Alternans and 2-D Spiral Wave Dynamics in Human Atria with Short QT Syndrome Variant 3: A Simulation Study

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Aims: The short QT syndrome is a genetic disease of heart which leads to an increased risk of heart arrhythmias and sudden cardiac death. Cardiac alternans and high-frequency spiral waves are believed to be strongly associated with heart arrhythmias. This study aims to use computational modelling to investigate the underlying mechanism of heart arrhythmias in human atria with short QT syndrome.

Methods: The Colman-Zhang human atria cell model was implemented for simulation. The alternans were observed in single cell modelling and the spiral wave dynamics were studied in 2D tissue simulation.

Results: For D172N mutation, alternans were found in the $[Ca^{2+}]_i$ trace from BCL of 250 ms to BCL of 300 ms. No alternans was observed in E299V mutation condition while the onset BCL of wide type was 410 ms. The life-span of spiral wave in 2D tissue was prolonged in D172N mutation condition. As for E299V, the life-span of the homozygous mutation was shortened and that of heterozygous mutation was prolonged. The minimal spatial length of S2 to initiate the re-entry decreased in all mutation type.

Conclusion: Gene mutations in SQT3 abbreviate the APD and lead to a decreased observation of alternation phenomenon. The temporal and spatial vulnerability to re-entry increased in mutation conditions.