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Editorial

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Finding Cardiac Resynchronization Therapy Responders: Postprocedural QRS-T Morphologies Matter

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▸ See the article "Association Between Subcutaneous Implantable Cardioverter Defibrillator Preimplantation Screening and the Response to Cardiac Resynchronization Therapy" in volume 50 on page 1062.

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Cardiac resynchronization therapy (CRT) leads to beneficial left ventricular (LV) remodeling, restoration of dyssynchrony, and reduction in hospitalization and mortality in patients with heart failure (HF).[1)] Beyond the western countries, the CRT implantation rates are steadily increasing in Asian population.[2)] However, appropriate patient selection for CRT is an important goal as 30–40% patients do not experience the expected benefit.[3)]

Although several studies have been conducted to identify appropriate candidates for CRT based on sex differences, HF etiology, LV volume, and left atrial volume, the simplest and most accepted method to detect ventricular dyssynchrony is 12-lead electrocardiography (ECG). In general, CRT response is predicted based on the patient's basic electrical dyssynchrony that can be improved by electrical manipulation. QRS duration and presence of left bundle branch block (LBBB) morphology on preprocedural ECG are strong predictors of CRT response.[4)]

Furthermore, many physicians have shown keen interest in predicting CRT response based on postprocedural ECG findings. However, shortening of QRS duration is not sufficient to accurately predict CRT response.[5)] Further, limited information is available regarding the application of other postprocedural ECG parameters reflecting complex LV electrical synchrony and its reversibility by electrical manipulation for predicting CRT response.

Recently, several studies have assessed the importance of different postprocedural ECG parameters for predicting CRT response. A study by Bode et al.[6)] showed that a positive vector in V1 and/or negative vector in lead I on postprocedural ECG, suggesting LV activation on the posterolateral capture from CRT, predicts CRT response. This effect was more prominent in patients without LBBB who benefited less from CRT than those with LBBB. Hence, identification of simple and novel ECG parameters, in addition to QRS duration or axis change, to predict CRT response seems crucial, but challenging.

The study by Jing et al.,[7)] in this issue of the *Korean Circulation Journal*, tried to investigate postprocedural ECG parameter other than QRS duration using QRS-T morphology screening (TMS), which was developed to identify patients who may be susceptible to T-wave

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oversensing and has been used for subcutaneous implantable cardioverter defibrillator (S-ICD) prescreening to avoid inappropriate shocks. The authors enrolled 55 patients eligible for CRT implantation according to the current guidelines; all patients had LBBB morphology and did not pass TMS during preprocedural ECG. On the third day after CRT implantation, patients were classified into two groups depending on the postprocedural TMS results—those who passed at least one vector (TMS-passing group) and those who did not pass (non-passing group). Clinical variables, echocardiographic parameters, and other ECG parameters were analyzed before and after CRT implantation. After CRT implantation, 39 (71%) patients passed TMS with biventricular pacing. Patients in the TMS-passing group showed a significantly higher clinical response rate to CRT than those in the non-passing group (80% vs. 31**%)**, and TMS passing was found to be independently associated with CRT response. Among the overall study population, patients passing more than 2 vectors had a greater response (odds ratio [OR], 17.6; 95% confidence interval [CI], 2.4–131.6) and those passing only one vector also had a better response (OR, 8.1; 95% CI, 1.3–48.7) during follow-up when compared with non-passing patients. As expected, most super-responders belonged to the TMS-passing group and showed a linear relationship with the number of vectors passed. Corresponding to the CRT responder rate, change in left ventricular end-systolic volume (LVESV) was significantly different between the TMS-passing group and the non-passing group (24% and 9% reduction, respectively). Other response parameters, such as the New York Heart Association class and left ventricular ejection fraction (LVEF), were not significantly different between the 2 groups.

The authors demonstrated that selected surface ECG measurement with TMS is a useful approach to predict CRT response and reflect whether LV pacing contributes to dyssynchrony correction and that adequate biventricular pacing is significant. TMS has been developed using ECG parameters including R-wave amplitude, T-wave amplitude, R/T ratio, QRS duration, and QT interval.[8] Delayed activation of the LV lateral wall causes mechanical dysfunction, and LBBB morphology has been recognized as a potential indicator of delayed LV lateral wall activation, which is reflected by the QRS complex.[9] Widening of the QRS duration and abnormal repolarization associated with ST-segment depression and T-wave inversion increases the probability of not passing TMS.[10] On analyzing iterative optimization efforts in detail, it seems that adequate biventricular pacing through CRT improves mechanical dyssynchrony and abnormal repolarization caused by delayed activation of the left lateral wall and results in not only QRS complex normalization but also non-inverted T-wave. Although the results of this study are limited to patients with LBBB, understanding the electrophysiology of vectorcardiography and biventricular pacing aid in achieving better outcomes after CRT implantation. These results are consistent with those reported by previous studies, supporting the role of ECG information in the clinical follow-up of CRT and novel contribution of TMS.

However, there are some challenges. First, there are different values for defining CRT response, including LVESV, LVEF, and HF symptoms. Although the resolution of LVESV was different between the 2 groups, HF symptom improvement and LVEF were similar. It would be more logical if these values were considered. Second, while the authors focused on CRT response, information regarding clinical outcomes such as HF hospitalization, all-cause death, and implantable cardioverter defibrillator therapy for ventricular arrhythmias is lacking. Long-term follow-up data are needed to provide more helpful information. Third, the results of the present study cannot be adopted in patients without LBBB. Finally, it is unclear whether the application of TMS during the CRT procedure will help the operator achieve more appropriate LV lead positioning. Further studies are warranted to determine the role of TMS in patients without LBBB, determine the clinical impact of TMS during CRT, and understand the ultimate association between TMS and electrical dyssynchrony.

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