Sgarbossa Criteria are Highly Specific for Acute Myocardial Infarction with Pacemakers

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Objective: In 1996 Sgarbossa reviewed 17 ventricular-paced electrocardiograms (ECGs) in acute myocardial infarction (AMI) for signs of ischemia. Several characteristics of the paced ECG were predictive of AMI. We sought to evaluate the criteria in ventricular-paced ECGs in an emergency department (ED) cohort.

Methods: Ventricular-paced ECGs in patients with elevated cardiac markers within 12 hours of the ED ECG and a diagnosis of AMI were identified retrospectively (n=57) and compared with a control group of patients with ventricular-paced ECGs and negative cardiac markers (n=99). A blinded board certified cardiologist reviewed all ECGs for Sgarbossa criteria. This study was approved by the institutional review board.

Results: Application of Sgarbossa's criteria to the paced ECGs revealed the following:
1) The sensitivity of "ST-segment elevation of 1 mm concordant with the QRS complex" was unable to be calculated as no ECG fit this criterion;
2) For "ST-segment depression of 1 mm in lead V1, V2, or V3," the sensitivity was 19% (95% CI 11-31%), specificity 81% (95% CI 72-87%), with a likelihood ratio of 1.06 (0.63-1.64);
3) For "ST-segment elevation >5mm discordant with the QRS complex," the sensitivity was 10% (95% CI 5-21%), specificity 99% (95% CI 93-99%), with a likelihood ratio of 5.2 (1.3 - 21).

Conclusion: In our review of ventricular-paced ECGs, the most clinically useful Sgarbossa criterion in identifying AMI was ST-segment elevation >5mm discordant with the QRS complex. This characteristic may prove helpful in identifying patients who may ultimately benefit from early aggressive AMI treatment strategies. [West J Emerg Med. 2010; 11(4):354-357.]

INTRODUCTION

Establishing the diagnosis of acute myocardial infarction (AMI) in the setting of a ventricular paced rhythm (VPR) is a difficult task and often results in delay of definitive treatment. In a 2001 retrospective cohort study, patients with a VPR were significantly less likely to receive emergent reperfusion and aspirin.[1] These paced patients were noted to have an increased long-term mortality rate when compared with non-paced controls, even after accounting for disease severity.

In the emergency department (ED), the diagnosis of AMI still relies primarily on history and the 12-lead electrocardiogram (ECG). Publications examining the utility of the ventricular paced ECG in the evaluation of acute chest pain have been limited to case reports, case series and review articles.[2-5] Occasionally, the intermittent presence of a native rhythm or progressive ECG changes may aid in the diagnosis of AMI.[6,7] The diagnostic accuracy of the ECG in the absence of these findings, however, has not been thoroughly evaluated.

In 1996 Sgarbossa published a retrospective review of 17 ventricular paced ECGs with AMI confirmed by cardiac biomarkers, compared with 17 ventricular-paced controls.[8] In

this study, several characteristics of the paced ECG were examined for findings that might be predictive of AMI.

Three findings appear to have low sensitivities, but potentially clinically useful specificities: 1) ST elevation >1mm in leads with a predominantly positive QRS (sensitivity 18%, specificity 94%); 2) ST segment elevation of >5mm in leads with predominantly negative QRS (sensitivity 55%, specificity 88%); 3) ST depression >1mm in v1, v2, v3 (sensitivity 29%, specificity 82%).

As this initial study had relatively small numbers (34 total patients), we sought to revisit the sensitivity and specificity calculations by reviewing a larger cohort of patients.

METHODS

This study is a chart review to identify a gold standard with de novo cardiology review of ECGs. The chart review identified existing patient records with paced ECGs who had an AMI. For this study, AMI is defined as a rise/and or fall of cardiac biomarker with at least one value above the most stringent manufacturer recommended cutoff or the suggestion of the hospital laboratory and a discharge International Disease Classification 9 (ICD-9) code of AMI (410.XX). This study was approved by the institutional review board.

The study reviewed records from two sites. Site A is a large tertiary care center with an ED volume of approximately 70,000 visits per year. Cardiologists' reads of ECGs are stored electronically and are searchable. ECGs of interest were identified by searching the text of the readings for "electronic pacemaker." These patients were then searched for a Troponin I greater than 0.8 Ng/ml (normal reference 0.000-0.080 Ng/ml before 2/1/08 and 0.000-0.120 after 2/1/08) within 12 hours of the ECG being performed. The cutoff of 0.8 Ng/ml was chosen as it is the most stringent manufacturer recommended criteria according to the American College of Emergency Physician clinical policies.[9] First, minimum and maximum Troponin I levels and times of the test were recorded. When available, cardiac catheterization information (at the minimum date and time of catheterization) was recorded as well. Controls for Site A were identified in a similar way to those with AMI, except that each control had at least one Troponin I performed, and all Troponin I's performed during that hospital stay were less than 0.080 Ng/ml.

Site B is a large community hospital with an ED volume of 100,000 visits per year. Unlike Site A, Site B does not store their ECG reads electronically. The search strategy for Site B consisted of identifying ED patients with a history of a permanent pacemaker by ICD-9 code (V45.01) recorded at that hospital. These were then searched for a Troponin I greater than 2 Ng/ml (reference range 0.0-0.3 Ng/ml before 5/1/04 and 0.0-0.1 Ng/ml after 5/1/04) within 12 hours of admission from the ED. A Troponin I of >2Ng/ml was defined as abnormal by the hospital laboratory from 8/16/98 onward. ED ECGs are routinely scanned into the medical information system with the ED chart with a unique, searchable code identifying them as ECGs. One abstracter searched all scanned ECGs to identify those whose machine interpretation was a paced rhythm. The abstracter then recorded the first value, minimum and maximum Troponin I values and times of the test.

Controls from Site B were identified in a similar way to those with AMI except that each control had at least one Troponin I performed and all Troponin I's performed during that hospital stay were less than 0.1 Ng/ml.

ECGs were de-identified and given a random number in a sequence. A blinded cardiologist reviewed these ECGs for signs of ischemia according to Sgarbossa criteria. When reproduction of the ECG changed the mV scale, the cardiologist adjusted appropriately (e.g., when the 10mm standard was measured at 8mm secondary to xeroxing adjustment, the 5mm discordance criteria was adjusted to 4mm).

Results were calculated using R (Vienna, Austria) version 2.7.2 with package DiagnosisMed version 0.0.2.[10,11] Microsoft Excel (Redmond, Washington) Version 11.5 was used for summary statistics.

RESULTS

For the ventricular-paced acute myocardial infarction (VPAMI) group, 72 paced ECGs with positive Troponin I were identified from Site A from December 1, 2002 to April 1, 2008. 39 were not coded as acute MI at hospital discharge. This left 33 ECGs from Site A. At Site B, 35 paced ECGs with positive Troponin I were identified from Site A from December 1, 2002 to April 1, 2008. Ten of these were not coded as AMI at hospital discharge. This left 25 ECGs from Site B, for a total of 58 ECGs in the VPAMI group.

For the control group, 101 ECGs with negative Troponin I were randomly selected. 100 was chosen as it was estimated there might be approximately 100 VPAMI ECGs.

When the cardiologist reviewed the ECGs, three were excluded (one control ECG and two ECGs from the VPAMI group) due to the presence of atrial pacers in two ECGs and missing information from lead V4 in an additional ECG. This left 57 ECGs from the VPAMI group and 99 control ECGs. The cardiologist also noted that seven ECGs (four potentially ischemic and three control) were recorded at one-half standard voltage; these were kept in the cohort, but 1/2 voltage Sgarbossa criteria were used. Only one ECG met more than one criteria (Score 3 and 2). This ECG was a control ECG and it was entered twice for data analysis.

The average age and sex distribution in the VPAMI group was 76.0 years with 63% male patients, while the control group averaged 73.8 years with 63% male patients.

Application of the Sgarbossa criteria to the ECGs found the following:

1) The sensitivity of ST-segment elevation 1 mm and concordant with QRS complex was unable to be calculated as none of the VPAMI ECGs fit this criteria.

2) For ST-segment depression 1 mm in lead V1, V2 or V3, the sensitivity was 19% (95% CI 11-31%), specificity 81% (95% CI 72-87%) and likelihood ratio 1.06 (0.63-1.64).
3) For ST-segment elevation >5mm and discordant with QRS complex, the sensitivity was 10% (95% CI 5-21%), specificity 99% (95% CI 93-99%) and a likelihood ratio of 5.2 (1.3 - 21).

DISCUSSION

We evaluated 57 ventricular-paced ECGs admitted and discharged with an elevated serum troponin and an ultimate diagnosis of AMI. This number represents to our knowledge the largest study population to date examining the diagnosis of AMI in the setting of a ventricular-paced ECG. We sought to evaluate the sensitivity and specificity analysis of Sgarbossa using 99 paced ECGs with normal serum troponins as the control group.

Using the criterion of ST segment elevation of 1mm with concordant QRS complex resulted in a sensitivity and specificity that could not be calculated as none of the VPAMI or control ECGs fit this criterion. It was noted to be the most specific finding in Sgarbossa's study (94% specificity) and was thus assigned the highest point value. In our study, the criteria of ST segment elevation >5mm and discordant with the QRS complex had the highest specificity (99%), but a low sensitivity (10%) when compared with Sgarbossa's study (specificity 88% with a sensitivity of 53%). The criteria of ST-segment depression in V1, V2 or V3 had similar test characteristics to Sgarbossa's study (sensitivity of 19%, specificity of 81% compared with a sensitivity of 29% and specificity of 82% in Sgarbossa's study). This criterion's test characteristics make it of limited value given its unacceptably high false positive and false negative rate.

The results of our study indicate that the ventricular-paced ECG is of little diagnostic value in ruling out the diagnosis of AMI using Sgarbossa criteria, but may be helpful in ruling in the diagnosis. Our key finding of applying Sgarbossa's criteria to paced ECGs, specifically the presence of ST segment elevation >5mm in leads with a discordant QRS, shows high specificity (99%) for the diagnosis of acute MI. The low sensitivity of ECG criteria for AMI in this study is consistent with a recent study by Kontos el al. They found that of 1641 patients with AMI, only 22% had diagnostic ST elevation on initial ECG..[12] As prior studies have suggested, possible benefit of early reperfusion with percutaneous intervention in patients with paced ECGs[13,14], the third Sgrabosssa criteria may be most useful in the ED setting to help rapidly identify patients to be considered for this intervention.

LIMITATIONS

Limitations of our study include the retrospective design and data collection. In addition, this study did not address in-hospital or long-term data regarding patient morbidity and mortality. ICD-9 codes and Troponin I values have inherent limitations in the diagnosis of AMI. Therefore, we chose to combine the two to ensure that the diagnosis was accurate. This likely excluded some ventricular- paced patients who had AMIs during the study time period.

Due to problems with reproduction, our sample included four ECGs that did not reproduce at the correct size. These were scaled by the reviewing cardiologist adjusting the criterion measured 10mm standard boxes. These measurements were not tested for inter-observer variability.

CONCLUSION

In our review of ventricular-paced ECGs, the most clinically useful Sgarbossa criterion in identifying AMI was ST-segment elevation >5mm discordant with the QRS complex. This criterion demonstrated a high specificity and low sensitivity suggesting that it may be helpful in identifying patients who could ultimately benefit from early, aggressive AMI treatment strategies. The clinical utility of the aggregate Sgarbossa criterion is questionable.

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