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THE SWEET FOOT
Relation of Glycemic Control with Diabetic Foot Lesions

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Introduction: Diabetes mellitus has become an epidemic in the past several decades, owing to the advancing age of the population. The average delay of 4-7 yrs in diagnosing type 2 diabetes mellitus translates into approximately 20% of patients of type 2 diabetes having some evidence of microvascular or neurological diabetic complications at the time of diagnosis.
Material & Method:
Design: Descriptive observational study.
Setting: Out door and indoor patients in P.I.M.S, Islamabad, Pakistan visiting during May to June 7th, 2004 i.e.5 weeks.
Patient Selection: All patients with diagnosed diabetes mellitus eligible to be included in the study.
Measurements included: 1) Glycosylated Hb. 2) Proteinuria by dipstick. 3) Retinal changes by fundoscopy; 4) Skin lesions 5) Neuropathy such as loss of sensations on self reported history and examination clinically.
Results: Out of a total of 36 patients, males were 39% (n = 14), females 61% (n = 22). Mean age at the time of diagnosis was 42 yrs (15 yrs - 56yrs); mean age at presentation to us was 53 yrs (25-69 yrs); mean duration of diabetes was 15 yrs (I month - 5yrs). Of these patients 94% (n = 34) were taking some form of treatment which included oral hypoglycemics in 94% (n = 32) and oral and parentral drugs i.e. insulin in 6% (n = 2). Of those taking treatment 56% (n = 20) had controlled diabetes mellitus (DM) while 44% (n = 16) were having uncontrolled DM at presentation. Mean value of glycosylated haemoglobin (Hb) was 8.2% (6 - 16.6%).
Conclusion: Incidence of diabetes foot lesion strongly correlates with poor glycemic control which is in itself best manifested by levels of glycoslated haemoglobin.

Key words: Diabetic foot lesions; Glycemic control.

Introduction

Type-2 diabetes mellitus (DM2) has become an epidemic in the past several decades owing to the advancing age of the population, substantially increased prevalence of obesity and decreased physical activity, all of which have been attributed to a western life style[1]. Longer survival of patients with DM and development of disease at an earlier age have increased the risk of development of the duration dependant complications[2]. The average delay of 4-7 years in diagnosing DM 2 translates into approximately 20% of patients with type 2 diabetes having some evidence of microvascular or neurological diabetic complications at the time of diagnosis. The complications are influenced not only by the duration of diabetes, but also by the average level of chronic glycemia, which is measured most reliably with the glycosylated haemoglobin assay[2-4].

A costly complication affecting the patients with diabetes is diabetic foot. About one in five people with diabetes will enter the hospital for foot problem[4]. People with diabetes can develop a variety of foot problems[4]. Diabetic foot ulceration is a serious and expensive complication with considerable morbidity that affects upto 15% of diabetic patients during their lifetime[5]. The high therapeutic costs and low quality of life caused by lower extremity amputation, the most severe consequence of the disease, account for a large part of these expenses. It is estimated that 80% of the amputations are preceded by foot ulcer[6]. Accordingly, it has been demonstrated that preventing the development of foot ulcers in patients with diabetes

reduces the frequency of lower extremity amputations by 49 -85%[7].

Several studies have established the role of intensive therapy in reducing long term complications in patients with DM 2.[8-9] These studies have helped in establishing the metabolic goals in the patients with type 2 DM as the glycosylated Hb value of <7.0%, an average fasting plasma glucose level of 90-130mg/dl (5.0-7.2 mmol/L), and a post prandial plasma glucose level of <180mg/dl (10.0mmol/L)[10]. Intensive glycemic control and aggressive treatment of hypertension and dyslipidemias are particularly demanding in patients with type 2 DM.[11]

Given the above, the guidelines on prevention and treatment of the diabetic foot follow the principles outlined in the International Consensus of the Diabetic Foot. Cornerstones of the guidelines based care are intensive glycemic control and optimal foot care. The health benefits and economic efficiency of the intensive blood glucose control and foot care programmes have been individually reported.[12-16]

This descriptive observational study was performed to correlate foot lesion in diabetic patients with the level of glycosylated Hb, and to identify risk factors leading to foot lesions and amputation in diabetes mellitus.

Patients and Methods

All patients with diagnosed diabetes mellitus visiting inpatient and outpatient departments of general medicine, dermatology, general surgery, cardiology and nephrology of Pakistan Institute of Medical Sciences, Islamabad during the period 1st May to 7th June 2004, i.e., 05 weeks were eligible for selection in the study. The relevant data was entered in performas. A total of 36 patients who had glycosylated Hb along with other tests were enrolled in the study. The glycemic control was tested by measuring the levels of Glycosylated Hb. Other risk factors and manifestations were also looked for i.e. proteinuria by dipstick, retinal changes by fundoscopy, neuropathy by self-reported history and clinical examination. Foot lesions such as granuloma annulare, callous formation, loss of plantar arch, localization of infection, ulcer, necrobiosis lipoidica, clawing of toes, discoloration of skin, fungal infection, charcoat neuroarthropathy with muscle wasting, hair loss and vascular insufficiency were looked for on clinical examination.

Frequencies regarding age, sex, presentation, duration of diabetes, treatment, control, type, alongwith personal habits like smoking, exercise and occupation were also entered in the proformas. Other causes of foot lesions were ruled out by history and clinical examination.

Results

Age and Sex Distribution: In a total of 36 patients of DM 2 included in the study, 14 were male and 22 females, with a male: female ratio of 1:1.57. The age at diagnosis ranged from 15 to 56 years, with a mean age of 42 years. Age at presentation ranged from 25 to 69 years, with a mean age of 53 years.

The mean duration of diabetes was 15 years (range: 1 month - 5years).

Of the 36 patients, 94% (n =34) were taking some form of treatment, while 6% (n =2) were not taking any treatment. Of these, 56% (n =20) had their diabetes controlled while 44% (n =16) were having uncontrolled diabetes.

Manifestations and Risk Factors: As shown in figure 1, glycosuria was observed in 61% of cases. Half of the patients had proteinuria. Amongst risk factors, smoking (33%), hypertension (44%), ischemic heart disease (28%) and hyperlipidemias (26%) were prominent. Neuropathy (28%) and retinopathy (11%) were common complications. Vasculopathy and impaired renal function tests were observed in 6% cases each.

HbA1c levels ranged from 6 to 16.6% with a mean level of 8.2%. The breakup of HbA1c level ranges, as correlated with frequencies of foot lesions have been depicted in Table 1.

Table 1: Association of HbA1c with Diabetic Foot Lesions

HbA1c Level (%)	% of Patients	Frequency of Foot Lesions (%)
6.1% - 7%	50	60
7.1% - 8%	25	80
8.1% - 9%	10	75
9.1% - 10%	03	90

10.1% - 11%	03	100
11.1% - 12%	03	100
12.1% - 13%	03	100

16.1% - 17%	03	100

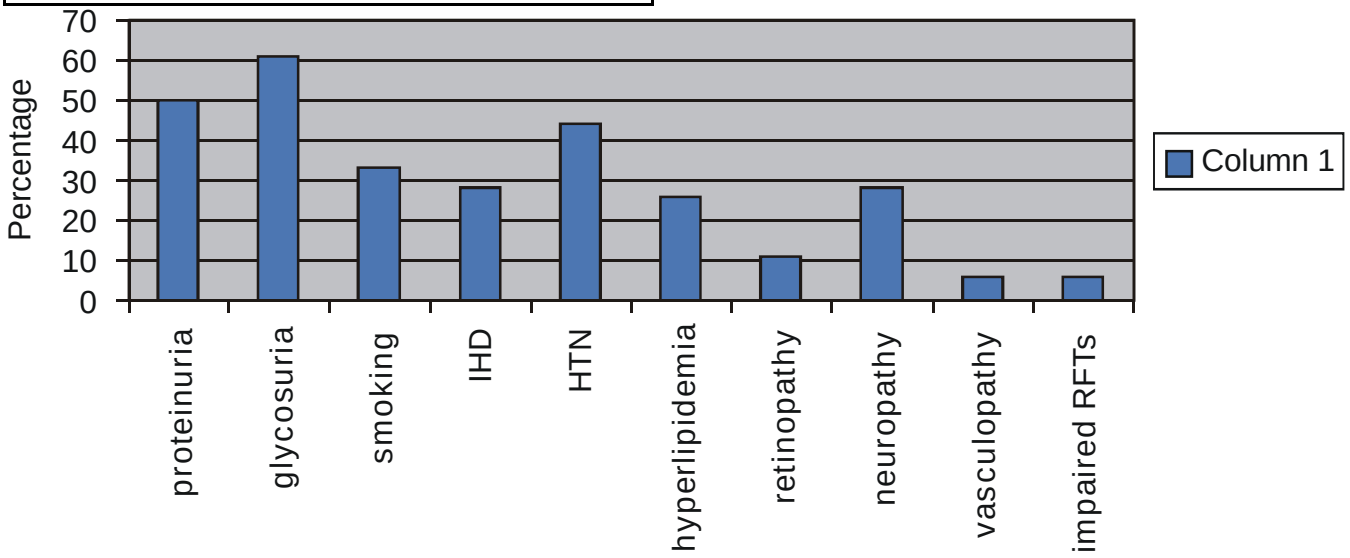

Fig. 2: Manifestation and Risk Factors

Discussion

Measurement of glycosylated Hb is the standard method for assessing the long-term glycemic control.[17] It is well accepted that glucose combines with Hb via a slow irreversible non-enzymatic reaction, the rate of which is determined by the serum glucose concentration.[18, 19] Thus HbA1c can be used as a time averaged index of the blood glucose concentration to which the Hb has been exposed[20] reflecting the glycemic history in the previous 2-3 months, since erythrocytes have an average life span of 120 days.[17] In our study 75% of patients showed an HbA1c level <8.0%; in 13% cases, it was between 8.1 and 10.0%, and in 12% of cases, it was >10%. Our data shows that there is almost a direct relationship of foot lesions with increasing Glycated Hb i.e. poorer blood sugar control. All the patients who had an HbA1c level >10% manifested with various types of foot lesions.

Poor glycemic control in type 2 Diabetes has serious implications on health and is a major risk factor for the development of diabetic complications. Good control of blood glucose concentration leads to fewer complications.[21]

Diabetic foot is usually the result of three primary factors: neuropathy, poor circulation and a decreased resistance to infections. Additionally foot deformities and trauma play major roles in causing ulcerations and infections in the presence of neuropathy or poor circulation; all of these are affected by glycemia[6]. Glycemic control is the prime factor. Each 2% increase in the HbA1c increases the risk of lower extremity ulcer by 1.6 times and the risk of lower extremity amputation by 1.5 times.

Diabetic foot pathology model structure was based on the model used in earlier studies.[8]

Similarly, in this study diabetic foot pathology was modeled by 13 health states describing the spectrum of the disease from causes to consequences: three risk health states, six wound type states, and four outcome states were included. The first three health states represented pathophysiologic precursors for development of ulcers. Based on the classification system of the International Working Group on the Diabetic Foot (IWGDF)[15], these states were defined as:

DFR1, no neuropathy

DFR2, sensory neuropathy

DFR3, sensory neuropathy and deformity or peripheral vascular disease.

Previous ulcer or amputation, the fourth risk factor identified by the IWGDF, was represented by the healed and post minor amputation states since the entrance of these states implied the occurrence of a previous episode of an ulcer or amputation.

The six wound health states reflect important characteristics of diabetic foot lesions, namely depth, presence of ischemia, and infection and they attempt to reconcile two established wound classification systems: Wegner's and the University of Texas classification systems.[17]

The remaining four health states encompass all possible outcomes of the diabetic foot disease: healed, amputation (major or minor), and death.

The same fact has been studied and proved in various studies in other parts of the world proving the relation of poor control of sugars and increased incidence of diabetic foot lesions and its complications.[22, 23] The most serious and disastrous of which is lower extremity amputation. The same fact was observed in our study.

Inadequate facilities for diabetes care, lack of education, poor socioeconomic conditions, and sociocultural practices such as walking bare foot[24] also contribute to the vicious cycle of diabetic foot.

The result of one Dutch study suggests that intensive glycemic control and optimal foot care reduces foot ulcers and amputations and leads to an improvement in life expectancy and quality; and is cost-effective and may even be cost saving in the management of diabetic foot[8].

Conclusion

Incidence of diabetic foot lesions strongly correlates with the poor glycemic control, which in itself is best manifested by the levels of glycosylated Hb.

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