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The Influence of Glucose Loading on the Content of Free Fatty Acids in Blood of Patients with Cerebral Infarction and with Acute Transient Circulatory Cerebral Insufficiency

Wpływ obciążenia glukozą na zawartość wolnych kwasów tłuszczowych we krwi chorych z zawałem mózgu oraz ostrą przemijającą niewydolnością krążenia mózgowego

Fatty acids are important energetic substrates of cells. The release of energy takes place in the process of β-oxidation of fatty acids and, as a result of this, in breaking down of acetylcoenzyme A in Krebs cycle.

In physiological conditions, free fatty acids are transferred in the blood together with albumins, and only a few per cent of them with lipoproteins (6, 8). Quality and quantity of free fatty acids in plasma depends on the applied diet as well as on factors influencing lipolysis (2, 6, 8). Concentration of free fatty acids in blood increases in the period of starvation and they become the main energetic substrate then. Biosynthesis of fatty acids is controlled hormonally (glycocorticoids, glucagon, insulin, triiodothyronine). Short-chain and medium-chain fatty acids are produced as a result of hydrolysis of fats contained in food, while long-chain fatty acids come from adipose tissue (8).

Research carried out so far suggests that the content of free fatty acids in blood becomes disturbed in patients with atherosclerosis, diabetes mellitus, nephrotic syndrome, and hepatic cirrhosis. It was proved that in cerebral ischemic focii the concentration of free fatty acids increases (7). It was also proved that free fatty acid concentration in blood increases in acute period of cerebral infarcts (1—4).

Acetylcoenzyme A plays a principal part in the integration of carbohydrate, fat and protein metabolism in cells. It is a common metabolite in the process of glycolysis and lipolysis. Thus it appears that the transformations are interdependent to some extent (8).

The aim of this study is to determine the content of free fatty acids in blood of patients with cerebral ischaemic infarction and with acute, transient, circulatory cerebral insufficiency in fasting state and after intravenous glucose loading.

MATERIAL AND METHODS

The study was carried out on 22 patients with cerebral ischaemic infarction and 15 patients with acute transient circulatory cerebral insufficiency. Clinical diagnosis was based on generally accepted criteria. The group of patients with cerebral ischaemic infarction included 10 women and 12 men, aged from 48 to 87 years, average: 67 years.

The group of patients with acute transient circulatory cerebral insufficiency included 9 women and 6 men, aged from 56 to 82 years, average: 64 years. The control group included 10 patients (5 women and 5 men) with regressing symptoms of radicular syndromes without metabolic disturbances. The age of control group patients and the patients belonging to the investigated group was similar.

Concentration of free fatty acids in blood was determined by means of Doyle's colorimetric method (9). Blood samples have been collected on the 1st, 3rd, 7th and 14th day since the onset of the disease from patients in fasting state, and after intravenous loading of 60 ml 40% solution of glucose in 4th, 8th, 16th, 32nd and 64th min after glucose administration. As glycaemic profile of healthy people and patients with various forms of cerebrovascular diseases has been established for the above test in the Lublin Teaching Hospital of Neurology on the basis of numerous tests, investigations and examinations, it was not necessary this time to determine the concentration of glucose in blood at every particular interval of its loading.

All the patients were kept on the standard hospital diet. They were not administered any medication on the day the tests were to be performed. The patients with liver function disturbances or other metabolic abnormalities were excluded from the experiment.

Results obtained were analyzed statistically by means of Student's t test. The differences for which the value p was equal or less than 0.05 were considered to be statistically significant. The error of the method was equal to 7%.

RESULTS

Mean concentration of free fatty acids in blood of patients with cerebral infarcts on the 1st day of their disease in fasting state was 20% higher than their mean concentration in the control group, the difference being statistically significant ($p < 0.05$).

That day, glucose loading administered to patients with cerebral infarction decreased the content of free fatty acids in blood but to a lesser degree than in control group. In the 4th, 8th, 16th, 32nd, and 64th min of intravenous glucose loading the mean concentration of free fatty acids in patients of the investigated group was higher than the respective mean control values by 24, 28, 29, 28 and 28%. All the differences were statistically significant ($p < 0.05$).

In patients with acute transient circulatory cerebral insufficiency on the 1st day of their disease, the mean concentration of free fatty acids in fasting state was higher than their mean concentration in the control group by 9%. The difference was not statistically significant ($p > 0.05$). The patients loaded with glucose the same day showed the decrease of the content of free fatty acids in blood, but the decrease was smaller than in the control group. In the 4th, 8th, 16th, 32nd and 64th min, of intravenous glucose loading the mean concentration of free fatty acids turned out to be higher than the respective mean control values by 11, 13, 13, 15 and 13%. None of the differences was statistically significant ($p > 0.05$).

On the 1st day of disease, mean concentration of free fatty acids in blood of patients with cerebral ischaemic infarction was, in fasting state, 13% higher than the mean concentration in patients with acute transient circulatory cerebral insufficiency, but the difference was not statistically significant ($p > 0.05$).

In the 4th, 8th, 16th, 32nd and 64th min of intravenous glucose loading the concentration of free fatty acids in blood of patients with cerebral ischaemic infarction turned out to be higher than in patients with acute transient circulatory cerebral insufficiency respectively by 15, 19, 19, 20 and 19%. All the differences except the first one, were statistically significant ($p < 0.05$).

The 3rd day of clinical observation the patients with cerebral ischaemic infarction showed in fasting state the mean concentration of free fatty acids in blood higher than in control group by 20%, and the difference was statistically significant ($p < 0.05$). Intravenous glucose loading of the patients decreased the content of free fatty acids in blood. In the 4th, 8th, 16th, 32nd and 64th min of the glucose loading concentrations of free fatty acids in blood of patients with cerebral ischaemic infarction were higher than control values respectively by 28, 28, 24, 20, and 25%. The differences were statistically significant ($p < 0.05$).

In patients with acute transient circulatory cerebral insufficiency on the 3rd day of clinical observation, the mean concentration of free fatty acids measured in patients in fasting state was higher than the mean control value by 64%, and the difference turned out to be statistically insignificant ($p > 0.05$). Intravenous glucose loading decreased concentration of free fatty acids in patient blood. In the 4th, 8th, 16th, 32nd and 64th min of glucose loasing concentrations of free fatty acids in blood were higher than respective control values. The differences amounted to 10, 13, 12, 16 and 6%, and they were not statistically significant ($p > 0.05$).

Comparison of free fatty acid concentrations in blood of patients with cerebral infarction and with acute transient circulatory cerebral insufficiency showed significantly higher values in blood of patients with cerebral infarction both in fasting state and in glucose loading state. The differences in the respective concentrations of fatty acids during intravenous loading test in the 4th, 8th, 16th, 32nd and 64th min of the test amounted to 15, 20, 18, 14, 7 and 21%, all of them being statistically significant except the 7% one obtained in 32nd min.

On the 7th day of ischaemic cerebral infarction mean concentrations of free fatty acids in blood of patients in fasting state were 9% higher than mean values of control concentrations but the differences were not statistically significant ($p > 0.05$). Intravenous glucose loading decreased content of free fatty acids in blood of patients. In the 4th min after glucose loading the difference increased to 13%, and in the 8th min — to 16%. These differences were statistically significant. Changes of mean values of concentrations found in the 16th, 32nd, and 64th min of glucose loading test in comparison with respective mean control

values had the same direction and amounted respectively to 13, 15 and 14%, but the differences were not statistically significant.

Mean values of concentrations of free fatty acids in blood of patients with acute transient circulatory cerebral insufficiency on the 7th day of clinical observation obtained in fasting state and in glucose loading state are respectively higher than control concentrations by 7, 9, 10, 11, 13 and 1% maintaining the same direction of changes, and are respectively lower by 3, 5, 6, 3, 3 and 14% than mean concentrations of fatty acids found in patients with ischaemic cerebral infarction. None of the differences was statistically significant.

Concentrations of free fatty acids in blood of patients with ischaemic cerebral infarction and with acute transient circulatory cerebral insufficiency found on 14th day of clinical observation, both in fasting state and in glucose loading state, were only slightly higher than control concentrations but none of the changes was statistically significant ($p > 0.05$).

The highest values of standard deviation i.e. the highest variability of obtained results were found on the 1st day of the disease. Therefore, the hypothesis that the variability is connected with instability of diet before the onset of the disease as well as with the highest intensification of vegetative disorders in initial phase of the disease may be true.

DISCUSSION

The results of the testing exploration presented here indicate the increase of the concentration of free fatty acids in blood of patients with ischaemic cerebral infarction and with acute transient circulatory cerebral insufficiency both in fasting state and in glucose loading state in initial phase of the diseases.

Earlier investigations carried out in the Teaching Hospital of Neurology in Lublin showed that in patients with severe type of ischaemic cerebral infarction an activation of the axis: hypothalamus—hypophysis—adrenal glands occurs along with an increase of adrenaline secretion (2), which can lead to the release of fatty acids from fat cells and to the increase of concentration of free fatty acids in blood.

Experiments carried out in animals show that decomposition of phospholipids takes place within cerebral infarction focus which consequently leads to the increase of free fatty acid content in the area (7). As necrosis of cerebral tissue was associated with injury of the barrier: blood—brain, the anomaly can promote the transit of fatty acids from the focus of cerebral necrosis to blood. This proces can be partly responsible for the increase of the concentration of fatty acids in blood of patients with cerebral infarction in initial phase of the disease.

Blood of patients with acute transient circulatory cerebral insufficiency did not show any statistically significant increase of concentration of free fatty acids in initial phase of the disease.

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STRESZCZENIE

Oznaczono stężenie wolnych kwasów tłuszczowych we krwi 22 chorych z niedokrwiennym udarem mózgu oraz u 15 chorych z ostrą przemijającą niewydolnością krążenia mózgowego. Badania przeprowadzono w I, III, VII i XIV dobie obserwacji klinicznej, na czczo i po dożylnym obciążeniu 60 ml 40% roztworu glukozy. Stwierdzono statystycznie istotny wzrost stężenia wolnych kwasów tłuszczowych we krwi chorych z zawałem mózgu na czczo w najwcześniejszym okresie choroby. U chorych z niewydolnością krążenia mózgowego nie stwierdzono istotnego statystycznie wzrostu stężenia wolnych kwasów tłuszczowych we krwi. Dożylne obciążenie glukozą powodowało obniżenie stężenia wolnych kwasów tłuszczowych we krwi, najwyraźniejsze we wczesnym okresie zawału mózgu.