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Distortion of the QRS in elderly patients with myocardial infarction

Juan C. García-Rubira[1], Iván Núñez-Gil[1], Rafael García-Borbolla[2], Vera Lennie[3], María C. Manzano[1], Miguel A. Cobos[1], Leopoldo Pérez de Isla[1], Antonio Fernández-Ortiz[1], Carlos Macaya[1]

[1]Cardiovascular Institute, Hospital Clínico San Carlos, Madrid, Spain
[2]Cardiology Department, Hospital Puerta del Mar, Cádiz, Spain
[3]Cardiology Department, Hospital Infanta Leonor, Madrid, Spain

Abstract

Background: *Distortion of the terminal portion of the QRS in the initial electrocardiogram (ECG) is a strong predictor of adverse outcome in myocardial infarction. Our purpose is to assess the relationship of distortion of QRS and other ECG characteristics with older age.*

Methods and results: *We analysed 634 consecutive patients (age 62.6 ± 13.7, 77% male) admitted in the first 12 hours of ST-elevation myocardial infarction. Two groups of age were defined: < 75 years-old and ≥ 75 years-old. Additionally, we defined two ECG groups according to the presence of ST segment elevation with distortion of the terminal portion of the QRS in two or more adjacent leads (QRS+) or the absence of this pattern (QRS–). Older people had more often QRS+ (30%* vs. *20%, p = 0.023). The older group with QRS+ had an in-hospital mortality of 18%,* vs. *7% with QRS– (p = 0.04), and an incidence of major adverse events of 40%* vs. *14% (p = 0.002). In the multivariate analysis, age ≥ 75 years was an independent predictor of distortion of the QRS (odds ratio 2.1, 1.2–4.9, p = 0.016).*

Conclusions: *The distortion of the terminal portion of the QRS in myocardial infarction is more frequent in elderly people, and is significantly related to adverse prognosis. This ECG finding can be helpful to promptly stratify the risk in elderly patients.* (Cardiol J 2009; 16, 5: 418–425)

Key words: elderly, myocardial infarction, QRS distortion

Introduction

Patients older than 75 years constitute more than 25% of myocardial infarctions, and their prognosis is clearly worse than that of younger patients [1, 2]. Elderly patients are more heterogeneous in clinical presentation as they tend to present with a higher number of comorbidities, and take more concomitant medications. As a result, the decision as to how to manage patients presenting with ST segment elevation is more difficult. This difficulty accounts for the delay in reaching the optimal reperfusion therapy. Furthermore, this age group is by far the least treated with any reperfusion therapy. In the GRACE registry, for instance, the odds ratio (OR) of not receiving reperfusion therapy in this group was 2.63 [95% confidence interval (CI) 2.04–3.38] [3].

On the other hand, the distortion of the terminal portion of the QRS complex in the electrocardio-

Address for correspondence: Dr. Juan C. García-Rubira, PhD, Coronary Care Unit, Cardiovascular Institute, Hospital San Carlos, Madrid, Spain, tel./fax: +34 91 3303220, e-mail: grubira@wanadoo.es

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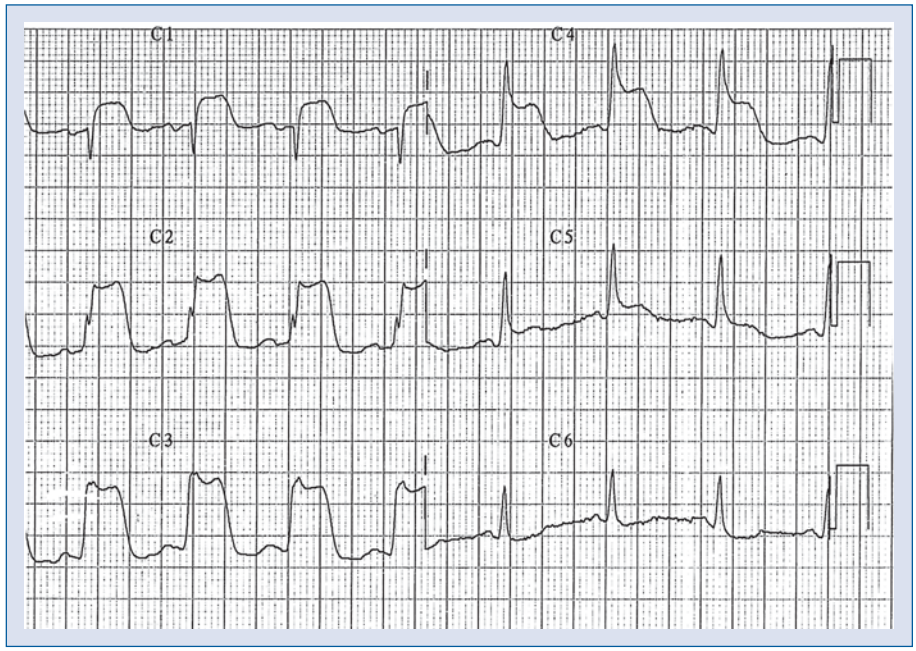

Figure 1. Anterior myocardial infarction with distortion of the QRS. Only precordial leads are shown. The J point is clearly above 50% of the height of the R wave in V2 and V3.

graphy (ECG) has been found to be significantly predictive of adverse outcome [4, 5]. The purpose of this study is to analyze the prevalence of this ECG pattern in patients ≥ 75 years of age admitted with ST segment elevation myocardial infarction, and its influence on their prognosis.

Methods

We analyzed all consecutive patients admitted to our Coronary Care Unit from March 2003 to May 2007 who met the following criteria: ST segment elevation ≥ 1 mm in two contiguous leads, less than 12 hours of evolution at admission, and analyzable 12-lead ECG taken before revascularization. We excluded patients with left bundle branch block, pacemaker rhythm, or requiring mechanical ventilation at the time of admission. The study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki. No written consent was required from patients for the purpose of this investigation, because all procedures were the routine management in our Institution.

Two age groups were considered: younger than 75 (NEP — non elderly people) and 75 or above (EP — elderly people).

Electrocardiographic analysis was prospective and blinded to the clinical course. The J point was identified in all R dominant leads with ST segment elevation. The height of the R wave and J point were measured. Those patients with a J/R > 0.5 in two or more adjacent leads were considered as indicative of QRS distortion (QRS+), as has been described in previous publications [4, 5]. Otherwise, patients were considered not to have QRS distortion (QRS–). Figures 1–4 show examples of patients with anterior infarction and QRS+, anterior infarction and QRS–, inferior infarction and QRS+ and inferior infarction and QRS–. Other ECG variables analyzed were: anterior localization, sum of ST segment elevations (ST sum), number of leads with ST elevation (ST elev) and number of leads with ST depression (ST dep).

The ejection fraction of the left ventricle was estimated by the visual examination on the echocardiogram performed in the first 48 hours of admission. The coronary lesions were defined as one, two or left main/three vessel disease. The flow of the coronary arteries after angioplasty was analyzed according to the Thrombolysis in Myocardial Infarction (TIMI) classification [6].

The delay to reperfusion was measured as the time from the onset of symptoms to the insertion of the guide-catheter of angioplasty or to the administration of fibrinolytic therapy. The analysis of the in-hospital clinical course included the occurrence of death, reinfarction, cardiogenic shock or the combined endpoint of these three variables (MAE — mayor adverse events).

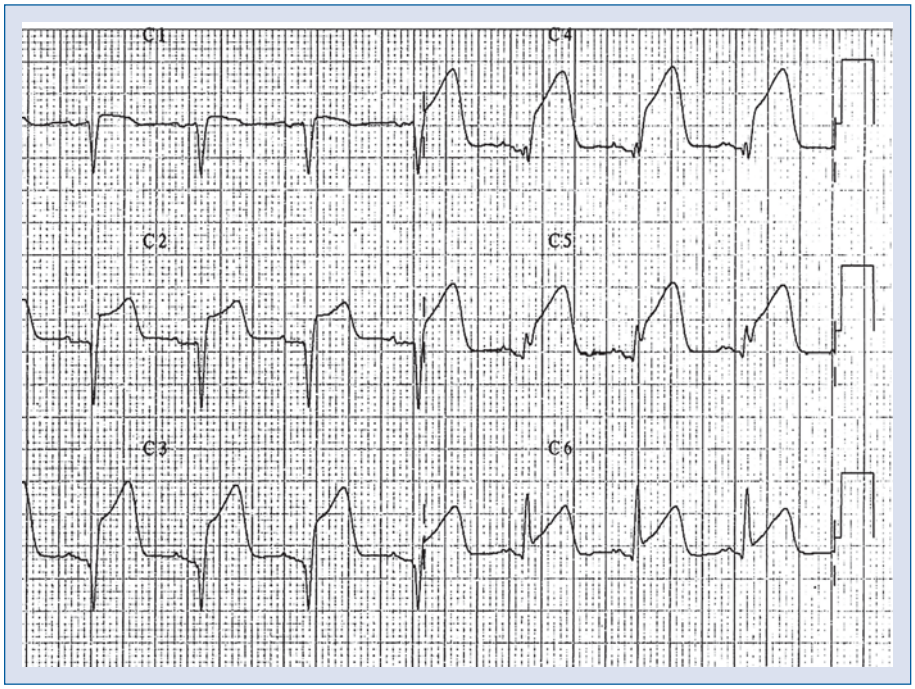

Figure 2. Anterior myocardial infarction without distortion of the QRS.

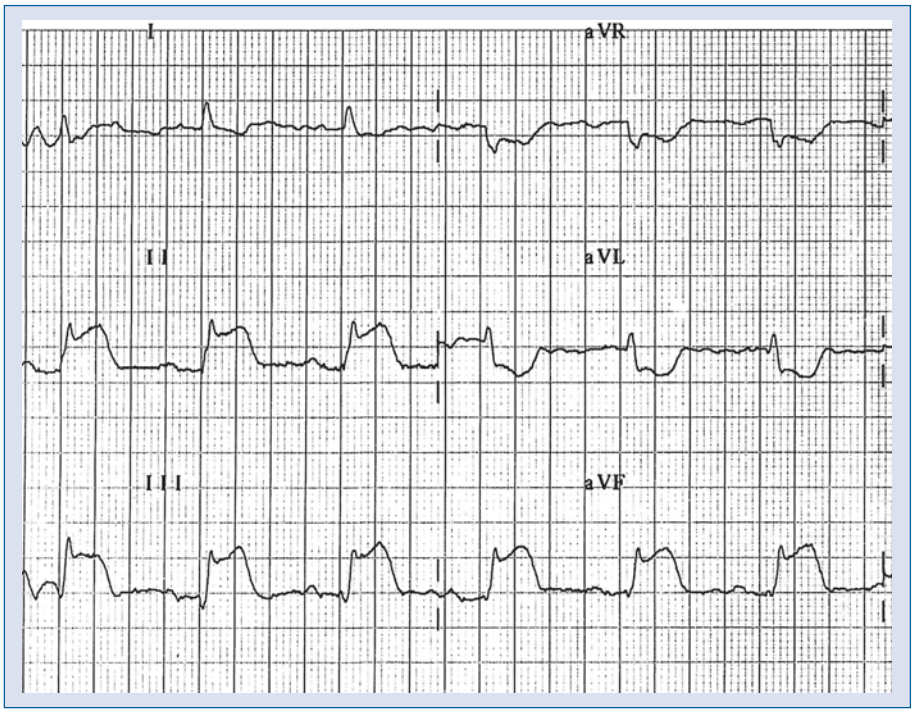

Figure 3. Inferior myocardial infarction with distortion of the QRS. Limb leads are shown. Criteria of QRS distortion are met in leads II, III and aVF.

The study was approved by the local bioethical committee and all patients gave their informed consent.

Statistical analysis

Statistical analysis was performed with the SPSS 12.0 software (SPSS, Chicago, Ill, USA).

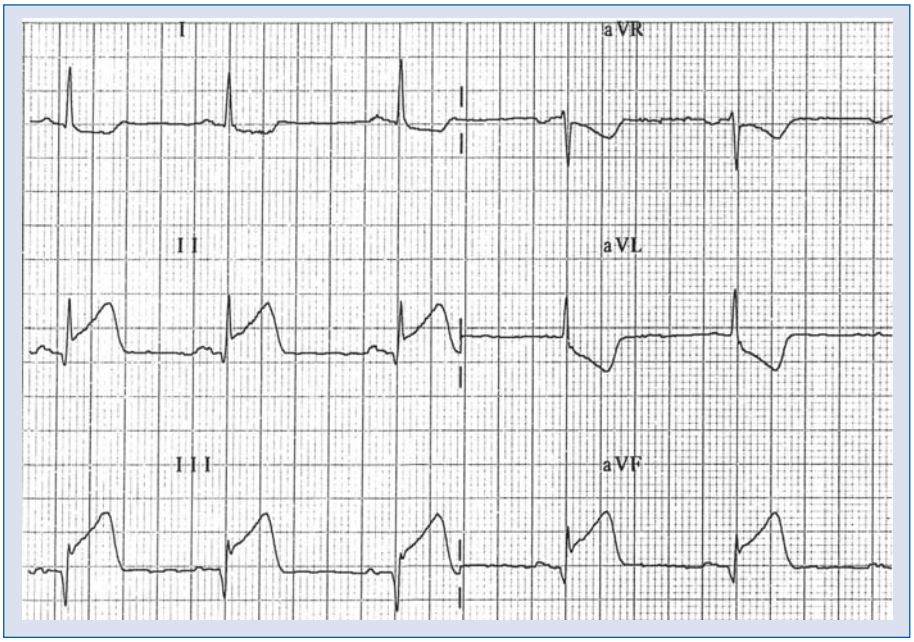

Figure 4. Inferior myocardial infarction without distortion of the QRS.

Clinical characteristics and in-hospital course were compared between both groups of age and between QRS+ and QRS–. Categorical characteristics of the patients in the two groups were compared by χ^2 test. Continuous factors were compared by Student's *t*-test. Logistic regression was used for multivariate analysis of predictors of QRS+, and 95% CI was estimated for the OR. Clinical variables at admission were also included in a logistic regression model to evaluate the independent value of age ≥ 75 and QRS+ on prognosis. Values of $p < 0.05$ were considered significant.

Results

We included 634 patients, 506 NEP and 128 EP. There were 141 patients with QRS+ (22%). The clinical flow of all the patients is represented in Figure 5. Primary angioplasty was the treatment of choice in 538, thrombolysis in 92, and no reperfusion treatment in four. Among the 92 patients treated with thrombolytics, 50 underwent urgent catheterization, either due to the absence of clinical data suggestive of reperfusion, or due to early recurrence of symptoms or ST segment elevation. There were no significant differences in the reperfusion therapy between NEP and EP.

The comparison of clinical and ECG characteristics between EP and NEP is shown in Table 1. EP were more often female, had a history of diabetes, hypertension, and presented more often with Killip class II or worse. The total number of patients showing distortion of the QRS (QRS+) was 141, 103 (20%) were NEP and 38 (30%) were EP ($p = 0.023$). EP had lesser number of leads with ST depression, but we did not find differences between groups in number of leads with ST elevation or the sum of all the ST segment elevation.

EP had a significantly lower ejection fraction (47 ± 11 *vs*. 51 ± 10, $p = 0.01$) and a higher peak of troponin I (118 ± 115 *vs*. 90 ± 97, $p = 0.006$). In addition, the EP group suffered more delay from the onset of symptoms to angioplasty, and the in-hospital stay was significantly longer (Table 2).The extension of coronary disease in EP was 22% three-vessels, 28% two-vessels, 45% one-vessel and 5% no significant coronary disease; *vs.* 11%, 27%, 58% and 4% respectively in NEP ($p = 0.012$).

The in-hospital clinical course was significantly worse in EP. Among 343 patients with inferior myocardial infarction, 48 developed third degree atrioventricular block, and this was more prevalent in the EP group ($p = 0.009$). Cardiogenic shock was developed by 55 patients, more frequently among EP ($p < 0.001$). There were no significant differences in reinfarction or ventricular fibrillation. The in-hospital prognosis, considered by either total mortality or by the combined endpoint, was significantly worse in EP group.

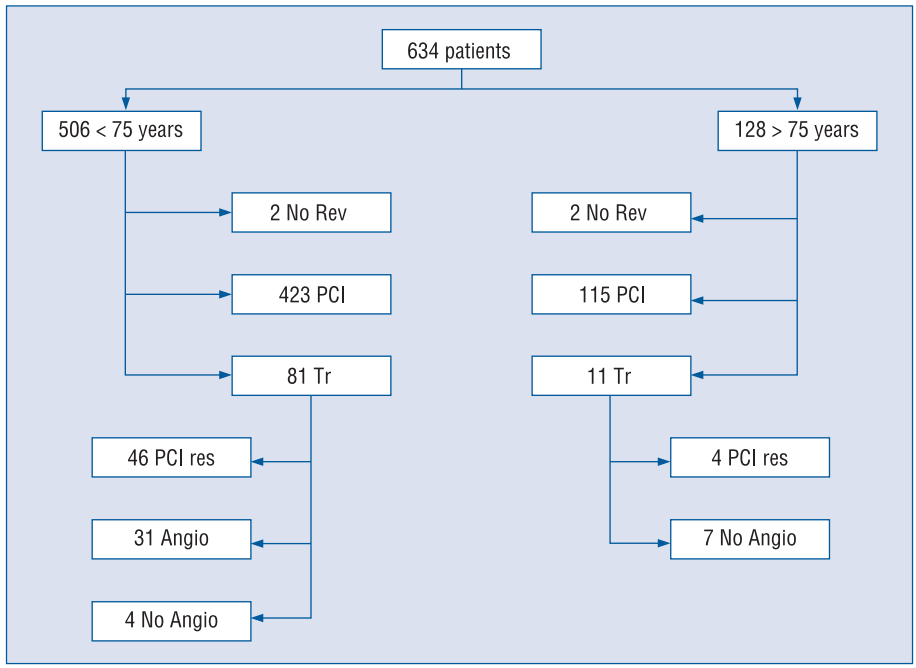

Figure 5. Schematic representation of the clinical flow of patients; No Rev — no revascularization treatment; PCI — primary angioplasty; Tr — thrombolytic therapy; PCI res — rescue angioplasty after failed thrombolysis; Angio — programmed coronariography.

Table 1. Clinical and electrocardiographic data according to age group.

	< 75 years (n = 506)	≥ 75 years (n = 128)	P
Clinical characteristics			
Female	16%	48%	< 0.001
Diabetes	20%	29%	0.02
Smoking	54%	9%	< 0.001
Hypertension	41%	60%	< 0.001
Previous myocardial infarction	8%	13%	NS
Killip > 1	16%	41%	< 0.001
ECG characteristics			
Anterior infarction	43%	56%	0.009
ST sum	14 ± 10	14 ± 9	NS
ST elevation	4.5 ± 1.7	4.7 ± 1.7	NS
ST depression	3.1 ± 2.1	2.6 ± 2.1	0.021
QRS+	20%	30%	0.023
Angiographic findings			
No significant stenoses	4%	5%	0.012
1 vessel	59%	45%	
2 vessels	27%	28%	
3 vessels or left main	11%	22%	
TIMI-3 after PCI	91%	88%	NS

PCI — percutanous coronary intervention; QRS (+) — distortion of the QRS

We additionally analyzed the relationship of in-hospital prognosis and QRS+ stratified by the group of age. The EP patients with QRS+ had an in-hospital mortality of 18%, *vs*. 7% with QRS– (p = 0.04). The incidence of MAE was 40% *vs*. 14% (p = 0.002). In the NEP group, QRS+ registered 3% mortality

Table 2. In-hospital course data according to age group.

	< 75 years (n = 506)	≥ 75 years (n = 128)	P
Time to PCI (min)	210 ± 138	289 ± 189	< 0.001
In-hospital stay (day)	7.5 ± 6.7	10.2 ± 11.9	< 0.001
3rd degree AVB	12%	29%	0.009
Ventricular fibrillation	10%	6%	NS
Re-infarction	1.6%	3.1%	NS
Shock	7%	17%	< 0.001
In hospital death	3%	12%	< 0.001
Combined endpoint	9%	22%	< 0.001

PCI — percutanous coronary intervention; AVB — atrioventricular block

vs. 2% with QRS– (no significant differences). The incidence of MAE was 17% with QRS+ *vs*. 7% with QRS– (p = 0.001) (Fig. 6).

Logistic regression of predictors of MAE included the following variables: sex, smoking, hypertension, diabetes, a history of previous infarction, Killip ≥ 2 at admission, sum of ST segment elevation, number of diseased coronary vessels, QRS+ and age ≥ 75. Only three variables were significantly related to MAE: Killip ≥ 2 at admission, a history of previous infarction, and QRS+ (p= 0.006, odds ratio 2.423, 95% CI 1.282–4.579).

Table 3 shows the variables that significantly related to the appearance of QRS distortion. Patients with QRS+ were more often EP, and showed signs of heart failure with greater frequency. Their ECG had a higher number of leads with ST segment elevation, or ST segment depression, and higher sum of ST segment elevations. The delay to angioplasty was lesser in QRS+. All of these variables were in-

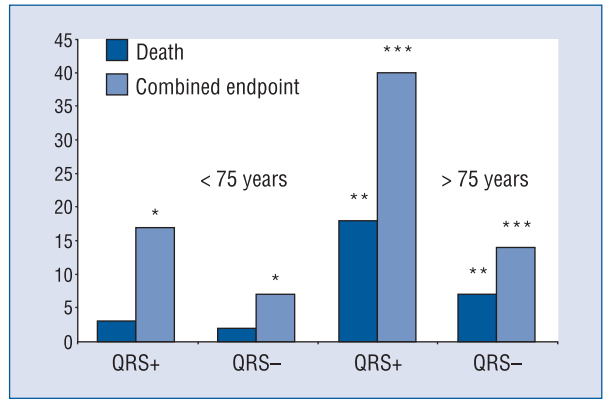

Figure 6. Incidence of death and the combined endpoint (death, reinfarction or shock) according to the presence of QRS distortion and group of age. The presence of distortion of the QRS was significantly associated with a worse outcome both in older and younger patients; QRS+ — distortion of the QRS; QRS– — no distortion of the QRS; *p < 0.01, **p < 0.02; ***p < 0.04.

Table 3. Predictors of QRS distortion.

Significant predictors on bivariate analysis	QRS distortion (n = 141)	No QRS distortion (n = 493)	p
≥ 75 years	27%	18%	0.023
Killip > 1	31%	18%	0.001
ST sum	22 ± 11	12 ± 8	< 0.001
ST elevation	5.3 ± 1.7	4.3 ± 1.7	< 0.001
ST depression	3.5 ± 2.0	2.9 ± 2.1	0.006
Time to PCI [min]	195 ± 129	233 ± 137	0.024
Independent predictors on multivariate analysis	**OR**	**95% CI**	**p**
≥ 75 years	2.1	1.2–4.0	0.016
ST sum	1.1	1.1–1.2	< 0.001
ST depression	1.3	1.2–1.5	< 0.001

PCI — percutanous coronary intervention; OR — odds ratio; CI — confidence interval

cluded in the logistic regression analysis. We found that the independent predictors of QRS+ were: age ≥ 75 years old, ST sum and ST dep.

Discussion

Although management of elderly people with ST-segment myocardial elevation remains controversial, the evidence favors an approach similar to the general recommendations [7]. Our group had a very similar approach to the treatment of elderly patients compared to younger ones. There were no differences in the rate of fibrinolysis, primary or programmed angioplasty. Only four patients in our series did not receive any reperfusion therapy, two from each age group. However, the EP group had a significantly longer delay time to reperfusion, a finding that has previously been described in both in the registries and in the clinical trials [3, 8], and this delay is partially responsible of the increased rate of adverse in-hospital events, as was shown in the Cooperative Cardiovascular Project database [9]. A quick stratification of patients would be useful in reducing the time to reperfusion in patients with more severe infarcts.

The classification of patients according to QRS distortion provides an additional tool to the prompt stratification of elderly people presenting with ST segment elevation. This ECG pattern was initially described by Birnbaun et al. [10]. They found a correlation between distortion of QRS and prognosis in patients with anterior myocardial infarction. They have also shown this association in large groups of patients who received either thrombolytic therapy or primary angioplasty [11]. Patients with QRS+ pattern presented a smaller proportion of salvaged myocardium after primary angioplasty, and more often developed heart failure or cardiogenic shock [2, 12]. The meaning of this association is that the distortion of the QRS identifies a more severe degree of ischemia. Weston et al. [13] obtained continuous ECG recordings from dogs undergoing coronary artery occlusion, and they estimated the severity of the ischemia by microsphere injections. After three hours of reperfusion, the salvaged myocardium correlated inversely with QRS complex prolongation ($r = -0.72$; $p = 0.003$). When dogs were paired by equal amount of ST elevation, less salvaged myocardium was found in those with QRS prolongation [13]. Some authors suggested that the absence of collaterals to the artery of the infarct could be responsible for this degree of ischemia [14].

In a recent publication, our group has shown that the distortion of the QRS was related to absence of collateral flow (OR 1.806, 95% CI 1.097–2.974, $p = 0.019$), and the presence of the no-reflow phenomena (OR 2.388, 95% CI 1.091–5.230, $p = 0.016$). Patients with distortion of QRS had less often adequate myocardial perfusion (OR 0.443, 95% CI 0.220–0.893, $p = 0.021$) [15]. Age is strongly related to the impairment of angiogenesis and endothelial function; therefore the development of new collateral circulation becomes blunted in elderly patients [16]. Moreover, it is not surprising that Kurotobi et al. [17] found that advanced age was an independent predictor of the absence of collaterals. In the multivariate analysis, they found that the absence of collaterals was an independent predictor of in-hospital mortality in patients over 70.

In this study, we have shown that advanced age is an independent predictor of the appearance of QRS distortion, and that EP with QRS distortion carries the worst prognosis. This ECG finding identifies patients with a more severe degree of ischemia, and probably poorer endothelial function and collateral development. These factors help explain the worse prognosis of EP with myocardial infarction.

Conclusions

Advanced age is an independent predictor of the appearance of distortion in the terminal portion of the QRS complex. This finding helps explain the higher mortality of elderly patients in the setting of an acute myocardial infarction. The QRS distortion could be of great assistance in promptly stratifying elderly patients presenting with an ST segment elevation myocardial infarction.

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