported 85.3% PPV at the cut-off value of 198 mg/dL (11 mmol/L) and the PPV increased to 95.3% at the cut-off value of 216 mg/dL (12 mmol/L), using a 75-g, 2-hour GTT as the diagnostic test[14].

Differences in the PPVs may result from the difference in the population characteristics with variations in GDM prevalences, screening strategies (i.e., universal or selective screening), and diagnostic testing and criteria (i.e., 75-g or 100-g OGTT). Nonetheless, despite inconsistent results, the 2008 Canadian Diabetes Association clinical practice guideline recommends a cut-off value of 185 mg/dL (10.3 mmol/L) for GDM diagnosis, in which case an OGTT does not need to be performed[16].

Some limitations of this study should be addressed. There were limited number of cases in higher cut-off category that might make the estimation of PPVs less accurate. Pre-pregnancy diabetes could not be excluded before enrollment and the proportion of these unknown cases in each cut-off category could not be evaluated. This may contaminated the actual PPVs at each cut-off level as well. In addition, improvement or prevention of possible adverse outcomes could not be evaluated in the current study to verify the benefit of early diagnosis and treatment.

Application of the results into clinical practice could lead to early diagnosis and treatment of GDM, which are important in improving maternal and neonatal outcomes. Unless the cut-off with 100% PPV is used, some normal pregnant women would be falsely diagnosed wih GDM (false positive cases) and also receive treatment. However, such unnecessary treatment should be only dietary couseling which causes no additional harm to their pregnancy. In addition, previous studies have reported that women

with false positive 50-g GCT results were still at increased risk of adverse perinatal outcomes, such as macrosomia and shoulder dystocia[17, 18]. In addition, appropriate treatment among this group of women, including dietary counseling and blood glucose monitoring, have shown to reduce the risk of macrosomia and cesarean delivery[18]. Moreover, should the appropriate cut-off be used in clinical practice, considerable cost and work load of additional testings would be reduced. Nonetheless, further studies are needed to verify the appropriate cut-off value of 50-g GCT and the benefits of its use with regard to adverse maternal and neonatal outcomes.

In conclusion, 50-g GCT can be considered a diagnostic test for GDM at ≥ 230 and ≥ 240 mg/dL cut-off value with 90% and 100% PPV, respectively, and the cut-off level might be lower in high-risk pregnant women, such as obese women. The diagnostic 100-g OGTT could be omitted in such cases and treatment could be initiated as necessary.

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จุดตัดของค่า 50-g glucose challenge test เพื่อการวินิจฉัยภาวะเบาหวานขณะตั้งครรภ์

ดิฐกานต์ บริบูรณ์หิรัญสาร, ตรีภพ เลิศบรรณพงศ์, ภวันตี ขันมะลิ

วัตถุประสงค์ *: เพื่อศึกษาจุดตัดของค่า 50-g glucose challenge test เพื่อการวินิจฉัยภาวะเบาหวานขณะตั้งครรภ์*
วัสดุและวิธีการ *: ทำการรวบรวมข้อมูลจากสตรีตั้งครรภ์ที่มีความเสี่ยงต่อภาวะเบาหวานขณะตั้งครรภ์ที่มีผลการตรวจ 50-g glucose challenge test ผิดปกติ (≥140 mg/dL) ก่อนอายุครรภ์ 20 สัปดาห์ จำนวน 816 ราย ที่มาฝากครรภ์ที่ ภาควิชาสูติศาสตร์-นรีเวชวิทยา คณะแพทยศาสตร์ศิริราชพยาบาล โดยกลุ่มที่ผลการตรวจ 100-g oral glucose tolerance test ปกติ จะได้รับการตรวจคัดกรองและวินิจฉัยซ้ำเมื่ออายุครรภ์ 24-28 สัปดาห์ ทำการวิเคราะห์ข้อมูลโดยแบ่งค่าจุดตัดของผล 50-g glucose challenge test เพิ่มขึ้นครั้งละ 10 mg/dL และคำนวนค่า positive predictive value สำหรับการวินิจฉัยภาวะเบาหวานขณะตั้งครรภ์*
ผลการวิจัย *: อายุเฉลี่ยของสตรีตั้งครรภ์ เท่ากับ 32.4±5.1 ปี อายุครรภ์เฉลี่ยเมื่อได้รับการตรวจคัดกรองครั้งแรก เท่ากับ 10.1±5.9 สัปดาห์ สตรีตั้งครรภ์ได้รับการวินิจฉัยภาวะเบาหวานขณะตั้งครรภ์จำนวน 290 ราย (ร้อยละ 35.5) อายุครรภ์เฉลี่ยเมื่อได้รับการวินิจฉัยเท่ากับ 19.1±10.3 สัปดาห์ สามารถวินิจฉัยภาวะเบาหวานขณะตั้งครรภ์ได้ ร้อยละ 90.5 และ 100 เมื่อใช้ค่าจุดตัดที่ ≥ 230 และ ≥ 240 mg/dL ตามลำดับ ผลการตรวจ 50-g glucose challenge test ไม่สัมพันธ์กับชนิดของภาวะเบาหวานขณะตั้งครรภ์*
สรุป *: ผลการตรวจ 50-g glucose challenge test ก่อนอายุครรภ์ 20 สัปดาห์ สามารถมาประยุกต์ใช้ในการวินิจฉัยภาวะเบาหวานขณะตั้งครรภ์ได้โดยเลือกใช้ค่าจุดตัดที่เหมาะสม*