

COMPARISON OF THE ORAL GLUCOSE TOLERANCE TESTS IN ADULTS USING 50G AND 75G GLUCOSE LOAD

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SYNOPSIS

Oral glucose tolerance tests (OGTT) using 50g and 75g glucose loads were performed on 10 healthy subjects and on 99 adult patients with glycosuria. None had vomiting with the 50g and 75g glucose loads. In the 99 patients, 8.1% had slight nausea after the 75g glucose load while 6.1% had slight nausea after the 50g glucose load. It is concluded that adult patients in Singapore can tolerate the 75g glucose load for the OGTT.

The mean 2-hour venous plasma glucose after the 75g glucose OGTT in the 99 patients was 168.9 mg/100 ml (9.4 mmol/L) while it was 145.9 mg/100 ml (8.1 mmol/L) after the 50g glucose OGTT; the difference is significant ($p < 0.001$). Thus the mean 2-hour venous plasma glucose during the 75g glucose OGTT was 23.0 mg/100 ml (1.3 mmol/L) higher than that after the 50g glucose OGTT.

Using the 1980 WHO criteria with the 75g glucose OGTT, in the 99 patients, 32 (32.3%) were diabetic, 17 (17.2%) had impaired glucose tolerance and 50 (51.5%) were normal; while using the 1965 WHO criteria with the 50g glucose OGTT, 38 (38.4%) were diabetic, 17 (17.2%) had impaired glucose tolerance and 44 (44.4%) were normal.

It is concluded that the recommendations of the 1980 WHO Expert Committee on Diabetes Mellitus on the performance and interpretations of the oral glucose tolerance test should be adopted in Singapore so as to conform to the practice in many other countries.

INTRODUCTION

In Singapore, the usual method of performing the oral glucose tolerance test (abbreviated to OGTT in the rest of the text) in the adult utilises an oral glucose load of 50g. This practice is not universal as in some countries (e.g. U.S.A.) 75g of glucose is commonly used (1) while in other countries 100g of glucose is used (2). In Singapore, the diagnosis of diabetes mellitus is usually made on a 2-hour venous plasma glucose of 140 mg/100 ml (7.8 mmol/L) or greater during the 50g glucose OGTT; this is based on the recommendation of the 1965 World Health Organisation Expert Committee on Diabetes Mellitus (2).

There is a developing consensus on a more uniform approach to the performance and interpretation of the OGTT; hence the WHO updated its first report and published its second report in 1980 (3). In this second report (3) an oral glucose load of 75g in the adult is recommended and the 2-hour venous plasma glucose for the diagnosis of diabetes is raised to 200 mg/100 ml (11.1 mmol/L) or greater.

In this paper we report our initial experience in performing and interpreting the OGTT as recommended by the 1980 WHO Expert Committee on Diabetes Mellitus (3).

MATERIALS AND METHODS

All subjects undergoing the OGTT were asked to take a normal diet (containing at least 150g of carbohydrate per day) for at least 3 days before the test. Each subject had 2 OGTTs at an interval of 3 to 5 days; one OGTT with 50g glucose and the other with 75g glucose. Subjects with odd serial numbers started with a 50g glucose load OGTT followed by the second OGTT utilising 75g glucose; in subjects with even numbers the procedure was reversed. During the OGTT subjects were asked to record any symptoms such as nausea, vomiting, abdominal discomfort, etc.

The OGTT was performed after an overnight fast. Two ml of venous blood were drawn into an oxalated tube. An oral glucose load of 50g or 75g (in 250 — 350 ml of water) was then given. Blood specimens at 1 hour and 2 hours after the glucose load were similarly obtained. During the whole procedure the subjects remained seated.

The blood glucose was determined by the standard glucose oxidase method using the Beckman Glucose Analyser; 10 μ L of plasma were used.

The subjects studied consisted of 10 healthy medical students and 99 patients with glycosuria.

Using the 50g glucose load, a 2-hour venous plasma glucose of 140 mg/100 ml (7.8 mmol/L) or greater was used to diagnose diabetes mellitus; impaired glucose tolerance was present when the 2-hour venous plasma glucose was less than 140 mg/100 ml (7.8 mmol/L) but greater than 120 mg/100 ml or 6.7 mmol/L (2).

Using the 75g glucose load, diabetes was diagnosed when the 2-hour venous plasma glucose was 200 mg/100 ml (11.1 mmol/L) or greater; impaired glucose tolerance was present when the 2-hour venous plasma glucose was less than 200 mg/100 ml (11.1 mmol/L) but greater than 140 mg/100 ml (7.8 mmol/L) (3).

RESULTS

In 10 healthy medical students (6 males, 4 females, mean age 23 years; age range: 22 to 24 years; mean body weight: 53.4 kg; mean body mass index: 19.6), the OGTTs using 50g and 75g glucose are shown in Table 1. The mean blood glucose at 2 hours using 50g glucose (91.3 mg/100 ml; 5.1 mmol/L) was slightly higher than that using 75g glucose (89.4 mg/100 ml; 5.0 mmol/L) but the difference (1.9 mg/100 ml; 0.1 mmol/L) or +2.1% is not significant. Six of the 10 subjects (60%) complained of slight nausea during the 50g glucose OGTT while 7 of the subjects (70%) had similar complaint during the 75g glucose OGTT, but the difference is not significant. None of the subjects vomited during the OGTTs using either 50g or 75g of glucose loads.

Of the 99 patients with glycosuria studied, (61 males and 38 females; mean age: 42 years; age range: 16 to 81 years; mean body weight: 61.4 kg and mean body mass index: 23.9) 6 (6.1%) complained of slight nausea during the 50g glucose OGTT while 8 (8.1%) had similar complaints during the 75g glucose OGTT, but the difference is not significant. None of the patients vomited.

The OGTTs in the 99 patients are shown in Table 2. The mean fasting and 1-hour blood glucose (venous plasma)

during the 50g glucose and 75g glucose OGTT are almost identical (Table 2). The mean 2-hour blood glucose during the 75g glucose OGTT was 168.9 mg/100 ml (9.4 mmol/L) while it was 145.9 mg/100 ml (8.1 mmol/L) during the 50g glucose OGTT; thus it was 23.0 mg/100 ml (1.3 mmol/L) or 15.8% higher in the 75g OGTT (Table 2); the difference is significant ($t = 5.29$; $p < 0.001$).

In the 75g glucose OGTT, the 2-hour venous plasma glucose of less than 140 mg/100 ml (7.8 mmol/L) was regarded as normal (3): utilising this criterion, 50 of the 99 patients had normal OGTTs. The OGTTs of these 50 patients are shown in Table 3. In the 75g glucose OGTT, the mean 2-hour blood glucose was 98.1 mg/100 ml (5.5 mmol/L) while it was 95.9 mg/100 ml (5.3 mmol/L) after the 50g OGTT; this difference of 2.2 mg/100 ml (0.1 mmol/L) or 2.3% is not significant. During the 50g glucose OGTT, 4 of the 50 patients (8.0%) had impaired glucose tolerance (2-hour blood glucose more than 120 mg/100 ml or 6.7 mmol/L but less than 140 mg/100 ml or 7.8 mmol/L) while 2 patients (4.0%) had diabetic 50g OGTT (2-hour blood glucose 140 mg/100 ml, 7.8 mmol/L or greater). The remaining 44 patients (88.0%) had normal 50g OGTT (2-hour blood glucose of 120 mg/100 ml [6.7 mmol/L] or less).

17 of the 99 patients or 17.2% had impaired glucose tolerance during the 75g OGTT (2-hour blood glucose greater than 140 mg/100 ml (7.8 mmol/L) but less than 200 mg/100 ml or 11.1 mmol/L). These 17 patients' (7 males and 10 females; mean age 39.2 years; mean body mass index 27.8) OGTTs are shown in Table 4. The mean 2-hour blood glucose during the 75g OGTT was 164.3 mg/100 ml (9.1 mmol/L); this was 8.2 mg/100 ml (0.5 mmol/L) or 5.3% higher than the mean 2-hour blood glucose during the 50g glucose OGTT (156.1 mg/100 ml or 8.7 mmol/L) but the difference is not significant ($t = 0.91$; $p > 0.05$).

32 of the 99 patients or 32.3% of the patients had diabetes during the 75g glucose OGTT (2-hour blood glucose 200 mg/100 ml i.e. 11.1 mmol/L or greater) while 38 patients (38.4%) had diabetes during the 50g OGTT (2-hour blood glucose 140 mg/100 ml or 7.8 mmol/L or greater). All the 32 cases who were diabetic with the 75g OGTT were also diabetic with the 50g OGTT. Of those 6 patients who were diabetic during the 50g glucose OGTT but not diabetic during the 75g glucose OGTT, all had impaired glucose tolerance during the 75g glucose OGTT. Thus during the 75g OGTT and using the 1980 criteria (3), 6 of the 38 patients (15.8%) were grouped as impaired glucose tolerance while all were diabetic during the 50g glucose OGTT and using the 1965 criteria (2).

The OGTTs of the 32 patients diabetic during the 75g glucose OGTT (22 males, 10 females, mean age: 47.9 years; mean body mass index: 24.9) are shown in Table 5. The mean 2-hour blood glucose during the 75g OGTT was 282.0 mg/100 ml (15.7 mmol/L); this was 63.4 mg/100 ml (3.5 mmol/L) or 29.0% higher than the mean during the 50g OGTT (218.6 mg/100 ml or 12.1 mmol/L); the difference is significant ($t = 8.45$; $p < 0.001$).

The final diagnosis of the 99 patients with glycosuria using 50g glucose and 75g glucose loads during the OGTT is summarised in Table 6.

DISCUSSION

In Singapore, the traditional method of performing the OGTT in the adult uses a glucose load of 50g. The 1965 WHO Expert Committee on Diabetes (2) states that while a 50g glucose load is widely used, a 100g glucose load is also acceptable. In some countries such as in the U.S.A., a 75g glucose load is often used (1). Thus there is no universal practice; to remedy this, the 1980 WHO Expert Committee on Diabetes (3) suggests that a uniform glucose load of 75g be used.

The present study shows that patients in Singapore can

VENOUS PLASMA GLUCOSE (MEAN ± S.D.)		GLUCOSE LOAD		P
		50 G	75 G	
FASTING	MG/100 ML MMOL/L	79.1 ± 10.4 4.4 ± 0.6	83.3 ± 6.9 4.6 ± 0.4	NS
1 HOUR	MG/100 ML MMOL/L	119.1 ± 25.5 6.6 ± 1.4	113.8 ± 27.0 6.3 ± 1.5	NS
2 HOURS	MG/100 ML MMOL/L	91.3 ± 28.0 5.1 ± 1.6	89.4 ± 17.7 5.0 ± 1.0	NS

TABLE 1 ORAL GLUCOSE TOLERANCE TESTS IN 10 HEALTHY SUBJECTS USING 50G AND 75G GLUCOSE LOADS.

VENOUS PLASMA GLUCOSE (MEAN ± S.D.)		GLUCOSE LOAD		P
		50 G	75 G	
FASTING	MG/100 ML MMOL/L	104.2 ± 35.5 5.8 ± 2.0	103.8 ± 35.7 5.8 ± 2.0	NS
1 HOUR	MG/100 ML MMOL/L	189.0 ± 77.2 10.5 ± 4.3	189.0 ± 74.0 10.5 ± 4.1	NS
2 HOURS	MG/100 ML MMOL/L	145.9 ± 73.9 8.1 ± 4.1	168.9 ± 93.2 9.4 ± 5.2	< 0.001

TABLE 2 ORAL GLUCOSE TOLERANCE TESTS IN 99 PATIENTS USING 50G AND 75G GLUCOSE LOADS.

VENOUS PLASMA GLUCOSE (MEAN ± S.D.)		GLUCOSE LOAD		P
		50 G	75 G	
FASTING	MG/100 ML MMOL/L	85.3 ± 13.9 4.7 ± 0.8	85.1 ± 18.0 4.7 ± 1.0	NS
1 HOUR	MG/100 ML MMOL/L	139.2 ± 45.2 7.7 ± 2.5	138.6 ± 42.5 7.7 ± 2.4	NS
2 HOURS	MG/100 ML MMOL/L	95.9 ± 34.1 5.3 ± 1.9	98.1 ± 23.2 5.5 ± 1.3	NS

TABLE 3 NORMAL ORAL GLUCOSE TOLERANCE TESTS IN 50 PATIENTS USING 50G AND 75G GLUCOSE LOADS.

VENOUS PLASMA GLUCOSE (MEAN ± S.D.)		GLUCOSE LOAD		P
		50 G	75 G	
FASTING	MG/100 ML MMOL/L	98.1 ± 20.8 5.5 ± 1.2	97.6 ± 16.2 5.4 ± 0.9	NS
1 HOUR	MG/100 ML MMOL/L	184.3 ± 42.4 10.2 ± 2.4	192.7 ± 37.7 10.7 ± 2.1	NS
2 HOURS	MG/100 ML MMOL/L	156.1 ± 45.2 8.7 ± 2.5	164.3 ± 15.0 9.1 ± 0.8	NS

TABLE 4 ORAL GLUCOSE TOLERANCE TESTS USING 50G AND 75G GLUCOSE IN 17 PATIENTS WITH IMPAIRED GLUCOSE TOLERANCE.

VENOUS PLASMA GLUCOSE (MEAN ± S.D.)		GLUCOSE LOAD		P
		50 G	75 G	
FASTING	MG/100 ML MMOL/L	137.1 ± 41.8 7.6 ± 2.3	136.4 ± 41.3 7.6 ± 2.3	NS
1 HOUR	MG/100 ML MMOL/L	269.3 ± 63.4 15.0 ± 3.5	266.0 ± 59.3 14.7 ± 3.3	NS
2 HOURS	MG/100 ML MMOL/L	218.6 ± 69.5 12.1 ± 3.9	282.0 ± 71.9 15.7 ± 4.0	< 0.001

TABLE 5 ORAL GLUCOSE TOLERANCE TESTS USING 50G AND 75G GLUCOSE IN 32 DIABETIC PATIENTS.

DIAGNOSIS	GLUCOSE LOAD	
	50 G	75 G
NORMAL	44 (44.4%)	50 (51.5%)
IMPAIRED GLUCOSE TOLERANCE	17 (17.2%)	17 (17.2%)
DIABETIC	38 (38.4%)	32 (32.3%)
ALL CASES	99 (100.00%)	99 (100.0%)

TABLE 6 FINAL DIAGNOSIS IN 99 PATIENTS WITH GLYCOSURIA USING 50G AND 75G GLUCOSE LOADS DURING THE ORAL GLUCOSE TOLERANCE TESTS.

tolerate an oral glucose load of 75g; none of the 10 healthy subjects or 99 patients with glycosuria had vomiting. The incidence of slight nausea was slightly higher in 10 healthy medical students after ingestion of 75g glucose (70.0%) than after ingestion of 50g glucose load (60.0%). Similarly, in 99 patients the incidence of slight nausea after ingestion of 75g glucose was slightly higher (8.1%) than after ingestion of 50g glucose (6.1%). In both instances, the difference is not significant.

In the 10 healthy subjects, the mean 2-hour venous plasma glucose in the 50g glucose OGTT (91.3 mg/100 ml; 5.1 mmol/L) closely resembled that in the 75g glucose OGTT (89.4 mg/100 ml, 5.0 mmol/L).

In the 99 patients, the mean 2-hour venous plasma glucose in the 75g glucose OGTT was 168.9 mg/100 ml (9.4 mmol/L) compared with 145.9 mg/100 ml (8.1 mmol/L) in the 50g glucose OGTT; the difference of 23.0 mg/100 ml (1.3 mmol/L) is highly significant (p<0.001). This difference is as expected as extrapolations from data on differences in response to 50g and 100g oral glucose loads suggest that the 2-hour values after 75g would be about 1 mmol/L (15 mg/100 ml) higher than after 50g and about the same lower than after 100g (3).

The 1980 WHO Expert Committee on Diabetes (3) recommendation to raise the diagnostic value for diabetes for the 2-hour venous plasma glucose from 140 mg/100 ml (7.8 mmol/L) or greater after 50g glucose load to 20 mg/100 ml (11.1 mmol/L) or greater after 75g glucose load is based on the following: (1) subjects with 2-hour glucose value, below the new cut-off point rarely show development of the specific complications of diabetes; (2) only a small proportion show metabolic deterioration "worsening to diabetes"; (3) many show spontaneous reversion to normal glucose values. Those with a 2-hour blood glucose of 140 mg/100 ml (7.8 mmol/L) or greater but below 200 mg/100 ml (11.1 mmol/L) are grouped as "impaired glucose tolerance"; the natural history of this group is unclear; they require no treatment but should be watched regularly for change in their glucose tolerance (3).

Based on a 75g glucose OGTT and the 1980 WHO criteria (3); of the 99 patients, 32 (32.3%) were diabetic; 17 (17.2%) had impaired glucose tolerance while 50 (51.5%) were normal; the same group of patients were grouped as diabetic in 38 (38.4%), impaired glucose tolerance in 17 (17.2%) and normal in 44 (44.4%) after a 50g glucose OGTT and using the 1965 WHO criteria (2). The 1980 WHO criteria (3), being stricter than the 1965 criteria (2) hence diagnosis a lower percentage of diabetics (32.3% as compared with 38.4%).

The 1980 WHO Expert Committee on Diabetes (3) spells out further clarifications for the diagnosis of diabetes: (1) If symptoms of diabetes are present, perform random or fasting blood glucose measurement. In adults, random venous plasma values of 11.1 mmol/L (200 mg/100 ml) or more or fasting values of 7.8 mmol/L (140 mg/100 ml) or more are diagnostic and fasting values below 5.6 mmol/L (100 mg/100 ml) exclude the diagnosis; (2) If results are equivocal, measure blood glucose concentration 2 hours after 75g of glucose take orally after an overnight fast. Two-hour venous plasma glucose values of 11.1 mmol/L (200 mg/100 ml) or more are diagnostic of diabetes. Values below 7.8 mmol/L (140 mg/100 ml) are normal and those in the range 7.8 to 11.1 mmol/L (140 to 200 mg/100 ml) are termed "impaired glucose tolerance". (3) In the absence of symptoms of diabetes at least one additional abnormal blood glucose value is needed to confirm the clinical diagnosis, e.g., a 1-hour post glucose value of 11.1 mmol/L (200 mg/100 ml) or more during the first test or an elevated 2-hour or fasting glucose value on a subsequent occasion.

There are a number of grey areas which have not been spelt out in the 1980 WHO Expert Committee on Diabetes (3): these include the question of the effect of age on glucose tolerance, the carbohydrate intolerance of pregnancy and diagnostic criteria for children (4).

It is hoped that the recommendations of the 1980 WHO Expert Committee on Diabetes (3) will be adopted universally so that a diabetic is a diabetic whether he is in Singapore, Kuala Lumpur, Melbourne, London, New York or in

any other parts of the earth!

REFERENCES

1. Prout T E: The use of screening and diagnostic procedures: the oral glucose tolerance test. In: Sussman, K.E., Metz, R.J.S. eds. Diabetes Mellitus, 1975: 57-67.
2. WHO Technical Report Series No 310: Diabetes mellitus: Report of a WHO Expert Committee, 1965.
3. WHO Technical Report Series No 646: WHO Expert Committee on Diabetes Mellitus, Second Report, 1980.
4. Zimmet P: When is Diabetes? — a new look at diagnostic criteria for diabetes mellitus. Aust New Zealand J Med 1980; 10: 346-50.



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