Transfer Entropy between RR and QT Intervals in Long QT Syndrome

Jiyeong Kim, Matias Kanniainen, Ilya Potapov, Esa Räsänen

Computational Physics Laboratory, Tampere University
Tampere, Finland

Aim: Recent studies have shown that healthy subjects exhibit strong information transfer from RR to QT intervals, especially when increasing the RR history. Our aim is to assess the dynamic coupling between RR and QT intervals for subjects with long QT syndrome (LQTS) - a potentially fatal genetic cardiac disease characterized by delayed myocardial repolarization.

Methods: We use the concept of transfer entropy (TE) to quantify the magnitude and direction of the information exchange between the RR and QT interval series in a coupled process. Using 24-hour Holter ECGs, we calculated TE as a function of RR and QT histories up to 50 beats and compared the results between healthy controls and subjects of three LQTS types.

Results: The healthy and LQTS subjects showed the asymmetry between TE from RR to QT ($TE_{RR\to QT}$) and from QT to RR ($TE_{QT\to RR}$), in which the former dominated. Compared to the healthy, the LQTS subjects had significantly smaller $TE_{RR\to QT}$ at RR history lengths longer than $\sim$18 beats, while $TE_{QT\to RR}$ was significantly larger at all RR and QT history lengths ($p<0.05$). The average characteristic RR history length to maximize $TE_{RR\to QT}$ was $\sim$27 beats for the healthy subjects, which was significantly longer than those for LQTS types 1 and 2 ($p<0.01$). Aging had no significant effect on $TE_{RR\to QT}$, but reduced $TE_{QT\to RR}$ for the LQTS subjects, whereas the gender and beta blocker were found to have relatively small effects on the TE.

Conclusion: The dynamic coupling between RR and QT intervals is altered by LQTS. Compared to the healthy subjects, the amount of information in the RR intervals explaining the QT variability is significantly reduced for the LQTS subjects and further decreases with longer history. In contrast, for LQTS subjects the QT series exhibits stronger influence on RR intervals than for healthy subjects.