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ScienceDirect

Journal of Electrocardiology 51 (2018) 175–181

JOURNAL OF Electrocardiology

www.jecgonline.com

Patients with left bundle branch block and left axis deviation show a specific left ventricular asynchrony pattern: Implications for left ventricular lead placement during CRT implantation☆,☆☆

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Abstract

Background: Left bundle branch block (LBBB) and left axis deviation (LAD) patients may have poor response to resynchronization therapy (CRT). We sought to assess if LBBB and LAD patients show a specific pattern of mechanical asynchrony.

Methods: CRT candidates with non-ischemic cardiomyopathy and LBBB were categorized as having normal QRS axis (within −30° and +90°) or LAD (within −30° and −90°). Patients underwent tissue Doppler imaging (TDI) to measure time interval between onset of QRS complex and peak systolic velocity in ejection period (Q-peak) at basal segments of septal, inferior, lateral and anterior walls, as expression of local timing of mechanical activation.

Results: Thirty patients (mean age 70.6 years; 19 males) were included. Mean left ventricular ejection fraction was 0.28 ± 0.06. Mean QRS duration was 172.5 ± 13.9 ms. Fifteen patients showed LBBB with LAD (QRS duration 173 ± 14; EF 0.27 ± 0.06). The other 15 patients had LBBB with a normal QRS axis (QRS duration 172 ± 14; EF 0.29 ± 0.05).

Among patients with LAD, Q-peak interval was significantly longer at the anterior wall in comparison to each other walls (septal 201 ± 46 ms, inferior 242 ± 58 ms, lateral 267 ± 45 ms, anterior 302 ± 50 ms; $p < 0.0001$). Conversely, in patients without LAD Q-peak interval was longer at lateral wall, when compared to each other (septal 228 ± 65 ms, inferior 250 ± 64 ms, lateral 328 ± 98 ms, anterior 291 ± 86 ms; $p < 0.0001$).

Conclusions: Patients with heart failure, presenting LBBB and LAD, show a specific pattern of ventricular asynchrony, with latest activation at anterior wall. This finding could affect target vessel selection during CRT procedures in these patients.

Keywords: CRT; left blunde block; left axis deviation; Tissue doppler

Cardiac resynchronization therapy (**CRT**) is an established treatment for selected patients with heart failure. The main mechanism underlying CRT efficacy is deemed to be the correction of the systo-diastolic dyssynchrony occurring between the interventricular septum and the left ventricular (**LV**) free wall, which, to a variable extent, may be associated with intraventricular conduction disturbances, mainly left bundle branch block (**LBBB**) [1]. The achievement of a good response to CRT depends on several factors, including among others the distance of the LV lead from the latest activated area of the left ventricle [2]. In most cases, the latter is located within the lateral or postero-lateral wall [3], that, accordingly, are preferably targeted during the implant procedure. However, a substantial variability of LV mechanical and electrical activation sequence has been described in LBBB patients [4–6]; therefore, the latest activated LV area may not be the one where the lead is more frequently positioned.

Only limited data are available on the relationship between some features of the surface ECG and the LV mechanical activation sequence. It has been reported that patients with LBBB and left QRS axis deviation (**LAD**) may

☆ Conflicts of interest: nothing to declare.

☆☆ The first and second author equally contributed to the design, drawing, data collection, drafting and review of the text.

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https://doi.org/10.1016/j.jelectrocard.2017.10.006
0022-0736/

have a worse response to CRT than patients with normal QRS axis [7]. We sought to determine, by tissue Doppler imaging (**TDI**), whether the mechanical activation sequence of the left ventricle in patients with LBBB and LAD is characterized by a specific asynchrony pattern.

Methods

Patients population

Consecutive patients undergoing CRT implant between December 2014 and April 2015 were screened for inclusion. They had been selected for CRT according to current guidelines [8]. Patients with ischemic cardiomyopathy were excluded. The patients were considered eligible for the study if they were in sinus rhythm and had complete LBBB at the surface electrocardiogram. Patients presenting with right bundle branch block or intraventricular conduction delay were excluded. LBBB was defined according to HRS recommendations for the standardization and interpretation of the electrocardiogram [9].

Subsequently, electrocardiograms were screened for the presence of LAD by two experienced electrophysiologists. Normal QRS axis was assumed to be within −30° and 90°. LAD was diagnosed if QRS axis was between −30° and −90° (Fig. 1). In addition to a conventional echocardiographic evaluation, all selected patients underwent TDI, to evaluate the mechanical activation sequence of the left ventricle prior to implantation of the CRT device.

LV dyssynchrony assessment

Echocardiographic examinations were performed by a single, trained in imaging, cardiologist in order to avoid, in an initial phase, inter-observer variability. He is blinded to the clinical and electrocardiographic data. A Vivid E9 (General Electric, Milwaukee, USA) was used to perform exams. Data were analyzed offline with commercial software.

TDI was performed by means of pulsed-wave Doppler from two apical views (four-chamber and two-chamber) to assess LV regional timing of mechanical activation. The sample volume was placed at the basal segments of the septal, inferior, lateral and anterior walls. Gain and filters were adjusted, when required, to eliminate background noise and to obtain well defined signals. In order to optimize frame rate, sector width was narrowed to the wall of interest. Tissue Doppler signals were recorded at a sweep of 100 mm/s. In some cases, the times of aortic valve opening and closure from the pulsed-wave Doppler signals were used as a reference to correctly identify the LV ejection period. For each segment, measures were obtained in held expiration from three consecutive heart beats and the average was calculated offline.

The time interval between the onset of the QRS complex and the peak of systolic velocity in the ejection period (Q-peak interval) was measured for each segment, as expression of local electromechanical delay. Subsequently, the latest mechanically activated LV segment between those examined was determined for each patient, as the one with the most prolonged Q-peak interval.

In two patients with LBBB and LAD who underwent electrophysiological study and catheter ablation before the CRT procedure, the electrical activation sequence of the left ventricle was reconstructed by electroanatomical mapping (CARTO, Biosense Webster Inc., Diamond Bar, California, USA) [10].

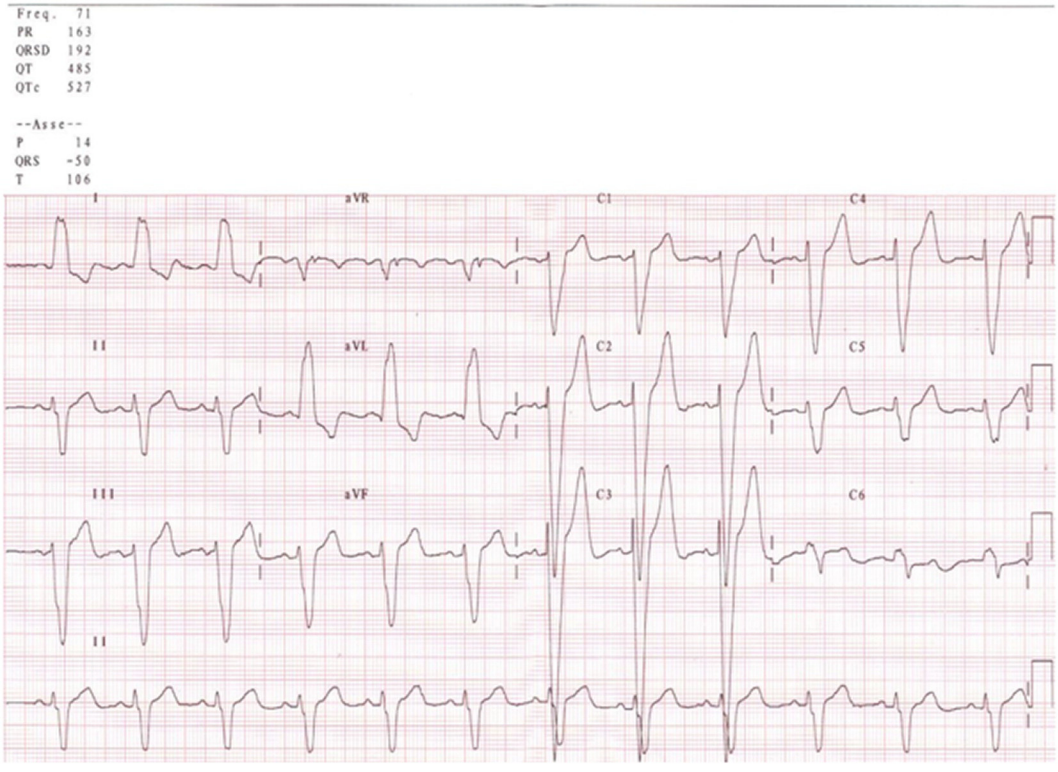

Fig. 1. Twelve-lead surface electrocardiogram of a patient with LBBB and left QRS axis deviation.