Estimation of the PVC Origin from Simulations Using Cellular Automaton

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It has been shown that simulating heart activation using a cellular automaton is an effective method for studying ventricular electrophysiology. We examined the possibility of such an approach to mimic the spontaneous premature ventricular contractions (PVCs).

We used ten patient-specific heart and torso models from the CT scan and started the ventricular activity from the several points inside the volume of the myocardium deployed in a 10 mm grid. The activation propagation was expressed as a multiple-dipole electrical generator, and the 12-leads ECG potentials were computed on the homogeneous torso model by the boundary element method. The simulated signals were compared with the signals measured in each patient during spontaneous PVCs by Pearson's correlation coefficient (PCC). The best mean PCC for all 12 leads for each patient was evaluated for five intervals within the QRS duration, increasing the length from the first 20% by the next 20% in the next time interval. The distance between the stimulation point with the best PCC and true ablation points was computed as the localization error (LE).

The number of stimulation points varied from 103 to 306 depending on the patient's heart model. The best mean PCC was between 0,99 and 0,66, and the LE ranged from 4,7 to 75,9 mm. The worst LEs were obtained when the first-shortest time interval was considered for evaluation (Figure 1), probably because this time interval had the smallest signal-to-noise ratio in the measured signal, 35 vs. 48 dB (Figure 2). For the last two intervals, the mean LE was 27,5 mm (4,7-45,4).

Despite the limitations of the simulations in a homogeneous heart and torso model, sparse positioning of the stimulation points, and simple activation propagation rules, the method allows the estimation of the PVC origin with accuracy comparable to that of the inverse methods.

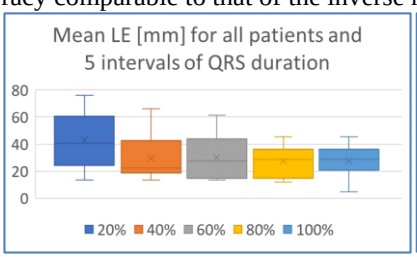

Figure 1

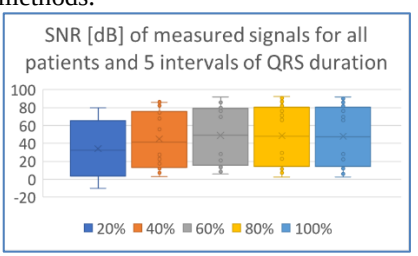

Figure 2