Equivalent Dipole Trajectories Assessed From the 12-Lead ECG Using an Adaptable Human Torso Model

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Aims: We present an application that utilizes a BEM method to calculate potentials on the surface of an adaptable quasi-realistic human torso model, which enables the determination of equivalent dipoles (ED) from the measured body potentials (the inverse model). We explored whether the application could provide reliable ED trajectories from the 12-lead ECGs.

Methods: A patient-specific torso was defined with a framework of 192 rounded isosceles trapezoids, of which shape varied along the torso axis as a function of anthropometric parameters (the torso height, width, and depth at the level of the shoulders, waist, and the hip). The parameters were obtained from the torso surface data (Fig1A). We calculated ED trajectories from each recording with the reduced set of the 12-lead ECG (6 precordial and 3 augmented limb leads) and with the complete set of 120 leads (BSPM) to assess differences in the trajectory shape, the length, and the position in space. The first one was represented by cos(alpha) as the mean instantaneous angle between the two trajectory directions, the second one as the relative length of the 12-lead trajectory for BSPM, and the third one as the offset between the trajectories. For the perfect congruence of the trajectories, cos(alpha) should approach 1, the relative size 1, and the offset zero.

Results and Discussion: We found a considerable level of resemblance between the trajectory shape and size as both the congruence parameter cos(alpha) and the relative trajectory length approached the value of one, 0.87±0.13, and 0.93±0.19 (mean±SD), respectively (Fig1B). The trajectory offset was considerable, 1.74±0.75 cm, compared to the BSPM trajectory length (6.08±1.00). Further research in ECGs with various pathology is needed to investigate the possible applicability of this analysis in future ECG diagnostic algorithms.

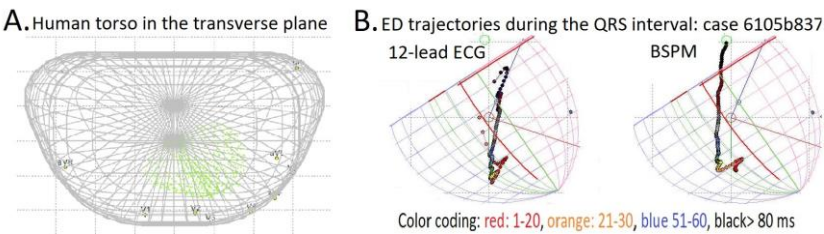

Figure 1. A. The model torso with rounded isosceles trapezoids. B. ED trajectories in the frontal plane with the biventricular heart model