Cardiac Resynchronization Therapy (CRT) involves placing several electrodes in the heart in an attempt to synchronize a dysynchronous heart chamber. According to the Ottawa Heart Institute, however, only 50% of patients respond positively to CRT treatment, based on evidence of reverse remodeling characterized by a 15% decrease in left ventricular (LV) end systolic volume (ESV). Furthermore, in 16% of cases treated with CRT, patient condition actually deteriorates as demonstrated by the PROSPECT study. Pacing at the wrong lead location can cause an immediate increase in intra-ventricular dyssynchrony. Several approaches have attempted to improve patient response by using echocardiographic guidance or hemodynamic feedback from a pressure sensor (+dP/dtmax) to test different pacemaker settings. Those attempts to date have been unsuccessful.

The positioning of the pacing electrodes can vary considerably from patient to patient. The best lead position locations are those that yield an acute improvement in pumping function as can be determined by LV pressure volume (PV) analysis. It has been demonstrated that these acute hemodynamic locations predicted the positive response to CRT due to the strong predictive power of the PV analysis. With guidance from intracardiac PV measurements, positive CRT response rate increased markedly up to 77% positive response based on reverse remodelling.

Quotes from literature

“The major finding of the study is the clear association of acute pump function improvement with reverse remodelling after 6 months of CRT. Furthermore, the data strongly suggest that acute stroke work (SW) improvement predicts long term response to CRT more accurately as compared with other invasively measured variables such as dP/dtmax.”

“In the present study, a 71% long-term response rate was observed in the overall population, whereas the response rate would rise to a substantial 77%, if the ‘narrow’ QRS (<120 ms) patients were to be excluded.”

Pressure-volume loops of two different patients during baseline (dotted) and during biventricular pacing (dark blue). Figure A shows substantial acute change in a long-term responder. Figure B shows negligible acute change in a long-term non-responder.
A recent editorial by Mafi Rad et al. reviewed the study by de Roest et al. and stated:

“The strong predictive power of the PV loop measurements as shown in this study, could allow a strategy in which CRT would be denied to patients who do not show a significant PV loop response.”

“This approach may have important additional value in subsets of patients in whom there is less consensus for a clinical benefit, i.e. patients with right bundle branch block, intraventricular conduction delay, or narrow QRS.”

“PV loop measurements could also be performed to optimize the LV lead position which has been shown to improve response to CRT.”

“This approach may particularly benefit patients with ischaemic cardiomyopathy, in whom implantation of the LV lead at areas with myocardial scar has been shown to reduce CRT effectiveness, de Roest et al. performed PV loop-guided lead position optimization and observed a considerably higher response rate compared with those reported in the literature.”

By adopting PV loops in standard clinical practice to guide CRT, the potential impact on cost savings is significant.

These cost savings are based on:

1) Sixteen percent of patients indicated for CRT show hemodynamic worsening by BiV pacing revealed by the PV technique. In such cases no pacemaker is implanted, resulting in direct cost savings by removing the material expense of the pacemaker.

2) The percentage of patients responding to CRT may improve from 50% up to 80%. The non-responder group, post implant, falls back on conventional treatment with frequent hospitalizations. As such, improvements in response rate constitute indirect savings. Also, benefits of CRT in the positive responder group may be further improved by the PV guided lead positioning contributing to the indirect savings.

References