A REVIEW ON THE IMPORTANCE OF HAEMATOLOGICAL MARKERS IN RELATION TO TYPE 2 DIABETES MONITORING

ABSTRACT

Diabetes mellitus is a chronic disease that occurs when the pancreas does not produce enough insulin or when the body cannot effectively use the insulin that it produces. The most common type of diabetes is type II diabetes, which is characterized by insulin resistance or relative insulin deficiency. Diabetes mellitus shows a significant derangement in various hematologicalparameters, including changes affectingred bloodcells.

Complete blood counts (CBCs) are a useful tool for monitoring a patient's diabetes control and for identifying potential CBC parameter changes that could be signs of diabetes mellitus detection and management. The main cause of both micro and macrovascular complications in diabetic patients is inadequate control of their blood sugar levels. Regular exposure to red cell hyperglycemia causes the haemoglobin protein to continuously glycated, altering the molecule's structure and function. Along with protein glycation, hyperglycemia affects red blood cells in other ways as well. These include altered mechanical characteristics, increased aggregation, and osmotic fragility, which alter erythrocyte structure and the hemodynamic process.

This research evaluates the predictive power of red blood cell characteristics for glycemic management in individuals with type 2 diabetes.

The aim of this study is to investigate the alterations in haematological parameters during diabetes mellitus.

Keywords: Diabetes Mellitus, HBA1C- Glycated Hemoglobin, Hyper Glycemic Index, RBC Indices

ABBREVIATIONS

CBC: Complete Blood Count
T2DM: Type2 Diabetic Mellitus
FBS: Fasting Blood Sugar
RBS: Random Blood Sugar
OGTT: Oral Glucose Tolerance Test
MCV: Mean Corpuscular Volume
MCH: Mean Corpuscular Hemoglobin
MCHC: Mean Corpuscular Hemoglobin Concentration
RDW: Red cell Distribution Width

1. INTRODUCTION

Diabetes mellitus is a chronic disease associated with the inability to produce an adequate amount of hormone insulin or to effectively use the insulin produced by the body [1]. It is a diverse set of disorders defined by different abnormalities in the control of protein, lipid, or carbohydrate metabolism[2]. Uncontrolled blood glucose levels have been associated with a number of conditions that can cause disability, such as cardiovascular disease, nerve damage that can result in different types of neuropathies and kidney damage that can leadto diabetic nephropathy, diabetic foot that can cause a drop in body temperature, and ocular diseases that primarily affect the retina and cause blindness and vision loss [3].

Long-term exposure to high glucose causes hemoglobin to be glycated by enzymes, and membrane proteins cause the aging of red blood cells, which may eventually causehyperlipemia with a lower red blood cell count. A different process might result from a change in the fluid electrolyte balance. In T2DM patients with high

blood glucose, the activity of the erythrocyte membrane cation pump protein is impaired[4].

The most widely used laboratory tests for screening and tracking blood glucose levels are HbA1C, OGTT, and FBS[5]. The hemoglobin variants known as HbA1C develop when the glucose molecule condenses and attaches itself to the beta chain of hemoglobin's N-terminus amino acid. The HbA1C blood test indicates a patient's average blood glucose level during the previous two to three months, or the predicted life span of red blood cells [6]. The best useof HbA1C as a biomarker is for long-term blood glucose monitoring. In contrast to other glucose-based tests, it is not as affected byvariables like dietary consumption, stress levels, physical activity, and immediate treatment response [7].

A complete blood count consists of a panel of tests that are typically used to differentiate between various forms of anemia. RBC parameters include MCV, MCH, MCHC, RDW, hemoglobin, hematocrit, and red blood cell count[8]. One potential cause of elevated RDW in T2DM patients could be hyperglycemia-induced oxidative damage and chronic inflammation. A high intracellular glucose concentration brought on by an influx of glucose to the erythrocyte via the insulin-dependent glucose transporter (GLUT1) may be the cause of an increased MCV in patients with poor glycemic control. This rapid diffusion of water into the cell flattens the biconcave disk and bloats the cell [8,9].

Even though HBA1C is still the gold standard for evaluating long-term glycemic management, poor nations have limited access due to the high cost of this test when it comes to routine diagnostic care[10]. Red cell characteristics that can be utilized to track the course of complications and diabetes control are the primary focus of this review. Thereby making them a valuable tool for the assessment of T2DM patients[11].

Ultimately, our efforts have been limited assess of HBA1C testing seems to be a key marker of inadequate glycemic control in T2DM patients as well as a major obstacle to improving glycemic control. HBA1C testing is relatively expensive in certain private sectors and is not easily accessible in public health faculties in rural areas of developing nations like India. Thus, in nations with limited resources, a widely available instrument for tracking glycemic status is required. Therefore, the goal of the study is to assess red blood cell characteristics for monitoring type 2 diabetes patients. Our findings may help with T2DM management in the future.

2.INSULIN RESISTANT DIABETES MELLITTUS

Diabetes mellitus is a type of metabolic disease characterized by elevated blood sugar levels, which are typically caused by abnormalities in insulin secretion, flow, or both. Because of hyperinsulinemia, the body's cells and tissues are not receiving enough insulin, which leads to irregularities in the metabolism of fat, protein, and carbohydrates. Insulin-dependent diabetes mellitus (type 1) and non-insulin-dependent diabetes mellitus (type 2) are the two main forms of diabetes. Reduced insulin secretion will prevent glucose from entering the cell, which will cause hyperglycemia. It is possible for insulin to reduce hyperglycemia[13].

Type 2 diabetes mellitus is the most prevalent type of disease in adults. It is a long-term metabolic illness characterized by low insulin synthesis or insulin resistance, both of which raise blood sugar levels[14]. Chronic hyperglycemia causes a number of physiological and pathological processes, such as oxidative stress, which impacts lipid metabolism, inflammatory response, cell growth, immunological, and hematological parameters, all of which are evident in patients with poorly controlled diabetes[15].Increasedoxidative stress causes hematological changes that impact platelets, WBCs, and RBCs in terms of their structure, function, and metabolism[16].

The primary cause of end-stage renal disease is diabetes mellitus, and a significant number of patients with diabetes mellitus experience renal complications[17].

Diabetes patients experience anemia twice as frequently as non-diabetics. When comparing individuals with diabetes nephropathy to those with nephropathy from other causes, the risk of anemia isincreased[18]. Chronic hyperglycemia associated with diabetes may cause a hypoxic environment in the renal interstitum, which will reduce erythropoietin synthesis.

An increased leukocyte count relates to the presence of neuropathy and vasculopathy[19].

The autoimmune response that results in the body's defense system attacking the beta cells in the pancreas that produce insulin is the cause of type 1 diabetes mellitus. The body can no longer create insulin as a result[20].

It's crucial to remember that patients with diabetes are more atherogenic from dyslipidemia than people without the disease. Dyslipidemia, hypertension, and altered hematological indicators are all components of the metabolic syndrome, which includes type 2 diabetes[21].

3.ASSESMENT OF GLYCEMIC INDEX

In patients with diabetes, inadequate management of their blood sugar levels is a major risk factor for the development of micro and macrovascular complications [22]. In diabetes, microvascular complications are the main cause of death rather than cardiovascular disease[23]. The disease known as atherosclerosis is inflammatory. Nearly every blood component, including platelets, WBCs and RBCs has a part in the underlying pathophysiology of atherosclerosis[24].

It's critical to achieve HBA1C range optimization of 6.5–7%[25]. Glycated protein, urine sugar, fructosamine, glycated hemoglobin (HbA1C), urine protein such as micro albuminuria, glucose level in plasma (random sample), and urine sugar are among the laboratory tests used to monitor patients with diabetes mellitus[26].

HBA1C is the glycemic range for the previous two to three months in individuals with diabetes. One can estimate the mean quantity of glucose based on the HBA1C level [27,28,29].

At first, HBA1C was thought to be an abnormal hemoglobin in diabetic patients[30]. The extremely porous erythrocyte cell membrane allows hemoglobin to be exposed to higher intracellular glucose levels during hyperglycemia. The non-enzymatic glycation of valine at the n-terminal of the hemoglobin beta-chain results in the formation of glucohaemos. [31]. Increased HbA1C is positively related to the longer duration of type 2 diabetes[32].

Diabetes patients may experience hypertension and vascular illness as a result of high levels of glycated hemoglobin, which have been demonstrated to impair endothelium-mediated vasoactive response[33]. The cytoplasmic viscosity of the red blood cell, osmotic disruption, and structural and functional alterations in the hemoglobin molecule can all be linked to delayed glycosylation. Any one or all of the red cell analytical measures, including Hb, RBC count, HCT, MCV, and MCHC, may show these alterations. Red cell indices can track the course of a diabetic patient's disease since microvascular complications are linked to elevated HBA1C, changes in red cell deformability, and other hemorheological alterations[34].

Erythrocytes typically live 117 days in men and 106 days in women. Erythrocytes with varied ages and degrees of hyperglycemia exposure are present in the blood sample. Although younger erythrocytes are more numerous, older erythrocytes are probably more exposed to hyperglycemia [35,36]. Numerous hematologic, genetic, and illness-related variables influence HbA1C [37,38].

4.ASSOCIATION OF BLOOD CELL PARAMETERS IN DIABETES MELLITTUS

The complete blood count, which consists of a panel of analytical tests typically used to distinguish between various types of anemia, includes RBC characteristics[39]. The metrics associated with red blood cells are as follows: the number of red blood cells, the hematocrit, the hemoglobin, the mean corpuscular volume, the mean corpuscular hemoglobin concentration, and the red cell distribution width[40].

Many studies have shown a relationship of RBC indices and HbA1C [41,42].

While mean corpuscular hemoglobin and mean corpuscular hemoglobin concentration characterize the hemoglobin content of RBC, mean corpuscular volume shows the size of RBC[43].Hyperglycemia affects red blood cell aggregation and deformability and shortens its lifespan [44].

Several hematological changes affect red blood cells, white blood cells and coagulation factors that are shown to be directly associated with diabetes mellitus. Other hematological abnormalities reported in diabetes patientS include RBC, WBC, and platelet dysfunction. RDW is a measurement of size variation among circulating red cells and is calculated as part of routine CBC. The RDW along with mean cell volume, is useful in the differential diagnosis of anemia [45].

Type 2 diabetes mellitus is a fundamental public health problem that has been increasing dramatically worldwide[46]. Inappropriate control of blood glucose in diabetes patients is the main key to the incidence of both micro and macrovascular problems[47].

Hemoglobin and diabetes profiles are closely related. Blood viscosity is also significantly influenced by hemoglobin levels. Blood platelets are essential to the process of blood coagulation. There have been reports of altered platelet shape and function in diabetes patients[48].

Glycation of hemoglobin and membrane proteins causes persistent hyperglycemia in diabetes, which is linked to metabolic, structural, and functional alterations in red blood cells. Moreover, endothelial tissue damage and RBC malfunction are linked to elevated levels of oxygen free radical generation and chronic inflammation[49]. In addition, RBC glycation causes increased aggregation and decreased deformities because it decreases membrane fluidity[50].

4. CONCLUSION

Haematological alterations during diabetes can lead to long-term complications, a poor quality of life, and even death.According to the current study's findings, anemia is more likely to occur in diabetic individuals with inadequate control. The CBC is a standard, easy test that provides significant results. A low-cost method for monitoring patients with type 2 diabetes is the CBC. These measures may be an early sign of the onset of anemia. This suggests that regular CBC examinations are necessary for the early identification and treatment of anemia in diabetes patients in primary care settings. This will help decrease the associated morbidity caused by impaired immunity related to anemia and complications such as diabetic ketoacidosis.

CONSENT

It is not applicable

ETHICAL APPROVAL (WHEREEVER APPLICABLE)

It is not applicable

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