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Guidance for Optimal Site Selection of a Leadless LV Endocardial Electrode Improves Acute Hemodynamic Response and Chronic Remodeling

Benjamin J. Sieniewicz, MBChB FHEA,[a,b] Jonathan M. Behar, MBBS,[a,b] Justin Gould, MBBS,[a,b] Simon Claridge, LLB MBBS,[a,b] Bradley Porter, MBBS,[a,b] Baldeep S. Sidhu, BM,[a,b] Steve Niederer, PhD,[a] Tim R. Betts, MBChB FRCP MD,[c] David Webster,[c] Simon James, MBChB HRUK,[d] Andrew J. Turley, MBChB,[d] Christopher A. Rinaldi, MD, FHRS[a,b]

ABSTRACT

OBJECTIVES This study hypothesized that guided implants, in which the optimal left ventricular endocardial (LV_{ENDO}) pacing location was identified and targeted, would improve acute markers of contractility and chronic markers of cardiac resynchronization (CRT) response.

BACKGROUND Biventricular endocardial (BiV_{ENDO}) pacing may offer a potential benefit over standard CRT; however, the optimal LV_{ENDO} pacing site is highly variable. Indiscriminately delivered BiV_{ENDO} pacing is associated with a reverse remodeling response rate of between 40% and 60%.

METHODS Registry of centers implanting a wireless, LV_{ENDO} pacing system (WiSE-CRT System, EBR Systems, Sunnyvale, California); John Radcliffe Hospital (Oxford, United Kingdom), Guy's and St. Thomas' Hospital (London, United Kingdom), and The James Cook University Hospital (Middlesbrough, United Kingdom). Centers used a combination of preprocedural imaging and electroanatomical mapping the identify the optimal LV_{ENDO} site.

RESULTS A total of 26 patients across the 3 centers underwent a guided implant. Patients were predominantly male with a mean age of 68.8 ± 8.4 years, the mean LV ejection fraction was 34.2% ± 7.8%. The mean QRS duration was 163.8 ± 26.7 ms, and 30.8% of patients had an ischemic etiology. It proved technically feasible to selectively target and deploy the pacing electrode in a chosen endocardial segment in almost all cases, with a similar complication rate to that observed during indiscriminate BiV_{ENDO}. Ninety percent of patients met the definition of echocardiographic responder. Reverse remodeling was observed in 71%.

CONCLUSIONS Guided endocardial implants were associated with a higher degree of chronic LV remodeling compared with historical nonguided approaches. (J Am Coll Cardiol EP 2018;■:■–■) © 2018 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

From the [a]Division of Imaging Sciences and Biomedical Engineering, King's College London, United Kingdom; [b]Cardiology Department, Guys and St. Thomas' National Health Service (NHS) Foundation Trust, London, United Kingdom; [c]Cardiology Department, The John Radcliffe Hospital, Oxford University Hospitals NHS Foundation Trust, Oxford, United Kingdom; and the [d]Cardiology Department, The James Cook Hospital, South Tees Hospitals NHS Foundation Trust, Middlesbrough, United Kingdom. Dr. Sieniewicz is supported by a British Heart Foundation Project Grant. Dr. Behar has received speakers fees from Abbott. Dr. Gould and Dr. Porter are on clinical research fellowship programs funded by Abbott. Dr. Sidhu is on a clinical research fellowship program funded by Medtronic Inc. Dr. Niederer is supported by the Wellcome Trust. Dr. Betts has received research funding from Abbott; and speakers', consultancy, and proctor fees from Abbott and Boston Scientific. He would also like to acknowledge that he is supported by the Oxford Biomedical Research Centre. Dr. Rinaldi receives research funding and/or consultancy fees from Abbott, Medtronic Inc., Boston, and LivaNova outside of the submitted work. He has also received speakers' fees and honoraria from EBR Systems, and is part of the steering group for SOLVE-CRT Study. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose.

All authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the *JACC: Clinical Electrophysiology* author instructions page.

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ABBREVIATIONS AND ACRONYMS

AHR = Acute hemodynamic response

BiV_{ENDO} = biventricular endocardial

CMR = cardiac magnetic resonance imaging

CRT = cardiac resynchronization therapy

EAM = electroanatomical mapping

LV = left ventricular

LVEF = left ventricular ejection fraction

LV_{ENDO} = left ventricular endocardial

Q-LV = interval between the onset of the QRS complex on the surface electrocardiogram to the first large positive or negative peak of the LV electrogram during a cardiac cycle

QRSd = QRS duration

US = ultrasound

Significant numbers of patients fail to respond to cardiac resynchronization (CRT) when it is delivered through an epicardial left ventricular (LV) lead placed via the coronary sinus (1-3). Furthermore, technical and anatomical limitations mean it is not always possible to implant an LV lead (4) and patients upgrading from a preexisting pacing system may have central venous stenoses preventing transvenous LV lead implantation (5). To overcome these challenges, novel methods of CRT delivery have been developed, including LV endocardial (LV_{ENDO}) stimulation (6,7). Chronic LV_{ENDO} pacing was initially delivered via transseptal pacing leads, mandating lifelong anticoagulation, but the introduction of new wireless technology may increase the use of LV_{ENDO} pacing and avoid anticoagulation (8,9).

The optimal LV_{ENDO} pacing location exhibits marked variability in ischemic (10) and nonischemic patients (11-13), with indiscriminate LV_{ENDO} CRT being inferior to traditional transvenous epicardial CRT (6). Avoiding scarred tissue while targeting viable, late-activating sites may improve conventional CRT response (14-16). Targeting the site of latest mechanical activation using speckle-tracking in the Targeted Left Ventricular Lead Placement to Guide Cardiac Resynchronization Therapy study improved the reverse remodeling rate to >70% (17). Alternative strategies include targeting the site of latest electrical activation, using the interval between the onset of the QRS complex on the surface electrocardiogram to the first large positive or negative peak of the LV electrogram during a cardiac cycle (Q-LV) (16) or using cardiac magnetic resonance (CMR) to identify late-activating, viable tissue (18).

We hypothesized that identification of the optimal LV_{ENDO} location for a wireless LV pacing electrode would result in improved acute hemodynamic response and chronic remodeling. We performed L_{ENDO} pacing using the WiSE-CRT wireless pacing system (WiSE-CRT System, EBR Systems, Sunnyvale, California) in conjunction with guidance to identify late-activating, viable LV_{ENDO} segments and measured acute markers of contractility and chronic markers of CRT response (reverse remodeling).

METHODS

Data were collected from 3 centers implanting the WiSE-CRT system. This co-implant system uses ultrasound (US) energy to activate a small leadless pacing electrode that is deployed transarterially via a retrograde transaortic approach in the LV_{ENDO} cavity. The US array, implanted subcutaneously, is triggered by the implanted pacemaker or transvenous defibrillator. Patients studied were part of the WiCS Post Market Surveillance Registry (Clinical trial study number NCT02610673), and all patients gave full written consent to participate in the study. The centers were the John Radcliffe Hospital, Oxford University Hospitals National Health Service (NHS) Foundation Trust (Oxford, United Kingdom), Guy's and St Thomas' NHS Foundation Trust (London, United Kingdom), and The James Cook University Hospital, South Tees Hospitals NHS Foundation Trust (Middlesbrough, United Kingdom).

LV_{ENDO} GUIDANCE. At each center, a combination of either preprocedural imaging and/or electroanatomical mapping (EAM) was used to identify the optimal LV_{ENDO} pacing site.

Echocardiographic-guided approach. This approach was undertaken at the James Cook University Hospital. Echocardiography using Speckle-tracking 2-dimensional radial strain analysis was used to identify and target the latest mechanically activated LV segment using multisegment models, as described previously (19). Regions of scar were defined as segments <0.5-mm thick and displaying abnormal increase in acoustic reflection. In addition, any myocardium that exhibited low-amplitude strain curves and a peak radial strain <16.5% was defined as scar (20,21). During LV_{ENDO} implantation, the LV free wall was visualized using fluoroscopy and was subdivided into 4 segments according to coronary venous anatomy; anterolateral, lateral, posterolateral, and posterior, as previously described (19). The electrode could then be implanted into the target segment.

Electrical latency (Q-LV). This work was undertaken at the John Radcliffe Hospital. Electrical latency was assessed using the WiSE-CRT delivery catheter. A minimum of 3 sites were tested. Two indices of electrical latency were used to identify the optimal pacing site; the Q-LV activation time (16) and the Q-LV/QRS ratio (7,15). Sites with a Q-LV <100 ms were excluded. The optimal target was the site that displayed the latest Q-LV during right ventricular pacing and a Q-LV/QRS ratio >0.66. Viability was assessed by excluding any sites with a pacing capture threshold >2 V.

EAM and CMR. This work was undertaken at Guy's and St. Thomas' NHS Foundation Trust. Patients were implanted using a hybrid approach of EAM and, where possible, CMR imaging, which had been performed before implantation of the co-implant device.