Background: Early repolarization (ER)—a common electrocardiographic finding defined by J-point elevation greater than 0.1 mV in at least 2 leads with slurring or notching morphology—was considered benign until it has been recently associated with idiopathic ventricular fibrillation and sudden cardiac arrest. To investigate whether ER is an independent electrocardiogram (ECG) signature, we aimed to examine whether ER patterns are associated with other measurements derived from the conventional computerized ECG analysis.

Methods: Twelve-lead resting ECGs of 889 men and women aged 35 to 74 years—from the population-based MONICA/KORA studies S1 and S2—were manually analyzed by 2 cardiologists for the presence of ER. The computerized ECG measurements (time intervals, amplitudes, axis) of the ER positive group (n = 192) were compared with those of the ER negative group (n = 697).

Results: Several ECG variables were associated with the presence of ER. The best discriminating computerized measurements for the entire study group were R durations in the leads II, aVR, V5 and V6, S duration in lead V6, R′ duration in lead aVR, R amplitude in lead aVR, S amplitude in lead V6, and QRS area in lead aVR ($P < .001$ for all analyses). Interestingly, some measures derived from lead aVR, which was not considered for visual analysis, showed highly discriminating power between the ER-positive and the ER-negative group. In addition, the ECG variables associated with the presence of ER differed between men and women, although identical ER criteria were used. Of the 176 quantitatively assessed ECG parameters, significant differences between ER-positive and ER-negative subjects were observed for 66 parameters in men and only 33 parameters in women, respectively ($P < .05$).

Conclusion: Early repolarization is to a major extent associated with ECG characteristics beyond the changes at the ST-T junction in specific leads. This result supports the hypothesis that ER is caused by a general transmural heterogeneity that affects many ECG parameters, however, to a certain extent with differences between men and women.

doi:10.1016/j.jelectrocard.2010.12.084

P5

Performance improvement of a phase space detection algorithm for electrocardiogram wave morphology classification

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An algorithm based on embedding phase space signal was developed by the authors in previous works. The algorithm detects the characteristic points of the waves of a multilead electroacardiogram (ECG). In the present work, the parameters of this algorithm are optimized to improve its performance. The algorithm uses 2 configurable parameters to obtain the phase space—the dimension of the phase space and the delay—and a threshold to select the points of the ECG. By a proper selection of these parameters, the algorithm obtains all the points in the ECG that are similar to a reference one that was selected by the analyst. Several strategies have been developed and incorporated in the phase space algorithm to obtain the optimal values of these parameters based on the sampling rate and the number of leads in the records. The professional only needs to mark the reference point and the associated wave to it, for example, the start and end of a P wave and its peak. The algorithm obtains every P wave of the ECG record and a classification of their morphology using clustering techniques. Moreover, a simple graphical interface has been developed to ease its use.

The algorithm was applied to detect the start, peak, and end of the P waves of a collection of ECG records of 6 minutes. Using this information, the algorithm extracts and classifies the P waves by applying clustering techniques to study their variability. The algorithm can also be used online to detect and classify different types of morphologies in any ECG wave. A future use of this algorithm will be the detection of several extracardiac pathologies in the ECG Holter, for example, sleep apnea.

doi:10.1016/j.jelectrocard.2010.12.085

P6

Descriptors for complex fractionated atrial electrograms: a comparison of three different descriptors

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Background: Catheter ablation of persistent atrial fibrillation (AF) is challenging. The underlying mechanisms are mostly unknown and discussed very controversially. Automated detection and signal analysis of complex fractionated atrial electrograms (CFAEs) is essential in supporting the physicians during the ablation procedure. To investigate the clinical value of descriptors for CFAEs, we calculate their value before and after pulmonary vein isolation (PVI). pPulmonary vein isolation effects the excitation propagation of AF. This should be detected by every descriptor. We calculated the dominant frequency (DF), the fractionation index (CFE-Idx), and the activity ratio (AR) before and after PVI.

Methods: (1) A common analysis technique of AF is DF analysis. It is an estimation of the atrial activation rates. (2) Ensite-NavX provides an algorithm that delivers a CFE-Idx based on the cycle length of distinguishable local activities in one electrogram. (3) A third method calculates atrial activity with a segmentation algorithm based on a nonlinear energy operator. Complex fractionated atrial electrograms are marked as active segments. The AR is then defined as the ratio between the length of active segments and the total length of the signal [2]. Dominant frequency, CFE-Idx, and AR were compared on data sets of 17 patients suffering from persistent AF. All patients were sent to hospital for catheter ablation. Electrograms of 5 seconds were recorded before and after PVI at customary 46 locations per patient in the left atrium. Nine patients terminated during ablation (A), whereas 8 patients did not terminate (B) and underwent an external cardioversion.

Results: The mean DF decreased from 5.7 ± 0.6 to 5.5 ± 0.3 Hz (A) and increased from 5.3 ± 0.5 to 5.5 ± 0.5 Hz (B). Mean CFE-Idx increased from 157 ± 68 to 223 ± 51 milliseconds (A) and from 222 ± 88 to 273 ± 72 milliseconds (B). Mean AR decreased from 0.65 ± 0.1 to 0.63 ± 0.04 (A) and increased from 0.69 ± 0.5 to 0.72 ± 0.1 (B).

Conclusion: More regular excitation should result in higher CFE-Idx and lower DF and AR. We found intergroup differences and could show the influence of PVI on the excitation during AF. The fractionation index of CFE has shown the most distinct results in differentiation of the 2 states of PVI (before/after) and also in differentiation of group A to B. Nevertheless, AR and DF are promising alternatives. Removal of outliers will increase performance of AR and DF.

doi:10.1016/j.jelectrocard.2010.12.086

P7

Sleep staging and apnea detection from single-lead electrocardiogram

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Background: The aim of this study was to investigate the feasibility of using only a single-lead electrocardiogram (ECG) instead of a polysomnography system to determine a person's sleep stage (SS) and the existence of obstructive sleep apnea (OSA) in each 30-second epoch for the whole night.

Methods: The ECG data (lead II, 200-Hz sampling rate) obtained during night sleep (mean duration, 7 hours) from 6 male and 12 female subjects (a total of approximately 15 000 epochs). Of 18 subjects, 10 were diagnosed with OSA syndrome (mean age, 51.2 years; range, 41-67 years), and 8 were healthy (mean age, 27.6; range, 26-34 years). The sleep staging and OSA existence were previously determined by the experts using polysomnography system in sleep laboratory. This work consisted of 4 parts: manual selection of epochs with clean ECG signals, RR-interval computation, feature extraction, and classification studies. For RR-interval computation, an R-peak search algorithm was used. The features selected were the median value, difference between 75 and 25 percentile values, and mean absolute