# Exploring Ventricular Repolarization Gradients in Normal Cases using the Equivalent Dipole Layer

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***Introduction:*** The electrical activity underlying the T-wave is less well understood compared to the QRS complex, as it is generated by small local electrical gradients and the simultaneous electrical activity for more than 200-300 ms. In this study we aim to investigate the relationship between T-wave morphology and the underlying ventricular repolarization gradients using the equivalent dipole layer (EDL).

***Methods:*** Body-surface-potential-maps (BSPM, 67-leads) were obtained in nine normal cases. Subject specific CT/MRI -based anatomical heart/torso models with electrode positions were created. The boundary element method was used to compute the transfer matrix to account for the volume conductor effects. The source strength at each ventricular node of the EDL was defined by the shape of the transmembrane potential. Three gradients were applied to investigate the effect of ventricular repolarization gradients on T-wave morphology: a) transmural, b) interventricular and c) apico-basal (**Figure 1**). The correspondence between the simulated and measured BSPM was assessed using the median (IQR) correlation coefficient (CC) and relative difference (RD).

***Results:*** Realistic T-waves could be simulated if: (a) repolarization times of the epicardium were smaller than the endocardium; (b) repolarization times of the right ventricle were smaller then the left ventricle and (c) repolarization times increased from apex towards base. The highest correspondence between measured versus simulated T-wave morphology was observed when applying an apico-basal gradient (CC=0.84(0.81-0.91);RD=0.68(0.61-0.71)) compared to a transmural gradient (CC=0.75(0.62-0.79);RD=1.14(0.74-1.61)) and an interventricular gradient (CC=0.71(0.67-0.80);RD=0.8(0.76-0.83)). Combining all three gradients resulted in a similar CC=0.83(0.82-0.89) and a reduced RD=0.61(0.51-0.63).

***Conclusion:*** A method to simulate ventricular repolarization gradients was established in EDL-based T-wave simulations, where an apico-basal gradient resulted in the best fit of simulated T-waves compared to measured T-waves. The findings obtained in this study will be used to optimize our EDL-based inverse procedure to assess repolarization abnormalities like cardiac ischemia and inherited cardiomyopathies.

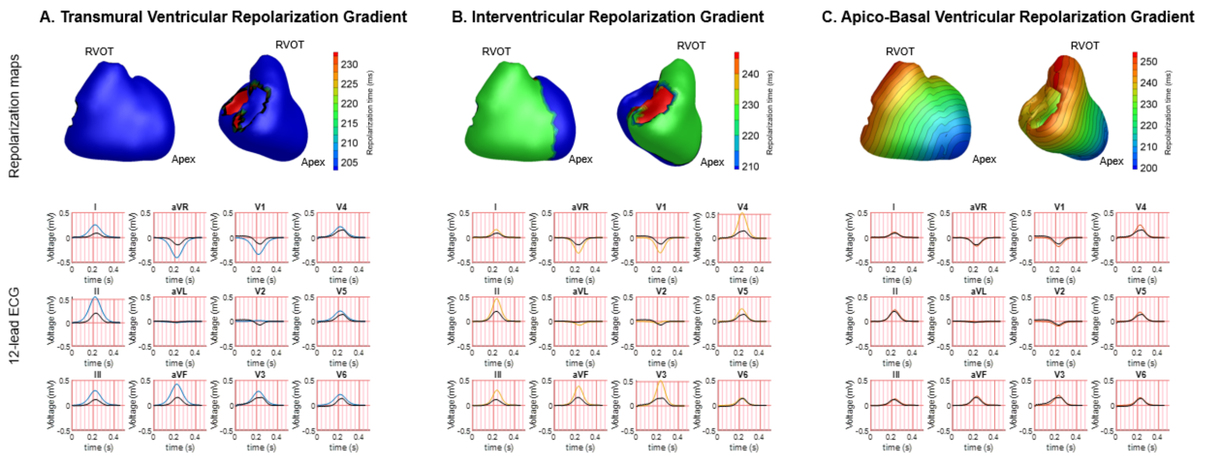


***Figure 1:*** *Effect of ventricular repolarization gradients on T-wave morphology in a normal case. The ventricular repolarization maps are displayed in the top panel. The 12-lead ECG is presented in the bottom panel: the black signal represents measured T-waves, the blue signal simulated T-waves for a transmural ventricular repolarization gradient, the yellow signal simulated T-waves for an interventricular repolarization gradient and the orange signal simulated T-waves for an apico-basal ventricular repolarization gradient. A transmural ventricular repolarization gradient resulted in a correlation coefficient (CC) of 0.61 and a relative difference (RD) of 2.81 in the body-surface-potential-map (BSPM). An interventricular repolarization gradient resulted in CC 0.87 and RD 1.60 and an apico-basal ventricular repolarization gradient resulted in CC 0.91 and RD 0.53.*