Respiratory Modulation in Permanent Atrial Fibrillation

Mostafa Abdollahpur, Fredrik Holmqvist, Pyotr G.Platonov, Frida Sandberg

Lund University
Lund, Sweden

Aim: Several studies have shown that the autonomic nervous system (ANS) can induce changes during atrial fibrillation (AF), but the individual variation is large. Individual differences in ANS induced variations may be linked to the progression of arrhythmia which may have implications for the treatment strategy. However, there is currently a lack of methods for quantifying ANS induced variations during AF. In this study, we propose a novel approach to quantify respiratory induced modulation in the f-wave frequency trend.

Method: Following qrst-cancellation, the local f-wave frequency is estimated by fitting a harmonic f-wave model signal and a quality index (SQI) is computed based on the model fit. The resulting frequency trend is filtered using a narrow-band fourth-order butterworth filter with a center frequency corresponding to the local respiration rate. The magnitude of the respiratory induced f-wave frequency modulation is estimated by the envelope of the filtered frequency trend. The performance of the method is validated using simulations and the method is applied to analyze ECG data from eight patients with permanent AF recorded during 0.125 Hz frequency controlled respiration before and after the full vagal blockade, respectively.

Result: Results from simulated data show the magnitude of the respiratory induced f-wave frequency modulation can be estimated with an error of less than 0.005 Hz if the SQI is above 0.45. The signal quality was sufficient for analysis (SQI > 0.45) in 7 out of 8 patients. For these patients, the magnitude of the respiratory frequency modulation during controlled respiration was 0.15 ± 0.01 Hz before full vagal blockade. The magnitude decreased $8.5 \pm 9.6\%$ after full vagal blockade; in 4 patients the magnitude decreased (> 0.005Hz) and in 3 patients there was no change ($< \pm 0.005$Hz).

Conclusion: Respiratory modulation in the f-wave frequency trend partly may be attributed to vagal regulation.