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Comparative study of blood glucose and glycated hemoglobin in type 2 diabetics in Lubumbashi city

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Abstract

Introduction: Diabetes mellitus is a complex disease, with polymorphic clinical expression and diverse etiopathogenesis, creating an absolute (insufficiency of secretion) or relative (resistance, etc.) defect in insulin effect. This defect in insulin secretion and/or action leads to chronic hyperglycemia with disturbances in carbohydrate, lipid and protein metabolism.

Objective: The objective of our study was to establish the relationship between variations in blood sugar and glycated hemoglobin (HbA1c) in type 2 diabetics in Lubumbashi city.

Methods: The study involved a sample of 39 known type 2 diabetics treated at the University Clinics of Lubumbashi. Venous blood samples were taken from all patients for the measurement of blood glucose after the 1st, 2nd and 3rd month of antidiabetic treatment and for the measurement of HbA1c after the 3rd month of treatment.

Results: The average blood glucose concentrations obtained after the 1st, 2nd and 3rd month of treatment were respectively 180.28 ± 51.09 mg/dl ; 154.20 ± 49.33mg/dl and 135.58 ± 36.45 mg/dl while the percentage of HbA1c after the 3rd month of treatment was 5.90 ± 0.55. Statistical analysis showed that the average blood glucose obtained after the 1st month of treatment was significantly higher ($P<0.05$) than those obtained after the 2nd and 3rd months of treatment. There was no significant difference between the average blood glucose obtained after the 2nd month of treatment and that obtained after the 3rd month of treatment. Furthermore, a positive correlation ($r=0.56$) was found between average blood glucose and HbA1c.

Conclusion: On the one hand, our results show that the antidiabetic treatment followed by the patients was effective and, on the other hand, they highlight the need to associate the measurement of blood glucose with that of HbA1c in the diagnosis and treatment monitoring in diabetic patients.

Keywords: Relationship; Blood glucose; Glycated hemoglobin; Type 2 diabetes; Lubumbashi

1. Introduction

Diabetes mellitus is a complex disease, with polymorphic clinical expression and diverse etiopathogenesis, creating an absolute (insufficiency of secretion) or relative (resistance, etc.) defect in insulin effect [1]. This defect in insulin

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secretion and/or action leads to chronic hyperglycemia with disturbances in carbohydrate, lipid and protein metabolism [2].

Most people who suffer from diabetes live in developing countries including the Democratic Republic of Congo (DR Congo) where this disease has been declared a public health problem and an economic and social scourge [3].

Glycated hemoglobin (A1c) corresponds to all the hemoglobin molecules modified by non-enzymatic fixation and mainly of glucose on the animated functions of the globin. This connection is all the more frequent as the serum glucose concentration is high, which makes the measurement of glycated hemoglobin an important element in the diagnosis and monitoring of diabetes [4]. However, there is a divergence in the interpretation of blood glucose values and those of hemoglobin A1c [4, 8], hence the interest of our study.

The objective of the present study is therefore to establish the relationship that exists between variations in blood glucose and hemoglobin A1c in type 2 diabetics in Lubumbashi, Demotratic Republic of Congo (DR Congo).

2. Material and methods

2.1. Site of research

Our investigations were carried out at the university clinics (CU) of Lubumbashi, the second city in DR Congo after the capital Kinshasa. Thanks to their capacity of 232 beds, the CU constitute the second large hospital center in the city of Lubumbashi.

2.2. Materials

2.2.1. Blood sampling equipment

For blood sample collection, we used the following materials: Tourniquet, cotton wool, denatured alcohol (disinfectant), 5 ml syringes and needles, racks, test tubes without anticoagulant and with an anticoagulant (Ethylene diamine tetraacetic or EDTA).

2.2.2. Equipment for laboratory assays

For laboratory assays, we used the following materials:

Spectrophotometer (Motic), refrigerator (Liebherr), Analyser Finecare™, centrifuge (Horizon), oven, water bath, micropipettes (Eppendorf), stopwatch, cuvettes, tips.

2.3. Study population

Our study focused on a sample of 39 known type 2 diabetics under treatment at CU. The selection of these 39 diabetics was made on the basis of the following inclusion criteria: being a known diabetic and under treatment, attending CU during the period of our study and giving informed consent to be part of the study.

The subjects selected were all in the age group between 25 and 69 years and of both sexes.

2.4. Methods

2.4.1. Type of study

We conducted a cross-sectional descriptive study with analytical aims

2.4.2. Collection and processing of blood samples

Blood samples were taken in the morning from the superficial veins of the elbow crease in fasting subjects. The blood was placed in test tubes without anticoagulant for the measurement of blood glucose and with an anticoagulant (EDTA) for the measurement of glycated hemoglobin, then centrifuged at 3000 rpm per minute for 10 minutes. The serum or plasma obtained was used for laboratory assays.

2.4.3. Laboratory assays

The measurement of blood glucose was carried out in diabetics after the 1st month, the 2nd month and the 3rd month of antidiabetic treatment while that of glycated hemoglobin was only carried out after the 3rd month of treatment.

Blood glucose measurement

Blood glucose levels were measured using an enzymatic and colorimetric method using glucose oxidase (GOD) according to the following reactions:

$$\text{Glucose} + O_2 \xrightarrow{\text{GOD}} H_2O_2 + \text{Gluconate}$$

$$H_2O_2 + \text{Phenol} + \text{4-aminophenazone} \xrightarrow{\text{Peroxidase}} \text{Quinone imine} + H_2O$$

The intensity of the pink coloring of quinone imine is proportional to the concentration of glucose in the sample.

Determination of glycated hemoglobin

The Finecare™ HbAlc Rapid Quantitative Test is based on fluorescence immunoassay technology, specifically the sandwich immunodetection method. Add the specimen to detection buffer and mix well. When the sample mixture is added into the sample well of the Test cartridge, the fluorescence-labeled detector antibody on the membrane will bind to antigen in specimen and form immune complexes. As the sample mixture migrates on the nitrocellulose membrane of test strip by capillary action, the complexes of detector antibody and antigen are captured to the other antibody that has been immobilized on membrane. Thus the more antigen in specimen, the more complexes are accumulated on membrane. Signal intensity of detector HbAlc antibodies reflect the amount of antigens and Finecare™ FIA Meters show HbAlc concentrations in blood specimen.

2.5. Statistical analysis

Statistical comparison of mean blood glucose results in diabetics between the 1st, 2nd and 3rd month of antidiabetic treatment was carried out using the Student's t test for paired data. Statistical significance was declared at the threshold of $P<0.05$.

To establish the correlation that exists between blood glucose and glycated hemoglobin, we determined the correlation coefficient (r) [5].

3. Results

3.1. Average results

The average blood glucose and glycated hemoglobin results are presented in Table 1.

Table 1 Average blood glucose and glycated hemoglobin (A1c) results after antidiabetic treatment at the 1st, 2nd and 3rd month

Antidiabetic Treatment	Blood glucose (mg/dl)	Hb A1c (%)
1st month	180.28± 51.09	-
2nd month	154.20 ± 49.33	-
3rd month	135.58 ±36.45	5.90±0.55

3.2. Statistical analysis

3.2.1. Comparison of average blood glucose results

Statistical comparisons of mean blood glucose values between the 1st, 2nd and 3rd month of antidiabetic treatment are presented in Tables 2, 3 and 4.

Table 2 Comparison of average blood glucose levels after the 1st month and the 2nd month of treatment

Groups compared	Numbers	Means	DOF	Tcal	Tth	Interpretation
1st month	39	180.28	76	2.29	1.96	S*
2nd month	39	154.20				

DOF = degree of freedom; Tcal = calculated T; Tth = theoretical T; S*=Significant difference (Tcal>Tth).

Table 3 Comparison of average blood glucose levels after the 1st month and the 3rd month of treatment

Groups compared	Numbers	Means	DOF	Tcal	Tth	Interpretation
1st month	39	180.28	76	4.45	1.96	S*
3rd month	39	135.58				

DOF = degree of freedom; Tcal = calculated T; Tth = theoretical T; S*=Significant difference (Tcal>Tth).

Table 4 Comparison of average blood glucose levels after the 2nd month and the 3rd month of treatment

Groups compared	Numbers	Means	DOF	Tcal	Tth	Interpretation
2nd month	39	154.20	76	1.89	1.96	NS
3rd month	39	135.58				

DOF = degree of freedom; Tcal = calculated T; Tth = theoretical T; NS = Non-significant difference (Tcal<Tth).

3.2.2. Correlation coefficient between blood glucose and glycated hemoglobin

$$r = \frac{Cov(xy)}{\sigma \times \sigma y} = 0.56$$

4. Discussion

Diabetes is a disease that causes disability and reduces life expectancy and generates high medical costs [6,7].

Our study involved 39 patients suffering from type 2 diabetes followed at university clinics in Lubumbashi. The average age of the patients was 46.46 ± 9.00 years, which confirms that the prevalence of type 2 diabetes increases with age [6,7].

In our study, we determined the average blood glucose values in diabetic patients after the 1st month, the 2nd month and the 3rd month of treatment.

These mean values were respectively 180.28 ± 51.09 mg/dl; 154.20 ± 49.33 mg/dl and 135.58 ± 36.45 mg/dl after the 1st month, the 2nd month and the 3rd month of treatment. We therefore have information on the glycemic levels of the previous three months. Furthermore, the statistical analysis showed that the average blood glucoseq obtained after the 1st month of treatment was significantly higher ($P < 0.05$) than those obtained after the 2nd month and the 3rd month of treatment. On the other hand, there was no significant difference between the average blood glucose obtained after the 2nd month of treatment and that obtained after the 3rd month of treatment. These results demonstrate the effectiveness of antidiabetic treatment established by doctors and the strict monitoring of this treatment by patients.

In principe, the blood glucose results suggest that the determination of blood glucose is sufficient to predict the progression of the disease. But isolated blood glucose, unlike glycated hemoglobin (HbA1c), does not account for the peaks of hyperglycemia recorded in previous days [7].

Indeed, hemoglobin A1c makes it possible to assess glycemic balance over a longer periode while fasting blood glucose is a snapshot of the glycemic state [9]. According to Zendjabil et al [11], the glycated hemoglobin lever is a cumulative and retrospective refection of the qualitif of glycemic balance over a period of 12 weeks preceding the dosage. Another advantage of the measurement of glycated hemoglobin is that it is much less subject to intra-individual variations than the measurement of blood glucose, the latter varying significantly depending on numerous parameters [4].

In our study, the HbA1c value after the 3rd month of treatment was 5.90 ± 0.55 % while the reference values are 3.5-6.5 % [6], which confirms that the antidiabetic treatment received by the patients was effective. Furthermore, our results showed that there is a positive correlation between HbA1c and blood glucose (r=0.56).

Indeed, there is a link between the increase in HbA1c and the increased risk of complications. Thus, for each 1% increase in HbA1c, it is observed a relative increase of 30% in microvascular complications in diabetics [10].

5. Conclusion

The average blood glucose obtained after the 1st month of antidiabetic treatment was significantly higher ($P<0.05$) than those observed after the 2nd and the 3rd months of treatment. The glycated hemoglobin value was 5.90 ± 0.55% and was within the physiological limits of this parameter. In addition, a positive correlation (r=0.56) was found between blood glucose and HbA1c. Our results indicate that the treatment followed by the patients was effective and show the need for measuring HbA1c at the same time as that of blood glucose in monitoring treatment in diabetic patients

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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