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When limited by cost in CRT-be a leftist!

Cardiac resynchronization therapy (CRT) over last two decades has transformed the management expectations of diligently selected patients with systolic heart failure. While the true inception of the idea dates back to 1925 when Wiggers showed that surface stimulation of the canine myocardium reduced the maximal LV pressure derivative (LV dp/dt_{max}) and lengthened isometric contraction, the observation in the 1980s by Grines et al. that LBBB reduces diastolic filling time and the septal contribution to LV ejection was sentinel to further developments. By 1990s a link emerged between electrical dyssynchrony and LV function and in 1987, Mower devised and was granted a patent for the concept of “biventricular pacing,” explicitly aimed at heart failure (HF) treatment [2].

However, the Achilles' heel for widespread benefit of this notion of biventricular (BiV) pacing remained the overall 30% non-responders and prohibitive cost in countries with no insurance backups for the masses. The latter has been a key issue in developing countries like India. The concept of LV (only) pacing emerged over last decade, has found some doubtful utility in non-responders to biventricular pacing and has been proven to be equal or non inferior to biventricular pacing in some studies. This led ESC guidelines to include it as an alternate to biventricular pacing in 2013 [3]. The algorithms like RV sense triggered LV pacing further pushed these developments.

Theoretically, LV mode may have some advantages over the BiV mode including increased longevity of the device and hence decreased cumulative costs. At times if the RV lead performance is compromised, a repeat surgery can be avoided by switching to changing the pacing mode from BiV to LV only [4]. But the cost reduction would be attended in real sense only when reasonably sufficient evidence arises for customizing an A-V Sequential/dual chamber pacing to deliver RA sense and LV only pacing. Another reason in favor of LV-only pacing regards specific categories of patients (patients with indication for CRT and frequent hospitalizations for HF, not requiring implantable cardioverter defibrillator back-up) in whom atrial-synchronous LV-only pacing can be achieved with cheaper solutions (i.e. a coronary sinus lead connected to a conventional DDD device) [5,8].

The present issue of this journal presents interesting data on application of customized dual chamber or VDD pacing to deliver optimized LV only pacing with electrical and mechanical fusion with intrinsic QRS [1]. However, AV conduction is variable is largely unpredictable due to circadian cycle, autonomic tone and drug therapy. Pacing algorithms like dynamic sense AV delays or negative AV hysteresis traditionally in CRT devices may prove helpful

if implemented in dual chamber pacemakers as well.

A series of observational studies and a few randomized studies aimed to compare the efficacy of BiV stimulation and LV-only stimulation in patients with moderate to severe HF; a meta-analysis supports the potential clinical value of LV-only pacing in candidates for CRT and may be of interest for a variety of reasons [7]. While some studies found no significant difference between BiV pacing and LV only pacing vis-à-vis the hemodynamic responses, DECREASE-HF Trial showed simultaneous BiV pacing was associated with a trend toward greater improvement in LV size compared with LV pacing. The GREATER-EARTH investigators report that LV stimulation was not reported to be superior to biventricular stimulation for CRT, although it appears to be safe and effective. GREATER-EARTH trial has significance also because it provides some rationale for initiating a programming change (BiV to LV) for a CRT device recipient who does not demonstrate clinical improvement [6].

We encountered a similar clinical scenario some time back. A 60 year old lady with chronic heart failure (LVEF 0.16, LVEDD 6.9 cm) with LBBB (QRS 160 ms) underwent a CRT-D implant. During her follow up she turned out a super responder with LVEDD after 6 months of implant reduced to 4.8 cm and LVEF jumped to 0.58. Unfortunately, the RV pacing threshold increased markedly, requiring high RV outputs. This expectedly decreased the estimated battery life to 2 years. So to overcome this problem, now she has been put on atrial sense and LV (only) pacing mode. She continues to have normal LVEF after 1 month of this switching, but only a longer follow-up would throw light on sustained improved LV function (Fig. 1).

The LV only mode of CRT needs to be tested against the mammoth large-scale clinical trials' evidence for conventional CRT devices. Another issue will be that all bradycardia pacing lead timing and therapy delivery are determined by right ventricular lead based sensing. It is unclear whether LV CRT offers any advantage to the future development of CRT LV leads or devices beyond BiV CRT. For the foreseeable future, sensing and treating bradyarrhythmia and tachyarrhythmia will require a right ventricular lead. The investment in clinical science required to establish the epicardial transvenous LV lead for these purposes is unlikely to occur. Current transvenous LV lead development is directed more toward solving clinical issues like high capture thresholds and phrenic nerve stimulation as part of a biventricular system. There may a greater interest in LV CRT with stimulation technologies that do not require a transvenous lead such as ultrasound-mediated pacing because leadless CRT may offer distinct advantages by reducing lead-related complications and may offer a more site-specific option to placement of the LV lead. It should be

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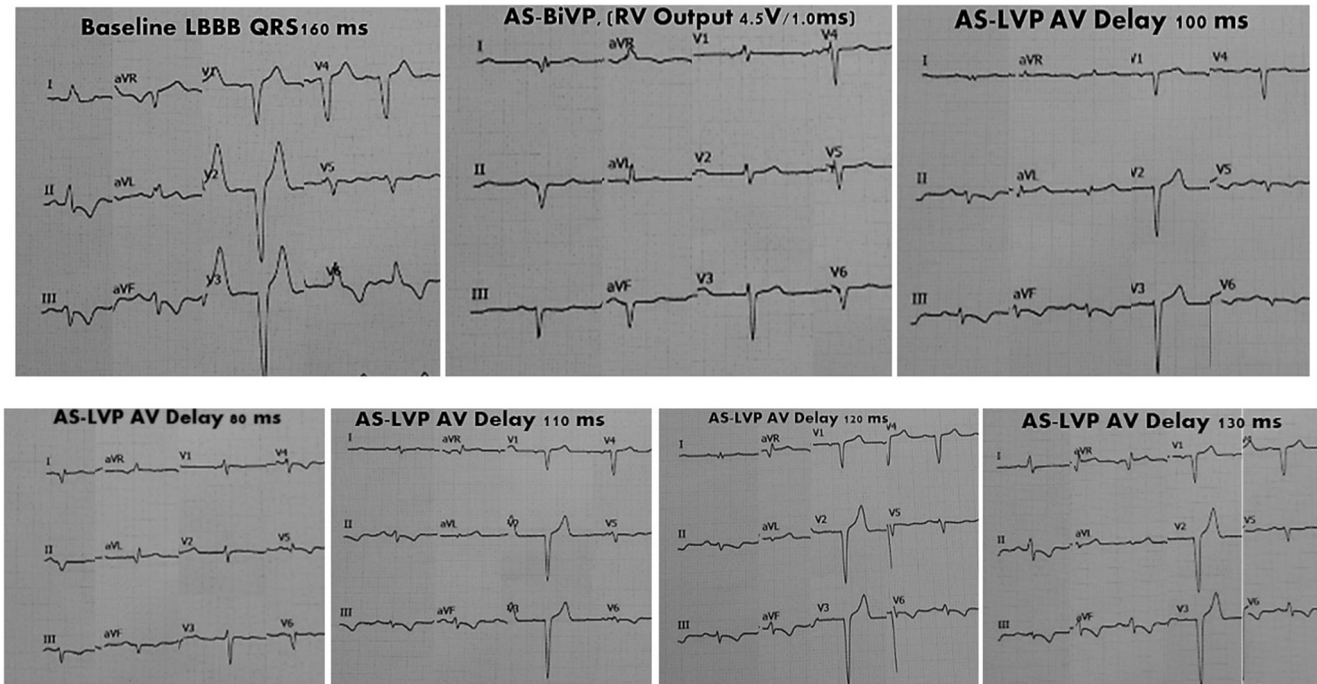


Fig. 1. The QRS morphologies with variable AV delays at Atrial Sense (AS) and Left Ventricle Pace (LVP) to create fused complexes.

noted that less than 500 patients have been studied with LV CRT over a nearly 10-year interval and with no more than 6–12 months of follow-up. In addition, unlike the confluence of consistent data from 2 large-scale clinical trials on BiV CRT, no study that has evaluated LV CRT has been powered to assess hospitalization and mortality outcomes. This is important because the mechanisms of mortality benefit with BiV CRT may extend beyond the establishment of mechanical synchrony with LV stimulation and may be right ventricular lead dependent.

Whereas, currently, there is limited reason not to place a right ventricular lead in a CRT system, because it is essential for defibrillation, the rationale for eliminating a right ventricular lead will likely become increasingly relevant with the development of new left ventricular leads (eg, multipolar or with defibrillation capacity) and novel implantation techniques. Currently, LV-only pacing may be considered as an additional possibility for improving the outcome of HF patients who are candidates for CRT, with effects similar to conventional BiV pacing. This possibility, also achievable with rather simple pacing systems, may be attractive in an era of economic constraints.

References

- [1] Rai MK, Prabhu MA, Sharma A, Vekariya R, Kamath P, Pai N, Kamath RL. 'Optimized' LV only pacing using a dual chamber pacemaker as a cost effective alternative to CRT. *Indian Pacing Electrophysiol J* 2017;17(3):72–7.
- [2] Leyva F, Nisam S, Auricchio A. 20 Years of cardiac resynchronization therapy. *JACC* 2014;64(10).
- [3] Faghfourian B, Homayoonfar S, Rezvanjoo M, Poorolajal J. Comparison of hemodynamic effects of biventricular versus left ventricular only pacing in patients

receiving cardiac resynchronization therapy: a before–after clinical trial. *J Arrhythm* 2017;33(2):127–9.

- [4] Rajni KR, Kumar UN, Schafer J, et al. Reduced ventricular volumes and improved systolic function with cardiac resynchronization therapy a randomized trial comparing simultaneous biventricular pacing, sequential biventricular pacing, and left ventricular pacing. *Circulation* 2007;115:2136–44.
- [5] Saxon LA. Left ventricular versus biventricular for cardiac resynchronization therapy comparable but not equal. *Circulation* 2011;124:2803–4.
- [6] Thibault B, Ducharme A, Harel A, White A, Meara E, Guertin MC, et al. Left ventricular versus simultaneous biventricular pacing in patients with heart failure and a QRS complex >120 milliseconds evaluation of resynchronization therapy for heart failure (GREATER-EARTH) investigators. *Circulation* 2011;124:2874–81.
- [7] Boriani G, Gardini B, Diemberger I, Reggiani MR, Biffi M. Meta-analysis of randomized controlled trials evaluating left ventricular vs. biventricular pacing in heart failure: effect on all-cause mortality and hospitalizations. *Eur J Heart Fail* 2012;14:652–60.
- [8] Leclercq C, Ansalone G, Gadler F, Boriani G. Biventricular vs. left univentricular pacing in heart failure: rationale, design, and endpoints of the B-LEFT HF study. *Europace* 2006;8:76–80.

Aniruddha Vyas, Cardiologist*
Medanta Hospital, Indore, India

Yash Lokhandwala
Arrhythmia Associates, Mumbai, India

* Corresponding author. Holy Family Hospital & Research Center, St Andrews Road, Bandra (W), Mumbai, India.
E-mail address: draniruddhavyas@gmail.com (A. Vyas).

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