Journal of Chemical Health Risks
www.jchr.org
JCHR (2024) 14(6), 500-503 | ISSN:2251-6727

Fragmented QRS Complex in Electrocardiogram as a Predictor for Diastolic Dysfunction in Type 2 Diabetes Mellitus

Dr Taheer Khan[1*], Dr G Premkumar[2], Dr G Rengaraj[3]

[1]Postgraduate Resident, Department of General Medicine, Aarupadai Veedu Medical College, Vinayaka Mission's Research Foundation (VMRF-DU), Puducherry, India (Corresponding author)

[2]Professor, Department of General Medicine, Aarupadai Veedu Medical College, Vinayaka Mission's Research Foundation (VMRF-DU), Puducherry, India

[3]Associate Professor, Department of Cardiology, Aarupadai Veedu Medical College, Vinayaka Mission's Research Foundation (VMRF-DU), Puducherry, India

(Received: 16 September 2024 Revised: 11 October 2024 Accepted: 04 November 2024)

KEYWORDS

Type 2 Diabetes Mellitus, Fragmented QRS Complex, Diastolic Dysfunction, Electrocardiogram, 2D Echocardiography, Cardiovascular Risk

ABSTRACT:

Background: Diabetes mellitus is an escalating public health concern, with the World Health Organization projecting it to be the seventh leading cause of death by 2030. Diastolic dysfunction, an early indicator of heart failure with preserved ejection fraction (HFpEF), is commonly observed in individuals with diabetes. **Objective:** To examine the association between the fragmented QRS (fQRS) complex on electrocardiography (ECG) and diastolic dysfunction, as identified by 2D echocardiography, in patients with type 2 diabetes mellitus (T2DM). **Methods:** This hospital-based, cross-sectional study was conducted over two years at Aarupadai Veedu Medical College & Hospital and included 193 T2DM patients aged 18 years and older. Patients with bundle branch blocks, coronary artery disease, decompensated chronic liver disease, and arrhythmias were excluded from the study. Participants underwent ECG to identify the presence of fQRS complexes and 2D echocardiography to assess diastolic function. **Results:** The mean age of participants was 54.4 ± 10 years, with a slight predominance of females (55.4% female, 44.6% male). An fQRS complex was observed in 45.1% of patients, and 39.4% exhibited diastolic dysfunction on 2D echocardiography. A significant association was found between the presence of fQRS and diastolic dysfunction ($p < 0.05$). The diagnostic performance of fQRS showed a sensitivity of 96.05%, specificity of 88.03%, positive predictive value (PPV) of 83.91%, negative predictive value (NPV) of 97.17%, and an overall accuracy of 91.19%. **Conclusion:** The presence of an fQRS complex on ECG is a highly sensitive and specific marker for diastolic dysfunction in T2DM patients, suggesting its potential as a viable alternative to 2D echocardiography, especially in settings with limited resources.

Introduction

Diabetes mellitus (DM) represents a significant and growing public health concern, with the World Health Organization (WHO) predicting it will become the seventh leading cause of death by 2030.(1-3) Individuals with diabetes, especially those with Type 2 Diabetes Mellitus (T2DM), are particularly vulnerable to developing diastolic dysfunction, a key precursor to heart failure with preserved ejection fraction (HFpEF).(4, 5) Despite this, the precise etiopathogenesis of diabetic cardiomyopathy remains poorly understood, with limited comprehensive studies elucidating the prevalence of diastolic dysfunction among diabetic populations in India.(6)

Access to 2D echocardiography (2D Echo), a standard diagnostic tool for identifying diastolic dysfunction, is limited across various regions, which complicates early diagnosis and intervention. This limitation is especially challenging as diastolic dysfunction in T2DM patients is a significant risk factor for progressing to HFpEF. Although 2D Echo is essential for the definitive diagnosis, it is not readily available in many primary care settings, and affordability issues further hinder its accessibility. Given these constraints, the fragmented QRS (fQRS) complex on electrocardiography (ECG) presents a valuable, accessible alternative.(7, 8) As an indicator of myocardial damage, fQRS on ECG can be a practical tool for early detection of diastolic dysfunction, particularly in regions with low cardiologist-to-patient

Journal of Chemical Health Risks
www.jchr.org
JCHR (2024) 14(6), 500-503 | ISSN:2251-6727

ratios and limited availability of advanced imaging tools like echocardiography.(9, 10)

ECG, sometimes referred to as the "poor man's echocardiogram," can thus play an important role in identifying diastolic dysfunction in T2DM patients unable to access cardiology services.(11) It serves as an initial screening tool for underlying cardiac issues, and in this context, may offer insights into diastolic dysfunction, potentially guiding further clinical management.(12, 13) This study, therefore, aims to evaluate the correlation between fQRS observed on ECG and diastolic dysfunction as identified by 2D echocardiography in patients with T2DM.

Materials and Methods

This hospital-based cross-sectional study was conducted over a two-year period at Aarupadai Veedu Medical College & Hospital, involving a cohort of 193 patients diagnosed with type 2 diabetes mellitus (T2DM) who were 18 years of age or older. The participants were either outpatients or inpatients in the General Medicine wards. The diagnosis of T2DM was made according to the criteria set by the American Diabetes Association. Patients with conditions that could interfere with the study outcomes, such as Right Bundle Branch Block, Left Bundle Branch Block, Coronary Artery Disease, Decompensated Chronic Liver Disease, and Arrhythmias, were excluded to maintain a homogeneous study sample.

The sample size was calculated based on findings from a similar study, which reported a 38.1% prevalence of diastolic dysfunction. To achieve a relative precision of 17% and a significance level of 5%, the final sample size was determined to be 193 patients. Participants were recruited consecutively from the eligible population. After obtaining informed written consent, each participant's medical history was collected using a predesigned pro forma, and they underwent comprehensive clinical assessments and laboratory testing. Each participant also received an electrocardiogram (ECG) to identify the presence of fragmented QRS (fQRS) complexes and a 2D echocardiography (2D Echo) to evaluate diastolic function. The presence of fQRS was defined as additional spikes within the QRS complex, while diastolic dysfunction was assessed according to standard echocardiographic criteria.(14)

Independent variables included patient age, sex, and results from 2D echocardiography. Confounding factors such as smoking, alcohol consumption, and the use of medications like glucocorticoids, antiarrhythmic drugs, and beta-blockers were also documented. The diagnostic performance of fQRS in predicting diastolic dysfunction was assessed by calculating sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy. The study adhered to ethical guidelines and received approval from the institutional ethics committee. Participants were assured of confidentiality and informed that their involvement was voluntary, with the option to withdraw at any point without impacting their medical care. A key benefit of the study was the potential identification of fQRS on ECG as a non-invasive, accessible marker for predicting diastolic dysfunction in T2DM patients. This could reduce the dependency on 2D echocardiography, which may be limited in resource-constrained settings. Risks to participants were minimal, primarily related to the mild discomfort or pain associated with blood sample collection. By rigorously evaluating the relationship between fQRS on ECG and diastolic dysfunction assessed through 2D Echo, this study aimed to improve early detection and management of cardiovascular complications in T2DM patients.

Statistical Analysis: Patient data were compiled into an Excel spreadsheet and analyzed using SPSS version 23.0 on Windows 10. Descriptive statistics, including mean, standard deviation, frequency, and percentage, were used to summarize the data. Categorical data were analyzed using the chi-square test, while continuous data were assessed using the unpaired t-test. A p-value of less than 0.05 was considered statistically significant.

Results

The study participants had a mean age of 54.4 ± 10 years, with a slight predominance of females (55.4% female, 44.6% male). Fragmented QRS (fQRS) was observed in 45.1% of patients, while 39.4% exhibited diastolic dysfunction on 2D echocardiography (2D Echo). There was a statistically significant concordance between the presence of fQRS and diastolic dysfunction ($p < 0.05$), suggesting a meaningful association between these findings.

The diagnostic performance of fQRS demonstrated a sensitivity of 96.05%, specificity of 88.03%, positive predictive value (PPV) of 83.91%, negative predictive value (NPV) of 97.17%, and an overall accuracy of 91.19%. The presence of fQRS on ECG in 45.1% of patients corresponded significantly with diastolic dysfunction observed on 2D Echo in 39.4% of patients,

Journal of Chemical Health Risks
www.jchr.org
JCHR (2024) 14(6), 500-503 | ISSN:2251-6727

underscoring a notable agreement between the two diagnostic modalities ($p < 0.05$).

Discussion

The presence of a fragmented QRS (fQRS) complex on an electrocardiogram (ECG) serves as a significant marker for various cardiac conditions. It is identified by the appearance of additional r or R waves, without the involvement of a bundle branch block or an RSR' pattern, occurring in at least two consecutive leads associated with a primary coronary artery region.(15) This fQRS complex is believed to result from myocardial fibrosis and scarring, which interfere with the normal, uninterrupted process of myocardial depolarization. This disruption in depolarization continuity can cause characteristic notching in the QRS complex, reflecting the slowed conduction resulting from myocardial scarring.(16)

Clinically, fQRS detection on ECG provides a practical and economically feasible approach for healthcare providers, offering a non-invasive and accessible marker of cardiac risk, especially in settings with limited resources.(17) Its proven association with significant cardiac conditions makes fQRS particularly valuable for early risk assessment and management of cardiovascular issues in patients with diabetes and other risk factors. This underlines its role as an essential element in cardiovascular risk stratification and management frameworks.(18)

The study demonstrates that the presence of fQRS on ECG is a robust, non-invasive indicator of diastolic dysfunction in patients with type 2 diabetes mellitus (T2DM). Among the 193 patients evaluated, 45.1% exhibited fQRS complexes. There was a significant concordance between the presence of fQRS and diastolic dysfunction as assessed by 2D echocardiography (2D Echo), with a p-value of less than 0.05, indicating statistical significance. Furthermore, fQRS showed excellent diagnostic performance in detecting diastolic dysfunction, with a sensitivity of 96.05%, specificity of 88.03%, positive predictive value (PPV) of 83.91%, negative predictive value (NPV) of 97.17%, and an overall accuracy of 91.19%.(19)

These findings underscore the utility of fQRS on ECG as a reliable and effective screening tool for identifying diastolic dysfunction in T2DM patients, particularly in clinical environments were advanced imaging technologies, like 2D Echo, may not be readily accessible. Incorporating fQRS evaluation into routine clinical assessments could significantly enhance the early identification and management of cardiac dysfunction in diabetic patients, ultimately contributing to improved cardiovascular outcomes in this high-risk population.(20)

Conclusion

The fragmented QRS (fQRS) complex on ECG serves as a reliable, non-invasive marker for identifying diastolic dysfunction in patients with type 2 diabetes mellitus. With its high sensitivity and specificity, fQRS offers an effective screening tool, particularly valuable in clinical settings were advanced imaging techniques, such as 2D echocardiography, may be unavailable. This finding supports incorporating fQRS assessment into routine clinical evaluations to enhance cardiovascular risk stratification and management in diabetic populations.

References

1. Khan MAB, Hashim MJ, King JK, Govender RD, Mustafa H, Al Kaabi J. Epidemiology of Type 2 Diabetes - Global Burden of Disease and Forecasted Trends. J Epidemiol Glob Health. 2020;10(1):107-11.
2. Saeedi P, Petersohn I, Salpea P, Malanda B, Karuranga S, Unwin N, et al. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas, 9(th) edition. Diabetes Res Clin Pract. 2019;157:107843.
3. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. Diabetes Care. 2004;27(5):1047-53.
4. Mgbemena O, Zhang Y, Velarde G. Role of Diabetes Mellitus in Heart Failure With Preserved Ejection Fraction: A Review Article. Cureus. 2021;13(11):e19398.
5. Rosano GM, Vitale C, Seferovic P. Heart Failure in Patients with Diabetes Mellitus. Card Fail Rev. 2017;3(1):52-5.
6. Gulsin GS, Athithan L, McCann GP. Diabetic cardiomyopathy: prevalence, determinants and potential treatments. Ther Adv Endocrinol Metab. 2019;10:2042018819834869.
7. Mahfouz RA, Arab MA, El-Dosoky II. Fragmented QRS Complex is Independently Associated with

Journal of Chemical Health Risks
www.jchr.org
JCHR (2024) 14(6), 500-503 | ISSN:2251-6727

Coronary Microvascular Function in Asymptomatic Patients with Diabetes Mellitus. JOURNAL OF INDIAN COLLEGE OF CARDIOLOGY. 2019;9(3).

8. Cetin S, Yıldız SS, Mazı EE, Keskin K, Cetinkal G, Gurdal A, et al. Relationship between a fragmented QRS and microalbuminuria in patients with type 2 diabetes mellitus. Endocrinología, Diabetes y Nutrición. 2017;64(9):464-70.
9. Patil VC, Patil HV, Shah KB, Vasani JD, Shetty P. Diastolic dysfunction in asymptomatic type 2 diabetes mellitus with normal systolic function. J Cardiovasc Dis Res. 2011;2(4):213-22.
10. Bouthoorn S, Valstar GB, Gohar A, den Ruijter HM, Reitsma HB, Hoes AW, et al. The prevalence of left ventricular diastolic dysfunction and heart failure with preserved ejection fraction in men and women with type 2 diabetes: A systematic review and meta-analysis. Diab Vasc Dis Res. 2018;15(6):477-93.
11. Grigorescu ED, Lacatusu CM, Floria M, Mihai BM, Cretu I, Sorodoc L. Left Ventricular Diastolic Dysfunction in Type 2 Diabetes-Progress and Perspectives. Diagnostics (Basel). 2019;9(3).
12. From AM, Scott CG, Chen HH. Changes in diastolic dysfunction in diabetes mellitus over time. Am J Cardiol. 2009;103(10):1463-6.
13. Sapra A, Vaqar S, Bhandari P. Diabetes Mellitus - PMID: 31855345. 2019.
14. Take Y, Morita H. Fragmented QRS: What Is The Meaning? Indian Pacing Electrophysiol J. 2012;12(5):213-25.
15. Yılmaz AS, Şatıroğlu Ö, Çetin M. Fragmented QRS predicted major adverse cardiovascular events in patients with coronary artery disease and percutaneous coronary intervention, 10-years of follow-up. Kardiologiia. 2022;62(1):72-9.
16. Çiçek Y, Kocaman SA, Durakoğlugil ME, Çetin M, Çanga A, Bozok Ş, et al. Relationship of fragmented QRS with prognostic markers and long-term major adverse cardiac events in patients undergoing coronary artery bypass graft surgery. J Cardiovasc Med (Hagerstown). 2015;16(2):112-7.
17. Lorgis L, Jourda F, Hachet O, Zeller M, Gudjoncik A, Dentan G, et al. Prognostic value of fragmented QRS on a 12-lead ECG in patients with acute myocardial infarction. Heart Lung. 2013;42(5):326-31.
18. Yagi K, Imamura T, Tada H, Liu J, Miyamoto Y, Ohbatake A, et al. Fragmented QRS on electrocardiography as a predictor for diastolic cardiac dysfunction in type 2 diabetes. J Diabetes Investig. 2022;13(6):1052-61.
19. Çetin Ş, Bayraktar A, Demiröz Ö, Karabay K, Yalçınkaya E. Fragmented QRS as a Predictor of Cardiovascular Events in Patients with Type 2 Diabetes Mellitus: A 36-Month Follow-Up Data. Anatol J Cardiol. 2024;28(4):208-12.
20. Xu Y, Qiu Z, Xu Y, Bao H, Gao S, Cheng X. The role of fQRS in coronary artery disease. A meta-analysis of observational studies. Herz. 2015;40 Suppl 1:8-15.

Table 1: Fragmented QRS on ECG and Diastolic dysfunction among patients

		Count	%
ECG fQRS	Absent	106	54.9
	Present	87	45.1
2D ECHO Diastolic dysfunction	Absent	117	60.6
	Present	76	39.4

Table 2: Correlation of fQRS on ECG with diastolic dysfunction on 2D ECHO among patients with diabetes mellitus

		2D-ECHO Diastolic dysfunction				Chi-square (p-value)
		Absent		Present		
		Count	%	Count	%	
ECG fQRS	Absent	103	97.2	3	2.8	131.57 (0.01)*
	Present	14	16.1	73	83.9	