A new ECG-based method to guide catheter ablation of ventricular tachycardia

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INTRODUCTION Catheter ablation is used to treat ventricular tachycardia (VT). It uses radiofrequency energy to destroy a small part of heart tissue that is causing rapid and irregular heartbeats. Automated localization of VT exit sites can facilitate the long and often challenging ablation procedures but current methods are not accurate enough, cannot be used in some conditions, and often require detailed information about the patient's anatomy.

The aim of this study was to optimize the accuracy of a previously proposed computer-based method for localization of arrhythmia exit sites. The effectiveness of the method was tested using simulated ECG data. We looked for optimal settings of the method allowing to apply it in clinical conditions.

METHODS The proposed algorithm works on any set of 3 or more ECG leads. The QRS complex integral (QRSi) of an ectopic beat is reduced to principal components (PCs) treated as coordinates of the exit site in ECG space and then projected to real space by a linear transformation based on a small number of QRSis paced at known locations. The accuracy of the method was tested on 8 patient-tailored models of the human heart and torso. For each model ~500 simulations were run, each for a different stimulus location. A set of training points was randomly chosen and all other locations were then estimated from simulated surface ECGs. The absolute and relative (to a neighboring stimulation site) localization errors (in mm) were computed for a 252-lead ECG, and Frank VCG and using different numbers of training points and principal components.

RESULTS The localization error depended on the size of the training set. By using patient’s mean transform matrix of stimulus position from ECG space to real space and Frank XYZ leads we found 15.5 ± 6.4 mm of mean absolute error. Starting from 9 pacing positions available and 3 PCs used we reached a similar level of mean error (15.22 ± 3.5 mm). With 20 stimulus points available and 7 PCs we got 10 ± 2 mm of error. Added noise had no significant influence on the results; even a 2 dB signal/noise ratio increased the error by only 1 mm.

DISCUSSION This study suggests that the proposed method can predict exit sites with a precision in the order of a centimeter. By dynamically switching the settings of the algorithm it is possible to obtain better accuracy.