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To Determine The Prevalence of Cardiac Autonomic Dysfunction in Patients With Type 2 Diabetes Mellitus in A Tertiary Care Centre

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Abstract

Background: Cardiac autonomic dysfunction (CAD) is a critical yet underdiagnosed complication of diabetes mellitus (DM), linked to increased cardiovascular morbidity and mortality. This cross-sectional study aimed to assess the prevalence, severity, and biochemical correlates of CAD in individuals with DM, emphasizing modifiable risk factors for early intervention.

Aim: To determine the prevalence of cardiac autonomic dysfunction in patients with type 2 diabetes mellitus in a tertiary care centre

Material and Methods: The study was carried out in the post graduate institute of medicine, GSVM Medical college. The material of study included patients of all age group having diabetes mellitus, conducted for a duration of 18 months.

Results: Of the 100 participants (mean age 58.3 ± 9.75 years; 57% male), cardiac autonomic dysfunction was common. Resting heart rate was abnormal in 29%, while deep breathing and standing tests showed dysfunction in 65% and 59%, respectively. Valsalva, postural hypotension, and handgrip tests revealed abnormalities in 12%, 15%, and 80%. Parasympathetic dysfunction was found in 79%, and sympathetic dysfunction in 87% of participants. Overall, 11% had no dysfunction, 25% had mild, 53% moderate, and 11% severe dysfunction. These findings indicate a high prevalence and varying severity of autonomic dysfunction among the studied population. Participants with cardiac autonomic dysfunction had significantly higher HbA1c levels. Those with sympathetic dysfunction showed a mean HbA1c of 9.22 ± 1.73 versus 8.05 ± 1.33 in those without (p = 0.0221). Similarly, parasympathetic dysfunction was associated with higher HbA1c (9.25 ± 1.78 vs. 8.39 ± 1.33, p = 0.0413). HbA1c levels also increased with dysfunction severity: 7.75 ± 0.74 (no dysfunction), 8.84 ± 1.73 (mild), 9.07 ± 1.61 (moderate), and 10.92 ± 1.57 (severe), with a significant difference (p = 0.0001). These

findings suggest a strong association between elevated HbA1c and the presence and severity of autonomic dysfunction.

Conclusion: The study revealed a strikingly high prevalence of autonomic dysfunction: 79% parasympathetic and 87% sympathetic impairment, with 64% of participants exhibiting moderate-to-severe dysfunction. A pivotal finding was the robust association between elevated HbA1c levels and autonomic dysfunction severity ($p = 0.0001$), underscoring glycemic control as a key modifiable target. Notably, sustained handgrip tests identified 80% abnormal responses, advocating their utility in routine screening

Keywords: Autonomic dysfunction, Diabetes mellitus, HbA1c, Cardiac autonomic neuropathy, Glycemic control.

Introduction

Cardiac autonomic dysfunction (CAD) is a serious but underrecognized complication of type 2 diabetes mellitus (T2DM), especially in India—the "diabetes capital of the world." CAD, driven by hyperglycemia, oxidative stress, and inflammation, impairs autonomic heart control, reducing heart rate variability and increasing arrhythmia risk. Despite its high prevalence (up to 52%), CAD remains underdiagnosed in India, particularly in second-tier cities with limited resources and awareness. This study aims to assess the prevalence of CAD in these areas, promoting early detection, integration of cardiac autonomic testing in diabetes care, and evidence-based strategies to reduce cardiovascular morbidity and improve health outcomes.

Materials and Methods

Study design: Cross-sectional study.

Inclusion Criteria

Patients eligible for inclusion met any one of the American Diabetes Association (ADA) diagnostic criteria**:** HbA1C level greater than 6.5%, fasting blood glucose level above 125 mg/dL, or a 2-hour postprandial blood glucose level exceeding 200 mg/dL. Additionally, all participants were required to be over 30 years of age.

Exclusion Criteria

Participants were excluded if they had intravascular volume depletion due to acute blood loss or dehydration, were pregnant or in the postpartum period, or had significant cardiac conditions including pericarditis, myocardial infarction, congestive heart failure, angina, or valvular heart disease. Other exclusions included hypothyroidism and the use of medications such as beta blockers, amiodarone, colchicine, dapsone, or vinca alkaloids**.**

Study Tool

Data collection was performed using a pre-structured questionnaire that captured demographic information, diabetes-specific history, comorbid conditions, and current medication use. Demographic variables included age, gender, occupation, and socioeconomic status, the latter assessed using the Kuppuswamy scale or a comparable index.

Diabetes-Specific History

Participants were asked to provide information on the duration of Type II Diabetes Mellitus, as well as their current mode of treatment, which could include oral hypoglycemic agents (OHAs), insulin therapy, or lifestyle modification alone. Glycemic control was evaluated based on the most recent HbA1c value, fasting blood sugar (FBS), and postprandial blood sugar (PPBS) levels. Information regarding the presence of **diabetes-**related complications such as retinopathy, nephropathy, peripheral neuropathy, and history of cardiovascular disease (CVD) was also collected.

Comorbid Conditions and Medication History

Participants were screened for common comorbid conditions including hypertension, dyslipidemia, and chronic kidney disease (CKD). A comprehensive list of medications was recorded, especially those known to influence autonomic function. These included antihypertensive drugs (such as beta-blockers and ACE inhibitors), lipid-lowering agents (such as statins), and other medications like antidepressants.

Evaluation of Autonomic Dysfunction

Autonomic dysfunction in patients with Type II Diabetes Mellitus (T2DM) was assessed using the CANS 504 computerized autonomic function analyzer (Diabetik Foot Care Pvt Ltd, India). The assessment relied on heart rate variability (RR interval) measurements taken during various physiological challenges such as deep breathing, standing, Valsalva maneuver, postural hypotension, and sustained handgrip.

Pre-Test Instructions

To maintain the accuracy of the test results, participants were advised to refrain from smoking, consuming caffeinated beverages, or taking antihypertensive medications for at least three hours prior to the evaluation.

Procedure

1. **Parasympathetic Function Assessment**
   The parasympathetic nervous system (PNS) was evaluated using the following three tests:

- **Deep Breathing Test**: Patients performed deep breathing at a rate of six breaths per minute, with heart rate responses measured as the expiration-to-inspiration (E:I) ratio.
- **Standing (30:15 Ratio) Test**: The patient transitioned from a supine to standing position, and the heart rate response was calculated as the 30:15 ratio.
- **Valsalva Maneuver**: Patients were instructed to exhale forcefully into a mouthpiece after a deep inhalation, and heart rate response was recorded as the Valsalva ratio.
- Abnormal findings in one or more of these tests were indicative of parasympathetic dysfunction.

2. **Sympathetic Function Assessment**
   The sympathetic nervous system (SNS) was evaluated with two tests:

- **Postural Hypotension Test**: Blood pressure was recorded as the patient moved from a lying to standing position. A drop in systolic BP ≥20 mmHg or diastolic BP ≥10 mmHg indicated sympathetic dysfunction.
- **Sustained Handgrip Test**: Patients squeezed a handgrip device at 30% of their maximum strength for 60–120 seconds. An increase in diastolic BP of less than 15 mmHg during the activity was considered abnormal.

Based on Ewing's criteria**,** autonomic dysfunction was classified into three categories:

- **Mild**: One abnormal finding
- **Moderate**: At least two abnormal findings
- **Severe**: Orthostatic hypotension with additional abnormal findings

Laboratory Investigations

Complementary to the autonomic function tests, the following laboratory investigations were conducted:

- **HbA1c (%)**, to assess long-term glycemic control
- **Fasting and postprandial blood glucose levels** (mg/dL), for short-term glucose control
- **Serum creatinine and estimated glomerular filtration rate (eGFR)**, to evaluate renal function

Ethical Consideration

Approval was obtained from the Institutional Ethics Committee (IEC) of Ganesh Shankar Vidyarthi Memorial

Medical College, Kanpur (Approval No: EC/78/Feb/24). Informed written consent was obtained from all participants after explaining the nature and purpose of the study. Participation was voluntary, and confidentiality of all personal and medical data was ensured. No invasive procedures were performed, and participants had the right to withdraw at any time without any consequences to their ongoing medical care.

Data Analysis and Statistical Methods

The data was entered in Microsoft Excel and cleaned for errors and missing values. Data analysis was done using licensed SPSS software version 21.0.Data is presented in the form of tables and appropriate diagrams. Qualitative data is summarized as proportions while quantitative data as mean, median and appropriate measures of dispersion including confidence intervals. Quantitative Data was analyzed using paired t-test and qualitative data by Chi square/fisher exact test with value of $p < 0.05$ is taken as significant.

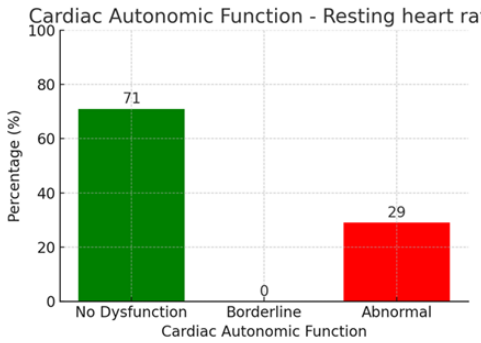
Results

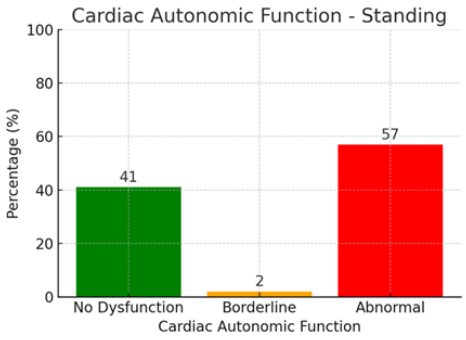
A total of 100 participants were included in the study. The mean age of the participants was 58.3 ± 9.75 years**.** In terms of sex distribution, the majority were male 57%)**,** while females constituted 43%.

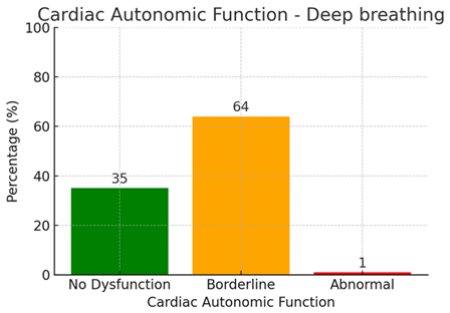
Cardiac autonomic function assessment across different maneuvers among 100 study participants, categorized as No Dysfunction, Borderline and Abnormal. For resting heart rate, 71 (71%) participants had no dysfunction, while 29 (29%) had abnormal function. In the deep breathing test, 35 (35%) had no dysfunction, 64(64%) were classified as borderline, and 1(1) had abnormal function. In the standing test, 41 (41%) had no dysfunction, 2 (2%) was borderline, and 57 (57%) had abnormal function. For the Valsalva maneuver, 77(77%) had no dysfunction, 11(11%) were borderline, and 12 (12%) had abnormal function. In postural hypotension, 68 (68%) had no dysfunction, 17(17%) were borderline, and 15 (15%) had abnormal function. The sustained hand grip test showed that 7(7%) had no dysfunction, 13 (13%) were borderline, and 80(80%) had abnormal function.

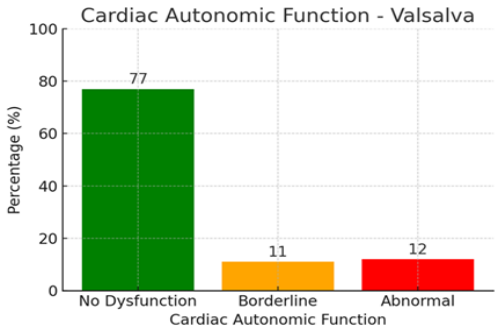
Table 1: Cardiac Autonomic Function during different maneuvers according to the study participants (N=100)

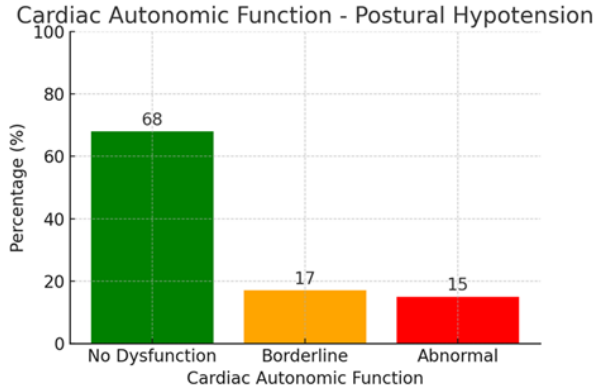
	No Dysfunction (%)	Borderline (%)	Abnormal (%)
Resting heart rate	71(71)	0(0)	29(29)
Deep breathing	35(35)	64(64)	1(1)
Standing	41(41)	2(2)	57(57)
Valsalva	77(77)	11(11)	12(12)
Postural Hypotension	68(68)	17(17)	15(15)
Sustained hand grip	7(7)	13(13)	80(80)











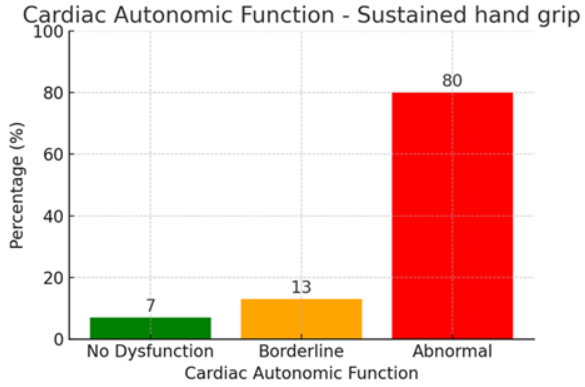


Figure 1: Bar chart presentation of Cardiac autonomic function with different maneuvers.

Table 2: Distribution of Para-sympathetic dysfunction among study participants (N=100).

Parasympathetic dysfunction was present in 79 (79%) of participants, while 21 (21%) did not exhibit dysfunction. This indicates a high prevalence of parasympathetic impairment among the study population.

Sympathetic dysfunction	Frequency	Percentage
Present	87	87
Absent	13	13
Total	100	100

Table 3: Distribution of Sympathetic dysfunction among study participants (N=100).

Dysfunction severity grading	Frequency	Percentage
No Dysfunction	11	11
Mild Dysfunction	25	25
Moderate Dysfunction	53	53
Severe Dysfunction	11	11
Total	100	100

Table 4: Dysfunction severity grading distribution according to the study participants (N=100).

Para-sympathetic dysfunction	Frequency	Percentage
Present	79	79
Absent	21	21
Total	100	100

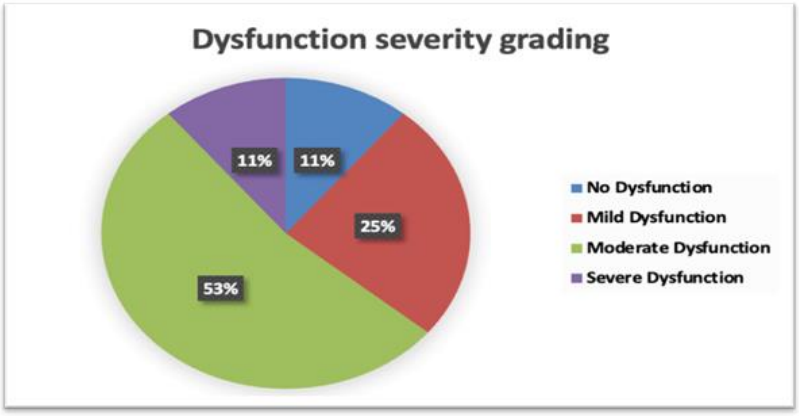


Figure 2: Pie chart showing distribution of dysfunction severity grading.

Table 5: Comparison of Hba1c among Sympathetic dysfunction, Para-sympathetic dysfunction and dysfunction severity grading

Categories	Mean $\pm SD$	p value
Sympathetic dysfunction		
Present	9.22$\pm$**1.73**	0.0221*
Absent	8.05$\pm$1.33	
Para-sympathetic dysfunction		

Present	9.25±1.78	0.0413*
Absent	8.39±1.33	
Dysfunction Severity grading		
No Dysfunction	7.75±0.74	0.0001#
Mild Dysfunction	8.84 ±1.73	
Moderate Dysfunction	9.07±1.61	
Severe Dysfunction	10.92±1.57	

*Unpaired t test

The table 9 presents a comparison of HbA1c levels (Mean ± SD) across different categories of sympathetic and parasympathetic dysfunction and dysfunction severity grading. Participants with sympathetic dysfunction had a higher HbA1c level (9.22 ± 1.73) compared to those without dysfunction (8.05 ± 1.33), with a statistically significant difference (p = 0.0221, unpaired t-test). Similarly, participants with parasympathetic dysfunction had a higher HbA1c level (9.25 ± 1.78) compared to those without dysfunction (8.39 ± 1.33), showing a significant difference (p = 0.0413, unpaired t-test). When categorized by dysfunction severity, the mean HbA1c levels increased with severity: 7.75 ± 0.74 in the no dysfunction group, 8.84 ± 1.73 in mild dysfunction, 9.07 ± 1.61 in moderate dysfunction, and 10.92 ± 1.57 in severe dysfunction. A one-way ANOVA showed a significant difference among these groups (p = 0.0001), indicating that HbA1c levels were significantly higher in participants with greater cardiac autonomic dysfunction.

Discussion

This study of 100 diabetic patients (mean age: 58.3 ± 9.75 years; 57% male) revealed a high prevalence of cardiac autonomic dysfunction (CAD): 79% parasympathetic and 87% sympathetic impairment, with 64% exhibiting moderate-to-severe dysfunction. The sustained handgrip test showed the highest abnormality (80%), aligning with Pathak et al. (2017)[2], while deep breathing and standing tests also indicated significant dysfunction. HbA1c levels strongly correlated with CAD severity (p = 0.0001), supporting Pop-Busui et al. (2017)[1] and Jun et al. (2015)[3], who linked chronic hyperglycemia to neuronal damage. However, serum creatinine, hemoglobin, and diabetes duration showed no significant associations, contrasting Moțățăianu et al. (2018)[4], who emphasized duration as a risk factor.

Demographics mirrored prior studies (Karthikeyan et al., 2023[5]; Moțățăianu et al., 2018[4]), with CAD prevalence higher than Dhumad et al. (2021)[6] (53%), possibly due to methodological differences. The HbA1c–CAD link underscores glycemic control's importance, as highlighted by Vinik et al. (2007)[7]. Despite renal markers' non-significance, Cha et al. (2016)[8] noted diabetic nephropathy's role in CAD progression.

The findings advocate routine CAD screening in diabetics, especially with poor glycemic control, to mitigate cardiovascular risks, as emphasized by Pop-Busui et al. (2017)[1]. Future research should explore socioeconomic and genetic influences on CAD heterogeneity.

Conclusion

This cross-sectional study of 100 individuals with diabetes mellitus found a high prevalence of cardiac autonomic dysfunction (CAD), with 79% showing parasympathetic and 87% sympathetic impairment,

mainly of moderate or severe grade. HbA1c levels were significantly associated with CAD severity (p=0.0001), highlighting poor glycemic control as a key contributor. No significant associations were found with serum creatinine, hemoglobin, or diabetes duration. These results support routine screening and early intervention focused on glycemic control to reduce CAD risk. Future research should examine genetic, socioeconomic, and lifestyle influences to develop personalized strategies for preventing and managing CAD in diabetic populations.

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