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CLINICAL RESEARCH

First experience of intraoperative echocardiography-guided optimization of cardiac resynchronization therapy delivery

Première expérience d'optimisation de la thérapie de resynchronisation cardiaque par une échocardiographie peropératoire

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KEYWORDS
Cardiac resynchronization therapy;
Mechanical dyssynchrony

Summary
Background. — Insufficient correction of mechanical dyssynchrony is a cause of non-response to cardiac resynchronization therapy (CRT).
Aims. — To determine if CRT delivery could be optimized during the implantation procedure by choosing the number and location of pacing sites using echocardiography guidance.
Methods. — In patients with a QRS ≥ 150 ms or a QRS < 150 ms and criteria for mechanical dyssynchrony, the objective of the implantation procedure was to shorten the left pre-ejection interval

Abbreviations: CRT, Cardiac resynchronization therapy; DDD, Dual-chamber; IVMD, Interventricular mechanical delay; LPEI, Left pre-ejection interval; LSWMD, Lateral-to-septal wall motion delay; LV, Left ventricular; LVEF, Left ventricular ejection fraction; LVET, Left ventricular ejection time; LVFT, Left ventricular filling time; MVRS/LAS, Mitral valve regurgitant surface divided by left atrial surface; NYHA, New York Heart Association; RPEI, Right pre-ejection interval; RV, Right ventricular; TDS, Total duration of systole.

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Left pre-ejection interval;
Intraoperative echocardiography;
Triple-site ventricular stimulation

(LPEI), measured online, by at least 10 ms compared with standard biventricular configuration, by moving the right ventricular (RV) lead at different locations and, if necessary, by adding a second RV lead.
Results. — Ninety-one patients (70 men; mean age 73 ± 10 years; left ventricular [LV] ejection fraction 29 ± 10%) were included. The final pacing configuration was standard biventricular in 15 (17%) patients, optimized biventricular in 22 (24%) and triple-site ventricular in 54 (59%). LPEI was shortened by ≥ 10 ms compared with standard biventricular stimulation in 73 (80%) patients. Compared with standard biventricular pacing, the final optimized pacing configuration improved global intraventricular synchrony (decreasing LPEI from 158 ± 36 ms to 134 ± 29 ms; $P < 0.001$), LV systolic efficiency (decreasing LPEI/LV ejection time from 0.58 ± 0.18 to 0.46 ± 0.13; $P < 0.001$) and LV filling (increasing LV filling time/RR from 44 ± 8% to 47 ± 7%; $P < 0.001$) and decreased mitral valve regurgitation.
Conclusion. — Intraoperative echocardiography-guided placement of RV lead(s) during CRT implantation is feasible and acutely improves LV synchrony compared with standard biventricular stimulation.

MOTS CLÉS
Thérapie de resynchronisation cardiaque ;
Désynchronisation mécanique ;
Délai pré-éjectionnel gauche ;
Échocardiographie peropératoire ;
Stimulation triple-site ventriculaire

Résumé
Contexte. — La correction insuffisante de la désynchronisation mécanique est une cause de non-réponse à la thérapie de resynchronisation cardiaque (CRT).
Objectif. — Déterminer si la CRT est optimisable durant l'implantation en faisant varier le nombre et le site de stimulation par guidage échocardiographique.
Méthodes. — Chez des patients avec un QRS ≥ 150 ms ou avec un QRS < 150 ms et une désynchronisation mécanique, l'objectif de la procédure d'implantation était de raccourcir le délai pré-éjectionnel gauche (LPEI), mesuré en temps réel, de ≥ 10 ms par rapport à la configuration biventriculaire standard, en déplaçant la sonde ventriculaire droite (VD) et si nécessaire en ajoutant une seconde sonde VD.
Résultats. — Quatre-vingt onze patients (70 hommes ; âge 73 ± 10 ans ; FEVG 29 ± 10 %) ont été inclus. La configuration de stimulation finale était biventriculaire standard chez 15 (17 %) patients, biventriculaire optimisé chez 22 (24 %) et triple-site ventriculaire chez 54 (59 %). L'objectif a été atteint chez 73 (80 %) patients. Comparée à la stimulation biventriculaire standard, la configuration de stimulation finale, optimisée, a amélioré la synchronisation intraventriculaire globale (LPEI raccourci de 158 ± 36 ms à 134 ± 29 ms ; $p < 0{,}001$), l'efficience systolique du ventricule gauche (VG) (LPEI/temps d'éjection VG diminuant de 0,58 ± 0,18 à 0,46 ± 0,13 ; $p < 0{,}001$), le remplissage VG (remplissage VG/RR augmentant de 44 ± 8 % à 47 ± 7 % ; $p < 0{,}001$) et a diminué l'insuffisance mitrale.
Conclusion. — Le guidage de la mise en place de la (des) sonde(s) VD durant l'implantation de la CRT par une échocardiographique peropératoire est faisable et améliore en aigu la synchronisation VG comparé à la stimulation biventriculaire standard.

Introduction

Cardiac resynchronization therapy (CRT) is an effective treatment for patients with symptomatic heart failure, low left ventricular ejection fraction (LVEF) and a wide QRS [1]. In controlled clinical trials, at least one third of patients do not respond clinically to CRT [2—6]. The causes of non-response are various, including improper patient selection and therapy delivery. Patient selection is presently based on QRS morphology and QRS width [1], but this approach could be too simplistic, as some wide QRS patients do not take advantage of CRT. Additionally, narrow QRS patients do not seem to benefit from standard implantation techniques, as demonstrated in EchoCRT trial [7], and alternative procedures are needed to address this particular patient population.

From a global mechanical perspective, the effect of resynchronization may be viewed as improvement of left ventricular (LV) efficiency by shortening the total systole duration without shortening the LV ejection time (LVET) [8], with a consequent increase in LV filling time (LVFT). In a previous study in patients with a QRS < 150 ms, we showed that selecting patients with pre-existing left atrioventricular, interventricular and/or temporal but not spatial left intraventricular dyssynchrony was associated with improved clinical response to CRT [9], irrespective of baseline QRS width and QRS change after CRT. However, and despite the optimized selection process, effective and/or optimal correction of mechanical dyssynchrony could not be achieved