# Optical Mapping of Heart during Global Ischemia


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## INTRODUCTION

Optical mapping provides an efficient tool to study electrophysiological heterogeneity and its role in the mechanisms of arrhythmogenesis, especially due to global ischemia. Global ischemia can increase electrical heterogeneity in the heart, thereby contributing to arrhythmias. However, changes in the heterogeneities between right (RV) and left ventricle (LV) during ischemia and their relationship to arrhythmogenesis remain poorly understood.

## HYPOTHESIS

Here we hypothesized that global ischemia and reperfusion induce inter-ventricular (RV-LV) electrical heterogeneities during periodic pacing.

## METHODS

- High resolution optical mapping was performed in several Langendorff-perfused rabbit hearts.
- Heart was paced using periodic pacing protocol, in which the basic cycle length (BCL) was changed from 300 to 100 ms.
- Voltage sensitive dye (Di-4-ANEPPS) was injected in heart and excited using green laser (532 nm).
- The electrical activity from LV and RV was recorded using 2 CCD cameras for 3 conditions – control, global ischemia, and reperfusion.
- Parameters such as action potential durations (APDs) and maximum slopes of APD restitution curves ($S_{max}$) were measured and analyzed for both LV and RV surfaces.

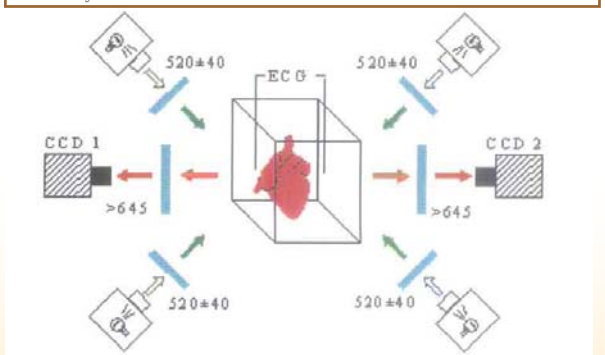


**Figure 1 –** Optical mapping setup. The lasers illuminate right (RV) and left (LV) ventricles of heart. Two CCD cameras record movies through emission filters blocking laser light.

## RESULTS

- The APD maps were very similar in control condition, indicating the absence of electrical heterogeneity (Fig. 3A).
- Ischemia shortens APDs in both ventricles, but the effect is more prominent in LV than in RV (Fig. 2B).
- The mean values of $S_{max}$ were similar in control condition, decreased in ischemia, and increased in reperfusion for both LV and RV (Fig. 6).

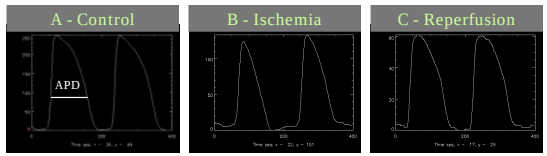


**Figure 2 –** APDs for Control (A), Ischemia (B) and Reperfusion (C) conditions.

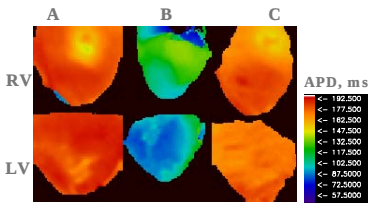


**Figure 3 –** APD maps for control condition (A), 20 min of ischemia (B), and reperfusion (C) for BCL= 300 ms. Color scale is in ms.

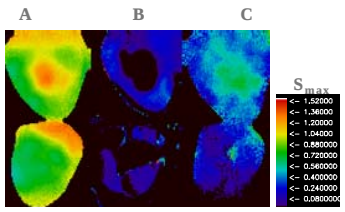


**Figure 4 –** Spatial distribution of $S_{max}$ for control condition (A), ischemia (B), and reperfusion (C). During ischemia, the values of $S_{max}$ cannot be defined for some spatial locations, which is indicated by the black color.

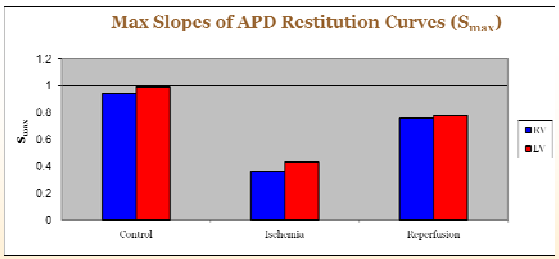


**Figure 6 –** Mean maximum slopes of APD restitution curves

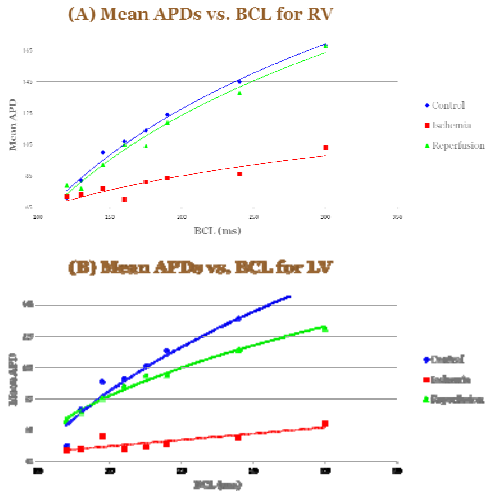


**Figure 5 –** Mean APDs as a function of BCL for RV (A) and LV (B) in control, ischemia, and reperfusion conditions.

## CONCLUSIONS

- No APD heterogeneity was observed in control hearts.
- Global ischemia induced inter-ventricular heterogeneity in APD that was abolished upon reperfusion.
- $S_{max}$ was uniformly decreased in both RV and LV and did not recover upon reperfusion, indicating the presence of residual changes in electrical properties of the heart.
- $S_{max}$ does not display any inter-ventricular heterogeneity despite of the presence of electrical heterogeneity.
- In conclusion, global ischemia indeed induces inter-ventricular heterogeneity in APD during periodic pacing.

## REFERENCES


- A. Matiukas, A. M. Pertsov, P. Kothari, and E. G. Tolkacheva (2009). Optical Mapping of Electrical Heterogeneities in the Heart During Global Ischemia.
- Mironov S, Jalife J, Tolkacheva E (2008). Role of conduction velocity restitution and short-term memory in the development of action potential duration alternans in isolated rabbit hearts. Circulation 118(1):17-25.