

# **Circuit Density Guided Ablation Offers Improved Efficiency in Treatment of Atrial Fibrillation**

## **Introduction**

Atrial fibrillation (AF) is the most prevalent cardiac arrhythmia, affecting 0.4% of the general population and increasing stroke risk 2-7 fold. One mechanism responsible for AF is multi-wavelet reentry (MWR). Here, multiple waves of excitation propagate through dynamic circuits resulting in self-perpetuating chaotic activation. Treatment strategies using catheter ablation aim to eliminate triggers of AF and constrain the propagation of waves. Unfortunately, success rates remain poor. Using a computational model of cardiac tissue, we have previously demonstrated that ablation in regions of high circuit density increases the probability of circuit interruption and termination of MWR. The present study quantitatively examines the impact of ablation on inducibility and perpetuation of MWR as a function of ablation length and overlap with circuit density.

## **Methods**

Using a cellular-automata model of cardiac excitation, we generated 2D tissues (80x80 cells) which manifest varying size and location of high circuit density regions. MWR was induced by burst pacing from 64 different positions. Mapping of circuit density was performed for 10 seconds per site. We then randomly generated sets of ablation lines with total lesion lengths between 10 and 150 cells. We evaluated the overlap of each ablation line with circuit density and examined its effect on inducibility and duration (up to 100 seconds) of MWR by repeating burst pacing from 20 random locations.

## **Results and Discussion**

Lesions with high circuit density overlap required less length than low overlap lesions to reduce MWR duration by a given amount. The greatest reductions in duration occurred when lesion length was sufficient to reach the far edge of a high circuit density patch from the tissue edge. The presence of ablation lesions increased the inducibility of MWR compared with baseline by increasing rotational asymmetry. Lesions limited to regions with significant preexisting rotational asymmetry, such as high circuit density patches, had the overall effect of reducing inducibility of MWR.