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Validity of QRS Configuration and Myeloperoxidase Level as Determinants of CAD Severity and Prognosis in Patients with STEMI

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Abstract

Background: Terminal QRS distortion and fragmentation (fQRS) with elevated myeloperoxidase (MPO) were linked to poor cardiovascular outcomes in acute coronary syndrome. We aimed to investigate these parameters in early prediction of coronary artery disease severity based on SYNTAX score and in-hospital adverse events in STEMI patients. **Methods:** A total of 215 patients with first STEMI admitted for primary PCI were included in the study. They were divided according to the admission ECG into group I with QRS distortion or fQRS, group II with combined QRS distortion and fQRS, and group III without QRS distortion or fQRS. Myeloperoxidase and troponin I levels, ST resolution ratio, left ventricular EF%, and severity of coronary artery lesions using SYNTAX risk score were measured. **Results:** MPO level, SYNTAX score, and in-hospital mortality were higher in group I and II and were higher in group II compared to group I. By regression analysis, QRS distortion, fQRS, and MPO > 412 ng/ml were independent predictors of both CAD severity and in-hospital mortality. DM was an independent predictor of CAD severity (OR: 2.851, P 0.012) while high SYNTAX score was an independent predictor of in-hospital mortality (OR: 6.113, P 0.001). Adding MPO level to any QRS configuration pattern increased predictive value for the detection of CAD severity that was more evident in the combined QRS distortion and fragmentation. **Conclusion:** Terminal QRS distortion, fragmentation, or combined QRS distortion and fragmentation have a significant value in predicting in-hospital adverse events and CAD severity as assessed by SYNTAX score in association with plasma myeloperoxidase level in STEMI patients. Combined QRS distortion and fragmentation, in spite less common, could be more helpful for early risk stratification and management.

Keywords

QRS Distortion, QRS Fragmentation, Myeloperoxidase Level, SYNTAX

Score, ST-Elevation Myocardial Infarction

1. Introduction

Acute coronary syndrome (ACS) is an emergency that threatens patients' life [1] [2] and has a higher poor in hospital outcomes [3]. Early risk stratification is essential in the management of ACS patients.

The standard 12-lead electrocardiogram (ECG), despite major advances in cardiac imaging techniques, continues to be the most used tool for both diagnostic and prognostic evaluations of ST-segment elevation myocardial infarction (STEMI).

Distortion of the terminal QRS observed on ECG of those patients reflects profound ischemia, which can affect the Purkinje fibers. Delayed conduction in the local Purkinje fibers resulting from regional myocardial ischemia can decrease the degree of cancellation and leads to decrease in the S-wave and increase in amplitude of the R-wave on the surface ECG [4] [5]. Since Purkinje cells are less sensitive to ischemia than contracting myocytes [6], a change at the QRS complex terminal portion will occur [5].

An association has also been reported between distortion of the terminal QRS with less residual flow to the infarct zone [7], less myocardial salvage and a rapid progression of necrosis [8]. It is also linked with larger infarcts [7] and increased all-cause mortality [9].

On the other hand, fragmented QRS (fQRS) originates from abnormal ventricular depolarization caused by the nonhomogeneous electrical activation of ischemic and/or injured ventricular myocardium [10].

fQRS is a marker of infarct size and acute ventricular remodeling in STEMI. The presence of fQRS is associated with a larger infarct size and peri-infarct zone, decreased left ventricular ejection fraction, and more myocardial perfusion abnormalities [11]. Also, fQRS is linked with three vessels CAD disease [12], increased morbidity and mortality and a predictor of adverse cardiac events in patients with ACS [13] [14] [15].

Likewise, Tanrivedi *et al.*, 2018 [16], demonstrated that a combination of QRS distortion and fragmented QRS was correlated with higher mortality, poor LVEF, high levels of cardiac biomarkers and low rate of ST resolution after PCI.

Cardiomyocyte damage in ACS can initiate a systemic and local inflammatory response and release inflammatory cytokines such as myeloperoxidase (MPO) that has been associated with atherosclerosis and recurrent coronary events [17] and has a prognostic value in predicting mortality [18]. Unlike CRP, the release of MPO in ACS is less involved in general systemic inflammation, thereby making it a more specific coronary marker [19].

MPO can be used in the emergency department as a diagnostic support and risk stratification tool in patients with ACS [20].

SYNTAX risk score is used to assess the severity of coronary artery lesions and guiding the best management to prevent morbidity and in hospital mortality [21].

Aim of the work: We hypothesized that increased cardiovascular outcomes in acute ST-segment elevation myocardial infarction (STEMI) patients with terminal QRS distortion and fragmentation on the admission ECG might be due to severity of coronary artery lesions. We investigated the relationship between terminal QRS distortion and fQRS in association with MPO level and early prediction of coronary artery disease severity based on SYNTAX score for risk stratification and early management of those patients.

2. Patients and Methods

Study population:

Two hundred fifteen patients admitted with the first acute STEMI to CCU, Zagazig University hospitals, in the period from November, 2018 to June, 2019 were included in the study. They were managed according to the European Society of Cardiology (ESC) guidelines [22] [23]. We included patients with chest pain, elevated cardiac biomarkers and ECG changes compatible with STEMI.

A written informed consent was taken from all patients and the study was approved by the monthly ethical committee of Cardiology Department, Zagazig Faculty of Medicine that was conforms to the principles outlined in the Declaration of Helsinki.

Exclusion criteria: Patients with previous myocardial infarction, coronary artery Bypass surgery (CABG), bundle branch block, atrial fibrillation, atrial flutter, paced rhythm, pre-excitation syndrome, uninterpretable ECG due to poor quality, and dilated cardiomyopathy.

All patients were subjected to:

- History taking and clinical examination.
- **Electrocardiography (ECG):**

Resting twelve-lead surface ECG was recorded in the emergency room at a gain of 10 mm/mV, a 25 mm/s speed and filter ranges from 0.5 Hz to 150 Hz with AC filter was 60 Hz. Two expert cardiologists reviewed and analyzed the ECG pattern of QRS.

Terminal QRS distortion was defined as emergence of the J point at ≥50% of the height of the R wave amplitude in qR configuration leads and/or absence of S wave in rS configuration leads (leads V1 - V3) (**Figure 1**, **Figure 2**) [24].

Fragmented QRS was defined as the presence of an additional R wave (R' prime), a notching in R wave or S wave, or fragmentation of RS complex or QS complex without the typical bundle branch block in 2 leads corresponding to a territory of coronary artery (**Figure 3**) [10] [25].

According to the presence of terminal QRS distortion and fragmentation, patients were divided into:

Group I: 91 patients with QRS distortion pattern or fragmentation.

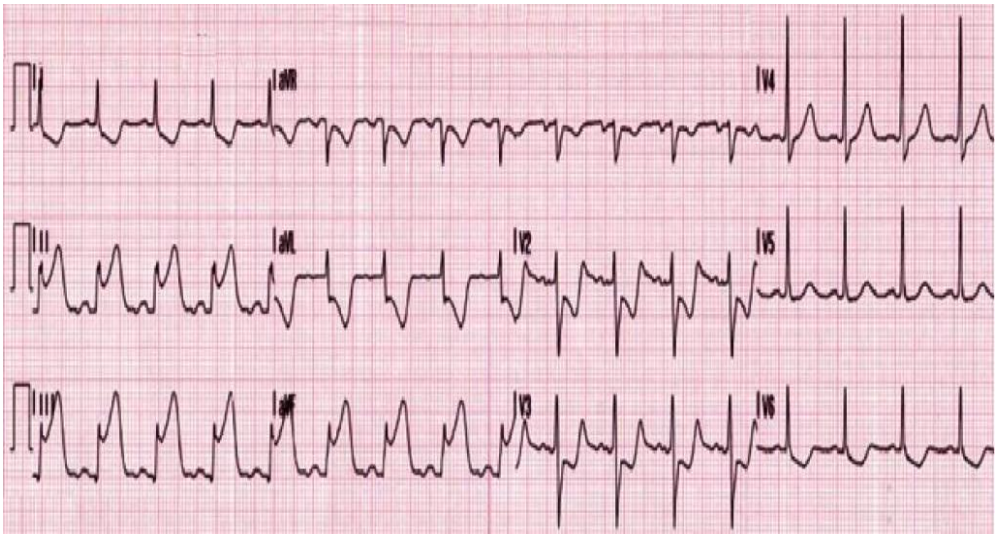

Figure 1. Electrocardiogram showing QRS distortion in a patient with inferior myocardial infarction (Emergence of J point at ≥50% of the height of the R wave).

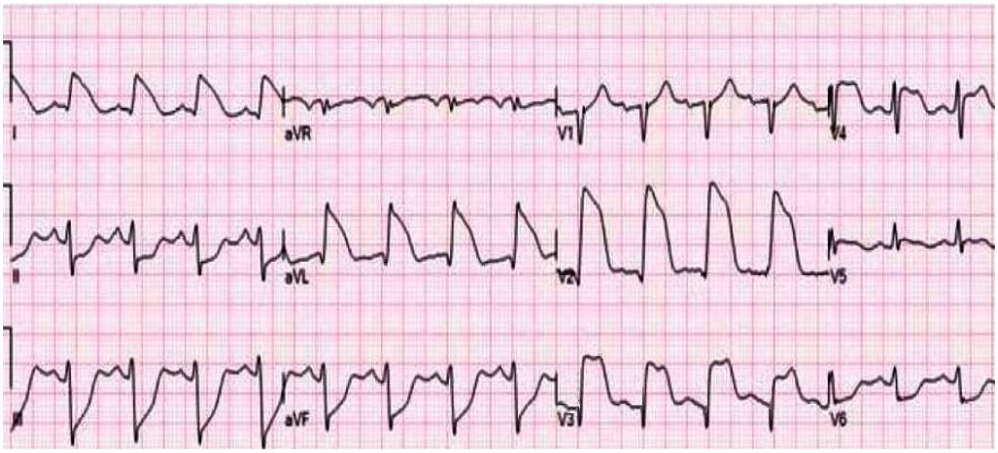

Figure 2. Electrocardiogram with QRS distortion in a patient with anterior myocardial infarction.

Group II: 58 patients with the combined QRS distortion and Fragmentation patterns.

Group III: 66 patients without QRS distortion or fragmentation (**Figure 4**).

Sum of ST elevations pre-PCI and post-PCI was used to calculate the ST segment resolution percentage [26].

Plasma myeloperoxidase (MPO) level: heparin-free blood sample was the first set of bloods drawn when our patients arrive to ER to avoid higher values induced by intravenous heparin [27]. MPO concentrations were determined by using commercially available kit; colometric method by the use of microlab 200 (marc, Germany) for quantitative determination of myeloperoxidase in plasma. Our results were calculated by automatic reader [28].

- **Echocardiography:** Routine two-dimensional echo-Doppler study was performed in the first 24 hours of admission. LV ejection fraction was measured by modified Simpson's method.

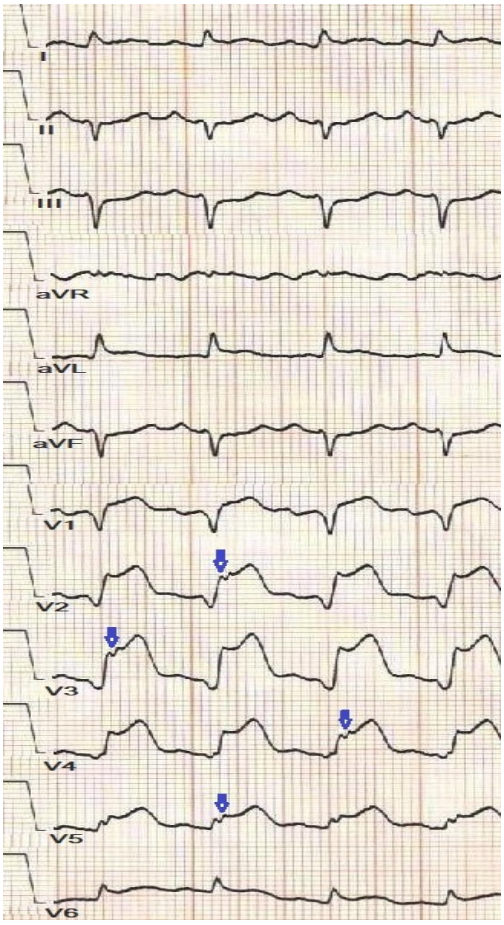

Figure 3. Electrocardiogram showing combined QRS distortion and fragmentation in a patient with anterior myocardial infarction (Emergence of J point at ≥ 50% of the height of the R wave with notched R wave).

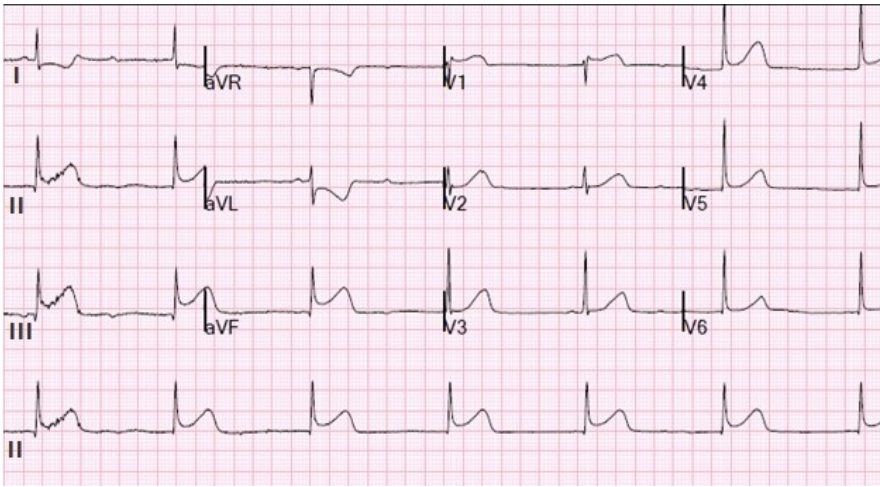

Figure 4. Electrocardiogram showing a patient with inferior myocardial infarction complicated with heart block without QRS distortion or fragmentation.

- **Coronary angiography and primary PCI:** All patients underwent coronary angiography according to the ESC guidelines, 2018 of the management of

acute coronary syndrome using standard techniques [23]. Multiple angiographic views were obtained in all patients and the coronary angiographic results were interpreted by interventional cardiologists. The coronary artery stenosis location, the number of affected vessels and the degree of stenosis were recorded for all patients. The severity of lesions was estimated using SYNTAX risk score, version 2.11 [21].

SYNTAX score is the sum of the points given to each individual lesion recognized in the coronary branches with >50% diameter narrowing in vessels > 1.5 mm diameter. The coronary branches are divided into 16 segments according to the AHA classification. Each segment is given a score of 1 or 2 depends on the presence of disease and this score is then weighted based on a chart, with values ranging from 3.5 for the proximal left anterior descending artery to 5.0 for left main, and 0.5 for smaller branches. A computer algorithm is then interrogated and a summed value is formed [29].

In this study, the SYNTAX score was classified into 3 different tertiles [30]:

Low risk SYNTAX score: <22

Intermediate risk SYNTAX score: 22 - 32

High risk SYNTAX score: ≥33

Statistical analysis:

Data were collected and analyzed using SPSS 22.0 software (SPSS Inc, Chicago, IL, USA). Continuous variables were expressed as the mean ± SD, and the categorical variables were expressed as a number (percentage). A one-way ANOVA was used to compare means of more than two groups of variables. The Tukey HSD ("Honestly Significant Difference") post-hoc test was used, to indicate which groups were significantly different from the others and it provides 95% confidence intervals around the differences between the groups. Comparisons between two groups were made by Student's t-test for continuous variables and by chi-square analysis for categorical variables. Spearman's rank correlation coefficient was calculated to assess the relationship between terminal QRS distortion and fragmentation and all variables.

Logistic regression analysis was used to identify the independent predictors of CAD severity and in-hospital mortality as well. Receiver operating characteristic (ROC) curve analysis was used to identify optimal cut-off value of QRS distortion and fragmentation before and after adding myeloperoxidase level with maximum sensitivity and specificity for predicting the severity of CAD.

A P-value less than 0.05 were considered as statistically significant.

3. Results

A total of 215 patients with STEMI were included in this study. Their ages ranged from 40 to 73 years and 143 (66.5%) of them were males. 128 patients were hypertensive (59.5%) and 150 were diabetic (69.7%). Their body mass index ranged from 30 to 44 kg/m^2 and 120 (55.8%) of them had a current history of smoking.

Patients were divided into 3 groups according to the presence of QRS distortion or fragmentation, combined QRS distortion and fragmentation, or without QRS distortion or fragmentation in their ECGs.

There were significantly less patients with diabetes mellitus in group III and significantly more with cardiac troponin I, myeloperoxidase level, and SYNTAX risk score in group II. Moreover, LV ejection fraction, ST resolution ratio, and in-hospital mortality rate were significantly different among the study groups (Table 1).

By using post hoc test analysis (Tukey Honestly Significant Difference) to compare in between groups, there was no significant difference between group I and group II regarding low risk and intermediate risk SYNTAX score (Table 2).

Also, myeloperoxidase level was insignificantly different between group I and group II patients with low risk or high risk SYNTAX score (Table 3, Figure 5).

Using logistic regression analysis, among many variables, diabetes mellitus, myeloperoxidase level > 412 ng/ml, QRS distortion, and fQRS were independent predictors of CAD severity while age, high SYNTAX score, myeloperoxidase level > 412 ng/ml, QRS distortion, and fQRS, were independent predictors of in-hospital mortality (Table 4).

Table 1. Patients characteristics, troponin I and myeloperoxidase levels, LV systolic function, and SYNTAX risk score in the 3 studied groups.

Parameters	Group I with QRS distortion or fragmentation (n = 91)	Group II with QRS distortion and fragmentation (n = 58)	Group III without QRS distortion or fragmentation (n = 66)	P-value
Age [years] Mean ± SD	56.33 ± 9.66	54.83 ± 8.726	57.33 ± 4.131	0.228*
Gender (NO & %)				
Male	61 (67.03%)	40 (68.97%)	42 (63.63%)	0.813
Female	30 (32.97%)	18 (31.03%)	24 (36.36%)	
Smoking (NO & %)	52 (57.14%)	31 (53.44%)	37 (56.06%)	0.905
Family History of CAD (NO & %)	20 (21.97%)	14 (24.13%)	14 (21.21%)	0.921
BMI [kg/m^2]	35.2 ± 4.4	34.9 ± 4.3	34.8 ± 4.6	0.840*
Hypertension (NO & %)	56 (61.5%)	33 (62.2%)	39 (59.09%)	0.889
Diabetes mellitus (NO & %)	69 (75.82%)	45 (77.58%)	37 (56.06%)	0.010
Dyslipidemia (NO & %)	47 (51.64%)	29 (50%)	34 (51.51%)	0.978
Heart rate (beats/min)	81.5 ± 16.5	84.6 ± 17.5	79.4 ± 17.2	0.310*
Mean arterial blood pressure (mmHg)	90.3 ± 6.8	88.2 ± 5.4	91.6 ± 7.4	0.781*
Creatinine level (mg/dl)	0.9 ± 0.9	1.1 ± 0.4	0.9 ± 0.6	0.881*
Maximum troponin I level (ng/ml) Mean ± SD	132.268 ± 41.827	146.024 ± 39.819	106.659 ± 38.726	0.039*
MPO level (ng/ml) Mean ± SD	401.123 ± 69.368	428.182 ± 47.824	188.446 ± 103.434	0.001*
LV ejection fraction %	51.23 ± 8.46	47.81 ± 7.26	58.30 ± 4.25	0.02*
SYNTAX score Mean ± SD	30.3 ± 5.57	32.91 ± 5.29	18.5 ± 6.8	0.001*
ST-resolution ratio (%)	60.8 ± 21.5	53.5 ± 12.7	74.2 ± 16.7	0.001*
In-hospital mortality (NO & %)	3 (3.2)	5 (8.6)	1 (1.5)	0.03

Chi-square test, P value is significant if < 0.05. *One way ANOVA test. MPO: Myloperoxidase.

Table 2. In between group comparison using post hoc test analysis as regards SYNTAX risk score.

	Low risk SYNTAX score				Intermediate risk SYNTAX score				High risk SYNTAX score			
	Diff.	95%CI		P	Diff.	95%CI		P	Diff.	95%CI		P
Group I vs Group II	2.80	−2.52	8.12	0.4186	1.00	−0.51	2.51	0.2600	0.83	0.10	1.55	0.0215
Group I vs Group III	−2.90	−5.73	−0.06	0.0444	−2.66	−4.35	−0.96	0.0011	−2.02	−3.26	−0.79	< 0.001
Group II vs Group III	−5.70	−10.41	−0.98	0.0143	−3.66	−5.54	−1.77	<0.001	−2.85	−4.12	−1.59	< 0.001

Table 3. In between group comparison using post hoc test analysis as regards troponin I and myloperoxidase levels.

	Low risk SYNTAX score (<22)				Intermediate risk SYNTAX score (22 - 32)				High risk SYNTAX score (≥33)			
	Diff.	95% CI		**P**	Diff.	95% CI		**P**	Diff.	95% CI		**P**
Troponin I level												
Group I vs Group II	−4.6	−75.39	66.19	0.9865	5.0	−24.87	34.87	0.9149	0.20	−19.21	19.61	0.7832
Group I vs Group III	−6.3	−44.03	31.43	0.9143	4.0	−29.38	37.38	0.9554	2.00	−30.83	34.83	0.9885
Group II vs Group III	−1.7	−64.44	60.98	0.9973	−1.0	−38.10	36.10	0.9960	1.80	−31.91	35.51	0.9911
Myloperoxidase level												
Group I vs Group II	23.37	−6.53	53.27	0.1528	12.00	2.10	21.89	0.0136	0.52	−13.10	14.14	0.9961
Group I vs Group III	−41.70	−57.61	−25.75	<0.001	−52.50	−63.55	−41.4	0.0000	−163.	−187.77	−140.	<0.001
Group II vs Group III	−65.07	−91.55	−38.58	<0.001	−64.5	−76.78	−52.2	0.0000	−164.	−187.77	−140.	<0.001

Table 4. Independent predictors of CAD severity and in-hospital mortality.

	Variable	Odds ratio	95% CI	P
CAD severity	**Diabetes mellitus**	2.851	0.603 - 13.727	0.012
	Myeloperoxidase level > 412 ng/ml	6.121	1.915 - 19.312	0.001
	GIII (reference group)			
	GI	5.760	1.93 - 17.89	0.010
	GII	7.826	2.89 - 26.77	0.007
In-hospital mortality	**Age**	1.16	1.02 - 1.07	0.014
	High SYNTAX SCORE	6.113	1.621 - 18.205	0.001
	Myeloperoxidase level > 412 ng/ml	4.632	2.765 - 16.734	0.001
	GIII (reference group)			
	GI	4.760	1.43 - 14.89	0.030
	GII	8.826	2.71 - 28.67	0.001

G I: QRS distortion or fragmentation; G II: Combined QRS distortion and fragmentation; G III: Without QRS distortion or fragmentation. ***Entered variables***: age, body mass index, family history of CAD, hypertension, diabetes mellitus, smoking, dyslipidemia, mean arterial blood pressure, heart rate, serum creatinine, maximum troponin I, myelopoeroxidase, LV ejection fraction, ST resolution ratio, SYNTAX score, QRS distortion and fragmentation.

Using ROC curve analysis, QRS distortion or fragmentation had a sensitivity of 74.9%, a specificity of 78.9%, a positive predictive value of 80.4%, and a negative predictive value of 71.2% with area under the curve (AUC) of 0.793 in

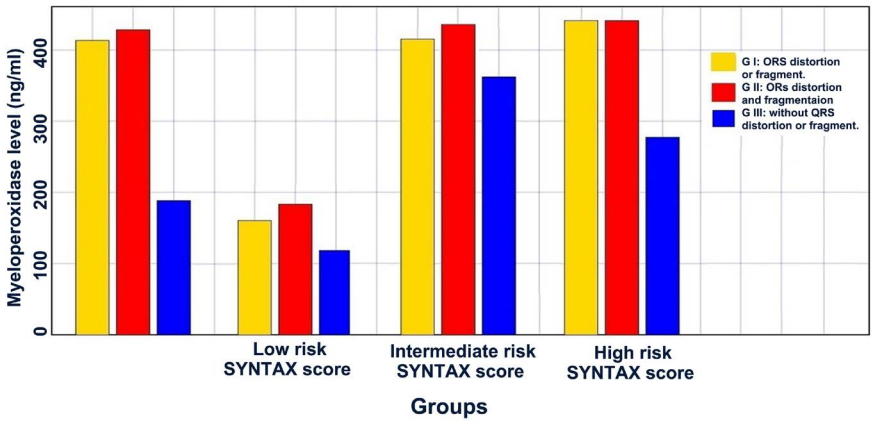

Figure 5. Mean values of myeloperoxidase (ng/ml) among the 3 studied groups. In between group comparison using post hoc test analysis, myeloperoxidase level was insignificantly different between group I and group II patients with low risk or high risk SYNTAX score (P > 0.05) but was significantly higher in group II patients with intermediate risk SYNTAX score (P = 0.013).

predicting severity of CAD (P value < 0.002). That figures were significantly changed at myeloperoxidase level of >412 ng/ml to 81.4%, 88.4%, 85.7%, and 70.8% respectively with AUC of 0.862.

Regarding QRS distortion and fragmentation, it had a sensitivity of 69.9%, a specificity of 85.2%, a positive predictive value of 80.4%, and a negative predictive value of 70.6% with area under the curve (AUC) of 0.856 in predicting severity of CAD (P value < 0. 0.019). That figures were significantly changed at myeloperoxidase level of >412 ng/ml to 89.4%, 93.5%, 90.7%, and 75.8% respectively with AUC of 0.985 (**Figure 6**).

4. Discussion

The early and rapid risk assessment of patients with acute coronary syndrome could be useful in reducing the time to early reperfusion in patients with more severe coronary artery disease. The standard 12-lead electrocardiogram (ECG) continues to serve as the most widely used tool in the diagnosis and risk stratification of patients with acute ST-segment elevation myocardial infarction (STEMI) and several new ECG parameters have been shown to be useful in determining patients at higher risk [31]. In our study, we investigated if the presence of ECG terminal QRS distortion or fragmentation and combined QRS distortion with fragmentation (fQRS) in patients with STEMI would be a useful tool for guiding risk stratification and early management.

Fragmented QRS occurs less commonly during early stages compared to terminal QRS distortion which considered an early finding in the admission ECG [12].

In this study, only Patients with first STEMI were included in this study. They were 91 patients (42.3%) with QRS distortion or fragmentation, 58 patients (26.9%) with combined QRS distortion and fragmentation, and 66 patients (30.6%) without QRS distortion or fragmentation on the admission ECG.

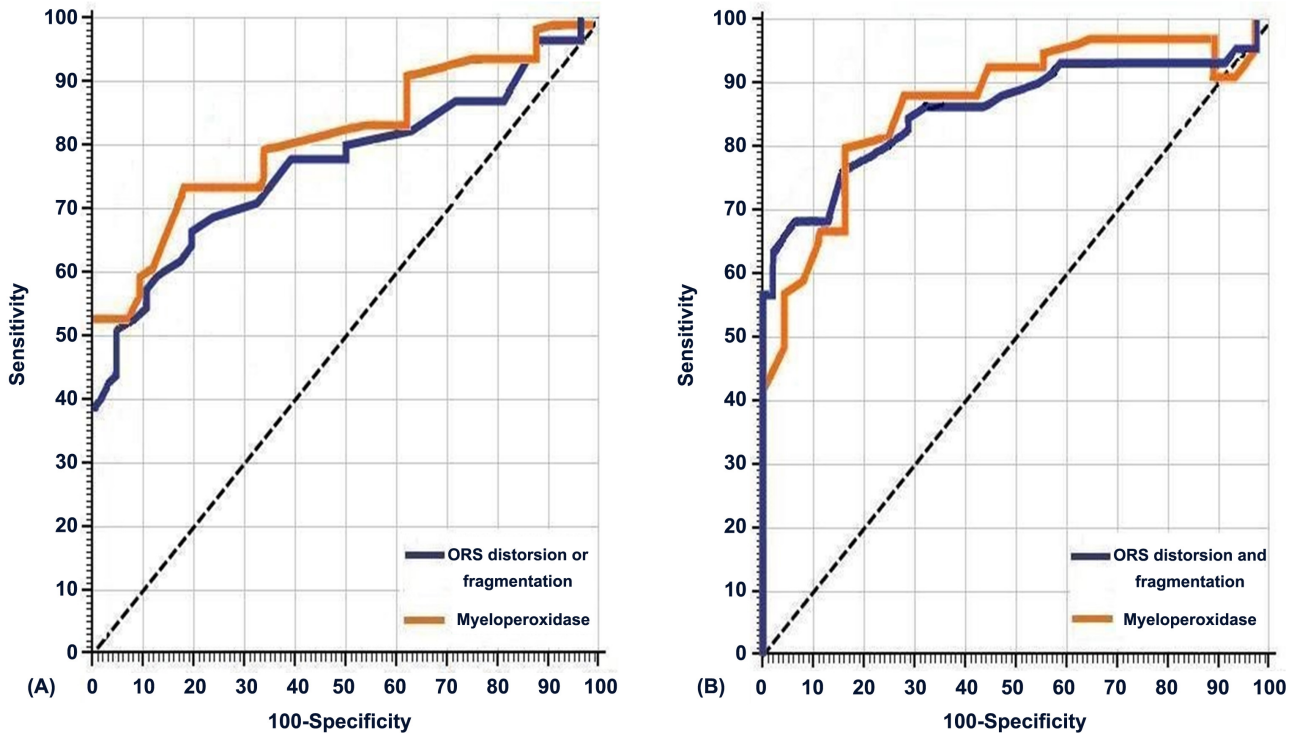

Figure 6. ROC curve analysis of QRS distortion (A) and combined QRS distortion and fragmentation (B) before adding myeloperoxidase (MPO) and after adding MPO in predicting severity of CAD.

The incidence of DM was higher in patients with QRS distortion, fragmentation, or combined QRS distortion with fragmentation and was an independent predictor of CAD severity in our study.

DM increases the risk for adverse outcomes in patients with MI and considered an independent risk factor in both short- and long-term mortalities after acute MI [32]. This could be related to impaired metabolic processes, activation of free radicals, endothelial dysfunction, arterial thrombus formation, and multivascular damages [33].

Myeloperoxidase (MPO) level was higher in patients with combined QRS distortion with fragmentation.

Current evidence supports a causative role of MPO in coronary plaque rupture (19), impairs coronary vessel dilatation and worsens cardiac ischemia [20]. It has also been linked to recurrent coronary events [34], and worsening cardiac remodeling [35]. When several biomarkers were compared to each other, elevated MPO concentration was found to be highly sensitive predictor of future cardiovascular events [34] [36]. Concentrations of MPO correlate with the presence [37] and severity of CAD [38].

In our study, MPO > 412 ng/ml was an independent predictor of CAD severity and in-hospital mortality as well. Also, adding MPO level to QRS distortion, fragmentation, or combined QRS distortion with fragmentation increased predictive value for the detection of CAD severity in our study. The SYNTAX risk score, which was served to assess the degree of coronary stenosis, increased pro-

gressively along with the increasing plasma MPO level. Düzgünçinar *et al.*, 2008, [39] found that plasma MPO level was related to the Gensini risk score in patients with CAD and Wainstein *et al.*, 2010, [40] showed a correlation between systemic MPO levels and the level of angiographically proven coronary artery lesions.

In this study, patients with QRS distortion, fragmentation, and patients with combined QRS distortion and fragmentation in their ECGs had more CAD severity (intermediate and high SYNTAX score) compared to patients without QRS distortion or fragmentation. These ECG changes may be related to increased ischemic myocardium. Ischemic myocardium may in turn contribute to abnormal conduction in the myocardium and hence the ECG pattern.

In consisted to our findings, Wolak *et al.*, 2007 [41], and Kocaman *et al.*, 2012 [42], have shown that fQRS and distortion of the terminal QRS are associated with myocardial scar extention and coronary artery disease prevalence. Also, Tanriverdi *et al.*, 2015 [12], stated that fQRS and QRS distortion may be useful for identifying patients at higher cardiac risk and QRS distortion had more frequent three vessels disease compared to one without QRS distortion whereas fQRS had more frequent three vessels disease compared even to QRS distortion and these findings may guide the physician deciding initial treatment modality in STEMI.

In our study, patients with combined QRS distortion and fragmentation had high SYNTAX score and MPO level compared to patients with QRS distortion or fragmentation alone. Also, those patients had more sensitivity and specificity to detect CAD severity either before or after adding MPO level as mentioned by ROC curve analysis.

Of note, similar statistical accuracy of both QRS distortion and combined QRS distortion with fragmentation and MPO level for detection of CAD severity was noted using ROC curve analysis.

Thus, an important relationship was found in our study between advanced CAD and combined fQRS with QRS distortion more than QRS distortion or fragmentation alone. This was in agreement with Tanriverdi *et al.*, 2018 [16], who found that QRS distortion and fQRS have been separately shown to be associated with poor prognosis and combined use of fragmented QRS and its distortion provides higher prognostic value compared to the presence of fragmented QRS or QRS distortion alone for early risk assessment in patients with ACS (STEMI) treated with primary PCI. In contrast, Ari *et al.*, 2012 [43], showed no relationship between fQRS and advanced CAD and this could be due to lower number of his patients (85 patients).

We used a SYNTAX risk score from many scoring systems to assess the severity of coronary artery disease because it is a one of the scoring systems for determining the extent and severity of CAD [21]. Although a number of studies have investigated the relationship between GRACE risk score, TIMI risk index, and CAD [44], none has addressed the association between both and the severity of CAD assessed by SYNTAX score in patients with ACS.

Cardiac Troponins I levels are sensitive and specific biomarker for myocardial injury [45]. In our study, cardiac troponin I level was significantly higher in patients with combined QRS distortion and fragmentation and, in spite non significant, was increased with increased CAD severity determined by SYNTAX score. It was noted that patients with ACS and high cardiac troponin I levels have a higher adverse cardiovascular outcome [45], and also have a higher incidence of complex multi-vessel disease [46]. We found that patients with combined QRS distortion and fragmentation had higher maximum troponin and MPO levels, lower LV ejection fraction, lower ST-resolution ratio, and higher SYNTAX score. All these results together may indicate that patients with this type of QRS configuration could have a larger amount of scar tissue and more liable for in-hospital MACE.

5. Limitations of the Study

1) Small sample size that could affect in-between group comparisons especially adverse in-hospital outcome.

2) Long term prognosis was not studied.

3) Location of infarction was not analyzed.

4) All patients in the study were scheduled for primary PCI but thrombolytic treated group was not included.

5) Correlating myeloperoxidase level with QRS distortion and/or fragmentation was not done.

6. Conclusions

Although terminal QRS distortion and fragmentation occurs with different mechanisms at the cellular level, both have a significant value in predicting in-hospital adverse events and CAD severity as assessed by SYNTAX score in association with plasma myeloperoxidase level in acute coronary syndrome (STEMI) patients. Combined QRS distortion and fragmentation on the admission ECG, in spite less common (was 26.9% in this study), could be more helpful.

We suggest that terminal QRS distortion and fragmentation can be used as a tool for prediction of higher risk STEMI patients on admission ECG, in addition to myeloperoxidase level, who may benefit from early risk stratification and management. Future studies in order to find the accurate cutoff point of plasma myeloperoxidase level in acute coronary syndrome (STEMI) patients are warranted.

Primary Funding Source

None.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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