UDC: 616.12-005.4-056.256-078 **DOI: https://doi.org/10.20998/BMPP.2024.01.06**

N. Ryndina, P. Poteiko, V. Nemtsova, V. Berezniakov, H. Korchevska, S. Kravchuk
Educational and Scientific Medical Institute of the National Technical University "Kharkiv Polytechnic Institute", Kharkiv, Ukraine.

PECULIARITIES OF CARBOHYDRATE METABOLISM IN PATIENTS WITH ISOLATED CORONARY HEART DISEASE AND ABDOMINAL OBESITY COMORBIDITIES

Summary

Introduction. Treatment of cardiovascular diseases remains an urgent task of modern medicine due to their prevalence. Undoubtedly, recent decades have marked significant progress in the treatment of these diseases, in particular coronary artery disease (CAD). The presence of risk factors significantly affect the CAD. One of the common risk factors for CFD is obesity, the presence of which significantly affects the prognosis

Purpose of the study is to assess the state of carbohydrate metabolism in patients with isolated coronary artery disease and in the presence of comorbid abdominal obesity, as well as to analyze the peculiarities of the relationship between indicators of carbohydrate metabolism in patients with coronary artery disease with and without accompanying obesity.

Materials and methods. 135 patients with CAD (a form of CAD – stable angina pectoris II-II functional class) were studied. All patients with CAD were divided into 2 groups: 1 – patients with CAD and accompanying abdominal obesity (n = 100), 2 – patients with CAD without obesity (n = 35).

The results. Significantly higher values of glycemia, insulinemia, and HOMA index were found in patients with CAD and accompanying obesity compared to patients with isolated CAD. In patients with CAD and obesity, direct correlations were found between the level of glucose and insulin, index HOMA, and in patients without obesity the relationships become inverse.

Conclusions. In patients with a combined course of CAD and obesity high levels of the HOMA index were found, which indicates insulin resistance. Determining indicators of carbohydrate metabolism (glucose, insulin, index HOMA) is appropriate for timely diagnosis of insulin resistance and prescribing treatment for comorbid metabolic disorders.

Keywords: *coronary heart disease, obesity, comorbidity, insulin, insulin resistance.*

Н. Г. Риндіна, П. І. Потейко, В. Д. Немцова, В. І. Березняков, Г. І. Корчевська, С. Л. Кравчук
Навчально-науковий медичний інститут Національного технічного університету «Харківський політехнічний інститут», Харків, Україна.

УДК: 616.12-005.4-056.256-078

ОСОБЛИВОСТІ ВУГЛЕВОДНОГО ОБМІНУ У ХВОРИХ З ІЗОЛЬОВАНОЮ ІШЕМІЧНОЮ ХВОРОБОЮ СЕРЦЯ ТА ЗА КОМОРБІДНОСТІ ОЖИРІННЯ АБДОМІНАЛЬНОГО ТИПУ

Аннотація

Вступ. Наявність факторів ризику істотним чином впливають на перебіг ішемічної хвороби серця (ІХС). Одним із розповсюджених факторів ризику ІХС є ожиріння, наявність якого істотно впливає на прогноз.

Мета. Оцінити стан вуглеводного обміну у хворих із ізольованою ІХС та за наявності коморбідного абдомінального ожиріння, а також проаналізувати особливості взаємин між показниками вуглеводного обміну у хворих із ІХС із супутнім ожирінням і без нього.

Матеріали та методи. Досліджено 135 хворих на ІХС (форма ІХС – стабільна стенокардія ІІ–ІІ ФК). Всі хворі з ІХС були поділені на 2 групи: 1 – склали хворі з ІХС та супутнім ожирінням абдомінального типу (n = 100), 2 – склали хворі з ІХС без ожиріння (n = 35).

Отримані результати. У хворих із ІХС та супутнім ожирінням знайдено достовірно більш високі значення глікемії, інсулінемії та індекса HOMA порівняно з хворими з ізольованою ІХС. У хворих із ІХС та ожирінням знайдено прямі кореляційні зв'язки між рівнем глюкози та інсуліном, індексом HOMA, а у хворих без ожиріння зв'язки набувають зворотнього характера.

Висновки. У хворих із поєднаним перебігом ІХС та ожиріння знайдено високі рівні індексу HOMA, що свідчить про інсулінорезистентність. Визначення показників вуглеводного обміну (глюкози, інсуліну, індексу Нома) доцільно для своєчасної діагностики інсулінорезистентності та призначення лікування за коморбідності метаболічних порушень.

Ключові слова: *ішемічна хвороба серця, ожиріння, коморбідність, інсулін, інсулінорезистентність.*

Introduction. Treatment of cardiovascular diseases remains an urgent task of modern medicine due to their prevalence. Undoubtedly, recent decades have marked significant progress in the treatment of these diseases, in particular coronary artery disease (CAD). However, CAD remains the leading cause of mortality and disability in the world population [1]. The presence of risk factors significantly affect the course of CAD. One of the common risk factors for CAD is obesity [2]. Today, obesity is not just a widespread medical and social problem, but a problem that has reached pandemic proportions, because more than a third of the world's adult population suffers from obesity [3, 4]. Abdominal adipose tissue cells – adipokines – have the properties of an endocrine organ and are able to synthesize proatherogenic factors, proinflammatory cytokines, which leads to the launch of a cascade of mechanisms aimed the development of atherosclerotic damage to arteries, including coronary ones [2, 5]. On the other hand, the presence of obesity is a risk factor for carbohydrate metabolism disorders [6]. Unfortunately, in the practice of health care, this issue is often neglected, and an obese patient begins treatment for carbohydrate metabolism disorders at the stage of type 2 diabetes mellitus (DM). Of course, it is impossible to ignore the fact that before the diagnosis of type 2 DM is put, patients around 10 years had impaired carbohydrate metabolism [6].

Purpose of the study. The purpose of the study is to assess the state of carbohydrate metabolism in patients with isolated coronary artery disease and in the presence of comorbid obesity of the abdominal type, as well as to analyze the peculiarities of the relationship between indicators of carbohydratemetabolism in patients with coronary artery disease according to the presence or absence of concomitant obesity.

Materials and methods. 135 patients with CAD (a form of coronary heart disease – stable angina pectoris II-II FC) were studied. All patients with CAD were divided into 2 groups: 1 – patients with CAD and accompanying abdominal obesity (n = 100), 2 – patients with CAD and normal body weight (n = 35). The average age of patients with CAD and obesity was 60.55 ± 1.76 years, and in patients of 2 group – 60.34 ± 1.64. Patients were included in the study after obtaining informed consent. The study complied with international ethical standards for biometric research.

Patients with acute or chronic inflammatory diseases, kidney failure, oncological diseases, type 2 DM, autoimmune diseases were not included in the study.

Patients with acute or chronic inflammatory diseases, kidney failure, oncological diseases, type 2 DM, autoimmune diseases were not included in the study.

The study determined anthropometric parameters of waist circumference (WC) and hipi circumference (HC), body mass index (BMI) to determine abdominal obesity.

BMI was calculated according to the formula: BMI = weight (kg)/height (m^2).

A BMI greater than 30 kg/m^2 was considered a criterion for obesity (Table 1).

Table 1. Diagnostic value of body mass index

BMI	Diagnostic value
15–19.9 kg/m^2	Insufficient body weight
20–24.9 kg/m^2	Normal body weight
25–29.9 kg/m^2	Overweight body
30–39.9 kg/m^2	Obesity
More than 40 kg/m^2	Marked obesity

WC was measured as the volume below the chest above the navel; HC – as the largest volume at the hip level. The value of WC > 102 cm for men, > 89 cm for women (according to ATP III – 2001) and the value of the WC/HC index > 0.90 for men, > 0.85 for women is a sign of the abdominal type.

Determination of insulin in blood serum was carried out by the enzyme immunoassay using the «DRG INSULIN ELISA KIT» reagent set. The glucose level was determined by the glucose oxidizing method. The HOMA index was used, which was calculated according to the formula: fasting insulin (mU/ml) * fasting glucose (mmol/l)/22.5. Patients with the HOMA index > 2.77 were considered insulin resistant.

Mathematical computer processing of the results was carried out using the software package «Statistika» (StaSoft Inc, USA). The following were calculated: average value (M), error of the average (m), probability and level of significance (p). For the comparative analysis of samples with a normal distribution, the reliability of the differences was confirmed using the Student's test (t). The data are presented in the form of M ± m, changes are probable at $p < 0.05$. The correlation coefficient (r) was used to assess the degree of relationship between the samples.

Results and discussion. In patients with CAD and concomitant obesity significantly higher fasting serum glucose values were found. The data are given in Table 2.

Table 2. Parameters of carbohydrate metabolism in patients with CAD depending on the presence of concomitant obesity of the abdominal type

Parameter	CAD and obesity (n = 100)	CAD without obesity (n = 35)	p
Glucose, mmol/l	5.83 ± 0.13	4.12 ± 0.09	< 0,001
Insulin, μU/l	23.94 ± 2.67	17.73 ± 2.62	< 0,001
Index HOMA	5.45 ± 1.41	2.03 ± 0.94	< 0,001
Waist circumference, cm	106.88 ± 1.23	81.01 ± 2.41	< 0,001
Hips circumference, cm	110.7 ± 1.03	96.44 ± 2.66	< 0,001
Waist circumference/hips circumference	0.96 ± 0.01	0.86 ± 0.09	< 0,001
BMI, kg/m^2	31.05 ± 0.55	24.14 ± 0.82	< 0,001

The level of insulin in patients with comorbidity of CAD and obesity was higher than in patients with isolated CAD. HOMA index in patients with CAD and concomitant obesity exceeded its level in patients with CAD without obesity (differences are significant, $p < 0.05$).

Anthropometry indicators in patients with CAD with and without accompanying obesity were studied (Table 2). The values of BMI, WC, HC and their ratio in patients with comorbidity of CAD and abdominal obesity significantly exceeded those in patients with isolated CAD.

The analysis of the relationship between indicators of carbohydrate metabolism in patients with CAD in the presence or absence of obesity revealed differences. The data are given in Tables 3, 4.

Table 3. Correlations between indicators of carbohydrate metabolism in patients with CAD and abdominal obesity

Parameter	Glucose	Insulin	Index HOMA
Glucose	x	0.47*	0.49*
Insulin	x	x	0.88*
Index HOMA	x	x	x

Notes: * – < 0.05.

Table 4. Correlations between indicators of carbohydrate metabolism in patients with isolated CAD

Parameter	Glucose	Insulin	Index HOMA
Glucose	x	-0.65*	-0.45*
Insulin	x	x	0.86*
Index HOMA	x	x	x

Notes: * – < 0.05.

In patients with CAD and obesity, direct correlations were found between the level of glucose and insulin, HOMA index, as well as a direct correlation between insulin concentration and HOMA index. In patients with CAD without obesity, a direct relationship between the level of insulin and HOMA index was obtained, as well as inverse relationships between glucose concentration and insulin, HOMA index. That is, in patients with CAD without obesity, the increase in insulin is accompanied by a decrease in the level of glucose, which is evidenced by the inverse character of correlations. Thus, the homeostasis system works completely physiologically. In patients with CAD and obesity, the increase in insulinemia is accompanied by an increase in the level of glucose Thus, homeostasis does not work physiologically in obese patients. Such changes are characteristic of an insulin-resistant state.

Discussion of research results. Higher glycemic levels were found in patients with comorbidity of CAD and obesity. But it should be noted that the concentration of this indicator remained within the normal range in patients with isolated CAD and in the comorbid course of CAD and obesity. Levels of insulinemia in patients with CAD and obesity significantly exceeded those in isolated CAD and obesity, while 40% of patients with a combined course of CAD and obesity had insulinemia levels above the normal. Analysis of the levels of the HOMA index showed that this indicator was higher in the combined course of CAD and obesity and exceeded the normal range. The obtained data are consistent with the data of the world medical community regarding the existing insulin resistance in obesity [3, 5, 7]. Thus, in case of the comorbidity of CAD and obesity, the changes in carbohydrate metabolism consist in the development of insulin resistance due to a decrease in the sensitivity of cells to insulin, which in turn is the basis for the increase in serum insulin levels and the development of compensatory hyperinsulinemia aimed at counteracting the reduced sensitivity of tissues to insulin. Such pathogenetic changes may be due to a decrease in insulin receptor mRNA stability as a result of miRNA-128 activation, which reduces the expression of insulin receptors in adipocytes [8]. In addition, such changes may occur due to reprogramming of mitochondria in adipose tissue [7]. The obtained results testify to the fact that in patients with CAD and abdominal obesity, there are shifts in the physiological functioning of carbohydrate metabolism in the direction of the development of insulin resistance, which is a risk for the development of type 2 DM in the future. Therefore, it is advisable for patients with CAD with abdominal obesity

to carry out a comprehensive determination of indicators of carbohydrate metabolism – glucose, insulin, HOMA index, which will allow to single out a group at high risk of developing disorders of carbohydrate metabolism, namely, type 2 DM in the reversal stage such as prediabetes, insulin resistance, adequate therapy of which will prevent the development of persistent violations of carbohydrate metabolism.

Conclusions.

1. In patients with comorbidity of coronary artery disease and abdominal obesity, there is an increase in the levels of insulinemia and HOMA index compared to patients with isolated coronary artery disease.

2. In patients with a combined course of coronary artery disease and abdominal obesity, levels of the HOMA index were found exceeding the normal ranges and testifying the presence of insulin resistance.

3. For patients with coronary artery disease and abdominal obesity, it is advisable to carry out a comprehensive determination of carbohydrate metabolism indicators (glucose, insulin, HOMA index) in order to distinguish the category of patients with a reversible disorder of carbohydrate metabolism, namely, insulin resistance for the timely appointment of adequate treatment and prevention of the development of type 2 diabetes mellitus.

The prospects of the study are the assessment of carbohydrate metabolism disorders in patients with coronary artery disease depending on the severity of the accompanying metabolic disorders.

Funding and conflict of interest. There is no conflict of interest.

Funding source: authors' own funds.

Publication ethics. Patients were included in the study after obtaining informed consent. The study complied with international ethical standards for biometric research.

REFERENCES

1. Ralapanawa U., Sivakanesan R. Epidemiology and the Magnitude of Coronary Artery Disease and Acute Coronary Syndrome: A Narrative Review. *J. Epidemiol. Glob. Health*. 2021. Vol. 11 (2). P. 169–177. doi: https://doi.org/10.2991/jegh.k.201217.001

2. Obesity and Coronary Artery Disease: An Updated Systematic Review / M. P. Manoharan et al. Cureus. 2022. Vol. 14 (9). P. e29480. doi: https://doi.org/10.7759/cureus.29480

3. Chronic adipose tissue inflammation linking obesity to insulin resistance and type 2 diabetes / F. Zatterale et al. *Front Physiol*. 2020. Vol. 10. P. 1607. doi: https://doi.org/10.3389/fphys.2019.01607

4. Chooi Y. C., Ding C., Magkos F. The epidemiology of obesity. *Metab. Mar*. 2019. Vol. 92. P. 6–10. doi: https://doi.org/10.1016/j.metabol.2018.09.005

5. Obesity and coronary heart disease: epidemiology, pathology, and coronary artery imaging / N. Katta, T. Loethen, C. J. Lavie, M. A. Alpert. Curr Probl Cardiol. 2021. Vol. 46. P. 100655. doi: https://doi.org/10.1016/j.cpcardiol.2020.100655

6. Wondmkun Y. T. Obesity, Insulin Resistance, and Type 2 Diabetes: Associations and Therapeutic Implications. *Diabetes Metab. Syndr. Obes.* 2020. Vol. 13. P. 3611–3616. doi: https://doi.org/10.2147/DMSO.S275898

7. Lin H.-Y., Shao-Wen W., Shen F. C. Abrogation of Toll-like receptor 4 (TLR4) mitigates obesity-induced oxidative stress, proinflammation, and insulin resistance through metabolic reprogramming of mitochondria in adipose tissue. *Antioxid Redox Signal*. 2020. Vol. 33 (2). P. 1–60. doi: https://doi.org/10.1089/ars.2019.7737

8. Obesity-related hypoxia via miR-128 decreases insulin-receptor expression in human and mouse adipose tissue promoting systemic insulin resistance / B. Arcidiacono et al. *EBioMedicine.* 2020. Vol. 1. P. 55. doi: https://doi.org/10.1016/j.ebiom.2020.102912

Надійшла до редакції 14.02.2024

Прийнята до опублікування 22.03.2024

Інформація про авторів (Information about the authors)

Ryndina Nataliia, Doctor of Medical sciences, Professor, Educational and Scientific Medical Institute of the National Technical University "Kharkiv Polytechnic Institute", Professor of the Department of Family medicine and internal diseases; Kharkiv, Ukraine.

Риндіна Наталія Геннадіївна, докторка медичних наук, професорка, Навчально-науковий медичний інститут Національного технічного університету «Харківський політехнічний інститут», професорка кафедри сімейної медицина та внутрішніх хвороб; Харків, Україна.

E-mail: nryndina81@gmail.com

http://orcid.org/0000-0003-2731-4491 D, E, F

Poteiko Petro, Candidate of Medical sciences, Associate Professor, Educational and Scientific Medical Institute of the National Technical University "Kharkiv Polytechnic Institute", Head of the Department of Family medicine and internal diseases; Kharkiv, Ukraine.

Потейко Петро Іванович, кандидат медичних наук, доцент, Навчально-науковий медичний інститут Національного технічного університету «Харківський політехнічний інститут», завідувач кафедри сімейної медицина та внутрішніх хвороб; Харків, Україна.

E-mail: petro.poteiko@khpi.edu.ua

https://orcid.org/0000-0002-6451-7151 D, E

Nemtsova Valeriya, Doctor of Medical sciences, Professor, Educational and Scientific Medical Institute of the National Technical University "Kharkiv Polytechnic Institute", Professor of the Department of Family medicine and internal diseases; Kharkiv, Ukraine.

Немцова Валерія Данилівна, докторка медичних наук, професорка, Навчально-науковий медичний інститут Національного технічного університету «Харківський політехнічний інститут», професорка кафедри сімейної медицина та внутрішніх хвороб; Харків, Україна.

E-mail: valeriyan@ukr.net

https://orcid.org/0000-0001-7916-3168 A, B, C, D, E, F

Berezniakov Vladyslav, Candidate of Medical sciences, Associate Professor, Educational and Scientific Medical Institute of the National Technical University "Kharkiv Polytechnic Institute", Associate Professor of the Department of Family medicine and internal diseases; Kharkiv, Ukraine.

Березняков Владислав Ігорович, кандидат медичних наук, доцент, Навчально-науковий медичний інститут Національного технічного університету «Харківський політехнічний інститут», доцент кафедри сімейної медицина та внутрішніх хвороб; Харків, Україна.

E-mail: vladyslav.berezniakov@khpi.edu.ua

https://orcid.org/0000-0001-7818-4864 D, E

Korchevska Hanna, Educational and Scientific Medical Institute of the National Technical University "Kharkiv Polytechnic Institute", Associate Professor of the Department of Family medicine and internal diseases; Kharkiv, Ukraine.

Корчевська Ганна Ігорівна, Навчально-науковий медичний інститут Національного технічного університету «Харківський політехнічний інститут», асистентка кафедри сімейної медицина та внутрішніх хвороб; Харків, Україна.

E-mail: hanna.korchevska@khpi.edu.ua [D, E]

Kravchuk Stanislav, Educational and Scientific Medical Institute of the National Technical University "Kharkiv Polytechnic Institute", Associate Professor of the department of Family medicine and internal diseases; Kharkiv, Ukraine.

Кравчук Станіслав Леонідович, Навчально-науковий медичний інститут Національного технічного університету «Харківський політехнічний інститут», асистент кафедри сімейної медицина та внутрішніх хвороб; Харків, Україна.

E-mail: stanislav.kravchuk@khpi.edu.ua [D, E]

A – Концепція та дизайн роботи (Work concept and design)
B – Збір та аналіз даних (Data collection and analysis)
C – Відповідальність за статистичний аналіз (Responsibility for statistical analysis)
D – Написання статті (Writing the article)
E – Критичний огляд статті (Critical review)
F – Остаточне затвердження статті (Final approval of the article)

Відповідальний автор:

Риндіна Наталія Геннадіївна, докторка медичних наук, професорка, Навчально-науковий медичний інститут Національного технічного університету «Харківський політехнічний інститут», професорка кафедри сімейної медицина та внутрішніх хвороб.

✉ Україна, 61000, м. Харків, вул. Григорія Сковороди, 79/1.

E-mail: nryndina81@gmail.com

Цитування: Ryndina N., Poteiko P., Nemtsova V., Berezniakov V., Korchevska H., Kravchuk S. Peculiarities of carbohydrate metabolism in patients with isolated coronary heart disease and abdominal obesity comorbidities. *Bulletin of medicine, Psychology and Pharmacy*. 2024. No. 1. P. 51–57. doi: https://doi.org/10.20998/BMPP.2024.01.06