The Restitution Portrait in Rabbit Epicardium Reveals Spatial Heterogeneity in Short-Term Memory

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Introduction: Transient and steady-state repolarization heterogeneity may occur due to spatial differences in action potential restitution and memory. The "restitution portrait" is a new method of simultaneously determining transient and steady-state restitution properties. The purpose of this study was to determine if spatially-dependent differences in the restitution portrait exist in rabbit epicardium.

Methods: Optical action potentials were recorded at three epicardial sites (apex, mid, base) in five adult NZW rabbit left ventricles stained with di-4-ANEPPS and arterially perfused with Tyrode's solution containing 2,3-BDM. The restitution portrait containing the dynamic (steady-state) restitution curve, S1-S2 restitution curves, and transient changes in action potential duration (APD) were determined for cycle lengths (BCL) from 1000 to 150 ms. The time constants for transient changes in APD (short-term memory) following step changes in BCL were calculated.

Results: Short-term memory on the order of tens of seconds was observed following both small (50-100ms) and large (>500ms) step changes in BCL. Memory time constants (tau) for large steps were significantly longer than those for small steps (24±0.9s vs 18±0.8s, $p<0.01$). Following large step changes, there was significant epicardial heterogeneity in tau (figure) with APD reaching steady-state earlier in the mid-ventricle compared to the apex and base. There were no significant spatial differences in steady-state APD, in dynamic or S1-S2 curve slopes, or in tau for small steps.

Conclusions: A large step change in BCL can create significant spatial heterogeneity of APD recovery to steady-state in adult rabbit epicardium. Dynamic spatial heterogeneities of repolarization may occur due to these spatial differences in short-term memory and may alter stability at the onset of a tachycardia.