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Research Article

QT Intervals Correlate with Carotid Artery Intima Media Thickness in a Gender-Specific and Segment-Specific Manner in Asymptomatic Dyslipidemic Patients

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Abstract

Objective: To investigate the relationship between cardiac repolarization (QT) or QT corrected (QTc) and carotid artery Intima Media Thickness (IMT) in primary prevention patients of the two genders.

Methods: 405 individuals, 183 men (55.3 ± 11.9 years) and 222 women (64.3 ± 9.6 years) were examined. QT and QT corrected formulae of Bazett (B), Fridericia (F), Hodges (H), Nomogram-Karjalainen (K), Rautaharju (R) and Sagie-Framingham (S-F) were applied.

Results: In men significant correlations between left internal carotid IMT and QT (r=0.192; P<0.001) or QTc (B) r=0.206, (F) r=0.238, (H) r=0.223, (K) r=0.237, (R) r=0.227, (S-F) r=0.247; (P<0.001) were detected. The associations between QT or QTc and left internal carotid IMT remained significant, after adjusting for different risk factors in the men.

In the women, there were significant associations between the QT intervals with right common carotid IMT (r=0.141, P<0.05) and left common carotid IMT (r=0.187, P<0.01). The associations between QT and left common carotid IMT remained significant, after adjustment in the women.

Conclusion: In dyslipidemic patients in primary prevention, QT intervals correlate with carotid IMT in a gender and segment-specific manner. These variables, easy to obtain in clinical practice, can provide a useful tool to estimate cardiovascular risk.

Keywords: Carotid intima media thickness; Dyslipidimia; Gender differences; Primary prevention; QT/QTc intervals

Abbreviations

AV: Atrioventricular; BMI: Body Mass Index; CC-IMT: Common Carotid-Intima Media Thickness; CV: Cardiovascular; CVD: Cardiovascular Disease; DBP: Diastolic Blood Pressure; ECG: Electrocardiogram; HDL-C: High Density Lipoprotein-Cholesterol; HR: Heart Rate; ICA-IMT: Internal Carotid Intima Media T hickness; IMT: Intima Media Thickness; LDL-C: Low Density Lipoprotein-Cholesterol; QTc QT: Interval Corrected; QT (B) QT: Interval Corrected with Bazett Formula; QT (F) QT: Interval Corrected with Fridericia Formula; QT (H) QT: Interval Corrected with Hodges Formula; QT (K) QT: Interval Corrected with Nomogram-Karjalainen Formula; QT (R) QT: Interval Corrected with Rautaharju Formula; QT (S-F) QT: Interval Corrected with Sagie-Framingham Formula; SBP: Systolic Blood Pressure; TG: Triglycerides; TC: Total Cholesterol

Introduction

The QT interval is measured from the beginning of the QRS complex to the end of the T-wave and should be corrected for heart rate to enable comparison with reference values. QT interval physiologically differs from women and men, because of hormonal effects and gender differences in autonomic tone [1]. Many studies have suggested a relationship between prolonged QT interval with total and Cardiovascular (CV) mortality [2,3]. A dose-response relationship between longer QTc intervals and the risk of all-cause deaths have been also reported. The association was strongest in men with QTc ≥ 466 ms [HR for CV disease 4.08; 95% Confidence Interval (CI) 2.93-5.69, P<0.001], whereas in women QTc intervals ≤ 379 ms produced a HR of 1.58 (95% CI 1.20-2.09, P=0.001) for Cardiovascular Diseases (CVD) mortality [4].

Carotid artery Intima-Media Thickness (IMT), measured by B-mode ultrasound, is a well recognized subclinical marker of atherosclerosis [5]. In view of the detected correlation between QT interval changes and mortality, the use of this non-invasive marker appears to be of particular interest for the early detection and prevention of cardiovascular diseases. Festa et al., [6] first reported a significant relationship between QT interval duration and atherosclerosis in asymptomatic non-diabetic subjects. QT interval was related to IMT of Common Carotid (CC-IMT), but not to that of the Internal Carotid Arteries (ICA-IMT). The association was stronger in women than in men and was partly associated to the presence of cardiovascular risk factors. A close association between QT corrected (QTc) according to Bazett formula (B) and CC-IMT was also observed in patients with type 2 diabetes [7]. A significant correlation between QTc (B) and the right CC-IMT in obese children was also reported [8].

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The influence of gender on the association between carotid IMT variables and QT or QTc intervals was investigated in healthy subjects [9]. An association between QTcs and ICA-IMT was observed in men, whereas in women a statistically significant relationship was found only between QT and CC-IMT [9].

The present study was aimed at investigating the relationship between QT interval duration, with and without correction for Heart Rate (HR) by different formulae, and carotid IMT in a population of dyslipidemic patients without cardio or cerebrovascular disease. In order to assess the role of QT as a marker of subclinical atherosclerosis potentially useful to estimate the cardiovascular risk in a gender-specific manner, all the analyses were stratified by gender.

Methods

Subjects and study design

A total of 405 caucasian subjects, 183 men (55.3 ± 11.9 years) and 222 women (64.3 ± 9.6 years), were included into the study. Inclusion criteria were: age > 18 years, Total Cholesterol (TC)>220 mg/dL, Low-Density Lipoprotein-Cholesterol (LDL-C)>130 mg/dL, Triglycerides (TG)<500 mg/dL. Exclusion criteria were: history of cardiovascular, cerebrovascular or peripheral artery diseases or cardiovascular interventions, ECG abnormalities (left of right bundle branch block, hemiblocks, atrioventricular block, atrial fibrillation), medications affecting QT interval duration (i.e. beta-blockers, digoxin, antiarrhythmics or antidepressant medications). All patients were examined regularly in our Lipid clinic and recruited in the study from January 2012 to April 2013.

Ultrasound examination

Carotid arteries ultrasonographic scans were performed by a Single trained observer (SC) by using an ESAOTE My Lab 25 Gold ultrasound machine, equipped with a multi-frequency probe of 8.5 MHz [10].

The ultrasonic protocol requires visualization of the near and far walls of both right (r-CC-IMT) and left (l-CC-IMT) common carotid IMT, carotid bifurcations and the first proximal cm of ICA-IMT in three different angles (lateral, anterior and posterior), for a total of 36 carotid segments per patient.

The maximal IMT of each segment was measured. The complete procedure is generally performed in approximately 30 to 35 minutes. The maximal IMT values for the three projections and for right and left carotid arteries were averaged to obtain the mean maximum IMT.

Assessment of cardiac repolarization

HR ($bxmin^{-1}$) and QT intervals (ms) were determined automatically from the resting ECGs using an electrocardiograph (Cardioline Delta 60 plus, Italy) at a paper speed of 25 mm/s. QT intervals were corrected for HR according to six previously published formulae, i.e., Bazett, Fridericia (F), Hodges (H), Nomogram-Karjalainen (K), Rautaharju (R) and Sagie-Framingham (S-F) (see Appendix) [9,11,12].

Laboratory procedures

Blood samples were collected after an overnight fast and centrifuged at 4°C at low speed. The determination of plasma concentrations of total cholesterol, High Density Lipoprotein-Cholesterol (HDL-C) and triglycerides was performed with certified methods using an Auto-Analyzer Integra 400 (Roche Diagnostics). Concentrations of LDL-C were calculated using the Friedewald formula [13].

Statistical analyses

Quantitative variables were reported as means ± SD; triglycerides were presented as median and range. Categorical variables were reported as frequency and percentage. Differences between groups were analyzed by Student t-test or by z-test for binary data. Variables with a skewed distribution were log-transformed before analyses. Correlation was evaluated considering non parametric test (Spearman's correlations). Associations between QT or QTcs and ultrasonographic variables were evaluated in crude analyses and after adjusting for conventional cardiovascular risk factors (e.g., age, BMI, HDL-C, LDL-C, SBP and DBP). P-values <0.05 were considered as statistically significant. All statistical analyses were performed using the SPSS 19.0 (Statistical Package for the University of Milano, Italy) software system.

Results

The descriptive statistics are summarized in table 1. HR was significantly higher in women than men (67.8 ± 10.0 vs. 63.3 ± 8.9 bpm; P<0.001). Non-corrected QT wasn't different in the two genders, but it resulted higher in women than in men. Using six QT correction formulae, QTcs were far greater in women (P<0.001). Analyzing IMT, we found segment-specific differences in the two genders: l-ICA-IMT and ICA-IMT_m were smaller in women compared with men (P=0.017 and 0.031 respectively).

All quantitative variables were reported as mean ± SD; triglycerides were presented as median (range) whereas ultrasonographic variables as geometric means (interval confidence). Categorical variables were reported as frequency and percentage.

Using Pearson's correlation analysis, the links between QT or QTcs and carotid IMT in the two genders were calculated (Table 2).

In men statistically significant correlation were found between QT and QTc intervals both with l-ICA-IMT (P<0.01) and ICA-IMT_m (P<0.01 or P<0.05 depending on which correction formula was used). In women, instead, only non-corrected QT correlated with r-CC-IMT (P<0.05), l-CC-IMT and CC-IMT_m (P<0.01).

Performing a multivariate linear regression, the association between QT or QTcs and IMT were adjusted for age (model 1) and for age, BMI, SBP, DBP, HDL-C and LDL-C (Model 2). In (Table 3a,b) were reported the coefficient B for the two models and the two genders. The coefficient B can be interpreted as the mean expected increase in the dependent variables (QT and QTc) for every 1 mm increase in the respective IMT parameter, and all other covariates remaining unchanged.

In men, all QT and QTc correlations with l-ICA-IMT remained significant after adjustment with model 1, whereas those with ICA-IMT_m were not significant. When we adjusted for age, BMI, SBP, DBP, HDL-C and LDL-C, only QTc (F,K,R,S-F) were remained correlated with l-ICA-IMT (P<0.05). In women, correlations between QT and l-CC-IMT and CC-IMT_m, found in the non-adjusted analysis, remained significant for both model 1 and model 2.

After having assessed that the strongest correlations were with l-ICA-IMT in men and l-CC-IMT in women (r=0.247 and r=0.187, respectively) a further analysis was performed.

l-ICA-IMT was stratified in men, while l-CC-IMT in women, according to their respective median values: i.e., 1 mm for men and 0.9 mm for women (Figure 1). In men, all QT and QTcs differences

	Men (n=183)	Women (n=222)	
	Mean ± SD	Mean ± SD	P-value
Age (years)	55.3 ± 11.9	64.3 ± 9.6	<0.001
BMI (Kg m^{-2})	26.1 ± 3.0	24.3 ± 3.3	<0.001
SBP (mm Hg)	127.2 ± 12.5	129.7 ± 15.1	ns
DBP (mm Hg)	80.5 ± 8.8	79.3 ± 8.2	ns
TC (mg/dL)	243.5 ± 46.2	244.2 ± 42.4	ns
TG (mg/dL)	137.0 (41-498)	102.5 (31-411)	<0.001
HDL-C (mg/dL)	47.3 ± 12.8	62.7 ± 15.7	<0.001
LDL-C (mg/dL)	164.8 ± 43.7	157.4 ± 41.5	ns
Hypertension (%)	42 (23.0)	81 (36.5)	0.005
Diabetes (%)	13 (7.1)	11 (5.0)	ns
Smoking (%)	125 (68.3)	78 (35.1)	<0.001
Statins (%)	52 (28.4)	104 (46.8)	<0.01
Fibrates (%)	46 (25.1)	29 (13.1)	0.003
HR (bpm)	63.3 ± 8.9	67.8 ± 10.0	<0.001
QT (ms)	401.4 ± 29.3	402.9 ± 29.6	ns
QTc (B) (ms)	409.8 ± 21.1	425.5 ± 21.9	<0.001
QTc (F) (ms)	406.7 ± 20.0	417.5 ± 20.8	<0.001
QTc (H) (ms)	407.2 ± 20.7	416.5 ± 20.6	<0.001
QTc (K) (ms)	408.1 ± 20.0	418.8 ± 20.3	<0.001
QTc (R) (ms)	408.5 ± 19.7	420.6 ± 20.0	<0.001
QTc (S-F) (ms)	406.5 ± 19.7	417.9 ± 20.1	<0.001
r-CC-IMT (mm)	0.93 (0.40-2.30)	0.95 (0.30-3.40)	ns
l-CC-IMT (mm)	1.07 (0.50-3.40)	0.96 (0.50-2.70)	ns
$CC\text{-}IMT_m$ (mm)	0.98 (0.50-2.70)	0.96 (0.40-3.05)	ns
r-ICA-IMT (mm)	1.08(0.40-3.90)	1.02 (0.40-4.00)	ns
l-ICA-IMT (mm)	1.01 (0.40-4.20)	0.92 (0.40-2.60)	0.017
$ICA\text{-}IMT_m$ (mm)	1.08 (0.50-3.65)	1.00 (0.45-2.75)	0.031
IMT_{Mean} (mm)	1.03 (0.57-1.98)	1.03 (0.48-2.04)	ns
IMT_{Max} (mm)	1.79 (0.70-5.10)	1.81 (0.60-4.70)	ns

Table 1: Clinical, electrocardiographic and ultrasound characteristics of participants stratified by gender.

BMI: Body Mass Index; CC: Common Carotid artery; CC_m/ICA_m (mean Common Carotid Artery/ mean Internal Carotid Artery); DBP: Diastolic Blood Pressure; HDL-C: HDL-Cholesterol; HR: Heart Rate; IMT: Intima Media Thickness; ICA: Internal Carotid Artery; l-CC/l-ICA (left Common Carotid Artery/ left Internal Carotid Artery); LDL-C: LDL-Cholesterol; QTc (B): QTc-Bazett; QTc (F): QTc-Fridericia; QTc (H): QTc-Hodges; QTc (K): QTc-Nomogram-Karjalainen; QTc (R): QTc-Rautaharju; QTc (S-F): QTc-Sagie-Framingham; r-CC/r-ICA (right Common Carotid Artery/right Internal Carotid Artery); SBP: Systolic Blood Pressure; TC: Total Cholesterol; TG: Triglycerides

were statistically significant (all $p<0.05$) (Figure 1). In women, only the non-corrected QT was significantly prolonged in the group with l-CC-IMT value above the median (Figure 1).

Covariate analysis was performed using QT and QTc as dependent variables, while carotid IMT and gender as independent variables after adjustment for age, BMI, SBP, DBP, HDL-C and LDL-C.

Significant interaction were found between l-CC-IMT, $CC\text{-}IMT_m$ and gender for QT, while l-ICA-IMT and gender for QTc (F,K,R,S-F) (Table 4). These results confirm the gender linked differences reported in the linear model analyses.

Discussion

Prolonged QT interval and increased carotid IMT have been both associated with cardiovascular morbidity and mortality in epidemiological studies [5,14-20] with significant gender related differences. This was underlined in the report by Nielsen et al., where, in women, a very short QTc interval has an equivalent risk as a moderately prolonged QTc interval. A recent meta-analysis [18] showed consistent associations between prolonged QT interval and increased risk of total, cardiovascular, coronary, and sudden death mortality in the general population; not providing, however, specific gender-related comparisons. In a follow up study of a larger population of both genders [19], the same authors reported an increased mortality risk associated with both the longest and the shortest QT intervals, thus suggesting that the presence of a significant number of women may bring to light the risk of very short QTc intervals.

Besides the association with clinical outcomes, a number of studies have evaluated the association of QT intervals (corrected or uncorrected) and subclinical atherosclerosis. Strohmer et al., [9] showed crude correlations between QT or QTcs (Bazett, Fridericia, Hodges, Rautaharju and Sagie-Framingham) and ICA-IMT in healthy men, as well as a significant crude correlation between QTcs and CC-IMT. In our series of dyslipidemic patients, we observed similar results but only for QT in women (Tables 2,3(a,b)) whereas our findings confirm the correlations between QT or QTc and ICA-IMT in men (Table 2). Differently from other authors [9], we did not find any correlation between QT or QTc and CC-IMT in men. After adjusting for age (Model 1, Table 3a), in men correlations were similar to those reported by Strohmer [9], while after adjusting for other clinical and laboratory parameters (Model 2, Table 3b), we found correlations between ICA-IMT and QTc calculated according to some formulas (F,K,R,S-F), but not for QTc calculated with others (B, H) or for uncorrected QT.

	Men (n=183)						Women (n=222)					
	r-CC	l-CC	CC_m	r-ICA	l-ICA	ICA_m	r-CC	l-CC	CC_m	r-ICA	l-ICA	ICA_m
QT	0.071	0.012	0.047	0.068	0.192**	0.168*	0.141*	0.187**	0.185**	0.002	-0.001	-0.002
QTc (B)	-0.001	0.042	0.021	0.056	0.206**	0.163*	0.028	-0.034	-0.005	0.035	-0.009	0.019
QTc (F)	0.035	0.035	0.038	0.073	0.238**	0.196**	0.09	0.07	0.09	0.025	-0.007	0.012
QTc (H)	0.045	0.014	0.03	0.079	0.223**	0.191**	0.101	0.088	0.106	0.022	-0.005	0.011
QTc (K)	0.035	0.031	0.035	0.075	0.237**	0.196**	0.087	0.067	0.086	0.023	-0.013	0.008
QTc (R)	0.027	0.025	0.027	0.072	0.227**	0.187*	0.066	0.031	0.054	0.025	-0.008	0.012
QTc (S-F)	0.031	0.042	0.04	0.067	0.247**	0.196**	0.081	0.062	0.081	0.021	-0.011	0.006

Table 2: Correlations (Pearson's) between QT, QTc intervals and carotid IMT.

CC_m/ICA_m (mean Common Carotid Artery/mean Internal Carotid Artery); l-CC/l ICA (left Common Carotid Artery/left Internal Carotid Artery); QTc (B): QTc-Bazett; QTc (F): QTc-Fridericia; QTc (H): QTc-Hodges; QTc (K): QTc-Nomogram-Karjalainen; QTc (R): QTc-Rautaharju; QTc (S-F): QTc-Sagie-Framingham; r-CC/r-ICA (right Common Carotid Artery/right Internal Carotid Artery). All variables were log-transformed before analysis. Data are expressed as Pearson's coefficient and P-value *= P<0.05: **= P<0.01

a	Men (n=183)						Women (n=222)					
Model 1	**r-CC**	**l-CC**	**CC_m**	**r-ICA**	**l-ICA**	**ICA_m**	**r-CC**	**l-CC**	**CC_m**	**r-ICA**	**l-ICA**	**ICA_m**
QT	0.001	-0.017	-0.013	0.003	0.024*	0.022	0.032	0.044*	0.050*	-0.003	-0.004	-0.006
QTc (B)	-0.009	-0.004	-0.01	0.001	0.020*	0.017	0.004	-0.008	-0.003	0.004	-0.002	0.002
QTc (F)	-0.006	-0.008	-0.011	0	0.021*	0.019	0.013	0.01	0.015	0.001	-0.003	0.001
QTc (H)	-0.004	-0.012	-0.013	0.001	0.020*	0.019	0.015	0.013	0.018	0.001	-0.003	0.001
QTc (K)	-0.005	-0.009	0.011	0.001	0.021*	0.019	0.012	0.008	0.013	0.001	-0.004	0.001
QTc (R)	-0.006	-0.008	-0.011	0.001	0.020*	0.019	0.009	0.003	0.007	0.002	-0.002	0
QTc (S-F)	-0.006	-0.007	-0.01	0.001	0.022**	0.019	0.011	0.008	0.012	0.001	-0.003	0.001
b												
Model 2	**r-CC**	**l-CC**	**CC_m**	**r-ICA**	**l-ICA**	**ICA_m**	**r-CC**	**l-CC**	**CC_m**	**r-ICA**	**l-ICA**	**ICA_m**
QT	0.004	-0.015	-0.01	-0.002	0.021	0.018	0.036	0.045*	0.054**	-0.003	-0.002	-0.003
QTc (B)	-0.009	0.005	-0.007	-0.004	0.016	0.01	0.005	-0.009	-0.003	0.005	0	0.004
QTc (F)	-0.005	-0.005	-0.008	-0.003	0.018*	0.012	0.016	0.01	0.017	0.002	0	0.002
QTc (H)	-0.002	-0.009	-0.01	-0.002	0.017	0.012	0.018	0.013	0.02	0.002	-0.001	0.002
QTc (K)	-0.004	-0.006	-0.008	-0.003	0.017*	0.012	0.014	0.008	0.015	0.002	-0.001	0.001
QTc (R)	-0.005	-0.005	-0.008	-0.003	0.017*	0.011	0.011	0.003	0.009	0.003	0	0.002
QTc (S-F)	-0.005	-0.003	-0.006	-0.004	0.019*	0.013	0.013	0.008	0.014	0.002	-0.001	0.001

Table 3a,b: Linear model analyses for QT or QTc intervals and carotid IMT.

CC_m/ICA_m (mean Common Carotid artery/mean Internal Carotid Artery); l-CC/l ICA (left Common Carotid artery/left Internal Carotid Artery); QTc (B): QTc-Bazett; QTc (F): QTc-Fridericia; QTc (H): QTc-Hodges; QTc (K): QTc-Nomogram-Karjalainen; QTc (R): QTc-Rautaharju; QTc (S-F): QTc-Sagie-Framingham; r-CC/r-ICA (right Common Carotid Artery/right Internal Carotid Artery). All variables were log-transformed before analysis. Data are expressed as B coefficient after adjustment for age (Model 1) and age, BMI, HDL-C, LDL-C, SBP and DBP (Model 2); P-value. *=P<0.05: **= P<0.01

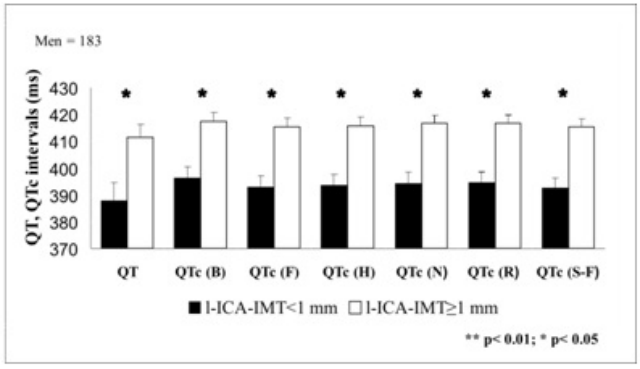

Figure 1a: QT and QTc variations depending on carotid IMT in men after adjustment for age, BMI, SBP, DBP, HDL-C, LDL-C.

l-ICA: left Internal Carotid Artery; QTc (B): QTc-Bazett; QTc (F): QTc-Fridericia; QTc (H): QTc-Hodges; QTc (K): QTc-Nomogram-Karjalainen; QTc (R): QTc-Rautaharju; QTc (S-F): QTc-Sagie-Framingham

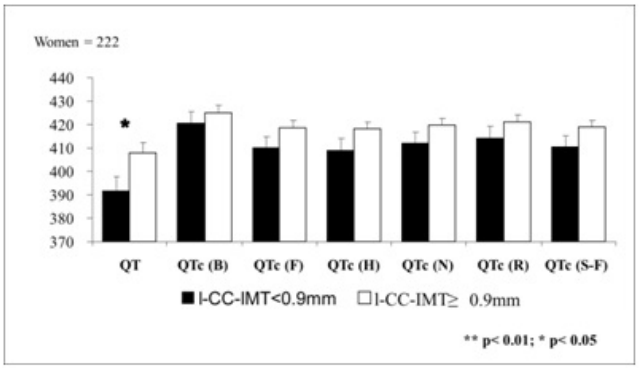

Figure 1b: QT and QTc variations depending on carotid IMT in women after adjustment for age, BMI, SBP, DBP, HDL-C, LDL-C.

l-CC: left-Common Carotid artery; QTc (B): QTc-Bazett; QTc (F): QTc-Fridericia; QTc (H): QTc-Hodges; QTc (K): QTc-Nomogram-Karjalainen; QTc (R): QTc-Rautaharju; QTc (S-F): QTc-Sagie-Framingham

Differently from Strohmer et al., [9], in the present study the two genders were more uniformly represented. In addition, we analyzed separately both right and left CC-IMT and ICA-IMT, not only the mean value of the two [9]. Finally, for the assessment of cardiac repolarization we used six correction formulae, not five.

Taken together, all of these findings indicate that the relationship between QT or QTc intervals and carotid IMT may differ between genders. The present findings, appear thus to indicate a different association between altered QT or QTc and specific arterial segments [9]. Previous data from our group indicated that the carotid IMT is best correlated to coronary IMT, as assessed by intravascular ultrasound [5]. In a recent large European study, Baldassarre et al., [20] evaluated the performance of several carotid IMT markers as predictors of cardiovascular events. They observed that CC-IMT is a better predictor of coronary events vs. ICA-IMT. In contrast, in the same study ICA-IMT was better correlated to combined or cerebrovascular events. In an earlier study by O'Leary et al., [21], on the other hand, there was the indication that, compared to CC-IMT, ICA-IMT may be a better predictor of cardiovascular but not of cerebrovascular events.

A review of several epidemiological studies has recently shown that in all eight studies reviewed CC-IMT by itself or combined with the ICA-IMT, was an independent predictor of cardiovascular events [22]. More recently Polak et al., [23] showed both CC-IMT and ICA-IMT are independent predictors of cardiovascular outcomes.

Conclusion

QT intervals, that reflect total duration of ventricular myocardial depolarization and repolarization, are associated with carotid IMT,

	Total (n=405)					
	r-CC*gender	l-CC*-gender	CC_m*-gender	r-ICA*-gender	l-ICA*-gender	ICA_m*-gender
	F	F	F	F	F	F
QT	1.042	5.872*	3.915*	0.218	2.559	1.972
QTc (B)	0.077	0.558	0.051	0	3.41	1.406
QTc (F)	0.483	0.457	0.669	0.058	4.278*	2.292
QTc (H)	0.524	1.238	1.196	0.111	3.823	2.224
QTc (K)	0.403	0.418	0.597	0.091	4.686*	2.518
QTc (R)	0.219	0.066	0.215	0.062	4.154*	2.154
QTc (S-F)	0.355	0.218	0.411	0.067	5.072*	2.65

Table 4: Interactions between QT or QTc, CA-IMT and gender.
CC_m/ICA_m (mean Common Carotid Artery/ Mean Internal Carotid Artery); l-CC/l-ICA (left Common Carotid Artery/left Internal Carotid Artery); QTc (B): QTc-Bazett; QTc (F): QTc-Fridericia; QTc (H): QTc-Hodges; QTc (K): QTc-Nomogram-Karjalainen; QTc (R): QTc-Rautaharju; QTc (S-F): QTc-Sagie-Framingham; r-CC/r-ICA (right Common Carotid Artery/right Internal Carotid Artery). Analyses were adjusted for age, BMI, HDL-C, LDL-C, SBP and DBP. Covariance analyses were used to evaluate interactions between QT, QTc, carotid IMT and gender. P-value. *= P<0.05: **= P<0.01

thus confirming that also these variables are markers of subclinical atherosclerosis. The fact that QT intervals correlate better with common carotid IMT in women and with internal carotid arteries IMT in men suggest that gender-specific differences exist regarding carotid segment involvement. Whether these differences imply also differences in the capacity of QT intervals to predict vascular events in men and in women remains to be determined.

Appendix

Log equations

[RR interval (s) = 60/HR]
Bazett [QTc (B) = QT/RR interval $^1/_2$]
Fridericia [QTc (F) = QT/RR interval $^1/_3$]

Linear equations

Hodges [QTc (H) = QT + 1.75(HR-60)]
Sagie-Framingham [QTc (S-F) = QT + 154 (1-60/HR)]

Other equations

Rautaharju QT(R) = QT+ [410-656/ (1+HR/100)]
Nomogram-Karjalainen QTc (N) = QT+ Nomogram correction factor

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