Degenerative Complications of Type 2 Diabetes: A Cross-Sectional Study in a Moroccan Population

Abstract

Diabetesis a well-establishedrisk factor for the development of major degenerative complications affectingvariousorgans, withseriousconsequences in terms of morbidity and mortality. Understanding the pathophysiologicalmechanisms and riskfactorsunderlyingthese complications may enable improvedpreventive and therapeuticstrategies.

Weconducted a cross-sectional study over a 2-month period, including 101 patients with type 2 diabetespresentingwith at least one degenerative complication. Epidemiological, clinical, and paraclinical data werecollectedfrommedical records and supplemented by bedside interviews.

The meanage of the patients was 68 years, with a male predominance (M/F ratio = 1.72). A familyhistory of diabetes and cardiovasculardiseasewasreportedin 57.42% and 21.78% of cases, respectively. The meandisease duration was 20 years, and 62.37% of patients weresymptomatic at diagnosis. The median HbA1c was 9%, and medianfasting plasma glucose was 1.84 g/L.

Personalmedicalhistoryincluded hypertension in 77.2% of cases, dyslipidemiain 77%, smoking in 18.81%, and obesityin 29.7%. Insulintherapywasusedin 75.2% of patients. Microangiopathic complications includeddiabeticnephropathyin 45.5% of patients, diabeticautonomicneuropathyin 37.62%, peripheralneuropathyin 31.68%, diabeticretinopathyin 33.7%, and maculopathyin 13.9%. Macroangiopathic complications werepresentin 80.2% of patients, mainlyischemicheartdisease (56.43%), lower-limbobliterativearteriopathy (52.5%), and stroke (31.7%).

Whencomparingthree groups of patients — thosewithboth macro- and microangiopathic complications, thosewithmicroangiopathyonly, and thosewithmacroangiopathyonly — wefoundthat patients withpoorglycemic control (high HbA1c), requiringinsulintherapy, and experiencing more hypoglycemicepisodeswere more likely to developmicroangiopathy. Age, sex, hypertension, dyslipidemia, obesity, and smoking were comparable across groups.

Introduction

Diabetesrepresents a major public health challenge, with a steadilyincreasingprevalence and heavysocioeconomicconsequences [1]. This rapid global riseisexplained by multiple factors, including population aging, urbanization, and lifestyle changes, resulting in a significanthealthcareburdenassociatedwith the disease and its complications [2,3].

Patients withdiabetesfrequentlyexhibitinsulinresistance and relative insulindeficiency, predisposingthem to microvascular and macrovascular complications. The risk of developingdegenerative complications isamplified by factorssuch as age, obesity, sedentary lifestyle, possible geneticpredisposition, and otheryetunknownriskfactors [4].

The severity of complications iscloselyrelated to the duration of hyperglycemia and prolongedexposure to elevatedblood glucose levels, highlighting the importance of earlyglycemic control and risk factor management to improveprognosis [5]. However, the mechanismsunderlying the development of complications remainincompletelyunderstood. Even among patients withsimilar profiles, different complication patterns can beobserved.

Research question: Are thereepidemiological, genetic, or therapeuticfactorsthatexplainthisdiversity?

Materials and Methods

Study Design:

Weconducted 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). Weincluded 101 patients with type 2 diabetespresenting at least one degenerative complication. Weexcluded patients with type 1 diabetes, uncomplicated type 2 diabetes, and incompletemedical records.

Patients wereclassifiedintothree groups according to the type of chronic complications:

1. Both micro- and macroangiopathic complications
2. Microangiopathyonly
3. Macroangiopathyonly

Definition of variables:

Physical inactivitywasdefinedusing the MARSCHALL score. Smoking includedcurrentsmokers and thosewhohadquitwithin the pastthreeyears.
Diabeticretinopathywasdiagnosedusing standard ophthalmologic exams (fundus examination).
Diabeticnephropathywasdefined by a urinaryalbumin/creatinine ratio >3 mg/mmol and/or a glomerular filtration rate <60 mL/min (MDRD).
Peripheralneuropathywasidentifiedusing the DN4 questionnaire and monofilamenttesting.
Coronaryarterydiseasewasdefined by ECG findings suggestive of ischemicsequelae, a positive stress test, or a history of angioplasty or coronary bypass surgery.
Lower-limbarteriopathywasconfirmed by Doppler ultrasound or arteriographyshowingatheromatous plaques, stenosis, or ischemiclesions.
Stroke wasdefined by a neurologicaldeficitwithischemiclesions on CT or MRI.

Data collection and ethics:

Demographic, clinical, and biological data werecollectedwhileensuring patient anonymity

and confidentiality. Informed consent wasobtainedfrom all participants. Ethicalcommitteeapprovalwas not required, as thisstudyused routine clinical data.

Statisticalanalysis:

Descriptive statisticswerepresented as medians [IQR] for continuous variables and frequencies [%] for categorical variables. Differencesbetween the three groups wereanalyzedusing ANOVA for continuous variables and Chi-square or Fisher's exact test for categorical variables. A bilateral p-value <0.05 wasconsideredstatisticallysignificant. Analyses wereperformedusing JAMOVI for Windows (version 1.6.23.0).

Results

Descriptive Results:

The meanagewas 68 years, with a male-to-female ratio of 1.72. Hypertension (77.2%) and dyslipidemia (77%) were the mostcommoncomorbidities, followed by obesity (29.7%) and smoking (18.81%). Ninety-eight percent of patients weresedentary. A familyhistory of diabetes and cardiovasculardiseasewasnotedin 58% and 21.78% of cases, respectively.

The meandiabetes duration was 20 years. The median HbA1c was 9%, and medianfasting glucose was 1.84 g/L. Insulintherapywasused by 75.2% of patients; 49.5% were on oral antidiabeticdrugs, mainlymetformin (34.7%), DPP-4 inhibitors (23.8%), sulfonylureas (19.8%), and SGLT2 inhibitors (5.9%). No patient wastreatedwith GLP-1 analogues.

Chronic Complications:

Microangiopathic complications werefoundin 81.88% of cases: diabeticretinopathy (33.7%), maculopathy (13.9%), nephropathy (45.5%), autonomicneuropathy (37.62%), and peripheralneuropathy (31.68%).
Macroangiopathic complications wereobservedin 80.2% of patients, mainlyischemicheartdisease (56.43%), lower-limbarteriopathy (52.5%), and stroke (31.7%).

AnalyticalResults:

No significantdifferencewasfoundbetween groups regardingmedianage or sex (p>0.05). Patients withmacroangiopathyonlyshowedhigher rates of dyslipidemia and hypertension comparedwiththosewithmicroangiopathyonly, though the differenceswere not statisticallysignificant (p>0.05), likely due to sample size limitations. A familyhistory of cardiovasculardiseasewas more frequent in patients withmacroangiopathy or both types of complications, though not significant (p>0.05).

Conversely, insulintherapy use, poorglycemic control (elevated HbA1c and fasting glucose), and hypoglycemiaepisodesweresignificantly more common in patients withmicroangiopathy (p<0.05).

Discussion

Over the two-monthstudyperiod, weincluded 101 patients, 81.88% of whomhadmicroangiopathy and 80.2% macroangiopathy. The meanage (68 years) reflects an elderly and vulnerable population, and the male predominancesuggeststhat men mayseekmedical 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 withfindingsfromJialin Li *et al.* [6]. Obesitywaspresentin 29.7% and overweightin 32.7%, aligningwithresultsfromGovindarajan*et al.* [7]. Thesefindingsemphasize the need for targetedweight management interventions.

Macroangiopathic complications werehighlyprevalent (80.2%), primarilyischemicheartdisease (56%), peripheralarterialdisease (52.5%), and stroke (31.7%), in agreement withpreviousstudies.
Microangiopathic complications werealsocommon: retinopathy (33.7%) and maculopathy (13.9%) rates were comparable to thosereported by Andaloussi*et al.* [8]; nephropathy (45.5%) mirroredfindingsfromKoubaa*et al.* [9]; and peripheralneuropathy (31.68%) matchedNajmeddine*et al.* [10].

A familyhistory of cardiovasculardisease (21.78%) was more frequentamong patients withmacroangiopathy or combined complications, suggesting a potentialgenetic contribution [11].
Poor glycemic control and insulin use weresignificantlyhigher in patients withmicroangiopathy, increasing the risk of hypoglycemia. Repeatedglycemic fluctuations and hypoglycemia are known to impair endothelialfunction and promotemicrovascular complications such as retinopathy and nephropathy [12–14].

Future targeted interventions to reducetheseriskfactorsmayimproveoutcomes. Furtherstudies on geneticsusceptibility are warranted to refinepreventive and therapeuticstrategies in this population.

Conclusion

The risingprevalence 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, oftenassociatedwithinsulintherapy, contributes to more frequenthypoglycemicepisodes and the development of microangiopathic complications. This underscores the importance of close monitoring and treatmentadjustment to minimizeglycemicvariability. Furthermore, the potentialgenetic influence on complication occurrence warrants furtherresearch.
Personalizedapproachescouldenhanceclinicaloutcomes and optimize patient management.

Strengths and Limitations

This studyprovides a detailed descriptive and analyticalassessment of a Moroccandiabeticcohort.

However, the relativelysmallsample size limitsgeneralizability 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:

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Table 1: Macroangiopathic and microangiopathic complications observed in patients

Variables	TotalN=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]
Peripheralneuropathy, n [%]	32[31.68]
Macroangiopathy, n [%]	81 [80.2]
Ischemicheartdisease, n [%]	57 [56.43]
Ischemic stroke (CVA), n [%]	32 [31.7]
Peripheralarterialdisease (PAD),n [%]	53 [52.5]

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

Variables	Total N=101	Patients withmicro+macroangiopathies N=62	Patients with microangiopathies N=20	Patients withmacroangiopathies 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
Medicalhistory					
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
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 cardiovasculardisease, 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	11 [17.7]	2 [10]	6 [31.6]	0.213

Variables	Total N=101	Patients withmicro+macroangiopathies N=62	Patients with microangiopathies N=20	Patients withmacroangiopathies N=19	P Value
	[18.8]				
Oral antidiabeticdrugs (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**
Hypoglycemiaepisodes 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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