

Cell unexcitability and electrotonic coupling phenomenon analysis of ablation-created lesions: a study case with ablated explanted human heart

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Aims: This study aimed to investigate the effect of radio frequency ablation (RFA)-created lesions on an explanted human heart in wedge preparation by simultaneous endo and sub-endo optical mapping.

Method: The heart was explanted from a patient with progressive heart failure (heart transplant procedure), perfused with Tyrode solution and ablated under 40 W using a non-irrigated electrode. The ventricle was stained with Vm sensitive dye Di-4-ANBDQPQ (JPW-6003) and excited with light bands of different penetration depths (red = 660nm, green = 525nm) to perform a CV difference analysis for CV alternans identification. The emitted fluorescence was acquired with 128x128 pixels of resolution (Evolve 128, Photometrics). In post-processing, baseline drift is removed, ensemble-averaged applied, followed by anisotropic 1D diffusion filter. Relative change in fluorescence ($\Delta F/F$) traces are analyzed before and after ablation and LAT is determined by the 50% approach. Local conduction velocity (CV) estimation is obtained with our previously validated circle method. The profile, spatial extent, and depth of created lesions were characterized by examining the CV maps for the presence of CV alternans correlated with transmural heterogeneities.

Results: After ablation $\Delta F/F$ reduced 60%. In complete transmural ablation, CV alternans were observable at slow pacing cycle length due to electrotonic coupling. The presence of CV alternans was due to reduced excitability in a non-homogeneous lesion consisting of excitable and non-excitable cells. The absence of CV alternans in optical mapping with green light excitation and their presence with deep-red light band excitation of deep tissue penetration depth illustrates incomplete ablation across the ventricular wall or non-homogeneous ablation in the mid-myocardial layer. It is in agreement with the images of the RFA-lesion.

Conclusion: The presence of an intramural scar impairs the efficacy of the RFA procedure, suggesting a need of alternative ablations strategies.