# Left ventricular lead positioning in cardiac resynchronization therapy

EDITORIAL COMMENTARY

# Left ventricular lead positioning in cardiac resynchronization therapy: Mission accomplished?

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Cardiac resynchronization therapy (CRT) is an effective treatment for patients with symptomatic heart failure, reduced systolic left ventricular (LV) function, and QRS delay.[1] Nevertheless, evidence continues to increase that the benefit of CRT can be improved by positioning the LV lead remote from scar in an area of late electrical or mechanical activation.[2,3] Numerous studies have emerged attempting to tackle this issue using variable modalities to guide LV lead placement to a patient-specific site of late activation remote from scar.[3–8] Delayed enhancement cardiac magnetic resonance imaging (DE-CMR) remains the criterion standard for myocardial scar assessment. Accordingly, this modality is predominantly used to guide LV lead placement outside scar in most of the aforementioned studies.

In this issue of **Heart**Rhythm, Behar et al[9] report on an evaluation of the use of computed tomography (CT) for selection of the optimal region for LV lead placement in a segment of late mechanical activation outside scar. This study was performed in 18 patients with existing pacing systems and therefore contraindications for CMR. Segmental mechanical activation was calculated as the time to peak strain, derived from the stretch of the endocardial surface throughout a heartbeat (stretch quantifier of endocardial engraved zones [SQUEEZE] using CT data sets together with electrical delay. Excluded as target segments were septal segments and segments with low-amplitude CT-SQUEEZE strain curves, the latter being regarded as nonviable. LV lead positioning was guided by acute hemodynamic response (AHR). After implantation, CT-SQUEEZE target segments were compared with AHR-target segments[7,8] and 70% concordance in target segments between both methods was found. AHR during pacing was not significantly lower in the CT-SQUEEZE target segments in comparison with the best achievable AHR and similar to pacing segments with latest electrical delay ("Q-LV"). Conversely, LV pacing in scar led to a considerable reduction in AHR. The principal finding was that CT-SQUEEZE may be a valuable tool to guide LV lead placement.

The authors are the first to implement an algorithm that computes mechanical activation from CT data sets for LV lead guidance in patients undergoing CRT and should therefore be congratulated for the novelty of their work. Moreover, they took the initiative to provide alternatives for DE-CMR scar assessment in patients with preexisting pacing systems, a study population that has been underexposed in previous studies about LV lead placement. Nonetheless, several limitations should be acknowledged, the majority of them already pointed out by the authors. First, CT assessment of scar was done by contrast enhancement ($n = 1$) or subjective judgment of wall thinning and hypoperfusion. However, in the end only low-amplitude strain was used to exclude segments as target. Second, CT-SQUEEZE circumferential strain has been validated against CMR tagging in an animal model of ischemia, but the reliability of associating low-amplitude strains from this metric as scar yet remains to be investigated.[10] Finally, although the sample size is sufficient for a feasibility study, the generalization of concordance between the AHR and the CT-SQUEEZE target segment remains limited.

The hypothesis that pacing at a site of delayed activation leads to more resynchronization, and subsequently improved clinical outcome seems plausible from an electrophysiological point of view. Nevertheless, data supporting this notion are limited to single-center studies using different imaging modalities and algorithms for mechanical activation computation. In the TARGET study, the mortality rate was indeed lower when the LV lead was placed in the latest activated region defined by speckle-tracking echocardiography.[3] However, even more mortality risk reduction was observed when the LV lead was placed remote from scar, suggesting that avoiding scar is more important than targeting latest activated regions. Another concern about the concept of positioning the LV lead in the segment with latest activation at baseline is that during right ventricular pacing, which is commonly used in CRT as part of biventricular pacing, the location of the latest activation differs from that of intrinsic activation in a large proportion of patients.[11,12] In addition,

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computer simulations showed that the best electrical resynchronization and AHR were achieved when the LV lead was positioned mid-basolateral, as this site induced fast activation of the LV, regardless of underlying conduction disturbance.[13]

Taken collectively, avoiding scar appears to be the priority for optimal LV lead placement. Accurate scar assessment in this context is therefore relevant, and thus validating imaging modalities other than DE-CMR for this purpose is desired. An additional advantage of CT-based scar assessment over DE-CMR may be the ability to evaluate the anatomy of the coronary veins, as it appears that target segments based on scar anatomy or activation are irrelevant in the absence of a coronary vein in that region.

In conclusion, positioning the LV lead remote from scar is relevant for optimal CRT response and may even more important than targeting regions of late activation. Evaluating scar by CT seems a promising method for LV lead guidance in patients with contraindication for CMR and may be even more useful for CRT road mapping when coronary venous anatomy is assessed preprocedurally as well.

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