Allocation of Ischemic Myocardial Segments from 12-Lead ECG in Humans by Means of Equivalent Dipole

Vito Starc

University of Ljubljana, Faculty of Medicine,
Ljubljana, Slovenia

Aims: Recently, we have shown that the location and orientation of the ST segment's equivalent dipole (STED) change characteristically during the coronary artery occlusion. Here, we hypothesize that during acute myocardial ischemia, the STEDs are orienting to point at the myocardial segment with the blood supply of the affected coronary artery, allocating thus the site of occlusion.

Methods: To determine STED trajectories from the 12-lead ECG, we solved the inverse problem utilizing a BEM method with an adaptable human torso model (Starc, CINC 2022). STED locations and orientations were expressed within the heart's local coordinate system, according to the published mean heart orientation. We used a 12-segment LV subdivision with three regions (1: apical, 2: middle, 3: basal) and four quadrants (1: anteroseptal, 2: anterosuperior, 3: lateral, 4: inferior). The myocardial segment number (MSN) was provided as MSN = (quadrant-1)*3+region. We considered that LAD supplies segments 1-5 and 10, LCA 6 - 9, and RCA 11-12, respectively.

We tested the hypothesis using the STAFF database with 103 patients undergoing elective coronary artery occlusion (RCA, LCX, and LDA). We identified parts of the ECG signal with signs of occlusion (e.g., ST-segment elevation) and extracted 20 s long signal specimens (after 1, 3, and 5 minutes of the occlusion).

Results and Discussion: We extracted 382 signal specimens of ECG signals to determine ST segment ED trajectories, including those with a minimal ST segment change during occlusion. The allocation of the corresponding myocardial segments was reasonable in LAD (in 94% of 144 specimens) and LCX (in 84% of 92 specimens) and deficient in RCA (in 42% of 146 specimens), primarily due to the overlap in segment 8. Since the missed allocations belonged only to the neighboring segments, a more appropriate blood supply distribution area could be found by a fine adjustment of the segment borders.