Individual Heart Rate Correction for QTi in Telemetric Recordings of Electrocardiograms (ECG)

Abstract

The QT interval (QTi) on the ECG is the interval from the beginning of the QRS complex to the end of the T wave. It is used as an indirect measure of the duration of the ventricular-action potential including ventricular repolarization which occurs by outward movement of potassium through specific channels in myocardial cell membranes.

Drug-induced prolongation of ventricular repolarization, and consequently QT prolongation, can cause arrhythmias, the most characteristic of which is the polymorphic ventricular tachycardia called torsade de pointes (twisting of the points), the name describing the characteristic "twisting" of the electrical axis on the ECG. While this is usually a self-limiting arrhythmia which causes dizziness or syncope, it may lead to ventricular fibrillation and sudden death.

As it is well known that the heart rate (HR) plays a major role among factors influencing QTi, it is necessary to evaluate QTi data in the context of the respective HR or the corresponding RR interval (RRi). The large number of QT correction formulae proposed in the literature (Bazett, Fridericia etc.) usually do not eliminate the correlation between QTi and RRi.

Because the relationship between the QTi and RRi data points is best-fitted by curves having approximately hyperparabolic shape, an appropriate approach is to use functions of that type to create a suitable individual or population data-based correction on non-drug data from the particular study. With this data-based correction, the correlation between QTi and RRi can be eliminated and the resulting corrected QT interval values [QTc (individual)] can be evaluated independently from RRi.

These QTc (individual) interval values are based on the best-fitted curve to QT and RR interval data points which can be searched among formulae with three parameters (α, β, γ) and the generic form:

\[ QTi = \alpha + \beta \phi(\text{RRi}^\gamma) \]

where \( \phi \) is a logarithmic, a negative exponential, an inverse tangent, a hyperbolic tangent, an inverse hyperbolic sine or a linear function.

The best fitted curve can be used as baseline relationship and - with the assumption that the non-drug values cover the whole RRi range of interest - the deviations from the baseline relationship can be used independently from RRi for statistical evaluations, e.g. repeated measurements analyses.