QT Interval Disturbances in Hospitalized Elderly Patients

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ABSTRACT: **Background:** The QT interval reflects the total duration of ventricular myocardial repolarization. Its prolongation is associated with increased risk of polymorphic ventricular tachycardia, or torsade de pointes, which can be fatal.

Objectives: To assess the prevalence of both prolonged and short QT interval in patients admitted to an acute geriatric ward.

Methods: This retrospective study included the records over 6 months of all patients hospitalized in an acute geriatric ward. Excluded were patients with pacemaker, bundle branch block and slow or rapid atrial fibrillation. The standard 12 lead electrocardiogram of each patient was used for the QT interval evaluation.

Results: We screened the files of 422 patients. QTc prolongation based on the mean of 12 ECG leads was detected in 115 patients (27%). Based on lead L2 only, QTc was prolonged in 136 (32%). Associated factors with QT prolongation were congestive heart failure and use of hypnotics. Short QT was found in 30 patients (7.1%) in lead L2 and in 19 (4.5%) by the mean 12 leads. Short QT was related to a higher heart rate, chronic atrial fibrillation and schizophrenia.

Conclusions: Our study detected QT segment disturbances in a considerable number of elderly patients admitted acutely to hospital. Further studies should confirm these results and clinicians should consider a close QT interval follow-up in predisposed patients. *IMAJ* 2009; 11: 147–150

KEY WORDS: Q-T interval, hospitalized elderly

The QT interval reflects the total duration of ventricular myocardial repolarization. QT prolongation is associated with polymorphic ventricular tachycardia and "torsade de pointes," which can be fatal [1]. The afore-mentioned term was coined in 1966 to describe the peculiar appearance of a ventricular tachycardia occurring in an elderly woman with heart block [2]. The QT interval duration exhibits a certain degree of variability between the leads on the electrocardiograph chart which may reflect heterogeneity in the recovery of repolarization [3]. Beat-to-beat QT interval variability is also a measure of repolarization liability and a predictor of sudden death [4]. Although torsade de pointes may occur in several settings, it is most often seen in association with drug therapy [5,6]; about 1% of patients on anti-arrhythmic medication develop torsade de pointes [5]. In the past decade, the most common cause of the withdrawal or restriction of drugs has been the prolongation of the QT interval associated with torsade de pointes [5].

Other known risk factors for prolonged QT are female gender, bradycardia, hypokalemia, diabetes, congestive heart failure, left ventricular hypertrophy and hypertension [7]. A positive correlation was detected between QT prolongation and mortality in patients with CHF, hypertension and LVH [8].

With ageing, there is a progressive prolongation of the QT interval, which is associated with a concomitant increase in mortality [9-11]. Polypharmacy, including drugs potentially causing torsade de pointes, is not rare in the elderly [12]. Therefore, detection of QT prolongation is of particular importance in this age group.

The short QT syndrome, characterized by a short refractory period, is a risk factor for atrial fibrillation, ventricular arrhythmias and sudden death [13]. Genetic factors are associated with both prolonged and short QT syndromes. [14]. In this study we set out to assess the prevalence of both prolonged and short QT in patients admitted to an acute geriatric ward and to identify conditions associated with these ECG disturbances.

PATIENTS AND METHODS

This is a retrospective study of patients hospitalized in one of the acute geriatric wards of Shmuel Harofe Hospital, comprising 36 beds. The hospital is a geriatric medical center affiliated to the Sackler Faculty of Medicine, Tel Aviv University. The files of all acute care patients hospitalized between January and July 2004 were evaluated, and relevant demographic, clinical, drug use and laboratory data were recorded. Since the presence of a cardiac pacemaker may interfere with the QT interval [15], patients with pacemaker and with bundle branch block were excluded. Also excluded were patients with extreme atrial fibrillation – i.e., rapid (> 120) or slow (< 50).

In order to avoid eventual transient ECG abnormalities due to any acute condition related to the cause of admission, the

Figure 1. ECG strips showing **[A]** prolonged QTc and **[B]** short QT

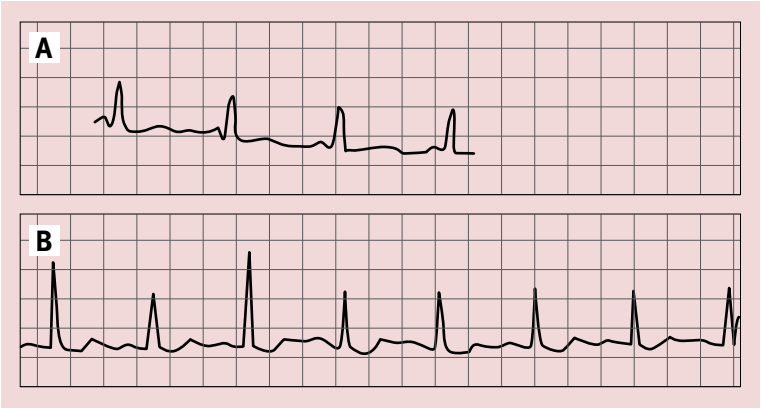

Table 1. Clinical data of 422 patients in study of QT prolongation

Diseases	Number	%
Hypertension	258	61
Dementia	178	42
Anemia	156	37
Ischemic heart disease	148	35
Diabetes mellitus	138	32
S/P stroke	107	25
Chronic obstructive pulmonary disease	92	21
Chronic renal failure	92	21
Chronic heart failure	91	21
Chronic atrial fibrillation	48	11
Medications		
Beta-blockers	127	30
Benzodiazepines	105	25
Antidepressants	69	15
Hypnotics	33	8
Anti-arrythmics	28	6
Digoxin	23	5.5
Anticholinergics	21	5
Neuroleptics	11	2. 2.6

last of the series of standard 12 lead ECGs in the patient's file was used for the QT interval evaluation. All measurements were performed by the same physician. The RR and QT intervals were measured by a graduated lens. The QT interval was measured from the beginning of the QRS complex to the end of the down slope of the T wave. The QT interval corrected for the previous cardiac cycle length was calculated according to the Bazzet formula: $QTc = QT/RR^{1/2}$ [16]. Prolonged QTc was considered as QTc > 0.47 seconds for women and QTc > 0.45 for men [9]. For statistical evaluation, borderline values – QTc 0.45–0.47 in women and 0.43–0.45 in men – were considered as normal values. Patients with short QT intervals (QT or QTc < 0.3 seconds) [14] were evaluated as a separate group. Representative examples of prolonged and short QT are shown in Figure 1.

A calculation of the mean QT was done in each lead, using the mean of two consecutive complexes. Two methods of measurement were performed for the evaluation of QTc: the mean QTc in 12 leads [9] and the QT of lead L2 [17]. The study/data analysis protocol was approved by the hospital's ethics committee.

STATISTICAL ANALYSIS

SPSS software was used for statistical processing. Descriptive analysis included frequencies and distributions of all study variables. Student *t*-test, chi-square or Fisher's exact test were performed comparing those with QTc prolongation to those with normal or borderline QTc. Pearson correlation test and multivariate analysis by logistic regression were performed to test the association of age, gender, co-morbidity, drugs and laboratory data with the mean QTc intervals.

RESULTS

The study group comprised 422 consecutive patients. Most patients (46%) were admitted because of infectious diseases (pneumonia and urinary tract infections), 15% after a stroke, 14% due to falls, 5% due to ischemic heart disease, 5% due to congestive heart failure, and 15% for other reasons. Relevant clinical data of patients are presented in Table 1. The incidence of QTc prolongation was higher in men [Table 2]. Prolongation of QTc was detected in 115 patients (27%) based on the mean of 12 ECG leads and in 136 patients (32%) based on lead L2 [Table 2].

`The in-hospital death rate was 6% (26 of 422) during the study period. The incidence of prolonged QTc among those who died was significantly higher: 9.6% versus 4.6% in the survivors, $P < 0.05$, based on lead L2, and with borderline significance for the mean of 12 leads.

We found that a higher heart rate was positively related to the QTc interval. (QT intervals, as expected, were negatively correlated to the pulse rate). The clinical parameters related to QTc prolongation were IHD and CHF.

The use of neuroleptics and hypnotics other than benzodiazepines were more frequent in those with prolonged QTc. The use of other drugs that can prolong QT interval, such as anti-arrythmics and antidepressants (used by 6% and 15% of patients respectively), was not related to QT prolongation in our study. The use of digoxin was lower in the group of

QTc = cardiac cycle length

IHD = ischemic heart disease

patients with prolonged QTc.

Among the relevant laboratory parameters, only low magnesium was related to prolonged QTc interval. Age was not related to QTc prolongation. Using multivariate logistic regression analysis, the main factors associated with prolonged QTc were CHF and use of hypnotics.

Short QT was found in 30 patients (7.1%) according to lead L2 measurements and in 19 (4.5%) with a mean of 12 leads. Mortality in these patients was 10%, not significant as compared to those with normal QT. The presence of short QT was related to a higher heart rate, chronic atrial fibrillation, schizophrenia, the use of digoxin and anticholinergics ($P < 0.05$ for all). This was shown by univariate and multivariate logistic regression analysis, measured in L2 and a mean of 12 leads. We also evaluated the incidence of short QTc (< 0.3 msec) as the corrected short QT, and found only four cases with this definition.

Table 2. Factors related to prolonged QTc in geriatric inpatients

	Mean 12 leads		Lead L2	
	Normal/Borderline	Prolonged	Normal/Borderline	Prolonged
N (%)	304 (73%)	115 (27%)	285 (68%)	136 (32%)
QTc (mean ± SD)	0.423 ± 0.027	0.493 ± 0.031	0.424 ± 0.028	0.494 ± 0.035
QTc (range)	0.270–0.470	0.451–0.658	0.270–0.490	0.451–0.670
Female (n=279)	212 (76%)	67 (24%)	195 (69%)	86 (31%)
Male (n=140), no. (%)	92 (66%)	48 (34%) †	90 (64%)	50 (36%)
Age (yrs)	81 ± 7.8	82 ± 9	80 ± 8	82.2 ± 8.6
Died	15 (5%)	11 (9.6%)	13 (4.6%)	13 (9.6%) *
Heart rate	77 ± 17	86 ± 22 *	81 ± 8	85 ± 21 *
Diseases				
IHD	107 (35%)	49 (43%)	96 (34%)	60 (44%) *
CHF	59 (19%)	31 (27%) **	50 (18%)	40 (29%) *
Medications				
Digoxin	21 (7%)	2 (1.7%) *	20 (7%)	3 (2.2%) **
Hypnotics	16 (5.3%)	16 (14%) *	17 (6%)	16 (11.8%) *
Neuroleptics	5 (1.6%)	6 (5.2%) **	6 (2.1%)	5 (3.7%)

Only factors that were found statistically relevant to QT prolongation are presented in the table.
* $P < 0.05$, ** $P < 0.05$, one-tail, * $P < 0.05$, comparing the incidence of prolonged QTc in females vs. males

DISCUSSION

This study showed a high incidence of prolonged QTc in elderly patients admitted to an acute geriatric ward. It was detected in 27% of the patients, based on a mean of 12 ECG leads, while 32% had prolonged QTc based on lead L2. A short QT interval was rare but still found in 7.1% of patients based on lead L2. Overall, 39% of these elderly hospitalized patients had QT interval disturbances.

The presence of CHF, IHD and the use of hypnotics correlated with QT prolongation. Previous studies found that QT prolongation was related to age, hypertension, CHF and diabetes. Likewise, multiple drugs and electrolyte disturbances have been related to QT prolongation [9-11]. Interestingly, previous studies reported that digoxin has a dual effect on the QT interval with both prolongation and shortening [18]. We found only the shortening effect of digoxin.

In this study we found that the short QT interval correlated to a higher pulse rate, schizophrenia, chronic atrial fibrillation, and the use of digoxin and anticholinergics. In the literature, risk factors for short QT are a genetic predisposition, hypercalcemia and hyperkalemia.

There are several limitations in our study. We included patients with atrial fibrillation although QT measurement may be inaccurate in this situation. Nonetheless, some previous studies also included such patients [19]. Patients with extreme (rapid or slow) atrial fibrillation were also excluded in our study. QT interval may be affected in patients with acute stroke; however, we measured the last ECG performed during hospitalization, which was much later than the acute event, usually 2–3 weeks.

Furthermore, the fact that this is a retrospective study may be a limitation. On the other hand, to the best of our knowledge, this is the first study to report the prevalence of short QT among elderly acutely hospitalized patients. Naturally, the question arises of a possible contribution of prolonged QT-induced ventricular tachcardia as a cause of death. Although we found a correlation between mortality and prolonged QTc, since this was a retrospective study this question could not be addressed.

In conclusion, our study revealed that QT interval disturbances, mainly prolongation, are a common finding in acute geriatric ward patients. These findings warrant confirmation by prospective studies in larger populations of acute elderly patients. In the meantime, more attention should be paid to this threatening condition in hospitalized elderly with significant co-morbidity and multiple medications. Their QT interval should be periodically recorded and closely watched like other vital signs.

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