

LIPID METABOLISM IN DIABETIC PATIENTS WITH AND WITHOUT BLOOD PRESSURE INCREASE

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As well known, in certain aspects uncontrolled diabetes mellitus resembles a fasting state — fatty acids oxidation within the tissues is intensified whereas the oxidation of carbohydrates is decreased, mobilization of free fatty acids from the adipose tissue is enhanced and, not infrequently, the blood triglyceride level is higher (3). Considerable changes in lipid metabolism are likewise observed in atherosclerosis (1, 2)

Diabetes mellitus is distinguished for the speeded up development of atherosclerosis, and often it runs a course characterized by blood pressure increase; on the other hand, it is a well known fact that there is a definite interdependence between atherosclerosis and hypertension.

We set out to verify whether or not the increase of blood pressure exerts effect on lipid metabolism and lipoprotein-lipase activity in diabetes mellitus.

Material and Methods

Studies were performed on a series including 38 patients with diabetes mellitus (16 with increased and 22 without increased blood pressure), 45 hypertensive patients (12 of them, all males, with I degree, and 33 with III degree of the disease according to Lang) and 17 practically healthy normotensive subjects. The diabetics without blood pressure increase were aged 23—67 years or 49 years in the average, diabetics with blood pressure increase — 22 to 70, average 50 years, patients with I degree hypertension according to Lang — from 19 to 22 years, average 19.5, patients with III degree hypertension according to Lang — from 28 to 61 years, average 49, and the practically healthy persons — from 20 to 56 years, average 36 years. Patients were maintained on diets suitable for their affection.

The heparin test was performed according to the following schedule: in the morning, before meal, 150 mg heparin was administered through i. v. drip infusion of 500 ml physiologic saline over a period of four hours. Determination of blood sugar, serum lipids and endogenous heparin was made just prior to and immediately after the infusion. Blood sugar was determined after the method of Hagedorn-Jensen, cholesterol — after Ilko, total lipids — after Braggdon-Bloor, phospholipids — after Svanberg-Svannerholm, beta-lipoproteins — after Burnstein, non-esterified fatty acids — after Dancomb, heparin — according to Pipta and lipoprotein-lipase activity — according to Lucasik.

Results and Discussion

The results of our studies show that in diabetics without blood pressure increase, apart from the blood sugar content, the levels of cholesterol, total lipids, phospholipids, triglycerides, beta-lipoproteins and non-esterified fatty acids are also substantially higher, while the content of endogenous heparin is considerably lower compared with healthy persons. No difference worth noting in the activity of lipoprotein lipase is recorded (Table 1). An analogical relationship is established among diabetics with increased blood pressure (Table 2). No difference is established between the two groups of diabetic patients in terms of serum lipid fractions, endogenous heparin and lipoprotein-lipase activity (Table 2).

Table 1

Correlation between Blood Sugar and Serum Lipids in Diabetics without Hypertension and in Healthy Individuals

| | Diabetics without hyper- tension n=22 M \pm σ | Healthy indi- viduals n=17 M \pm σ | t | P |
|---|---|---|-------|-----------------|
| 1. Blood sugar in mg % | 231 \pm 82 | 105 \pm 14 | 11.55 | <0.001 |
| 2. Cholesterol in mg % | 271 \pm 54 | 223 \pm 37 | 6.9 | <0.001 |
| 3. Total lipids in mg % | 707 \pm 146 | 568 \pm 73 | 9.2 | <0.001 |
| 4. Phospholipids in mg % | 227 \pm 37 | 196 \pm 26 | 3.3 | \approx 0.001 |
| 5. Triglycerides in mg % | 204 \pm 109 | 153 \pm 44 | 3.0 | >0.01 |
| 6. Beta lipoproteins in F. E. | 60 \pm 19 | 40 \pm 11 | 9.0 | <0.001 |
| 7. Non-esterified fatty acids in μ M/ml | 0.72 \pm 0.2 | 0.52 \pm 0.1 | 3.3 | \approx 0.001 |
| 8. Lipoprotein-lipase in μ M/ml | 1.94 \pm 0.28 | 2.40 \pm 0.42 | 1.6 | >0.10 |
| 9. Heparin in U/ml | 7 \pm 2.4 | 9 \pm 0.61 | 8.6 | <0.001 |

Table 2

Correlation between Blood Sugar and Serum Lipids in Diabetics with and without Hypertension and in Healthy Individuals

| | Diabetics with hyper- tension n=16 M \pm σ | Diabetics without hyper- tension n=22 M \pm σ | t | P | Healthy indi- viduals n=17 M \pm σ | t | P |
|---|---|--|------|-------|---|------|--------|
| 1. Blood sugar in mg % | 203 \pm 55 | 231 \pm 82 | 2.1 | <0.05 | 105 \pm 14 | 10.9 | <0.001 |
| 2. Cholesterol in mg % | 287 \pm 60 | 271 \pm 54 | 0.88 | >0.10 | 223 \pm 37 | 6.7 | <0.001 |
| 3. Total lipids in mg % | 736 \pm 121 | 707 \pm 146 | 1.8 | <0.10 | 568 \pm 73 | 11.5 | <0.001 |
| 4. Phospholipids in mg % | 228 \pm 27 | 227 \pm 37 | 0.23 | >0.10 | 196 \pm 26 | 3.8 | >0.001 |
| 5. Triglycerides in mg % | 215 \pm 79 | 204 \pm 109 | 0.6 | >0.10 | 153 \pm 44 | 3.7 | >0.001 |
| 6. Beta-lipoproteins in F. E. | 64 \pm 16 | 60 \pm 19 | 1.33 | >0.10 | 40 \pm 11 | 8.8 | <0.001 |
| 7. Non-esterified fatty acids in μ M/ml | 0.72 \pm 0.2 | 0.72 \pm 0.2 | 0.10 | >0.10 | 0.52 \pm 0.1 | 2.8 | >0.01 |
| 8. Lipoprotein lipase in μ M/ml | 1.88 \pm 0.34 | 1.94 \pm 0.28 | 0.13 | >0.10 | 2.40 \pm 0.42 | 1.2 | >0.1 |
| 9. Heparin in U/ml | 7 \pm 2.2 | 7 \pm 2.4 | 1.2 | >0.10 | 9 \pm 0.61 | 7.4 | <0.001 |

Upon comparison of the content of lipid fractions, endogenous heparin and lipoprotein-lipase activity in diabetics without increase of the blood pressure, and in hypertensive patients, I and III degree according to Lang, it is demonstrated that the content of individual lipid fractions is considerably elevated, and the content of endogenous heparin and lipoprotein-

Table 3

Correlation between Blood Sugar and Serum Lipids in Diabetics without Hypertension and Patients with Hypertension, Stage I and III

| | Diabetics without hyperten- sion n=22 M±σ | Hyperten- sion I stage n=12 M±σ | t P | Hyperten- sion III stage n=33 M±σ | t P |
|---|---|--|--------------|---|--------------|
| 1. Blood sugar in mg % | 231 ± 82 | 66 ± 18 | 13.7 < 0.001 | 99 ± 37 | 11 < 0.001 |
| 2. Cholesterol in mg % | 271 ± 54 | 153 ± 32 | 11.8 < 0.001 | 244 ± 46 | 3 < 0.01 |
| 3. Total lipids in mg % | 707 ± 146 | 474 ± 89 | 8.6 < 0.001 | 579 ± 119 | 5.5 < 0.001 |
| 4. Phospholipids in mg % | 227 ± 37 | 163 ± 29 | 6.4 < 0.001 | 210 ± 35 | 1.9 ≈ 0.05 |
| 5. Triglycerides in mg % | 204 ± 109 | 158 ± 56 | 2.6 < 0.02 | 124 ± 73 | 4.44 < 0.001 |
| 6. β-lipoproteins in F. E. | 60 ± 19 | 39 ± 13 | 4.95 < 0.001 | 43 ± 16 | 5 < 0.001 |
| 7. Non-esterified fatty acids in μM/ml | 0.72 ± 0.2 | 0.44 ± 0.16 | 5.6 < 0.001 | 0.43 ± 0.25 | 6 < 0.001 |
| 8. Lipoprotein lipase in μM/ml | 1.94 ± 0.28 | 0.62 ± 0.5 | 4.3 < 0.001 | 0.51 ± 0.04 | 4.9 < 0.001 |
| 9. Heparin in U/ml | 7 ± 2.4 | 10 ± 6.6 | 4.5 < 0.001 | 5 ± 1 | 7 < 0.001 |

lipase activity are significantly lowered among the diabetic patients (Table 3). The same dependence is also established between the group of diabetic patients with increased blood pressure and the patients with hypertension, I and III degree (Table 4).

Table 4

Correlation between Blood Sugar and Serum Lipids in Diabetics with Hypertension and in Patients with Hypertension, Stage I and III

| | Diabetics with hyper- tension n=16 M±σ | Hyperten- sion stage I n=12 M±σ | t P | Hyperten- sion stage III n=33 M±σ | t P |
|---|--|--|--------------|---|--------------|
| 1. Blood sugar in mg % | 203 ± 55 | 66 ± 18 | 9.13 < 0.001 | 99 ± 37 | 10.4 < 0.001 |
| 2. Cholesterol in mg % | 287 ± 60 | 153 ± 32 | 7.4 < 0.001 | 244 ± 46 | 4.0 < 0.001 |
| 3. Total lipids in mg % | 736 ± 121 | 474 ± 89 | 6.7 < 0.001 | 579 ± 119 | 6.7 < 0.001 |
| 4. Phospholipids in mg % | 228 ± 27 | 163 ± 29 | 6.0 < 0.001 | 210 ± 35 | 2.25 < 0.05 |
| 5. Triglycerides in mg % | 215 ± 79 | 158 ± 56 | 2.89 < 0.02 | 124 ± 73 | 5.0 < 0.001 |
| 6. β-lipoproteins in F. E. | 64 ± 16 | 39 ± 13 | 4.46 < 0.001 | 43 ± 16 | 5.53 < 0.001 |
| 7. Non-esterified fatty acids in μM/ml | 0.72 ± 0.2 | 0.44 ± 0.16 | 4.00 < 0.001 | 0.43 ± 0.25 | 6.0 < 0.001 |
| 8. Lipoprotein lipase in μM/ml | 1.88 ± 0.34 | 0.62 ± 0.5 | 6.6 < 0.001 | 0.51 ± 0.04 | 4.0 < 0.001 |
| 9. Heparin in U/ml | 7 ± 2.2 | 10 ± 6.6 | 4.43 < 0.001 | 5 ± 1 | 6.5 < 0.001 |

In general outline, the studies performed on the lipid metabolism in diabetics fail to show any difference in the metabolism of lipids, dependent upon the degree of blood pressure, or in other words, the increase of blood pressure in diabetic patients has no repercussions whatsoever on the lipid fractions, endogenic heparin and lipoprotein-lipase activity, and any variations in lipid metabolism should be attributed primarily to the basic disease (Table 5).

Table 5

Heparin Effect on the Level of Blood Sugar and Serum Lipids in Diabetic Patients without Hypertension

| | Pre-heparin values n=22 M \pm s | Post-heparin values n=22 M \pm s | t P |
|---|--|---|--------------|
| 1. Blood sugar in mg % | 231 \pm 82 | 185 \pm 83 | 4.4 < 0.001 |
| 2. Cholesterol in mg % | 271 \pm 54 | 254 \pm 58 | 3.6 > 0.001 |
| 3. Total lipids in mg % | 707 \pm 146 | 639 \pm 129 | 6.0 < 0.001 |
| 4. Phospholipids in mg % | 227 \pm 37 | 227 \pm 37 | 0.75 > 0.10 |
| 5. Triglycerides in mg % | 204 \pm 109 | 159 \pm 109 | 3.4 > 0.001 |
| 6. β -lipoproteins in F. E. | 60 \pm 19 | 45 \pm 13 | 7.2 < 0.001 |
| 7. Non-esterified fatty acids in μ M/ml | 0.72 \pm 0.17 | 0.95 \pm 0.18 | 10.5 < 0.001 |
| 8. Lipoprotein lipase in μ M/ml | | 1.94 \pm 0.38 | |
| 9. Heparin in U/ml | 7 \pm 2 | 8 \pm 3 | 5.0 < 0.001 |

Table 6

Heparin Effect on Blood Sugar and Serum Lipids in Diabetics with Hypertension

| | Pre-heparin values n=16 M \pm s | Post-heparin values n=16 M \pm s | t P |
|--|--|---|--------------|
| 1. Blood sugar in mg % | 203 \pm 55 | 159 \pm 40 | 3.41 < 0.01 |
| 2. Cholesterol in mg % | 287 \pm 60 | 265 \pm 55 | 2.53 < 0.02 |
| 3. Total lipids in mg % | 736 \pm 121 | 678 \pm 120 | 5.27 < 0.001 |
| 4. Phospholipids in mg % | 228 \pm 27 | 215 \pm 27 | 2.20 > 0.05 |
| 5. Triglycerides in mg % | 215 \pm 79 | 192 \pm 94 | 2.15 < 0.05 |
| 6. β -lipoproteins in F. E. | 64 \pm 16 | 54 \pm 13 | 4.10 < 0.001 |
| 7. Non-esterified fatty acid in μ M/ml | 0.72 \pm 0.2 | 1.02 \pm 0.34 | 10 < 0.001 |
| 8. Lipoprotein lipase in μ M/ml | | 1.88 \pm 0.34 | |
| 9. Heparin in U/ml | 7 \pm 2.2 | 9 \pm 1.7 | 8.3 < 0.001 |

The latter circumstance, up to a certain degree, warrants the assumption that the increase of blood pressure, observed in some of the patients

with diabetes mellitus, by no means represents essential hypertension, or else, in this case it is not a matter of a combination between diabetes mellitus and hypertension, but rather of hypertension concomitant to diabetes mellitus which, in all likelihood, has its proper genesis, different from that of the hypertensive disease.

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ОБМЕН ЛИПИДОВ У ДИАБЕТИКОВ С И БЕЗ ПОВЫШЕННОГО КРОВЯНОГО ДАВЛЕНИЯ

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РЕЗЮМЕ

Липопротеинлипазная активность и влияние гепарина на уровень сахара в крови и липидов сыворотки крови исследованы у 38 больных сахарной болезнью (16 из них с повышенным и 22 без повышенного кровяного давления), 45 больных гипертонической болезнью и 17 практически здоровых лиц с нормотонией.

У диабетиков с и без гипертонии, в сравнении с больными гипертонической болезнью и здоровыми лицами устанавливается более высокое содержание не только сахара в крови, но и липидных фракций в сыворотке крови, а содержание эндогенного гепарина — более низкое.

Результаты исследования липидного обмена при диабете не показывает различия в метаболизме липидов, в зависимости от высоты артериального кровяного давления.