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Availability of a baseline Electrocardiogram changes the application of the Sclarovsky-Birnbaum Myocardial Ischemia Grade

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Abstract

Background and aims: The electrocardiogram (ECG) based Sclarovsky-Birnbaum Ischemia Grade may be used to determine the prognosis of patients with ST-elevation myocardial infarction (STEMI). However, application of the method is based on assumption of the baseline QRS morphology. Thus, the aims of this study were to determine if the baseline QRS morphology was correctly assumed based on an ECG recorded during induced ischemia, and if reference to the baseline ECG altered the designated Ischemia Grade.

Methods: Sixty-three patients with chronic ischemic heart disease that underwent elective percutaneous transluminal coronary angioplasty were included. Baseline ECG and ECG during the procedure were recorded. In the latter, Ischemia Grade was classified according to assumed baseline QRS morphology. Then the baseline ECG was used as reference and Ischemia Grade was determined based on change from the baseline ECG.

Results: In 66.6% (42/63) of patients the criteria for STEMI were fulfilled; the incidence was similar between left anterior descending (LAD) and right coronary artery (RCA) occlusion. In LAD patients who fulfilled STEMI criteria, assumption of baseline QRS morphology in involved leads was accurate in only 35% (7/20) and this altered the Ischemia Grade in 10% (2/20) of patients. In RCA patients who fulfilled STEMI criteria, assumption of baseline QRS morphology in involved leads was accurate in 77.3% (17/22) and this altered the Ischemia Grade in 9.1% (2/22) of patients.

Conclusion: Application of the Sclarovsky-Birnbaum Ischemia Grade with reference to a baseline ECG altered Ischemia Grade in approximately 10% of patients. All patients that were reclassified were assigned a higher Ischemia Grade. Future research is needed to determine the impact of availability of the baseline ECG on the clinical diagnostic and prognostic performances of the Sclarovsky-Birnbaum Ischemia Grade.

Keywords: Electrocardiogram; Sclarovsky-Birnbaum Ischemia Grade; STEMI; Myocardial ischemia

Introduction

During acute myocardial ischemia, morphological electrocardiogram (ECG) changes may be observed in the QRS complex, ST segment and T wave. Sclarovsky and Birnbaum developed a method for grading the severity of ischemia utilizing the ECG at first clinical presentation, based on assumed morphology of the baseline ECG [1,2]. The Sclarovsky-Birnbaum Ischemia Grade has been shown to correlate with final infarct size, salvage by reperfusion therapy, and short- and long-term prognosis, in patients presenting with ST elevation myocardial infarction (STEMI) [3–8]. Furthermore, recently the Ischemia Grade was combined with the Anderson-Wilkins score that indicates acuteness of ischemia, and was shown to predict salvage, infarct size and left ventricular ejection fraction [9]. Basing an Ischemia Grade on assumed baseline

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morphology, may however lead to both under- and overestimation of the severity of ischemia, which could affect triage of patients with STEMI in the acute phase. The effect of availability of a baseline ECG on the application of the Sclarovsky-Birnbaum Ischemia Grade has not previously been reported. The baseline ECG may be of value if it is used as a reference to evaluate changes during ischemia. However, usually no ECG prior to the acute event is available as reference. Hence, it is important to determine if the Sclarovsky-Birnbaum Ischemia Grade may be accurately applied based on assumed baseline ECG morphology.

The objective of this study was to determine the Ischemia Grade in patients with available pre-ischemic baseline standard 12 lead ECG recordings. The selected population received elective percutaneous transluminal coronary angioplasty (PTCA), prior to the era of coronary stenting, for chronic ischemic heart disease (IHD). ECGs were recorded before and during the procedure. The specific aims of the current study were to determine if the baseline QRS morphology required for application of the Ischemia Grade was correctly assumed based on an ECG recorded during induced ischemia; and if reference to the baseline ECG altered the designated Ischemia Grade.

Methods

Study population

The study population, recruited between 1992 and 1995 at the Charleston Area Medical Center, West Virginia, consists of a consecutive series of 122 patients, who received elective PTCA due to chronic IHD. Balloon inflation was maintained for 5 minutes, unless the patient could not tolerate this. Local research ethics committee approved the study and informed consent was obtained for all patients. The specific exclusion criteria for this retrospective study were balloon occlusion in the left circumflex coronary artery (n = 34), inadequate ECG recordings (n = 20), and bundle branch block (n = 5). Patients with left circumflex coronary artery occlusion were excluded since these patients mostly have ST segment depression and not ST elevation, which is included as a criterion in the Sclarovsky-Birnbaum Ischemia Grade. None of the patients were excluded due to either having a pacemaker or being paced during PTCA. Thus, 63 patients were included in this study.

ECG acquisition and analysis

Twelve-lead ECGs were recorded and stored at baseline prior to catheter insertion and at 2 and 4 minutes after balloon inflation. An ECG obtained at 2 minutes of inflation was used in those 4 patients where inflation could not be maintained. ECGs were analyzed in conference by two investigators (EAC and GSW), using × 2 magnification. In the baseline ECG we determined the QRS configuration, and if signs of previous myocardial infarction (MI) were present. In the ECG recorded during induced ischemia we applied the Sclarovsky-Birnbaum Ischemia Grade and secondly compared the ECGs from baseline and during ischemia to identify if terminal QRS distortion was present. The ST-segment deviation was measured at the J point using the TP segment as baseline. The current STEMI definition of ST-elevation at J point in at least 2 contiguous leads of $\geq$ 0.2 mV in men or $\geq$ 0.15 mV in women in leads V2–V3 and/or $\geq$ 0.1 mV in other contiguous chest leads or the limb leads was used to identify patients with significant ST elevation. Furthermore, ST-depression $\geq$ 0.05 mV was identified if present in $\geq$ 2 contiguous chest leads (V1–V4) [10].

The Ischemia Grading system defines 3 grades of ischemia – tall, symmetrical and peaked T waves (Ischemia Grade 1); peaked T waves and ST-segment elevation (Ischemia Grade 2); peaked T waves, ST-segment elevation and distortion of the terminal portion of the QRS complex (Ischemia Grade 3). Grade 3 indicates the most severe ischemia. The specific Ischemia Grade was assigned when the changes were present in 2 or more adjacent leads. The definition of "terminal QRS distortion" in leads V1–V3 (leads with assumed baseline rS/Rs configuration) is the complete disappearance of S waves. In leads I, II, III, aVL, aVF and V4–V6 (leads with assumed baseline qR configuration) "terminal QRS distortion" is defined as J point/R wave amplitude ratio $\geq$ 0.5, but if a terminal S-wave and ST elevation is seen in leads I, II, III, aVL, aVF or V4–V6, this implies a baseline Rs configuration and thus no terminal QRS distortion, and therefore Ischemia Grade 2 [11]. Based on the latter of these criteria we further considered disappearance of a terminal S wave in lead I-III, aVL, aVF or V4–V6 (determined with the availability of the baseline ECG) to be Ischemia Grade 3.

Statistical analysis

Continuous variables are reported as mean and standard deviation and categorical variables as numbers and percentages. Independent categorical variables were compared using Fisher's exact test. Statistical calculations were performed using IBM SPSS Statistics version 20. A p-value < 0.05 was considered statistically significant.

Results

The study population had a mean age of 59.8 years, with 57.1% being male and 42.9% having ECG evidence of previous MI (Table 1). Approximately half the patients had coronary balloon inflation in the LAD (44.4%) and the other half in the RCA (55.5%). Two patients with LAD

Table 1
Patient characteristics.

	n = 63
Age, mean (SD)	59.8 (12.4)
Male	36 (57.1)
Previous MI	27 (42.9)
Balloon occluded in	
LAD	28 (44.4)
RCA	35 (55.5)

Data are presented as absolute number and percent, unless otherwise stated. LAD: left anterior descending; RCA: right coronary artery. MI: myocardial infarction.