

## ***Serum biochemical parameters of patients with periprosthetic joint infection of the hip in carbohydrate metabolism disorders***

**Elena L. Matveeva, Anna G. Gasanova✉, Artem M. Ermakov**

Ilizarov National Medical Research Centre for Traumatology and Orthopedics, Kurgan, Russian Federation

**Corresponding author:** Anna G. Gasanova, [gasanova.08@mail.ru](mailto:gasanova.08@mail.ru)

### **Abstract**

**Introduction** As the demand for joint replacement increases over time, the number of concurrent complications such as periprosthetic joint infection (PJI) will also increase. Surgical approaches in carbohydrate metabolism disorders (CMD) remain under-explored. Epidemiological and pathogenetic aspects of the metabolic status of patients with PJI and disorders of carbohydrate metabolism must be examined prior to revision total hip replacement. The objective was to identify statistically significant differences in blood serum biochemical parameters in patients with PJI of the hip joint in groups of patients with and without carbohydrate metabolism disorders. **Material and methods** The blood serum of 76 patients with PJI of the hip without a history of carbohydrate metabolism disorders and 56 patients with PJI of the hip and CMD as a concomitant pathology was examined. Patients had a history of diabetes mellitus and impaired glucose tolerance. Obesity, a preclinical form of CMD, was determined by calculating the body mass index (BMI > 30). Serum C-reactive protein (CRP), bilirubin, glucose, urea, total protein, albumin and globulins, creatinine, aminotransferase (ALT) and aspartate aminotransferase (AST) levels were measured using an automatic biochemical analyzer ILab Aries and BioSystems reagent kits. The measurements were compared using generally accepted methods of variation statistics. **Results** C-reactive protein and globulin levels were increased (the albumin-globulin coefficient was not within normal limits) in patients with PJI. Fasting glycemia, urea and creatinine showed significant differences in patients with CMD as compared comparison with those in no-CMD patients. Reliable excesses of the measurements do not, however, deduce them beyond the limits of normal values. **Discussion** Our findings indicate preclinical renal changes in patients with PJI of the hip and CMD.

**Keywords:** periprosthetic joint infection, diabetes mellitus, impaired glucose tolerance, body mass index, creatinine, urea

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## **INTRODUCTION**

Total joint arthroplasty is the most common surgical intervention for end-stage degenerative diseases and consequences of joint injuries. The technologies of medical perioperative support are of great importance. With the increasing utilization of arthroplasty and revision interventions the proportion of complications also increases [1, 2, 3]. Surgical approaches in cases of comorbidity or metabolic disorders remain under-explored. Epidemiological and pathogenetic aspects of restoring metabolic balance in patients with impaired carbohydrate metabolism before and after total hip arthroplasty (THA) require further

investigation [4, 5, 6]. Morbidly obese patients are 8.5 times more likely to undergo THA than people of normal weight and the need for revision surgery boosts by 1.5 times in patients with a body mass index (BMI) of 30 kg/m<sup>2</sup> or higher and is higher in earlier terms [7, 8]. Patients with carbohydrate metabolism disorder (CMD) should be monitored preoperatively in accordance with individual treatment goals [9].

**The objective** was to identify statistically significant differences in blood serum biochemical parameters in patients with PJI of the hip joint in groups of patients with and without CMD.

## **MATERIAL AND METHODS**

Blood biochemistry characteristics of patients treated at the Clinic of Infection Osteology of the Kurgan Ilizarov Centre between 2019 and 2020 were retrospectively reviewed. The patients underwent revision arthroplasty. Serum biochemistry panel was evaluated preoperatively. Serum biochemistry tests of 76 patients with periprosthetic joint infection (PJI) of the hip joint without a history of CMD were included in the first group (Table 1).

Serum biochemistry tests of 56 patients with PJI and comorbidities including diabetes mellitus, impaired glucose tolerance and preclinical forms of CMD, obesity defined as body mass index (BMI) greater than or equal to 30 kg/m<sup>2</sup> were assigned to the second group. Patients with CMD were subdivided into 2 groups: a group of patients with diabetes mellitus and a group of patients without diabetes mellitus which included obese cases (Table 2).

Table 1

## Characterization of patients

Description	Group 1 (no CMD in the history)	Group 2 (CMD in the history)
Number of patients	73	56
Age, years	57 (42; 65)	64 (50; 75; 69)
Gender (m/f)	49 / 24	30 / 26
Body mass index (kg/m <sup>2</sup> )	24.80 (21.46; 27.04)	33.83 (31.48; 37.74)

Table 2

## Characterization of CMD patients

Description	Obese patients	Patients with diabetes mellitus type 2
Number of patients	38	18
Age, years	63 (49; 25; 69; 00)	66,5 (61,5; 68,75)
Gender (m/f)	23 / 15	7 / 11
Body mass index (kg/m <sup>2</sup> )	33.87 (31.69; 38.09)	33.63 (30.06; 37.55)

The study groups were comparable by gender and age. The exclusion criteria were mismatched age and incomplete data in the medical record. Primary total joint arthroplasty was carried out at the National Research Ilizarov Centre for Trauma and Orthopaedics and other orthopaedic and trauma institutions of the Russian Federation and CIS countries. The study was performed in accordance with ethical principles for medical research involving human subjects stated in the Declaration of Helsinki developed by the World Medical Association, Order of the Ministry of Health of the RF dtd 19<sup>th</sup> June 2003 No. 266 on Clinical Practice Guidelines in the Russian Federation. Written informed consent was obtained from all patients for publication of the findings without identifying details.

Serum C-reactive protein (CRP), bilirubin, glucose, urea, total protein, albumin and globulins, creatinine, aminotransferase (ALT) and aspartate aminotransferase (AST) levels were measured using an automatic biochemical analyzer ILab Aries and BioSystems reagent kits. The tabulated results of the study were presented as medians and percentiles (0.25; 0.75). The values of the patients' findings were compared with those of the reference group. The significance of differences between groups of patients was assessed with normality of the samples determined with the Shapiro-Wilk test. The Mann-Whitney T-test was used to assess the statistical significance of differences between groups. The minimum significance level (p) was adopted as being equal to 0.05.

## RESULTS AND DISCUSSION

The results of our studies are presented in Table 3. Evaluation of serum biochemical parameters of PJI patients in groups 1 and 2 showed that a number of parameters were beyond the normal limits. Significant differences were revealed for three parameters including

C-reactive protein, globulins and the ratio of albumins and globulins that indicated an increased content of globulins including C-reactive protein and the presence of an inflammatory process that was characteristic of PJI cases.

Table 3

Major serum biochemical parameters of patients with PJI of the hip without CMD (Group 1) and with CMD (Group 2)

Parameter	Group 1	Group 2	Normal value
C-reactive protein, mg/L	<u>20.55 (2.10; 77.5)</u>	<u>22.8 (5.93; 67.88)</u>	0–5.0
ALT, un/L	16.10 (11.65; 24.08)	19.05 (11.25; 27.13)	0–41.0
AST, un/L	19.80 (16.58; 25.33)	20.4 (16.2; 29.8)	0–40.0
Total bilirubin, µmol/L	8.40 (5.50; 11.10)	8.95 (6.05; 12.35)	5.1–20.5
Glucose, mmol/L	<b>5.40 (5.00; 5.80)</b>	<b>5.8 (5.3; 6.5)<sup>0.014</sup></b>	4.0–6.1
Creatinine, µmol/L	<b>85.00 (76.00; 98.00)</b>	<b>100.00 (88.00; 116.75)<sup>0.004</sup></b>	71.0–115.0
Urea, mmol/L	<b>4.8 (3.95; 6.3)</b>	<b>5.8 (4.9; 8.2)<sup>0.014</sup></b>	2.5–8.3
Albumin, g/L	36.3 (33.63; 40.10)	37.6 (33.15; 41.9)	34.0–48.0
Total protein, g/L	66.70 (61.40; 73.20)	69.6 (60.85; 72.5)	64.0–83.0
Globulins	<u>30.05 (27.65; 34.18)</u>	<u>31.55 (27.88; 34.45)</u>	25.0–30.0
A / G	<u>1.23 (0.94; 1.44)</u>	<u>1.24 (1.08; 1.47)</u>	1.5–2.3

Note: \* – parameters with statistically significant differences between the groups were identified; the level of significance is indicated with the index above. Measurements that were beyond normal limits are underlined.

A sufficient level of significance was found for three serum biochemical parameters to establish significant differences between the two groups. Those were concentrations of glucose, creatinine and urea. Patients of Group 2 had a significantly higher fasting glucose level that was within the normal range. This was not without the reason for patients with CMD having obviously higher values of fasting glycemia [9]. Diabetes mellitus like any CMD is associated with a higher surgical and anesthetic risk but was not a contraindication to surgery. Clinical guidelines [10] suggest that the patients follow a strict diet preoperatively and take hypoglycemic drugs to normalize the target glucose values. Patients with CMD have a higher perioperative risk of renal failure as one of the complications with hypovolemia,

renal hypoperfusion and dehydration as the cause and a provoking factor.

Significant differences in the parameters of renal function and urea were revealed in CMD patients with diabetes mellitus and obese that were significantly higher and measured the superior limit of the norm in patients with diabetes mellitus. No nephropathy was recorded in the history of 56 PJI patients who had CMD as a concomitant pathology. However, the renal parameters changed values as compared with those in the group of patients without CMD. Elevated urea levels require monitoring of kidney and liver function, and control of nitrogen metabolism in patients with diabetes mellitus and impaired glucose tolerance [11–16].

Table 4

Major serum biochemical parameters in patients with PJI of the hip and CMD in obesity and diabetes mellitus

Parameter	Obesity (n = 38)	DM (n = 18)	Normal value
C-reactive protein, mg/L	33.5 (3.85; 67.95)	21 (12.2; 67.6)	0–5.0
ALT, un/L	19.9 (11.25; 27.13)	18.8 (13.9; 25.83)	0–41.0
AST, un/L	19.3 (16.2; 24.2)	20.45 (16.3; 37.35)	0–40.0
Total bilirubin, $\mu$ mol/L	8.40 (5.63; 12.23)	9.9 (7.68; 12.1)	5.1–20.5
Glucose, mmol/L	5.65 (5.3; 6.2)	6.45 (5.7; 7.2)	4.0–6.1
Creatinine, $\mu$ mol/L	99 (92; 110)	116 (83; 137)	71.0–115.0
Urea, mmol/L	<b>5.4 (4.4; 7.5)</b>	<b>8.05 (5.63; 10.1)<sup>0.029</sup></b>	2.5–8.3
Albumin, g/L	37.6 (32.95; 42.15)	37.35 (34.45; 41.6)	34.0–48.0
Total protein, g/L	69.4 (60.85; 73.43)	69.7 (66.88; 74.3)	64.0–83.0
Globulins	30.75 (27.5; 34.45)	32.6 (30.58; 34.05)	25.0–30.0
A / G	1.29 (1.08; 1.47)	1.22 (1.10; 1.41)	1.5–2.3

Note: \* – parameters with statistically significant differences between the groups were identified; the level of significance is indicated with the index above.

## CONCLUSION

A thorough preoperative examination is required for patients with PJI of the hip joint to prevent complications in revision arthroplasty. Renal function tests are essential for patients with CMD to assess renal function. Elevated levels of creatinine and urea in the group of patients require additional tests that

are sensitive to the detection of early signs of the pathology. Estimation of serum creatinine, serum urea, albuminuria, glomerular filtration rate among patients with PJI is practical for assessment of subclinical renal impairment before revision total hip arthroplasty.

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#### Information about the authors:

1. Elena L. Matveeva – Doctor of Biological Sciences, matveevan@mail.ru;
2. Anna G. Gasanova – gasanova.08@mail.ru;
3. Artem M. Ermakov – Candidate of Medical Sciences, ema\_cab@mail.ru.