The Usefulness and Limitation of Impedance Cardiography for Cardiac Resynchronization Therapy Devices Optimization

Kojiro Ogawa
Miyako Igarashi
Tomoaki Hasegawa
Akihiko Nogami
Kazutaka Aonuma
Masaki Ieda

Introduction: Identifying the optimal atrioventricular (AV) or interventricular (VV) delay is beneficial to patients using cardiac resynchronization therapy (CRT) devices. Ultrasound echocardiography (UCG) has been the most commonly used method; however, it requires high technical knowledge. Impedance cardiography (ICG) can calculate stroke volume by measuring changes in transthoracic electric impedance. This study sought to assess the clinical utility of ICG in comparison with UCG for the optimization of CRT devices.

Methods: The patients who underwent CRT device implantation were retrospectively analyzed. Cases of upgrading to a CRT device were included. A week after implantation, optimization of AV delay (AVD) was performed in every patient with ICG (AVD-ICG) and UCG (AVD-UCG). VV delay (VVD) was then determined according to the optimal AVD using these two methods.

Result: Forty-two patients were finally enrolled. Average AVD-ICG was significantly shorter than AVD-UCG (128 ± 49 vs. 146 ± 41 ms, p = 0.018). The difference between AVD-ICG and AVD-UCG were 20 ms or less in nineteen patients (45%) including five patients (12%) who had the same optimized AVD with two methods. The remaining twenty-three patients had the difference over 20 ms, here defined as AVD-ICG/AVD-UCG mismatch. Among these patients, AVD-ICG was shorter in sixteen (38%) and longer in seven (17%) when compared to AVD-UCG (Figure A). Simple regression analysis revealed a mild positive correlation between AVD-ICG and AVD-UCG ($r = 0.48$, $p = 0.001$, Figure B). In multivariate analysis, the presence of moderate or severe mitral regurgitation (MR) postoperatively was an independent predictor of AVD-ICG/AVD-UCG mismatch (odds ratio=10.71; 95% confidence interval=1.72 to 66.72; $p = 0.018$). On the other hand, the results of optimization of VV delay were similar using both ICG and UCG (0 [0 to 20] vs. 20 [0 to 20] ms, $p = 0.153$). VVD-ICG and VVD-UCG were exactly the same in 19 (45%) patients.

Conclusion: ICG is a non-invasive monitoring tool to optimize the settings of CRT devices which could substitute UCG. In VVD optimization, ICG could substitute UCG as the results were similar between the two methods. However, there was a significant difference in AVD optimization results between ICG and UCG, especially in patients with MR after CRT.