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Study of the Correlation between Postprandial Glucose and Mean Blood Glucose Calculated from HbA1c in a Diabetic Population

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ABSTRACT

The Glycemic control is a fundamental pillar in the management of the diabetic disease. Many studies and clinical trials have shown that good (see excellent) glycemic control can prevent the development and progression of micro and microvascular complications of diabetes. Although the measurement of HbA1c remains the absolute reference in the evaluation of glycemic control, there is no consensus if PPG is a better predictor of glycemic Control when Hba1c will not be available The objective of this study is to shed light on PPG, a parameter of glycemic control that has remained poorly evaluated for a long time, by determining the existence of its correlation with the mean blood glucose (MBG) calculated from glycated hemoglobin (HbA1c). Explain the risks of postprandial hyperglycemia in diabetic subjects. Describe the difficulties encountered in our context when carrying out this examination. try to formulate proposals that can help develop effective post-meal glucose control strategies for people with type 1 diabetes (T1D) and type 2 diabetes (T2D), taking into account treatments and resources available locally. The aim of this study was to gather evidence on the importance of PPG in the glycemic control of PPG in glycemic control, and to prove its correlation with Hba1c and therefore with mean blood glucose. In this descriptive study, we recruited 198 diabetic patients type 1 and 2 at the biochemistry department of the Avicenne military hospital in Marrakech. We used the Pearson correlation coefficient to find statistical significance. PPG is strongly correlated with HbA1c. The correlation coefficient was 0.626 ($P < 0.01$). PPG, therefore, has a strong association with HbA1c and with the mean blood glucose. Control of postprandial hyperglycemia is therefore essential to achieve satisfactory overall glycemic control.

1. INTRODUCTION

Glycemic control is the most important way of managing diabetes. Chronic hyperglycemia during diabetes is associated with a large number of complications and dysfunctions that can affect the eyes, kidneys, nervous system, heart and vascular system [1]. Among the parameters indicative of glycoregulation, glycated hemoglobin HbA1c, or fasting glucose (GAJ) are the most studied. In contrast, postprandial glucose (PPG), which is established 2 hours after the start of the meal, is neglected. Until recently (2, 3), treatments focused primarily on lowering HbA1c levels, with a focus on fasting plasma glucose [4]. Although control of fasting hyperglycemia is necessary, it is usually insufficient to achieve optimal glycemic control. A growing body of evidence suggests that reducing plasma glucose excursions after meals is also important [5], or even more important for achieving HbA1c targets [6].

The aim of the study:

Our study aims to: • to shed light on the GPP, a parameter of glycemic control that has been poorly evaluated for a long time, by determining the existence of its correlation with the average blood glucose (GM) calculated from glycated hemoglobin (HbA1c). • Explain the risks of postprandial hyperglycemia in diabetic subjects. • Describe the difficulties encountered in our context when carrying out this examination. • And try to formulate proposals that can help develop effective post-meal glucose control strategies for people with type 1 diabetes (T1D) and type 2 diabetes (T2D), taking into account treatments and resources available locally.

2. MATERIALS AND METHODS:

This is a cross-sectional analytical study conducted in patients presenting at the Biochemistry Department of AVICENNE Military Hospital (HMA) in MARRAKECH Data collection was interrupted over a period of six months, from 20/10/2016 to 25/02/2017, including 198 diabetic patients.

The consent of all participants was obtained prior to their participation.

All diabetic patients with fasting blood glucose, postprandial glucose, and HbA1c were included in the study.

Diabetic patients who have not respected pre-analytical conditions and precautions, Patients for whom the diagnosis of diabetes is not yet established, even having a glycemic balance, have been excluded.

For the collection of information, a record of exploitation was realized. The collection of information took place in the HMA collection room.

GAJ and GPP are taken from a gray cap tube with potassium oxalate anticoagulant and a glycolysis inhibitor; sodium fluoride to obtain plasma.

HbA1c is taken from a tube with EDTA as an anticoagulant to obtain whole blood.

The assays are performed on calibrated, controlled and maintenance-free automata.

HbA1c is analyzed on the VARIANT II high-performance liquid chromatography (Biorad) automated system, with a technique connected to that of NGSP (natural glycohemoglobin standardization program). The results are expressed in %.

The GAJ and GPP are assayed on COBAS 6000 (Roche diagnostic) with the hexokinase technique, which is the reference method for the determination of glucose in the blood. The results are expressed in mmol / l.

GM is calculated from the formula: GM = (1.59 x HbA1c) -2.59 and is expressed in mmol / L

3. RESULTS:

Our study concerns 198 diabetic patients aged 22 to 84 years, with an average age of 54.99 +/- 9.92, the majority of diabetics (145 patients or 73.23%) have an age of over 50 years. The population of our study is 53.8% men and 46.2% women, 107 men and 92 women The majority of the population studied (87.4% or 174 patients) belong to the urban environment The distribution of patients by type of diabetes shows that 86.36% of patients have type 2 diabetes (171 patients), and 13.63% are type 1 diabetics (27 patients) (Figure 1).

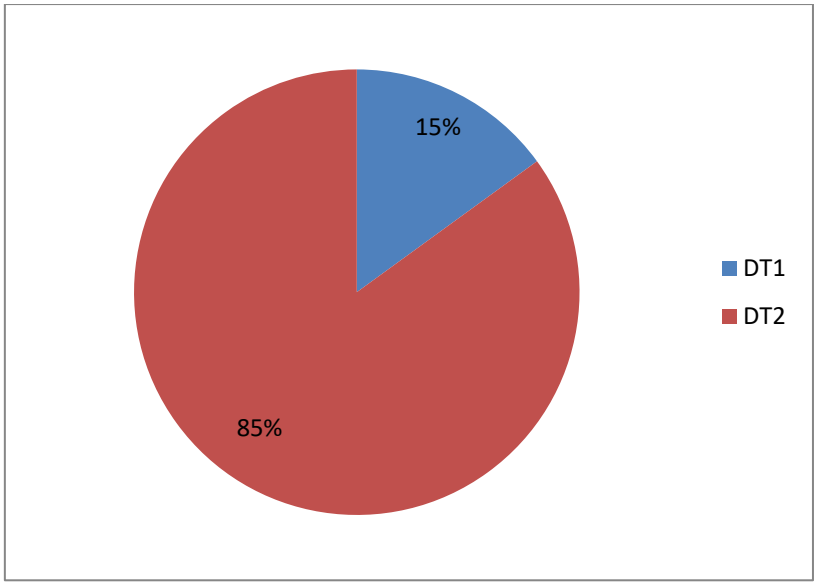

Figure 1: Distribution of patients by type of diabetes

In our studied population, the duration of evolution is on average of 105 months (8.75 years), with extremes ranging from 2 to 408 months or 2 months to 34 years. The proportions of the study population that have a duration of the evolution of 5 to 10 years and more than 10 years are the largest and are equal to 32% (Figure 2).

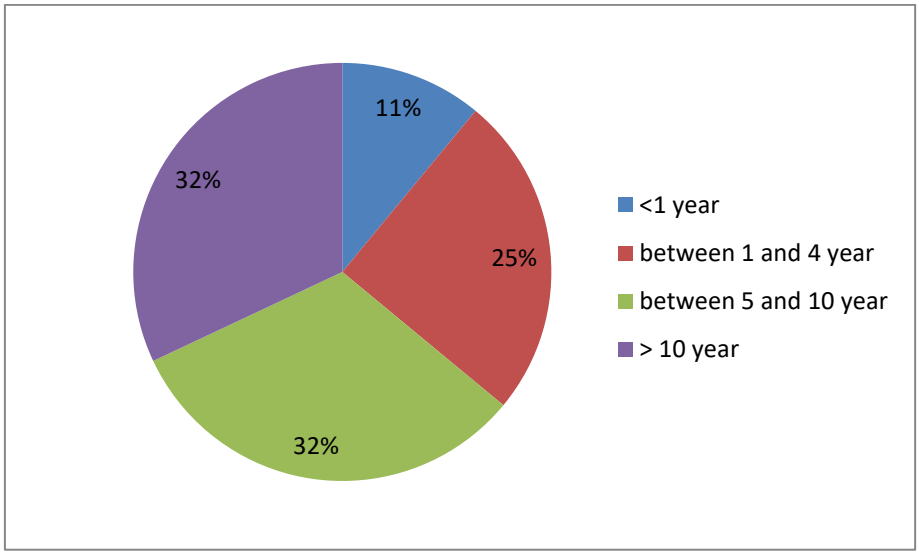

Figure 2: Distribution of patients by duration of diabetes

Associated risk factors are present in 59% of patients. The majority of patients suffer from obesity: 136 patients or 69%. 79 patients or 39.90% have dyslipidemia. 73 patients or 36.87% have hypertension. 31 patients or 15.66% are smokers. All these results are grouped in the following graph (figure 3).

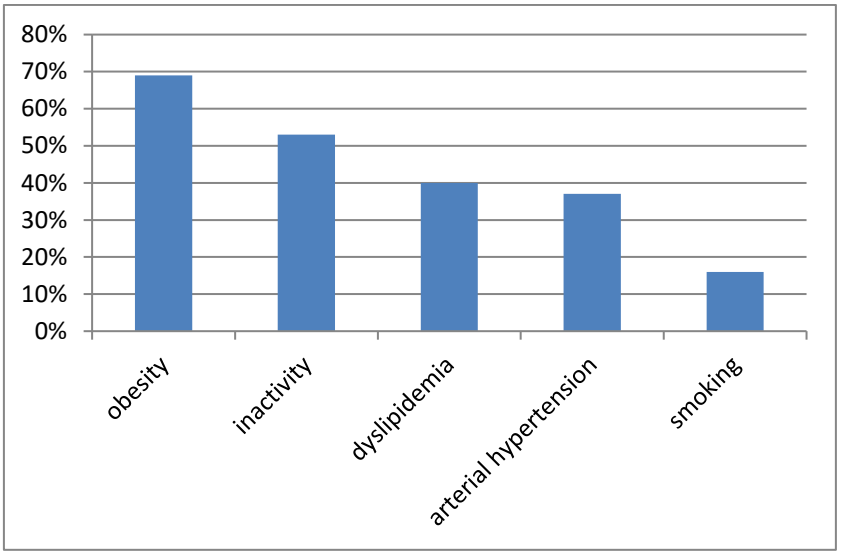

Figure 3: Distribution of risk factors associated with diabetes in the study population

In our study, 68 patients, or 34% of cases (68 patients) have diabetic retinopathy, while the rest has a normal ophthalmic examination. 9% of patients (17 cases) have nephropathy. The calculation of the creatinine clearance in our patients, according to the Cockcroft formula, showed an average of 112.13 ml/min. 86% of patients have a normal renal function, 12% have mild renal impairment, 2% have moderate renal impairment, and no patient in our series suffers from a severe or terminal renal impairment. Only 9% of patients (17 cases) report a history of cardiovascular events,3% of patients (5 cases) report the notion of podiatric involvement (Figure 4).

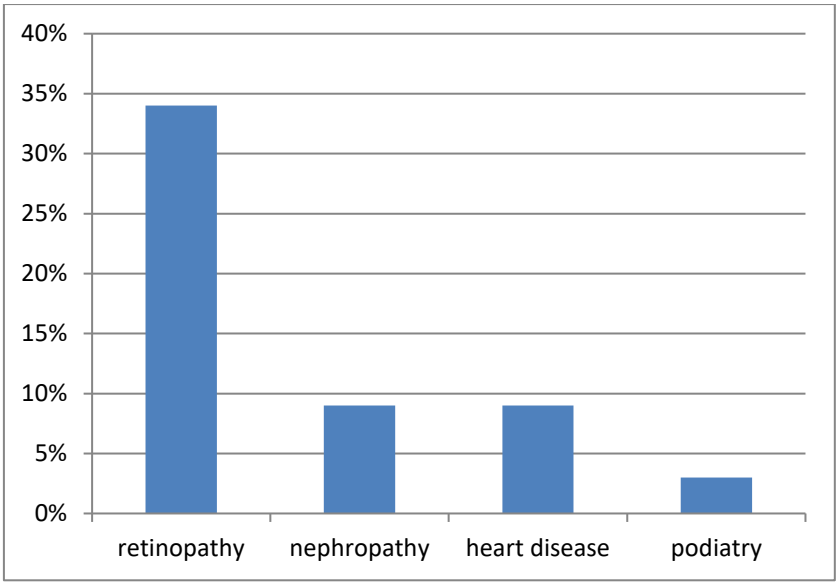

Figure 4: Distribution of degenerative complications of diabetes

One hundred and twenty-six (126) patients (63.64%) are on ADO, 29 patients (14.65%) are on insulin, 25 patients (12.63%) on ADO-insulin, and only 18 patients (9.09%) are under hygienic and dietary measures (MHD) only.

The glycemic profile of patients is shown in Table I.

The average HbA1c is 7.63%. Only 38% of patients have HbA1c <7% (Table I).

Tableau I Average values of glycemic parameters

Biological Parameter	Type of Diabetes	Average Value	Reference Value of the Laboratory
HbA1c	DT1	8.34%	<6%
	DT2	7.63%	
PPG	DT1	12.87mmol/l	<7.80mmol/l
	DT2	12.77mmol/l	
FG	DT1	9.52mmol/l	3.90-6.10mmol/l
	DT2	9.12mmol/l	
MBG	DT1	10.95mmol/l	----
	DT2	11.01mmol/l	

Of the 198 patients enrolled, only 47 patients (23.74%) had good glycemic control (that is, HbA1c <6.5%), 61 patients (30.81%) had diabetes. fairly controlled (ie, 6.6% <HbA1c <8%), and 90 patients (45.45% of cases) are poorly controlled (ie HbA1c> 8%). Thirty eight percent (38%) have HbA1c <7%. Among them, 65% (n = 49) have a FG> 6.10 mmol / l (ie 1.10 g / l), and 44% (n = 33) have a PPG> 7.80 mmol / l (either 1.26 g / l) (Figure 5).

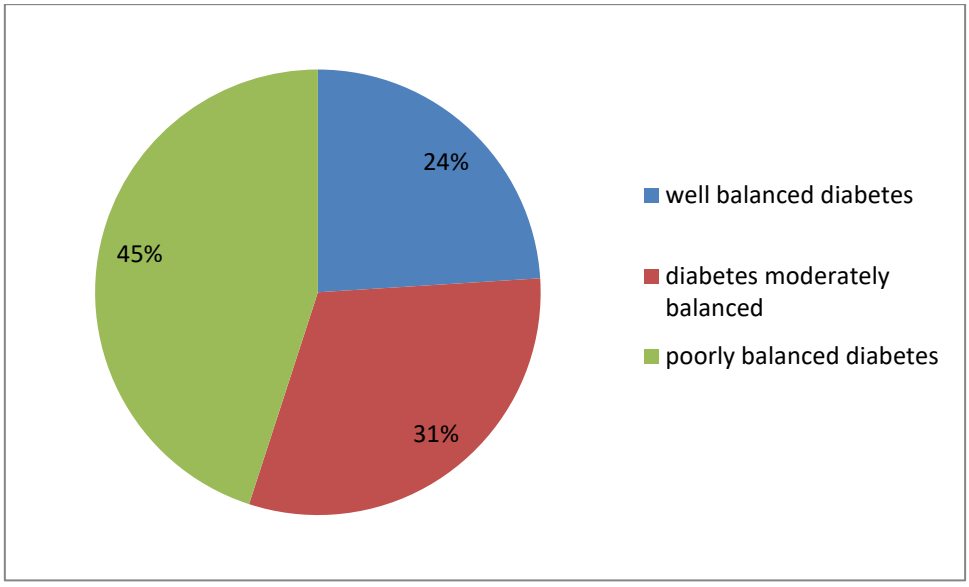

Figure 5: Distribution of patients according to the value of HbA1c and the glycemic balance.

In our series, 168 diabetic patients (85%) had a postprandial glucose> 7.80 mmol / l compared to 30 patients (15%) only who had a normal PPG (PPG <7.8 mmol / L) (Figure 6)

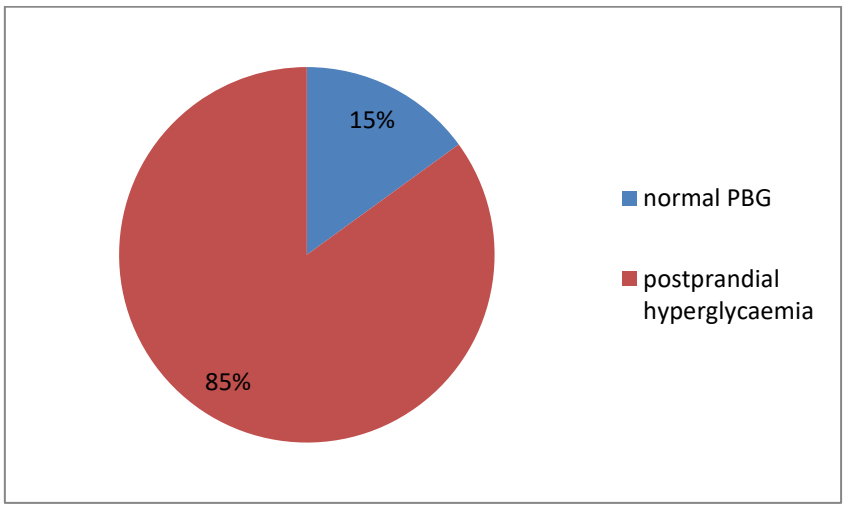

Figure 6: Distribution of patients according to PPG

Of the 198 patients, only 35 (17%) had a normal fasting glucose level of [3.90-6.10 mmol / l]. In contrast, 163 patients (82%) had fasting hyperglycemia (FG> 6.10 mmol / l) (Figure 7).

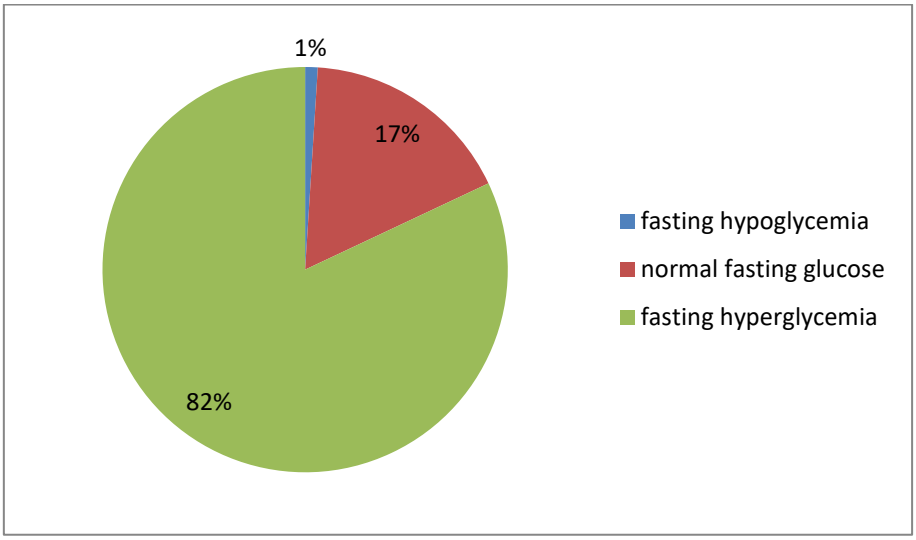

Figure 7: Distribution of patients according to the level of FBG.

Fasting blood glucose greater than 7 mmol / l, which is the diagnostic threshold for diabetes, is observed in 69.70% of patients (138 patients).

A positive correlation was found between PPG and HbA1c in all patients in our series. The correlation coefficient "r" is 0.626.

A positive correlation was also found between FG and HbA1c / MBG in all patients in the series.

We have noticed that MBG and PPG are both well correlated with each other in our series. The correlation coefficient "r" is 0.686 in patients who were sampled 2 hours after the start of the meal (Table II).

Table II: Correlation between different parameters of glycemic control

	PPG	**FG**	**MBG**	**HbA1c**
HbA1c	0.626	0.688	0.977	---
MBG	0.634	0.692	---	0.997
PPG	---	0.686	0.634	0.626
FG	0.686	---	0.692	0.688

4. DISCUSSION

Diabetes is a major public health problem because of its high prevalence on the one hand, and its socio-economic impact on the other hand [35]. As a result, diabetes is currently one of the most worrisome diseases in both industrialized and developing countries. Currently, in Morocco, a country in the midst of a demographic, nutritional and epidemiological transition, [36] diabetes is emerging as an important public health issue and represents a challenge that doctors face in their daily practice. Rigorous management of diabetic disease is required. It includes, in addition to controlling all the associated risk factors, glycemic control, which represents a major therapeutic objective. Many efforts are being made to obtain satisfactory glycemic control. But the majority of diabetic patients fail to achieve this goal, despite the therapeutic targeting of HbA1c and FG. [37) Farouqi.A et al [38] showed that in Morocco, glycemic control in type 1 and type 2 diabetics is insufficient: an HbA1c <7% is obtained for only 20.8% of patients with diabetes type 1 and 30.9% of those with type 2 diabetes.

These results are lower than those of our study: 37% of T1D patients and 38% of T2D patients have an HbA1c level of <7%. This can be explained by closer monitoring of patients in our series who all benefit from health insurance which facilitates their access to care.

Even though HbA1c remains the gold standard of glycemic control, several studies have been conducted in order to find an alternative when it will not be available.

On the other hand, HbA1c has many limitations, and many medical conditions are associated with an impairment of its value (hemolytic anemia, tumor, pregnancy ...) which makes it provides unreliable information [39]. In addition to these factors, HbA1c provides no information on glucose dynamics, and it does not provide information on glucose variability for short periods of time, whereas these variabilities are essential for making timely therapeutic decisions [40]. As for postprandial glucose, this is a hot topic of major concern for patients. A great deal of research has been conducted to prove the importance of PPG in the surveillance of diabetic patients. Three reasons are mentioned for wanting to reduce the postprandial glycemic peak, that is to say, the difference between PPG and FG: first, to reduce the risk of macrosomia during pregnancy, secondly to reduce cardiovascular risk, and thirdly to lower the level of HbA1c [41]. In fact, it seems that to reduce the latter to 7%, the most important is to obtain preprandial blood glucose levels below 6.66mmol / l (ie 1.20 g / l). Therefore, according to the authors of this article, patients should be asked to measure their postprandial blood sugar

only when the objective is to reduce the glycated hemoglobin level to below 7 or 6.5%, for example during pregnancy or in case of discordance between fasting blood glucose (below 1.20 g / l) and HbA1c (above 7%). In order to prove the contribution of PPG in glycemic control, we conducted this study within the biochemistry department of the Avicenne Military Hospital in Marrakech, which included a total of 198 diabetic patients, 84% of whom are type 2. The average age of patients is 54 years, 40% have at least one degenerative complication of diabetes, and 63.64% are on oral antidiabetic drugs alone (in combination with hygienic measures).

The mean value of HbA1c in our series is 7.66%, and 48.48% of patients were moderately controlled (6.5% <HbA1c <8%). The PPG is on average 12.77 mmol / l (2.30g / l). In this study, we investigated a possible correlation between PPG and mean blood glucose calculated from HbA1c in patients with type 1 and type 2 diabetes. The correlation is positive and significant. The Pearson correlation coefficient is 0.626. FG is also strongly correlated with mean glucose and HbA1c. With a correlation coefficient of 0.686, FG is more correlated with mean blood glucose (and HbA1c) than PPG. These results are consistent with those reported by Gupta et al. [42], which focused on 50 types 2 diabetic patients. This study concluded that both GPP and GAJ are positively and significantly correlated with HbA1c. with a stronger correlation between FG and HbA1c. On the other hand, Masram et al [43] and Rosediani M [44] have revealed in their work that PPG has a stronger correlation with HbA1c compared to FG. Bonora et al [45] evaluated the elevation of blood glucose after meals; the relationship between plasma glucose levels during different periods of the day (ie, fasting and 2-3 hours after the meal) and the relationship between these and HbA1c in a population of type 2 diabetics not treated with insulin, concluded that although HbA1c is more related to FG than to PPG, monitoring of glycemic control and evaluation of treatment efficacy cannot be limited to FG or HbA1c alone. . Indeed, FGand HbA1c are both poor indicators of glycemic levels during other periods of the day, that is during the postprandial period. Eleven similar studies found in the literature had calculated the Pearson correlation coefficient to measure the strength of the association between FG or PPG and HbA1cAmong these studies, 7 found a better correlation between PPG and HbA1c than FG. In contrast to this, the other 3 studies indicated a stronger correlation between FG and HbA1c than PPG. Only one study found almost equal correlation coefficients for both trials.

All of these studies indicated a statistically significant correlation between PPG or FG and HbA1c. The correlation coefficient extended from 0.43 to 0.86 for PPG and 0, 28 to 0, 84 for the FG.

In Africa, 76% of diabetes deaths are in people under 60 years of age. In North Africa, 1 in 10 adults has diabetes. It should also be noted that diabetes caused 5.1 million deaths in 2013, and every six seconds a person dies. [11] The contribution of PPG is predominant in patients with moderate or low glycemic control (HbA1c between 6.5 and 8%), whereas the contribution of fasting glucose levels increases with glycemic imbalance (HbA1c> 8%). This seems to reconcile the different results of the literature because the variation of the respective contribution of these two parameters appears as a spectrum which varies according to the level of glycemic control.

Woerle et al [49] used a different approach to estimate the relative contribution of PPGand FG to overall blood glucose. Of the patients who were able to achieve the HbA1c target (<7%), only 64% achieved a target FG value of either FG <5.55 mmol / l (<1g / l); 94% of these patients were able to reach the PPG target, ie FG <7.78 mmol / l (<140mg / dl).

In our series, only 23.74% of patients were able to reach the HbA1c target, of which only 11% achieved the PPG goal, and 38% achieved the goal of FG DECODE and DECODA [50,51], which analyzed the fasting glucose and post-load blood glucose data at 2 hours, found that 2-hour plasma glucose was a better predictor of cardiovascular disease and mortality from any cause other than fasting plasma glucose.

In our work, only 9% of patients (18 patients) had a cardiovascular event of which 83.33% (or 15 patients) had hyperglycemia.

The observations also included individuals with diabetes for whom postprandial plasma glucose was a stronger predictor of cardiovascular events than fasting plasma glucose in type 2 diabetes, particularly in women.

Although postprandial and post-load hyperglycemia is known to be related to the development and progression of diabetes-related macrovascular disease [52,53], there is limited data on the relationship between hyperglycemia. postprandial and microvascular complications related to diabetes. A recent prospective observational study in Japan [54] demonstrated that postprandial hyperglycemia is a better predictor of diabetic retinopathy than HbA1c. The investigators

conducted a cross-sectional study of 232 people with type 2 diabetes who were not treated with insulin injections. Multiple regression analysis revealed that postprandial hyperglycemia was independently correlated with the incidence of diabetic retinopathy and neuropathy. In addition, postprandial hyperglycemia was also associated, though not independently, with the incidence of diabetic nephropathy.

In our series, 40.40% of patients (80 patients) have at least one degenerative complication of diabetes. Of these, 85% of cases (68 patients) are postprandial hyperglycemia, and only 15% (12 patients) have normal PPG.

However, the main objective of our work was not to study cardiovascular events, the number of patients included and the follow-up time was not sufficient to answer this question.

5. CONCLUSION:

With an estimated 246 million people worldwide, the diabetes epidemic is a growing concern. In addition, poorly controlled diabetes is one of the leading causes of death in developed countries and is associated with the development of complications such as diabetic neuropathy, kidney failure, blindness, and macro-vascular disease.

Our interest in postprandial glucose in this work is related to the fact that its management must now be an integral part of the management of diabetic disease, and therefore, special attention should be given to its management. monitoring and its treatment, in order to obtain an optimal level of HbA1c and thus, to prevent microvascular and macrovascular complications of diabetes. Our study, which looked at 198 patients with type 1 and types 2 diabetes, showed that PPG is strongly correlated with HbA1c and therefore with the average blood glucose obtained from HbA1c, and thus contributes significantly to global glycemic control. This work enabled us to recall the deleterious effects of postprandial hyperglycemia, the expected benefits of its management and treatment, the basic rules for the determination and monitoring of postprandial glucose, the target values to be achieved, and therapeutic, non-pharmacological and pharmacological means for obtaining optimal control of PPG; and also to recall a number of recommendations aimed at highlighting the role and importance of PPG, and to guide clinicians on how to evaluate PPG and decide on appropriate therapeutic interventions to maintain PPG. optimal glycemic control in their patients.

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