Cathodic-anodal left ventricular stimulation during cardiac resynchronization therapy: haemodynamic evaluation and electrocardiographic analysis

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Background: Cardiac resynchronization therapy (CRT) is an established treatment for heart failure with reduced ejection fraction (HFrEF). However, one third of patients are "non responders". Cathodic-anodal (CA) left ventricle (LV) capture is a multisite pacing occurring during CRT using both bipolar and quadripolar LV lead. It allows depolarization to arise simultaneously from the cathode and the anode of the bipole located on the LV epicardium, activating a larger volume of myocardium than cathodal pacing alone, thus potentially improving electromechanical synchrony (figure 1). We have previously proven that CA-LV stimulation is feasible and similar to bicathodic multipoint pacing (MPP) in terms of QRS wavefront activation.

Purpose: We aimed to evaluate both the acute intraprocedural haemodynamic and electrical effects of CA biventricular stimulation (CA-BS), comparing it with right-ventricle only pacing (Right Ventricle-Stimulation: RV-S), single-point CRT (Single Point-Biventricular Stimulation: SP-BS) and multipoint bicathodic biventricular stimulation (Multi Point-Biventricular Stimulation:MP-BS) in de novo CRT implants.

Methods: Ten patients candidates to CRT (LV ejection fraction $\leq$35% and left bundle branch block) received a quadripolar LV lead. Four pacing configurations were tested: RV-S, SP-BS, MP-BS and CA-BS, where cathode and the anode were the same electrodes used as cathodes in MP-BS. QRS duration by 12-lead ECG was defined as the time from the earliest ventricular deflection until the return to the isoelectric line. Haemodynamic assessment by radial artery catheterization using Pressure Recording Analytical Method processed the following parameters: dP/dT max (mmHg/msec), systolic arterial pressure (aPsys, mmHg), diastolic arterial pressure (aPdia, mmHg), mean arterial pressure (aPmean, mmHg), Cardiac Index (CI, l/min/m^2), Stroke Volume Index (SVI, ml/min/m^2).

Results: dP/dT max and aPmean increased significantly from RV-S to SP-BS (mean dP/dT max 0,82±0,28 versus 0,87±0,29 mmHg/msec, p=0,02; mean aPmean 89±19 versus 93±20 mmHg, p=0,01), but not from RV-S to MP-BS. Comparing RV-S to CA-BS, only aPmean exhibited a significant increase (mean aPmean 89±19 versus 92±20 mmHg, p=0,01). There were no haemodynamic differences between SP-BS, MP-BS and CA-BS. QRS duration reduced significantly from RV-S (167±10 msec) to each biventricular stimulation (135±14 msec, p=0,0002 for SP-BS; 130±17 msec, p=0,0001 for MP-BS; 129±18 msec, p=0,0002 for CA-BS) and from SP-BS to MP-BS and CA-BS (p=0,03 for both), whereas there were no difference comparing MP-BS and CA-BS.

Conclusions: CA-LV stimulation is not superior to single-point CRT in terms of acute haemodynamic performance, whereas it reduces the duration of ventricular electrical activation, showing an electrohaemodynamic mismatch. Long-term studies are needed to evaluate if acute electrical benefits of CA stimulation can predict chronic benefits, in terms of reverse cardiac remodelling.

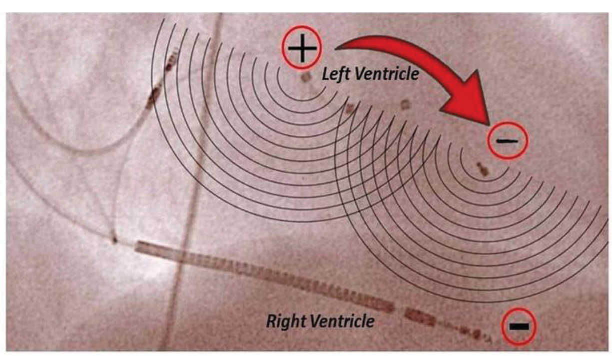

Figure 1: During CRT, a beneficial anodal left ventricular (LV) stimulation, simultaneos to cathodic one, can be demonstrated using a bipolar or preferably quadripolar LV lead in which the proximal and distal electrodes serves respectively as the anode and the cathode interfacing and depolarizing the myocardium. This so-called cathodic-anodal (CA) stimulation may activate a larger volume of LV myocardium than cathodal pacing of identical intensity by a nearly flat activation wavefront.

Cathodic-anodal left ventricular capture