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RESEARCH LETTER

Left bundle branch block criteria in the 2021 ESC guidelines on CRT: a step back in identifying CRT candidates?

Ahmed S. Beela [1,2]*, Jesse H.J. Rijks [3], Claudia A. Manetti[1], Kevin Vernooy [3], A.M.W. van Stipdonk[3], Frits W. Prinzen[4], Tammo Delhaas [1], Lieven Herbots [5,6], and Joost Lumens [1]

[1]Department of Biomedical Engineering, Cardiovascular Research Institute Maastricht (CARIM), Maastricht University Medical Center (MUMC+), 6200 MD Maastricht, The Netherlands; [2]Department of Cardiovascular Diseases, Faculty of Medicine, Suez Canal University, 41522 Ismailia, Egypt; [3]Department of Cardiology, Cardiovascular Research Institute Maastricht (CARIM), Maastricht University Medical Center (MUMC+), 6200 MD Maastricht, The Netherlands; [4]Department of Physiology, Cardiovascular Research Institute Maastricht (CARIM), 6200 MD Maastricht, The Netherlands; [5]Department of Cardiology, Jessa Hospital, 3500 Hasselt, Belgium; and [6]Biomedical Research Institute, Faculty of Medicine and Life Sciences, Hasselt University, 3590 Diepenbeek, Belgium

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In the latest version of the European Society of Cardiology (ESC) guidelines on cardiac pacing and cardiac resynchronization therapy (CRT), a new and stricter definition of left bundle branch block (LBBB) was introduced (ESC-2021).[1] In the current work, we investigate the impact of applying the ESC-2021 vs. the ESC-2013 definitions of LBBB on the relation between LBBB at baseline and (i) LV reverse remodelling after CRT and (ii) baseline mechanical dyssynchrony, both assessed by echocardiography.[2]

We retrospectively investigated 244 CRT patients in sinus rhythm from two European centres, Jessa Hospital in Hasselt, Belgium ($n = 164$) and Maastricht University Medical Center+ (MUMC+) in Maastricht, The Netherlands ($n = 80$). Pre-implant ECGs were analysed according to the ESC-2013 and ESC-2021 LBBB definitions (*Table 1*). Mechanical dyssynchrony was evaluated using echocardiography, both qualitatively based on the presence of either apical rocking or septal flash (ApRock/SF),[3] and quantitatively using the strain-derived systolic stretch index (SSI).[4] LV reverse remodelling was measured as the relative change of LV end-systolic volume (LVESV) at 12 ± 6 months follow-up. The study was approved by the Ethics Review Committee of both Jessa Hospital and the MUMC+.

Of the study population, 70% were males and 51% had ischaemic cardiomyopathy. Mean age was 69 ± 10 years and baseline QRS duration 154 ± 24 ms. ApRock/SF was present in 57% of the study population.

Applying the ESC-2021 definition, 18% of the patients ($n = 45$) had LBBB compared with 64% ($n = 157$) when applying the ESC-2013 definition. Stratifying the population per the ESC-2021 guideline classes of recommendation, 14% ($n = 35$) had class I recommendation (LBBB + QRS $\geq$ 150 ms), 44% ($n = 107$) had class IIa (LBBB + QRS 130–149 ms or non-LBBB + QRS $\geq$ 150 ms), 29% ($n = 70$) had class IIb (Non-LBBB + QRS 130–149 ms), and 13% ($n = 32$) were not recommended because of having baseline QRS between 120 and 129 ms. On the other hand, applying the ESC-2013 guidelines, 64% ($n = 157$) had class I (LBBB + QRS $\geq$ 120 ms), 13% ($n = 32$) had class IIa (non-LBBB + QRS $\geq$ 150 ms), and 23% ($n = 55$) had class IIb (Non-LBBB + QRS 120–149 ms), *Figure 1*, top panel.

Assessment of ApRock/SF was successfully conducted in 100% of the study population, whereas SSI was obtained in 88% of cases, limited by suboptimal image quality for strain analysis. The prevalence of ApRock/SF in patients with LBBB was similar between the ESC-2021 and ESC-2013 definitions (80% vs. 73%, respectively). However, among patients without LBBB, the prevalence differed: 52% vs. 30% according to the ESC-2021 vs. the ESC-2013 definitions, respectively. Overall, the agreement between LBBB and ApRock/SF was weak applying the ESC-2021 (kappa agreement coefficient = 0.15, $P = 0.001$) and moderate applying the ESC-2013 (0.41, $P < 0.001$).

Similarly, there was no significant difference in SSI values between patients with and without LBBB according to the ESC-2021 definition (3.0%, interquartile range (IQR): [2.0–5.0] vs. 3.0%, IQR: [1.0–6.0], $P = 0.9$). On the other hand, applying the ESC-2013 definition, patients with LBBB had significantly higher values of SSI compared with patients without LBBB (4.0%, IQR: [2.0–7.0] vs. 2.0%, IQR: [1.0–4.0], $P = 0.001$), *Figure 1*, middle panel.

At CRT follow-up, there was no significant difference in LV reverse remodelling between patients with and without LBBB according to the ESC-2021 definition (44%, IQR: [31–62] vs. 38%, IQR: [20–57], $P = 0.08$), neither among the four ESC-2021 guideline classes. However, when applying the ESC-2013 definition, LV reverse remodelling was significantly more pronounced in patients with LBBB than in patients without LBBB (43%, IQR: [30–63] vs. 31%, IQR: [10–49], $P < 0.01$). In addition, patients with an ESC-2013 class I indication showed significantly more pronounced decrease in LVESV at CRT

* Corresponding author. E-mail: a.salembeela@maastrichtuniversity.nl

Table 1 Criteria of the ESC-2021 and ESC-2013 definitions of LBBB

ESC-2013 definition	ESC-2021 definition
(1) QRS duration ≥ 120 ms.	(1) QRS > _120 ms.
(2) QS or rS in lead V1.	(2) Notches or slurring in the middle third of QRS in at least two of the following leads: V1, V2, V5, V6, I, and aVL—with a prolongation at the delayed peak in R in V5–V6 to longer than 60 ms.
(3) Broad (frequently notched or slurred) R waves in leads I, aVL, V5, or V6.	(3) Generally, the ST segment is slightly opposed to the QRS polarity, and particularly when it is at least 140 ms and is rapidly followed by an asymmetrical T wave also of opposed polarity.
(4) Absent Q waves in leads V5 or V6.	(4) Horizontal plane: QS or rS in V1 with small 'r' with ST slightly elevated and positive asymmetrical T wave and unique R wave in V6 with negative asymmetric T wave. When the QRS is <140 ms, the T wave in V6 may be positive.
	(5) Frontal plane: exclusive R wave in I and aVL often with a negative asymmetrical T wave, slight ST depression, and usually QS in aVR with positive T wave.
	(6) The QRS axis is variable.

ESC, European Society of Cardiology; LBBB, left bundle branch block.

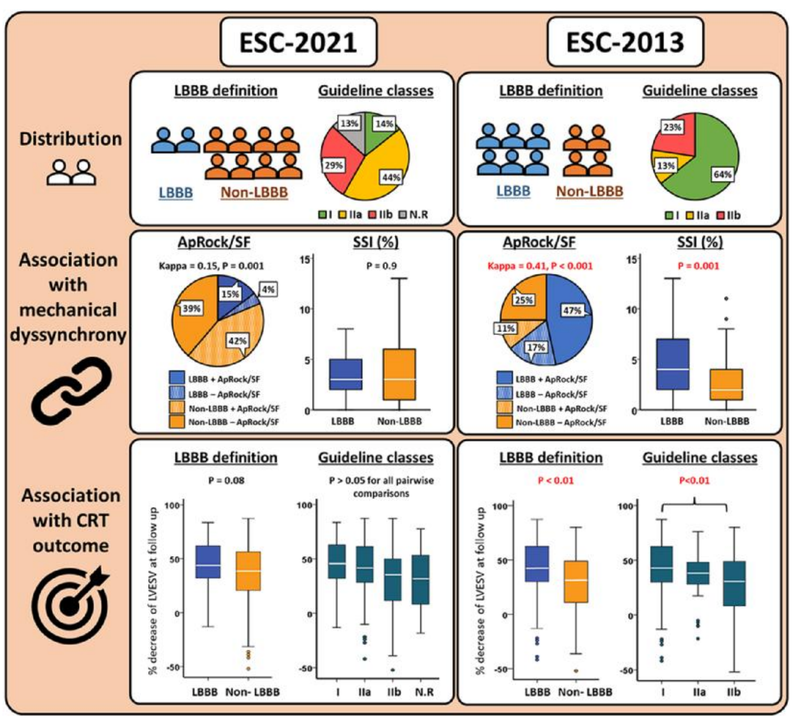

Figure 1 Top panel shows the study population stratified per LBBB definition as well as per CRT recommendation classes according to both the ESC-2021 and ESC-2013 guidelines. Middle panel shows the correlation with LBBB definitions mechanical dyssynchrony indices. Lower panel shows the association of both (i) LBBB definition and (ii) CRT recommendation classes with LV reverse remodelling post-CRT. ApRock/SF, apical rocking and/or septal flash; CRT, cardiac resynchronization therapy; ESC: European Association of Cardiology; Kappa Coeff, kappa agreement coefficient; LBBB, left bundle branch block; LVESV, left ventricular end-systolic volume; N.R, not recommended; SSI, systolic stretch index.

follow-up compared with patients with a class IIb indication ($P < 0.01$), while other pairwise comparisons were non-significant, *Figure 1*, lower panel.

To the best of our knowledge, this is the first study to examine the effects of different ECG-based definitions of LBBB on the associations of LBBB with both mechanical dyssynchrony as well as CRT outcome. Prior research highlighted that novel indices of mechanical dyssynchrony, such as ApRock/SF and SSI, encompass both electrical disturbances due to LBBB and non-electrical substrates like ischaemia or scarring. These indices have been consistently linked to CRT efficacy.[3,4]

Our findings revealed a substantial disconnect when applying the ESC-2021 criteria. Over 50% of patients classified as non-LBBB under ESC-2021 exhibited significant mechanical dyssynchrony. This discrepancy suggests that the ESC-2021 criteria fail to identify many patients with electromechanical substrates amenable to CRT, also reflected in the lack of significant differences in LV reverse remodelling post-CRT between LBBB and non-LBBB patients as well as across CRT recommendation classes under the ESC-2021 guidelines.

The stricter ESC-2021 criteria led to a substantial reduction in the number of patients classified as LBBB, resulting in fewer class I CRT recommendations compared with the ESC-2013 guidelines. This restrictiveness may exclude many patients who could benefit from CRT.

In light of the stricter LBBB criteria introduced in the ESC-2021 guidelines, our study critically assesses their impact on patient selection for CRT. While the ESC-2021 definition aims to enhance diagnostic specificity, our findings suggest that it might be overly restrictive, failing to identify many patients with significant mechanical dyssynchrony who could benefit from CRT. It is essential that guideline modifications are underpinned by substantial evidence demonstrating improved patient care outcomes. Our analysis indicates a lack of such evidence supporting the ESC-2021 adjustments, highlighting the need for a reassessment to ensure comprehensive patient inclusion criteria that align with CRT efficacy.

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Conflict of interest: None declared.

Data availability

The data underlying this article will be shared on reasonable request to the corresponding author.

References

1. Glikson M, Nielsen JC, Kronborg MB, Michowitz Y, Auricchio A, Barbash IM *et al.* 2021 ESC Guidelines on cardiac pacing and cardiac resynchronization therapy. *Eur Heart J* 2021;**42**:3427–520.
2. Brignole M, Auricchio A, Baron-Esquivias G, Bordachar P, Boriani G, Breithardt O *et al.* 2013 ESC Guidelines on cardiac pacing and cardiac resynchronization therapy: The Task Force on cardiac pacing and resynchronization therapy of the European Society of Cardiology (ESC). Developed in collaboration with the European Heart Rhythm Association (EHRA). *Europace* 2013;**15**:1070–118.
3. Beela AS, Ünlü S, Duchenne J, Ciarka A, Daraban AM, Kotrc M *et al.* Assessment of mechanical dyssynchrony can improve the prognostic value of guideline-based patient selection for cardiac resynchronization therapy. *Eur Heart J Cardiovasc Imaging* 2019;**20**: 66–74.
4. Gorcsan J III, Anderson CP, Tayal B, Sugahara M, Walmsley J, Starling RC *et al.* Systolic stretch characterizes the electromechanical substrate responsive to cardiac resynchronization therapy. *JACC Cardiovasc Imaging* 2019;**12**:1741–52.