EP CASE REPORT

Combined computed tomographic perfusion and mechanics with predicted activation pattern can successfully guide implantation of a wireless endocardial pacing system

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The WiSE-CRT wireless pacing system (EBR Systems, CA, USA) delivers ultrasound energy via a transmitter placed subcutaneously to a leadless endocardial left ventricular (LV) electrode to achieve biventricular pacing. Endocardial pacing has a number of advantages, including early access to fast endocardial conduction and a pacing location unconstrained by coronary anatomy. Currently, there is no recommended method to identify the optimal location for the LV electrode. Avoiding myocardial scar and pacing in late contracting or activating regions improves patient outcomes.[1,2] Identifying scar with cardiac magnetic resonance imaging is limited in these patients since they all have previous cardiac electronic implantable devices and image quality will therefore be degraded. Cardiac computed tomography with dynamic perfusion (CTP) has a number of advantages in such patients and may have the ability to identify areas of heterogeneous perfusion which can act as a surrogate for myocardial infarction. We hypothesized that CTP would be able to help guide WiSE-CRT implantations by identifying the optimal location for the electrode.

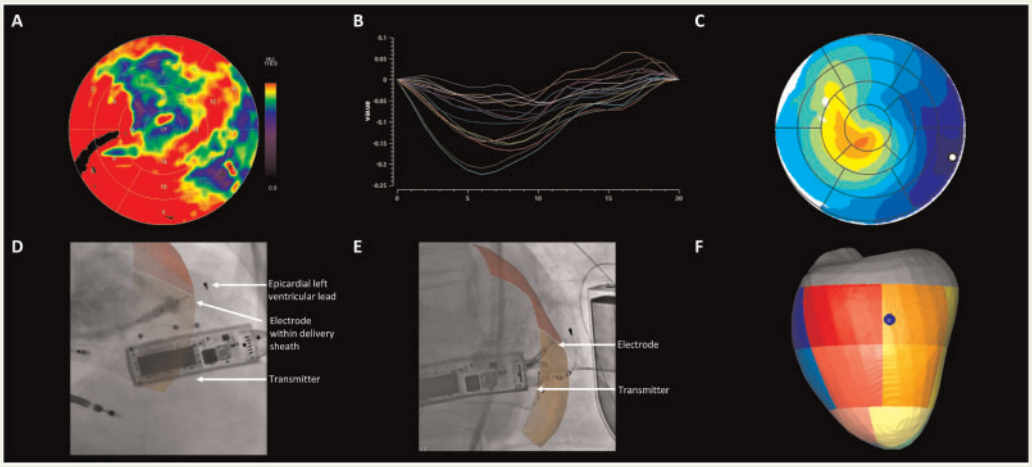

Figure 1 Cardiac computed tomography with dynamic perfusion to successfully guide implantation of a WISE-CRT system. Cardiac computed tomography with dynamic perfusion was able to successfully guide implantation of a WISE-CRT system. (*A*) Images were analysed on a dedicated platform to reveal areas of hypo-perfusion which were represented on a 17-segment American Heart Association model and shown as blue and purple. (*B*) Mechanical activation showed the latest activation was in the basal inferior segment (light blue). (*C*) The basal inferolateral segment had a predicted 90% delay in electrical activation time (dark blue). All the pre-procedural information was processed together, and we hypothesized the optimal site for electrode deployment was between the basal inferolateral and inferior segments. (*D–F*) A three-dimensional shell with the target segments (basal inferior–orange and inferolateral–red) was overlaid onto live fluoroscopy to provide real-time guidance. The greatest improvement in acute haemodynamic response was seen between the basal inferior and inferolateral segments, with areas of hypo-perfusion demonstrating no pacing capture or low increase in acute haemodynamic response. The narrowest QRS duration resulted from pacing in the target segment while pacing in a suspected perfusion defect resulted in a poor acute haemodynamic response and broadening of the QRS duration. Fluoroscopic images in a anterior-posterior (D) and left anterior oblique (E) projection are shown and a three-dimensional model (F) displays the final position of the electrode (blue dot). These all demonstrate the electrode was deployed within the target area.

A 70-year-old man with ischaemic, severely impaired LV systolic function (left ventricular ejection fraction 21%), New York Heart Association Functional Class III, and pacing dependent with a right ventricular (RV) paced QRS duration of 218 ms was listed for a WiSE-CRT system after his LV lead resulted in phrenic nerve stimulation in all configurations. He had suffered previous myocardial infarctions in the left anterior descending and left circumflex artery territories. Cardiac computed tomography with dynamic perfusion was used to identify well perfused regions. Retrospective-gated computed tomography was analysed to identify late contracting regions. Electrophysiology simulations were performed to predict late activating regions. We segmented the left ventricle on a dedicated platform and used modelling to simulate the effect of pacing within different regions to determine the area of latest electrical activation. Areas of perfusion heterogeneity were combined with latest mechanical and electrical activations to identify the target segments for electrode implantation; between the basal inferior and inferolateral segments (*Figure 1*). Pre-procedural target segments were overlaid onto a 3D shell and merged with live fluoroscopy, providing real-time guidance (Artis-Q biplane Combi Suite, Siemens Healthcare, Germany).[3] A PressureWire X guidewire (Abbott, CA, USA) was placed in the left ventricle to measure the acute haemodynamic response (AHR) by comparing biventricular pacing to RV pacing using CoroFlow measurement system (Coroventis Research, Sweden). The greatest improvement in AHR was used to select the final position for the electrode and this was compared with the predicted target segments. Areas of heterogeneous perfusion corresponded to either no LV capture or low improvement in AHR and broadening of the QRS duration. The greatest improvement in AHR (33%) corresponded to the target segment, with final QRS duration of 130 ms.

In summary, we have shown the successful use of CTP to guide implantation of the WiSE-CRT system. Pre-procedural planning using a combination of perfusion heterogeneity, the measured latest mechanical and the simulated electrical activating segments enabled us to identify the most viable myocardial segments. This target area was in keeping with optimal AHR measurements. We believe this is the first ever case to successfully guide placement of the WiSE-CRT system using CTP.

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