Transmural ventricular heterogeneities play a major role in determining T-wave morphology at different serum potassium levels

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Background and aim: End-stage renal disease (ESRD) affects more than 10% of the population. ESRD patients present impaired potassium homeostasis, which increases the risk for ventricular arrhythmias and sudden cardiac death. Preventive, noninvasive estimation of serum potassium, [K⁺], is therefore of major importance. We investigated three T-wave morphological descriptors, assessed their relationship with [K⁺] and ascertained mechanisms responsible for their large inter-individual differences.

Methods: Electrocardiograms (ECGs) of twelve ESRD patients undergoing hemodialysis and ECGs calculated from simulated ventricular fibers were processed to quantify the T-wave width (Tw), slope-to-amplitude ratio (TSA) and temporal morphological variability (dw). [K⁺] was measured at different time points during hemodialysis and simulated from 2 to 8 mmol/l in the modeled ventricular fibers.

Results: In ESRD patients, Tw, TSA and dw were closely related with [K⁺] during hemodialysis, with median Spearman correlation coefficients of −0.5, 0.8 and 0.65, respectively. However, the pattern of such relationships depended highly on the characteristics of each patient. This variability, more manifest at high [K⁺], was reproduced in the simulations. Simulated descriptors were highly sensitive to the proportion of mid-myocardial cells, with 10% variations in this proportion leading to more than 15% changes in the T-wave descriptors.

Conclusions: Changes in [K⁺] have remarkable effects on Tw, TSA and dw, but the pattern of the relationship is highly patient-dependent, particularly under elevated [K⁺]. Differences in the proportion of mid-myocardial cells may play a role in explaining such inter-individual variability.