



# The effects of gestational diabetes mellitus screening and diagnostic tests on fetal macrosomia

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## Abstract

**Objective:** To assign the detection rate of the clinical gestational diabetes mellitus by using American Diabetes Association criteria, and to compare the results of the 50 g glucose challenge test (GCT) and 100 g oral glucose tolerance test (OGTT) with fetal macrosomia.

**Methods:** The results of 50 g GCT and 100 g OGTT of 690 pregnant were examined for fetal macrosomia. The pregnant divided into three groups. Group 1 included pregnant women with normal glucose challenge test (n=580), Group 2 included pregnant women with abnormal 50 g GCT but normal 100 g OGTT results (n=66), and Group 3 included pregnant women with a diagnosis of gestational diabetes (n=44). The fetal macrosomia rates within groups ( $\geq 4000$  g) and the efficacy of the 50 g GCT and 100 g OGTT to predict fetal macrosomia were evaluated.

**Results:** The prevalence of the gestational diabetes mellitus was 6.3% (CI 4.7-8.4%). The prevalence of the fetal macrosomia was 4.4% (26/580; CI 3.0-6.4%) in Group 1, 18.1% (12/66; CI 10.7-29.1%) in Group 2, and 34% (15/44; CI 21-48%) in Group 3. For the detection rate of fetal macrosomia, sensitivity and specificity of 50 g GCT and 100 g OGTT were 50%, 55%, and 86% and 65% respectively. Positive predictive values were 24% and 34%. There was significantly positive correlation between 50 g GCT and 100 g OGTT fasting value and birth weight (p). There was no positive correlation between 100 g OGTT (1- hour, 2-hour and 3-hour) and birth weight.

**Conclusion:** 50 g GCT and oral glucose tolerance test are not sensitive tests for prediction of the fetal macrosomia. Even if patients over 140 mg/dL as a result of 50 g GCT screening test are not 100 g OGTT positive, they should be followed up closely in terms of fetal macrosomia as gestational diabetes mellitus patients.

**Key words:** Fetal macrosomia, gestational diabetes mellitus, glucose tolerance test.

## Gebelik diyabeti tarama ve tanı testlerinin fetal makrozomi üzerine etkileri

**Amaç:** Amerikan Diabetes Association kriterleri kullanılarak gestasyonel diabetes mellitus prevalansının belirlenmesi ve gestasyonel diyabetes mellitusun komplikasyonlarından birisi olan fetal makrozominin, 50 g glukoz challenge test (GCT) ve 100 g oral glukoz tolerans testi (OGTT) sonuçları ile arasındaki ilişkinin incelenmesidir.

**Yöntem:** 690 gebenin 50 g GCT ve 100 g OGTT sonuçları fetal makrozomi açısından değerlendirildi. Gebeler 3 gruba ayrıldı. Grup 1 (n=580): 50 g GCT sonuçları normal gebeler; Grup 2 (n=66): 50 g GCT sonuçları yüksek ancak 100 g OGTT sonuçları normal olan gebeler; Grup 3 (n=44): Gestasyonel diabetes mellitus tanısı alan olgular. Gruplar içerisinde, fetal makrozomi oranları ( $\geq 4000$  g) ve fetal makrozomiyi saptamada 50 g GCT ve 100 g OGTT'nin etkinliği araştırıldı.

**Bulgular:** Popülasyonumuzda, gestasyonel diabetes mellitus prevalansı %6.3 (CI %4.7-8.4) bulundu. Fetal makrozomi prevalansı; Grup 1'de %4.4 (26/580; CI %3.0-6.4), Grup 2'de %18.1 (12/66; CI %10.7-29.1), Grup 3'te ise %34 (15/44; CI %21-48) idi. Fetal makrozomiyi saptamada, sırası ile 50 g GCT ve 100 g OGTT'nin sensitivitesi %50, %55, spesifitesi %86, %65; pozitif prediktif değerleri ise, %24, %34 bulundu. 50 g GCT ve 100 g OGTT açlık değeri ile doğum kiloları arasında anlamlı pozitif korelasyon saptandı. 100 g OGTT 1. saat, 2. saat, 3. saat değerleri ile fetal ağırlıklar arasında korelasyon saptanmadı.

**Sonuç:** 50 g GCT ve 100 g OGTT makrozomik fetus sıklığının saptamasında duyarlı testler değildir. 50 g GCT tarama sonucu 140 mg/dl'nin üzerindeki hastalar 100 g OGTT pozitif olmasa bile gestasyonel diyabetes mellitus hastaları gibi fetal makrozomi açısından yakından izlenmelidir.

**Anahtar sözcükler:** Fetal makrozomi, glukoz tolerans testi, gestasyonel diabetes mellitus.

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## Introduction

Gestational diabetes mellitus (GDM) is defined as the carbohydrate intolerance detected during pregnancy first.<sup>[1]</sup> Although its prevalence varies by countries, it is generally between 3.1% and 6.8%.<sup>[2]</sup> Screening and diagnostic tests of gestational diabetes mellitus are performed between 24 and 28 weeks of gestation.<sup>[3]</sup> Today, there has been still no consensus for the screening and diagnosis tests yet. As in the world, single-phase 75 g OGTT test in addition to 2-phase test approach consisting of 50 g glucose challenge test (GCT) and 100 g oral glucose tolerance test (OGTT) is adopted in Turkey.

The purpose of these screening and diagnostic tests is to establish early diagnosis and to prevent complications that may develop in mother or baby through increases in blood glucose. One of the complications of gestational diabetes is macrosomia.<sup>[4]</sup> Widely accepted definition of macrosomia is the fetal birth weight over 4000 g.<sup>[5]</sup> According to the bulletin of American College of Obstetric and Gynecology (ACOG), although considering 4500 g and above as macrosomic is practical, considering as 4000 g and above is more widely accepted in terms of reducing mortality and morbidity.<sup>[6,7]</sup> There are many risk factors for macrosomic fetus. Gaining too much weight during pregnancy, being obese, postterm pregnancy, and macrosomic fetus history are among these factors. The highest risk factor is to be a diabetic mother. In the studies analyzing fetal macrosomia frequency, fetal macrosomia incidence at GDM is 16-29% while it is 10% in pregnancy not complicated by diabetes.<sup>[8]</sup> Many risk factors have been presented. Gaining too much weight during pregnancy, being obese, postterm pregnancy, and macrosomic fetus delivery history are among these factors. The highest risk factor is to be a diabetic mother

When the literature is reviewed, it is seen that the pregnant women who have 100 g OGTT results within normal limits despite the high 50 g GCT results are under more risk compared to normal pregnant women in terms of obstetric outcomes.<sup>[9,10]</sup>

The purpose of our study is to determine GDM prevalence in our own population, to analyze the relationship of fetal macrosomia which one of the GDM complication with the results of 50 g GCT and 100 g OGTT, and to detect cases who have high 50 g GCT results but within normal limits of 100 g OGTT and to evaluate them in terms of fetal macrosomia.

## Methods

The study performed between September 2009 and August 2010 in Gynecology&Obstetrics Department and Medical Biochemistry Department of GATA Hospital. Results of 999 pregnant women who admitted for 50 g GCT at 24-28 weeks of gestation for routine pregnancy follow-up were evaluated retrospectively. The results of 690 pregnant women who gave birth in our clinic have been reached. Pregnants who were positive for 50 g GCT but no OGTT result, pregnant who had only OGTT results, cases followed up with pre-gestational diabetes diagnosis and multiple pregnancies were excluded from the study. For OGTT,  $\geq 130$  mg/dL at 50 g GCT was considered as the limit<sup>[11]</sup> and 100 g OGTT diagnostic test was applied to patients who were above this limit. Gestational diabetes mellitus diagnosis was established when 2 or more higher values were detected according to ADA criteria (fasting 105 mg/dL, 1-hour 190 mg/dL, 2-hour 165 mg/dL, 3-hour 145 mg/dL).<sup>[12]</sup> The patients were divided into 3 groups; Group 1 included normal pregnant (n=580; 50 g GCT <130 mg/dL), Group 2 included pregnant who were established GDM diagnosis at the limit (n=66; 50 g GCT  $\geq 130$  mg/dL, normal 100 g OGTT results), and Group 3 included pregnant who were established GDM diagnosis (n=44). Those who had birth weight as 4000 g and above were considered as macrosomia. While 13 of the patients in gestational diabetes mellitus group were receiving insulin therapy and following diet, 31 patients only followed diet.

Blood samples collected for glucose challenge test and OGTT were taken into gray-capped (BD Vacutainer Plastic fluoride/oxalate) tubes. Glucose measurement was performed by Olympus AU2700 (Hamburg, Germany) auto-analyzer. Hexokinase method was used as measurement method.

For statistical analyses, Student's t-test, Pearson correlation analysis and ROC analysis were used on SPSS 15.0 (SPSS Inc., Chicago, IL, USA) program. Results were considered as statistically significant when p value was found to be <0.05.

## Results

In 110 (15.9%, CI 13.4-18.8%) of the 690 patients included to the study, 50 g GCT was positive ( $\geq 130$ ), 100 g OGTT was used. According to American Diabetes Association (ADA) criteria, 6.3% (44/690; CI

4.7-8.4%) of the patients were established GDM diagnosis.

Mean ages of pregnant were 28.8±4.8 in Group 1, 30.2±4.6 in Group 2, and 32.0±5.2 in Group 3. There was statistically significant difference between Group 1 and Group 3 in terms of age (p<0.001). Mean fetal birth weight was 3422±344 g in Group 1, 3524±455 g in Group 2, and 3380±684 g in Group 3. There was statistically no significant difference between groups in terms of age or fetal birth weights; however, there was statistically significant difference between groups in terms of glycemia values at 50 g GCT (1-hour) and 100 g OGTT (0, 1, 2, and 3-hours) (Table 1).

When all groups were analyzed together, fetal macrosomia rate was found to be 7.6% (53/690; CI 5.9-9.9%). Mean fetal weight of 53 cases who found to have fetal macrosomia was 4189±167 g.

When subgroups were evaluated, fetal macrosomia rate was 4.4% (26/580; CI 3.0-6.4%) in Group 1, 18.1% (12/66; CI 10.7-29.1%) in Group 2 and 34% (15/44; CI 21-48%) in Group 3. Also, when Groups 2 and 3 which have positive 50 g GCT are evaluated together, fetal macrosomia rate was found as 24.5% (27/110; CI 17-33%).

In terms of the relationship of fetal weights of 50 g GCT (+) group (Groups 2 and 3) with GCT and OGTT results, positive correlation was found only between 50 g GCT (1 hour), 100 g OGTT (fasting) and fetal weights (p<0.05); however, there was no correlation between fetal weights and 1-hour, 2-hour and 3-hour of 100 g OGTT (p>0.05).

When groups with and without fetal macrosomia were evaluated separately, significant correlation was found only between birth weights in the group without macrosomia and 2-hour value of 100 g OGTT (p<0.001) while there was no correlation in macrosomic group between 50 g GCT (1-hour) and 100 g OGTT values (Fig. 1).

In Group 2, 50 g GCT result of all macrosomic babies was found to be above 140 mg/dL (Fig. 1). In the ROC analysis of Group 2 with 50 g GCT value at and above 140 mg/dL, macrosomic fetus labor sensitivity was found to be 100% and the specificity was found to be 45.3% (Fig. 2).

For macrosomia of 50 g GCT, the sensitivity was 50%, specificity was 86%, positive predictive value (PPV) was 24%, negative predictive value (NPV) was 95%, and likelihood ratio (LR) was 3.9. For macrosomia of 100 g OGTT according to ADA criteria, sensitivity was found as 55%, specificity as 65%, positive predictive value (PPV) was 34%, negative predictive value (NPV) was 81%, and likelihood ratio (LR) was 1.5.

## Discussion

The prevalence of gestational diabetes mellitus varies between 3.1% and 6.8%.<sup>[2]</sup> In Turkish population, it was found to be 4.48% according to ADA criteria.<sup>[13]</sup> In our study, this rate was found as 6.3% (CI 4.7-8.4%).

In our study, the mean age of pregnant women diagnosed with GDM was 32±5 while it was 28.8±4.8 for normal pregnant women. As known, advanced maternal age is a risk factor for GDM; therefore, the findings in our study is consistent with the literature.<sup>[14]</sup>

**Table 1.** Demographic, clinical and laboratory data of pregnant who undergone gestational diabetes mellitus screening at 24-28 weeks of gestation.

	Group 1 GCT (-) n= 580 (Mean±SD)	Group 2 GCT (+) GDM (-) n= 66 (Mean±SD)	Group 3 GDM (+) n= 44 (Mean±SD)	p
Age	28.8±4.8	30.2±4.6	32.0±5.2	NS
Fetal birth weight	3422±344	3524±455	3380±684	NS
50 g GCT	100±29.3	145.1±9.7	171.6±27.1	<0.001
100 g OGTT Fasting	-	84.1±5.7	94±11.4	<0.001
100 g OGTT 1-hour	-	158±26.3	198.3±22	<0.001
100 g OGTT 2-hour	-	133.8±18.1	165±30.7	<0.001
100 g OGTT 3-hour	-	99.4±19.4	129.5±28.5	<0.001

GCT: glucose challenge test, GDM: gestational diabetes mellitus, NS: not significant, OGTT: oral glucose tolerance test, SD: standard deviation.

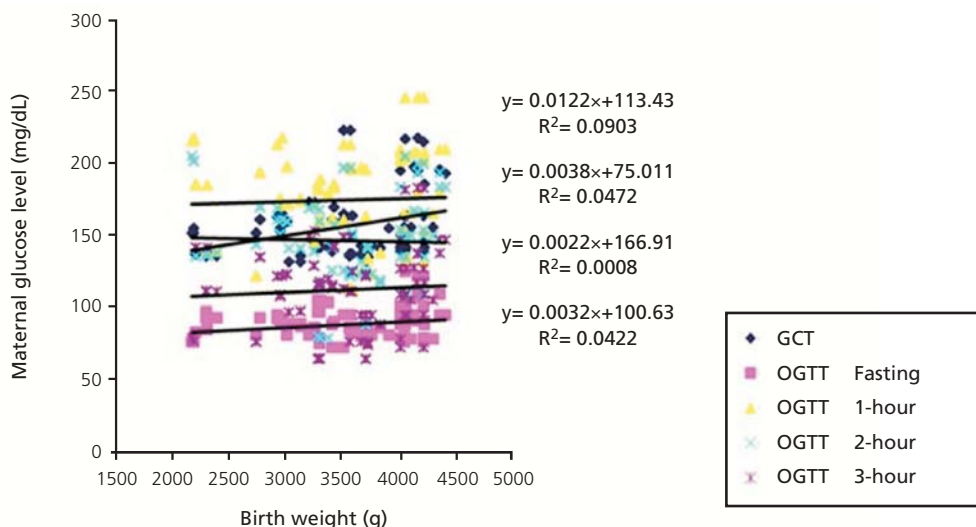


Fig 1. The relationship between birth weight and loading test values.

Fetal macrosomia is a clinical condition which develops as a result of metabolic events with fetal and maternal traumas associated with mechanical factors, and should be predicted prenatally due to perinatal death; therefore its risk factors and possible complications

should be known and intrapartum and postpartum clinical managements should be carried out carefully.

When compared with normoglycemics, macrosomia is three times higher in diabetics and this is associated with various morbidities in the babies of diabetic mothers.<sup>[15]</sup> In addition to the gestational diabetes, macrosomia history, pre-gestational weight, weight gained during pregnancy, multiparity, male fetus, pregnancies exceeding 40 weeks, and maternal size are the other risk factors for macrosomia. Macrosomia incidence in gestational diabetes is reported as 16-29% in the literature, but this rate is 10% in those without gestational diabetes.<sup>[8]</sup> In our study, macrosomia incidence was 5.9% in the group without GDM diagnosis (Groups 1 and 2), and it was 34% in the group with GDM diagnosis. Also, macrosomia rate was found to be 24.5% in the group (Groups 2 and 3) which was positive for 50 g GCT. The recent data from Turkey presents macrosomia rate in the general population as 5.15%.<sup>[16]</sup> In our study, this rate was found as 7.6%.

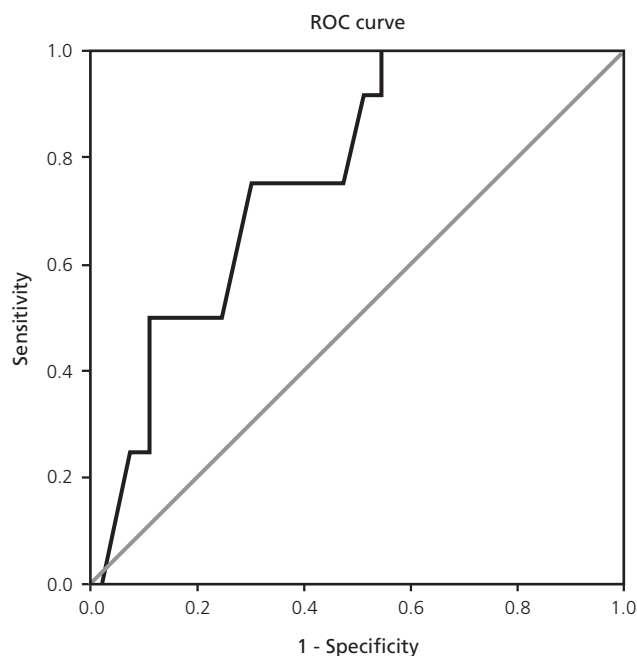


Fig 2. The relationship between 50 g glucose screening test and macrosomia - ROC analysis.

50 g screening test and 100 g OGTT were compared in the literature when other risk factors are got under control, and it was found that the possibility of delivering macrosomic fetus in cases with high 50 g screening test result but normal 100 g OGTT result was higher than the pregnant with normal 50 g screening test result.<sup>[17]</sup> In our study, this rate was 4,4% (CI 3.0-6.4%) in Group 1 (26/580) and 18.1% (CI 10.7-29.1%) in Group 2 (12/66).

It was shown in the literature that the most significant risk factor for macrosomia was 140 mg/dL positive GCT.<sup>[18]</sup> In our study, no macrosomic baby was seen in Group 2 pregnant who were below 140 mg for 50 g GCT. The sensitivity and specificity for delivering macrosomic baby in results at and above 140 mg/dL were found to be 100% and 45.3%, respectively.

In the studies performed in Turkey, a significant relationship was detected between macrosomia and blood glucose value found to be high at OGTT. Also, fasting screening test and 2-hour OGTT blood glucose level were found to be independent risk factors for fetal weight.<sup>[19]</sup> In our study, where we evaluated the relationship of fetal birth weight with GCT and OGTT results of the group (Groups 2 and 3) which was positive for 50 g GCT, positive correlation was only found between 50 g GCT & OGTT fasting results and birth weights ( $p < 0.05$ ); there was no correlation between OGTT 1-hour, 2-hour, and 3-hour values and birth weights ( $p > 0.05$ ). Groups with and without macrosomia were evaluated separately, birth weights in non-macrosomic group was only correlated with OGTT 2-hour ( $p < 0.001$ ) while there was no significant correlation in 50 g GCT and OGTT values of macrosomic group.

In our study, when threshold value of 50 g GCT was considered as 130 mg/dL, we calculated that sensitivity was 50% (37-63%), specificity was 86% (84-89%), PPV was 24% (17-33%), NPV was 95% (93-96%), and LHR was 3.9 (2.8-5.4) for detecting macrosomia while sensitivity was 55% (37-72%), specificity was 65% (54-74%), PPV was 34% (21-48%), NPV was 81% (70-89%), and LHR was 1.5 (1.0-2.4) for OGTT.

## Conclusion

We have concluded that 50 g GCT and 10 g OGTT (fasting, 1-hour, 2-hour, and 3-hour) are not sensitive tests for detecting macrosomic fetus frequency.

**Conflicts of Interest:** No conflicts declared.

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