50 Grams Glucose Challenge Test for Screening of Gestational Diabetes Mellitus in Each Trimester in Potential Diabetic Pregnancy

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Objective: *To evaluate the cutoff value of the 50 grams glucose challenge test (GCT) for screening of gestational diabetes mellitus (GDM) in each trimester in potential diabetic pregnancy and to determine the prevalence of GDM.*
Study design: *Retrospective descriptive study (Diagnostic test).*
Setting: *Section of Obstetrics and Gynecology, Taksin Hospital.*
Subjects: *Two thousand and ten potential diabetic pregnant women who attended the antenatal care clinic at Taksin Hospital between August 2004 and December 2005 were identified and recruited based on risk indicators.*
Material and Method: *A GCT was performed. If GCT was positive, 100 grams oral glucose tolerance test (OGTT) was done to confirm the GDM. All relevant data including demographic information, GCT and OGTT results were collected. The receiver operating characteristic (ROC) curve was used to identify the cutoff value of GCT for screening of GDM.*
Main outcome measures: *The cutoff value of GCT for screening of GDM in each trimester by using ROC curve.*
Results: *The cutoff values of GCT in 1st, 2nd, 3rd, and all trimesters were 179, 177, 184, and 179 mg/dl respectively. The authors recommended 177 mg/dl as the cutoff value of GCT for screening of GDM in potential diabetic pregnancy in each trimester. The prevalence of GDM in 1st, 2nd, 3rd, and all trimesters were 14.22, 13.04, 11.96, and 13.2% respectively.*
Conclusion: *The threshold of 177 mg/dl was recommended as the cutoff value of GCT for screening of GDM in each trimester in potential diabetic pregnancy. The prevalence was 13.2%.*

Keywords: *50 grams glucose challenge test, Gestational diabetes mellitus, Each trimester, Potential diabetic pregnancy*

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Gestational diabetes mellitus (GDM) is one of the most common clinical issues facing obstetricians and their patients. Diabetes mellitus is classified as type 1 or type 2 according to whether the patient requires insulin injections to avoid ketoacidosis. GDM has been characterized as carbohydrate intolerance that begins or is first recognized during pregnancy. Undetected GDM is associated with 3 to 4 folds increase in perinatal morbidity and mortality including preeclampsia, polyhydramnios, fetal macrosomia, shoulder dystocia, birth trauma, operative delivery, neonatal metabolic complications, hyperbilirubinemia, and perinatal death. In addition, women with GDM have an increased risk of developing diabetes later in life. Therefore, accurate screening and early diagnosis of this condition are very important to enable timely intervention in order to ensure a satisfactory pregnancy outcome[1-6].

The prevalence of GDM varies worldwide and among population characteristics and diagnostic

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criteria. The worldwide prevalence ranges from 1-14%[3,7-11]. In Thailand, the rates of 2.02 to 20.17% were reported[12-15]. At Taksin Hospital, 50 grams glucose challenge test (GCT) screening by risk factors and confirmed by 100 grams oral glucose tolerance test (OGTT) has been practiced for many years without extensive evaluation. The pregnant women came to the antenatal care clinic (ANC) in varied gestational age from 1st to 3rd trimester and most cutoff values of GCT were used in 2nd trimester[16-18]. Therefore, the present study was conducted to determine the cutoff value in GCT screening of GDM and the prevalence in each trimester in potential diabetic pregnancy.

Material and Method

The present study was approved by the Ethics Committee for Researches Involving Human Subjects, the Bangkok Metropolitan Administration. Two thousand and ten potential diabetic pregnancies who attended the ANC at Taksin Hospital between August 2004 and December 2005 were retrospectively enrolled into the present study. All relevant data including demographic information, GCT and OGTT results were collected for further analysis.

Criteria for potential diabetic pregnancy are either one or more of the following:

1. Age of 30 years or more at the first time at ANC
2. Previous history of GDM, including familial history
3. Previous fetal weight $\geq$ 4,000 grams
4. Previous infants of congenital anomalies
5. Previous unexplained fetal loss
6. Obesity defined as Body Mass Index (BMI) $\geq$ 27 kg/m^2
7. Hypertension
8. Glucosuria by urine strip
9. Previous history of diabetic complications
10. Polyhydramnios

Screening test of GDM was performed in all pregnant women who had risk indicators. GCT using 50 grams glucose oral load with plasma glucose measurement after 1 hour was done at the first ANC, 24-28 weeks, and 32-34 weeks of gestation. The positive result was defined as plasma glucose of 140 mg/dl or greater. Subsequently, OGTT with 100 grams glucose ingestion was performed for GDM diagnosis using the plasma glucose cutoff values of 105, 190, 165, and 145 mg/dl at the fasting period, 1, 2, and 3 hours, orderly. The OGTT was considered positive or GDM when any two of plasma glucose values were equal or greater than the normal criteria[19].

The sample size was calculated by using sensitivity and specificity from the study of Juntarat W et al[14]. The maximum permissible error (d) was not more than 15% and $\alpha = 0.05$.

The outcome measures were the cutoff value in GCT screening of GDM, the receiver operating characteristic curve (ROC curve), sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and the prevalence in each trimester by using STATA 7.0 and SPSS 15.0 programs. The results were considered statistically significant at $p < 0.05$ with 95% of confidence interval (CI).

Results

During the period, 2,010 potential diabetic pregnancies attended the ANC clinic. One thousand one hundred and fourteen pregnant women had positive results of GCT. In these 1,114 pregnant women, the average maternal age was 30.99 $\pm$ 5.28, 31.44 $\pm$ 6.22, 30.49 $\pm$ 5.79, and 31.02 $\pm$ 5.77 years in 1st, 2nd, 3rd, and all trimesters respectively. The frequency of nullipara was 43.4%, 32.2%, 35.9%, and 37.4% in 1st, 2nd, 3rd, and all trimesters respectively. The average maternal BMI was 23.44 $\pm$ 4.01, 24.97 $\pm$ 4.39, 27.49 $\pm$ 4.74, and 24.97 $\pm$ 4.61 kg/m^2 in 1st, 2nd, 3rd, and all trimesters respectively (Table 1).

Table 1. Demographic data in the studied populations (n = 1,114)

	Trimester			
	1st (n = 422)	2nd (n = 391)	3rd (n = 301)	All (n = 1,114)
Age (years)	30.99 $\pm$ 5.28	31.44 $\pm$ 6.22	30.49 $\pm$ 5.79	31.02 $\pm$ 5.77
Nullipara (%)	183 (43.4)	126 (32.2)	108 (35.9)	417 (37.4)
BMI (kg/m^2)	23.44 $\pm$ 4.01	24.97 $\pm$ 4.39	27.49 $\pm$ 4.74	24.97 $\pm$ 4.61

Values are given as mean $\pm$ SD; n = number

In the first trimester, there were 422 pregnant women with positive results of GCT, 60 pregnant women had positive results of OGTT (Table 2). When sensitivity and 1-specificity were used to perform ROC curve, the cutoff value of GCT for screening of GDM was 179 mg/dl, which had maximum area under the receiver operating characteristic curve (AUC) (Table 3, Fig. 1). From the 2*2 table of the cutoff value 179 mg/dl (Table 4.1), the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and the prevalence were 78.33% (95% CI 74.4-82.26), 65.75% (95% CI 61.22-70.27), 27.49% (95% CI 23.23-31.74), 94.82% (95% CI 92.71-96.94), and 14.22% (95% CI 10.89-17.55) respectively (Table 5).

In the second trimester, there were 391 pregnant women with positive results of GCT, 51 pregnant women had positive results of OGTT (Table 2). When sensitivity and 1-specificity were used to perform the

Table 2. The efficacy of GCT for GDM detection by using OGTT as the diagnostic test

Trimester	OGTT		Total
	Negative	Positive	
1st	362	60	422
2nd	340	51	391
3rd	265	36	301
Total	967	147	1,114

Table 3. The cutoff value of GCT

Trimester	GCT	AUC	95% CI
1st (n = 422)	177	0.7011	0.64-0.76
	178	0.708	0.65-0.77
	179	0.7204*	0.66-0.78
	180	0.7023	0.64-0.76
	181	0.7064	0.65-0.77
2nd (n = 391)	175	0.674	0.60-0.75
	176	0.6701	0.59-0.74
	177	0.6789*	0.61-0.75
	178	0.6721	0.60-0.74
	179	0.675	0.60-0.75
3rd (n = 301)	182	0.6802	0.59-0.77
	183	0.6802	0.59-0.77
	184	0.684*	0.59-0.77
	185	0.66	0.58-0.74
	186	0.6618	0.58-0.75
All (n = 1,114)	177	0.6914	0.65-0.73
	178	0.6921	0.65-0.73
	179	0.6983*	0.66-0.74
	180	0.693	0.65-0.73
	181	0.6932	0.65-0.73

AUC = the area under the receiver operating characteristic curve (ROC curve)
95% CI = 95% of confidence interval
* = Maximum AUC

Table 4.1 The 2*2 table of the cutoff value 179 mg/dl in the 1st trimester

1st trimester GCT	OGTT		Total
	Negative	Positive	
< 179 mg/dl	238	13	251
≥ 179 mg/dl	124	47	171
Total	362	60	422

Table 4.2 The 2*2 table of the cutoff value 177 mg/dl in the 2nd trimester

2nd trimester GCT	OGTT		Total
	Negative	Positive	
< 177 mg/dl	255	20	275
≥ 177 mg/dl	85	31	116
Total	340	51	391

Table 4.3 The 2*2 table of the cutoff value 184 mg/dl in the 3rd trimester

3rd trimester GCT	OGTT		Total
	Negative	Positive	
< 184 mg/dl	230	18	248
≥ 184 mg/dl	35	18	53
Total	265	36	301

Table 4.4 The 2*2 table of the cutoff value 179 mg/dl in all trimesters

All trimesters GCT	OGTT		Total
	Negative	Positive	
< 179 mg/dl	719	51	770
≥ 179 mg/dl	248	96	344
Total	967	147	1,114

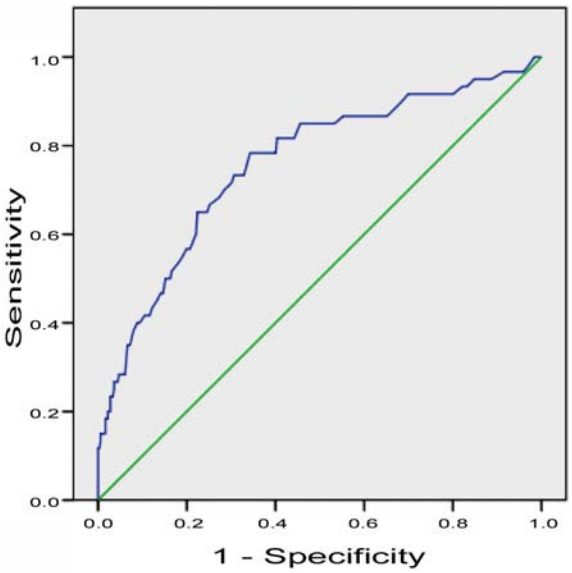

Fig. 1 ROC curve of the 1st trimester

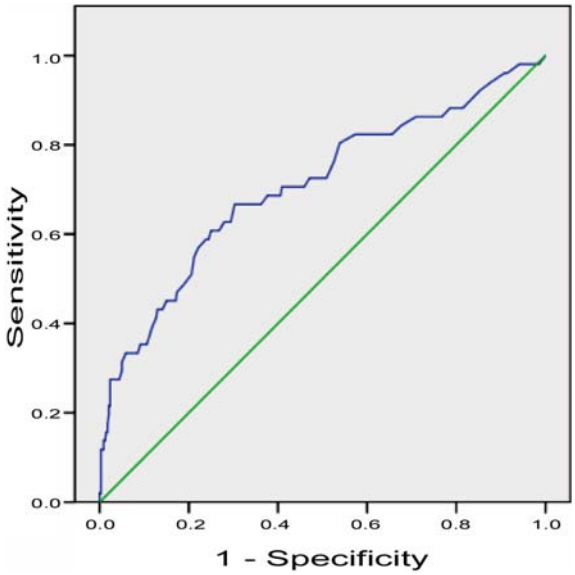

Fig. 2 ROC curve of the 2nd trimester

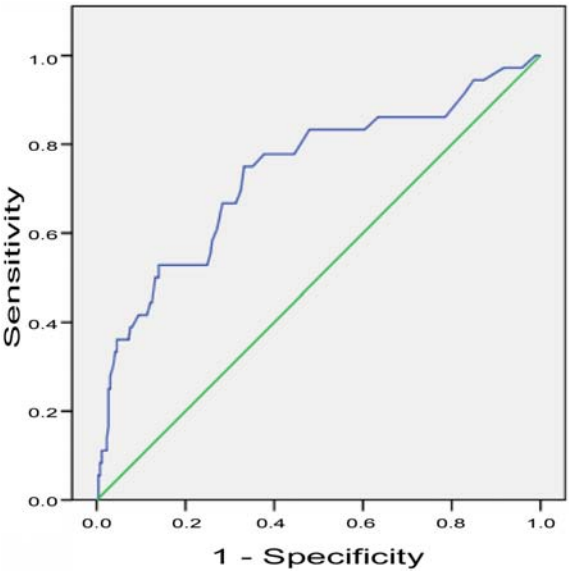

Fig. 3 ROC curve of the 3rd trimester

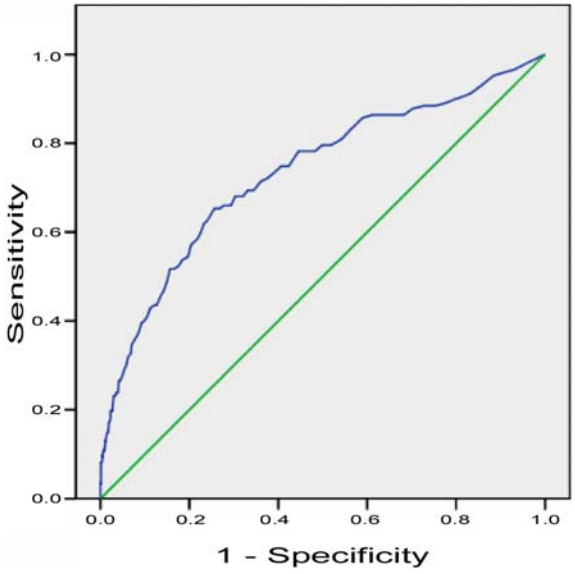

Fig. 4 ROC curve of all trimesters

ROC curve. The cutoff value of GCT for screening of GDM was 177 mg/dl, which had maximum AUC (Table 3, Fig. 2). From the 2*2 table of the cutoff value 177 mg/dl (Table 4.2), the sensitivity, specificity, PPV, NPV, and the prevalence were 60.78% (95% CI 55.94-65.62), 75% (95% CI 70.71-79.29), 26.72% (95% CI 22.34-31.11), 92.73% (95% CI 90.15-95.3), and 13.04% (95% CI 9.71-16.38) respectively (Table 5).

In the third trimester, there were 301 pregnant women with positive results of GCT, 36 pregnant women had positive results of OGTT (Table 2). When sensitivity and 1-specificity were used to perform ROC curve. The cutoff value of GCT for screening of GDM was 184 mg/dl, which had maximum AUC (Table 3, Fig. 3). From the 2*2 table of the cutoff value 184 mg/dl (Table 4.3), the sensitivity, specificity, PPV, NPV, and

Table 5. Sensitivity, specificity, PPV, NPV, prevalence of the cutoff value of GCT

Trimester	1st	2nd	3rd	All
Cutoff value of GCT	179	177	184	179
Sensitivity % (95% CI)	78.33 (74.4-82.26)	60.78 (55.94-65.62)	50.00 (44.35-55.65)	65.31 (62.51-68.1)
Specificity % (95% CI)	65.75 (61.22-70.27)	75.00 (70.71-79.29)	86.79 (82.97-90.62)	74.35 (71.79-76.92)
PPV % (95% CI)	27.49 (23.23-31.74)	26.72 (22.34-31.11)	33.96 (28.61-39.31)	27.91 (25.27-30.54)
NPV % (95% CI)	94.82 (92.71-96.94)	92.73 (90.15-95.3)	92.74 (89.81-95.67)	93.38 (91.92-94.84)
Prevalence % (95% CI)	14.22 (10.89-17.55)	13.04 (9.71-16.38)	11.96 (8.29-15.63)	13.20 (11.21-15.18)

PPV = Positive predictive value
NPV = Negative predictive value
95% CI = 95% of confidence interval

the prevalence were 50% (95% CI 44.35-55.65), 86.79% (95% CI 82.97-90.62), 33.96% (95% CI 28.61-39.31), 92.74% (95% CI 89.81-95.67), and 11.96% (95% CI 8.29-15.63) respectively (Table 5).

In all trimesters, there were 1,114 pregnant women with positive results of GCT, 147 pregnant women had positive results of OGTT (Table 2). When sensitivity and 1-specificity were used to perform the ROC curve. The cutoff value of GCT for screening of GDM was 179 mg/dl, which had maximum AUC (Table 3, Fig. 4). From the 2*2 table of the cutoff value 179 mg/dl (Table 4.4), the sensitivity, specificity, PPV, NPV, and the prevalence were 65.31% (95% CI 62.51-68.1), 74.35% (95% CI 71.79-76.92), 27.91% (95% CI 25.27-30.54), 93.38% (95% CI 91.92-94.84), and 13.2% (95% CI 11.21-15.18) respectively (Table 5).

Discussion

From the previous studies, the authors recommended the use of GCT level at 130-140 mg/dl for screening of GDM in potential diabetic pregnancy between 24-28 weeks of gestation[16-18]. While Vitoratos N et al recommended 126 mg/dl[20] and Tanir et al recommended 185 mg/dl[8]. Therefore, there was still variable cutoff value of GCT for screening of GDM. In the present study, the cutoff values of GCT in 1st, 2nd, 3rd, and all trimesters were 179, 177, 184, and 179 mg/dl respectively. The values had increasing tendency with progressing pregnancy. All cutoff values were higher than the previous reports that recommended 130-140 mg/dl[16-18, 20]. These findings may be due to the differences in race and nutrition of the population. These cutoff values had sensitivity 50-78.33% and specificity 65.75-86.79% (Table 5). The PPV were 26.72-33.96%, although the PPV were low, GCT is a screening test and must be confirmed by OGTT for GDM diagnosis. The NPV were 92.73-94.82%, the NPV were high that meant low false negative. The authors recommended 177 mg/dl as the cutoff value for screening of GDM in each trimester in potential diabetic pregnancy.

The average BMI in the present study was rather low (24.97 $\pm$ 4.61 kg/m^2). The BMI was least in the 1st trimester (23.44 $\pm$ 4.01 kg/m^2) and most in the 3rd trimester (27.49 $\pm$ 4.74 kg/m^2). These findings were due to increasing weight as progressing pregnancy. These cutoff values may be useful for the population that has low BMI or non-obese pregnancy.

The prevalence of 1st, 2nd, 3rd, and all trimesters were 14.22, 13.04, 11.96, and 13.2% respectively. They were in the range of previous studies, 20.17% in the study of Juntarat W et al[14], 7.05% in the study of Chanprapaph P et al[13], 2.02% in the study of Sirirat S et al[12]. The differences of the prevalence among studies might be from the different gestational age performing the screening.

Although the recommended cutoff GCT level was 177 mg/dl for screening of GDM in each trimester in potential diabetic pregnancy and it was suitable for low BMI or non-obese pregnancy. The associations of GCT level, nutrition and the pregnancy outcome have not yet been identified. Therefore, these associations need to be studied in the future.

Conclusion

1. The threshold of 177 mg/dl was recommended as the cutoff value of 50 grams glucose challenge test for screening of gestational diabetes mellitus in each trimester in potential diabetic pregnancy and suitable for low BMI or non-obese pregnancy.

2. Prevalence of gestational diabetes mellitus in potential diabetic pregnancy at Taksin Hospital was 13.2%.

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การตรวจคัดกรองโรคเบาหวานขณะตั้งครรภ์โดยใช้ 50 grams glucose challenge test ในแต่ละไตรมาสในสตรีตั้งครรภ์ที่มีแนวโน้มเป็นเบาหวาน

ชาญวิทย์ พันธุมะผล, พุทธวรรณ ทีฆสกุล

วัตถุประสงค์: *เพื่อหาค่าที่เหมาะสมในการตรวจคัดกรองโรคเบาหวานขณะตั้งครรภ์โดยใช้ 50 grams glucose challenge test (GCT) ในแต่ละไตรมาสในสตรีตั้งครรภ์ที่มีความเสี่ยง และเพื่อหาความชุกของโรคเบาหวานขณะตั้งครรภ์*

ประเภทงานวิจัย: *Retrospective descriptive study (Diagnostic test)*

สถานที่ทำการวิจัย: *กลุ่มงานสูติ-นรีเวชกรรม โรงพยาบาลตากสิน*

กลุ่มตัวอย่าง: *สตรีตั้งครรภ์ที่มาฝากครรภ์ ณ โรงพยาบาลตากสิน ระหว่างเดือน สิงหาคม พ.ศ. 2547 ถึง ธันวาคม พ.ศ. 2548 และมีความเสี่ยงต่อการเกิดโรคเบาหวานขณะตั้งครรภ์ตามเกณฑ์ที่กำหนด จำนวน 2,010 ราย*

วัสดุและวิธีการ: *สตรีตั้งครรภ์ที่ถูกคัดเลือกทั้งหมดได้รับการตรวจ GCT ถ้าผลการตรวจ GCT ให้ผลเป็นบวกจะได้รับการตรวจ 100 grams oral glucose tolerance test (OGTT) เพื่อยืนยันว่าเป็นโรคเบาหวานขณะตั้งครรภ์ ทำการเก็บข้อมูลพื้นฐาน ผลการตรวจ GCT และ OGTT และใช้ Receiver operating characteristic (ROC) curve เพื่อหาจุดตัดที่เหมาะสมของ GCT เพื่อตรวจคัดกรองโรคเบาหวานขณะตั้งครรภ์*

ตัววัดที่สำคัญ: *จุดตัดที่เหมาะสมของ GCT จาก ROC curve เพื่อการตรวจคัดกรองโรคเบาหวานขณะตั้งครรภ์ในแต่ละไตรมาส*

ผลการศึกษา: *จุดตัดที่เหมาะสมของค่า GCT ในไตรมาสที่ 1, 2, 3 และทุกไตรมาสคือ 179, 177, 184 และ 179 มิลลิกรัม/เดซิลิตร ตามลำดับ ผู้รายงานเสนอค่า 177 มิลลิกรัม/เดซิลิตร เป็นค่าของ GCT เพื่อการคัดกรองโรคเบาหวานขณะตั้งครรภ์สำหรับแต่ละไตรมาส ค่าความชุกของโรคเบาหวานขณะตั้งครรภ์ ในไตรมาสที่ 1, 2, 3 และทุกไตรมาสมีค่า 14.22, 13.04, 11.96 และ 13.2 % ตามลำดับ*

สรุป: *ค่า 177 มิลลิกรัม/เดซิลิตร เป็นจุดตัดที่เหมาะสมของ GCT ในการตรวจคัดกรองโรคเบาหวานขณะตั้งครรภ์ในแต่ละไตรมาสในสตรีตั้งครรภ์ที่มีแนวโน้มเป็นเบาหวาน และมีค่าความชุกเท่ากับ 13.2%*