

EDITORIAL

Rapid Diagnosis of STEMI Equivalent in Patients With Left Bundle-Branch Block: Is It Feasible?

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In patients presenting with symptoms compatible with acute coronary syndromes (ACS) it is crucial to rapidly identify those who have ongoing ischemia and necrosis that could benefit from emergent reperfusion therapy. It is accepted that in patients with narrow QRS complexes, ST elevation on the presenting ECG signifies acute occlusion of an epicardial artery, so-called ST-segment–elevation myocardial infarction (STEMI). Emergent reperfusion therapy is a class I recommendation by the current guidelines.^{1,2} However, it is well known that not all patients with acute occlusion of an epicardial artery show ST elevation. Although it seems plausible that these patients can also benefit from emergent reperfusion therapy, direct evidence is lacking. Patients with non–ST-segment–elevation myocardial infarction (NSTEMI) may not have ongoing persistent active ischemia and a large percentage do not have ECG changes at all or only nonspecific ECG changes. Thus, in patients with narrow QRS, the ECG is insensitive for diagnosing all acute myocardial infarctions (AMI). It is also known that a large percentage of patients with STEMI do not have total occlusion of the epicardial coronary artery and that the angiographic findings in patients with STEMI can be indistinguishable from those in patients with NSTEMI.

It is conceivable that patients with underlying left bundle-branch block (LBBB) can present with AMI with either STEMI equivalent (acute occlusion of an epicardial artery) or NSTEMI equivalent physiology. LBBB distorts the surface ECG resulting in secondary ST-T changes that interfere with the interpretation and identification of ischemia (STEMI and NSTEMI).³ Whereas in the past, the presence of new or presumably new LBBB in a patient with symptoms compatible with AMI was considered a class I indication for emergent reperfusion therapy (STEMI-equivalent, also known as occlusion MI, or OMI), the 2013 American College of Cardiology Foundation/American Heart Association Guideline for the Management of STEMI states: “A new or presumably new LBBB has been considered a STEMI equivalent. Most cases of LBBB at time of presentation, however, are ‘not known to be old’ because a prior ECG is not available for comparison. New or presumably new LBBB at presentation occurs infrequently, may interfere with ST-elevation analysis, and should not be considered diagnostic of AMI in isolation.”² The European Society of Cardiology guidelines acknowledge the difficulties in diagnosing STEMI equivalent in patients with LBBB. These guidelines consequently recommend that patients with a clinical suspicion of ongoing refractory myocardial ischemia, “regardless of ECG or biomarker findings,” should be managed in a way similar to patients with STEMI, regardless of the presence or absence of

See Article by Nestelberger et al.

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LBBB, or whether the LBBB is previously known.¹ They also comment that the presence of a (presumed) new LBBB alone is not, by itself, predictive of AMI.¹

If we cannot rely on ST elevation, how can we identify the subgroup of patients with LBBB who could potentially benefit from acute reperfusion therapy? It seems reasonable that we should target patients with a relatively large ischemic area at risk and ongoing ischemia secondary to an acute occlusion of an epicardial artery. However, the end points chosen by the different investigators varied between simple increase in cardiac markers (creatinine kinase MB or troponin) and various combinations of elevated cardiac markers with angiographic data. However, as it is expected that some of the patients with LBBB and STEMI equivalent physiology will have residual coronary flow (as in patients with narrow QRS and STEMI), various thresholds of cardiac markers have been used in patients with angiographic Thrombolysis in Myocardial Infarction flow grade more than 0. As the threshold decreases, more patients are included. However, it could be that not all patients have STEMI equivalent physiology and not all of them would benefit from emergent reperfusion therapy. Moreover, as the sensitivity of the ECG (and echocardiography) to detect NSTEMI in patients with narrow QRS is low, why would we expect it to be better in patients with LBBB?

Several ECG scores have been suggested for rapid identification of patients with LBBB and STEMI equivalent. The first score was described by Sgarbossa et al, suggesting that concordant ST-segment elevation of ≥ 1 mm in ≥ 1 lead or concordant ST-segment depression of ≥ 1 mm in leads V1-V3 is a sign of “transmural” ischemia owing to AMI.⁴ Originally tested for identifying AMI (elevated creatine kinase-MB levels), this score has low sensitivity for detecting OMI (adjudicated by coronary angiography). In the original article they described a third criterion (excessively discordant ST elevation, defined as ≥ 5 mm in leads with negative QRS complexes).⁴ This criterion was found to be less predictive and later was modified by Smith et al to adjust the absolute magnitude of the ST elevation to the size of the QRS complex (≥ 1 mm ST elevation with an ST elevation to S-wave amplitude ratio ≥ 0.25).^{5,6} The reported sensitivity of the modified criteria is higher than that of the original Sgarbossa criteria.^{5,6} More recently, a new modification called the Barcelona criteria, was derived, but not validated, in a large cohort of patients referred for primary percutaneous coronary intervention ($n=484$); however, the outcome criteria for OMI included patients with Thrombolysis in Myocardial Infarction-3 flow and peak troponins only 10x the upper reference limit, which includes troponin values that are seen in almost all NSTEMI patients and thus would include almost all non-OMI. The Barcelona algorithm includes ST deviation >1 mm concordant with

QRS polarity in any ECG lead or ST deviation >1 mm discordant with QRS polarity; in any lead with maximal QRS (R or S wave) voltage <6 mm is considered predictive of STEMI equivalent.⁷ This algorithm was tested in a relatively large cohort of patients referred for primary percutaneous coronary intervention ($n=484$) and reported better accuracy than the Sgarbossa and Smith criteria. Yet, it has not been validated in an independent cohort. The study included selected patients who were referred for primary percutaneous coronary intervention, rather than patients who presented with symptoms compatible with ACS to the emergency medical service ambulances or emergency department. The control group included patients with LBBB without clinical suspicion of ACS.

Many patients presenting with LBBB have underlying cardiomyopathies (ischemic or nonischemic). Many may present with symptoms compatible with ACS (shortness of breath, pulmonary edema, hypotension) and could have elevation in cardiac troponin levels. Yet, many could have type-2 AMIs because of supply-demand mismatch or even nonischemic myocardial injury.⁸ A large number of patients with advanced cardiomyopathy have small amplitude QRS and therefore there is a concern that using the Barcelona algorithm, overdiagnosis of STEMI equivalent could be frequent if applied to patients with LBBB presenting with acute heart failure exacerbation. On the other hand, using the Smith modification allows for exclusion of patients with LBBB and left ventricular hypertrophy who have an absolute magnitude of discordant ST segment deviation in leads with large amplitude QRS complexes.

A major issue of the previously mentioned studies, including a study by Nestelberger et al,⁹ is the definition of the end point. As mentioned, Sgarbossa et al tested their ECG criteria for identifying patients with creatine kinase MB elevation (not limited to STEMI equivalent),⁴ whereas the Barcelona algorithm was tested against relatively lower magnitude of cardiac troponin elevation, which would include virtually all patients with AMI, not just those with OMI.⁷ The same holds for the Nestelberger study.^{9,10} In contrast, Smith et al used a much higher threshold of cardiac troponin elevation that probably restricted the “positive” to patients with true STEMI equivalence.⁶

The 2013 American College of Cardiology Foundation/American Heart Association Guideline for the Management of STEMI suggest that transthoracic echocardiography may provide evidence of focal wall motion abnormalities and facilitate triage in patients with ECG findings that are difficult to interpret, including patients with LBBB.² The European guidelines also give class IIa recommendation for emergent echocardiogram if the diagnosis of STEMI equivalent is uncertain.¹ However, the accuracy of transthoracic echocardiography in detecting true

STEMI equivalent could be difficult from the following reasons:

1. Many patients with LBBB and symptoms compatible with ACS have acute heart failure. They are dyspneic and cannot lie flat, making image quality less than optimal.
2. The European guidelines give the following recommendation: "Routine echocardiography that delays emergency angiography is not recommended."¹¹ Many times the echocardiographic equipment and the personnel in the emergency department are suboptimal to make rapid and accurate decisions.
3. Patients with LBBB have abnormal septal motion owing to the delayed activation of the septum. Identification of regional wall motion abnormalities on top of the abnormal septal motion could be difficult, especially if image quality is suboptimal.
4. Many patients with LBBB have underlying structural heart disease with preexisting left ventricular systolic dysfunction. Frequently, recent echocardiograms may not be available for comparison, making the diagnosis of new regional wall motion abnormalities impossible.

In this issue of the *Journal of the American Heart Association (JAHA)*, Nestelberger et al described their experience in using echocardiography for diagnosing any AMI in patients presenting with LBBB.¹¹ They evaluated patients with suspected AMI and LBBB who presented to 26 emergency departments in 3 international prospective studies. They included only patients in whom imaging quality was sufficient to clearly distinguish regional wall motion abnormality from paradoxical septal motion and the echocardiograms were performed in the emergency department before revascularization. Of the 10 959 patients who presented to these emergency departments, 286 (2.6%) had LBBB of whom only 100 (35%) underwent echocardiographic examination. The end point of the study was adjudicated AMI, rather than OMI (STEMI equivalent); but only OMI is an indication for emergent reperfusion therapy.¹¹ Data on peak troponin levels and angiographic findings are not provided. AMI was diagnosed in 41 (41%) of the patients, whereas regional wall motion abnormalities were seen in 77 patients. The prevalence was similar among patients with versus without AMI. As predicted, left ventricular ejection fraction was reduced in both patients with and without adjudicated AMI without a significant difference between the groups. It should be emphasized that the echocardiograms were interpreted by central adjudicated laboratory and not on site in the emergency department when the clock is ticking and that the accuracy of the

interpretation is probably much better than in the real-world scenario.

The hypothesis of Nestelberger et al was that patients with AMI presenting with LBBB will have large infarction because of left main or proximal left anterior descending coronary artery occlusion that could be easily detected by echocardiography.¹¹ However, this seems to occur only rarely. Acute complete occlusion of the left main or proximal left anterior descending coronary artery can cause right bundle branch block rather than LBBB.¹²

This study does not answer well the question we most want to know: does a wall motion abnormality have high sensitivity for OMI? If a patient has no wall motion abnormality, can we wait for the troponin diagnosis and avoid emergent catheterization laboratory activation? What is its sensitivity (or negative predictive value or negative likelihood ratio) for OMI? They have certainly shown that wall motion abnormalities has low sensitivity for any AMI, but many non-OMI AMI are very small and would not be expected to have a wall motion abnormalities. Moreover, we know non-OMI without persistent symptoms or instability do not need rapid diagnosis; we can diagnose them less urgently with serial troponin measurements.

If echocardiography does not improve the diagnosis of OMI and can cause delays in reperfusion therapy, we would need to continue using a combination of clinical evaluation, ECG scores, and serial troponin tests as suggested by Cai et al.¹³ It should be emphasized that if the patient continues to have symptoms despite initial medical therapy, is hemodynamically unstable, or develops sustained ventricular arrhythmia, an immediate invasive strategy is recommended even if the diagnosis of STEMI equivalent is uncertain.

ARTICLE INFORMATION

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Disclosures

None.

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