Measurement of QT Interval and Duration of the QRS Complex at Different ECG Sampling Rates

Abstract

- QT interval is a marker for malignant ventricular arrhythmias.
- QT interval must be corrected to become independent of heart rate (HR) using two different techniques: Bazzett and individualized.
- The ECG recordings were originally sampled at 500 Hz, and then were down-sampled by intervals of 25 Hz until the minimum sampling rate of 75 Hz.
- The QRS complex duration, RR and QT intervals for each subject, condition and sampling rate were measured.
- The effect of the sampling rate was modeled with an exponential decay function.

Introduction

- Precise measurement of QT and RR interval and QRS complex is highly important because it indicates different cardiac abnormalities.
- The goal of QT interval correction is to convert each measured interval to a standard value, independent of HR.
- In studies with drugs which modify QT interval, a bad correction method may induce erroneous conclusions about the effect of drugs.
- The QT interval was measured when autonomic nervous system (ANS) has been blocked with a combination of drugs and postural changes.
- An incorrect choice of the sampling rate (Fs) may introduce errors when the fiducial points of the ECG are measured, and therefore the intervals or segments between these points.

Methods

Bazzett:

\[ QTc[i] = \frac{QT[i]}{\sqrt{RR[i]}} \]

Individual algorithm

\[ Y(F_s) = y_0 + a \cdot e^{-F_s/\tau} \]

Experimental Protocol

Database:

- 52 ECG recordings
- 7 min/recording
- 360 Hz Sampling Rate
- 8 bit vertical resolution
- 5 min/recording

Experimental Protocol

Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Control</th>
<th>Atropine</th>
<th>Propranolol</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td>RRMSu</td>
<td>878.9±112</td>
<td>604.4±139.2†</td>
<td>1038.7±144.8*</td>
<td>655.4±62.7†</td>
</tr>
<tr>
<td>RRMSSt</td>
<td>738.8±96.3</td>
<td>502.4±56.9‡</td>
<td>912.2±88.1†</td>
<td>645.3±50.1*</td>
</tr>
<tr>
<td>RRSPSu</td>
<td>76.3±28.1</td>
<td>19±26.2‡</td>
<td>84.2±55.2</td>
<td>11.5±7.7‡</td>
</tr>
<tr>
<td>RRSPSt</td>
<td>72.4±37.9</td>
<td>15.3±9.1‡</td>
<td>67.2±54.3</td>
<td>11.8±4.2*</td>
</tr>
</tbody>
</table>

* (P < 0.05); † (P < 0.005); ‡ (P < 0.0005)

Conclusions

The present study used a database where a wide variation range of RR and QT intervals were obtained using combinations of pharmacological and postural procedures. The recordings in this database allowed the analysis of RR and QT intervals in a full range of physiological situations, therefore it was possible to appreciate the effect of two QT interval correction methods. Finally, it was verified that sampling rate affects the measurements of QT interval and duration of QRS complex, in both cases these variables were overestimated at ECG sampling rates below 300 Hz.