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Prevalence and Types of Arrhythmias in Type 2 Diabetes Mellitus: Insights from 24-Hour Holter Monitoring in a Tertiary Care Setting

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KEYWORDS

Type 2 Diabetes Mellitus, Holter Monitoring, Cardiac Arrhythmias, ECG width; Gingival displacement .

ABSTRACT:

Background: Cardiac arrhythmias are common but often underdiagnosed complications in individuals with Type 2 Diabetes Mellitus (T2DM). These disturbances can significantly elevate the risk of stroke, sudden cardiac death, and other cardiovascular events. Despite this, the role of continuous rhythm monitoring remains underutilized in diabetic care, especially in resource-limited settings. This study aimed to determine the prevalence and types of arrhythmias in patients with T2DM using 24-hour Holter ECG monitoring and assess their correlation with clinical symptoms, demographic factors, comorbidities, and resting ECG findings.

Methods: This cross-sectional study included 100 adult patients with T2DM presenting with symptoms suggestive of arrhythmia. The study was conducted over six months at BIRDEM General Hospital, Dhaka. Clinical data, comorbidities, and laboratory findings were recorded, and all participants underwent 24-hour Holter monitoring. Arrhythmias were classified according to standard diagnostic criteria.

Results: Holter monitoring revealed arrhythmias in 75% of patients. The most frequent types were ventricular extrasystoles (52%), supraventricular extrasystoles (47%), atrial fibrillation (14%), and supraventricular tachycardia (30%). Arrhythmia prevalence was significantly associated with older age, male gender, hypertension, ischemic heart disease, and dyslipidemia ($p<0.05$). Resting ECG identified far fewer abnormalities compared to Holter data. Symptoms such as dizziness and palpitations were strongly linked to arrhythmic events.

Conclusion: Arrhythmias are highly prevalent in T2DM and are often undetected by routine ECG. Holter monitoring is a valuable tool for early diagnosis, particularly in symptomatic patients or those with cardiovascular comorbidities.

Introduction

Cardiovascular complications remain the leading cause of morbidity and mortality in individuals with Type 2 Diabetes Mellitus (T2DM) [1]. Among these, arrhythmias—defined as disturbances in the heart's electrical conduction—are increasingly recognized for their prevalence and prognostic significance in diabetic populations [2]. Diabetic individuals often exhibit a constellation of pathophysiological changes including

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autonomic neuropathy, ischemic heart disease (IHD), and electrolyte disturbances, all of which contribute to heightened arrhythmogenic potential [3].

The global burden of diabetes is substantial and growing. An estimated 285 million people were living with diabetes worldwide in 2010, a figure projected to reach 438 million by 2030 [4]. T2DM accounts for the vast majority of these cases and carries an increased risk for cardiovascular morbidity, including both structural and electrical cardiac abnormalities [5]. While myocardial infarction and heart failure are well-characterized complications, arrhythmias often remain underdiagnosed, particularly in asymptomatic or minimally symptomatic patients [6].

Several studies have demonstrated a high prevalence of arrhythmic events in patients with diabetes, especially when continuous ambulatory monitoring is used [7,8]. Ewing et al. reported that diabetic patients exhibit significant abnormalities in 24-hour heart rate profiles due to cardiac autonomic neuropathy, a common complication of long-standing diabetes [9]. Similarly, Binici et al. identified that excessive supraventricular ectopic activity on ambulatory ECG is predictive of atrial fibrillation and stroke [10]. Such findings highlight the clinical utility of 24-hour Holter monitoring in unmasking occult arrhythmias.

Moreover, arrhythmias in diabetes are often multifactorial. Chronic hyperglycemia leads to glycation of ion channels and structural remodeling of cardiac tissue, fostering a substrate for electrical instability [11]. Dyslipidemia, hypertension, and autonomic dysfunction further exacerbate this vulnerability [12]. Aronson and Burger, in a study of patients with severe left ventricular dysfunction, found that diabetes was independently associated with an increased occurrence of ventricular arrhythmias [13]. This adds weight to the necessity of timely and accurate arrhythmia detection in diabetic cohorts.

Despite mounting evidence, routine arrhythmia screening is not universally implemented for diabetic patients, even those presenting with suggestive symptoms like palpitations, dizziness, or syncope [14]. Clinical guidelines remain inconsistent regarding the role of Holter monitoring in asymptomatic or minimally symptomatic diabetic patients. Consequently, arrhythmias often go unnoticed until they manifest with serious complications such as stroke or sudden cardiac death [15].

Given the silent and transient nature of many arrhythmic events, continuous ECG monitoring tools such as 24-hour Holter provide a non-invasive, high-yield method for identifying rhythm abnormalities [16]. However, data on the types and prevalence of arrhythmias among T2DM patients in South Asian populations remain limited.

This study aims to determine the prevalence and types of arrhythmias in patients with T2DM using 24-hour Holter monitoring, and to correlate arrhythmia incidence with demographic variables, comorbidities, clinical presentations, and resting ECG findings. This research seeks to bridge a critical gap in the literature by providing evidence from a tertiary care setting in Bangladesh.

Methodology & Materials

This study employed a cross-sectional design and was conducted at BIRDEM General Hospital, located in Shahbagh, Dhaka. The research was carried out over six months from March 2013 to August 2013. Departments involved in the study included Internal Medicine, Cardiology, and Neurology. The study involved a total of 100 adult patients with Type 2 Diabetes Mellitus (T2DM) who were referred for 24-hour Holter ECG monitoring due to symptoms suggestive of arrhythmia. Patients were selected from the inpatient departments of the aforementioned units.

Sample Selection

Inclusion Criteria

- Age 18 years or older.
- Both male and female patients.
- Diagnosed with Type 2 Diabetes Mellitus.
- Referred for Holter monitoring due to symptoms suggestive of arrhythmia.

Exclusion Criteria

- Patients with Type 1 Diabetes Mellitus.
- Non-diabetic patients.
- Patients with permanent pacemaker implantation.

Data Collection and Study Procedure: Participants were enrolled based on inclusion and exclusion criteria. Clinical evaluations, laboratory investigations, and 24-

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hour Holter ECG monitoring were conducted. During Holter monitoring, patients were instructed to log any episodes of palpitations, dizziness, or syncope. Demographic and clinical data—including age, gender, medical history, comorbidities, and glycemic control—were collected using a structured data collection sheet and validated against patient medical records. Arrhythmia types were documented and classified per standard diagnostic criteria. Lown classification was used for ectopic beats (Grades 2, 3, and 4 included). Additional arrhythmias identified included sinus bradycardia, sinus arrest, AV blocks, supraventricular tachycardia (SVT), ventricular tachycardia (VT), and atrial fibrillation. Comorbidities such as hypertension, dyslipidemia, ischemic heart disease (IHD), stroke, thyroid disorders, etc., were also evaluated based on clinical and diagnostic parameters.

Ethical Considerations: The study was approved by the Ethical Review Board of BIRDEM Academy and the Bangladesh College of Physicians and Surgeons (BCPS). The objectives, benefits, and risks of participation were clearly explained in the local language. Written informed consent was obtained from all participants. Confidentiality was maintained throughout the study.

Statistical Analysis: Data were analyzed using SPSS for Windows, version 10. Descriptive statistics such as frequencies and percentages were used to describe baseline characteristics. Inferential statistics, including chi-square tests, were employed to evaluate relationships between variables. A p-value of <0.05 was considered statistically significant. Data visualization was done using Microsoft Office Chart tools

Results

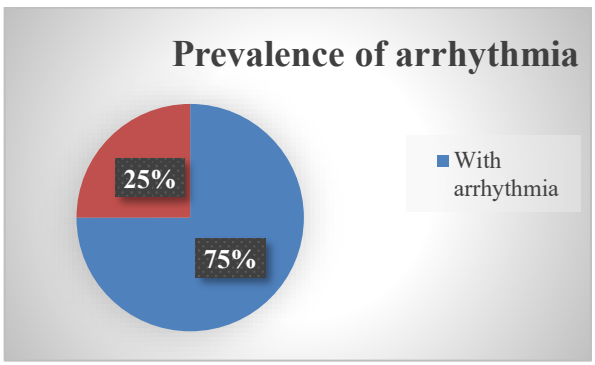

Figure 1: Prevalence of Arrhythmia in Type 2 Diabetes Mellitus

Table 1: Relation between Age distribution of the study subjects and arrhythmia

Age (years)	With arrhythmia (n=75)	Without arrhythmia (n=25)
40-49 (n=18)	16	2
50-59 (n=30)	22	8
60-69 (n=31)	25	6
≥ 70 (n=21)	12	9
Total	75	25

The maximum number of patients with arrhythmia was found in the age group of 60-69 years. (Table 1)

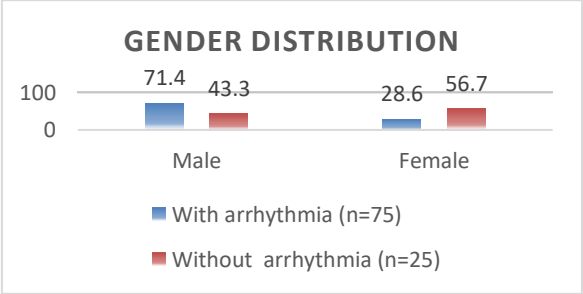

Figure 2: Pie diagram showing relation between gender distribution of the study subjects and arrhythmia.

Among the study subjects, 71.4% males and 28.6% females had documented arrhythmia (p=0.01) (Figure 2).

Table 2: Relation between co-morbid conditions and arrhythmia

Co-morbid conditions	Number	Arrhythmia		P value
		Present	Absent	
Hypertension	83	70	13	<0.001
IHD	62	57	5	<0.001
Dyslipidaemia	54	43	11	0.022

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Stroke	24	9	15	<0.001
Hyperthyroidism	10	8	2	1
Hypothyroidism	4	0	4	

Among the study subjects, Hypertension, IHD and dyslipidaemia were more prevalent, followed by Stroke, Hyperthyroidism and Hypothyroidism, as co-morbid conditions. However, I did not find any relationship between arrhythmia and Hyperthyroidism in this study. (Table 2).

Table 3: Resting ECG findings and incidence of arrhythmia in the study subjects

Resting 12 lead ECG finding	Number	Arrhythmia on holter monitoring	
		Present	Absent
Atrial fibrillation	16	14	2
Atrial flutter	1	1	0
Atrial ectopics	50	47	3
Ventricular ectopics	54	52	2
Features of hypokalaemia	11	3	8
Features of hyperkalaemia	3	0	3
Sinus bradycardia	14	11	3
AV block	9	7	2
Features of ischaemia	13	8	5
Normal findings	11	4	7

On ECG recordings, atrial fibrillation was found in 16 subjects, atrial flutter in 1, atrial ectopics in 50, ventricular ectopics in 54, features of hypokalaemia in 11, features of hyperkalaemia in 3, sinus bradycardia in 14, atrioventricular block in 9, features of ischaemia in 13, and normal findings in 11subjects (Table 3).

Table 4: Relation between clinical presentation and documented arrhythmia

Presentation	Arrhythmia		P value
	Present	Absent	
Palpitation (n=55)	40 (72.7%)	15 (27.3%)	0.01
Dizziness (n=34)	30 (88.2%)	04 (11.8%)	
Syncope (n=11)	05 (47.4%)	06 (52.6%)	

Among the study subjects, 55% presented with palpitation, 34% had dizziness and 11% had history of syncope. Their Holter monitoring revealed arrhythmia in 72.7%, 88.2% and 47.4% respectively(p=0.01) (Table 4).

Table 5: Types of Arrhythmias detected in the study subjects

Type of arrhythmia	Number	Percentage
Atrial fibrillation	14	14
Atrial flutter	1	1
Atrial extrasystoles	47	47
Ventricular extrasystoles	52	52
Supraventricular tachycardia	30	30
Ventricular tachycardia	2	2
Atrioventricular block	7	7
Sinus bradycardia	11	11

On Holter monitoring, arrhythmia was found in the form of atrial fibrillation in 14%, atrial flutter in 1%, ventricular ectopy in 52%, and supraventricular ectopy in 47%, ventricular tachycardia (VT) in 2%, supraventricular tachycardia (SVT) in 30%, atrioventricular block (AV block) in 7%, sinus bradycardia in 11% (Table 5).

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Table 6: 24-hour Holter ECG monitoring findings of ventricular ectopy

Events	Number	Percentage
Single PVC's	41	41
Triplets	17	17
Couplets	12	12
Ventricular run	8	8
Late VE's	2	2
Bigeminy	11	11
Trigeminy	7	7
Mean ± SD total ventricular ectopic beats in 24 hours (Maximum-Minimum)	7315.98±5289.33 (18334-17)	

Regarding ventricular ectopy, it was seen that 8% subjects had ventricular runs, 41% had single PVCs. Besides these findings, triplets (17%), couplets (12%), bigeminy (11%) and trigeminy (7%) were observed (Table 6).

Discussion

This study revealed a high prevalence (75%) of arrhythmias in patients with Type 2 Diabetes Mellitus (T2DM) using 24-hour Holter ECG monitoring. The findings underscore the significance of cardiac rhythm disturbances in diabetics and highlight the utility of ambulatory ECG as a diagnostic tool in symptomatic patients or those at high cardiovascular risk. The most common arrhythmias detected were ventricular ectopy (52%) and supraventricular ectopy (47%), followed by atrial fibrillation (14%) and supraventricular tachycardia (30%).

Cardiac arrhythmias represent a heterogeneous group of conditions characterized by abnormalities in heart rate and rhythm. In diabetic patients, several factors—such as chronic hyperglycemia, insulin resistance, autonomic dysfunction, electrolyte imbalance, and microvascular ischemia—contribute to increased arrhythmogenic potential [11]. These mechanisms not only increase arrhythmia susceptibility but also heighten the risk of adverse cardiovascular events, including sudden cardiac death and stroke [5].

Our findings are consistent with previous research. Potolochnaia and Burvalova reported similar arrhythmic patterns in diabetics using Holter monitoring, emphasizing its superiority over standard resting ECGs in detecting transient or silent arrhythmias [7]. Zimetbaum et al. likewise observed a higher diagnostic yield from continuous ambulatory ECG compared to conventional short-duration monitoring [16]. In our study, standard ECGs missed many significant rhythm abnormalities later identified on Holter monitoring, reinforcing this diagnostic gap.

Age and gender were significantly associated with the prevalence of arrhythmias in this study. The majority of arrhythmic cases occurred in patients aged 60–69 years. Male subjects also had a significantly higher prevalence of arrhythmia (71.4%). These observations reflect findings from Nichols et al., who demonstrated that increasing age and male gender are independent predictors of arrhythmic risk in diabetics [17].

Comorbid conditions were frequent among study participants. Hypertension (83%), ischemic heart disease (62%), and dyslipidemia (54%) were significantly associated with arrhythmia. These comorbidities exacerbate cardiac stress, promote autonomic dysfunction, and contribute to electrical instability [9]. Although hyperthyroidism is a recognized trigger for arrhythmias in the general population, no significant association was found in this study, possibly due to the small number of affected cases.

Symptoms such as dizziness, palpitations, and syncope were closely associated with arrhythmia, particularly in patients with dizziness (88.2%) and palpitations (72.7%). These findings are similar to those reported by Irfan et al., who demonstrated that symptomatic presentations—especially dizziness and palpitations—are frequently linked to arrhythmic events in diabetic patients [14]. However, some studies suggest that symptoms are not always predictive of arrhythmia type or severity, emphasizing the importance of objective rhythm monitoring regardless of symptom profile [18].

Our study also found a significant relationship between poor glycemic control and arrhythmia. The mean fasting blood glucose level was 15.06 mmol/L and HbA1c was

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10.13%, both indicating poor metabolic regulation. This correlates with the findings of Jacoby and Nesto, who showed that hyperglycemia and insulin resistance promote arrhythmic risk via structural and electrical myocardial remodeling [19].

Electrolyte imbalances, particularly in potassium and magnesium, were also linked to arrhythmic episodes. Hypokalemia was found in 13% of patients and hyperkalemia in 8%, both significantly associated with arrhythmias ($p=0.03$). These findings are in line with those of Adabag et al., who reported increased arrhythmic events in diabetics with electrolyte disturbances [20].

Regarding arrhythmic subtypes, Holter monitoring detected not only common premature atrial and ventricular contractions but also serious forms like atrial fibrillation, AV blocks, and ventricular tachycardia. The ventricular ectopic burden included PVCs (41%), couplets (12%), triplets (17%), and runs (8%), similar to the results from Binici et al., who found a correlation between high ectopic activity and future atrial fibrillation or stroke [10]. Supraventricular ectopic activity also varied, with atrial runs, PACs, and bigeminy frequently observed. These variations were significantly more common in patients with uncontrolled blood glucose ($p<0.01$), suggesting a dose-response relationship between hyperglycemia and electrical instability.

Despite these important findings, it is important to recognize the limitations of 24-hour Holter monitoring. Some arrhythmias, particularly those that occur infrequently or during sleep, may be missed within this short window. Hanke et al. advocate for extended or implantable monitors in high-risk patients to improve diagnostic sensitivity [21].

In conclusion, this study reaffirms the high prevalence and diversity of arrhythmias among patients with T2DM. Holter ECG proves to be a valuable diagnostic modality, particularly in symptomatic patients or those with cardiovascular comorbidities. Early detection of arrhythmias in diabetics is critical for initiating timely interventions, reducing complications, and improving long-term cardiovascular outcomes.

Limitations and recommendations

The study was limited by its cross-sectional design, relatively small sample size, and short Holter monitoring duration (24 hours), which may have missed infrequent arrhythmic events. Additionally, the single-center setting may affect the generalizability of results. Future research should include multicenter, longitudinal studies with extended monitoring durations to capture a broader spectrum of arrhythmias.

Conclusion

This study revealed a high prevalence of arrhythmias (75%) in patients with Type 2 Diabetes Mellitus using 24-hour Holter monitoring. Ventricular and supraventricular ectopic were the most frequently detected abnormalities, with significant associations found between arrhythmias and age, gender, comorbidities, and symptomatic presentations. Holter monitoring proved to be superior to resting ECG in detecting occult arrhythmias. These findings highlight the need for more proactive cardiac rhythm surveillance in diabetic patients, particularly those with suggestive symptoms or cardiovascular risk factors, to enable early diagnosis, risk stratification, and appropriate intervention, potentially reducing adverse cardiovascular outcomes.

Acknowledgment

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Conflicts of interest

There are no conflicts of interest.

Ethical approval

The study was approved by the Institutional Ethics Committee.

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