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ECG evaluation in patients with pacemaker and suspected acute coronary syndrome: Which score should we apply?

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Abstract

Background/Purpose: In patients with right ventricular pacing, the ECG shows a left bundle branch block (LBBB) pattern. There are several criteria to diagnose ST-elevation myocardial infarction (STEMI) in patients with LBBB. The aim of this study was to validate and compare Sgarbossa's with two new scores – Selvester's and Smith's – in this context.

Methods: We identified pacemaker patients submitted to coronary angiography due to acute coronary syndrome. ECGs were analyzed by 2 blinded cardiologists. STEMI was defined according to angiographic and biochemical criteria. Sensitivity, specificity, positive and negative predictive values were calculated.

Results: Forty-three patients with ventricular pacing were included for analysis. STEMI was diagnosed in 26 patients (60%). The most sensitive score was Selvester's (38.5%; 95% CI: 20.2–59.4) while the most specific was Sgarbossa's (100%; 95% CI: 80.5–100).

Conclusions: The sequential application of these scores proved to be clinically useful in the context of STEMI.

Keywords: Myocardial infarction; Coronary occlusion; Electrocardiography; Cardiac pacemaker; Artificial

Introduction

Early diagnosis and appropriate treatment of myocardial infarction are of major importance in reducing mortality [1,2]. In this context the electrocardiogram (ECG) is of major importance since it recognizes ST-segment elevation myocardial infarction (STEMI) which is a reliable indicator of an acute occluded coronary artery. However there are subgroups of patients with different ECG findings that represent "STEMI-equivalents" since they correlate with an occluded coronary artery [2]. Patients with left bundle-branch block (LBBB) represent one of these subgroups. In this population the ECG displays repolarization changes that hamper ST-segment analysis. In 1996, Sgarbossa et al. [3] developed and validated the first prediction rule based on ECG criteria to diagnose myocardial infarction in patients with chest pain and LBBB. Although this score was very specific, it lacked sensitivity. In this context, Gregg et al. [4] and Smith et al. [5] developed other ECG criteria to redefine Sgarbossa's score and make it more sensitive while retaining specificity.

Patients with pacemaker represent another subgroup in whom it is important to recognize "STEMI-equivalent" findings on the ECG to prompt immediate revascularization. The diagnosis of acute myocardial infarction with an occluded artery is even more difficult in this population since right ventricular pacing induces a LBBB pattern and only Sgarbossa's score was validated in this population, although with less specificity [6].

The purpose of this study was to evaluate the capability of Sgarbossa's, Selvester's and Smith's scores in identifying acute myocardial infarction with coronary artery occlusion in a population with pacemaker presenting with chest pain in an emergency setting.

Methods

Study population and design

Data were collected between January/2010 and December/2014 from a high volume single-center prospective registry comprising consecutive patients submitted to invasive coronary angiography. Patients with pacemaker and suspected acute coronary syndrome (ACS) were included. Pacing in AAI mode does not affect QRS morphology since sensing and

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Table 1
Characteristics of the patients at baseline.

	STEMI (n = 26)	Controls (n = 17)	*P* value
Demographics			
Age, median (IQR)	78 (70–85)	80 (70–85)	0.66
Male, no. (%)	20 (77)	11 (64.7)	0.38
Medical history			
Heart failure, no. (%)	3 (12)	2 (12)	0.98
Hypertension, no. (%)	22 (85)	16 (94)	0.34
Diabetes, no. (%)	14 (54)	8 (47)	0.66
Dyslipidemia, no. (%)	14 (54)	8 (47)	0.66
Active smoker, no. (%)	6 (23)	3 (17)	0.67
Stroke, no. (%)	5 (19)	1 (6)	0.22
CKD, no. (%)	4 (15)	2 (12)	0.74
COPD, no. (%)	2 (8)	1 (6)	0.82
Previous CABG, no. (%)	5 (19)	3 (18)	0.90
PAD, no. (%)	2 (8)	0	0.24
Previous MI, no. (%)	9 (35)	4 (24)	0.44
Previous PCI, no. (%)	7 (27)	4 (24)	0.80
Peak troponin I (ng/mL), median (IQR)	19.4 (4.2–59.3)	1.18 (0.2–1.9)	0.0001

CKD = chronic kidney disease; COPD = chronic obstructive pulmonary disease; CABG = coronary artery bypass graft; IQR = interquartile range; MI = myocardial infarction; PCI = percutaneous coronary intervention; PAD = peripheral arterial disease.

pacing are conducted in the atria. Biventricular pacing involves simultaneous pacing of both ventricles producing an atypical QRS morphology. As such these two groups of patients were excluded.

ECG analysis

Twelve-lead ECGs at 25 mm/s recorded at first medical contact were analyzed. All measurements were performed by two cardiologists blinded for the coronary angiography result. R-wave and S-wave amplitudes were measured in all leads. ST deviation was measured at the J point. All measurements were performed relative to the PR segment and rounded to the nearest 0.5 mm (0.05 mV). In case of discrepancy of at least 1 mm (0.1 mV), a third cardiologist reviewed the ECG.

Definitions

Three different scores for the diagnosis of STEMI were evaluated. Sgarbossa's score [3] requires at least 3 points from the following criteria: (1) concordant ST-segment elevation ≥1 mm (0.1 mV) in at least 1 lead (5 points); (2) concordant ST-segment depression ≥1 mm in leads V1 to V3 (3 points); and (3) excessively discordant ST-segment elevation, defined as ≥5 mm of ST-segment elevation when the QRS amplitude is negative (2 points). The more recent scores maintain Sgarbossa's first two criteria and change the third; these new rules are unweighted, requiring just 1 of 3 criteria for a positive result. Selvester's score uses "ST elevation greater than the STEMI threshold (2 mm in V2 and V3; 1 mm for all other leads) plus 10% of |R − S| amplitude". Smith's score uses a "ST/S ratio ≤−0.25 in any lead" [4,5].

Even though STEMI is defined according to the presence of ST-elevation on the ECG, the nature of this study impelled us to define STEMI with angiographic and biochemical criteria: evidence of acute occlusion [Thrombolysis In Myocardial Infarction grade (TIMI) flow 0 or 1] [7] or coronary stenosis with peak 24-h cardiac troponin I level ≥10 ng/mL to include patients who might have arrived at the catheterization laboratory with reperfusion of the culprit artery either spontaneously or pharmacologically [8–10]. When multiple stenoses were present and troponin I was ≥10 ng/mL, the culprit artery was classified as "uncertain". Lesions classified by the operator as chronic total occlusions were excluded from the definition of STEMI. Patients who did not fulfill the criteria for STEMI were used as controls.

Statistical analysis

Data are presented as mean ± standard deviation for parametric and median (interquartile range) for non-parametric variables. Baseline characteristics were compared between the two groups using Pearson's chi-square for categorical variables and Student *t* test or Mann–Whitney *U* test for continuous variables. Pearson correlation and intraclass correlation coefficient were used to compare inter-observer agreement of ECG measurements. Sensitivity, specificity, and positive and negative predictive values were calculated for each score. The discriminative ability of each score was quantified by concordance (*c*) statistic, where *c* is identical to the area under the receiver operating characteristic (ROC) curve in binary outcomes such as the studied ones. Comparison between each score's areas under the curve (AUC) was achieved with DeLong et al. method [11]. All tests were 2-sided and statistical significance was accepted if *P*-value ≤0.05. All analyses were performed using SPSS 21.0 and MedCalc 9.3.8.

Results

From a total of 5072 invasive coronary angiography procedures performed from January/2010 to December/2014, we identified 51 patients with ACS and previous implanted permanent pacemaker. Eight patients were excluded due to AAI pacing rhythm; no patients with biventricular pacing were found. The final analysis was performed in 43 patients. STEMI was identified in 26 patients (60%). The troponin I cut-off level only identified 4 patients as STEMI while the remaining 22 patients presented with an occluded coronary artery at the catheterization laboratory. The control group consisted of 17 patients: 3 had negative troponin I and the remaining had a positive troponin I below the defined 10 ng/mL cut-off value with TIMI grade flow 2 or 3. Besides peak troponin I, there were no other differences in baseline characteristics between the two groups (Table 1). The culprit artery is shown in Table 2.

Table 2
Culprit coronary artery in STEMI patients (n = 26).

Culprit artery	
Left anterior descending, no. (%)	8 (31)
Circumflex, no. (%)	5 (19)
Intermediate branch, no. (%)	1 (4)
Right coronary, no. (%)	9 (35)
Uncertain, no. (%)	3 (11)

STEMI = ST elevation myocardial infarction.