

Effect of LV pacing lead position and presence of ventricular dyssynchrony on response to cardiac resynchronization therapy: A CMR study

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Introduction/Purpose. Cardiac resynchronization therapy (CRT) using a bi-ventricular pacemaker has shown benefit in a series of randomized, multi-center, controlled trials. However, even in these trials, 1 out 3 individual patients do not respond by either clinical or quantitative imaging-based endpoints [Bax, et al JACC 2005]. Two reasons have been postulated for the lack of response: 1) a lack of underlying dyssynchrony and 2) sub-optimal LV lead placement. Since CRT corrects dyssynchrony, a level of baseline dyssynchrony must be present in order to see a benefit from the therapy. For optimal physiologic response, the LV lead should be placed in the region that contracts latest, having the so-called *concordant* lead position. Studies that have looked at the effect of both dyssynchrony and lead position on response to CRT have produced conflicting results, often because of poor imaging methodology [Chung et al, Circulation, 2008]. CMR using high temporal resolution cine imaging is uniquely suited to determine the 3D contraction timing pattern in the LV and determine the region of latest contraction [Suever et al, JMRI 2013]. We conducted a study where patients underwent CMR before CRT and we hypothesized that patients with evidence of dyssynchrony and a concordant LV lead position as determined by CMR would have superior response to CRT compared to patients with a remote lead position or no evidence of dyssynchrony.

Methods: 30 patients (age 62±12, 56% male, 77% non-ischemic) meeting current criteria for CRT were enrolled. A CMR study including high temporal resolution short axis cine imaging (60 frames/cardiac cycle) was performed before the procedure on a 1.5T system. Endocardial borders were traced on the short-axis cine images in the MASS program (AZL, Leiden, the Netherlands) and radial displacement maps showing timing of contraction toward the center of the LV were generated and mapped to an AHA 17-segment model. The AHA segment with the earliest and the latest contraction was identified, figure 1.

Evidence of dyssynchrony: Dyssynchrony was defined as the presence of a line of block on the CMR radial displacement maps. A line of block was present if the latest and earliest contracting segments were adjacent in the radial displacement maps (ref).

Determination of lead position. During the CRT procedure, biplane catheter coronary venography was performed before and after lead placement. Fluoroscopic imaging with a contrast agent before lead implantation defined coronary venous anatomy, and imaging after implantation and identified final LV lead position, which was then mapped to the AHA 17-segment model using a modified Mortenson O'clock method. Final LV lead placement was considered *concordant* if within 1 segment of the latest contracting AHA segment on the CMR-determined contraction maps, and *remote* if > 1 segment from the latest contracting segment.

Definition of response: Patients underwent echocardiography at baseline and 6 months post-implant. Positive response was defined as reverse remodeling (>15% reduction in end-systolic volume (ESV) at 6 months).

Results: Twelve patients (40%) did not show evidence of dyssynchrony. In the patients with evidence of dyssynchrony, 10 (56%) had a concordant lead position, and the response rate in these patients was 90%. Response rate in all other subjects (no evidence of dyssynchrony or non-concordant lead) was 35% ($p=0.007$ by Fishers exact test).

Conclusion: The response rate to CRT was higher in patients identified by CMR as having evidence of dyssynchrony and having the LV lead position in the latest contracting segment compared to all other patients. The data suggest CMR could be used to prospectively select patient and guide lead placement in CRT.

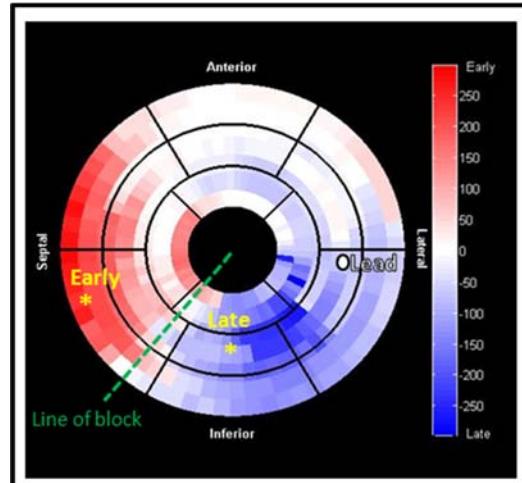


Figure 1. Example patient showing contraction timing map from short axis cine image. Location of early and late contraction segments, the line of block and the final lead position.