

Diabetes Mellitus and Erythrocytes: A Relationship

Abstract

Hyperglycemia, or high blood sugar, is a primary sign of diabetes mellitus (DM). The most numerous cells in the bloodstream, erythrocytes are also the first to notice changes in the composition of the plasma. Erythrocyte structure and function are impacted by persistent hyperglycemia. Erythrocyte-related markers can serve as a useful guide for the prevention, diagnosis, and treatment of diabetes mellitus (DM) and its consequences. In order to provide more indicators for the early prevention of DM complications and to monitor the therapeutic effect of DM, this paper reviews the normal structure and function.

Keywords: diabetes mellitus • type 1 diabetes • type 2 diabetes • cognitive impairment • risk factor • probable diabetes • diagnosis • hemoglobin

Introduction

A series of metabolic illnesses known as diabetes mellitus (DM) are characterised by hyperglycemia and abnormalities in insulin secretion and/or activity. Diabetes risk factors include heredity, obesity, inactivity, poor diet, stress, urbanisation, impaired glucose tolerance, and hypertension. Patients with diabetes who have chronic hyperglycemia have a higher risk of long-term damage to and functioning of multiple organs, especially the eyes, kidneys, nerves, heart, and blood vessels, which can lead to a variety of diabetic complications. These issues affect patients' quality of life while also raising the risk of morbidity and mortality [1]. Global prevalence of diabetes in individuals over 18 has climbed from 4.7% in 1980 to 9.3% (463 million) in 2019, and it is predicted to rise to 10.2% (578 million) by 2030 and 10.9% (700 million) by 2045, according to an epidemiological survey, which found that DM is widespread around the world. Diabetes continues to be a metabolic disease that endures throughout life and is challenging to cure, despite advancements in medical technology and substantial research into the condition. As a result, the focus of diabetes diagnosis and treatment has shifted to minimising the likelihood of complications, managing their development, and enhancing quality of life. Red blood cells (RBCs), also known as erythrocytes, are the cells that consume the most glucose [2]. The morphology, metabolism, and function of erythrocytes are invariably prone to a number of alterations when there is persistent hyperglycemia, which also affect hemorheology and microcirculation. What alterations take place in erythrocytes, and how do these alterations relate to the development of diabetes? What impact do these developments have on diabetes diagnosis, care, and prognosis? This study seeks to provide more information on the erythrocyte changes seen in diabetic patients, the role of erythrocytes in the emergence of diabetes complications, and the use of erythrocyte-related markers to track the course of the disease and avoid complications [3].

The majority of the blood's cells are erythrocytes. Due to their flexibility, they can freely move across capillaries, carrying carbon dioxide to the lungs and supplying oxygen to tissues. The primary oxygen-carrying protein, hemoglobin (Hb), is the most prevalent protein

Albert Gunawardena*

Department of Applied Nutrition, Wayamba University of Sri Lanka, Makandura, Sri Lanka

*Author for correspondence:

Gunawardena@gmail.com

Tel: 944520197652

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in erythrocytes. Erythrocytes' membrane is crucial for preserving the stability of cell shape and function. Erythrocytes can carry oxygen due to deformation, aggregation, and adhesion. Erythrocytes' unusual biconcave shape and tiny volume result in a high surface area to volume ratio that allows oxygen and carbon dioxide to enter and exit the cell quickly and gives rise to the cell's remarkable deformability [4]. The red bone marrow produces erythrocytes, which mature for around 7 days before being discharged into the bloodstream. Erythropoietin regulates the creation of erythrocytes in the bone marrow, which happens at a startling rate of more than 2 million cells every second (EPO). Erythrocytes have a lifespan of 100 to 120 days on average, and they are primarily degraded in the liver and spleen's reticuloendothelial system. Human erythrocyte synthesis and destruction contribute to the maintenance of a dynamic equilibrium and a constant erythrocyte count [5].

Materials and Methods

Using the 1999 WHO diagnostic criteria for diabetes mellitus as our guide, we decided to focus our research on type 2 diabetes mellitus (DM) patients who were hospitalised to Sir Run Shaw Hospital between March 2011 and March 2012. Exclusion criteria for the study included patients with the following conditions or treatments: (i) acute diabetic complications; (ii) insulin treatment; (iii) use of medications like thiazolidinedione, statins, vitamin K, warfarin, vitamin D, calcium supplements, bisphosphonates, vitamin A, and hormones; (iv) bone conditions like bone tumours, osteoporosis, and fracture; and (v) nephropathy, liver dysfunction, kidney dysfunction. The medical ethics committee at Sir Run Shaw Hospital gave their approval to this study [6].

Each participant signed an informed consent form in writing. First, the patients were split into the three groups HbA1c-H, HbA1c-M, and HbA1c-L based on whether their blood sugar levels were well-controlled or clearly hyperglycemic. The three groups were compared using the TOC, ucOC, and other indicators. The patients were then split into two groups, Group tOC-H and Group tOC-L, based on the average level of tOC. The two groups' glucose metabolism indexes were contrasted. Finally, the patients were split

into Group ucOC-H and Group ucOC-L based on the average level of ucOC. The two groups' glucose metabolism indexes were also contrasted [7].

Discussion

Microangiopathy and HbA1c were not only significant risk factors for CI in T1DM patients but also biological risk markers for CI among the risk factors discussed above. Blood vessels, especially the teeny blood vessels and the small peripheral blood vessels, were known to be harmed by T1DM. It is possible to anticipate the development of intracerebral vascular lesions and CI by observing changes in peripheral small vessels, such as the central retinal artery's narrowing and the central vein's enlargement [8]. HbA1c was a frequently used indicator of glycaemic control and glycaemic monitoring. Given that HbA1c and CI have a linear relationship, we may use HbA1c in conjunction with retinal blood vessels to predict the onset of CI early on.

According to the study, these individuals' baseline cognitive abilities were superior, which allowed them to effectively control their blood sugar levels. These findings might possibly inspire new theories about mild hypoglycemia. We might therefore draw the conclusion that there was a relationship between glucose control and cognitive function. But we did point out that these studies included T2DM patients [9]. Such research was important to draw T1DM patients' attention to blood glucose control and CI and give clinical researchers a fresh idea for therapy or prevention because there was no intervention trial on T1DM patients with the goal of preventing cognitive loss.

Cognitive function was also impacted by hypertension. In children with T1DM, the incidence of hypertension and hyperlipidaemia was substantially higher from 1 to 20 years after beginning than it was in children without diabetes, according to a study [10]. Both peripheral and central neuropathy may be caused by hypertension. Numerous factors contributed, such as oxidative stress, vascular endothelial damage, inflammation, and others. Pathological alterations such white matter lesions, blood brain barrier damage, and neurovascular unit injury may result from these pathways. Additionally, a different

study discovered that children with T1DM may develop hypertension if gut flora, such as bifid bacteria, was diminished. In T1DM patients, lowering blood pressure was useful in lowering the incidence of CI [11].

Conclusions

As they mature, erythrocytes shed all of their organelles, making them fairly unusual cells. They decrease the amount of energy consumed for the major functions they must carry out and only conserve a small number of metabolic pathways for getting energy. Erythrocytes are hence extremely vulnerable to any disease. Diabetes patients' glucose metabolism disorders have a significant impact on the morphological makeup and physiological operations of erythrocytes. These disorders also cause inadequate microcirculation perfusion, hypoxia, and OS, which promote the development of diabetic complications and lower the quality of life for diabetic patients. Because erythrocytes play a significant role in the pathological development of diabetic complications, the relevant erythrocyte detection markers also correlate with the occurrence and development of these issues. Although there have been many advances in the study of diabetes, the prevention and management of its consequences continue to be significant public health issues. Erythrocyte-related indicators can offer more clinical data and can be used to track the development of diabetes and associated complications as they are one of the cells that can sense blood glucose changes early and continually.

Conflict of Interest

None

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