Rapid Short Communication

Post-prandial triglyceride profile in a population-based sample of Type 2 diabetic patients

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Abstract

Aims/hypothesis. Postprandial lipaemia is considered an emerging risk factor for cardiovascular disease also in the Type 2 diabetic population. However, little information exists on the daily triglyceride profile of these patients, especially during everyday life. The aim of the study was to evaluate the daily triglyceride profile of Type 2 diabetic patients during their everyday life.

Methods. 145 Type 2 diabetic patients (66 men/79 women, age range 45–65 years) at a health district near Naples, Italy, participating in a screening survey for the evaluation of diabetic complications, and 30 non-diabetic subjects of the same area underwent four daily capillary triglyceride profiles by Accutrend (Roche)—a previously validated method.

Results. Triglyceride values (mmol/l; Means $\pm$ SE) were 2.22 ± 0.08 at fasting, decreased before lunch (2.03 ± 0.07), reached a peak 3 h after lunch ($2.73 \pm$

0.09) and remained substantially high before dinner (2.47 ± 0.09) (all $p < 0.001$ vs fasting). The triglyceride profile of non-diabetic subjects was significantly lower at each point (average difference of 0.73 mmol/l). The percentage of patients with values above 2.25 mmol/l was 61% 3 h after lunch and 49% before dinner. Moreover, in 30% of patients with optimal fasting values (< 1.69 mmol/l) triglyceride concentrations 3 h after lunch ranged between 1.69 and 2.25 mmol/l, and in 31% they were above 2.25 mmol/l.

Conclusion/interpretation. Most Type 2 diabetic patients have postprandial triglycerides above optimal concentrations for several hours after meals. Moreover, optimal fasting concentrations are not always a good predictor of postprandial triglycerides. [Diabetologia (2004) 47:19–22]

Keywords Post-prandial lipemia · Type 2 diabetes mellitus · cardiovascular risk · post-prandial triglycerides · triglyceride self-monitoring

Postprandial lipaemia is considered an emerging cardiovascular risk factor also in the Type 2 diabetic population [1]. In particular, postprandial triglyceride concentrations above 2.25 mmol/l have been associated with an increased carotid artery intima-media thickness in a group of Japanese Type 2 diabetic pa-

tients with normal fasting triglyceride values [2]. Therefore it seems very important to evaluate possible postprandial lipid abnormalities in these patients during their everyday life.

Most of the studies on postprandial lipaemia have used test meals very rich in fat, therefore very far from normal living conditions, and the methodologies used were very complicated [1]. Unfortunately, these methodologies are not applicable on a large scale and their complexity does not allow repeated measurements, which is important considering the very high variability of triglyceride-rich lipoproteins from day-to-day and also during the same day. Very recently a new apparatus has become available, the Accutrend GCT, which allows self monitoring of triglycerides

Received: 16 April 2003 / Revised: 7 August 2003

Published online: 26 November 2003

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Abbreviations: GCT, Glucose-cholesterol triglycerides.

[3, 4]; it is similar to the well known method for self monitoring of blood glucose.

We therefore decided to use this methodology in a population-based sample of Type 2 diabetic patients to evaluate their daily triglyceride profile during everyday life and to compare it with that of a reference group of non-diabetic people living in the same area.

Subjects and methods

We studied a population-based sample of Type 2 diabetic patients from a health district near Naples. They participated in a screening survey for the evaluation of diabetic complications and they met the following criteria: age between 45 and 70 years, absence of renal or liver failure, no myocardial infarction or stroke in the 6 months prior to enrollment, no thyroid stimulator hormone increase and no use of hypolipidaemic drugs.

Patients were asked to perform two daily triglyceride and blood glucose profiles per week on two non-consecutive working days, by Accutrend GCT (Roche Diagnostics Mannheim, Germany). Self measurements were done at fasting, before lunch, 2 and 3 h after lunch, before dinner, 2 and 3 h after dinner.

A control group of 30 non-diabetic subjects of the same geographical area and meeting specific criteria (age 45–70 years, absence of renal, liver, cardiovascular or any other chronic diseases) was selected from the patients' list of a local general practitioner, and asked to do four daily triglyceride profiles with the Accutrend at the same hours as the patients.

On the day of the recruitment, a fasting blood sample was taken to determine blood glucose, serum triglycerides and cholesterol, HDL cholesterol, and glycosylated haemoglobin (only diabetic patients); anthropometric and anamnestic data were also collected. All participants gave their informed consent and the study was approved by the Ethics Committee of Federico II University Medical School, Naples.

Analytical methods. Self measurements of capillary triglycerides were done with the Accutrend GCT by a process of dry chemistry and colorimetry. Triglyceride measurements by Accutrend were previously validated against standard enzymatic methods (a correlation coefficient of 0.94 was found) [3].

Serum glucose, cholesterol and triglycerides were analyzed by enzymatic standard methods (Hitachi 912 auto analyzer, Roche Diagnostics, Basel, Switzerland), glycosylated haemoglobin by HPLC. The HDL cholesterol was assayed after precipitation of apoB-containing lipoproteins with a sodium phosphotungstate and magnesium chloride solution [5].

Statistical methods. The data are expressed as means $\pm$ standard deviation (means $\pm$ SD), unless otherwise stated. ANOVA for repeated measures and a Student's unpaired *t* test was used for comparisons. A *p* value of less than 0.05 was considered statistically significant. All statistical tests were done on a computer using the Statistical Package for Social Sciences (SPSS/PC) software.

Results

Accutrend was given to 161 patients, but 16 (10%) were unable to adequately self-monitor their triglyceride concentrations; therefore all the analysis were

Fig. 1. Triglyceride daily profile in Type 2 diabetic patients ($n=145$) and in a control group of non-diabetic subjects ($n=30$) (means $\pm$ SE). * $p<0.0001$ vs fasting; § $p<0.0001$ vs non-diabetic subjects (ANOVA for repeated measures)

Table 1. Main characteristics of the participants

	Diabetic patients	Control group
<i>n</i>	145	30
Age (years)	54 $\pm$ 7	50 $\pm$ 5
Sex (men/women)	66/79	14/15
BMI (kg/m ²)	30.8 $\pm$ 5.9	27.3 $\pm$ 2.7
Glucose (mmol/l)	9.1 $\pm$ 3.2	4.6 $\pm$ 0.5
HbA _{1c} (%)	6.7 $\pm$ 1.6	—
Cholesterol (mmol/l)	5.40 $\pm$ 1.06	5.38 $\pm$ 0.86
Triglycerides (mmol/l)	1.84 $\pm$ 1.25	1.33 $\pm$ 0.61
HDL cholesterol (mmol/l)	1.25 $\pm$ 0.29	1.38 $\pm$ 0.34
Therapy: Diet alone (%)	12	—
Oral drugs (%)	81	—
Insulin (%)	7	—

done on 145 patients. The patients' main clinical characteristics and those of the control group are shown in Table 1.

The daily triglyceride profile (average of the four profiles) of diabetic patients is shown in Fig. 1. The daily triglyceride profile of the control group shows significantly lower triglyceride values at each point, with an average difference of 0.73 mmol/l (Fig. 1). However, the trend throughout the day was very similar to that of diabetic patients.

The percentage of Type 2 diabetic patients with triglyceride values higher than 2.25 mmol/l 3 h after lunch was 61% and of these as many as 23% had normal fasting values (<1.69 mmol/l). Moreover, considering pre-dinner values, this percentage was still 49%, with 19% of them having normal fasting triglyceride values. In the control group the percentage of subjects with a triglyceride value above 2.25 mmol/l 3 h after lunch and before dinner was 17%.

To better understand to which extent fasting triglyceride values predict postprandial triglycerides, we divided the diabetic patients into three categories according to their triglyceride fasting concentrations

(<1.69 mmol/l, $n=65$; between 1.69 and 2.25 mmol/l, $n=25$; >2.25 mmol/l, $n=55$) and examined the distribution of postprandial triglycerides in these three groups. Almost all patients (98%) with fasting triglyceride values above 2.25 mmol/l had triglyceride values above 2.25 mmol/l 3 h after lunch. In the intermediate group (1.69–2.25 mmol/l) very few (4%) had triglyceride concentrations below 1.69 mmol/l 3 h after lunch, 40% returned to their fasting values (1.69–2.25 mmol/l) and 56% remained at concentrations above 2.25 mmol/l. In the group with optimal fasting triglyceride concentrations (<1.69 mmol/l) less than half (39%) returned to their fasting concentrations, whereas 61% still presented values above 1.69 mmol/l; more specifically, 30% had triglyceride values between 1.69 and 2.25 mmol/l and 31% concentrations above 2.25 mmol/l.

No major difference was found between subjects with optimal fasting triglycerides who returned to fasting values and those who did not, taking into account BMI (29.3 ± 5.0 vs 31.4 ± 6.3 kg/m², $p=0.19$), HbA_{1c} (7.0 ± 1.8 vs $6.3 \pm 1.3\%$, $p=0.12$), 2-h postprandial blood glucose (8.87 ± 2.51 vs 7.94 ± 2.44 mmol/l, $p=0.15$), total calorie intake ($2,004 \pm 666$ vs $2,036 \pm 476$ kcal/die, $p=0.83$), type of hypoglycaemic therapy (on diet 18 vs 18%; on oral drugs 82 vs 75%; on insulin 0 vs 7%).

Discussion

The daily triglyceride profile of our diabetic patients indicates that in this study population: (i) the peak value is reached 3 h after lunch and dinner; (ii) the postprandial increase is larger after lunch than after dinner; (iii) the lowest triglyceride concentrations during the day do not occur before breakfast but before lunch. Although with significantly lower values, the trend throughout the day of our control group is very similar to that of diabetic patients. Therefore, it is very likely that this time course is mainly due to the dietary habits of our region, where people (diabetic and non-diabetic) are used to a very light breakfast (or, in many cases, no breakfast at all), a main meal at lunch time and a lighter one at dinner time. This observation is also confirmed by a study on [6] a group of healthy Dutch normolipidaemic men with different dietary habits characterized by a more consistent breakfast and a main meal at dinner time. Of note, in this North European group pre-lunch triglyceride values were significantly higher compared to fasting ones and the highest increase was present after dinner and not after lunch.

Another piece of evidence coming from our study is that a large number of Type 2 diabetic patients (61%) have postprandial triglyceride values well above 2.25 mmol/l, a value found to be linked to a greater intima-media thickness of the carotid artery in

Type 2 diabetic patients [2]. Moreover, values above 2.25 mmol/l are not confined to only a few hours after lunch and dinner, but, as shown by the daily profile, they are still present 6 to 7 h after lunch.

Finally, what is still more relevant, especially from a clinical point of view, is that 23% of Type 2 diabetic patients who have 3-h postprandial triglyceride values below 2.25 mmol/l, have fasting triglyceride concentrations considered optimal, above 1.69 mmol/l, according to the new recommendations for the prevention of cardiovascular diseases in diabetic patients [7, 8].

This point leads us to discuss the other relevant result of our study, that optimal fasting triglyceride values do not necessarily imply acceptable values, neither in the postprandial period nor 6 to 7 h after eating. Only in less than half of these patients did triglyceride values return to fasting concentrations, whereas in the others they remained above 1.69 mmol/l; in particular, in 31% they were above 2.25 mmol/l. Very similar figures came out when pre-dinner values were considered. These data indicate that also some Type 2 diabetic patients with optimal fasting triglyceride concentrations—therefore considered at a lower cardiovascular risk—possibly have triglyceride concentrations during the day that could increase their cardiovascular risk.

Many factors, both genetic and environmental [9], can explain the diversity in the postprandial state. We evaluated some of these factors (BMI, blood glucose control, type of therapy) but did not find any difference. Thus there could be other components worth investigating to try to identify patients with normal fasting triglyceride values who will respond abnormally to meals.

In conclusion, most Type 2 diabetic patients during their everyday life have postprandial triglyceride concentrations above 2.25 mmol/l and this finding is not confined to a few hours after meals, but lasts many hours.

Moreover, optimal triglyceride values at fasting are not always a good predictor of acceptable postprandial triglyceride concentrations. Indeed, many of these patients have triglyceride concentrations above 2.25 mmol/l during their postprandial phase.

Acknowledgements. Accutrend and triglyceride strips were supplied by Roche diagnostics. This work was supported in part by funds from the Italian Ministry of Health (ICS 110.1/RF 98.97).

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