Content available at: https://www.ipinnovative.com/open-access-journals

Indian Journal of Clinical Anatomy and Physiology

Journal homepage: https://www.ijcap.org/

Original Research Article

Study of QT interval prolongation in asymptomatic type-2 diabetes mellitus patients with and without microalbuninuria

Farzana Mustafa[1],*, Abdul Hai Mohammed[2]

[1]*Dept. of physiology, Malla Reddy Institute of Medical Sciences, Telangana, Hyderabad, India*
[2]*Deccan College of Medical Sciences, Hyderabad, Telangana, India*

ARTICLE INFO

Article history:
Received 28-08-2021
Accepted 13-09-2021
Available online 01-10-2021

Keywords:
QT interval prolongation
Diabetes mellitus
Microalbuminuria
Type 2 DM
CAD (Coronary artery disease)
CAN (Cardiac autonomic neuropathy)

ABSTRACT

QT interval abnormalities are the best predictors of cardiovascular deaths. Microalbuminuria is an independent marker for cardiovascular disease in diabetes mellitus. Hence QT interval abnormalities in diabetics with or without microalbuminuria were evaluated in this study.

Objective: To study QT interval abnormalities in asymptomatic type 2 diabetic patients with or without microalbuminuria.

Material and Methods: Open label controlled study with 214 subjects of either sex. Group A healthy subjects (n=100), group B asymptomatic, type 2 diabetics with no clinical evidence of cardiac disease. Group B subdivided into B_1 with microalbuminuria (n=62), B_2 without microalbuminuria (n=52). Corrected QT interval (QTC), microalbuminuria, and blood pressure were measured for all subjects. QTC was calculated by using Bazzet's formula. QTC more than 440msec was considered prolonged.

Results: QTC was within normal range in diabetic patients(415+25msec). Highly significant ($p<0.0001$) prolongation was observed in diabetics, compared to healthy subjects. Both B_1 ($p<0.0001$) and B_2 ($p<0.001$) groups showed a significant increase in QTC than in healthy subjects. Among B_1 and B_2 groups QTC was not statistically significant.

Conclusion: Prolongation of QTC is indicative of CAN. CAN is often under-recognised and undiagnosed cardiac complication.QTC was more in asymptomatic type 2 diabetics irrespective of microalbuminuria compared to healthy individuals, though values were within normal range. This denotes high risk for future cardiovascular complications in diabetic patients.

1. Introduction

Epidemiological data shows alarming values that predict a worrisome projected future for T2DM. According to the International Diabetes Federation[1] (IDF)in 2019 diabetes caused 4.2 million deaths; and 463 million adults aged between 20 and 79 years old were living with diabetes, a number that will likely rise up to 700 million by 2045. Diabetes was the underlying cause of at least 720 billion USD in health expenditure in 2019. Ninety percent of Diabetic patients have type 2 Diabetes mellitus and it has emerged as one of the 21st' century's health problems.[2,3]

The true disease burden of T2DM is likely an under representation as 1 in 3 diabetic people were under diagnosed, equivalent to 232 million people. The greatest number of people suffering from diabetes are aged between 40 and 59 years old. Incidence and prevalence of T2DM vary according to geographical region, with more than 80% of patients living in low to-middle-income countries, which poses additional challenges in effective treatment. Patients with T2DM have a 15% increased risk of all-cause mortality compared with people without diabetes with cardiovascular

* *Corresponding author*.
E-mail address: drfarzana.m@gmail.com (F. Mustafa).

https://doi.org/10.18231/j.ijcap.2021.052

disease (CVD) as the greatest cause of morbidity and mortality associated with T2DM[4] (Unai Galicia-Garcia et al. 2020).

Type 2 Diabetes Mellitus (T2DM) is one of the most common metabolic disorders world wide. Over 90% of diabetes mellitus cases are T2DM, a condition marked by deficient insulin secretion by pancreatic islet β-cells, tissue insulin resistance (IR) and an inadequate compensatory insulin secretory response.[4] Diabetes mellitus may lead to complications affecting many organ systems. The microvascular complications are retinopathy, nephropathy and neuropathy. The macrovascular complications are coronary artery disease, peripheral arterial disease and cerebrovascular disease. Nonvascular complications are gastroparesis, infections and skin changes. Jake Rajbhandari et al. Diabetic heart disease: A clinical update

World J Diabetes. 2021[5] mentions that diabetic heart disease is a conglomeration of coronary artery disease (CAD), cardiac autonomic neuropathy (CAN), and diabetic cardiomyopathy (DCM)·· Higher prevalence at a lower age and more aggressive disease in DM-associated CAD make diabetic individuals more vulnerable to premature death.[5]

The main cause of death and morbidity in patients with diabetes is vascular complications.[6] Diabetes is a known cardiovascular risk factor and there is a necessity to identify the factors that may improve cardiovascular risk in diabetic patients by using non-invasive and low cost approaches[7] (Giunti et al. 2012). One possible way to risk stratification in diabetic patients, is to use QT interval analysis, QT abnormalities can predict cardiac death in several disease states including chronic heart failure, systemic hypertension and peripheral vascular disease.

Two studies have already shown that QT interval abnormalities are particularly best predictors of cardiac death, with regard to Type-2 diabetes mellitus.[8]

Prevalence of corrected QT interval (QTC) prolongation is 26% in type 2 DM.[9]

Different factors contribute to the duration of QT Interval, insulin resistance, glucose tolerance, glycemic control and diabetic complications, Thus QTC prolongation in diabetes is of multi-factorial origin.[10]

Microalbuminuria is an independent marker of cardiovascular disease. Microalbuminuria alone could not explain the increased morbidity and mortality in diabetic patients. Hence estimation of QT interval and QTC along with microalbuminuria, that reflects total cardiac depolarization and repolarization, could be a better indicator of diabetic cardiac autonomic neuropathy[11] (CAN) Diabetic cardiac autonomic neuropathy (CAN) is a well recognized complication of type 2 DM and its incidence had been reported to be 20-40%[12] (Mate) et al 2010).

The present study was conducted to determine whether QTC prolongation is linked to microalbuminuria in patients with type 2 diabetes and to investigate their association by comparing with healthy individuals.

Our hypothesis was that asymptomatic Type -2 diabetic patients with microalbuminuria had cardiac involvement that might be subclinical, as reflected by more prolonged QTC, as compared to those without microalbuminuria and healthy controls.

2. Materials and Methods

It was an open label controlled study with a total of 214 subjects of either sex. The present study was conducted in Gandhi Medical College, Hyderabad, India, after approved by Institutional Ethics Committee and obtaining informed consent, Inclusion criteria were asymptomatic type 2 diabetic patients with no clinical evidence of cardiac disease, no H/O chest pain or shortness of breath, no H/O cardiac procedures, age between 30-70 years. Exclusion criteria were H/0 coronary heart disease, H/O chest pain or shortness of breath, ECG abnormalities, patients with hepatic and renal abnormalities, type 1 diabetes mellitus, patients taking drugs, which affects the QT interval. And patients with abnormal levels of serum Potassium and Calcium were excluded.

The study subjects were divided into 1) Group A — Healthy controls (n=100) 2) Group B — Asymptomatic, type 2 diabetic patients. Group B was again subdivided into 2 groups. Group B 1 diabetic patients with microalbuminuria (n=62), Group B2 diabetic patients without microalbuminuria (n=52). All participants were subjected to detailed history and physical examination, Blood pressure was recorded. Biochemical tests, fasting blood sugar levels (FBS), post-prandial blood sugar (PPBS). Serum potassium, calcium and urine for microalbuminuria were done ECG was taken and QT interval and corrected QT interval (QTC) were calculated. ECG abnormalities were registered according to Minnesota code.

QT interval was measured manually in chest leads V3, V4 V5, V6 and limb leads LII.

Lead with the longest QT interval was taken since QT interval is affected by heart rate. The interval between two successive R-R waves was calculated and corrected QT (QTC) interval was calculated using Bazzet's formula (Bazett. 1920)[13]

$$QTC = \frac{QT\ interval}{\sqrt{R-R interval(msec)}}$$

Value of QTC interval exceeding 440 msec was taken as prolonged.

For measuring microalbuminuria early morning or spot urine samples were used. Urine was tested using routine dip sticks for RBC, leukocytes and protein. If urine was negative for above, then a sample was sent for microalbuminuria estimation.

Specimen was analyzed as soon as possible after the collection, as the storage time and temperature may affect the albumin levels in the urine.

Urine albumin levels were measured by immunoturbidimetric method and concentration more than 20 mg/L was taken as positive.

The normal microalbuminuria value is less than 20 mg / L. The value greater than 20 mg/L was taken as positive for microalbuminuria.[14]

2.1. Statistical analysis

All values were expressed as mean+standard deviation (SD).

Analysis of Variance, (ANOVA) was applied to compare the data between the two groups Unpaired 't' test was used to calculate p value. P<0.05 was considered statistically significant.

3. Results

A total of 214 subjects of either sex were evaluated in the study. Out of which 100 were healthy subjects and 114 were asymptomatic type-2 diabetic patients. In Group A, 60 were males and 40 were females. Age in Group A was 49+9.4 years, in Group B was 53+10 years.

Microalbuminuria in healthy subjects was 8.8+3.8 mg/ dl and in diabetics, it was 32.4+54 mg/dI showing highly significant (p<0.0001) increase in diabetic patients (Table 1).

Microalbuminuria within the diabetic groups, B_1 was 49+69 mg/dl and in Group B was.

12.6+6 5 mg/dl There was highly significant (p<0 0001 increase in microalbuminuria in Group B_1 compared to Group B_2 (Table 1). Both the diabetic groups B_1 and B_2 showed significant increase in microalbuminuria which was p<0.0001 and p<0.001 respectively, compared to healthy controls. (Table 1)

QTC interval in healthy subjects was 388+21 msec and in Group B diabetic patients, it was 415+25 msec which showed highly significant (p<0.0001) increase in QTC interval when compared to Group A healthy controls (Table 1), though they were within the normal range.

In Group B_1, diabetic patients with microalbuminuria, QTC interval was 419+22 rnsec, and in Group B_2, diabetics without microalbuminuria it was 411+28 msec.

Both B_1 and B_2 groups showed highly significant increase in QTC interval, which was significant p<0.0001 and p<0.001 respectively, compared to healthy controls. (Table 1)

In between B_1 and B_2, QTC interval was found to be statistically insignificant. (Table 1).

The mean systolic blood pressure (SBP) in healthy subjects was 120±9.0 mm of Hg and in diabetic patients it was 132±18 mm of Hg. There was highly significant(p<0.0001) increase in mean SBP in diabetic patients., compared to healthy controls.

Mean diastolic blood pressure (DBP) in healthy subjects was 74±8.0 mm of Hg and in diabetic patient it was 79+11 mm of Hg, showing highly significant increase in diabetics than the healthy subjects. In groups B_1 and B_2 they did not show any significant difference in both SBP and DBP (Table 1).

Fasting blood sugar (FBS) in healthy subjects was 79±9.0 mg/dl whereas in diabetic group it was 126±45 mg/dl. there was highly significant increase in FBS within the diabetic patients compared to the control group. FBS within the diabetic groups B_1 and B_2 was not statistically significant (Table 1).

Postprandial blood sugar (PPBS) in healthy subjects was 132±12 mg/dl whereas in diabetic group B was 187±73 mg/dl showing highly significant increase in PPBS in diabetic patients compared to healthy subjects. Within the diabetic groups B_1 and B_2 PPBS was not statistically significant.

There was no statistically significant difference in serum potassium and serum calcium levels between diabetic patients and healthy controls (Table 1).

4. Discussion

In the present study we have observed that microalbuminuria was significantly increased in asymptomatic type 2 diabetes mellitus patients, with no clinical evidence of coronary heart disease, compared to healthy controls. Similar to our findings there are several studies which have demonstrated to have significant microalbuminuria in type 2 diabetic patient.[15]

Presence of microalbuminuria in patients with Type -2 DM was a predictor of clinical proteinuria and increased mortality. It is a strong independent risk factor for cardiovascular disease in diabetic and non-diabetic individuals and may be a useful marker for diffuse endothelial dysfunction.[15]

Microalbuminuria may also be strongly related to confounding factors like hyperglycemia, hypertension, insulin resistance or atherosclerotic disease.

The sensitivity, specificity and positive predictive value of QTc prolongation for the diagnosis of CAN were 76.5%, 75% and 81.3% in type 2 diabetes.[16] Higher CAN scores correlated with longer QTc intervals.[16]

Our study showed that QTC prolongation in type 2 diabetes mellitus patients was significantly higher, when compared to healthy controls, though they were within the normal range. Similar to our results Takebayashi et al. observed that type 2 patients had greater QTC prolongation than healthy controls[17] (Takebayashi et al. 2003). With regard to type 2 DM, two studies have shown that QT interval abnormalities are particularly good predictors of cardiac death[8,9] (Naaset al 1998, Sawick et al 1996). In the previous studies (Porwal et al. 2005, Vegilo et al. 2002) it was observed that QT interval was increased above normal

Table 1: Characteristics of study subjects

S. No.	Parameters	Group A [n=100] Mean+SD	Group B[n=114] Mean+SD	P Value	Group B1 [n=62] Mean+SD	Group B2 [n=52] Mean+SD	P value
1	SBP (mm of Hg)	120+9.0	132+18	<0.0001	133.5+18.3	130+18.7	NS
2	DBP (mm of Hg)	74+ 8.0	79+11	<0.0001	78.2+11.5	80.1+10	NS
3	FBS (mg/dl)	79+9.0	126+45	<0.0001	128+53.1	122.6+32.1	NS
4	PPBS (mg/dl)	132+12	187+73	<0.0001	195+84.4	177.6+58.3	NS
5	Serum K+ mmol/L	4.4+0.7	4.3+0.7	NS	4.3+0.7	4.2+0.5	NS
6	Serum Ca+2 mg/dl	10.0+0.9	10.1+0.9	NS	10.1+0.9	10.3+0.6	NS
7	Microalbumin in urine(mg/L)	8.8+3.8	32.4+5.4	<0.0001	49+69	12.6+6.5	<0.0001
8	QTC interval (msec)	388+21	415+25	<0.0001	419+22	411+28	NS

Group A: Healty subjects, Group B- Diabetics, Group B1Diabetics with microalbuminuria.
Group B2: Diabetics without microalbuminuria.
SBP: Systolic blood pressure; DBP -Diastolic blood pressure, FBS- Fasting blood sugar; PPBS- Post prandial blood sugar; QTC is corrected QT interval

range (>440 msec) in 26% of type 2 diabetes patients with or without microalbuminuria.[18,19] We observed QTC prolongation > 440 msec in 29% of diabetic patients with or without microalbuminuria in our study.

Similar to previous studies we observed QTC was prolonged >440 msec in 18 out of 62 patients with microalbuminuria and 2 out of 52 patients with normoalbuminuria.

No subjects had QTC prolongation of >440 msec in the control group.

Previous studies demonstrated significant increase of QTC interval in type 2 diabetes mellitus patients with microalbuminuria, when compared to normoalbuminuric diabetic patients,[11,20] (Rutter et al.2002, Yeo et al. 2004).

However we found no statistically significant difference in QTC interval within the diabetic patients with or without microalbuminuria. This is because linear regression analysis showed that QT prolongation was not strongly linked to albumin excretion rate but more

strongly to factors associated with microalbuminuria such as blood pressure and factor XIIa[11] Rutter et al. 2002). In our study, diabetic patients had significantly higher microalbuminuria than healthy controls. This might suggest that the microalbuminuria in diabetic patients without overt coronary heart disease could be an early indicator of cardiovascular autonomic neuropathy[20] (Yeo et al 2004).

QTC abnormalities can occur independently of autonomic dysfunction or myocardial ischemia and may be related to the process which increases urinary albumin leakage and QT prolongation may contribute to increased mortality observed in microalbuminuria; subjects with type 2 diabetes mellitus[11] (Rutter et al. 2002). QTC interval is an independent marker for coronary heart disease and is a predictor of sudden cardiac death.[8]

In our study we have observed that mean systolic and diastolic blood pressures were significantly higher in diabetic patients, compared to healthy subjects. Our results were consistent with the previous studies[18,21] (Porwal et al. 2005, Vegilo et al. 2002, Sallas et al. 2006) which reported that diabetic patients tend to have high blood pressure and higher cardiovascular complications which affect QT interval more than healthy individuals.

Another study demonstrated that diabetic patients with microalbuminuria had higher mean systolic and diastolic pressures recorded over a 24 hour period, than normoalbuminuric diabetic patients.[22] In our study, there was no sIgnificant difference in mean systolic and diastolic blood pressures between microalburninuric and ormoalbuminuric type 2 diabetic patients, as we have not recorded blood pressure over 24 hour period. However, presence of microalbuminuria that reflects renal involvement in diabetic patients, has been reported as a major determinant of ambulatory blood pressure.[20]

Microalbuminuria has been found independently predictive of mortality in clinical studies in Type-2 diabetic patients.[20] Presence of Subclinical autonomic neuropathy is an important determinant of mortality in Type-2 diabetic patients by causing cardiac arrest.(Wirta et al.1997).

Microalbuminuria is an independent risk factor for cardiovascular and renal out- come in a patient with Type 2 diabetes. The evidence that intensive glycemic control reduces the microvascular complications of diabetes is based almost exclusively on prevention of micro- albuminuria.[22] (Peter P. Swoboda et, al 2017) Asymptomatic diabetes mellitus patients with persistent microalbuminuria have markers of diffuse cardiac fibrosis.[22]

In a recent study S Sakthi Selva Kumar et al. has shown that there is a significant association between QTc

interval prolongation and microalbuminuria as evidenced by a greater number of cases with microalbuminuria having prolonged QTc interval.[23]

The prevalence of CAN in diabetes mellitus is high. Higher age, longer duration of diabetes and peripheral neuropathy are significant risk factors.[16] QTc interval in the ECG can be used to diagnose CAN with reasonable sensitivity, specificity and positive predictive value.[16] The study suggests that QTc prolongation may be taken as a direct evidence of cardiac autonomic neuropathy in diabetics.[24]

5. Conclusion

Although common among diabetic individuals, CAN is often under-recognised and undiagnosed cardiac complication.Though optimal management of DM from early stages of the disease can reduce the risk of diabetic heart disease.CAN is a common serious complication seen in Type-2 diabetic patient, it is associated with variety of adverse outcomes including cardiovascular deaths. Hence it is practically difficult to diagnose CAN in the clinics. Screening asymptomatic Type -2 diabetic patients for pronlonged QTC is a simple objective of diagnosing CAN, with reasonable sensitivity, specificity and positive predictive value which can help us to monitor the patients more closely.

The lifetime risk seems to be invariably high in almost all patients with diabetes. The recent ESC guidelinesconsiders that diabetes risk approaches the CHD risk when microalbuminuria is present.

Stratification of diabetic patients improves accuracy in prediction of subclinical CAD, silent ischemia and future cardiovascular events. Risk stratification is necessary to individualize treatment, and to reduce morbidity and mortality.

6. Source of Funding

None.

7. Conflict of Interest

The authors declare no conflict of interest.

References

1. International Diabetes Federation. IDF Diabetes Atlas, 9th edition (Online), 2019. Available from: https://www.diabetesatlas.org/en/.
2. Stumvoll M, Goldstein BJ, Haeften TV. Type 2 diabetes: Principles of pathogenesis and therapy. *Lancet*. 2005;365:1333–46. doi:10.1016/S0140-6736(05)61032-X.
3. Leiter LA. Beta cell preservation: A potential role for the thiazolidinediones to improve clinical care in type 2 Diabetes. *Diabet Med*. 2005;22:963–72.
4. Galicia-Garcia U, Benito-Vicente A, Jebari S, Larrea-Sebal A, Siddiqi H, Uribe KB, et al. Pathophysiology of Type 2 Diabetes Mellitus. *Int J Mol Sci*. 2020;21(17):6275. doi:10.3390/ijms21176275.
5. Rajbhandari J, Fernandez CJ, Agarwal M, Yeap BXY, Pappachan JM. Diabetic heart disease: A clinical update. *World J Diabetes*. 2021;12(4):383–406. doi:10.4239/wjd.v12.i4.383.
6. Turner RC, Cull CA, Frighi V, Holman RR. Glycemic control with diet, sulfonylurea, metformin, or insulin in patients with type 2 diabetes mellitus: progressive requirement for multiple therapies (UKPDS 49). UK Prospective Diabetes Study (UKPDS) Group. *JAMA*. 1999;281(21):2005–12.
7. Gunti S, Gruden G, Fornengo P, Barutta F, Amione C, Ghezzo G, et al. Increased QT interval dispersion predicts 15-year cardiovascular mortality in type 2 diabetic subjects: the population-based Casale Monferrato Study. *Diabetes Care*. 2012;35(3):581–3.
8. Rana BS, Lim PO, Naas AAO, Oqston SA. QT interval abnormalities are often present at diagnosis in diabetes and are better predictors of cardiac death than ankle -brachial pressure index and autonomic function tests. *Heart*. 2005;91(1):44–50.
9. Naas AA, Davidson NC. QT and ETC dispersion are accurate predictors of cardiac death in newly diagnosed non-insulin dependent diabetes. Cohort study. *BMJ*. 1998;316:745–17.
10. Laitinen T, Vauhkonen I, Niskanen L, Hartikainen J, Uusitupa M, Laakso M. Prolonged corrected QT interval is associated with acute and chronic hyperinsulinemia in non diabetic subjects. *Diabetes Care*. 2003;26:2480–1. doi:10.2337/diacare.26.8.2480-a.
11. Rutter MK, Viswanath S, Mccomb JM, Marshall SM. QT prolongation in patients with type 2 diabetes and microalbuminuria. *Olin Auton Res*. 2002;12(5):366–72.
12. Matel D, Chiochina AD, Stratone A. Utility of QTC interval for the diagnosis of cardiac autonomic neuropathy in type 2 diabetes mellitus. *Rev Med Chir Soc Med Nat Last*. 2010;114(1):282–6.
13. Bazett HC. An analysis of the time relations of the electrocardiogram. *Heart*. 1920;7:353–57.
14. Kleg MJ, Whelton PK, Randall BL, Neaton JD, Brancati FL, Stamler J. End-stage renal disease in African-American and white men. 16-year MRFIT findings. *JAMA*. 1997;227(16):1293–8.
15. Suarez GA, Clark VM, Norell JE, Kottke TE, Callahan MJ, O'Brien PC, et al. Sudden cardiac death in diabetes mellitus: risk factors in the Rochester diabetic neuropathy study. *J Neurol Neurosurg Psychiatry*. 2005;76(2):240–5. doi:10.1136/jnnp.2004.039339.
16. Pappachan JM, Sebastian J, Bino BC, Jayaprakash K, Vijayakumar K, Sujathan P, et al. Cardiac autonomic neuropathy in diabetes mellitus: prevalence, risk factors and utility of corrected QT interval in the ECG for its diagnosis. *Postgrad Med J*. 2008;84(990):205–10.
17. Takebayashi K, Sugita R, Tayawa K, Aso Y, Takemura Y, Inukai T. The connection between QT dispersion and autonomic neuropathy in patients with type 2 diabetes. *Exp Clin Endocrinol Diabetes*. 2003;111(6):351–7.
18. Porwal V, Raman PG. QT interval in diabetes mellitus. *Int J Drab Dev Ctries*. 2005;25:46–9.
19. Vegilo M, Bruno G, Barra M. Prevalence of increased OT interval duration and dispersion in type 2 diabetic patients and its relationship with coronary heart disease. A population based cohort. *J Inter Med*. 2002;25:46–9.
20. Yeo CK, Nawawi HM, Kadir KA, Nazainimoon WMW. The comparison of QT dispersion and 24 hour ambulatory blood pressure monitoring amongst diabetic patients with and without microalbuminuria. *Med J Malaysia*. 2005;59:185–9.
21. Spallone V, Gambardelia S, Malello MR, Barini A, Frontoni S, Menzinger G. Relationship between autonomic neuropathy, 24-h blood pressure profile, and nephropathy in normotensive IDDM patients. *Diabetes Care*. 1994;17(6):578–84.
22. Swoboda PP, McDiarmid AK, Erhayiem B, Ripley DP, Ripley LE, Dobson P, et al. RESEARCH ARTICLE PDF/EPUB Tools Share Jump to Abstract Introduction Methods Results Discussion Conclusions Author Contributions Sources of Funding Disclosures Footnotes References Diabetes Mellitus, Microalbuminuria, and Subclinical Cardiac Disease: Identification and Monitoring of Individuals at Risk of Heart Failure. *J Am Heart Assoc*. 2017;6(7):17. doi:10.1161/JAHA.117.005539.
23. Kumar SSS, Palaniandavan S, Padma V. Association Between Prolonged QTc Interval and Microalbuminuria in Patients of Type II

Diabetes Mellitus Research. *J Res Med Dent Sci*. 2021;9(5):170–4.
24. Sharma JK, Rohatgi A, Sharma D. Diabetic autonomic neuropathy: a clinical update. *J R Coll Physicians Edinb*. 2020;50(3):269–73. doi:10.4997/JRCPE.2020.310.

Author biography

Farzana Mustafa, Assistant Professor

Abdul Hai Mohammed, House Surgeon

Cite this article: Mustafa F, Mohammed AH. Study of QT interval prolongation in asymptomatic type-2 diabetes mellitus patients with and without microalbuninuria. *Indian J Clin Anat Physiol* 2021;8(3):235-240.