Am J Blood Res 2020;10(5):252-256
www.AJBlood.us /ISSN:2160-1992/AJBR0122811

Original Article

Detection value of glycosylated hemoglobin in the diagnosis of diabetic microangiopathy

Bo Yue[1*], Danjie Li[1*], Xiaoqiang Wei[2]

Departments of [1]Clinical Laboratory, [2]Blood Transfusion, Changhai Hospital, Naval Medical University, Shanghai, China. [*]Equal contributors and co-first authors.

Received September 3, 2020; Accepted September 26, 2020; Epub October 15, 2020; Published October 30, 2020

Abstract: Objective: To analyze the detection value of glycosylated hemoglobin (HbA1c) in the diagnosis of diabetic microangiopathy. Methods: A total of 45 diabetic patients with microangiopathy treated in our hospital from January 2017 to December 2017 were enrolled in the study group, and 45 diabetic patients without microangiopathy in the same period were enrolled in the control group. The levels of HbA1c, fasting blood glucose, D-dimer and antithrombin III (AT-III) of patients were compared between the two groups. Results: Compared with the control group, the study group had significantly higher fasting blood glucose (7.42±0.54 mmol/L vs. 11.36±0.83 mmol/L) and glycosylated hemoglobin (7.62±0.32% vs. 10.65±0.72), but significantly lower D-dimer (842.96±195.74 μg/L vs. 511.36±110.25 μg/L) and AT-III levels (73.52±23.69% vs. 73.52±23.69%; all P<0.05). Conclusion: Glycosylated hemoglobin level can not only clearly show the specific conditions of microangiopathy, but also help to diagnose, prevent and treat diabetic microangiopathy, which is worthy of promotion in clinic.

Keywords: Glycosylated hemoglobin, diabetic microangiopathy, hypersensitivity C-response protein, D-two dimer

Introduction

At present, diabetes is a common chronic metabolic disorder in clinic, which is characterized by high blood sugar [1]. So far, the pathogenic factors of diabetes are not completely clear. Microangiopathy is a specific complication of diabetes, of which the pathological manifestations are mainly disorders in nerve tissue, retina, myocardium and kidney [2]. Diabetic microangiopathy is generally becoming a hot spot nowadays. In clinic, glycosylated hemoglobin (HbAlc) level is the widely used gold standard for diabetes control [3]. In patients with diabetic microvascular disease, their blood glucose is in a high level for a long time, causing chronic injury and dysfunctions in many tissues [4]. For example, physiological reactions such as fiber activity and anticoagulation may occur, which then lead to various changes, affecting the treatment and prognosis of patients [5]. Therefore, this study mainly analyzes the detection value of glycosylated hemoglobin in the diagnosis of diabetic microvascular lesions.

Materials and methods

Patients

A total of 45 patients with diabetic microvascular lesions treated in Changhai Hospital, Naval Medical University from January 2017 to December 2017 were recruited in the study group. In the same period, 45 diabetic patients without microvascular lesions were recruited in the control group. This experiment was approved by the Ethics Committee.

In the control group, there were 26 cases of male patients, 19 cases of female patients, with the mean age of 62.41±2.36 years old (range from 50 to 75 years old). In the study group, there were 15 male patients and 20 female patients, with the mean age of 62.89± 2.45 years old (range from 51 to 74 years old). There was no significant difference in basic data between the two groups (P>0.05).

Inclusion criteria: Patients in the study group were clearly diagnosed as diabetic microvascu-

Table 1. Comparison of glycosylated hemoglobin and fasting blood glucose levels

Groups	Case	Glycosylated hemoglobin (%)	Fasting blood glucose (mmol/L)
Control group	45	7.62±0.32	7.42±0.54
Study group	45	10.65±0.72	11.36±0.83
t		25.797	26.692
P		0.000	0.000

Table 2. Comparison of D-dimer and AT-III

Groups	Case	D-dimer (μg/L)	AT-III (%)
Control group	45	511.36±110.25	96.47±16.85
Study group	45	842.96±195.74	73.52±23.69
t		9.902	5.296
P		0.000	0.000

Note: AT-III: antithrombin III.

lar disease; all the enrolled patients had signed the informed consent voluntarily. Exclusion criteria: Patients with psychological and mental diseases; patients with physiology and language dysfunction; patients with heart, liver, kidney and other serious organ dysfunction; patients had gout, trauma, inflammatory diseases, liver cirrhosis and kidney diseases; patients with kidney disease, and their urinary protein level was 3 g/L or above; patients had urinary tract infection; patients with neuromuscular disease caused by other factors.

Outcome measurement

The levels of HbAlc (normal value: 4%-6%), fasting blood glucose (normal value: 7.0 mmol/L), D-dimer (normal value: <0.2 mg/L) and the AT-III (normal value: 230-350 mg/L) were detected and compared between the two groups.

Detection methods

About 4 mL of fasting venous blood was collected into two tubes. A tube (2 mL) contained EDTA-K2 anticoagulants and the blood sample stand at room temperature for 2 hours, and then Hba1c level was detected by borate affinity chromatography method. As for the blood in another tube, the sample was centrifuged to detect fasting blood glucose, Hypersensitive C-reactive protein (CRP), D-dimer and antithrombin III (AT-III) by olympos AU480 automatic biochemical analyzer. Hypersensitive CRP was detected by immunofluorescence dry quantitative method. D-dimer and AT-III were detected by immune turbidimetric method and developing substrate method.

Statistical analysis

Statistical software SPSS 21.0 was used for data analysis. Measurement data was expressed as mean ± standard deviation ($\bar{x}$ ± sd) and analyzed by t test. Counting data were expressed as rate (%) and analyzed by χ^2 test. P<0.05 indicated a statistically significant difference.

Results

Diabetic patients with microvascular lesions had significantly higher HbAlc and fasting blood glucose levels than those without

Compared with the control group, the study had significantly higher HbAlc and fasting blood glucose (both P<0.001). The results are shown in **Table 1**.

Diabetic patients with microvascular lesions had significantly lower D-dimer and AT-III levels than those without

The D-dimer level in the control group and the study group were 511.36±110.25 μg/L and 842.96±195.74 μg/L, while AT-III were 96.47±16.85% and 73.52±23.69%, respectively. Compared with the control group, the study group had significantly lower D-dimer and AT-III levels (both P<0.001, **Table 2**).

Discussion

In recent years, with the rapid social and economic development in China, people's living standard has been significantly improved, so the diet structure of Chinese has changed greatly. The incidence of diabetes in China has gradually increased. At present, there is still no cure method for diabetes, and the current treatment is mainly based on reducing diabetic complications and controlling blood glucose. Generally, with the development of the disease, diabetic patients will have a variety of complications, including cardiovascular and cerebrovascular diseases and microvascular lesions as well as retinopathy, diabetic peripheral neuropathy and renal disease, among which the

more common complications are microvascular lesions. The main characteristics of diabetic microangiopathy are the formation of microthrombus, thickening of capillary basement membrane and vascular proliferation [6]. Diabetic microvascular disease causes serious damage to the patients on multiple organs, which is a serious threat for life safety of patients as it reduces the patients' quality of life. Hence, early diagnosis and treatment of diabetic microvascular disease is particularly important, which may help control the further development of the diabetes, improve the life quality, and reduce the mortality and disability of patients [7]. The clinical manifestations of the microvascular lesions are not significant specificity, therefore, patients are often diagnosed in the advance stage and they already have been accompanied by many systemic complications. The best treatment time has been missed, and they often have poor prognosis. Thus, how to implement effective diagnostic methods and prediction methods of diabetic microvascular disease is particularly important [8].

HbAlc can accurately diagnose microvascular lesions, and it has been paid close attention by lots clinical researchers [9]. HbAlc refers to the proportion of hemoglobin that can bind glucose in all hemoglobin, which plays an important role in treatment and prognosis assessment. The synthesis process of glycosylated hemoglobin is relatively slow, and cannot be reversed. HbAlc level can accurately reflect the blood glucose levels in the body. Moreover, the HbAlc level won't be influenced by outside factors, such as glucose fluctuation, and food, etc., therefore, HbAlc can accurately reflect the blood sugar levels in patients over the past six to eight weeks [10-12]. HbAlc plays an important role in controlling blood sugar levels [13]. In the diagnosis of diabetes complications, HbAlc may also provide important reference data. Fasting blood glucose can correctly reflect only blood sugar levels, but it can be easily influenced by outside factors at some point, including eating and sugar metabolism. In our study, we found that diabetic patients with microvascular lesions had significantly higher HbAlc and fasting blood glucose levels than those without. It can be seen that HbA1c can clearly show the changes of patients' diseases and has high sensitivity, which can provide data reference for clinical treatment, diagnosis and evaluation of diabetic microvascular disease [14].

Diabetic patients with microvascular disease have rough capillary wall, and the endothelium is significantly damaged. At the same time, they are accompanied by thick capillary basement membrane and abnormal platelet function [15]. Once the diabetic patients had microvascular lesions, their platelet activation status, form and function were significantly changed. Meanwhile, their blood glucose is high in the body for a long time, which damages the vascular endothelium, strengthens the function of activated platelet to hyperfunction status, thus further damages the microvascular endothelial, increases ischemia and hypoxia conditions, eventually leads to diabetes microvascular lesions [16]. Platelet count can accurately reflect the dynamics and generation of platelets, and the average volume of platelets can accurately reflect the function and activation state of platelets. Therefore, platelet count and average volume of platelets can be regarded as the main diagnostic indicators in the diagnosis of diabetic microvascular diseases [17].

D-dimer can reflect thrombosis and hypercoagulability in vivo. It is a major indicator for the identification and diagnosis of secondary fibrinolysis and primary fibrinolysis, and is particularly important in the diagnosis, prognosis and observation of therapeutic effects of thrombotic and hypercoagulability. We found that diabetic patients with microvascular lesions had significantly lower D-dimer level than those without. The reason may be that in diabetic patients, their body fat metabolism change and lipid synthesis increase, causing the microcirculation disorder and thus leading hypoxia and ischemia, which then causes damage to vascular intima, induces the chronic complications such as vascular sclerosis of arterial congee appearance, and leads to high coagulation state of blood in the body. Eventually, the level of the D-dimer improved [18-20]. In addition, elevated d-dimer level indicates the abnormal of the fibrinolysis system and hypercoagulability in patients with diabetic microangiopathy.

The AT-III is the key substance that avoids thrombosis. The high coagulation state can be reflected by the level of AT-III. Our results showed that diabetic patients with microvascular

lesions had significantly lower AT-III level than those without. The possible reason may be that on the one hand, the damage of vascular endothelial cell leads to the decrease of AT-III release; on the other hand, the exposure of vascular collagen stimulates the clotting factors, which inhibited the blood coagulation factor and fibrinolysis and thrombin activation, thus inducing the AT-III itself inactivation [21]. The study results from Yang et al. showed that the study group had significantly higher glycosylated hemoglobin and fasting blood glucose levels than the control group, which is consistent with the results of our study [22].

In conclusion, detection of glycated hemoglobin plays an important role in the assessment and diagnosis of diabetic microvascular lesions. Regular detection of fasting blood glucose, glycosylated hemoglobin, D-dimer and the AT-III could help improve the accuracy of microvascular lesion assessment, which is worth further promotion in clinic.

Disclosure of conflict of interest

None.

Address correspondence to: Xiaoqiang Wei, Department of Blood Transfusion, Changhai Hospital, Naval Medical University, No. 168 Changhai Road, Yangpu District, Shanghai 200433, China. Tel: +86-15618846338; E-mail: shuxuekewxq@163.com

References

[1] Hu FL. The value of glycosylated hemoglobin in the evaluation of diabetic microangiopathy. Chin Heal Standard Management 2017; 8: 103-104.

[2] Xu HB. The value of glycosylated hemoglobin detection in the evaluation of diabetic microangiopathy. Chin J Mod Drug Appl 2016; 18: 50-51.

[3] Zhao F. The clinical value of glycosylated hemoglobin detection in the evaluation of diabetic microangiopathy. Chin J Clin Ration Drug Use 2016; 9: 139-140.

[4] Chen LQ. Application value of glycosylated hemoglobin A1c detection in clinical evaluation of diabetic microangiopathy. World Clin Med 2016; 10: 237-238.

[5] Ahn J, Cha KS, Choi JC, Choi JH, Choi JH, Hong TJ, Jang HY, Lee HC and Oh JH. TCT-346 clinical impact of five-month follow-up glycosylated hemoglobin on cardiovascular outcomes in diabetic patients with ST-segment elevation myocardial infarction undergoing primary percutaneous coronary intervention. J Am Coll Cardiol 2016; 60: 40-46.

[6] Cao YL. The clinical value of glycosylated hemoglobin detection in the evaluation of diabetic microangiopathy. Chin Heal Standard Management 2017; 8: 115-116.

[7] Li L. The value of HbA1c detection in the clinical evaluation of diabetic microangiopathy. Diabetes New World 2016; 19: 63-65.

[8] Ma HL. The value of HbA1c detection in the evaluation of diabetic microangiopathy. Chin J Mod Drug Appl 2016; 10: 89-90.

[9] Huang GL, He XH and Pu R. Significance of detection and analysis of coagulation function in patients with type 2 diabetes and microangiopathy. Shenzhen J Integr Tradit Chin Western Med 2017; 27: 65-66.

[10] Zhao Y, Chen SY, Chen WJ, Yang XY and Huang YM. Analysis of glycosylated hemoglobin and coagulation function in patients with type 2 diabetes. J Tropical Med 2016; 16: 1264-1266.

[11] Li SF, Shi JL, Li RX, Xu FJ, Jin NN, Gao PF, Han Y, Tian XB and Liu Y. The relationship between diabetic microangiopathy and type 2 diabetes course and glycosylated hemoglobin. Prac Clin Med 2016; 17: 10-13.

[12] Fei LN. Observation on the clinical value of combined detection of glycosylated hemoglobin, blood lipids, blood sugar and various biochemical indicators of renal function. Lab Med Clin 2016; 13: 290-291.

[13] Jin YL, Yuan YH, Quan JH, Wang JM, Wu JF, Yang FH, Qin XL and Chen XM. Clinical study of the effect of blood homocysteine on diabetic nephropathy and type 2 diabetes with carotid plaque. Diabetes New World 2016; 19: 119-121.

[14] Gao Y, Yuan LL and Zhang HS. Effect of safflor yellow on angiotensin II type 1 receptor in kidney cells of diabetic nephropathy model rats. J Clin Rehabil Tis Eng Res 2016; 20: 2677-2683.

[15] Zhang S, Zhang T, Yang JW, An M and Tang BS. Safety and effectiveness of tranexamic acid in reducing bleeding during total knee replacement in type 2 diabetic patients. J Clin Rehabil Tis Eng Res 2017; 21: 1681-1687.

[16] Zhu LP. Study on the correlation between glycosylated hemoglobin and fasting blood glucose in diabetic patients. Chin J Mod Drug Appl 2017; 11: 51-52.

[17] Yoneda C, Tashima-Horie K, Fukushima S, Saito S, Tanaka S, Haruki T, Ogino J, Suzuki Y and Hashimoto N. Association of morning fasting blood glucose variability with insulin antibodies and clinical factors in type 1 diabetes. Endocr J 2016; 63: 603-609.

[18] Ito H, Omoto T, Abe M, Matsumoto S, Shinozaki M, Nishio S, Antoku S, Mifune M and Togane M. Relationships between the duration of illness and the current status of diabetes in elderly patients with type 2 diabetes mellitus. Geriatr Gerontol Int 2017; 17: 24-30.
[19] Wang FJ. The application value of glycosylated hemoglobin determination in diagnosing cardiovascular complications of diabetes. Contemp Med 2016; 22: 98-99.
[20] Su DD and Li YY. Application analysis of glycosylated hemoglobin and fasting blood glucose in clinical diagnosis and treatment of diabetes. Diabetes New World 2016; 19: 90-91.
[21] Xie HJ and Liang WL. Significance of detection of glycosylated hemoglobin and uric acid in patients with diabetic nephropathy. Chin Prac Med 2016; 11: 46-47.
[22] Yang XR. The evaluation value of glycosylated hemoglobin detection for diabetic microangiopathy. Henan Med Res 2017; 26: 2749-2750.