Electrocardiographic signal broadband properties

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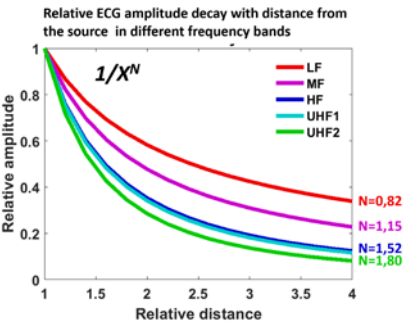
Background: Low, high, and ultra-high-frequency ECG measure ventricular activation in different ways. However, its principle and properties have not yet been studied systematically.

Method: 5 kHz ECG resting recordings were acquired in 134 subjects. We used an extended 12-lead ECG setup with 6+7 precordial leads. With the magnetic resonance images, we measured the distance of all precordial leads to the ventricular geometrical center. For each lead, we determined the amplitude of frequency components by computing the area of the averaged amplitude envelopes during the QRS complex. We used five frequency bands: LF (0.2-20 Hz), MF (20-80 Hz), HF (80-300 Hz), UHF1 (300-500 Hz), and UHF2 (800-1000 Hz).



Results: The results provide the relative amplitude decrease in selected frequency bands with relative distance from the myocardial depolarization source - Figure. The decay coefficient in the LF band is more than two times lower than the UHF2 band coefficient. All differences between frequencies are significant $p<0.005$.

Conclusion: The results show ECG signal decay properties in the frequency spectrum. It opens possibilities for a more accurate description of activation patterns. Lower frequencies can see distant areas and higher near areas. Combining multiple frequency bands (broadband ECG) has the potential to localize activation sources more precisely.