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Cardiovascular autonomic neuropathy in patients with type 2 diabetes mellitus: A hospital-based study

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Abstract

Purpose: Cardiovascular autonomic neuropathy (CAN) is often an overlooked complication of diabetes mellitus (DM). This study investigated the prevalence of CAN in patients with type 2 DM and its association with the duration and control of diabetes. **Methods:** In this cross-sectional observational study, 66 patients with type 2 DM were included. Clinical, biochemical, and metabolic parameters of the patients were recorded. Expiration: inspiration (E: I) ratio, 30:15 RR ratio, and resting heart rate were recorded for evaluating the parasympathetic nervous system. Sympathetic nervous system dysfunction was tested by orthostatic hypotension. **Results:** CAN was present in 63.6% of patients with type 2 DM. Severe CAN was mostly seen in patients above 60 years of age. Abnormal E: I ratio was the most common (62.1%) CAN abnormality. 66.7% of patients had numbness and claudication and 65.2% had tingling sensations. Duration of diabetes was less than 5 years in 43.9% of patients. The majority (77.3%) of patients had glycated hemoglobin (HbA1c) ≥7%. CAN had a significant association with HbA1c levels and the duration of diabetes (p=0.001 each). **Conclusion:** CAN occurred in a high number of patients with type 2 DM and was mostly parasympathetic. CAN was dependent on the duration and control of diabetes.

Keywords: Cardiovascular autonomic neuropathy, Type 2 diabetes mellitus, Silent myocardial ischemia, Complications of diabetes, Diabetic neuropathy.

Introduction

The increasing prevalence of diabetes has become a significant public health burden worldwide. According to the Diabetes International Federation Atlas 2021, approximately 537 million adults aged 20-79 are currently diagnosed with diabetes mellitus, accounting for nearly 1 in 10 people globally. Alarmingly, this figure is projected to rise to 783 million by 2045, highlighting the urgent need for effective strategies to combat this growing epidemic. The escalating numbers underscore the importance of comprehensive public health initiatives, early diagnosis, and improved management to mitigate the impact of diabetes on individuals and healthcare systems globally.[1] Approximately 90% of these cases are attributed to type 2 diabetes mellitus (DM).

Diabetic neuropathy is one of the most frequently occurring yet significantly underdiagnosed and undertreated complications of diabetes. Despite its high prevalence among diabetic patients, it often remains overlooked in clinical settings, leading to insufficient treatment and management. This condition, which affects

the nerves and can cause symptoms ranging from pain and numbness to serious mobility issues, demands greater attention from healthcare providers. The lack of adequate diagnosis and treatment not only impacts the quality of life for individuals but also increases the risk of further complications, emphasizing the need for improved awareness and comprehensive care strategies.[2] Diabetes involves the complex interplay of both the somatic and autonomic nervous systems, leading to a multifaceted pathophysiology. The disease affects the somatic nervous system, which controls voluntary muscle movements, often resulting in muscle weakness, pain, and sensory disturbances. Simultaneously, it impacts the autonomic nervous system, which regulates involuntary functions such as heart rate, blood pressure, and digestion, leading to complications like cardiovascular issues, gastrointestinal problems, and sexual dysfunction. The intricate nature of this pathophysiology makes the management of diabetes particularly challenging, requiring a comprehensive approach to address the diverse and interconnected effects on both nervous systems.[2-5] Cardiovascular autonomic neuropathy (CAN) occurs within the context of diabetic autonomic neuropathy after ruling out other causes of autonomic dysfunction[2]. The prevalence of CAN varies from nearly 2% in patients with newly diagnosed or well-controlled diabetes, to 60% in patients with long-standing type 2 diabetes mellitus.[6,7] It causes imbalances in cardiovascular, genitourinary, and gastrointestinal systems and even derangements in metabolic functions - glucose counter-regulation.[8] CAN is associated with a higher incidence of cardiac arrhythmias and sudden cardiac deaths.[9] The assessment of Cardiovascular Autonomic Neuropathy (CAN) in diabetic patients holds significant clinical and prognostic relevance. Early identification of CAN is crucial because it allows for the timely implementation of intensive interventions that can alter the course of the disease. Recognizing patients at risk enables healthcare providers to focus on key areas such as lifestyle modifications, stringent blood glucose control, and management of cardiovascular risk factors. These proactive measures can not only slow down the progression of CAN but also, in some cases, reverse its effects, thereby improving patient outcomes. Moreover, early intervention may prevent the onset of more severe cardiovascular complications associated with CAN, ultimately enhancing the quality of life for diabetic patients. Given the serious implications of CAN on overall health, prioritizing its assessment and early management should be an integral part of diabetes care strategies to optimize long-term health outcomes.[10,11]

As such the present study was undertaken to determine the prevalence of CAN and its association with duration and control of type 2 DM.

Materials and methods:

Dataset:

The study was a cross-sectional observational study conducted at a tertiary care hospital in Uttarakhand, India from July 2021 to June 2022. A total of 66 patients with type 2 DM of age above 18 years were included in this study after obtaining their written informed consent.

Ethics approval:

Ethical clearance was obtained from the institutional ethics committee (No. ……/ETHICS/ 2022/343 dated May 25, 2021).

Study protocol:

The diagnosis of type 2 DM was based on the American Diabetes Association diagnostic criteria, 2016[11]. Patients with other diseases affecting the autonomic nervous system like small fiber neuropathies of other causes, multisystem atrophy, severe systemic illness (cardiac, renal, pulmonary, diseases and malignancy), Parkinson's disease, excessive or chronic alcohol consumption, episode of hypoglycemia in the preceding 24 hours before testing, patients on drugs causing autonomic dysfunction like beta-blockers, diuretics, nitrates, adrenergic drugs and antiarrhythmics, individuals with type 1 DM, secondary forms of diabetes, gestational diabetes and congenital syndromes of diabetes, were excluded.

All patients were subjected to a questionnaire to record history, treatment details, duration of diabetes, comorbidities, symptoms suggestive of microvascular and macrovascular complications (tingling and numbness, claudication, gastrointestinal symptoms-post prandial fullness, nausea, vomiting and altered bowel habits, urinary symptoms, visual abnormalities, gustatory sweating, and erectile dysfunction). A detailed

clinical examination was done. Relevant investigations like complete hemogram, urine routine and microscopy, fasting and post-prandial blood sugars, glycated hemoglobin (HbA1c), serum creatinine, fasting lipid profile, 12 lead ECG, and fundus examination were done. HbA1c was measured using high-performance liquid chromatography.

All patients underwent the following tests for the detection of CAN.

Parasympathetic function tests:

a) Resting heart rate (HR): The patient was made to lie supine and a standard 12-lead ECG was recorded. Resting HR>100/minute was considered abnormal.[2,12]

b) Expiration: Inspiration (E: I) ratio: The patient was made to lie supine and asked to breathe deeply 6 times per minute. An expiration/inspiration (E: I) R-R ratio was obtained by dividing the longest RR interval during expiration by the shortest RR interval during inspiration. E: I ratio <1.1 was considered abnormal.[2,13,14]

c) HR response to standing: 30:15 ratio was calculated by obtaining the ratio of RR interval at the 30th beat and 15th beat after standing. A ratio <1.03 was considered abnormal.[2,13,14]

Sympathetic function tests:

a) Blood pressure response to standing: Blood pressure was recorded in the supine position and 2 minutes after standing. Systolic blood pressure (SBP) difference ≥20mm Hg and diastolic blood pressure (DBP) difference ≥10mm Hg was considered abnormal.[2,14,15]

Based on the results, CAN was categorized as:

i. Absent
ii. Early CAN: 1 abnormal parasympathetic function test.
iii. Definite CAN: ≥ 2 abnormal parasympathetic function tests.
iv. Severe CAN: abnormality in both sympathetic and parasympathetic function tests.[5]

Statistical Analysis:

Statistical Analysis was performed using SPSS software version 22. Tests of significance used were Pearson Chi-square (or Fisher's Exact Test) for categorical variables and unpaired t-test for continuous variables. The Chi-square test was used for the comparison of qualitative data and for measuring the association between different variables. A p-value <0.05 was taken as statistically significant.

Results

The mean age of patients with type 2 DM was 55.7 years (age range 32-77 years). The majority of patients belonged to the age group of 51 to 70 years (68.1%). Male: female ratio was 1.86:1. The majority of patients had a duration of diabetes less than 5 years (43.9%). 6.1% of patients were smokers and 9.1% of patients used to take alcohol occasionally (Table 1).

Table 1: Baseline characteristics of patients with type 2 DM

Characteristics	Number of patients (%)
Age group	
31-40 years	4 (6.1%)
41-50 years	14 (21.2%)
51-60 years	23 (34.8%)
61-70 years	22 (33.3%)
>70 years	3 (4.5%)
Gender	
Male	43 (65.2%)
Female	23 (34.8%)

Duration of diabetes (years)	
<5	29 (43.9%)
6-10	24 (36.4%)
>10	13 (19.7%)
BMI (kg/m^2)	
Underweight (<18.5)	1 (1.5%)
Normal (18.5-24.9)	26 (39.4%)
Overweight (25-29.9)	33 (50%)
Obese (>30)	6 (9.1%)
HbA1C (%)	
<7	15 (22.7%)
≥7	51 (77.3%)
Comorbidities	
Dyslipidemia	3 (4.5%)
Hypertension	27 (40.9%)
Hypothyroidism	5 (7.6%)
Personal habits	
Active smokers	4 (6.1%)
Occasional alcoholics	6(9.1%)

DM: diabetes mellitus; BMI: body mass index; HbA1c: glycated hemoglobin;

Numbness, claudication, and tingling were the most common symptoms. Urinary symptoms and presyncope were present in a relatively less but sizeable number of patients with type 2 DM (Table 2).

Table 2: Clinical features of patients with type 2 DM

Clinical feature	**Number of patients (%)**
Presyncope	10 (15.2%)
Gastrointestinal symptoms	3 (4.5%)
Numbness	44 (66.7%)
Claudication	44 (66.7%)
Tingling	43 (65.2%)

Urinary symptoms	13 (19.7%)
Retinopathy	8 (12.1%)
Gustatory sweating	1 (1.5%)

DM: diabetes mellitus

The majority of the patients had a resting heart rate (HR) <100 bpm (75.8%). E: I ratio was abnormal in 62.1% of patients. 30:15 ratio was abnormal in 54.5% of patients. Systolic blood pressure (SBP) difference was abnormal in 10.6% of patients and diastolic blood pressure (DBP) difference was abnormal in 4% of patients (Table 3).

Table 3: CAN testing parameters among patients with type 2 DM

CAN testing parameters	**Number of patients (%)**
Resting heart rate (bpm)	
<100	50 (75.8%)
>100	16 (24.2%)
E: I ratio	
Normal (>1.1)	25(37.9%)
Abnormal (<1.1)	41(61.2%)
30:15 ratio	
Normal (>1.03)	30(45.5%)
Abnormal (<1.03)	36(54.5%)
Systolic blood pressure Difference (mm Hg)	
Normal (<20)	59(89.4%)
Abnormal (>20)	7(20.6%)
Diastolic blood pressure (mm Hg)	
Normal (<10)	62(93.9%)
Abnormal (>10)	4(6.1%)

DM: diabetes mellitus; bpm: beats per minute; E: I: expiration: inspiration.

CAN was present in 63.6% of patients with type 2 DM. Early CAN was present in 19.7% of patients, definite CAN was present in 34.8% of patients, and severe CAN in 9.1% of patients.

The majority of patients with early CAN belonged to the age group of 51 to 60 years (46.2%); the majority with definite CAN belonged to the age group of 61 to 70 years (56.5%) and the majority with severe CAN belonged to 61 to 70 years (50%). A significant increase in the severity of CAN was seen with advancing age (p = 0.001). Among patients with CAN, HbA1c was <7% in 4.8% of patients and ≥7% in 95.2% of patients. A significant association was seen between uncontrolled diabetes and CAN (p=0.001). There was no statistically significant association of gender, personal habits, and BMI with the severity of CAN (Table 4).

Table 4: Relationship between predictors and severity of CAN

Predictors	**Number of patients (%)**				**p-value**
	CAN				
	Absent (n=24)	**Early (n=13)**	**Definite (n=23)**	**Severe (n=6)**	
Age (years)					
31-40	4(16.7%)	0	0	0	0.001
41-50	9(37.5%)	4(30.8%)	1(4.3%)	0	
51-60	8(33.3%)	6(46.2%)	8(34.8%)	1(16.7%)	
61-70	3(12.5%)	3(23.1%)	13(56.5%)	3(50%)	
>70	0	0	1(4.3%)	2(33.3%)	
Gender					
Male	16(66.7%)	8(61.5%)	16(69.9%)	3(50%)	0.82
Female	8(33.3%)	5(38.5%)	7(30.4%)	3(50%)	
Duration of diabetes					
<5 Years	19(79.2%)	4(30.8%)	6(26.1%)	0	0.001
6-10 Years	5(20.8%)	8(61.5%)	10(43.5%)	1(16.7%)	
>10 Years	0	1(7.7%)	7(30.4%)	5(83.3%)	
Active smoking					
No	23(95.8%)	11(84.6%)	22(95.7%)	6(100%)	0.45
Yes	1(4.2%)	2(15.4%)	1(4.3%)	0	
Alcohol					
NO	23(95.8%)	11(84.6%)	21(91.3%)	5(83.3%)	0.62

	YES	1(4.2%)	2(15.4%)	2(8.7%)	1(16.7%)	
	BMI (kg/m^2)					
	Underweight	0	0	1(4.3%)	0	
CAN:	Normal	9(93.7%)	6(46.2%)	9(39.1%)	2(33.3%)	0.59
	Overweight	14(58.3%)	6(46.2%)	11(47.8%)	2(33.3%)	
	Obese	1(4.2%)	1(7.7%)	2(8.7%)	2(33.3%)	
	HbA1c (%)					
	<7	13(54.2%)	1(7.7%)	1(4.3%)	0	0.001
	≥7	11(45.8%)	12(92.3%)	22(95.7%)	6(100)	

cardiac autonomic neuropathy; BMI: body mass index; HbA1c: glycated hemoglobin

In patients with CAN, the duration of diabetes was less than 5 years in 10 (23.8%) patients, between 6 to 10 years in 19 (45.2%) patients, and more than 10 years in 13 (31%) patients. Among patients with CAN, HbA1C was <7% in 2 (4.8%) patients and ≥7 in 40 (95.2% patients). Duration of diabetes and uncontrolled diabetes showed a significant association with CAN (p= 0.001). Uncontrolled diabetes had a significant association with E: I ratio and 30:15 ratio among various cardiovascular autonomic neuropathy testing parameters. Duration of diabetes had a significant association with resting HR, 30:15 ratio, and SBP difference among various CAN testing parameters (Table 5).

Table 5: Association of CAN and individual CAN testing parameters with control and duration of diabetes

Parameters	**Number of patients**		**p-value**	**Number of patients**			**p-value**
	HbA1c (%)			**Duration of diabetes (years)**			
	<7 (n=15)	**≥7 (n=51)**		**<5 (n=29)**	**6-10 (n=2)**	**>10 (n=1)**	
CAN							
Present	2	40	0.001	10	19	13	0.001
Absent	13	11		19	5	0	
Parasympathetic function tests							
Resting HR (bpm)							
<100	14	36	0.064	26	18	6	0.01
>100	1	15		3	6	7	
E: I ratio							

Normal (>1.1)	10	15	0.01	15	8	2	0.06
Abnormal (<1.1)	5	36		14	16	11	
30:15 ratio							
Normal (>1.03)	13	17	0.001	22	7	1	0.001
Abnormal (<1.03)	2	34		7	17	12	
Sympathetic function tests							
Fall in SBP (mmHg)							
Normal (≤20)	15	44	0.14	29	23	7	0.001
Abnormal (≥20)	0	7		0	1	6	
Fall in DBP (mmHg)							
Normal (≤10)	15	47	0.34	27	24	11	0.16
Abnormal (≥10)	0	4		2	0	2	

CAN: cardiac autonomic neuropathy; HbA1c: glycated hemoglobin; HR: heart rate; E: I: expiration: inspiration; SBP: systolic blood pressure; DBP: diastolic blood pressure.

Discussion

Our study used simple bedside tests for testing CAN in diabetic patients like E: I ratio, 30:15 ratio, and resting heart rate for parasympathetic dysfunction, and orthostatic hypotension for sympathetic dysfunction.[16]

The most common symptoms of diabetic neuropathy include numbness and claudication, each affecting 66.7% of patients, followed closely by a tingling sensation in 65.2% of cases. Bladder symptoms were reported by 19.7% of patients, while presyncope, a feeling of near-fainting, was present in 15.2%. Gastrointestinal symptoms, such as post-prandial fullness, abdominal bloating, constipation, diarrhea, and fecal incontinence, were noted in 4.5% of cases, with gustatory sweating reported by 1.5% of patients. A study by Bhuyan et al. further highlighted that 14.28% of participants were clinically asymptomatic, despite having diabetic neuropathy. Among symptomatic individuals, 21.4% experienced only gastrointestinal symptoms, while 17.1% reported cardiovascular symptoms, and another 17.1% suffered from urinary bladder dysfunction or erectile dysfunction in men. Additionally, 17.1% of participants exhibited a combination of gastrointestinal and cardiovascular symptoms, and 12.8% had a combination of symptoms involving all three systems. This diverse presentation underscores the complexity of diabetic neuropathy and the importance of comprehensive symptom assessment to ensure accurate diagnosis and tailored treatment strategies for affected individuals.[18] Clinical features indicative of peripheral neuropathy, such as tingling, numbness, and claudication, alongside signs of autonomic dysfunction, including gastrointestinal symptoms, bladder issues, and gustatory sweating, should be carefully monitored in patients with uncontrolled diabetes. Additionally, the presence of retinopathy is another crucial indicator of diabetes-related complications. Early detection and recognition of these symptoms are essential for timely intervention and management, as they can signal the progression of diabetic complications. Addressing these issues promptly can help prevent further deterioration and improve overall patient outcomes in the context of diabetes care.

The most common comorbidity was hypertension (40.9%) followed by hypothyroidism (7.6%) and

dyslipidemia (4.5%). There were 6.1% of smokers and 9.1% of patients consumed alcohol occasionally. No significant association was found between current smoking or occasional alcohol consumption and the development of CAN. The number of smokers as well as patients taking alcohol was less in our study in comparison to 26.9 % smokers and 20.1% alcoholics present in a study by Cha et al.[17] The less number of alcohol consumers may be due to the exclusion of moderate and heavy alcohol consumers in our study as excessive alcohol consumption could lead to the development of CAN.

E: I ratio abnormality was the most common CAN abnormality observed (62.1%). This was in accordance with the study findings of an abnormal E: I ratio in 56% of patients in a study by Bhuyan et al[18]. Whereas, in a study by Birajdar et al., an abnormal 30:15 ratio was the most common CAN abnormality (38% of cases).[19] The prevalence of an abnormal 30:15 ratio was relatively higher (54.5%) in our study. We observed resting tachycardia (HR ≥100/min) in 24.2% of patients which was slightly higher than resting tachycardia observed in 17% of patients by Bhuyan et al.[18] Isolated sympathetic dysfunction was not present. Sympathetic dysfunction was seen at the later stages of CAN when parasympathetic dysfunction had already manifested. It implies that CAN occurs mainly due to the involvement of the parasympathetic nervous system as it appears early during the course of uncontrolled diabetes and involves the sympathetic nervous system later as the disease progresses.

The overall prevalence of Cardiovascular Autonomic Neuropathy (CAN) in patients with type 2 diabetes mellitus (DM) was found to be 63.6%. Among these, 19.7% had early-stage CAN, 34.8% had definite CAN, and 9.1% had severe CAN. These findings align with the study by Birajdar et al., which reported a similar prevalence of CAN at 58%. The high prevalence of CAN in these studies underscores the importance of early detection and management of this complication in patients with type 2 DM to prevent progression and associated cardiovascular risks.[19] In yet another study conducted in northeast India, the prevalence of CAN was 70%.[18] In a study by Anca et al, in Romania, the prevalence of CAN was 39.1% in type 2 DM patients.[20] In other studies, the prevalence of CAN in type 2 DM patients have been reported between 31 to 73%.[21] A high prevalence of CAN in our region probably occurs due to a lack of awareness, poor socioeconomic conditions especially in rural areas, and lack of access to proper healthcare facilities in hard-to-reach hilly areas which delays the diagnosis and proper management of diabetes.

Male: female ratio was 1.86:1. Gender distribution in our study was in accordance with the study by Birajdar et al where the male gender was dominant.[19] A higher proportion of male subjects was possibly due to more importance attached to the health of male members who are generally the primary income earners in the Indian context.

There was no significant association found between CAN and gender in our study. Gender association with CAN was also not significant in the study done by Bhuyan et al. [18] In another study, although CAN was more common in females than in males, the difference was not statistically significant.[22] However, in a large study that included more than 8,000 patients with type 2 diabetes, the prevalence of CAN was higher in women than in men.[23]

The mean age of the study population was 55.7 years, with an age range of 32 to 77 years. The largest proportion of patients, 34.8%, fell within the 51 to 60-year age group. This distribution highlights that middle-aged individuals are most commonly affected in this study, emphasizing the importance of targeted interventions for this age group in managing and preventing diabetes-related complications.

Among patients with early CAN, the majority belonged to the 51 to 60 years (46.2%) age group. The majority of patients with definite and severe CAN belonged to the age group of 61 to 70 years (56.5% and 50%). The severity of CAN had a significant association with advancing age which could be either due to a long duration of diabetes or the effect of older age per se. Known mechanisms implicated in the development of CAN include increased oxidative stress, generation of excessive free radicals, and deficiency of neurotrophic growth factors with advancing age.[24] Our study findings were similar to the observations by Migisha et al and Bhuyan et al. who found the prevalence and severity of CAN to be highest in old age.[18,25] However, Am et al found no significant increase in CAN with advancing age.[26] We found a significant association between CAN and the duration of diabetes which is supported by observations of Ahire et al. that patients with more than 5 years' duration of diabetes had a significant risk of definite and severe CAN as compared to individuals with diabetes

for less than 5 years.[27]

Our observations revealed that among patients with less than 5 years of diabetes, 30.8% had early-stage Cardiovascular Autonomic Neuropathy (CAN), and 26.1% had definite CAN, while none had progressed to severe CAN. This finding suggests that CAN can exist in a subclinical form well before diabetes is formally diagnosed. Many patients experience a prolonged asymptomatic phase during which intermittent blood glucose spikes may occur, yet remain undiagnosed. This latency could also be due to delayed detection of diabetes, leading to an underestimation of the early onset of CAN. These results imply that the development of CAN begins in the initial stages of diabetes, even when clinical symptoms may not be apparent. Early-stage CAN may thus serve as an important indicator of underlying diabetes, highlighting the need for vigilant screening and monitoring of autonomic function in newly diagnosed patients. This underscores the critical importance of early intervention and proactive management to prevent the progression of CAN and reduce the risk of severe cardiovascular complications associated with diabetes. Early detection and treatment strategies could significantly improve outcomes and help to manage the long-term risks associated with diabetes-related autonomic dysfunction.[28]

The mean HbA1c, which reflects glycemic control, in our study population was 8.4%. A striking 95.2% of patients with HbA1c values of 7% or higher were found to have Cardiovascular Autonomic Neuropathy (CAN). There was a significant association between glycemic control, as indicated by HbA1c levels, and the presence of CAN, aligning with the findings of Dhumad et al.[29] Specifically, among patients with definite CAN, 95.7% had HbA1c levels of 7% or higher, while only 4.3% had levels below 7%. Furthermore, all patients with severe CAN had HbA1c values of 7% or more, with none falling below this threshold. This suggests a positive correlation between poor glycemic control and the severity of CAN in our study. The data indicate that higher HbA1c levels are strongly associated with both the presence and severity of CAN, highlighting the critical role of stringent blood glucose management in preventing or mitigating the progression of this complication. However, it's important to note that contrasting findings were reported by Bhuyan et al., who observed no significant association between CAN and HbA1c levels, suggesting that other factors may also influence the development and severity of CAN, and further research is needed to fully understand these relationships.

We observed orthostatic hypotension in 11 (6%) patients. It was much higher (24.65%) in a study by Dhumad et al. and marginally higher in the study by Bhuyan et al. who observed orthostatic hypotension in 11% of cases.[29,18] Orthostatic hypotension is suggestive of sympathetic nervous system dysfunction and severe CAN.[13,30,31] CAN is also associated with an increased risk of sudden cardiac death.[32] By the time patient develops postural hypotension, the disease has usually progressed from a subclinical to a clinal stage. Disabling symptoms such as weakness, postural giddiness, dizziness, and presyncope have already appeared impacting one's daily activities.

Since Cardiovascular Autonomic Neuropathy (CAN) is frequently underdiagnosed and often overlooked, we recommend that all diabetes patients, including those newly diagnosed, undergo screening for CAN and other associated complications. This proactive approach is crucial because CAN and related issues may be present at the time of the patient's initial diagnosis, despite the absence of symptoms. Early detection through routine screening can facilitate timely intervention, allowing for better management and prevention of further progression. Comprehensive assessment at the onset of diabetes ensures that all potential complications are identified and addressed promptly, improving overall patient care and outcomes.

Conclusion

In our study, we observed a high prevalence of Cardiovascular Autonomic Neuropathy (CAN) among patients with type 2 diabetes. Notably, involvement of the parasympathetic nervous system was more common compared to the sympathetic nervous system. Isolated sympathetic dysfunction was not observed in our cohort, suggesting that parasympathetic dysfunction may be a primary feature in the development of CAN in these patients. The duration of diabetes was significantly associated with the development of CAN, indicating that longer disease duration increases the risk of autonomic dysfunction. Additionally, uncontrolled diabetes, as

evidenced by higher HbA1c levels, had a strong association with CAN, emphasizing the impact of poor glycemic control on the development and progression of this complication. Our findings also revealed a significant correlation between advancing age and the severity of CAN, with older patients exhibiting more severe manifestations of autonomic neuropathy. This underscores the importance of considering both the duration of diabetes and the age of patients when assessing the risk of CAN. Given these findings, early screening for CAN using simple bedside tests is crucial for diabetic patients. Implementing strict glycemic control measures and providing patient education are essential strategies to halt the progression of CAN. Such proactive approaches can help reduce the overall morbidity and mortality associated with diabetic autonomic complications, ultimately improving patient outcomes and quality of life.

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