Virtual Computer Simulation Modeling for Prediction of Response to Cardiac Resynchronization Therapy

Jae-Sun Uhm  
Min-Cheol Park  
Min Kim  
In-Soo Kim  
Moo-Nyun Jin  
Hee Tae Yu  
Jaewon Oh  
Chan-Joo Lee  
Tae-Hoon Kim  
Boyoung Joung  
Hui-Nam Pak  
Seok-Min Kang  
Minki Hwang  
Moon-Hyoung Lee  
Eun Bo Shim

Introduction: Although cardiac resynchronization therapy (CRT) is an effective treatment strategy in patients with heart failure, it still has a problem in identifying non-responder to CRT. We recently developed the in-silico CRT modeling. The objective of this study was to validate the accuracy of the in-silico model.

Methods: We retrospectively included 14 patients (age, 66.1 ± 10.7 years, 4 men) with CRT who underwent cardiac computed tomography (CT) and magnetic resonance (MR) before CRT implantation. To construct the in-silico CRT model, we combined the 3D image using cardiac CT and MR images, based on electromechanical ventricular model with a lumped model of the circulatory system and electric pacing device (Figure). In-silico CRT response was defined as Δleft ventricular end-systolic volume (LVESV) = [LVESVpre-CRT–LVESVpost-CRT]x100/ LVESVpre-CRT ≥ 15%. We compared in-silico CRT response with clinical CRT response.

Result: In the in-silico model, 8 in 14 patients were CRT-responders. In clinical observation, 5 in 14 patients were CRT-responders. Positive and negative predictive value and accuracy rate of the in-silico model were 62.5%, 100%, and 78.6%, respectively. Agreement of CRT-responder between the in-silico model and clinical observation was moderate (Cohen’s κ coefficient = 0.588, p = 0.016).

Conclusion: The present in-silico CRT modeling was feasible in identifying CRT-responders.