Original article

An elevated 1-h post-load glucose level during the oral glucose tolerance test detects prediabetes

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A R T I C L E   I N   F O

Article history:  
available online xxx

Keywords:  
Prediabetes  
OGTT  
1-h post-load glycemia  
HOMA  
HbA1c  
Diagnosis

A B S T R A C T

Aim: The objective of the study was to compare the diagnosis of dysglycemic states by conventional oral glucose tolerance test (OGTT) criteria (fasting and 2-h plasma glucose) with the 1-h post-load plasma glucose level.  
Material and methods: 34 individuals (mean age: 55 ± 13 years; BMI: 27.7 ± 6.3 kg/m²) at risk for prediabetes were administered a 75-g OGTT. Individuals with normal glucose tolerance (NGT) or prediabetes were identified according to fasting and/or 2-h plasma glucose (PG) concentrations. Subsequently, subjects were divided in 2 groups: group 1 (n = 21) with a 1-h PG < 155 mg/dl and group 2 (n = 13) with a 1-h PG ≥ 155 mg/dl. HOMA was performed to assess β-cell function and insulin sensitivity.  
Results: NGT or prediabetes based on conventional criteria correlated with the 1-h PG < or > 155 mg/dl (p < 0.001). Moreover, the 1-h PG > 155 mg/dl was associated with higher HbA1c levels (6.1 ± 0.5 vs. 5.5 ± 0.3, p < 0.001) and significantly impaired insulin secretion and hyperbolic product (BxS) on HOMA test vs. 1-h PG < 155 mg/dl.  
Conclusion: The 1-h post-load plasma glucose value > 155 mg/dl is strongly associated with conventional criteria for (pre)diabetes and alterations of β-cell function.

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1. Introduction

Epidemiologic studies have documented an increased global prevalence of prediabetes. According to the latest International Diabetes Federation data, it was estimated in 2015 that more than 300 million people, or 6.7%, in the age-group 20–79 years had prediabetes [1]. Therefore, diagnosis is vital since numerous clinical studies have demonstrated that a substantial number of individuals with prediabetes will progress to overt diabetes [2,3]. Prediabetes is also associated with a variety of disorders, recently reviewed by Buysschaert et al. [4] in particular cardiovascular disease [5,6] and cancer [7]. For these reasons, early detection of this condition is now a public health priority [8].

Fasting plasma glucose (FPG) as well as the 2-h plasma glucose (2-h PG) during an OGTT and glycated hemoglobin (HbA1c) are indicated for screening and diagnosing glucose disorders [9–11]. However, recently, a 1-h plasma glucose (PG) ≥ 155 mg/dl (8.6 mmol/l) has been shown to be a better predictor of type 2 diabetes and associated complications than FPG or 2-h PG [12]. The latter observation was confirmed by Alyass et al. in the Botnia and the Malmö prevention trials [13]. Furthermore, those with NGT according to conventional criteria, but having a 1-h PG > 155 mg/dl, were found to have insulin resistance and/or worse β-cell function compared with a 1-h PG < 155 mg/dl [14–17].

Therefore, the aim of our study was to analyze in a real-world clinical setting the association of the 1-h PG value with conventional FPG and 2-h PG levels during an OGTT and with surrogate insulin indices in individuals with risk factors for prediabetes.

2. Patients and methods

We included 34 individuals (11 M; 23 F) who were evaluated in the Diabetes Clinic of the Catholic University of Louvain for prediabetes. A 75-g OGTT was conducted following an overnight

http://dx.doi.org/10.1016/j.dsx.2016.12.002  
1871-4021/© 2016 Published by Elsevier Ltd on behalf of Diabetes India.
fast with samples collected fasting, 60 and 120 min for plasma glucose and insulin determinations.

Prediabetes was diagnosed according to American Diabetes Association (ADA/EASD) criteria [9]; prediabetes was defined by a FPG between 100 and 125 mg/dl and/or a 2-h PG between 140 and 199 mg/dl. Diabetes was diagnosed with a FPG ≥126 mg/dl and/or a 2-h PG ≥200 mg/dl. Subsequently, the level of agreement of the 1-h PG <155 mg/dl [group 1] and ≥155 mg/dl [group 2] with diagnosis based on conventional criteria (FPG and 2-h PG) was assessed.

HbA1c was determined in all subjects. In addition, individuals underwent an assessment of insulin sensitivity (S), β-cell function (β) and hyperbolic product (BxS), using the Homeostasis Model Assessment (HOMA-2) computer-based version [18,19]. Plasma glucose, insulin and HbA1c (determined by high-performance liquid chromatography, Tosoh Biosciences) were measured at the Central Laboratory of the Hospital St-Luc.

Informed consent was given before enrolling in the study.

Results are expressed as means ± 1 standard deviation (SD), medians (m) or as in number (n) or proportions (%) of subjects. Mean values were compared with the one-way analysis of variance (ANOVA) and by non-parametric tests. Differences between proportions were assessed by the Chi-Squared ($\chi^2$) test. Data analyses were carried out using SPSS version 2.3. Results were considered statistically significant if p < 0.05.

3. Results

3.1. Cohort characteristics

As shown in Table 1, mean age was 55 ± 13 years (mean ± 1 SD) and body mass index (BMI) 27.7 ± 6.3 kg/m². Subjects demonstrated good blood pressure control (with or without antihypertensive agents). Mean LDL-cholesterol levels were 103 ± 28 mg/dl (with or without lipid-lowering drugs). For all the patients included in groups 1 and 2 (n = 34), PG values during OGTT were 96 ± 15, 151 ± 56 and 125 ± 54 mg/dl at T0, T60’ and T120’, respectively.

3.1.1. Group 1 (1 h PG < 155 mg/dl) vs. group 2 (1 h PG ≥ 155 mg/dl)

As indicated in Table 1, mean 1-h PG values were 114 ± 24 mg/dl in group 1 and 212 ± 34 mg/dl in group 2 (p < 0.001). The mean age was comparable in the two groups. BMI was slightly, but not significantly, higher in individuals in group 2 (p = 0.055). Blood pressure levels and lipid profiles were comparable in the two groups. HbA1c levels were 5.5 ± 0.3 vs. 6.1 ± 0.5 in groups 1 and 2, respectively (p < 0.001).

Table 2 shows the association between the 1-h PG value < or ≥155 mg/dl and normal glucose tolerance or prediabetes diagnosed following conventional criteria. Thus, 20 subjects had NGT on the basis of FPG and/or 2-h PG. All but one of these subjects was also found to have 1-h PG level <155 mg/dl. In contrast, a majority of individuals with IFG (impaired fasting glucose) or IGT (impaired glucose tolerance) and all subjects with diabetes had a T60’ value >155 mg/dl (p < 0.001). Moreover, those with a 1-h PG ≥ 155 mg/dl also had significantly decreased insulin secretion assessed by HOMA-B (141 ± 70% (m: 132%) in group 1 vs. 84 ± 50% (m: 63%) in group 2, p = 0.018) and reduced BxS product (105 ± 32% (m: 117%) in group 1 vs. 66 ± 28% (m: 54%) in group 2, p = 0.001) (Fig. 1) compared with those in group 1 (<155 mg/dl). HOMA-S values were comparable: 98 ± 61% (m: 80%) vs. 95 ± 43% (m: 86%) (p = 0.902) in group 1 and 2, respectively.

4. Discussion

Plasma glucose criteria (fasting and/or 2-h PG during OGTT) have been used for decades to establish the diagnosis of prediabetes (IGF and/or IGT) [10,11]. On the other hand, a recent survey among primary care physicians showed that only 7% of providers recommended a conventional OGTT to diagnose prediabetes [20]. Recently, the HbA1c determination has been recommended to diagnose dysglycemic conditions [9–11,21,22]. However, the utility of HbA1c as a screening tool, although much more convenient than OGTT in clinical practice, is still debated given the discordance between HbA1c and OGTT in addition to which several factors may influence its reliability [23]. In this context, Abdul-Ghani et al. [12] indicated that the 1-h PG during OGTT ≥155 mg/dl was also a good predictor for future risk of type 2 diabetes and associated complications, including atherosclerosis [15,24]. They also demonstrated with others that the 1-h PG correlated strongly with β-cell function [14–17]. Recently, in a long-term follow-up study, the 1-h PG level was reported to predict mortality even when the 2-h level was <140 mg/dl [25,26]. The present findings are relevant particularly as they are derived from a real-world clinical setting. Our results demonstrate an association between NGT or (pre)diabetes, assessed by conventional criteria, and the 1-h post-load glucose level. Hence,

Table 1

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total group (n = 34)</th>
<th>Group 1 (1 h PG &lt; 155 mg/dl n = 21)</th>
<th>Group 2 (1 h PG ≥ 155 mg/dl n = 13)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>55 ± 13 (58)</td>
<td>55 ± 14 (57)</td>
<td>54 ± 12 (59)</td>
<td>0.831</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>27.7 ± 6.3 (271)</td>
<td>26.8 ± 7.3 (25.6)</td>
<td>29.0 ± 4.1 (28.1)</td>
<td>0.055</td>
</tr>
<tr>
<td>Blood pressure (mmHg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>systolic</td>
<td>125 ± 15 (122)</td>
<td>124 ± 17 (130)</td>
<td>126 ± 11 (120)</td>
<td></td>
</tr>
<tr>
<td>diastolic</td>
<td>80 ± 8 (80)</td>
<td>81 ± 7 (80)</td>
<td>80 ± 10 (80)</td>
<td></td>
</tr>
<tr>
<td>HbA1c (%)</td>
<td>5.8 ± 0.5 (5.7)</td>
<td>5.5 ± 0.3 (5.6)</td>
<td>6.1 ± 0.5 (6.2)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>OGTT T60’ (mg/dl)</td>
<td>151 ± 56 (140)</td>
<td>114 ± 24 (108)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lipid profile (mg/dl)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>total cholesterol</td>
<td>184 ± 36 (186)</td>
<td>184 ± 35 (182)</td>
<td>186 ± 39 (202)</td>
<td>0.897</td>
</tr>
<tr>
<td>LDL cholesterol</td>
<td>103 ± 28 (97)</td>
<td>101 ± 26 (97)</td>
<td>105 ± 32 (101)</td>
<td>0.705</td>
</tr>
<tr>
<td>HDL cholesterol</td>
<td>62 ± 16 (61)</td>
<td>64 ± 14 (62)</td>
<td>60 ± 19 (54)</td>
<td>0.540</td>
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<tr>
<td>triglycerides</td>
<td>98 ± 43 (89)</td>
<td>95 ± 53 (92)</td>
<td>102 ± 23 (103)</td>
<td>0.673</td>
</tr>
</tbody>
</table>

mean ± 1 SD (median).

* group 1 vs. group 2.
most individuals with 1-h PG < 155 mg/dl had NGT demonstrated by fasting and/or 2-h PG values, while those with a 1-h PG ≥ 155 mg/dl had (pre)diabetes. These results are confirmed by the higher HbA1c values in group 2 vs. group 1, observations consistent with Bergman et al. who showed that the 1-h post load glucose was continuously associated with increasing HbA1c values [25]. In addition, our data confirm and extend previous observations showing that patients with a 1-h PG ≥ 155 mg/dl had impaired β-cell function indicated by HOMA-B values as well as by a reduced hyperbolic product (insulin secretion adjusted to sensitivity) when compared with those in group 1. However caution is needed in the interpretation of our data based on the relatively small number of subjects. Nevertheless, our results perfectly concord with previous observations suggesting that the 1-h PG ≥ 155 mg/dl could be included in a diagnostic algorithm for detecting prediabetes and possibly serve as an alternative to conventional OGTT criteria or HbA1c, as recently reported by Jagannathan et al. [22].

In conclusion, 1-h post load PG ≥ 155 mg/dl are associated (pre)diabetes based on conventional glucose criteria. Moreover, individuals with a value ≥ 155 mg/dl clearly had impaired indices of β-cell function. Further prospective studies are needed to confirm the 1-h PG value as a validated tool for diagnosing (pre)diabetes and related disorders.

Conflict of interest

The authors declare that they have no conflict of interest.

References