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Determination of the value of glycated hemoglobin HbA_{1c} and fructosamine in assessing the risk of perioperative complications after cardiac surgery in patients with type 2 diabetes

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Abstract

Introduction: Patients with diabetes have a worse postoperative course and longer length of hospital stay after surgery. A good indicator of proper long-term (3 months) glycemic control is glycated hemoglobin (HbA_{1c}), and fructosamine in the short term (2–3 weeks).

Aim: To determine the degree of glycemic control evaluated preoperatively by HbA_{1c} and/or fructosamine influence on the postoperative course of patients with diabetes undergoing coronary artery bypass grafting (CABG) in 2014–2015.

Material and methods: Before the operation HbA_{1c} (N < 7.0) and fructosamine (N < 280 µmol/l) were measured and depending on the results the respondents were divided into 4 groups: group I (n = 46) – normal both parameters; group II (n = 22) – high both values; group III (n = 4) – normal fructosamine/HbA_{1c} high; group IV (n = 33) – high HbA_{1c}/fructosamine normal. Statistical analysis was performed using the t-test assuming $p < 0.05$ to be statistically significant.

Results: One hundred and five patients were treated by CABG/OPCAB (39 female, 66 males). The mean age was 65.7 ±7.3, HbA_{1c}: 7.23 ±1.2%, fructosamine: 261.8 ±43.8. There was no difference in the incidence of other postoperative complications between the two groups.

Conclusions: Glycated hemoglobin and fructosamine levels to a similar extent define the risk of perioperative complications in patients undergoing cardiac surgery. In patients in whom there is a need to quickly compensate for elevated blood glucose consider enabling determination of fructosamine.

Key words: glycated hemoglobin, fructosamine, diabetes mellitus.

Streszczenie

Wstęp: Chorzy na cukrzycę mają gorszy przebieg pooperacyjny i dłuższy czas hospitalizacji po operacjach. Dobrym wskaźnikiem prawidłowego, długoterminowego (3 miesiące) wyrównania glikemii są wartości hemoglobiny glikowanej (HbA_{1c}), a krótkoterminowego (2–3 tygodnie) – fruktozaminy.

Cel: Ocena, jak stopień wyrównania glikemii przedoperacyjnej oceniany wartością HbA_{1c} i/lub fruktozaminy wpływa na przebieg pooperacyjny u chorych na cukrzycę poddanych pomostowaniu tętnic wieńcowych (CABG).

Materiał i metody: Przeanalizowano łącznie 105 pacjentów chorych na cukrzycę poddanych CABG w latach 2014–2015. Przed operacją oznaczono wartości HbA_{1c} (N < 7,0) i fruktozaminy (N < 280 µmol/l) i w zależności od wyników chorych podzielono na 4 grupy: grupa I (n = 46) – prawidłowe wartości obu parametrów, grupa II (n = 22) – duże wartości obu parametrów, grupa III (n = 4) – prawidłowa wartość HbA_{1c} i wysoka fruktozaminy, grupa IV (n = 33) – wysoka wartość HbA_{1c}, a fruktozaminy w normie. Dane opracowano statystycznie przy użyciu t-testu, przyjmując $p < 0,05$ za istotne statystycznie.

Wyniki: Analizie poddano 105 chorych, w tym 39 kobiet, 66 mężczyzn, operowanych metodą CABG/OPCAB. Średnia wieku wynosiła 65,7 ±7,3 roku, HbA_{1c} 7,23 ±1,2%, a fruktozaminy 261,8 ±43,8. Najczęstszym powikłaniem było pooperacyjne napadowe migotanie przedsionków (n = 13) obserwowane w grupie I. Nie stwierdzono różnic w zakresie częstości występowania innych powikłań pooperacyjnych pomiędzy obiema grupami.

Wnioski: Stwierdzono, że odsetek HbA_{1c} i stężenie fruktozaminy w podobnym stopniu definiują ryzyko powikłań okołooperacyjnych u chorych poddawanych zabiegom kardiochirurgicznym. Ze względu na dynamikę czasową zmian stężeń tych substancji w przypadku szybkiej normalizacji glikemii należy

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rozważyć włączenie oznaczenia fruktozaminy do panelu badań wykonywanych przed zabiegiem, zwłaszcza u chorych, u których zachodzi konieczność szybkiego wyrównania podwyższonego stężenia glukozy.

Słowa kluczowe: hemoglobina glikowana, fruktozamina, cukrzyca typu 2.

Introduction

Diabetes, in particular type 2, is a condition which significantly increases the risk of development and progression of atherosclerosis [1, 2]. It is estimated that 60% of patients hospitalized with coronary artery disease have varying degrees of impaired glucose tolerance [3, 4]. Metabolic disorders in diabetes can cause coagulation disorders, hypertension, dyslipidemia, and synthesis of free radicals [5]. They can worsen the perioperative course and prognosis in patients undergoing cardiac surgery [6]. According to the recommendations of the Polish Association of Diabetes, metabolic preparation of the patient for surgery includes normalization of blood glucose [7]. The measure of glycemic control is the determination of the concentration of glycated hemoglobin (HbA_{1c}). It is assumed that the patient eligible for surgery should have a balanced glucose level of HbA_{1c} < 7%. Remember, however, it should be that the concentration of glycated hemoglobin reflects the alignment within 3 months preceding the mark [8]. In a situation where the patient is eligible for the procedure, and does not meet the metabolic control (HbA_{1c} < 7%), it is necessary to intensify hypoglycemic therapy that will lead to the normalization of the blood glucose profile. There remains the situation where the patient has a normal blood glucose daily profile and still maintains elevated glycosylated hemoglobin, which according to the recommendations disqualifies a patient from the planned surgery.

The process of non-enzymatic glycation, which is the product of glycated hemoglobin, is a reaction that includes all proteins. It consists of a combination of a glucose molecule with the free amino group of the polypeptide chain [9]. The protein albumin is subject to glycation and as a result of this process produces fructosamine, a somewhat forgotten parameter that determines the glycemic control. Given the life of albumin, the concentration of fructosamine determines glycemic control during the 3–4 weeks prior to the measurement [10]. It seems, therefore, that determination of fructosamine can be a useful study determining the metabolic alignment, especially the situation of hypoglycemic treatment and the need to verify the information factors.

Aim

Glycemic control is necessary in patients with diabetes subjected to cardiac surgery. Evaluation of alignment is based on the determination of the percentage of glycated hemoglobin A_{1c}, which reflects the alignment of the preceding 3 months. The open issue is whether the determination of the concentration of fructosamine reflecting alignment in the previous 3 weeks will be a comparable parameter. The aim of the study is to evaluate metabolic control by the concentration of fructosamine and the percentage of HbA_{1c} with respect to the occurrence of postoperative complications in diabetic patients undergoing coronary artery bypass grafting.

Material and methods

We analyzed the results of off-pump coronary artery bypass (OPCAB) and coronary artery bypass graft (CABG) procedures performed in 105 patients with type 2 diabetes in 2014–2015. The mean age was 65.7 ±7.3.

Diabetes duration was 9.2 ±2.3 years. In all subjects, the concentration of fructosamine and HbA_{1c} was designated. The analysis included postoperative complications. We analyzed the following complications: delirium, stroke, prolonged respiratory therapy > 24 h, slow wound healing, visceral ischaemia, death.

Statistical analysis

The results were statistically analyzed. Average value ± SD and events of interest were calculated. Comparisons between selected groups were made using the χ^2 test with Yates correction for continuity.

Results

Mean HbA_{1c} level in the study group was 7.23 ±1.2% and fructosamine concentration was 261 ±43.8 mmol/l. Figure 1 shows the correlation between the percentage of glycated hemoglobin A_{1c} and fructosamine. There was a significant correlation between these parameters ($r = 0.597$, $p < 0.001$).

In the total study group of 105 patients perioperative complications occurred in 9 (8.5%) patients. There was a higher, though not significantly, value of the tested parameters of glycemic control in diabetic patients with perioperative complications compared to patients with an uncomplicated course (Tab. I).

Next we calculated percentages of patients who experienced perioperative complications depending on the HbA_{1c} and the corresponding concentration of fructosamine. As the cut-off point for HbA_{1c} we adopted HbA_{1c} 7% – a reference value for optimal glycemic control during the perioperative period [7]. Complications occurred in 4 (3.8%) patients with HbA_{1c} < 7%, and 5 (4.8%) patients with HbA_{1c} ≥ 7% (n.s.). For fructosamine the figures were 6 (5.7%) patients with a concentration of < 285 µmol/l and 3 (2.9%) at a concentration ≥ 285 µmol/l (n.s.).

Discussion

In the present study, we found that the percentage of HbA_{1c} as much as the concentration of fructosamine de-

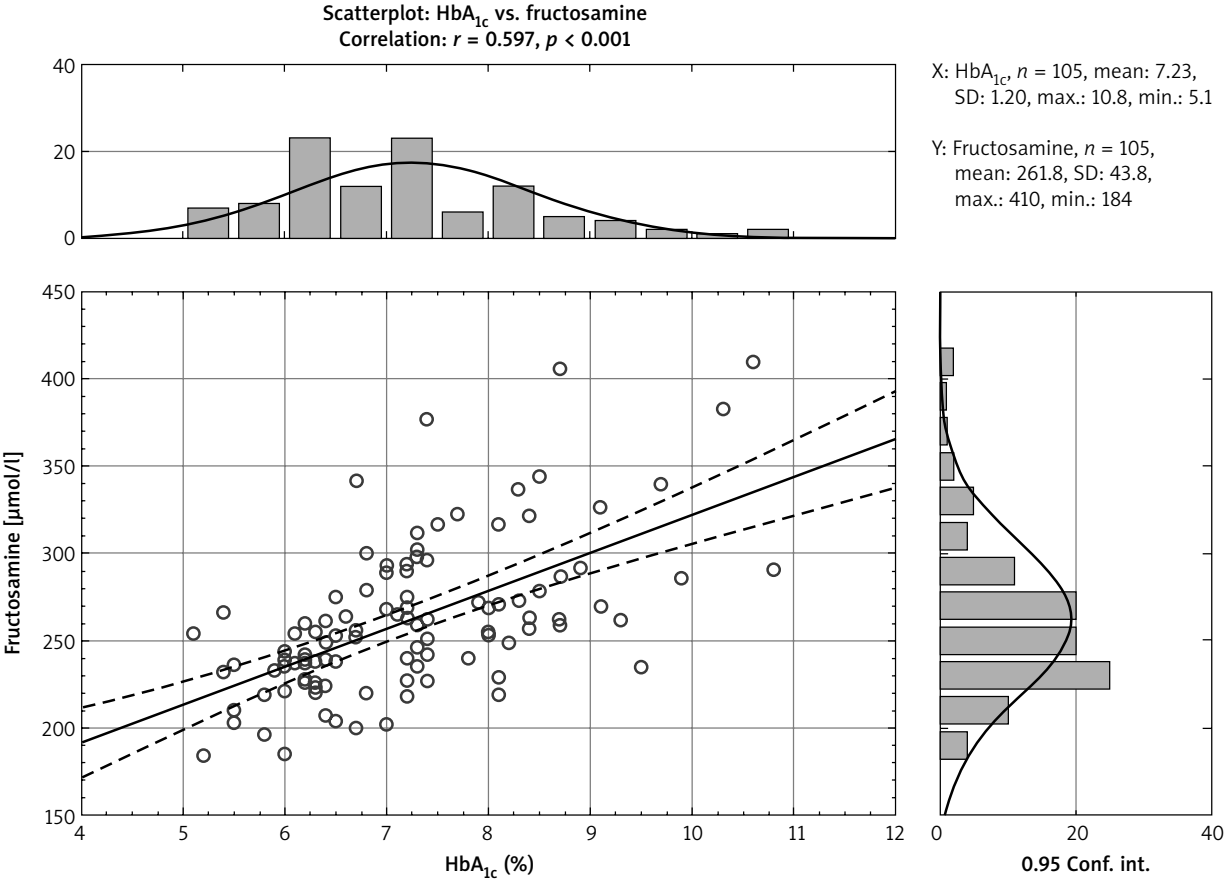

Fig. 1. Correlation between HbA_{1c} vs. fructosamine

fines the risk of perioperative complications in patients undergoing cardiac surgery. The analysis includes only those complications that are potentially associated with the environment hyperglycemia [11].

First, an analysis of the correlation between HbA_{1c} and fructosamine was performed. There was a high, statistically significant correlation, indicating that both of these parameters to a comparable extent describe the metabolic control of patients.

Subsequently we rated interdependent incidence of perioperative complications and concentrations of the test parameters. Noteworthy is the fact that the incidence of complications in the study group is small, not different from their appearance in our center [12]. This is due to the fact that one of the elements taken into account to qualify for the surgery is the degree of metabolic control.

Glycemic control plays an important role in the prognosis after cardiac surgery [13, 14]. Zerr *et al.* analyzing a database including 8910 patients, including 1585 patients with diabetes, found that the implementation of procedures of treatment, enabling one to obtain blood glucose during the perioperative period of less than 200 mg%, reduces the incidence of deep wound infection from 2.4% to 1.5% ($p < 0.02$). We noted a similar percentage of deep wound infection in our study, where one of the elements of the qualification is to assess glycemic control. In the present analysis, the percentage of patients with delayed wound healing was 2.17% in the group with $HbA_{1c} < 7\%$, and 1.69.% for $HbA_{1c} \geq 7\%$ and the corresponding concentration of fructosamine.

Tab. I. Percentages of glycated hemoglobin (HbA_{1c}), and fructosamine, in patients with perioperative complications compared to patients with uncomplicated course (data are presented as mean ± SD)

Parameter	Patients with perioperative complications	Patients without perioperative complications
HbA_{1c} (%)	7.2 ±1.19	7.5 ±1.4
Fructosamine [µmol/l]	260 ±40	286 ±69

Conclusions

The HbA_{1c} and fructosamine levels to a similar extent define the risk of perioperative complications in patients undergoing cardiac surgery. Given the dynamics of temporal changes in the concentrations of these substances in the event of a rapid normalization of blood glucose, one should consider including designation of fructosamine panel tests performed before surgery, especially in patients in whom there is a need to quickly compensate for elevated blood glucose.

Disclosure

Authors report no conflict of interest.

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