Research Article

Anemia and Microvascular Complications in Type 2 Diabetes Mellitus

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Abstract

Background: In Type 2 Diabetes Mellitus, anemia affects tissue oxygenation and glycemic homeostasis, which promotes the premature onset of microvascular damage.

Objective: To determine the association between the degree of anemia and microvascular complications in patients with type 2 diabetes mellitus.

Methods: This is a cross-sectional, analytical study. Patients with diabetes mellitus and any complications were included. A review of electronic medical records of patients who met the selection criteria was conducted. The information was captured in a database previously structured in the SPSS statistical software and analyzed using inferential statistics.

Results: With a total of 113 patients, with an average age of 62.23±10.3 years. Of the patients with Type 2 Diabetes Mellitus, 54.9% (62) presented with anemia. Of these, 46.9% (53) presented with Grade I, 5.3% (6) with Grade II, and 2.7% (3) with Grade III anemia, according to the World Health Organization. In terms of microvascular complications, only 5.3% (6) of those with diabetic retinopathy presented with anemia, the most frequent being Grade I. In the group of patients with diabetic neuropathy, Grade I was found in 19.5% (22), and with nephropathy it was 35.4% (40), with 30.1% (34) being Grade I.

Conclusions: Anemia was present in each of the microvascular complications, with Grade I being the most frequent.

Keywords: Diabetes mellitus; Type 2; Diabetes mellitus complications; Anemia

Introduction

Diabetes Mellitus (DM), a metabolic disease, is characterized by insufficient insulin production or the body's inability to use it efficiently, leading to elevated plasma glucose levels. The World Health Organization (WHO) considers it one of the most significant non-communicable diseases worldwide [1,2]. Approximately 50% of patients are not diagnosed until the onset of the first complications, which increases treatment costs and lost workdays [3]. According to a study conducted in 2018, the prevalence of diabetes in the population over 20 years old increased to 10.3% in men and 11.4% in women, compared to 9.2% and 9.7% in 2012, respectively [4].

DM complications are associated with various factors, including age, especially in postmenopausal women, whom the National Cholesterol Education Program (NCEP) recognizes as a high-risk group for complications. Studies conducted in middle-aged patients found that DM-related microvascular complications are more prevalent in those exceeding this age, often due to coexisting comorbidities such as obesity, hypertension, or prolonged episodes of hyperglycemia [5]. Therefore, this protocol will include patients over 40 years old, aiming to identify microvascular complications more accurately in these individuals.

DM complications can be divided into macrovascular and microvascular disease, considering endothelial damage, the proinflammatory state, and causing vascular remodeling that mainly affects small-caliber blood vessels, impacting organs such as the eyes, kidneys, and limbs [6]. Regarding microvascular complications, a prevalence of 42.6% is reported for neuropathy, 27.5% for retinopathy, and 20.5% for nephropathy [7].

In microvascular complications, diabetic retinopathy is a chronic complication that occurs at the retina level, of varying degrees in almost all patients with a long-standing DM, leading to decreased visual acuity or blindness. It typically begins 10

and 20 years after the onset of diabetes, with rapid progression of uncontrolled glucose [8,9]. Diabetic nephropathy is a glomerulopathy secondary to chronic hyperglycemia, present in both type 1 and type 2 diabetes mellitus. Its diagnosis is based on the presence of albuminuria in 24-hour urine, urinary sediment, and the creatinine clearance test [10]. In the case of diabetic neuropathy, it is a complication where symptoms and signs correspond to peripheral nerve dysfunction, when other causes have been ruled out. There is a prevalence of 10 to 90% in DM patients. It's related to 70% of non-traumatic amputations. It occurs 10 years after the onset of the disease, but less than 50% of them will show symptoms. The prevalence of diabetic neuropathy increases with the progression of DM and the age of the patient, related to the extent and severity with the degree and duration of hyperglycemia [11].

In the management of Type 2 Diabetes Mellitus, metformin, which is well-tolerated, primarily causes gastrointestinal adverse effects that may dissipate shortly after treatment begins. However, a significant side effect is its ability to interfere with vitamin B12 absorption by competing with calcium-dependent receptors needed for this process. This interference can lead to a vitamin B12 deficiency, which in turn can trigger anemia. This vitamin B12 deficiency is more common in older individuals and diabetic patients, regardless of their treatment [12].

Iron deficiency is a common cause of anemia worldwide and is more frequently observed in diabetic patients compared to non-diabetics. Low serum iron levels can alter glucose homeostasis, complicating optimal diabetes control and increasing the risk of vascular complications [13].

Regarding the prevalence of anemia in diabetic patients, it is more commonly observed in women compared to men (38.5% vs. 21.6%, respectively), especially in those with inadequate glycemic control. The onset of anemia occurs at an average age between 55 and 60 years [14].

These complications increase both population morbidity and mortality and require greater government investment for proper care. Previous studies suggest that anemia can compromise tissue oxygenation and glycemic homeostasis, promoting the early development of microvascular damage [15,16]. Therefore, it is crucial for primary care physicians to identify the prevalence of anemia before diagnosing microvascular complications. The aim of this study is to determine the relationship between anemia and microvascular complications in patients with type 2 diabetes mellitus.

Materials and Methods

The research was developed at the Family Medicine Unit No. 17 in Manzanillo, Colima. It is an observational, analytical, and cross-sectional study that involved the review of medical records from August 2021 to November 2021. Patients over 40 years old diagnosed with diabetes mellitus, both with and without anemia, were included.

Variables

In the review of the records, hemoglobin concentration was considered as the independent variable and the classification of anemia as the dependent variable, aiming to estimate the frequency of anemia in patients with type 2 diabetes mellitus and microvascular complications. Data obtained from the medical records included information on sex, age, presence of anemia, diabetic retinopathy, diabetic nephropathy, diabetic neuropathy, glycemic control, systolic blood pressure, and diastolic blood pressure.

The collected data were reported by the researcher to eliminate or reduce any potential bias, and were subsequently entered into a previously structured database using the SPSS statistical software.

Statistical Analysis

Descriptive statistics were used to summarize the characteristics of the population. Continuous variables were expressed using means and standard deviations, while categorical variables were presented using frequencies and percentages. To achieve the main objective, the percentage of patients who had anemia among those with microvascular complications and those without complications was calculated. Additionally, the chi-squared test was used. A p-value less than 0.05 were considered statistically significant. The same methodology was applied to determine the relationship between the degree of anemia and microvascular complications.

Ethics

The present research was conducted in accordance with the provisions of the Declaration of Helsinki and the International Ethical Guidelines (CIOMS) for Health-related Research, specifically regarding biomedical research involving human beings. The work stemmed from a research project that was evaluated and approved by the Ethics Committee and the Local Research Committee and holds the institutional registration number R-2021-601-020.

Results

A review of 113 electronic medical records that met the selection criteria was conducted, with 52 men (46%) and 61 women (64%). The average age and its standard deviation were 62±10.03 years (60±10 for men and 64±10 for women). Of the patients with microvascular complications from diabetes, 12 (10.6%) had diabetic retinopathy, 59 (52.2%) had Chronic Kidney Disease (CKD), and 45 (39.8%) had neuropathy. The average hemoglobin concentration was 12.68±1.79g, with 13.01±2.19 in men and 12.4±1.32 in women. When determining the presence of anemia, 51 (45.1%) patients did not have anemia, and 62 (54.9%) had some degree of anemia. According to the World Health Organization's anemia grade classification, 53 (46.9%) patients presented with Grade I, 6 (5.3%) with Grade II, and 3 (2.7%) with Grade III, (Table 1).

Table 1: General characteristics of study participants (n=113).

Variables		Average or %	(ED) or %
Age, years		113 years	10.03
Sexo	Male	52	46%
	Female	61	54%
Diabetic retinopathy		12	10.6%
Chronic kidney disease		59	52.2%
Diabetic neuropathy		45	39.8%
Hemoglobin (g)	Male	13.01 g	2.19
	Female	12.4 g	1.32
Glucose (mg/d)		193.1 mg/dl	93.47
Anemia	Grade I	53	46.9%
	Grade II	6	5.3%
	Grade III	3	2.7%
No anemia		51	45.1%

The frequency of microvascular complications in patients with anemia was found to differ between the various grades of anemia. Complications were more common in patients with Grade I anemia at 51.7% (p= 0.42) than in Grade II at 6.7% and Grade III at 2.2% (Table 2).

The relationship between the presence of anemia and microvascular complications due to DM was studied. The frequency of patients with one or more microvascular complications and anemia was 54 (60.7%), compared to patients without anemia which was 35 (39.3%). Patients without complications and with anemia were 8 (33.3%), and without anemia 16 (66.7%). Therefore, there is a 1.7% probability that microvascular complications are associated with the presence of some degree of anemia (Table 3).

Table 2: Frequency of complications and degrees of anemia.

Feature		Grade 1	Grade 2	Grade 3	No anemia	Total
COMPLICATION	YES %	46*	6	2	35	89
		86.8%	100.0%	66.7%	68.6%	78.8%
	NO %	7	0	1	16	24
		13.2%	0.0%	33.3%	31.4%	21.2%
Total		53	6	3	51	113
		100.0%	100.0%	100.0%	100.0%	100.0%

*$X2 = 8.225$, yates correction (p=0.042)

Table 3: Relation between the presence of anemia and microvascular complications.

Feature		The presence of complication	No complications	Total
ANEMIA	yes	54*	8	62
		60.7%	33.3%	54.9%
	no	35	16	51
		39.3%	66.7%	45.1%
Total		89	24	113
		100.0%	100.0%	100.0%

*$X2 = 5.706$ (p=0.017).

Discussion

The present study allows to corroborate the association between various degrees of anemia and the presence of ERC as a microvascular complication. Microvascular complications can lead to loss of function, early retirement, and a negative impact on the patient's quality of life. According to the article by Sarduy Rodríguez et al. (2020), uncontrolled diabetes and hypertension can generate long-term complications, mainly at the cardiovascular level. However, it must be considered that reduced hemoglobin levels can accelerate this metabolic deterioration, causing premature complications.

According to the article by Aldallal y Jena (2018), anemia was detected in 21% of participants. However, in this study, 45.3% of patients had grade I anaemia.

In the context of diabetic retinopathy, as mentioned in the article Tenorio y Ramírez-Sanchez (2010), there is an insufficient assessment of patients with diabetes by the ophthalmological services, which can lead to a late diagnosis of diabetes and a delay in its treatment.

On the other hand, an association was found between diabetic nephropathy and a certain degree of anemia. As explained in the article Rico Fontalvo (2020) this finding, together with other factors, may be the trigger for the development of chronic kidney disease, which can trigger multiple complications and deteriorate the quality of life of the patient.

Conclusions

Anemia was present in each of the microvascular complications of our patients, the Grade I was predominant which leads us to consider that this chronic disease must be evaluated, controlled and above all prevented with vital importance by the first-level health personnel, where by making greater emphasis on the control of hemoglobin, as is done with the rest of the tests or additional studies, it could be achieved to delay, to the extent possible, the complications that can end in patients amputeed, in need of dialysis or hemodialysis and even in patients with visual impairment.

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