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Originalarbeiten

Changes of some lipid and lipid peroxidation characteristics in obese people as a result of a low energy diet

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Summary: In blood samples of 54 obese persons (13 men, 41 women) some lipid components, malondialdehyde (MDA), and the activities of free radical protecting enzymes superoxide-dismutase (SOD) and glutathione-peroxidase (GSH_{px}), were determined before and after a seven-day slimming diet of 2.1 MJ/day.

Body weight, triglycerides, HDL-cholesterol, and HDL-3-cholesterol all decreased, total cholesterol increased after the seven days hospitalization. After continuing the slimming diet (5.0–6.3 MJ/day) at home, HDL-2-cholesterol increased and total cholesterol returned to the initial value after three months.

MDA decreased in the groups of hyperlipoproteinemia II/a and II/b and also in the group with high cholesterol and triglyceride levels (above 5.7 and 2.7 mmol/l). Correlation coefficients refer to the dominant role of high TG in the intensity of lipid peroxidation.

The activity of SOD fell after the slimming, independent of lipid parameters. GSH_{px} activity remained unchanged except a drop in the male participants having high cholesterol levels. The behavior of the free radical protecting enzymes needs further examination.

Zusammenfassung: Es wurden vor und nach einer 7tägigen Entfettungskur (2,1 MJ/Tag) von 54 Fettsüchtigen stammende Blutproben auf einige Lipidkomponenten (Malondialdehyd [MDA] und die Aktivität der vor freien Radikalen schützenden Enzyme Superoxid-Dismutase [SOD] und Glutathionperoxidase [GSH_{px}]) untersucht.

Nach 7tägiger Krankenhausbehandlung wurde eine Erniedrigung des Körpergewichts, der Triglyceride, des HDL-Cholesterin- und des HDL-3-Cholesterins sowie eine Zunahme von Gesamtcholesterin festgestellt. Nach einer zu Hause fortgesetzten drei Monate dauernden Kur (5,0–6,3 MJ) wurde eine Zunahme von HDL-2-Cholesterin und ein Rückgang von Gesamtcholesterin auf den Ausgangswert beobachtet.

Bei an Hyperlipoproteinämie leidenden Vpn. und auch bei denen, die einen erhöhten Cholesterin- und Triglyceridgehalt aufwiesen, wurde eine höhere MDA-Konzentration festgestellt.

Nach der Entfettungskur, unabhängig von den Lipiden, fällt die SOD-Aktivität. Die GSH_{px}-Aktivität ist unverändert, ausgenommen bei Männern mit hohem Cholesterinniveau.

Weitere Untersuchungen über die vor freien Radikalen schützenden Enzyme sind erforderlich.

Key words: lipid peroxidation; obesity; hyperlipoproteinemia; superoxide-dismutase; glutathione-peroxidase

Schlüsselwörter: Lipidperoxidation; Übergewicht; Hyperlipoproteinämie; Superoxiddismutase; Glutathion-Peroxidase

Introduction

Obesity is a well-known risk factor in cardiovascular disease. Our group recently pointed out that lipid peroxidation also has an unfavorable effect on the lipid metabolism in obese people (2).

In the 4th Department of Internal Medicine of the Tétényi hospital, since 1983 obese people have been admitted with coronary risk factors and hyperlipoproteinemia; they underwent a slimming diet of 2.1 MJ/day combined with full examination and multifactorial intervention. The average body weight loss for 2500 patients was 3.8 kg after one week. This result gives a positive motivation to the patients. The principle of the hospitalization was to prepare the patients after one week for a long-term diet.

The changes of lipid parameters were checked in our patients from time to time. As a second step of our earlier experiment we decided to examine other blood components of the patients referring to the lipid peroxidation. Only few data are available about the effect of slimming treatment on the lipid peroxidation in vivo (6).

Experimental Conditions and Methods

Fifty-four obese people (13 men, 41 women) were chosen for the experiment. Their ages ranged from 20 to 60 years. The patients received a diet of 2.1 day MJ for a week in the hospital. The diet contained 50 g protein originating mainly from meat, horse mackerel, mushrooms, and also fruits and vegetables rich in dietary fiber. The diet was supplemented with small amounts of vegetable oil, milk products free of fat, and wheat bran for moderating the appetite.

Before and after the slimming treatment body weight was measured and the other examinations were carried out. Cholesterol was determined by the Gödecke test (5) and triglycerides by the enzymatic test of Boehringer (1). HDL-C was determined in the blood sera by the Gödecke test (5) after precipitation with phosphotungstic acid and magnesium chloride after Lopez at al. (7). For the evaluation of HDL-3-C, a precipitation with dextrane sulphate (4) was used followed by the same test. HDL-2-C was calculated as the difference of the two results.

Malondialdehyde (MDA) was assayed in the blood sera after an ascorbic acid induction after Ohkawa et al. (12). From the free radical protecting enzymes superoxide dismutase (SOD) was determined by the inhibition of the adrenaline oxidation (13). The activity of glutathione-peroxidase (GSH_{px}) was evaluated by the measurement of the reduced glutathione (10).

After discharge from the hospital the testsubjects were instructed to follow a diet adapted to their personal characteristics, but generally containing 5.0–6.3 MJ, 40–50 g fat and 120 g carbohydrate daily. Three months later they were called back and those who lost or maintained their body weight were checked by biochemical examinations.

Table 1. Laboratory results from the blood samples in the hospitalization period; 1 = initial state; 2 = after seven days slimming.

		Males n = 13		Females n = 41		Total n = 54	
Bodyweight	1	101.5 ± 20.7	$p < 0.05\,\%$	93.6 ± 20.3	$p < 0.05\,\%$	95.5 ± 21	$p < 0.05\,\%$
kg	2	97.1 ± 19.8		89.3 ± 19.0		91.2 ± 19	
Cholesterol	1	6.38 ± 1.22		5.50 ± 0.94		5.71 ± 1.07	$p < 5\,\%$
mmol/l	2	6.71 ± 1.10		5.75 ± 1.01		5.99 ± 1.11	
HDL-C	1	0.99 ± 0.28		1.24 ± 0.35	$p < 0.1\,\%$	1.18 ± 0.35	$p < 0.1\,\%$
mmol/l	2	0.961 ± 0.27		1.09 ± 0.31		1.06 ± 0.31	
HDL-2-C	1	0.453 ± 0.13		0.507 ± 0.11		0.494 ± 0.12	
mmol/l	2	0.471 ± 0.14		0.483 ± 0.12		0.480 ± 0.12	
HDL-3-C	1	0.541 ± 2.26		0.737 ± 0.35	$p < 0.5\,\%$	0.690 ± 0.34	$p < 1\,\%$
mmol/l	2	0.490 ± 0.28		0.623 ± 0.33		0.591 ± 0,32	
TG	1	4.65 ± 4.43	$p < 2.5\,\%$	1.47 ± 0.65	$p < 2.5\,\%$	2.23 ± 2.58	$p < 0.5\,\%$
mmol/l	2	2.11 ± 1.43		1.22 ± 0.48		1.44 ± 0.88	
MDA	1	84.1 ± 53.2		58.3 ± 41.4		64.5 ± 45.3	$p < 2.5\,\%$
mmol/l	2	61.6 ± 38.7		47.7 ± 33.6		51.1 ± 35	
SOD	1	87.1 ± 14.7	$p < 0.05\,\%$	61.7 ± 22.6	$p < 0.05\,\%$	67.8 ± 23.5	$p < 0.05\,\%$
E/mg prot.	2	52.6 ± 22.5		42.8 ± 20.2		45.2 ± 21.0	
GSH_{px}	1	7.71 ± 1.4	$p < 2.5\,\%$	5.66 ± 2.9		6.16 ± 2.8	
E/mg prot.	2	5.03 ± 2.8		5.47 ± 2.3		5.37 ± 2.4	

Table 2. Malondialdehyde levels (mmol/l) in the types of hyperlipoproteinemia (mmol/l); 1 = initial state; 2 = after seven days slimming.

		Males		Females		Total	
Total	1	84.1 ± 53.2		58.3 ± 41.4		64.5 ± 45.3	p < 2.5 %
	2	61.6 ± 38.7 n = 13		47.7 ± 33.6 n = 41		51.1 ± 35 n = 54	
II/b							
Chol > 5.7 TG > 2.7	1	111 ± 60	p < 5 %	–		111 ± 60	p < 5 %
	2	63.0 ± 47 n = 7				63.0 ± 47 n = 7	
Chol < 5.7 TG < 2.7	1	47.8 ± 19		48.5 ± 37		48.3 ± 34.6	
	2	53.8 ± 18 n = 4		38.3 ± 19.6 n = 20		40.2 ± 19.7 n = 24	
II/a							
Chol > 5.7 TG < 2.7	1	61.4		70.6 ± 44.9	p < 1 %	69.7 ± 42.7	p < 2.5 %
	2	64.0 n = 2		57.5 ± 42.1 n = 19		56.9 ± 33.3 n = 21	
Chol > 5.7	1	100.2 ± 56	p < 2.5 %	70.6 ± 44.9	p < 1 %	80.1 ± 50,0	p < 0.2 %
	2	64.0 ± 43 n = 9		57.5 ± 41.1 n = 19		59.7 ± 41.9 n = 28	
TG > 2.7	1	111 ± 59.7	p < 5 %	40.4		95.5 ± 61	p < 5 %
	2	63.0 ± 47 n = 7		29.3 n = 2		55.5 ± 43.3 n = 9	

Table 3. Superoxide-dismutase (SOD) activities (E/mg prot.) in the type of hyperlipoproteinaemia; 1 = initial state; 2 = after seven days slimming.

		Males		Females		Total	
Total	1	87.1 ± 14.7	$p < 0.05\,\%$	61.7 ± 22.6	$p < 0.05\,\%$	67.9 ± 23.5	$p < 0.05\,\%$
	2	52.6 ± 22.5 n = 13		42.9 ± 20.2 n = 41		45.2 ± 21.0 n = 54	
II/b							
Chol > 5.7 TG > 2.7	1	89.0 ± 18.5	$p < 0.1\,\%$	–		89,0 ± 18,5	$p < 0.1\,\%$
	2	46.1 ± 23.2 n = 7				46.1 ± 23.2 n = 7	
Chol < 5.7 TG < 2.7	1	85.0 ± 36.0		63.5 ± 17.5	$p < 0.1\,\%$	67.1 ± 18.0	$p < 0.1\,\%$
	2	53.1 ± 36.0 n = 4		46.1 ± 19.6 n = 20		47.0 ± 21.2 n = 24	
II/a							
Chol > 5.7 TG < 2.7	1	84.5		58.5 ± 27.5	$p < 0.1\,\%$	61.0 ± 27.7	$p < 0.1\,\%$
	2	54.7 n = 2		39.4 ± 20.9 n = 19		43.4 ± 21.4 n = 21	
Chol > 5.7	1	88.0 ± 17.8	$p < 0.05\,\%$	58.5 ± 39.4	$p < 0.1\,\%$	68.0 ± 28,2	$p < 0.05\,\%$
	2	52.4 ± 19.8 n = 9		39.4 ± 20.9 n = 19		43.7 ± 21.1 n = 28	
TG > 2.7	1	89.0 ± 18.5	$p < 0.1\,\%$	74.5		85.8 ± 18.3	$p < 0.05\,\%$
	2	46.1 ± 23.2 n = 7		28.7 n = 2		41.8 ± 20.3 n = 9	

Results

From Table 1 it can be observed that already after one week favorable antiatherogenic changes occurred in three parameters. Body weight (average loss of 4.3 kgs), serum triglycerides (TG), and MDA, the characteristic metabolite of lipid peroxidation were significantly reduced.

Superoxide dismutase (SOD) decreased significantly both in men and women, glutathione peroxidase (GSH_{px}) only in the male group.

As for cholesterol level and lipoprotein fractions, we had to face some unfavorable results. The increase of serum cholesterol is only marginal, but the HDL-C, HDL-3-C level decreased significantly. It is a favorable fact that HDL-2-C subfraction, responsible for the antiatherogenic effect was unchanged in both sexes.

Based on the laboratory results, the obese people were classified according to the types of hyperlipoproteinemia after Frederickson and Lees (3). Table 2 shows that MDA decreased in the groups of hyperlipoproteinemia II/a and II/b and also in the groups with abnormally high cholesterol and triglyceride level (above 5.7 and 2.7 mmol/l). In people with normolipoproteinemia there was no change in MDA concentration of blood sera.

As a result of one week's slimming the significant decrease in the activity of SOD was independent of the cholesterol and triglyceride level in blood (Table 3). However, the drop of GSH_{px} activities was distinct in males with a high cholesterol level in blood.

We had the possibility to compare the laboratory data of 17 people after three months slimming with that of the hospitalization period (Table 5). Unexpectedly the MDA levels were much higher after three months than in the initial state. Triglyceride values also raised from the treatment in hospital but they were much less than at the initial state. Cholesterol values significantly decreased during the slimming at home and attained the initial values. Total HDL-cholesterol did not show any changes after three months but in the distribution of fractions the ratio of HDL-2-cholesterol increased at the cost of HDL-3-cholesterol.

Discussion

The comparison of the changes in biochemical parameters is difficult between the various slimming treatments because of the different energy

Table 4. Glutathione-peroxidase (GSH_{px}) activities (E/mg prot.) in the sera of high cholesterol level; 1 = initial state; 2 = after seven days slimming.

		Males		Females	Total
Total	1	7.71 ± 1.47	$p < 2.5\,\%$	5.67 ± 3.0	6.16 ± 2.8
	2	5.04 ± 2.8		5.48 ± 2.4	5.37 ± 2.5
		n = 13		n = 41	n = 54
Chol > 5.7	1	7.80 ± 1.4	$p < 0.1\,\%$	5.85 ± 2.6	6.47 ± 2.4
	2	4.89 ± 3.1		5.13 ± 2.7	5.05 ± 2.8
		n = 9		n = 19	n = 28

Table 5. Comparison of the laboratory data gained in different stages of slimming treatment; 1 = initial state; 2 = after seven days slimming; 3 = after three months; blood sera of eight men and nine women (n = 17).

Malondialdehyde mmol/l	1	81.6 ± 38.4	p < 0.05 %
	2	61.7 ± 41.7	
	3	39.2 ± 31.7	
Triglycerides TG mmol/l	1	2.86 ± 2.86	p < 2.5 %
	2	1.76 ± 1.23	
	3	2.17 ± 1.43	
Cholesterol mmol/l	1	5.9 ± 1.66	p < 5 %
	2	6.51 ± 1.65	
	3	5.93 ± 1.19	
HDL-C mmol/l	1	1.24 ± 0.55	p < 5 %
	2	1.13 ± 0.45	
	3	1.14 ± 0.34	
HDL-2-C mmol/l	1	0.50 ± 0.11	p < 0.05 %
	2	0.48 ± 0.13	
	3	0.66 ± 0.13	
HDL-3-C mmol/l	1	0.70 ± 0.49	p < 1 %
	2	0.64 ± 0.49	
	3	0.47 ± 0.32	

values and periods. A general phenomenon is the decrease of triglycerides and cholesterol in blood sera and the increase of HDL (8, 9). The explanation of our higher cholesterol levels after seven days could be a change of the cholesterol streaming out of the big pools from the digestive system to the sera.

Table 6. Correlations with malondialdehyde depending on the type of cholesterol and triglyceride level in the sera; 1 = initial state; 2 = after seven days slimming.

		Triglycerides			Cholesterol		
		r	n	p %	r	n	p %
Total	1	0.49	54	< 0.1	0.45	54	< 0.1
Chol < 5.7 TG < 2.7	1 2				0.43	24	< 5
II/a							
Chol > 5.7 TG < 2.7	1 2	0.42	21	< 2			
Chol > 5.7	1 2	0.54	28	< 1			
TG > 2.7	1 2	0.80	9	< 0.1			

In order to find an explanation of the results referring to lipid peroxidation we calculated the significant correlations between MDA and the level of triglycerides and cholesterol respectively (Table 6), compared with the data of Table 2. It seems that both triglycerides and cholesterol are involved in the extent of lipid peroxidation reactions. In higher TG concentration blood lipid may be rather a precursor of MDA synthesis, but in other cases cholesterol peroxides could be formed (2) which are also responsible for producing MDA.

Only few data are available dealing with the free radical defending enzymes during slimming. Koizumi et al. (6) reported the increase of catalase activity after a low energy diet. The loss of activity of SOD could be attributed either to the decreased requirement to exert a defending effect or to the lower protein intake. But the exhaustion of the defending system could be also taken into account as the activity of GSH_{px} lowered in sera with high cholesterol level potentially active in lipid peroxidation. Further experiments are needed to explain these changes.

Concluding our results, besides the favorable effect of seven days slimming on some lipid parameters, the intensity of the lipid peroxidation significantly decreased, meaning that the cardiovascular risk factor originating from this reaction (11) favorably changed during this short-term period. After leaving the hospital the intensity of lipid peroxidation again increased, which calls for investigation of this reaction under well-controlled conditions in a long-term slimming cure.

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