JACC: CARDIOVASCULAR IMAGING
VOL. ■, NO. ■, 2017

ISSN 1936-878X/$36.00
PUBLISHED BY ELSEVIER
http://dx.doi.org/10.1016/j.jcmg.2016.08.015

Long-Term Outcome After CRT in the Presence of Mechanical Dyssynchrony Seen With Chronic RV Pacing or Intrinsic LBBB

Ivan Stankovic, MD,[a,b] Christian Prinz, MD, PhD,[c] Agnieszka Ciarka, MD, PhD,[a] Ana Maria Daraban, MD,[a,d] Yujing Mo, MD,[e] Marit Aarones, MD, PhD,[f] Mariola Szulik, MD,[g] Stefan Winter, MD,[h] Aleksandar N. Neskovic, MD, PhD,[b] Tomasz Kukulski, MD, PhD,[g] Svend Aakhus, MD, PhD,[f,i] Rik Willems, MD, PhD,[a] Wolfgang Fehske, MD, PhD,[h] Martin Penicka, MD, PhD,[e] Lothar Faber, MD, PhD,[b] Jens-Uwe Voigt, MD, PhD[a]

ABSTRACT

OBJECTIVES The aim of this study was to compare the volumetric response and the long-term survival after cardiac resynchronization therapy (CRT) in patients with intrinsic left bundle branch block (LBBB) versus chronic right ventricular pacing (RVP) with respect to the presence of mechanical dyssynchrony (MD).

BACKGROUND Chronic RVP induces an iatrogenic LBBB and asynchronous left ventricular contraction that is potentially reversible by upgrading to CRT.

METHODS A total of 914 patients eligible for CRT (117 with conventional pacemakers and 797 with intrinsic LBBB) were included in the study. MD was visually assessed before CRT and was defined as the presence of either apical rocking and/or septal flash on baseline echocardiograms. Patients with a left ventricular end-systolic volume decrease of ≥15% during the follow-up were considered responders. Patients were followed for all-cause mortality during the median follow-up of 48 months (interquartile range: 29 to 66 months).

RESULTS MD was observed in 51% of patients with RVP versus 77% in patients with intrinsic LBBB ($p < 0.001$). Patients with RVP and MD had a similar likelihood of volumetric response as did patients with intrinsic LBBB and MD (adjusted odds ratio: 0.71; 95% confidence interval: 0.33 to 1.53; $p = 0.385$). There was no significant difference in long-term survival between patients with RVP and intrinsic LBBB (adjusted hazard ratio: 1.101; 95% confidence interval: 0.658 to 1.842; $p = 0.714$). Patients with visual MD and either intrinsic LBBB or RVP had a more favorable survival than those without MD ($p < 0.001$).

CONCLUSIONS The likelihood of volumetric response and a favorable long-term survival of patients with RVP was similar to those of patients with intrinsic LBBB and were mainly determined by the presence of MD and not by the nature of LBBB. (J Am Coll Cardiol Img 2017;■:■–■) © 2016 by the American College of Cardiology Foundation.

From the [a]Department of Cardiovascular Diseases, University Hospital Gasthuisberg, Catholic University Leuven, Leuven, Belgium; [b]Department of Cardiology, Clinical Hospital Centre Zemun, Faculty of Medicine, University of Belgrade, Belgrade, Serbia; [c]Department of Cardiology, Heart and Diabetes Centre of North-Rhine Westphalia, Ruhr University Bochum, Bad Oeynhausen, Germany; [d]Department of Internal Medicine and Gastroenterology, Clinical Emergency Hospital, University of Medicine and Pharmacy "Carol Davila," Bucharest, Romania; [e]Cardiovascular Center Aalst, OLV Clinic, Aalst, Belgium; [f]Department of Cardiology, Oslo University Hospital, Rikshospitalet, Oslo, Norway; [g]Department of Cardiology, Congenital Heart Diseases and Electrotherapy, Silesian Medical University- Katowice, Silesian Center for Heart Diseases, Zabrze, Poland; [h]Klinik für Innere Medizin und Kardiologie, St. Vinzenz Hospital, Cologne, Germany; and the [i]Faculty of Medicine, Norwegian University of Science and Technology, Trondheim, Norway. Dr. Stankovic was supported by a research grant from the European Association of Cardiovascular Imaging. Dr. Daraban was supported by a research grant from the European Heart Failure Association. Dr. Neskovic is partially supported by a grant (175099) of the Ministry of Science, Republic of Serbia. Dr. Willems has received research funding from Biotronik, Boston Scientific Belgium, and Medtronic Belgium; has received speakers' and consultancy fees from and participated in clinical trials by different manufactures of cardiac implantable electronic devices (Medtronic, Boston Scientific, Biotronik, St. Jude Medical, Sorin); and is supported as a clinical researcher by the Fund for Scientific Research Flanders. Dr. Voigt is supported by a research grant of the University Hospitals Leuven (OT/12/085); and holds a personal research mandate from the Flemish Research Foundation (1832912N). All other authors have reported that they have no relationships relevant to the contents of this paper to disclose.

Manuscript received June 16, 2016; revised manuscript received August 15, 2016, accepted August 26, 2016.

ABBREVIATIONS AND ACRONYMS

ApRock = apical rocking

ATM = apical transverse motion

CI = confidence interval

CRT = cardiac resynchronization therapy

LBBB = left bundle branch block

LV = left ventricle

LVEF = left ventricular ejection fraction

NYHA = New York Heart Association

RVP = right ventricular pacing

SF = septal flash

Cardiac resynchronization therapy (CRT) has become a standard therapeutic option for patients with chronic heart failure and wide QRS complex who remain symptomatic despite optimal medical therapy (1). However, a high rate of nonresponders to this expensive treatment remains unaffected despite years of accumulated experience and technological advances. However, patients with wide QRS width and left bundle branch block (LBBB) morphology have the highest likelihood of improvement after CRT (1). It leads to an early activation of the ventricular septum and a delayed activation of posterolateral wall and may result in dyssynchronous left ventricle (LV) contraction and deleterious remodeling (2,3). This typical contraction pattern induced by an intrinsic LBBB can be described by septal flash (SF) and apical rocking (ApRock) and is potentially correctable by CRT (4-7). Successful correction of SF and ApRock has been associated with volumetric response and an improved long-term survival following CRT but neither all patients with intrinsic LBBB exhibit SF and ApRock nor all benefit from CRT (8-11).

Chronic right ventricular pacing (RVP) in patients with bradyarrhythmias prolongs the QRS duration and induces an asynchronous electrical activation pattern of the LV similar to that of an intrinsic LBBB (2,12). Similar to patients with intrinsic LBBB, patients with chronic RVP may also benefit from upgrading to biventricular pacing (13,14) but the prevalence and prognostic implications of SF and ApRock in this subgroup of patients are unknown. Furthermore, the studies comparing long-term outcomes between the CRT candidates with RVP and an intrinsic LBBB are scarce.

In this retrospective analysis of the PREDICT-CRT study, we assessed the prevalence of visual SF/ApRock in patients with heart failure with conventional pacemakers who underwent upgrading to CRT and also compared the long-term survival after CRT in patients with intrinsic LBBB versus RVP with respect to the presence of visual mechanical dyssynchrony.

METHODS

The primary results of the PREDICT-CRT study have been published (9). After excluding all patients with non-LBBB QRS morphology from the PREDICT-CRT study population, a total of 914 patients (117 with conventional pacemakers and 797 with intrinsic LBBB) who underwent CRT according to guideline criteria (LV ejection fraction [LVEF] ≤35%, QRS duration ≥120 ms, New York Heart Association [NYHA] functional class II-IV, and on optimized pharmacological therapy at least 3 months before implantation) were included into this retrospective analysis. The availability of standard echocardiographic examination before CRT was also a prerequisite for inclusion. LBBB was defined according to conventional criteria: a wide QRS, QS, or rS in lead V1, and monophasic R wave with no Q waves in leads V6 and I. Patients with ischemic origin of heart failure, proven by coronary angiography or by a documented history of myocardial infarction, were eligible for the study provided they were optimally revascularized. Data on all-cause mortality were acquired from medical records, by interview with the patients' general practitioner or relatives, and/or from national death registries. The study was approved by the ethical committee of the University Leuven.

ECHOCARDIOGRAPHIC DATA. Echocardiographic data were acquired using commercially available scanners (Vivid 7 and E9, GE Vingmed Ultrasound, Horten, Norway) and digitally stored for off-line analysis using EchoPac (GE Vingmed Ultrasound). To assess the volumetric response to CRT, the LV volumes and LVEF were calculated using the modified biplane Simpson method. Patients with an LV end-systolic volume decrease of ≥15% during follow-up were regarded as responders (15).

VISUAL ASSESSMENT OF MECHANICAL DYSSYNCHRONY. Mechanical dyssynchrony was visually assessed by evaluating ApRock and SF and was defined as a presence of either ApRock or SF. This method for assessing dyssynchrony has been described and evaluated in previous studies (6,9). Briefly, in the apical 4-chamber view, ApRock is characterized by a short septal motion of the apex caused by early septal contraction in systole and a subsequent long motion to the lateral wall during ejection phase (**Figure 1**, Online Videos 1 and 2). The presence of SF was identified visually in apical 4-chamber view as a short inward motion of the septum in early systole (within the QRS width) (Online Video 1). All readings were initially performed by 2 readers blinded to clinical data, using the same criteria for patients with RVP and intrinsic LBBB. In case of disagreement, the readings of a blinded third reader were used to reach a majority decision.

QUANTIFICATION OF MECHANICAL DYSSYNCHRONY. Quantification of SF and ApRock was performed in a subset of patients and the results compared with those obtained by visual approach. ApRock was quantified by measuring apical transverse motion