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RESEARCH ARTICLE

Difference between 2 h and 3 h 75 g glucose tolerance test in the diagnosis of gestational diabetes mellitus (GDM): Results from a national survey on prevalence of GDM

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Abstract The possibility of the 2 h oral glucose tolerance test (OGTT) as an alternative to the 3 h OGTT was investigated based on data from a national survey on pregnancy-associated diabetes. Data were retrieved from 4179 pregnant women who had OGTT performed after an abnormal 50 g glucose challenge test (GCT). All of the 4 glucose levels during their OGTT were collected and analyzed. According to American Diabetes Association (ADA) gestational diabetes mellitus (GDM) diagnostic criteria, among the 4179 pregnant women who required OGTT, 3429 (82.1%) were normal and 750 (17.9%) were diagnosed as GDM. If the 3rd h glucose levels were omitted from OGTT, 79 cases of GDM (10.5%) would be overlooked. No trend was shown where women with more risk factors were more likely to be overlooked if the 3rd h test was omitted (χ^2 for trend = 0.038, $P > 0.05$). No significant differences were found in the rate of cesarean section (CS), preterm births or macrosomia between the 79 cases and those with normal OGTT results and in the gestational weeks when OGTT was performed. It shows that in order to diagnose one woman with GDM, another 52 pregnant women would have an innocent 3rd h glucose test. Omission of the 3rd h glucose test in OGTT might be reasonable due to its convenience, better compliance and a small number of possibly miss-diagnosed cases, and their pregnancy outcomes have no significant difference from those of normal pregnant women.

Keywords diabetes; gestational; oral glucose tolerance test

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1 Introduction

Gestational diabetes mellitus (GDM) is defined as carbohydrate intolerance of various degrees of severity

with onset or first recognition during pregnancy [1]. Researches on pregnancy complicated with diabetes in China were initiated in the 1980s [2]. Now, more and more attention has been paid to GDM universally as GDM not only affects maternal health during the indexed pregnancy, but also has adverse effects on the health of the mothers and babies in the long run.

Recent studies in China have shown that the incidence of GDM in Chinese women is around 3%–5% [3,4], and the figure is much closer to overseas countries [5]. With the changing of life styles and diet, more and more people are suffering from adult diabetes, including pregnant women; and with the increasing population in China, the number of those affected with GDM is anticipated to rise in the future.

There are different diagnostic criteria for GDM worldwide. However, it is well accepted that GDM should be diagnosed according to a 75 g or 100 g oral glucose tolerance test (OGTT) after an abnormal glucose challenge test (GCT) at 24–28 weeks of gestation or maybe earlier if the pregnant women have any high risk factors for developing GDM [6].

Despite the different diagnostic criteria worldwide, the most commonly used criterion in China is the 3 h OGTT. Given the large number of women who are on the OGTT wait list and non-compliance of pregnant women, researchers both in China and overseas countries have attempted to provide evidence for the possibility of omission of the 3rd h glucose test in OGTT [7,8]. The aim of this study was to search the evidence for the use of 2 h OGTT as an alternative for diagnosing GDM as it is time- and cost-saving, based on data from the largest survey on the prevalence of pregnancy complicated with diabetes in China, which was completed in 2007.

2 Methods

A national survey on the prevalence of GDM and gestational impaired glucose tolerance (GIGT) in China was conducted from April 1, 2006 to September 30, 2006, organized by the Department of Obstetrics and Gynecology, Peking University First Hospital, Beijing, and a total of 26 hospitals in 18 cities around the country participated in it.

Altogether, 16 309 pregnant women who came for prenatal visits consecutively in the above 26 hospitals and who had not taken GCT in the current pregnancy were enrolled in the survey.

A fifty gram GCT was done for all pregnant women at 24–28 gestational weeks or at earlier screening if any high risk factors for developing GDM or GIGT existed. Those with abnormal GCT results ($\geqslant$7.8 mmol/L) required further investigation with either a 3 h 75 g OGTT (GCT $\geqslant$ 7.8 mmol/L, but < 11.1 mmol/L) or fasting plasma glucose (FPG) if GCT $\geqslant$ 11.1 mmol/L.

Diagnosis of GDM was made if one of the following criteria was met: (1) at least two of the four glucose values were abnormal in the 3 h OGTT when 50 g GCT $\geqslant$ 7.8 mmol/L and < 11.1 mmol/L; (2) FPG $\geqslant$ 5.8 mmol/L after an abnormal 50 g GCT ($\geqslant$11.1 mmol/L); and (3) random FPG $\geqslant$ 5.8 mmol/L twice.

ADA criterion was applied for diagnosing GDM. The abnormal fasting, 1st h, 2nd h and 3rd h glucose values for OGTT were over 5.3, 10.0, 8.6 and 7.8 mmol/L, respectively.

Among the 16 309 pregnant women in this survey, 23 had a complication of pregestational diabetes and were excluded from the study first. Among the rest 16 286 pregnant women, 4288 required OGTT during their prenatal visit due to abnormal GCT and all four OGTT values were available in 4179 cases out of the 4288 women.

All results of the OGTT and basic information on these 4179 women were retrieved and re-analyzed.

All data for the survey were input and double-checked using the Epidata database. Statistical analysis was performed with SPSS12.0. χ^2 or Fisher's Exact test and *t*-test were used.

3 Results

3.1 Basic information

Among these 4179 pregnant women who required OGTT after abnormal GCT, 2597 (62.1%) had all normal OGTT results in the four glucose values according to ADA criterion. Totally 832 women (19.9%) had only one abnormal glucose level and GDM was diagnosed in 750 (17.9%) pregnant women. Clinical information on these 4179 pregnant women and those with normal OGTT results are listed in Table 1.

Table 1 Basic information of women who had OGTT performed

basic information	all OGTT performed	normal OGTT	possibly miss-diagnosed cases
mean age/yr*	31.0±4.2 (*n* = 4179)	29.8±3.8 (*n* = 2597)	31.0±4.1 (*n* = 79)
prepregnant BMI*	22.0±6.7 (*n* = 4179)	21.1±2.8 (*n* = 2597)	21.3±2.8 (*n* = 79)
delivery weeks/wk*	39.1±1.6 (*n* = 2857)	39.2±1.6 (*n* = 1733)	39.0±1.4 (*n* = 56)
birth weight/g*	3412.0±584.2 (*n* = 2857)	3415.0±957.6 (*n* = 1733)	3233.5±496.1 (*n* = 56)

*: No significant difference was found among the three groups. OGTT: oral glucose tolerance test; BMI: body mass index.

3.2 Analysis of the OGTT results

Out of the 4179 women who had OGTT performed, 283 (6.8%) showed abnormal 3rd h glucose results. However, there were 478 (11.4%), 1036 (24.8%) and 862 (20.6%) women who had abnormal fasting, 1st h and 2nd h glucose results, respectively ($\chi^2 = 59.53, 510.43, 339.26, P < 0.001$ compared with the percentage of abnormal 3rd h results).

3.3 Omission of the 3rd h test in OGTT

Among the 750 GDM women, 204 women had three abnormal values in OGTT and 66 had four abnormal values, which meant omission of the 3rd h test would not change their diagnosis.

The rest 480 women with only two abnormal glucose levels in OGTT were further analyzed. Abnormal fasting, 1st h, 2nd h and 3rd h glucose results were found in 134, 389, 358 and 79 cases, respectively. If the 3rd h test were omitted, 79 GDM cases would have been miss-diagnosed (equal to 10.5% of all GDM women, or 1.9% of all women who received OGTT or 0.5% of all pregnant women). The basic information for these 79 cases are listed in Table 2.

3.4 Analysis of the 79 cases of possibly miss-diagnosed women

3.4.1 Risk factors

Among the 16 risk factors investigated in the survey, the distributions of the number of risk factors presented were added up. However, no trend was shown where women with more risk factors were more likely to be overlooked if the 3rd h test was omitted (χ^2 for trend = 0.038, $P > 0.05$, Table 2).

3.4.2 Glucose level distribution

Distributions of the abnormal glucose levels at each point in OGTT among these 79 women who might have been miss-diagnosed, were analyzed (Table 3). Thirty-three out of the 79 possibly miss-diagnosed cases had a higher glucose level at the 3rd h than at the 2nd h.

Among the 79 cases, the glucose levels at the 3rd h of 74 (93.7%) cases were between 7.8–9.9 mmol/L, including 14 (17.7%) at 7.8–7.9 mmol/L, 40 (50.6%) at 8.0–8.9 mmol/L, and 20 cases (25.3%) at 9.0–9.9 mmol/L, respectively. Only 2 cases (2.5%) had a glucose value at 11.0–11.9 mmol/L and 3 (3.8%) at 10.0–10.9 mmol/L.

Among the 79 cases, if the National Diabetes Data Group (NDDG) criteria were adopted, 30 would remain in the GDM group, 35 would be diagnosed as IGT, and 14 would be regarded as normal and have not any medical management.

3.4.3 Pregnancy outcomes of the possibly miss-diagnosed cases compared with those with normal OGTT

Pregnancy outcomes of the possibly miss-diagnosed cases (n = 79) were compared with those with normal OGTT results and no significant differences were found in the rate of CS, preterm births or macrosomia (Table 4).

Table 2 Risk factors analysis of the possibly miss-diagnosed cases

	total number	no risk factor	1 risk factor	2 risk factors	3 risk factors	≥4 risk factors
		n (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)
miss-diagnosed cases	79	19 (24.1)	28 (35.4)	23 (29.1)	8 (10.1)	1 (1.3)
all who had OGTT	4179	1051 (25.1)	1612 (38.6)	993 (23.8)	377 (9.0)	146 (3.5)
χ^2		0.05	0.32	1.22	0.12	–
P value		> 0.05	> 0.05	> 0.05	> 0.05	> 0.05

Table 3 Distribution of the abnormal glucose values in OGTT in 79 miss-diagnosed cases

glucose level /mmol·L^{-1}	fasting	1st h (≥10.0 mmol/L)	2nd h (≥8.6 mmol/L)	miss-diagnosed cases (3rd h value≥7.8 mmol/L)
	n (%)	*n* (%)	*n* (%)	*n* (%)
13 (≥13, < 14.0)			1 (2.17)	
12–			1 (2.17)	
11–		9 (39.1)	2 (4.35)	2 (2.5)
10–		14 (60.9)	3 (6.52)	3 (3.8)
9–			26 (56.52)	14 (17.7)
8–			13 (28.26)	40 (50.6)
7–				20 (25.3)
6–	1 (10.0)			
5.3–	9 (90.0)			
total number	10 (100.0)	23 (100.0)	46 (100.0)	79 (100.0)

Table 4 Comparison of pregnancy outcomes between those possibly miss-diagnosed cases and women with normal OGTT

	possibly miss-diagnosed cases ($n = 56$)*		normal OGTT cases ($n = 1733$)*		χ^2	P value
	number	%	number	%		
cesarean section	16	28.6	688	39.7	2.81	> 0.05
preterm birth	4	7.1	185	10.7	0.72	> 0.05
macrosomia	4	7.1	113	6.5	0.03	> 0.05

*: data from those cases were available.

3.4.4 Association with the gestational weeks when OGTT was performed

The average weeks at which OGTT was performed were 29.5 ± 3.6 weeks for the 79 possibly miss-diagnosed cases, and were 29.3 ± 4.2 for all the 4179 women ($P > 0.05$). The weeks of gestations are listed in Table 5. No difference was found in the miss-diagnosis rate in those receiving OGTT before and after 28 weeks.

Table 5 The gestational weeks when OGTT was performed

	total number	≥28 weeks	24–28 weeks	< 24 weeks
		n (%)	n (%)	n (%)
miss-diagnosed cases	79	53 (67.1)	24 (30.4)	2 (2.5)
all who had OGTT	4179	2614 (62.6)	1280 (30.6)	285 (6.8)
χ^2		0.68	0.0	2.27
P value		> 0.05	> 0.05	> 0.05

OGTT: oral glucose tolerance test.

4 Discussion

4.1 Majority of the women who received OGTT would be normal and do not need the 3rd h test in OGTT

It is well accepted that OGTT would be the golden standard in diagnosing abnormal glucose metabolism during pregnancy. However, 3 h OGTT during pregnancy has many inconveniences. Firstly, pregnant women are required to fast from the night before the day for OGTT till the end of the test which usually takes the whole morning. Secondly, 4 blood samples are taken for each pregnant woman and this usually is not easily accepted by all subjects even when they are really at risk of developing diabetes during pregnancy. Thirdly, 3 h OGTT produces a heavy work load for the laboratory although glucose tests now can be performed by a machine. The results in this study show that 62.1% of the women who had OGTT performed would have 4 normal values. Adding those 19.9% of women who had only one abnormal value, 82.0% of the women did not require any management. Who wants to suffer the pain of having blood taken when it is known that more than 4/5 would be normal, and even in those with a final diagnosis of GDM, only 10.5% are finally diagnosed depending on the third h test, which means nearly 90% or more do not necessarily have the last test.

4.2 Omission of the 3rd h test in OGTT would only result in missing a few cases

Thus, the idea arises whether we should have 2 h OGTT instead of 3 h OGTT. An early publication on this topic was from Isreal [8]. The diagnostic criteria applied in that study were the same as the current study, except with 100 g glucose intake. Out of the 876 pregnant women in their study, 28.4% (249) were diagnosed as GDM and 26.4% (231) GDM were identified if the 3rd h glucose level was omitted. The author concluded that a 100 g 2 h OGTT carried a higher patient compliance, and was time-saving, simple and inexpensive. No difference was found in the perinatal outcomes between the 18 possibly miss-diagnosed cases and the study cohort. Another report, using NDDG criteria, showed a 13% failure rate in diagnosing GDM cases if the 3rd h glucose level was omitted [9]. This result is unfavorable for the omission strategy in OGTT.

Over the last two to three decades, both medical doctors and pregnant women in China have become increasingly aware of the many implications of GDM on the health of the mothers and babies in both the short- and long-term [10]. There were an estimated over 500 publications in China on pregnancy-associated diabetes, and few mentioned the possibility of omission of the 3rd h glucose test. Yang *et al*. [11] did a retrospective study on 647 GDM and 233 GIGT women through a 13-year period and reported that omission of the 3rd h test in OGTT results in failure of diagnosing 2.9% GDM women and 1.7% GIGT women. Xie *et al*. [7] discussed the possibility of omission of the 3rd h OGTT also, in which 404 pregnant women who had OGTT performed were included. Among the 404 pregnant women, 111 were diagnosed as GDM and 72 as GIGT. When the 3rd h test was carried out, 5 GDM (4.5%) and 1 GIGT (1.4%) would be missed. Further, in the latter publication, the pregnancy outcomes were compared between the possibly miss-diagnosed cases and those with normal OGTT results after abnormal GCT; no difference was found in the rate of pre-eclampsia, macrosomia, large for gestational age (LGA) and Apgar≤3. However, in fact, none of these cases were miss-diagnosed in real practice, and they should have received some kind of management. Thus this, together

with the small number of cases, might contribute to the above pregnancy outcomes. However, another publication in China proposed the opposite opinion [12] that omission of the 3rd h test would result in 31.3% GDM cases missing. However, the total number of GDM cases in their analysis was too small (only 115 GDM cases).

The present national survey on pregnancy-associated diabetes is the largest investigation in China so far. By using ADA criteria, we found that 79 cases would be overlooked without management if the 3rd h test were omitted. This number is equal to only 1.9% of all women who had OGTT after an abnormal GCT, which means another 52 pregnant women need to do the 3rd h test in order to diagnose one GDM woman.

For the 3 h glucose level in these 79 cases, up to 76% were $<$ 9.0 mmol/L, and a comparison between these 79 cases and those with normal OGTT results revealed no significant differences in the basic information and pregnancy outcomes in this analysis. Also, there is no evidence to support that the rate of possibly miss-diagnosed cases has any relationship with the gestational weeks or the number of risk factors. Therefore, if there is some way by which we can identify these possibly miss-diagnosed cases, we can definitely change the 3 h OGTT to the 2 h test. Recently, the ADA has issued its new "Standards of Medical Care in Diabetes — 2010", in which the three points OGTT was recommended [13].

5 Conclusions

Omission of the 3rd h glucose test in OGTT might be feasible due to its convenience, better compliance and a small rate of possibly miss-diagnosed cases.

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