*ELECTRONICS AND ELECTRICAL ENGINEERING*
*ISSN 1392 – 1215* *2007. No. 3(75)*
*ELEKTRONIKA IR ELEKTROTECHNIKA*

*MEDICINE TECHNOLOGY*
*T 115*
*MEDICINOS TECHNOLOGIJA*

# Assessment of QT Dispersion in Prediction of Life-threatening Ventricular Arrythmias in Recipients of Implantable Cardioverter Defibrillator

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## Introduction

The implantable cardioverter defibrillator (ICD) has become the dominant therapeutic modality for the treatment of life-threatening ventricular tachyarrhythmias (ventricular tachycardia and/or ventricular fibrillation). However, the ICD does not prevent the occurrence of ventricular tachycardia and/or ventricular fibrillation and repeated tachyarrhythmias may therefore result in the delivery of multiple shocks, which cause premature ICD battery depletion necessitating generator replacement [1]. In such situations most patients become anxious and agitated, and psychosocial consequences often outlast the acute event. Therefore the investigation and detection of potential predictors of life-threatening arrhythmias remains the important task in cardiology. Despite some controversial data, several studies showed that increased QT dispersion (QTd) is a significant predictor of cardiovascular mortality [2; 3] and is related to susceptibility to life-threatening ventricular arrhythmias, independent of degree of left ventricular dysfunction [4]. The aim of our study was to investigate a high risk patients of an ICD, and to evaluate QTd in respect to its ability to predict occurrence or recurrence of life-threatening ventricular arrhythmias (ventricular tachycardia and/or ventricular fibrillation).

## Patients and methods

The study population consisted of 40 unselected ICD recipients (31 patients in Kantonsspital St.Gallen and 9 patients in Kaunas University`s of Medicine Clinic): 33 males and 7 females, age 62 $\pm$ 12.3 years with coronary artery disease (CAD) or cardiomyopathy (CMP) and left ventricular ejection fraction (EF) of 29.8 $\pm$ 12.5 %. Duration of observation in this study covered 19.2 + 3.2 months. QT intervals at rest were analysed and QTd calculated by means of Schiller CS electrocardiography software (Kantonsspital St.Gallen) and the computer software, developed at the Institute of Cardiology Kaunas Medical University. The symptom limited bicycle stress was performed using twelve-leads of electrocardiogram. The Veterans Specific Activity Questionnaire was used to individualize the ramp protocol. The percentage of achieved workload in respect to the expected one (according the age, weight and height of the patient), was calculated (Schiller CS electrocardiography software, Kantonsspital St.Gallen).

SPSS 10 was used for statistical analysis. Group comparisons were calculated using 2-tailed T test, p value $< 0.05$ was considered as statistically significant. Receiver operating characteristic (ROC) curves and the areas under ROC curves were used to quantitatively analyse QTd, the longest and the shortest QT interval for predicting occurrence and/or recurrence of ventricular tachycardia or/and ventricular fibrillation.

## Results and Discussion

The patients were divided in two groups: group I consisted of 16 patients with occurrence and/or recurrence of ventricular tachycardia and/or ventricular fibrillation as documented on ICD electrocardiogram, group II – 24 patients without these life-threatening arrhythmias. The groups did not differ according to the age, sex, EF and use of beta-blocking agents (BB) or cordarone (Table 1).
QT dispersion, evaluated at resting electrocardiography, did not differ significantly between the groups with (58.5±9.3 ms) and without life- threatening ventricular arrhythmias (57.04 ±6.9 ms) in ICD recipients (Table 2). The length of the longest as well as the shortest QT interval did not differ significantly between the groups as

well. The percentage of achieved workload in respect of expected one had a tendency to be higher in the group II (79.4±7.0 %) as compared to the group I (65.0±4.66 %), the difference was though insignificant (p = 0.1).

**Table 1.** Baseline characteristics of ICD recipients with (group I) and without (group II) occurrence and/or recurrence of ventricular tachycardia or/and ventricular fibrillation

| Clinical variable | I group (n =16) | II group (n =24) | p |
|---|---|---|---|
| Age (years) | 62±2.3 | 61±2.8 | ns |
| Male | 87.5% | 79.2% | ns |
| EF (%) | 32.2±3.6 | 28.4±2.4 | ns |
| Use of BB | 70 % | 89.5 % | ns |
| Use of cordarone | 62 % | 63 % | ns |

**Table 2.** QT parameters of ICD recipients with (group I) and without (group II) occurrence and/or recurrence of ventricular tachycardia and/or ventricular fibrillation

| Variable | I group (n = 16) | II group (n = 24) | p |
|---|---|---|---|
| QTd (ms) | 58.5± 9.3 | 57.04±6.9 | 0.8 |
| Longest QT (ms) | 435.1±17.9 | 468.8±10.9 | 0.4 |
| Shortest QT (ms) | 394.6±16.7 | 415.3±12.3 | 0.3 |

Variables are expressed as mean±SE

Analysis of leads according to the longest and the shortest QT interval showed, that the longest QT interval was registered in lead II, V1-V3, and the shortest one in lead I, V1, V4-V6 (Fig.1).

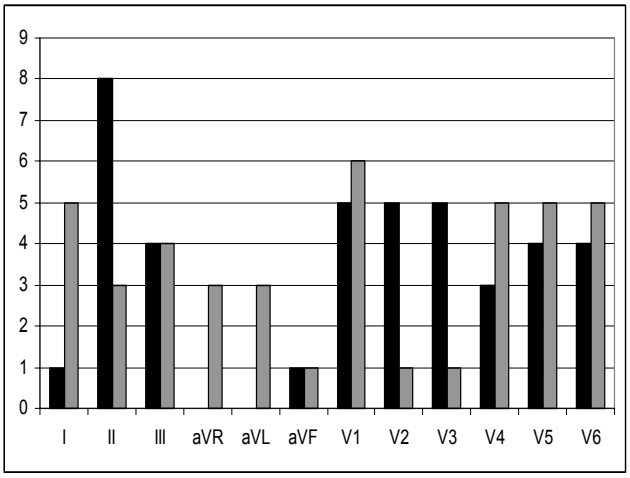


**Fig.1.** Distribution of electrocardiographic leads in which QT interval (dark color) was longest and (grey color) – shortest in ICD recipients

The prognostic accuracy of QT interval parameters for predicting occurrence and/or recurrence of ventricular tachycardia and/or ventricular fibrillation was defined using ROC curves and areas under ROC curves. The accuracy of this test depends on how well the test discriminates the groups. An area of 1 represents a perfect test.

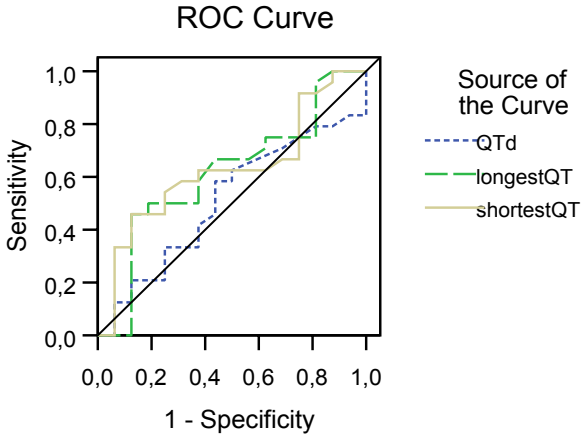


**Fig.2.** ROC curves of QTd, longest QT and shortest QT for predicting occurrence and/or recurrence of ventricular tachycardia or/and ventricular fibrillation in ICD recipients

Further analysis of data according to the diagnosis of CAD or CMP showed, that QT dispersion was significantly higher in ICD recipients with CAD as compared to the ICD recipients with CMP (p=0.023) (Table 3).

**Table 3.** QT parameters in ICD recipients according to the diagnosis of CAD or CMP

| Variable | CAD (n=28) | CMP (n=12) | p |
|---|---|---|---|
| QTd (ms) | 65.7±7.1 | 38.7±4.9 | 0.023 |
| QT longest (ms) | 454.4±9.8 | 481.5±22.2 | 0.203 |
| QT shortest (ms) | 391.6±9.2 | 442.8±23.0 | 0.017 |

Variables are expressed as mean±SE

**Table 4.** Baseline characteristics and QT parameters in ICD recipients with CAD and with (goup IA) and without (group IB) occurence and/or recurrence of ventricular tachycardia or/and ventricular fibrillation

| Variable | Group IA (n=11) | Group IB (n=17) | p |
|---|---|---|---|
| QTd (ms) | 67.2±12 | 64.7±8.6 | 0.8 |
| QT longest (ms) | 446.7±17.7 | 459.2±11.8 | 0.5 |
| QT shortest (ms) | 379.6±12.9 | 399.4±12.5 | 0.3 |
| EF (%) | 25.1±2.0 | 26.6±2.6 | 0.6 |
| Age (years) | 65.2±2.3 | 66.5±2.2 | 0.7 |
| Male | 100% | 76% | 0.09 |
| Use of BB | 71% | 86% | 0.44 |
| Use of cordarone | 27% | 53% | 0.18 |

Variables are expressed as mean±SE

In our study the area under ROC curve of QTd was 0.51±0.09, p=0.9 95% confidence interval (CI) [0.32; 0.69], the area under ROC curve of longest QT was

0.62±0.09, p=0.2 95% CI [0.43; 0.79] and the area under ROC curve of shortest QT was 0.63±0.09, p=0.17 95% CI [0.45; 0.8]. These results demonstrated a poor discrimination power of QTd, the longest and the shortest QT interval for prediction occurrence and/or recurrence of ventricular tachycardia and/or ventricular fibrillation (Fig. 2).

We have divided the patients with CAD in two groups: IA – ICD recipients with CAD and with life-threatening arrhythmias, IB – ICD recipients with CAD and without life-threatening arrhythmias. These groups did not differ according to the age, sex, EF, use of BB and cordarone. No significant differences were found between these groups according to the QT dispersion as well (Table 4).

## Discussion

Evaluation of non-invasive risk markers in low-or moderate- risk populations requires studies involving very large numbers of patients and in such studies, documentation of the occurrence of ventricular tachyarrhythmias is difficult. In the present study we have investigated a high risk population of an ICD, and evaluated QTd in respect to its ability to predict occurrence or recurrence of life-threatening ventricular arrhythmias ventricular tachycardia and/or ventricular fibrillation. C.P.Day at al. [5] proposed the use of QTd measurement as an index of the inhomogenity of myocardial repolarisation, which could be applied as a potential tool in the detection of future ventricular tachyarrhythmic events and death. Several studies later showed that increased QT dispersion (QTd) is a significant predictor of cardiovascular mortality [2; 3], and is related to susceptibility to life-threatening ventricular arrhythmias, independent of degree of left ventricular dysfunction (4). There are some controversial data that QTd correlates only with the parameters of vectorcardiographic T loop morphology [6] and does not predict the life-threatening arrhythmias. Our data of this high risk patients showed, that QTd, evaluated at rest electrocardiography, did not differ significantly between the groups with (58.5±9.3 ms) and without life-threatening ventricular arrhythmias (57.04± 6.9 ms) in ICD recipients. QT dispersion though was significantly higher (p=0.023) in ICD recipients with CAD as compared to the ICD recipients with CMP. This could be explained because of the potentially higher inhomogenity of repolarisation in patients with CAD.

## Conclusions

1. QT dispersion at rest did not predict the occurrence and/or reoccurrence of ventricular tachycardia and/or ventricular fibrillation in high risk patients - ICD recipients.
2. QT dispersion was significantly higher (p=0.023) in ICD recipients with coronary artery disease as compared to the ICD recipients with cardiomyopathy.

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Submitted for publication 2007 02 22

**I. Blužaitė, H. Rickli, R. Widmer, P. Ammann, G. Urbonavičienė, Z. Bertašienė, V. Zabiela. Assessment of QT Dispersion in Prediction of Life-threatening Ventricular Arrythmias in Recipients of Implantable Cardioverter Defibrillator // Electronics and Electrical Engineering. – Kaunas: Technologija. 2007. – No. 3(75). – P. 73–76.**

The aim of the study was to investigate a high risk population of an implantable cardioverter defibrillator (ICD), and to evaluate QT dispersion and its ability to predict occurrence or recurrence of life-threatening ventricular arrhythmias (ventricular tachycardia and/or ventricular fibrillation). The study population consisted of 40 unselected ICD recipients. The patients were divided in two groups: group I consisted of 16 patients with occurrence and/or recurrence of ventricular tachycardia and/or ventricular fibrillation as documented on ICD electrocardiogram, group II – 24 patients without these life-threatening arrhythmias. The groups did not differ according to the age, sex, ejection fraction, use of beta-blocking agents and cordarone. QT dispersion, evaluated at resting electrocardiogram, did not differ significantly between the groups with (58.5 $\pm$ 9.3 ms) and without life-threatening ventricular arrhythmias (37.04 $\pm$ 6.9 ms) in ICD recipients. The percentage of achieved workload in respect of expected one at bicycle test, had a tendency to be higher in the group II (79.4 $\pm$ 7.0 %) as compared to the group I (65.0 $\pm$ 4.66 %), the difference was though insignificant (p = 0.1) as well. Analysis of QT dispersion according to the diagnosis showed, that QT dispersion was significant higher in ICD recipients with coronary artery disease as compared to the ICD recipients with cardiomyopathy (p = 0.023). Ill. 2, bibl. 6(in English; summaries in English, Russian and Lithuanian).

**И. Блужайте, Г. Рикли, Р. Видмер, П. Амман, Г. Урбонавичене, З. Берташене, В. Забела. Анализ дисперсии QT при прогнозировании опасных для жизни желудочковых арритмий для больных, которым имплантированы кардиовертеры дефибрилляторы // Электроника и электротехника. – Каунас: Технология. 2007. – № 3(75). – С. 73–76.**

В проспективное исследование были включены 40 больных с повышенным риском опасных для жизни желудочковых аритмий, которым имплантированы кардиовертеры дефибрилляторы (ICD). Цель исследования − выяснить, может ли дисперсия QT интервала (QTd) предсказать желудочковую тахикардию или фибрилляцию желудочков. Больных распределили на 2 группы. В первую группу (I) были включены 16 больных, которым желудочковая тахикардия и/или фибрилляция желудочков были документированы в элэктрокардиограмме ICD, во вторую группу (II) − 24 больные без опасных для жизни желудочковых аритмий. Группы не различались по поводу пола, возроста, фракции изгнания левого желудочка, приёма β-блокаторов и амиодарона. Мы не установили различий QTd между I-ой (58,5±9,3 мс) и в II-ой (37,04±6,9 мс) группами. Нагрузка, которую больные смогли достичь во время велоэргометрического исследования имела тенденцию быть больше в I-ой группе (79,4±7,0%) по сравнению с II-ой (65,0±4,66%), но разница была незначительная (p=0,1). QTd была значительно больше в группе больных с ишемической болезнью сердца по сравнению с больными с кардиомиопатией (p=0,023). Ил. 2, библ. 6 (на английском языке; рефераты на английском, русском и литовском яз.).

**I. Blužaitė, H. Rickli, R. Widmer, P. Ammannб G. Urbonavičienė, Z. Bertašienė, V. Zabiela. QT intervalo dispersijos reikšmė numatant ligonių su implantuotu kardioverteriu defibriliatoriumi gyvybei pavojingas skilvelines aritmijas // Elektronika ir elektrotechnika. – Kaunas: Technologija. 2007. – Nr. 3(75). – P. 73–76.**

Darbo tikslas buvo ištirti didelės rizikos ligonių su implantuotu kardioverteriu defibriliatoriumi (ICD) kontingentą ir nustatyti, ar QT dispersija gali padėti numatyti gyvybei pavojingas skilvelines aritmijas (skilvelių tachikardiją ir/ar skilvelių virpėjimą). Tiriamųjų kontingentą sudarė 40 ligonių, kuriems implantuotas ICD. Ligoniai buvo suskirstyti į dvi grupes. Pirmąją grupę sudarė 16 ligonių, kuriems kilo skilvelinė tachikardija ar/ir skilvelių virpėjimas ir tai buvo užregistruota ICD elektrokardiogramoje. Antrąją grupę sudarė 24 ligoniai, kuriems šių ritmo sutrikimų nebuvo užregistruota. Grupės nesiskyrė pagal amžių, lytį, išstūmimo frakciją, beta blokatorių ir kordarono vartojimą. QT dispersija statistiškai reikšmingai tarp grupių nesiskyrė ir buvo atitinkamai 58,5 $\pm$ 9,3 ms ir 37,04 $\pm$ 6,9 ms. Numatyto pagal amžių, ūgį ir svorį veloergometrijos testo metu pasiekto krūvio procentas antroje grupėje buvo didesnis (79,4 $\pm$ 7,0 %), negu pirmoje (65,0 $\pm$ 4,66 %), tačiau skirtumas buvo nepatikimas, tik tendencija (p = 0,1). Vertinant QT dispersiją pagal diagnozes, nustatyta, kad ligonių, sergančių išemine širdies liga, QT dispersija buvo patikimai didesnė (p = 0,023), nei ligonių, sergančių kardiomiopatija. Il. 2, bibl. 6 (anglų kalba, santraukos anglų, rusų ir lietuvių k.).

DOI: 10.5755/j02.eie.10703