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Lipid characteristics and malondialdehyde level in the sera of obese people

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Summary: In the blood sera of 70 obese persons (26 men, 44 women) some lipid components and malondialdehyde (MDA) level were determined before slimming. The people were classified into groups of hyperlipoproteinaemia on the basis of laboratory results, according to Fredrickson and Lees.

In 32 people with high blood cholesterol level (above 5.7 mmol) there were negative correlations between MDA and high-density lipoprotein (HDL) fractions. Correlation coefficients were the greatest in the group IIa of hyperlipoproteinaemia (HDL-C. $r = -0.74$; HDL-2-C. $r = -0.54$; HDL-3-C. $r = -0.78$). Correlations were not found in subjects with a normal cholesterol level.

The results were attributed to the formation of oxidized cholesterol products, caused by lipid peroxidation, which may decrease the HDL synthesis. It seems that in hypercholesterolaemia coupled with obesity, lipid peroxidation can contribute to the reduction in HDL levels, which is an important protective factor against cardiovascular diseases.

Zusammenfassung: Bei 70 fettsüchtigen Personen (26 Männer, 44 Frauen) wurden im Blutserum einige Lipidkomponenten und der Gehalt an Malondialdehyd (MDA) vor ihrer Abmagerungskur bestimmt. Aufgrund der klinischen Laborbefunde waren diese Patienten bei der Gruppe der Personen mit Hyperlipoproteinämie einzuordnen (Einteilung nach Fredricksson und Lees).

Bei 32 Personen war der Blutcholesteringehalt hoch (über 5,7 mmol/l), es bestand eine negative Korrelation zwischen MDA und hochdichten Lipoproteinfraktionen (HDL). Der größte Korrelationskoeffizient wurde in der Gruppe II/a bei Hyperlipoproteinämie festgestellt (HDL-C, $r = -0{,}74$; HDL-2-C, $r = -0{,}54$; HDL-3-C, $r = -0{,}78$). Bei Personen mit normalem Serumcholesteringehalt konnte keine Korrelation nachgewiesen werden.

Die Ergebnisse werden mit den durch Lipidperoxidation oxidierten Cholesterinderivaten, welche die HDL-Synthese mindern, erklärt. Es scheint, daß bei Hypercholesterinämie der Fettsüchtigen die Lipidperoxidation beim Rückgang des HDL-Wertes eine bedeutende Rolle spielt und damit also einen wichtigen Schutz gegen kardiovaskuläre Erkrankungen bildet.

Key words: lipid peroxidation, high-density-lipoproteins, obesity, oxidized cholesterol, hypercholesterolaemia

Introduction

Lipid peroxidation and the presence of its precursors, the free radicals, may damage the membrane proteins of living tissues, and these alterations could play a role in the development of aging processes, atherosclerosis or even cardiac infarcts (3, 11, 14). Gryglewski (9) proposed a mechanism to explain the effect of lipid peroxidation on atherogenic processes. However, very little data are available about the possible interaction between the peroxidation reactions and lipid characteristics acting as risk factors in cardiovascular lesions.

Our aim was to carry out observations on obese people in order to determine the relationship between some lipid components and the malondialdehyde (MDA) level in the blood. MDA as a degradation product was chosen to characterize the extent of lipid peroxidation. Obesity, in most cases resulting from improper nutrition and lifestyle, can be a risk factor in the development of cardiovascular diseases, too.

Experimental conditions and methods

70 obese persons (26 men, 44 women) were chosen for the experiment, who applied for a slimming diet. Their age ranged between 20 and 60 years. The observation took place before the diet in the Municipal Hospital of "Tétényi út".

Anthropometric status was evaluated according to the classical Broca-Index. Blood pressure was also measured. Cholesterol was determined by the Gödecke-test (7) and triglycerides by the enzymatic test of Boehringer (2) HDL-C was determined in the blood sera by the Gödecke-test (7) after precipitation with phospho-tungstenic acid and magnesium chloride after Lopez et al. (10). For the evaluation of HDL-3-C, a precipitation with dextranesulphate (6) was used, followed by the same test. HDL-2-C was calculated as the difference of the two results.

MDA was assayed in the blood sera after an ascorbic acid induction after Ohkawa et al. (12).

Uric acid determination in blood sera was carried out by the Peridochrom enzymatic, colorimetric test (1).

Results

From Table 1 it can be seen that, based on the classical Broca-Index, a 20% average surplus of body weight was found in men, and 39% in women, which clearly verifies the fact of obesity in the group.

The average blood pressure values were moderately elevated. In some cases we measured high values, e.g. 220/130 mm.

Table 1. Anthropometric status of subjects.

Number of subjects		Body weight (average) (kg)	Height (cm)	Body weight surplus (%) (Broca-Index)	Blood pressure	
					systolic	diastolic
Total	70	90.3	170.0	+29	144 ± 22	92 ± 13
Female	44	89.4	164.2	+39	142 ± 21	90 ± 11
Male	26	91.1	175.6	+20	146 ± 24	94 ± 16

Table 2. Lipid characteristics, MDA and uric acid level in the sera of examined subjects.

Number of subjects		Triglycerides (mmol/l)	Total cholesterol (mmol/l)	HDL-C (mmol/l)	HDL-2-C (mmol/l)	HDL-3-C (mmol/l)	MDA (nmol/l)	Uric acid (μmol/l)
Total	70	2.38 ± 2.1	6.15 ± 1.7	0.96 ± 0.47	0.53 ± 0.34	0.43 ± 0.21	43.1 ± 17	328 ± 87
Female	44	1.76 ± 0.94	6.17 ± 1.4	1.02 ± 0.45	0.62 ± 0.43	0.44 ± 0.20	43.4 ± 15	327 ± 96,
Male	26	3.11 ± 2.6	6.14 ± 2.0	0.85 ± 0.47	0.45 ± 0.30	0.42 ± 0.24	42.9 ± 21	348 ± 88

Table 3. Lipid characteristics and MDA result classified by the type of hyperlipoproteinaemia.

Type of hyperlipoproteinaemia		Number of people	Triglycerides (mmol/l)	Total cholesterol (mmol/l)	HDL-C (mmol/l)	HDL-2-C (mmol/l)	HDL-3-C (mmol/l)	MDA (nmol/l)
Chol. −, TG −	normal cases	32	1.47 ± 0.52	5.05 ± 0.5	0.99 ± 0.40	0.57 ± 0.34	0.44 ± 0.20	43.8 ± 17.9
Chol. +, TG −	IIa	21	1.64 ± 0.56	6.89 ± 1.03	0.93 ± 0.58	0.48 ± 0.36	0.43 ± 0.27	41.2 ± 14.2
Chol. −, TG −	IV	2	3.05	5.31	1.19	0.69	0.49	62.7
Chol. +, TG +	IIb	12	5.71 ± 2.65	8.44 ± 1.85	0.86 ± 0.49	0.49 ± 0.34	0.37 ± 0.17	46.1 ± 19.6

Table 2 shows the lipid components and MDA levels in blood sera. It is well-known that the levels of high-density lipoprotein (HDL) and its fractions show a negative relationship with the frequency of cardiovascular lesions. The average triglyceride content was higher in the examined men than in women, and in the male group it slightly exceeded the tolerated upper limit (2.7 mmol/l). The total cholesterol level did not show sex-related differences but the average value was moderately above the tolerated upper limit (5.7 mmol/l). The figures for HDL and its fractions were near to the lower limit of normal range. Regarding the HDL-C and HDL-2-C, as regular, we found higher concentrations in women than in men. There were no sex-related differences in MDA levels. Average values of uric acid reached the upper limit of the normal range, which may refer to the disturbance of lipid metabolism. Uricaemia may occur in type IV hyperlipoproteinaemia.

Based on the laboratory results (cholesterol and triglyceride), the obese people were classified according to the types of hyperlipoproteinaemia, after Frederickson and Lees (5). One half of the obese persons had no hyperlipoproteinaemia (Table 3). In the Type IIa classification of hyperlipoproteinaemia an elevated number of people were found. Twelve people belonged to Type IIb, where values were high both for cholesterol and for triglycerides. The values of lipid components appeared as expected. Type IV and IIb people had the highest MDA levels, but for this product there was no significant difference between the groups.

Table 4 shows significant correlations between serum MDA levels and HDL fractions. The results from people having normolipoproteinaemia showed no correlations. In Type IIa, we found the highest negative correlations, especially for total HDL-C and HDL-3-C levels. Including all the 32 persons with a high blood cholesterol level in our calculations, we also found strong correlations. It can be concluded that only at a high blood serum cholesterol level were negative correlations between MDA and HDL fractions found.

Table 4. Significant correlations between HDL-fractions and MDA levels in blood sera.

Groups			Number of people	HDL-C	HDL-2-C	HDL-3-C
Total			65	$r = -0.42$ $p < 0.1\,\%$	$r = -0.23$ $p = 5\,\%$	$r = -0.52$ $p < 0.1\,\%$
Chol.	+	IIa	21	$r = -0.74$ $p < 0.1\,\%$	$r = -0.54$ $p < 2\,\%$	$r = -0.78$ $p < 0.1\,\%$
TG	−					
Chol.	+	IIb	12	$r = -0.63$ $p < 5\,\%$	$r = -0.57$ $p = 5\,\%$	$r = -0.66$ $p < 2\,\%$
TG	+					
Chol.	> 5.7 mmol/l		32	$r = -0.67$ $p < 0.1\,\%$	$r = -0.52$ $p < 0.2\,\%$	$r = -0.70$ $p < 0.1\,\%$

Discussion

As the formation of MDA also presumes the presence of polyunsaturated fatty acids (PUFA), we found some contradictory data about the effect of PUFA on HDL (14), but the majority of the results showed an HDL-decreasing tendency. Tall and Small (16) proposed a mechanism which supposed that diets rich in PUFA-containing fats produce a bigger chylomicrone diameter, and this phenomenon is a rate-limiting step in the enzymatic pathway of HDL synthesis.

Our results on the negative correlations between MDA and HDL-fractions lead us to the hypothesis that cholesterol oxidation products, caused by lipid peroxidation (3), may also be responsible for the decreased level of HDL fractions. Peng and Taylor (13) proved that 25-hydroxy-cholesterol can build, only to a small extent, into the transitory HDL discs, which is a rate-limiting step during the HDL synthesis. We presume that the apparent high cholesterol level, measured by the Gödecke-test, cannot exclude the oxidized products. Cholesterol alpha-oxide was first isolated in human serum by Gray et al. (8).

On the other hand, cholesterol peroxides (4) might also damage the membranes of chylomicrones, so hindering the activity of lipoprotein lipase.

Our results reflect to the role of lipid peroxidation in the decreased level of HDL fractions in people suffering from obesity and in the disturbance of lipid metabolism. The protecting role of HDL fractions against cardiovascular diseases is well known. The hypothesis should be confirmed by the isolation of oxidized cholesterol products in obese people with a high blood cholesterol level.

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