Lipid Metabolism in Urban Residents with Type 2 Diabetes and Cardiovascular Diseases

E A Sharlaeva1, I V Bobina1 and G G Sokolova1

1 Altai State University, 61 Lenina pr., Barnaul 656049 Russia
E-mail: sharlaeva1@mail.ru

Abstract. The paper studies the lipid and lipoprotein spectrum in blood serum from Barnaul residents suffering from type 2 diabetes mellitus (type 2 diabetes) and cardiovascular diseases (CVD). The authors examined 187 people (98 women and 89 men) with type 2 diabetes and CVD, aged 30-90. All subjects in the blood serum were tested for total cholesterol (TC), cholesterol of low-density lipoprotein (LDLC), very low-density lipoprotein cholesterol (VLDLC), high-density lipoprotein cholesterol (HDLC), and triglycerides (TG). The TC, LDLCl, VLDLC, HDLCl, and TG concentration were established on the Konelab automatic analyzer (manufactured by “Thermo Fisher Scientific Oy,” Finland). In the lipid spectrum of blood in women with CVD, the level of TC is above the reference values. A similar situation is observed with TG in the blood in patients with verified diabetes type 2 and CVD. The concentration of LDL cholesterol in the blood of women with cardiovascular pathologies exceeds the norm. The level of HDL cholesterol in men with type 2 diabetes, on the contrary, is below the reference values. There are significant differences in HDL cholesterol content in the blood between men and women with type 2 diabetes and cardiovascular diseases. Additionally, a significant difference in the level of TC and LDL-C is established in residents with both pathologies. Lipidogram indices are of prognostic value in CVD development in patients with type 2 diabetes and with cardiovascular pathologies.

Keywords: Type 2 diabetes ∙ Cardiovascular disease ∙ Ischemic heart disease

1. Introduction

Particular attention of the world medical community in the 21st century is paid to the growth of diabetes mellitus and the frequency of its serious consequences. According to the World diabetes federation, in 2010, there were about 9 million people with diabetes in Russia, of which 80%–90% are patients with type 2 diabetes. According to preliminary data, by 2025, the number of patients will reach 333 million [17].

The danger of type 2 diabetes is that it is increasingly diagnosed at the stage of micro- and macrovascular complications [23]. Type 2 diabetes is a serious risk factor for developing cardiovascular pathologies [8, 21]. With existing type 2 diabetes, the degree of occurrence of diseases of the cardiovascular system is 3–4 times higher than in its absence [1]. An increased risk of cardiovascular disorders in patients with type 2 diabetes is associated with high triglycerides, low content of high-density lipoproteins, and hyperproduction of low-density lipoproteins in the blood [15, 16].

Atherosclerosis is the most common cause of cardiovascular disease. As a result of atherosclerosis development, such serious cardiovascular pathologies as myocardial infarction, coronary heart disease, disturbance of peripheral and cerebral circulation, etc. can appear [1].
Studying changes in lipid metabolism will prevent the development of micro- and macrovascular complications in patients with type 2 diabetes and patients with cardiovascular diseases to prevent the occurrence of repeated relapses. It is necessary to use effective medications and follow an appropriate diet to reduce the risk of adverse outcomes from this pathology [14, 19].

The research aims to study the state of lipid metabolism in residents of the city of Barnaul with type 2 diabetes and cardiovascular diseases.

2. Materials and Methods
The results of a survey of 187 people were analyzed (98 women and 89 men aged 30–90 years). All examined patients were divided into three groups (group 1 – patients with type 2 diabetes mellitus; group 2 – with type 2 diabetes mellitus and cardiovascular diseases; group 3 – patients with diseases of the cardiovascular system). In the blood serum of the examined patients, we determined total cholesterol (TC), low-density lipoprotein cholesterol (LDLC), very low-density lipoprotein cholesterol (VLDLC), high-density lipoprotein cholesterol (HDLC), and triglycerides (TG). The laboratory studies were carried out based on the clinical diagnostic laboratory of the Altai regional cardiology dispensary using the automatic analyzer Konelab (manufactured by “Thermo Fisher Scientific Oy,” Finland).

3. Results and Discussion
Biochemical analysis of the blood of Barnaul residents showed that the level of total cholesterol in blood serum in women with cardiovascular diseases exceeded the norm. A similar situation was observed with TG’s content in the blood in patients of group 2 with both pathologies (table 1).

| Groups examined | The lipid metabolism parameters (mmol/l) |
|-----------------|-----------------------------------------|
|                 | TC       | LDLC    | VLDLC   | HDLC    | TG        |
| group one       |          |         |         |         |           |
| Total sample    | 4.48±0.42| 3.10±0.30| 0.65±0.09| 1.12±0.09| 1.42±0.19 |
| Women           | 5.06±0.53| 3.08±0.44| 0.65±0.08| 1.33±0.10*| 1.42±0.18 |
| Men             | 4.60±0.51| 3.13±0.42| 0.65±0.19| 0.81±0.05##| 1.43±0.41 |
| group two       |          |         |         |         |           |
| Total sample    | 4.46±0.22| 2.72±0.19| 0.52±0.12| 1.18±0.05 | 1.93±0.21 |
| Women           | 4.43±0.33| 2.63±0.27| 0.52±0.12| 1.24±0.08 | 1.84±0.35 |
| Men             | 4.50±0.31| 2.81±0.28| 0.63±0.16| 1.12±0.06 | 1.52±0.22 |
| group three     |          |         |         |         |           |
| Total sample    | 5.47±0.13^| 3.65±0.12^| 0.70±0.08| 1.23±0.05 | 1.81±0.11 |
| Women           | 5.67±0.16#| 3.81±0.15#| 0.74±0.13| 1.34±0.08*| 1.83±0.16 |
| Men             | 5.25±0.20| 3.47±0.18| 0.66±0.09| 1.11±0.04 | 1.68±0.15 |
| Norm            | 3–5.4    | 2.6–3.6  | no more 0.9| 0.7–2.0 | 0.45–1.86 |

Source: Compiled by the authors.

Table 1. Lipid metabolism in the examined men and women (M ± m).

The reason for the increase in TS in women of group 3 is a mild form of hypercholesterolemia (OXC content from 5.0 to 6.5 mmol/l). Hypercholesterolemia is associated with a decrease in the number of LDLC receptors in liver hepatocytes, as a result of which the content of total cholesterol in the blood...
increases [7]. The presence of hypercholesterolemia in patients with cardiovascular diseases indicates a less effective quality of these patients’ diagnosis and treatment.

According to the data obtained from residents of the city with verified type 2 diabetes mellitus and cardiovascular diseases (the second group), the level of TG in blood serum was higher than normal (1.93 mmol/l) (table 1). This is probably because, in most patients of this group, hypertriglyceridemia was observed against the background of the low sensitivity of visceral adipose tissue to the antilipolytic effect of insulin. This process led to an increase in lipolysis, a large amount of free fatty acids entering the portal bloodstream, and an increase in the synthesis of TG and VLDLC by the liver. The disruption of the catabolism of TG-rich lipoproteins occurs as a result of a decrease in the activity of lipoprotein lipase, hydrolysis of TG of chylomicrons and VLDLC, and the formation of fatty acids. Lipoprotein lipase activity decreases with untreated and poorly controlled type 2 diabetes mellitus [2, 13].

In the lipoprotein spectrum of blood in women of the third group with cardiovascular diseases, an increase in the concentration of LDLC in the blood serum was revealed relative to the reference values. In men of group 1 with type 2 diabetes mellitus, a decrease in HDLC cholesterol content was noted (table 1). A decrease in HDLC concentration in the serum in men with type 2 diabetes was noted with newly diagnosed or previously diagnosed with type 2 diabetes. At this time, patients were on complex therapy, including the use of insulin, oral glycemic drugs, and diet [5, 11]. Additionally, an increase in hepatic lipoprotein lipase activity and an acceleration of HDLC metabolism can serve as the reason for the low content of this indicator in the blood [22].

According to some authors, a decrease in HDLC in patients with type 2 diabetes is predictive in relation to morbidity and mortality due to coronary heart disease. Thus, a decrease in HDLC <0.9 mmol/l is accompanied by a fourfold increase in the risk of mortality from coronary heart disease [3, 10]. In our study, the level of HDLC in men of the first group was 0.81±0.05 mmol/l (table 1). Therefore, most patients with type 2 diabetes have a high risk of death from cardiovascular disease.

In women of groups 1 and 3, the level of HDLC in blood serum is significantly higher than in men: (1.33±0.10 mmol/l; 1.34±0.08 mmol/l – in women; 0.81±0.05 mmol/L; 1.11±0.04 mmol/l in men). In women of reproductive age, estrogens increase anti-atherogenic HDLC and lower the concentration of atherogenic fractions of LDLC and VLDLC [9]. Also, they favorably affect the cardiovascular system: they have a vasodilating effect, stimulate the synthesis of vascular nitrogen nitrite by endothelial cells, and have an antioxidant effect on the heart muscle [4]. Due to this, women before menopause have a significantly lower risk of developing coronary heart disease than men of the same age.

In most patients of the studied groups, the level of VLDLC, LDLC, HDLC, TC in the blood serum was normal (table 1). This means that they could achieve target lipid values through therapy, including the use of drugs that lower blood lipids. Today, statins are considered the most effective lipid-lowering drugs, the mechanism of action of which is to inhibit HMG-CoA reductase, a key enzyme in the synthesis of cholesterol in liver cells. A decrease in the formation of intracellular cholesterol leads to activation of hepatocyte surface receptors for the apoproteins B and E, which leads to an increase in the uptake of LDLC, VLDLC, HDLC, and their content in the blood [6, 12, 18, 20].

4. Conclusion

The study results on changes in the lipid and lipoprotein spectrum in the blood serum of patients with type 2 diabetes mellitus and cardiovascular diseases led to the following conclusions:

1. The level of VLDLC in the blood of the examined groups corresponded to reference values, while the concentration of TC, LDLC (in the blood of patients with cardiovascular diseases), and TG in the examined groups exceeded average values. In men with diabetes, the HDLC level in the blood was below 1.0 mmol/l (0.81±0.05 mmol/l).
2. The indicators of TC, LDLC, and TG in blood serum in Barnaul residents with cardiovascular diseases were slightly higher compared to other groups of patients.
3. The level of HDLC in men with type 2 diabetes mellitus and cardiovascular diseases was significantly lower than in women of the same groups. This means that the risk of developing cardiovascular disease in women with type 2 diabetes is lower than in men.

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