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RESEARCH ARTICLE

DEGENERATIVE COMPLICATIONS OF TYPE 2 DIABETES: A CROSS-SECTIONAL STUDY IN A MOROCCAN POPULATION

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Abstract

Diabetes is a well-established risk factor for the development of major degenerative complications affecting various organs, with serious consequences in terms of morbidity and mortality. Understanding the pathophysiological mechanisms and risk factors underlying these complications may enable improved preventive and therapeutic strategies. We conducted a cross-sectional study over a 2-month period, including 101 patients with type 2 diabetes presenting with at least one degenerative complication. Epidemiological, clinical, and paraclinical data were collected from medical records and supplemented by bedside interviews. The mean age of the patients was 68 years, with a male predominance (M/F ratio = 1.72). A family history of diabetes and cardiovascular disease was reported in 57.42% and 21.78% of cases, respectively. The mean disease duration was 20 years, and 62.37% of patients were symptomatic at diagnosis. The median HbA1c was 9%, and median fasting plasma glucose was 1.84 g/L. Personal medical history included hypertension in 77.2% of cases, dyslipidemia in 77%, smoking in 18.81%, and obesity in 29.7%. Insulin therapy was used in 75.2% of patients. Microangiopathic complications included diabetic nephropathy in 45.5% of patients, diabetic autonomic neuropathy in 37.62%, peripheral neuropathy in 31.68%, diabetic retinopathy in 33.7%, and maculopathy in 13.9%. Macroangiopathic complications were present in 80.2% of patients, mainly ischemic heart disease (56.43%), lower-limb obliterative arteriopathy (52.5%), and stroke (31.7%). When comparing three groups of patients — those with both macro-and microangiopathic complications,those with microangiopathy only, and those with macroangiopathy only — we found that patients with poor glycemic control (high HbA1c), requiring insulin therapy, and experiencing more hypoglycemic episodes were more likely to develop microangiopathy.Age,sex, hypertension, dyslipidemia, obesity, and smoking were comparable across groups.

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Introduction:-

Diabetes represents a major public health challenge, with a steadily increasing prevalence and heavy socioeconomic consequences [1]. This rapid global rise is explained by multiple factors, including population aging, urbanization, and lifestyle changes, resulting in a significant healthcare burden associated with the disease and its complications [2,3].Patients with diabetes frequently exhibit insulin resistance and relative insulin deficiency, predisposing them to microvascular and macrovascular complications. The risk of developing degenerative complications is amplified by factors such as age, obesity, sedentary lifestyle, possible genetic predisposition, and other yet unknown risk factors [4].The severity of complications is closely related to the duration of hyperglycemia and prolonged exposure to elevated blood glucose levels, highlighting the importance of early glycemic control and risk factor management to improve prognosis [5]. However, the mechanisms underlying the development of complications remain incompletely understood. Even among patients with similar profiles, different complication patterns can be observed.

Research question: Are there epidemiological, genetic, or therapeutic factors that explain this diversity?

Materials and Methods:-

Study Design:

We conducted a descriptive and analytical cross-sectional study in the Department of Endocrinology at Cheikh Khalifa Ibn Zayed Al Nahyan Hospital in Casablanca over a 2-month period (September–November 2023). We included 101 patients with type 2 diabetes presenting at least one degenerative complication. We excluded patients with type 1 diabetes, uncomplicated type 2 diabetes, and incomplete medical records.

Patients were classified into three groups according to the type of chronic complications:

1. Both micro- and macroangiopathic complications
2. Microangiopathy only
3. Macroangiopathy only

Definition of variables:

Physical inactivity was defined using the MARSCHALL score. Smoking included current smokers and those who had quit within the past three years.Diabetic retinopathy was diagnosed using standard ophthalmologic exams (fundus examination).Diabetic nephropathy was defined by a urinary albumin/creatinine ratio >3 mg/mmol and/or a glomerular filtration rate <60 mL/min (MDRD).Peripheral neuropathy was identified using the DN4 questionnaire and monofilament testing.Coronary artery disease was defined by ECG findings suggestive of ischemic sequelae, a positive stress test, or a history of angioplasty or coronary bypass surgery.Lower-limb arteriopathy was confirmed by Doppler ultrasound or arteriography showing atheromatous plaques, stenosis, or ischemic lesions.Stroke was defined by a neurological deficit with ischemic lesions on CT or MRI.

Data collection and ethics:

Demographic, clinical, and biological data were collected while ensuring patient anonymity and confidentiality. Informed consent was obtained from all participants. Ethical committee approval was not required, as this study used routine clinical data.

Statistical analysis:

Descriptive statistics were presented as medians [IQR] for continuous variables and frequencies [%] for categorical variables. Differences between the three groups were analyzed using ANOVA for continuous variables and Chi-square or Fisher's exact test for categorical variables. A bilateral p-value <0.05 was considered statistically significant. Analyses were performed using JAMOVI for Windows (version 1.6.23.0).

Results:-

Descriptive Results:

The mean age was 68 years, with a male-to-female ratio of 1.72. Hypertension (77.2%) and dyslipidemia (77%) were the most common comorbidities, followed by obesity (29.7%) and smoking (18.81%). Ninety-eight percent of patients were sedentary. A family history of diabetes and cardiovascular disease was noted in 58% and 21.78% of cases, respectively.The mean diabetes duration was 20 years. The median HbA1c was 9%, and median fasting glucose was 1.84 g/L. Insulin therapy was used by 75.2% of patients; 49.5% were on oral antidiabetic drugs, mainly

metformin (34.7%), DPP-4 inhibitors (23.8%), sulfonylureas (19.8%), and SGLT2 inhibitors (5.9%). No patient was treated with GLP-1 analogues.

Chronic Complications:
Microangiopathic complications were found in 81.88% of cases: diabetic retinopathy (33.7%), maculopathy (13.9%), nephropathy (45.5%), autonomic neuropathy (37.62%), and peripheral neuropathy (31.68%). Macroangiopathic complications were observed in 80.2% of patients, mainly ischemic heart disease (56.43%), lower-limb arteriopathy (52.5%), and stroke (31.7%).

Analytical Results:
No significant difference was found between groups regarding median age or sex ($p>0.05$).Patients with macroangiopathy only showed higher rates of dyslipidemia and hypertension compared with those with microangiopathy only, though the differences were not statistically significant ($p>0.05$), likely due to sample size limitations. A family history of cardiovascular disease was more frequent in patients with macroangiopathy or both types of complications, though not significant ($p>0.05$).Conversely, insulin therapy use, poor glycemic control (elevated HbA1c and fasting glucose), and hypoglycemia episodes were significantly more common in patients with microangiopathy ($p<0.05$).

Discussion:-
Over the two-month study period, we included 101 patients, 81.88% of whom had microangiopathy and 80.2% macroangiopathy. The mean age (68 years) reflects an elderly and vulnerable population, and the male predominance suggests that men may seek medical care later in the disease course.High rates of hypertension (77.2%) and dyslipidemia (77%) highlight their major contribution to the development of complications, consistent with findings from Jialin Li et al. [6].Obesity was present in 29.7% and overweight in 32.7%, aligning with results from Govindarajan et al. [7]. These findings emphasize the need for targeted weight management interventions.
Macroangiopathic complications were highly prevalent (80.2%), primarily ischemic heart disease (56%), peripheral arterial disease (52.5%), and stroke (31.7%), in agreement with previous studies.Microangiopathic complications were also common: retinopathy (33.7%) and maculopathy (13.9%) rates were comparable to those reported by Andaloussi et al. [8]; nephropathy (45.5%) mirrored findings from Koubaa et al. [9]; and peripheral neuropathy (31.68%) matched Najmeddine et al. [10].A family history of cardiovascular disease (21.78%) was more frequent among patients with macroangiopathy or combined complications, suggesting a potential genetic contribution [11].Poor glycemic control and insulin use were significantly higher in patients with microangiopathy, increasing the risk of hypoglycemia. Repeated glycemic fluctuations and hypoglycemia are known to impair endothelial function and promote microvascular complications such as retinopathy and nephropathy [12–14].Future targeted interventions to reduce these risk factors may improve outcomes. Further studies on genetic susceptibility are warranted to refine preventive and therapeutic strategies in this population.

Conclusion:-
The rising prevalence of complications in type 2 diabetes highlights the severity of this condition and the need for effective risk factor management, particularly hypertension and dyslipidemia. Poor glycemic control, often associated with insulin therapy, contributes to more frequent hypoglycemic episodes and the development of microangiopathic complications. This underscores the importance of close monitoring and treatment adjustment to minimize glycemic variability. Furthermore, the potential genetic influence on complication occurrence warrants further research. Personalized approaches could enhance clinical outcomes and optimize patient management.

Strengths and Limitations:-
This study provides a detailed descriptive and analytical assessment of a Moroccan diabetic cohort. However, the relatively small sample size limits generalizability and may have underestimated certain associations. Additionally, essential aspects of diabetes management — such as nutrition, risk factor control, adherence, and follow-up — were not addressed.

List of Tables:
Table 1: Macroangiopathic and microangiopathic complications observed in patients

Table 1: Macroangiopathic and microangiopathic complications observed in patients

Variables	Total N=101
Chronic complications:	
Microangiopathy, n [%]	82 [81.88]
Rétinopathy/maculopathy, n [%]	34 [33.7]
Nephropathy, n [%]	46 [45.5]
eGFR, median [IQR]	71 [41-91]
Peripheral neuropathy, n [%]	32[31.68]
Macroangiopathy, n [%]	81 [80.2]
Ischemic heart disease, n [%]	57 [56.43]
Ischemic stroke (CVA), n [%]	32 [31.7]
Peripheral arterial disease (PAD),n [%]	53 [52.5]

Table 2: Demographic, clinical, and paraclinical parameters of the three patient groups

Variables	**Total N=101**	**Patients with micro+macroangiopathies N=62**	**Patients with microangiopathies N=20**	**Patients with macroangiopathies N=19**	**P Value**
Age, median [IQR] (years)	68.0 [62-75]	68.5 [63-75]	65.0 [60-71]	67.0 [62-75.5]	0.540
Female, n [%]	37 [36.6]	22 [35.5]	8 [40]	7 [36.8]	0.939
Medical history					
Hypertension, n [%]	78 [77.2]	51 [82.3]	13 [65]	14 [73.7]	0.218
Dyslipidemia, n [%]	78 [77.2]	48 [77.4]	15 [75]	15 [78.9]	1.000
Obesity, n [%]	30 [29.7]	19 [30.6]	6 [30]	5 [26.3]	0.936
BMI, median [IQR] (kg/m²)	26.9 [23.5-31.1]	27.1 [23.5-31.6]	28.1 [25.4-31.1]	25.3 [23.3-29.1]	–
Sedentary lifestyle, n [%]	99 [98]	60 [96.8]	20 [100]	19 [100]	0.526

Variables	Total N=101	Patients with micro+macroangiopathies N=62	Patients with microangiopathies N=20	Patients with macroangiopathies N=19	P Value
Smoking, n [%]	19 [18.8]	11 [17.7]	4 [20]	4 [21.1]	0.857
Family history of diabetes, n [%]	58 [57.4]	38 [61.3]	13 [65]	7 [36.8]	**0.072**
Family history of nephropathy, n [%]	2 [1.9]	1 [1.6]	1 [5]	0 [0]	0.598
Family history of cardiovascular disease, n [%]	22 [21.8]	14 [22.6]	4 [20]	4 [21.1]	1.000
Diabetes profile					
HbA1c, median [IQR] (%)	9 [7.7-10.1]	9 [7.7-10.1]	9.8 [8.07-11.4]	8 [6.85-9.4]	**0.021**
Fasting glucose, median [IQR] (g/L)	1.84 [1.35-2.35]	1.83 [1.36-2.34]	2.35 [1.57-3.24]	1.73 [1.35-1.98]	**0.040**
Treatment					
Diet only, n [%]	19 [18.8]	11 [17.7]	2 [10]	6 [31.6]	0.213
Oral antidiabetic drugs (OAD)					
Sulfonylureas, n [%]	20 [19.8]	11 [17.7]	5 [25]	4 [21]	0.769
Metformin, n [%]	35 [34.7]	23 [37.1]	4 [20]	8 [42.1]	0.283
SGLT2 inhibitors, n [%]	6 [5.9]	4 [6.5]	0 [0]	2 [10.5]	0.367
DPP4 inhibitors, n [%]	24 [23.8]	15 [24.2]	3 [15]	6 [31.6]	0.474
Insulin, n [%]	76 [75.2]	49 [79]	19 [95]	8 [42.1]	**0.001**
Hypoglycemia episodes per week					
0, n [%]	83 [82.2]	51 [82.3]	15 [75]	17 [90]	**0.034**
1, n [%]	10 [9.9]	8 [12.9]	2 [10]	0 [0]	
2, n [%]	7 [6.9]	2 [3.2]	3 [15]	2 [10.5]	
≥4, n [%]	1 [1.0]	1 [1.6]	0 [0]	0 [0]	

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