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Correlation between 50-gram Glucose Challenge Test and Neonatal Birth Weight

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ABSTRACT

Objectives: To determine the correlation between the 50 gram glucose challenge test (50-g GCT) and neonatal birth weight.

Materials and Methods: The study comprised of 1879 women who underwent 50-g GCT at 24-28 weeks of gestation and delivered term infants. We determined the correlation between 50-g GCT by percentile and neonatal birth weight by using Pearson's correlation. ROC analysis was used to determine the threshold of 50-g GCT for predicted low birth weight and macrosomia infants.

Results: The correlation coefficient between 50-g GCT by percentile and neonatal birth weight yielded a result of 0.885 (strong positive correlation). Using ROC analysis, 50-g GCT level ≥ 130 mg/dl predicted macrosomia infants with a sensitivity of 41%, specificity 72%, positive predictive value (PPV) 2% and negative predictive value (NPV) 99%. 50-g GCT level ≤ 105 mg/dl predicted low birth weight infants with a sensitivity of 40%, specificity 65%, PPV 6% and NPV 95% respectively.

Conclusion: There is a positive correlation between 50-g GCT and neonatal birth weight. 50-g GCT can be used as predictor for macrosomia infants and low birth weight infants.

Keywords: 50g glucose challenge test, neonatal birth weight.

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ความสัมพันธ์ระหว่างค่า 50-gram glucose challenge test และน้ำหนักตัวแรกคลอดของทารก

สุนทรี ทองแฉล้ม, กมล ภัทราดูลย์

บทคัดย่อ

วัตถุประสงค์: *เพื่อศึกษาหาความสัมพันธ์ระหว่างค่า 50-gram glucose challenge test และน้ำหนักตัวแรกคลอดของทารก*

วัสดุและวิธีการ: *ศึกษาข้อมูลย้อนหลังตั้งแต่เดือน มกราคม 2555-ธันวาคม 2557 โดยมีหญิงตั้งครรภ์จำนวน 1,879 คน ที่คลอดบุตรที่ภาควิชาสูติศาสตร์-นรีเวชวิทยา คณะแพทยศาสตร์วชิรพยาบาล มหาวิทยาลัยนวมินทราธิราช ถูกคัดเข้าร่วมการศึกษา โดยใช้ Spearman's correlation หาความสัมพันธ์ระหว่างค่า 50-gram glucose challenge test และน้ำหนักตัวแรกคลอดของทารก และหาค่า 50-gram glucose challenge test เพื่อทำนายภาวะทารกน้ำหนักตัวน้อยและทารกน้ำหนักตัวมากผิดปกติโดยใช้ ROC analysis*

ผลการศึกษา: *ค่าความสัมพันธ์ระหว่าง 50-gram glucose challenge test แบ่งตาม percentile กับน้ำหนักตัวทารกแรกคลอดคือ 0.885 นับเป็นความสัมพันธ์ทางบวกที่มีนัยสำคัญทางสถิติ และเมื่อหาค่า 50-gram glucose challenge test เพื่อทำนายภาวะทารกน้ำหนักตัวมากผิดปกติ พบว่าค่า 50-gram glucose challenge test ที่มากกว่าหรือเท่ากับ 130 มี sensitivity ร้อยละ 41 specificity ร้อยละ 72 NPV ร้อยละ 99 PPV ร้อยละ 2 ตามลำดับ และค่า 50-gram glucose challenge test เพื่อทำนายภาวะทารกน้ำหนักตัวน้อยพบว่าค่า 50-gram glucose challenge test ที่น้อยกว่าหรือเท่ากับ 105 มี sensitivity ร้อยละ 40 specificity ร้อยละ 65 NPV ร้อยละ 95 PPV ร้อยละ 6 ตามลำดับ*

สรุป: *พบความสัมพันธ์เชิงบวกระหว่างค่า 50-gram glucose challenge test และน้ำหนักตัวทารกแรกคลอด และค่า 50-gram glucose challenge test ยังสามารถใช้ทำนายภาวะทารกน้ำหนักตัวน้อยและน้ำหนักตัวมากผิดปกติได้*

คำสำคัญ: *การทดสอบการรับประทานน้ำตาลกลูโคส 50 กรัม, น้ำหนักตัวแรกคลอดของทารก*

Introduction

From the reports of American Diabetic Association, the incidence of gestational diabetic mellitus (GDM) in different race groups has increased by 10-100% during the past 20 years[1]. In Thailand, GDM affects 1/7 of Thai pregnant women diagnosed by WHO criteria. The incidence rises to 23% if we use the International Association of Diabetes and Pregnancy Study Groups criteria for diagnosis[2]. As far as adverse pregnancy and perinatal outcomes are concerned, GDM is associated with preeclampsia, fetal macrosomia, and neonatal mortality.

The 50-gram glucose challenge test (50-gGCT) is used for GDM screening. This test is done in all pregnant women as a universal screening or in women having risk of GDM at gestational age between 24 and 28 weeks, in which the maternal hormone has maximal effect on glucose metabolism. If the level of 50-g GCT is equal or higher than 140 mg/dl, they will be tested with the 100-gram oral glucose tolerance test (100-g OGTT). Four values of serum glucose are measured during 100-g OGTT. Woman who have at least 2 abnormal values of serum glucose are diagnosed with GDM[3]. There are some women with positive 50-g GCT but normal 100-g OGTT, called false positive 50-g GCT. Several studies showed the association between false positive 50-g GCT and adverse perinatal outcomes especially fetal macrosomia as in GDM patients[4]. Furthermore, some studies also revealed the association between low levels of 50-g GCT and fetal growth restriction[5]. The effect of maternal glucose status on fetal growth has been well established. In utero exposure of the fetus to maternal hyperglycemia leads to fetal hyperinsulinemia causing increase fetal fat cells, this leads to fetal macrosomia. In contrast, maternal hypoglycemia can cause fetal hypoinsulinemia and contribute to poor fetal growth[6]. These indicate that 50-g GCT may represent maternal glucose metabolic status and effect fetal growth.

Our hypothesis was that 50-g GCT had a direct correlation with neonatal birth weight. We determined the level of correlation between 50-g GCT and neonatal weight by using a correlation coefficient, and to find the cut-off point of 50-g GCT to predict low birth weight and macrosomia infants.

Materials and Methods

This study was undertaken at the Department of Obstetrics and Gynecology, Faculty of Medicine, Vajira Hospital, Navamindradhiraj University, Bangkok, Thailand. After approval from the Research Ethics Board at Faculty of Medicine, Vajira Hospital, medical records were reviewed. All pregnant women who delivered term singleton without anomaly at the labor unit of Vajira Hospital between January 2012 and December 2014, and had undergone 50-g GCT at 24-28 weeks of gestation were included. If the level of 50-g GCT was equal or higher than 140 mg/dl, they underwent a 100-gram oral glucose tolerance test (100-g OGTT) according to Carpenter and Coustan's criteria. Pregnant women who had preexisting medical diseases (chronic hypertension, autoimmune diseases, chronic infections, hypothyroidism, hyperthyroidism), diagnosed with GDM, or no report of 50-g GCT value were excluded. Maternal characteristics including age, parity, body mass index before pregnant, maternal weight gain, history of smoking and drug abuse during pregnancy, and pregnancy induced hypertension in current pregnancy were collected. We also collected data of fetal sex, value of 50-g GCT, and neonatal birth weight. The 50-g GCT values of each woman and birth weight of their neonate were analyzed to determine the correlation coefficient by using Spearman's correlation. The 50-g GCT values were divided into percentile. The correlation coefficient of mean birth weight of each percentile and percentile of 50-g GCT were analyzed with Pearson's correlation. The cut-off value of 50-g GCT predicting low birth weight and macrosomia was examined by receiver operating characteristic (ROC) analysis. IBM statistics SPSS version 22 was used to analyze all data sets.

Results

The medical records of 1879 pregnant women

who met the study criteria were reviewed. Most of patients were below 35 years old (88%) and multipara (55.8%). Obese patients were only 5.2%. The number of maternal smoking, drug abused, gestational hypertension and preeclampsia subjects were very low. Most neonates had a normal birth weight. The number of low birth weight infants and macrosomia infants were only 5.3% and 1.3%, respectively (Table 1).

Table 1. Baseline characteristic of study population (N = 1,879).

Characteristic	Mean ± SD, Median or N (%)
Maternal characteristic	
Maternal age (years)	26.7± 6.8
Parity	
Nullipara	830 (44.2%)
Multipara	1049 (55.8%)
Pre-pregnancy BMI (kg/m^2)	21.6 ± 4.2
BMI < 30 kg/m^2	1782 (94.8%)
BMI ≥ 30 kg/m^2	97 (5.2%)
Weight gain during pregnancy (kg)	14 ± 6.3
Smoking	4 (0.2%)
Drug abused	5 (0.3%)
Pregnancy induced hypertension	
Gestational hypertension	24 (1.3%)
Preeclampsia	52 (2.8%)
50-g GCT (mg/dl)	116.4 ± 25.5
Neonatal characteristic	
Sex	
Male	995 (53.0%)
Female	884 (47.0%)
Birth weight	3086
< 2500 grams	100 (5.3%)
2500-4000 grams	1755 (93.4%)
≥ 4000 grams	24 (1.3%)

The correlation of 50-g GCT and neonatal birth weight was determined by Spearman's correlation because the data of neonatal birth weight was not a normal distribution (most neonates had normal birth weight). The correlation between 50-g GCT and neonatal birth weight was statistically significant but a weak positive correlation (correlation coefficient = 0.115) so, we divided 50-g GCT into percentile to determine correlation by Pearson's correlation again. We found that the correlation between 50-g GCT by percentile and neonatal birth weight had a significantly strong correlation (correlation coefficient = 0.885) (Table 2) (Fig. 1).

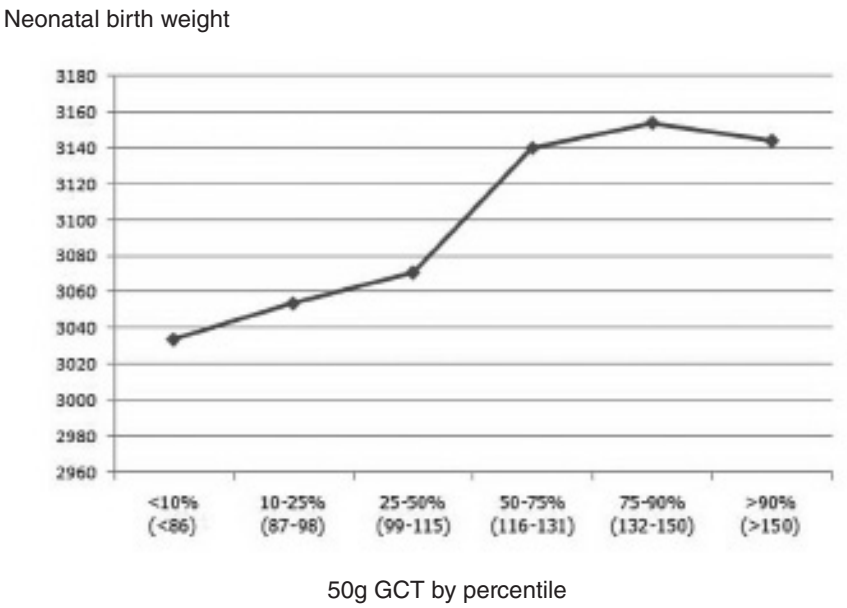

Fig. 1. Correlation between 50-g GCT and neonatal birth weight.

Table 2. Correlation between 50-g GCT and neonatal birth weight.

Correlation	Correlation coefficient	p value
50-g GCT vs Birth weight	0.115 (Spearman's)	53.5%-74.9%
50-g GCT by percentile vs Birth weight	0.885 (Pearson's)	0.019

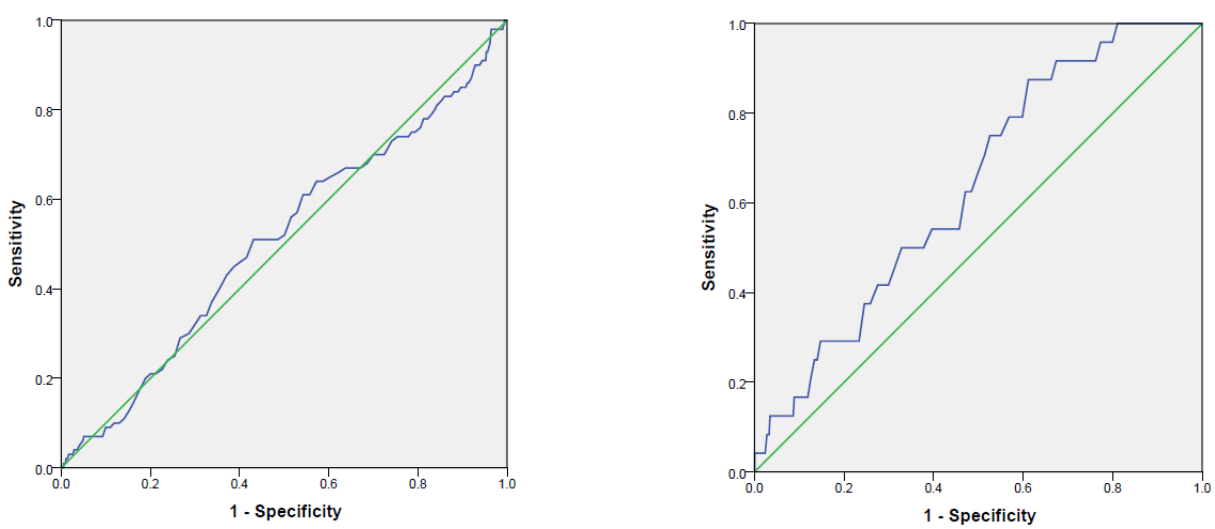

Fig. 2. Receiver operating characteristic analysis.

Table 3. Predictive accuracy of 50-g GCT for predicting low birth weight and macrosomia infants.

Outcomes	AUC	Threshold (mg/dl)	Sensitivity (%)	Specificity (%)	NPV (%)	PPV (%)
Low birth weight	0.507	≤ 100	30	71	95	6
(Birth weight < 2500 g)		≤ 105	40	65	95	6
		≤ 110	51	57	95	6
Macrosomia	0.635	≥ 120	54	57	99	2
(Birth weight ≥ 4000 g)		≥ 130	41	72	99	2
		≥ 140	29	83	99	2

AUC, area under the curve; NPV, negative predictive value; PPV, positive predictive value

For the secondary outcomes, we found the threshold of 50-g GCT for predicting not only low birth weight infants but also macrosomia infants by ROC analysis (Fig. 2). But the number of low birth weight infants and macrosomia infants were very low when we used ROC analysis. The area under the curve was nearly 0.5 and the negative predictive value (NPV) and positive predictive value (PPV) for each value of 50-g GCT were not different (Table 3).

Discussion

An optimal fetal growth is very important for a good neonatal outcome, but an accurate assessment of fetal growth may be difficult for a general practitioner to predict. Based on basic knowledge, maternal glucose metabolism plays the very important role in fetal growth. Our main findings was that 50-g GCT had a weak positive correlation to neonatal birth weight (Spearman r = 0.115) because the distribution of our population sample was not normal (most pregnant woman had normal 50-g GCT results and most neonates had normal birth weight). Therefore, we divided the 50-g GCT into percentile and correlated with neonatal birth weight again to enhance the different of birth weight between groups. We found a strong correlation between the 50-g GCT by percentile and neonatal birth weight (Pearson r = 0.885). This indicated that 50-g GCT represents maternal glucose metabolism and affected fetal growth.

The maternal glucose is supplied to the fetus though the placenta by a concentration dependent mechanism. In a maternal hypoglycemia state, the glucose supply is limited so fetal hypoglycemia and growth restriction occurs[7]. Several previous studies have shown the association between low 50-g GCT and low neonatal birth weight. The level of 50-g GCT below 88.5 mg/dl predicts low neonatal birth weight with low sensitivity and specificity (48.5% and 58.1% respectively)[5]. Decreasing the cut-off value of 50-g GCT below 74.5 mg/dl had 67% sensitivity and 55% specificity to predict small for gestational age (SGA) infants[8]. Compared with our study, the prediction of low neonatal birth weight with 50-g GCT ≤ 105 mg/dl had 40% sensitivity and 65% specificity. The cut off value of our study was higher than the previous study. We selected the cut off value ≤ 105 mg/dl because the cut off value in the previous study had very low sensitivity, so we cut off at the higher level of 50-g GCT to achieve better sensitivity. High NPV (> 90%) was found in Nir Malamed et al., and in our study. When a pregnant woman had a 50-g GCT lever higher than the cut-off value, the risk of low birth weight was very low. Furthermore, low 50-g GCT had significant lower risk of cesarean delivery and shoulder dystocia[5].

By contrast, maternal hyperglycemia prompts fetal hyperglycemia which stimulates excessive somatic growth or macrosomia[6]. Previous studies demonstrated an association between a high 50-g GCT result and large for gestational age (LGA) infants despite absence of maternal GDM. The elevation of 50-g GCT without GDM based on O'Sullivan's criteria was an independent risk factor for adverse perinatal outcome[4] and

associated with higher odd ratio of perinatal morbidity including neonatal macrosomia[9]. According to Carpenter and Coustan's criteria, pregnant women with positive 50-g GCT without GDM had no significant correlation to macrosomia and neonatal birth weight[10]. When we grouped the 50-g CGT level in percentile, we found that 50-g GCT had a positive correlation to neonatal birth weight as in the previous two studies[9,10], in spite of the difference in diagnostic criteria for GDM. The 50-g GCT for predicting neonatal macrosomia was ≥ 130 mg/dl which had sensitivity 41% and specificity 72%. Because the number of neonatal macrosomia was very low, a good cut point level could not be established. We thus select the cut point level that gives sensitivity the same as the specificity.

Our study was the first study that defined the correlation between 50-g GCT and neonatal birth weight. Although there was a weak positive correlation between 50-g GCT and neonatal birth weight, the correlation was stronger when we divided into a group of percentile. Because of the limitation of sample size, we could not show the difference of NPV and PPV between each cut-off values of 50-g GCT. There were some confounding factors, such as pre-pregnancy body mass index, maternal weight gain, maternal smoking, gestational hypertension and preeclampsia, which effects fetal growth and fetal weight so prospective study design should be performed in a further study.

In general, a very low level of 50-g GCT is classified as normal and routine antenatal care is exercised. In addition, with a high level of 50-g GCT with normal 100-g OGTT, it is not necessary to control blood sugar or diet. Because of the correlation between 50-g GCT and neonatal birth weight shown in this study, pregnant women with high or low levels of 50-g GCT should not be in routine antenatal care. Nutritional advice and fetal growth monitoring should be carried out with this group.

Potential conflicts of interest

The authors declare no conflict of interest.

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