Display of Heart-Surface Potentials Derived from 12-lead Electrocardiograms

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We investigated whether the ischemic region due to occlusion of a coronary artery can be visualized on the bull's-eye display of the heart surface by using just ST measurements from the 12-lead ECG. Torso model with 352 body-surface and 202 heart-surface nodes was used. Coefficients for deriving 352 body-surface potentials from 8 independent potentials of 12-lead ECG were derived from Dalhousie Superset (n = 892) of 120-lead ECGs. The test set consisted of 120-lead ECGs acquired for 45 patients during ischemia induced by balloon-inflation angioplasty; three subgroups of equal size comprised patients whose LAD, LCx, and RCA were occluded, respectively. BSPMs at J point of each patient were reconstituted from the 12-lead ECG and similarity of original and reconstituted maps was assessed by a similarity coefficient SC (dot product of 352-dimensional vectors divided by the product of their lengths, in percent). We applied inverse-solution methodology (Tikhonov regularization with 2nd order regularizing operator) to calculate heart-surface potentials and visualize them on bull's-eye display. Reconstitution of known body-surface distributions from the 12-lead ECG achieved an overall SC 92.46 $\pm$ 6.95% (mean $\pm$ SD); SC for subgroups was: 89.79 $\pm$ 9.95% for LAD, 93.89 $\pm$ 2.86% for LCx, and 93.70 $\pm$ 5.77% for RCA group. All characteristic spatial features of maps were preserved. We calculated and displayed heart-surface potentials and found that the area of positive potentials on the heart surface corresponded, in general, with the underperfused territory caused by the occlusion of each specific vessel. For the LAD group 11/15 bull's-eye images indicated the correct territory; for the RCA and the LCx groups 10/15 and 12/15 images were correct (with incorrect classifications being RCA /LCx mix ups). Better-then-expected results can be attributed to the strongly dipolar character of distributions caused by injury current. Our approach shows promise for ischemia monitoring.