Stability of Ventricular Fibrillation Is Altered by Wall Deformation after the Onset of Fibrillation

Shin Inada¹, Takashi Ashihara², Ryo Haraguchi¹, Michiaki Iwata¹, Kazuo Nakazawa¹

¹National Cerebral and Cardiovascular Center Research Institute, Japan, ²Shiga University of Medical Science

Background: There are many studies to investigate mechanisms of induction and maintenance of ventricular fibrillation (VF); however, the mechanisms have not been clarified yet. It is known that the thickness of ventricular wall varies with time during VF; i.e., thickness of left ventricular wall is increased whereas that of right ventricular wall is decreased. We hypothesized that such deformation of ventricular walls during VF alters the stability of VF. To clarify this issue, we conducted computer simulation of VF in the ventricular wall slab models deformed with time.

Methods: We constructed slab models with 10-mm thickness for left ventricular wall and with 5-mm thickness for right ventricular wall. Electrical heterogeneity and rotational anisotropy through the ventricular wall were included. After the onset of VF, thicknesses of the slabs were varied dynamically. The scroll wave filament (3-dimensional reentrant center) was expressed as a continuum of phase singularities.

Results: In the deforming right ventricular wall, filament trajectory on the epicardial surface was gradually decreased, confirming stability of the scroll wave reentry. In the deforming left ventricular wall, filament was separated into several parts and filament trajectories traced complicated patterns. In contrast, the scroll waves without deformation were terminated by the annihilation of all filaments.

Conclusion: Deforming ventricular walls during VF play important roles to maintain VF.

Keywords: computer simulation, ventricular fibrillation