BEATS: An Interactive Research Oriented ECG Marker System

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We have developed BEATS (Beat Editing And T-wave marker Software) using MATLAB. The purpose of BEATS is to detect QRS complexes and interactively mark features of the ECG at different heart rates. BEATS will accept 8-channel ASCII data ECG recordings (leads I, II, V1-V6) of any length. A corresponding Vector Cardiogram (VCG) is computed from the ASCII data by matrix multiplication. Beats are detected from the spatial velocity by means of a user-adjustable threshold. Noise can be rejected, missed beats can be inserted and incorrectly detected fiducial points can be adjusted. The VCG is displayed using X, Y and Z leads. Also, spatial velocity, vector magnitude and the first derivative thereof can be displayed. Since recordings can show a wide range of heart rates, initial guesses for a number of markers are made: the user has to mark at least 5 isoelectric points (IEP) at different heart rates. The intervals between these markers and their corresponding fiducial points are used to calculate, by interpolation, all IEPs in the recording. These IEPs are used as anchor points for a linear baseline correction. The user then marks onset and end of the QRS complex and the T apex at different heart rates to globally calculate these values for each beat. Each individual T apex is calculated by a 2nd degree polynomial fit, T end is calculated as the intersection of the tangent to the steepest slope and the isoelectric line. Any outliers in heart rate, QT interval and all other markers are flagged to facilitate easy checking and editing. BEATS generates files with all estimated and calculated markers with respect to their fiducial points and the baseline corrected ECG. After a one-time carefully processing of the recordings, other programs can run unattended to extract features like T-Wave alternans in exercise tests.