Original Article

Evaluation of glucose challenge and oral glucose tolerance test results in pregnancy and estimation of prevalence of gestational diabetes mellitus at Sema Hospital in İstanbul

Ahmet Ruhi TORAMAN[1], Ahmet GÜREL[2], Zeynep ULUSAL[3], Gülnihal BÜLBÜL[3],

Ayşe Gülçin DEMİRDÖVEN[3], Melek UZUN[3], Ali ÖZCAN[4], Muzaffer ÇAKMAK[5]

Aim: This study was designed to evaluate glucose screening and oral glucose tolerance test results, and to assess the prevalence of gestational diabetes in pregnant patients admitted to our hospital.

Materials and methods: This retrospective study was carried out at Sema Hospital in İstanbul, Turkey. The study subjects were recruited between January 2006 and August 2009. A glucose challenge test (GCT) was given to 1681 pregnant women and based on the results 494 went on to take an oral glucose tolerance test (OGTT). A diagnosis of gestational diabetes mellitus (GDM) was made according to the criteria defined by the National Diabetes Data Group.

Results: Out of the 1681 pregnant women tested, 58 were diagnosed with gestational diabetes. Pregnant women with GDM had GCT results greater than or equal to 145 mg/dL. While the percentage of GCT false positives was 87.8% when the cut-off value was taken to be 140 mg/dL, it was calculated to be 84.3% when the cut-off value was taken to be 145 mg/dL. For the 140 mg/dL cut-off value of GCT, specificity was 100% and sensitivity was 4.3%, and for the 145 mg/dL cut-off value of GCT, specificity was 98.3% and sensitivity was 28.3%.

Conclusion: The prevalence value in this study was calculated at 3.45%. Pregnant women diagnosed with GDM had GCT results higher than 145 mg/dL. When the cut-off value was increased from 140 mg/dL to 145 mg/dL, a decrease was observed in false positives, and an increase was observed in sensitivity.

Key words: Gestation, gestational diabetes, glucose screening test, oral glucose tolerance test, prevalence

Introduction

Gestational diabetes can be the cause of serious health problems during the physiologic changes associated with pregnancy (1). Gestational diabetes mellitus (GDM) is described as carbohydrate intolerance of variable severity with onset or first recognition during pregnancy (2). GDM is not only of clinical relevance, but is also an important public health issue. The complications of diabetes that can affect the mother and fetus are well known. The importance of GDM is that it is a common complication of pregnancy and results in a high risk of developing type 2 diabetes mellitus. The investigations show that maternal complications include preterm labor, preeclampsia, nephropathy, birth trauma, cesarean section, and postoperative wound complications (3). It also causes different complications in prenatal, natal, or postnatal periods. It has been suggested that maternal GDM

[1] Health Services of Sema Hospital, İstanbul – TURKEY
[2] Biochemistry Laboratory, Sema Hospital, İstanbul – TURKEY
[3] Outpatient Clinics of Obstetrics and Gynecology, Sema Hospital, İstanbul – TURKEY
[4] Biochemistry Laboratory, Central Hospital, İstanbul – TURKEY
[5] Outpatient Clinics of Internal Medicine, Sema Hospital, İstanbul – TURKEY

Correspondence: *Ahmet Ruhi TORAMAN, Sema Hospital, Yalı mah. Sahil Yolu Sok. No: 16, 34844 Dragos, Maltepe, İstanbul – TURKEY*
E-mail: artoraman@semahastanesi.com.tr

increases the offspring's cardiometabolic risk, and in utero hyperinsulinemia is an independent predictor of abnormal glucose tolerance in childhood (4). Studies by different authors show that fetal complications include fetal wastage from early pregnancy loss or congenital anomalies, neonatal hypoglycemia, fetal macrosomia, shoulder dystocia, stillbirth, growth restriction, and perinatal death (5,6). Thus, early detection of GDM in women may prevent or delay these diseases in mother and baby, thereby improving their quality of life.

Studies of GDM prevalence is still an important issue that must not be underestimated. The stepwise algorithm of the National Diabetes Data Group (NDDG) is one of the guidelines most widely accepted for the screening and diagnosis of GDM. According to this procedure, all pregnant women without previously diagnosed diabetes are offered screening for GDM with a 50-g 1-h glucose challenge test (GCT) administered universally at the gestational age of 26 weeks (±2 weeks). Patients with a GCT of 140 mg/dL or higher underwent a 100-g 3-h diagnostic OGTT (7). The prevalence of GDM, as reported in different studies, varies between 1% and 14% (8,9). The differences in the prevalence of GDM reported in these studies are as much due to ethnic and racial characteristics as to the screening protocols and diagnostic criteria used by the researchers in question (10).

The purpose of this study was to investigate the prevalence of GDM and evaluate the GCT and OGTT results of pregnant women at a private hospital in İstanbul.

Materials and methods

Setting

This retrospective study was carried out at Sema Hospital, a private hospital in İstanbul, Turkey, which serves a mostly medium- and high-income population in the southern part of İstanbul. The study subjects were recruited between January 2006 and August 2009. The hospital information system used at our hospital offers the capability of conducting test-based screening and data collection. We conducted screening based on GCT and OGTT tests utilizing this capability. Patient name and surname, hospital

identification number, age, and test results were used as test parameters. Parameters such as gestational age, number of pregnancies, weight, and height that were collected and stored as paper document files were excluded. On the other hand, nonpregnant patients receiving 50- and 100-g glucose loads were excluded from the assessment. By screening results among pregnant women we recruited 1681 GCT and 494 OGTT recipients. Both GCT and OGTT recipient patient data were paired. Body mass index (BMI) values were calculated in the screening test.

Procedures of glucose loading tests

In our hospital, a 50-g GCT was given to the patients at any time of day, regardless of whether or not they were fasting, and blood was drawn after 1 h. Each pregnant woman attending the antenatal clinic was screened in this way between week 24 and 28 of her pregnancy. If their plasma glucose on screening was equal to or greater than 140 mg/dL (7.8 mmol/L), they were recruited for a standard 3-h OGTT. Patients were classified as gestationally diabetic if 2 or more out of 4 plasma glucose concentrations were equal to or greater than the following values: fasting blood sugar of 105 mg/dL (5.8 mmol/L); 1st hour level of 190 mg/dL (10.5 mmol/L); 2nd hour level of 165 mg/dL (9.1 mmol/L); and 3rd hour level of 145 mg/dL (8 mmol/L) (7).

Statistical analysis

Data analysis was performed using SPSS for Windows 14.0. All data were presented as mean ± standard deviation (SD). Differences in the prevalence of GDM between groups were analyzed using chi-square tests. The linear trend in the prevalence of GDM with age was calculated by logistic regression. Analysis of variance was performed for comparison of different groups and Tukey's honestly significant difference (HSD) test was used for multiple comparisons. The differences were considered significant when the probability was less than 0.05.

Results

The results of the GCT and OGTT screening are summarized in the Table. Of the 1681 pregnant women, 526 (31.3%) had a positive result in the screening test; the OGTT was given to 494 (90.3%) of these pregnant women. Thirty-two (1.9%) patients

Table. Characteristics of pregnancies, number of GDM (-) and GDM (+) cases, and prevalence value (mean ± standard deviation) in the pregnant women studied.

	N	Age	GCT (mg/dL)	Parity	BMI (kg/m²)	GDM (-)	GDM(+)	Prevalence
Pregnant	1681	28.3 ± 4.4	125 ± 29	1.6 ± 0.9	25.16 ± 3.12	1623	58	3.45

GCT: glucose challenge test, BDM: body mass index, GDM: gestational diabetes mellitus.

with an abnormal result did not complete the study protocol for differing reasons and were excluded from this study. GDM was diagnosed for 58 (11.7%) of the 494 pregnant women. No significant difference was found for BMI between the GCT-negative and GCT-positive groups and between the GDM-negative and GDM-positive groups.

Prevalence of GDM

The Table presents prevalence values according to all pregnant women tested. According to the NDDG criteria, 58 out of the 1681 pregnant women had GDM (3.45%). We determined that prevalence increased by age and it was statistically significant (P < 0.05).

Evaluation of results of GCT

We observed that pregnant women diagnosed with GDM had first hour glucose values above 145 mg/

dL. The GCT result was above 140 mg/dL in 475 of the pregnant women. In 58 of them, the OGTT was positive while in 417 of them it was negative. Therefore, the false positive rate was 87.8%. The GCT result was above 145 mg/dL in 370 pregnant women. In 58 of them, the OGTT was positive while in 312 of them it was negative. Therefore, the false positive rate in this group was 84.3%. Additionally, the receiver operating characteristic (ROC) analysis revealed that the GCT results showing 140 mg/dL had 100% specificity and 4.4% sensitivity, while the GCT results showing 145 mg/dL had a specificity of 98.3% and a sensitivity of 28.3%. ROC analyses were performed separately for GCT values of 140 mg/dL and 145 mg/dL, and the area under the curve was calculated to be 0.767 for the 140 mg/dL value (Figure 1) and 0.779 for the 145 mg/dL value (Figure 2).
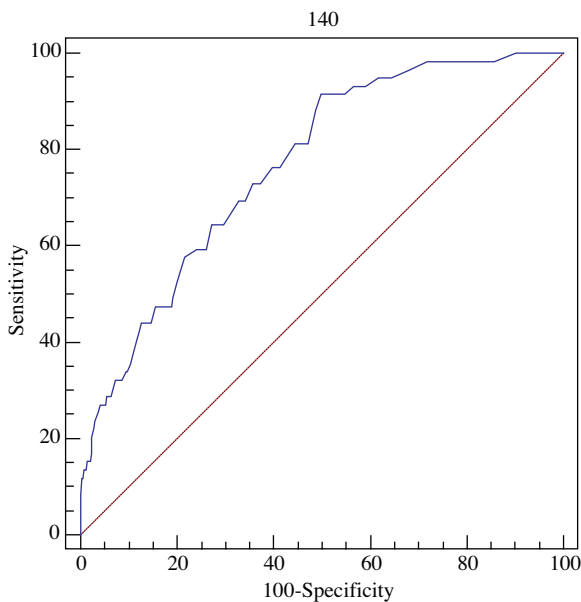

Figure 1. ROC curve of GCT values for 140 mg/dL (area under curve: 0.767).
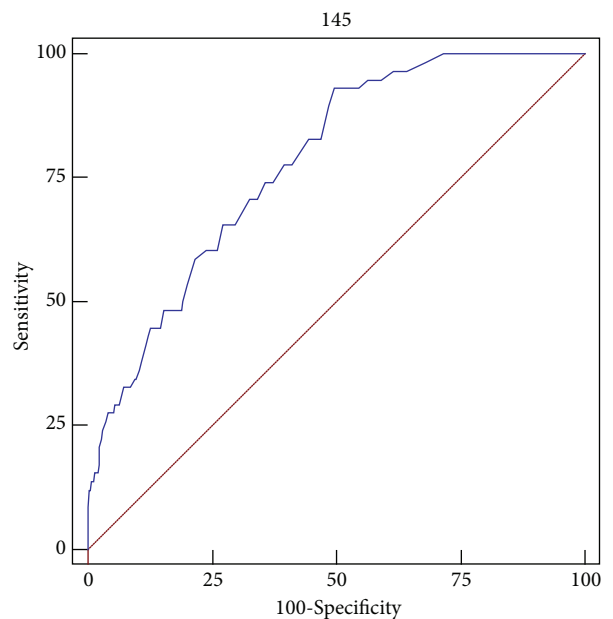

Figure 2. ROC curve of GCT values for 145 mg/dL (area under curve: 0.779).

Discussion

Although studies on GDM prevalence have been conducted for a long time, they maintain their validity since no definite ratio can be specified. Many researchers conduct prevalence studies for their respective societies and share their results with fellow researchers. In this context, we conducted a retrospective study for the period between 2006 and 2009. We determined the GDM prevalence for all age groups to be 3.45%. Compared to other studies conducted in Turkey, we observed similar ratios. As a matter of fact, the prospective study conducted on 21,531 pregnant women between 2005 and 2007 by Karcaaltincaba et al. (11) reported respective prevalence orders of 3.17% and 4.48% according to NDDG and Carpenter and Coustan criteria. On the other hand, studies conducted in 2 central Anatolian provinces in Turkey reported prevalences of 3.1% (12) and 3.3% (13). However, prevalence according to another study conducted in a northeastern province in Turkey (Trabzon) returned rather different results compared to our study and those of other researchers. In that study, Erem et al. (14) determined prevalence among all age groups in their own region to be 1.23%, which is a considerably lower value compared to other studies. Geographical region, ethnicity (15), and time are significant factors in prevalence studies and each have an important effect on prevalence. We consider ethnicity as a factor affecting the results. Our study and the one by Erem et al. (14) differ from each other in terms of both geographical region and time of study. We assume that these differences had an effect on prevalence results. As a matter of fact, a study conducted by Seshiah et al. (16) drew attention to the increase in prevalence as people migrate from rural to urban environments. Studies conducted by some other Indian researchers determined different prevalence values in different regions of the country on the same dates (17,18). One of the secondary factors that differentiate our study from the others could be the dates they were conducted. The literature supports this idea because an increase in prevalence can be observed over the years (19). Meanwhile, a similar trend can be observed with studies conducted by the same scientists at different dates. Dietz et al. (20) reported that a prevalence of 2.9% in 1999 had risen to 3.6% by 2006. Feig et al. (21) declared that the incidence of gestational diabetes increased

significantly over the 9-year study period, from 3.2% in 1995 to 3.6% in 2001. Similarly, some authors (22) reported that the prevalence of GDM among Kaiser Permanente of Colorado members increased 2-fold from 1994 to 2002 (2.1%–4.1%). Although the prevalence values we calculated are consistent with other research results, they appear to be lower compared to data from current literature. As a matter of fact, the study by Adegbola and Ajayi (23) reported a prevalence value of 5.4% for the entire pregnant group (with and without risk factors). A community-based prospective study showed the prevalence of GDM to be 13.9% (17). Another study by Punthumapol and Tekasakul (24) was conducted to determine GDM prevalence in the 1st, 2nd, and 3rd trimesters and in the entire pregnancy period of 2010 pregnant women. They showed GDM prevalence to be 14.22%, 13.04%, 11.96%, and 13.2%, respectively. On the other hand, Wei et al. (25) reported a prevalence rate of 5.078% in a prospective population-based study of 16,286 pregnant women according to the American Diabetes Association criteria.

GCT is the first step in diagnosing GDM. Depending on the results, the OGTT is conducted as a second step, which allows a final diagnosis. The OGTT is conducted for first hour glucose values above 140 mg/dL. Recent studies have started a debate on the value of the 140 mg/dL criterion. Considering complications, Cheng et al. (26) recommended using 130 mg/dL as the limit value for GCT. However, some studies have contradicted this. Adegbola and Ajayi (23) reported that a cut-off level of 140 mg/dL had higher sensitivity and specificity compared to 130 mg/dL. Some researchers argue that false positive rates were high for the 140 mg/dL value. As a matter of fact, Ortega-Gonzalez et al. (27) reported that the false positive rate decreased significantly if a value of 170 mg/dL was considered as the cut-off value. The results of a multicenter study on GDM screening methods conducted by Wu et al. (28) argue that 150 mg/dL could be used as a cut-off value. Punthumapol and Tekasakul (24), on the other hand, recommended a cut-off value of 177 mg/dL each trimester for GCT when used for GDM screening purposes. A study comparing a 50-g glucose screening test and second hour postprandial blood sugar values in diagnosing GDM argued that the false positive rate is high at 140 mg/dL, the value accepted for the 50-g screening

test. The same study recommended a cut-off value of at least 182 mg/dL to minimize false positives (29). In results similar to those from the literature, in the present study it was observed that the GCT values among GDM-diagnosed pregnant women were above 145 mg/dL. In addition, we observed that when a cut off value of 145 mg/dL was used instead of 140 mg/dL, the false positive rate was lower. In this study, a GCT cut-off value of 140 mg/dL gave 100% specificity and 4.4% sensitivity, while a GCT cut-off value of 145 mg/dL gave 98% specificity and 28.3% sensitivity. Therefore, we also think that the cut-off value should be revised. Although an increase of

approximately 24% was observed in the sensitivity value, a cut-off value of 145 mg/dL is not ideal. However, this observation demands support from a larger database and wider population studies.

As a result, the study presented here shows that the incidence of GDM in pregnant women in the population studied was 3.45%. Pregnant women diagnosed with GDM had GCT results higher than 145 mg/dL. When the cut-off value was increased from 140 mg/dL to 145 mg/dL, a decrease was observed in false positives, and an increase was observed in sensitivity.

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