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The association between prolongation in QRS duration and presence of coronary collateral circulation in patients with acute myocardial infarction

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Abstract

Background: It is known that QRS duration is related to prognosis in acute myocardial infarction. The relation between QRS duration and coronary collateral circulation is uncertain. In the present study, we aimed to determine the relation between QRS duration and coronary collateral circulation in patients admitted with acute myocardial infarction.

Methods: The present study was composed of 109 consecutive patients with acute myocardial infarction. All patients had total occlusion in the left anterior descending coronary artery. Electrocardiographic recordings on admission were obtained for the assessment of QRS duration. The Rentrop classification was used to define coronary collateral circulation on coronary angiography. Patients were divided into two groups as follows: Group 1 with poor coronary collateral circulation (Rentrop 0–1) and Group 2 with good coronary collateral circulation (Rentrop 2–3).

Results: Of all patients, 62 patients were included in group 1 and 47 patients in group 2, respectively. In the present study, patients in the group 1 had longer QRS duration than patients in the group 2 ($p < 0.005$). Additionally, we found that Rentrop grading had negative correlation with both QRS duration and white blood cell count (r: -0.28; $p < 0.005$ and r: -0.35; $p < 0.001$).

Conclusion: Our study showed that there was an inverse relationship between QRS duration on admission and presence of coronary collateral circulation in patients with acute myocardial infarction.

Keywords

QRS duration, coronary collateral circulation, myocardial infarction

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Background

Coronary artery disease (CAD) is a leading cause of death in developed countries. Acute myocardial infarction (AMI) is one of the most fatal outcomes of CAD. AMI usually develops due to occlusion of the coronary vessel by intracoronary thrombus or ruptured plaque.[1] Coronary collaterals develop as a result of myocardial ischemia and protect the viable myocardium. They have positive effect on prognosis. In previous studies related to coronary collaterals, it was shown that coronary collaterals may restrict the extent of ischemia and protect viability of the myocardium in myocardial infarction.[2–4]

The most significant stimulating factor for development of coronary collaterals is pressure gradient between normal and occluded vessel zones.[5] The pressure gradient leads to the deployment of coronary collaterals by improving blood flow in collateral circulation, inducing endothelial activation and secretion of growth factors.[6,7]

The QRS duration assessed by electrocardiography (ECG) is related to ventricular dysfunction. Prolonged QRS duration can lead to ventricular dysfunction in

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long term and also it can be a direct result of ventricular dysfunction. Additionally, it was found that prolonged QRS duration was related to poor prognosis in AMI.[8] In previous studies, it was shown that prolonged QRS on admission was related to cardiac adverse events.[9–11] However, the relation between QRS duration and collateral circulation has not been searched thoroughly.

In this study, we evaluated the association between QRS duration and presence of coronary collateral circulation in the patients with AMI.

Methods

Patient selection

The present study was composed of 109 consecutive patients with anterior wall AMI. Coronary angiography was performed on admission. The diagnosis of AMI was confirmed in the presence of at least two of the followings: chest pain lasted longer 20 min, increase of creatinine kinase myocardial band more than two times of upper limit, and new ST elevation of at least 0.1 mV in two or more contiguous precordial leads. Previous myocardial infarction, bundle branch block, cardiogenic shock, renal failure, unstable angina pectoris, and non-ST elevation myocardial infarction were exclusion criteria. The local Ethics Committee approved the study protocol. Informed written consent of each patient was obtained.

A standard 12-lead ECG of each patient was obtained on admission. The QRS duration was manually measured by two cardiologists blinded to the present study and calculated from the beginning of the QRS complex to the end of QRS deflection. All measurements were taken from the infarct-related artery leads. Average of measurements from relevant precordial leads was considered for each cardiologist. The average QRS duration measured by two cardiologists was used for the analysis. The intraobserver and interobserver variability were low (<2 and <3%, respectively). Only patients with sinus rhythm were included in the study.

The echocardiographic examination by using a Hewlett Packard SONOS 4500 and 2.5–3.5 mHz transducer was performed following the coronary angiography. The left ventricular ejection fraction (EF) was calculated according to the modified Simpson's method.

All coronary angiograms were performed via Philips device by using at least two views of the right coronary artery and four views of the left coronary artery. The cine-angiographical timing was adequate for the interpretation of coronary collateral flow. Rentrop classification was used for grading the coronary collateral vessels:[12] grade 0, no filling; grade 1, filling of side branches of the artery to be the epicardial segment; grade 2, partial filling of the epicardial artery; and grade 3, complete filling of the epicardial artery. Two cardiologists blinded to the study assessed the grade of the coronary collateral vessels by using the Rentrop classification and had enough experience such as administrating adequate amount of contrast and allowing adequate duration of angiographic runs to evaluate the Rentrop classification. All patients were divided into two groups as follows: Group 1, poor coronary collateral circulation (Rentrop 0 or 1) and Group 2, good coronary collateral circulation (Rentrop 2 or 3). Reproducibility of the Rentrop classification was assessed by two observers viewing 30 samples of the coronary angiograms. Intra- and interobserver agreements were 90 and 95%, respectively.

Statistical analyses

Statistical analyses were performed by using SPSS 18.0 (SPSS, Inc, Chicago, Illinois). Kolmogorov–Smirnov test was used for the normality of the distribution of continuous variables. For continuous variables, Student's *t*-test was utilized to test differences between the groups. Pearson correlation analysis was used for correlation analysis. Continuous variables were expressed as mean ± SD, and categorical variables were expressed as percentages. P value of <0.05 was considered to be statistically significant.

Results

The present study included 18 female and 91 male patients. The study group consisted of patients with at least proximal left anterior descending vessel having ≥90% stenosis. Of all patients, 62 patients and 47 patients were included in group 1 and group 2, respectively. Demographic features of patients were indicated in Table 1. Both the groups were similar in terms of age, sex, family history for CAD, smoking, diabetes mellitus, and hypertension ($p > 0.05$). The EF was statistically lower in the Group 1 compared to the Group 2 ($p < 0.001$) while WBC count was significantly higher in the Group 1 ($p < 0.001$).

Rentrop grading and QRS duration on admission in both groups were shown in Table 2. Patients with poor coronary collateral circulation had longer QRS duration on admission ($p < 0.001$). Additionally, we found that Rentrop grading had negative correlation with both QRS duration and white blood cell count (r: −0.28; $p < 0.005$ and r: −0.35; $p < 0.001$).

Discussion

In this study, QRS duration prolongation on admission was angiographically associated at poor coronary collateral circulation in patients with AMI.

Table 1. Comparison of the groups in respect to demographic parameters.

	Group 1 (n:62)	Group 2 (n:47)	p
Age	56 ± 10	57 ± 12	0.74
Sex (female/male) (n %)	9/53 (14.5%)	9/38 (19.1%)	0.52
HT (n %)	14 (22.6%)	13 (22.7%)	0.54
DM (n %)	7 (11.3%)	6 (12.8%)	0.81
Smoking (n %)	29 (46.8%)	19 (40.4%)	0.51
Family history (n %)	10 (16.1%)	3 (6.4%)	0.12
Hematocrit,	42 ± 4	41 ± 4	0.44
WBC Count, ($\times 10^9$/l)	15.1 ± 3.7	12.4 ± 3.4	<0.001
Glucose (mg/dl)	167 ± 75	140 ± 49	0.02
Peak CKMB (IU/l)	198 ± 20	169 ± 17	0.001
LDL (mg/dl)	126 ± 32	122 ± 33	0.37
HDL(mg/dl)	38 ± 10	37 ± 9	0.59

CKMB: creatinine kinase myocardial band; DM: diabetes mellitus; HDL: high density lipoprotein; HT: hypertension; LDL: low density lipoprotein; WBC: white blood cell.

Table 2. Comparison of the groups in respect to QRS duration, ejection fraction, and luminal diameter stenosis.

	Group 1 (n:62)	Group 2 (n:47)	p
Left ventricular ejection fraction	38 ± 7	43.2 ± 8	<0.001
Number of significantly narrowed coronary arteries (>50% of luminal diameter)	1.67 ± 0.7	1.65 ± 0.7	0.77
QRS duration on admission (ms)	85 ± 16	74 ± 23	<0.001

AMI leads to heart failure, arrhythmia, and mortality in patients, and coronary collaterals have had a potential cardioprotective effect, because of its relationship with limited infarct areas, and improved ventricular function and survival in myocardial infarction.[13] In the patients of severe occlusion, coronary collateral circulation is the other sourch in terms of maintaining perfusion to myocardial area of ischemia.[14] Several clinical and biochemical factors could influence the development of coronary collateral.[15] The patients with good coronary collateral circulation compared with patients with poor coronary collateral circulation were shown to have lower mortality risk.[16]

The ECG was used to measure QRS duration in patients with AMI. The QRS duration was thought to be an important prognostic marker as shown in patients with heart failure and myocardial infarction.[17,18] In previous studies, interventricular conduction delay due to myocardial ischemia was directly reflected as prolongation in QRS duration.[19,20] In addition, Kosuge et al. showed an association between high QRS score on admission and impaired myocardial reperfusion.[21] The other study showed that the presence of fragmented QRS on ECG emerged as a sign of poor coronary collateral circulation.[22] Similarly, Erdoğan et al. detected that fragmented QRS was independently associated with poor coronary collaterals in patients with chronic total occlusion.[23] In addition, the QRS duration was related to increased 30-day mortality after myocardial infarction, and only patients with normal QRS duration were involved in this study.[24] A similar association was indicated in the GUSTO-1 patients with normal QRS duration (<100 ms) after myocardial infarction.[25] Another study showed that patients with prolongation of QRS duration had increased ventricular volumes, decreased left ventricular EF, and higher incidence of sudden cardiac death.[26] Different than the previous studies, we searched the relation of QRS duration and collateral circulation in patients with anterior wall AMI. Thus, this is a unique study in this aspect. The present study showed an association between QRS duration prolongation and poor coronary collateral circulation. Average QRS duration of Group 1 was significantly higher than that of Group 2. This finding was similar to the previous study carried out among patients with non-ST elevation AMI.[27]

Conclusion

The present study showed an inverse association between QRS duration on admission and coronary collateral circulation in patients with anterior wall AMI. Further studies are required to find clinical implications of the relationship between the QRS duration and coronary collateral circulation.

Limitations

There were some limitations of present study. First, the number of patients was comparatively low. Second, our study examined only the visualized coronary collaterals rather than total coronary collateral circulation since collateral vessels less than 100 μm in diameter cannot be evaluated by angiography. Moreover, we were unable to make neither the scar burden by using MRI nor the number of dysfunctional segments by using echocardiography for data on infarct.

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All authors contributed equally.

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