Experimental Investigation on Spatial Dynamics of Bifurcation to Alternans in Paced Rabbit Hearts

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Introduction
- A beat-to-beat alternation in the action potential duration (APD) is known as alternans
- Alternans is a direct precursor to ventricular fibrillation in the whole heart
- The transition from constant APD response to alternans is termed bifurcation
- The characterization of the type of bifurcation to alternans remains controversial

Objective
To experimentally identify the spatial distribution of bifurcation characteristics that govern the transition to alternans in isolated whole rabbit hearts.

Methods
- Optical mapping: To capture the electrical activity of paced whole hearts (4 rabbits; total 8 trials)
- Alternate pacing protocol [1]: \( BCL_n = BCL + (-1)^n \delta \)
- \( \delta \) is perturbation \( \{\delta = 5, 10, 15, 20\} \) ms

Results

Fig. 1 A) Representative action potential traces with constant APD; B) APD alternans;

Fig. 2 A) 2D steady state (SS) alternans maps for decreasing BCL; Red and green boxes indicate the onset of alternans, BCL_{start}, and the BCL just prior to onset of alternans, BCL_{prior}, respectively; B) 2D induced alternans maps at BCL_{prior} for increasing perturbation \( \delta \); C) 2D Gain maps for increasing \( \delta \)

Fig. 3 Average bifurcation trend values for left ventricular (LV) surface across all trials

Fig. 4 Spatial correlation of SS alternans with bifurcation characteristics

Fig. 5 Spatial correlation of induced alternans with bifurcation characteristics

Conclusions
- Transition to alternans in the heart occurs predominantly through smooth bifurcation characteristics
- Region with induced and SS alternans correlates significantly with smooth bifurcation

References

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