EP CASE REPORT

Intra-procedural evaluation of a computational modelling method for cardiac resynchronization therapy

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Introduction

Left ventricular (LV) lead position significantly impacts the long-term outcomes in cardiac resynchronization therapy (CRT).[1] Currently, LV lead positioning is largely empiric, and there is no universally accepted optimization method that incorporates the substrate, mechanics, and electrophysiology. The past decade saw tremendous progress in cardiac electrophysiology (CEP) modelling.[2] We assessed the feasibility of intra-procedural CEP simulations to optimize LV lead positioning.

Methods

A male patient with ischaemic cardiomyopathy was enrolled [71-year-old; ejection fraction = 29%; New York Heart Association 3; QRS duration (QRSd) = 181 ms]. *Prior to intervention*, cardiac magnetic resonance imaging (MRI) identified a postero/postero-lateral scar of unconfirmed transmurality. Two models were hence estimated from MRI and 12-lead electrocardiogram (ECG) in less than an hour[3]: M1 (transmural scar) and M2 (partially conductive scar). *The next day*, a CRT system with a quadripolar LV lead was implanted. During the procedure, the model was updated to match the epicardial activation map derived from a 252-lead body surface potential map, as well as the sensed P-right ventricle (RV) and RV–LV delays at CRT OFF (<1 min processing time). Six CRT experiments with different LV lead positions and atrio-

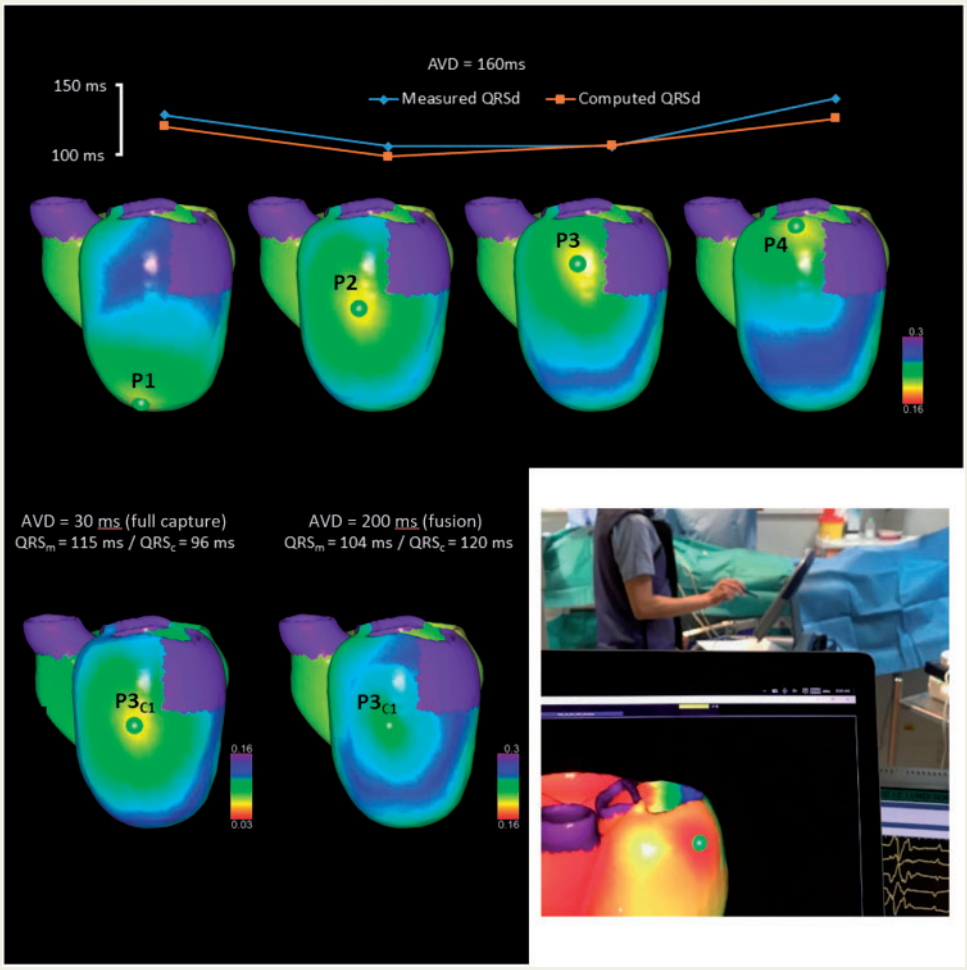

Figure 1 Individualized simulations of cardiac electrophysiology performed and evaluated during cardiac resynchronization therapy procedure. Predicted changes in QRS duration matched procedural observations. QRSd, QRS duration. AVD, atrio-ventricular delay.

ventricular delays, including full capture and fusion, were tested and simulated concomitantly (<1 s processing time). QRS duration predicted by the model was compared with QRSd measured on the patient's surface ECG, a non-invasive biomarker of long-term CRT response.

Results

During the procedure, the model was updated to fit a narrower baseline QRSd (154 ms) and an RV activation identified on the epicardial activation map. M1 was selected considering the measured RV–LV delay ($RV–LV_{measured}$ = 130 ms, $RV–LV_{M1}$ = 128 ms; $RV–LV_{M2}$ = 117 ms). Sensed P-RV delay was 160 ms. Results are reported in *Figure 1*.

Discussion

Cardiac electrophysiology simulations could be done the day prior and during the procedure. The model was refined on-the-fly to fit the interventional data with CRT OFF, yielding excellent agreement between predictions and observations.

Conclusions

Optimization of LV lead positioning by intra-procedural computational modelling of CEP is feasible.

Disclaimer: The concepts and information presented in this article are based on research results that are not commercially available.

Conflict of interest: T.M. and H.H. are employees of Siemens Medical Solutions USA, Inc. All the other authors have no conflicts of interest to declare.

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