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The Correlation between QRS Dispersion and Coronary Artery Disease Severity in Patients with Non ST Elevation Myocardial Infraction

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Non ST elevation myocardial infarction (NSTEMI) has been the subject of numerous studies. Risk stratification is a fundamental element for the management of NSTEMI; therefore, several scores have been established in this direction, particularly prognostic markers derived from the ECG.

Aims: The aim of our study is to correlate the dispersion of the QRS with the severity of coronary lesions assessed by the GENSINI score in patients admitted for NSTEMI at the University Hospital of Marrakech.

Methods: A retrospective study was conducted in the cardiology department of Mohammed VI university hospital of Marrakech from January 01, 2022 to March 31, 2022. Data was derived from the hospitalization register, including 30 patients (16 women and 14 men). Age ranged from 56 to 74

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years with an average of 64.6 ± 9.3. Data was analyzed by SPSS, the level of significance set at p <0.05.

Results: We found, in our study, a highly significant positive correlation between QRS dispersion (considered important if >20 ms) and admission heart rate (p=0.003) as well as the level of ultrasensitive troponins (p=0.003). There is also a very significant correlation between QRS dispersion and corrected QT interval (p=0.005), Moreover, we concluded that in patients admitted for NSTEMI, the greater the dispersion of the QRS, the higher the score of GENSINI (p<0.0001).

Conclusion: The dispersion of the QRS is a simple marker on the ECG that can have a predictive value in different clinical contexts, particularly in acute ischemic heart disease. Further studies are needed, however, to validate its usefulness in routine practice.

Keywords: Cardiology; coronary artery disease; myocardial infarction; prognostic markers.

1. INTRODUCTION

Coronary artery disease (CAD) is the leading cause of mortality among adults in the in both developed, and developing countries [1]. Therefore, all patients, especially those with non-ST elevation myocardial infarction (NSTEMI), should undergo early risk stratification. This latter will impact decision making between an invasive treatment or non-invasive one.

Different risk stratification scores have been created. Prognostic markers related to standard ECG findings in particularly have been interesting. Dispersion of surface ECG wave durations has been the subject of multiple studies, in the quest of a simple non-invasive cardiac marker that can be used to predict the risk of arrhythmias and sudden cardiac death. However, this marker showed some intrinsic and methodological issues that question its utility [2].

This article presents data supporting the benefit of QRS dispersion as an easy accessible marker with potential value in the assessment of risk stratification in patients presenting with NSTEMI.

2. MATERIALS AND METHODS

2.1 Study Design and Population

Thirty patients with NSTEMI, were admitted to the Cardiology Care Unit for NSTEMI in university hospital of Marrakech, during the period between January 2022 and March 2022, they were 14 males and 16 females, their age varied from 56 to 74 years with a mean of 64.6 ± 9.3.

The work has been done respecting the *ethical* principles for medical research *involving human* subjects by the world medical association (WMA).

2.1.1 Inclusion criteria

- Typical angina
- Non persistent ST segment elevation in limb leads or in precordial leads
- Positive high sensitive cardiac troponin test.

2.1.2 Exclusion criteria

- History of myocardial infarction, or previous revascularization,
- History of congenital heart diseases,
- History of severe valvular heart disease,
- Pacemaker rhythms, bundle branch blocks, AV blocks, accessory pathway,
- Antiarrhythmic treatment,
- Electrolyte abnormalities,
- History of cerebrovascular disease,
- End stage kidney disease.

2.2 Patients Data

2.2.1 Cardio-vascular risk factors

- Smoking: four groups were determined: never smoked, non-current smokers, smokers (not daily) and daily current smokers.
- Diabetes mellitus: when HbA1C>6,5%.
- Dyslipidemia: when LDLc ≥130 mg/dl, HDLc< 40 mg/dl, total cholesterol ≥ 200 mg/dl, triglycerides ≥ 150 mg/dl.
- Hypertension: The definition used was systolic blood pressure ≥140mmHg and/or diastolic blood pressure ≥ 90mmHg and/or current treatment with antihypertensive medication.
- Obesity: Defined as BMI≥30 kg/m2.

2.2.2 Physical examination

Heart rate (HR), systolic blood pressure (SBP), signs of left heart failure (Killip class).

2.2.3 QRS and QT measurements

- QRS measurements: QRS duration is measured from the start of the Q wave to the end of the S wave. The normal duration varies from 40 to 100 milliseconds. QRS dispersion is the difference between the maximum QRS duration and the minimum QRS duration of the 12 lead ECG.
- QT measurements: QT interval is measured from the start of the QRS complex to the end of the T-wave, and should be corrected by heart rate to allow comparison with reference values. The correction was done using Bazett's formula.

2.2.4 Laboratory tests

- High Sensitive-Troponin T level on admission.
- Serum creatinine.
- Electrolyte level

2.2.5 Trans–thoracic echocardiographic examination

- A GE Vivid E9 ultrasound machine was used to evaluate patientsin the first 24 hours of admission. The following measurements were taken:
- LV diameters and left ventricular mid-diastolic wall thickness were measured on a parasternal long-axis view on 2D data recording.
- Ejection fraction (%) was measuredin the apical four-chamber view using the Simpson disk summation method.
- E wave represents early diastole and A wave represents atrial contraction peak velocities of mitral valve, (E') early diastolic mitral annular velocity obtained by tissue Doppler imaging. The ratio of trans-mitral E peak velocity to E' peak diastolic mitral annular velocity (E/E' ratio) was an important indicatorofleft ventriculardiastolic function.

2.2.6 Coronary angiography findings/ GENSINI score

The coronary angiography was performed for all enrolled individual. Two observers analyzed the results and calculated the Gensini score, according to the article "A guide for Gensini score calculation" by Georgios P. Rampidis [3].

"**The calculation of Gensini score:** the degree of stenosis and the coronary artery lesion site were scored as follows: 1 point for ≤ 25% narrowing, 2 points for 26-50% narrowing, 4 points for 51-75% narrowing, 8 points for 76-90% narrowing, 16 points for 91-99% narrowing, and 32 points for total occlusion. Then, each lesion score is multiplied by a factor that takes into account the importance of the localization of the lesion in the coronary tree (5 for left main coronary artery, 2.5 for the proximal segment of the left anterior descending coronary artery, 2.5 for the proximal segment of the circumflex artery, 1.5 for the mid-segment of the left anterior descending coronary artery, 1.0 for the right coronary artery, the distal segment of the lest anterior descending coronary artery, the posterolateral artery, and the obtuse marginal artery, and 0.5 for the rest of the segments. Afterwards, and adjustment based on collaterals should be done: If a segment is totally occluded or 99% stenosis and receiving collaterals, a collateral adjustment factor is used, and the adjustment is reduced by the extent of disease in the vessel that is the source of collaterals (Fig. 1). The final GS is the sum of all the lesion scores" [3].

2.2.7 The GRACE risk Score

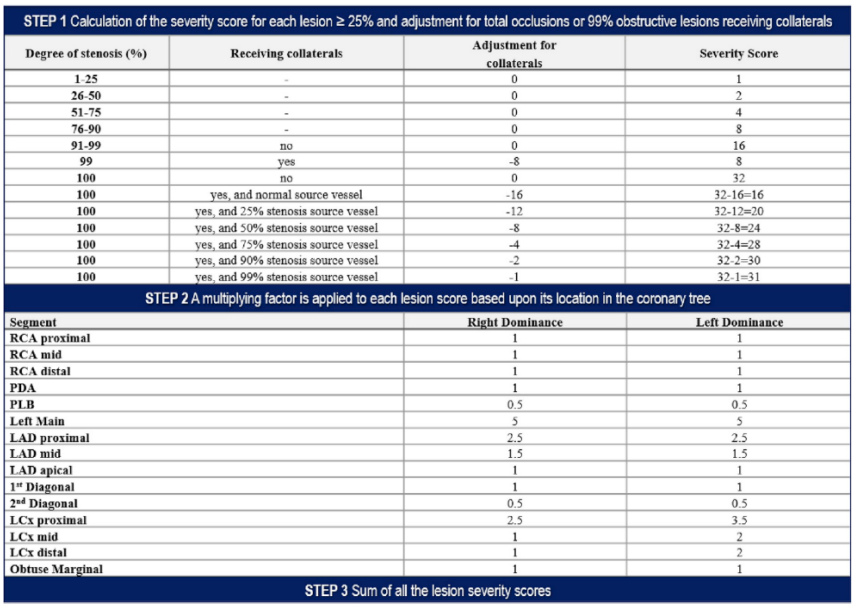
"The GRACE risk score predicts 6-month mortality after a patient has been discharged following hospital admission for ACS. It uses a predictive logistic model with eight prognostic variables to determine a patient's probability of death due to any cause during the first 6 months after discharge: Age, heart rate, systolic blood pressure, Killip class, creatinine, cardiac arrest at presentation, elevated troponin, St-segment deviation. To each variable, we can associate certain number of points.

Patients can be classified into three categories of GRACE risk score: Low risk: 140 points, intermediate risk: 109 to 140 points, and high risk: >140 points" [4].

2.3 Statistical Analysis

Based on the QRS dispersion, the enrolled patients were classified into 2 groups:

- First group: dispersion of QRS ≤ 20 ms (18 patients)



STEP 1 Calculation of the severity score for each lesion ≥ 25% and adjustment for total occlusions or 99% obstructive lesions receiving collaterals			
Degree of stenosis (%)	**Receiving collaterals**	**Adjustment for collaterals**	**Severity Score**
1-25	-	0	1
26-50	-	0	2
51-75	-	0	4
76-90	-	0	8
91-99	no	0	16
99	yes	-8	8
100	no	0	32
100	yes, and normal source vessel	-16	32-16=16
100	yes, and 25% stenosis source vessel	-12	32-12=20
100	yes, and 50% stenosis source vessel	-8	32-8=24
100	yes, and 75% stenosis source vessel	-4	32-4=28
100	yes, and 90% stenosis source vessel	-2	32-2=30
100	yes, and 99% stenosis source vessel	-1	32-1=31
STEP 2 A multiplying factor is applied to each lesion score based upon its location in the coronary tree			
Segment		**Right Dominance**	**Left Dominance**
RCA proximal		1	1
RCA mid		1	1
RCA distal		1	1
PDA		1	1
PLB		0.5	0.5
Left Main		5	5
LAD proximal		2.5	2.5
LAD mid		1.5	1.5
LAD apical		1	1
1st Diagonal		1	1
2nd Diagonal		0.5	0.5
LCx proximal		2.5	3.5
LCx mid		1	2
LCx distal		1	2
Obtuse Marginal		1	1
STEP 3 Sum of all the lesion severity scores			

Fig. 1. Step by step algorithm for the Gensini Score calculation.

Fig. 1. Step by step algorithm for the Gensini score calculation

- Second group: dispersion of QRS> 20 ms (12 patients)

Data were collected, tabulated on Microsoft Excel. All the analyses were performed using" SPSS version 16.0", for "Windows statistical software". P value was considered significant if $P < 0.05$.

3. RESULTS

Table 1 display the main cardiovascular risk factors characteristics of the population: 30 patients in total (14 males and 16 females) were included in the study, their age varied between 56 and 74 years with a mean of 64.6 ± 9.3. the most common cardio-vascular risk factor was dyslipidemia (86%), then hypertension was second most common CV risk factor with a percentage of 80%, then diabetes mellitus and obesity in 3rd and 4th place with an incidence of 60% and 33% respectively.

Table 2 showed that patients with a significant Gensini score had a higher admission heart rate, maximum troponin level and longer QTc. Furthermore, a higher Gensini score was correlated with a higher age range, QRS dispersion and Grace score.

Table 3 manifest the clinical, biological and echocardiographic differences between both subgroups. We noticed that SBP and HR were higher in the subgroup with QRS dispersion>20ms,and that LV diastolic and systolic dysfunction was correlated with higher QRS dispersion. It also showed that there was a notable difference between both groups when it comes to maximum QRS dispersion and QTc durations.

Table 4 showed that, concerning Initial admission troponin level and Grace score, there was a big difference between subgroups.

Table 1. Main population characteristics

Population characteristics (n=30)		**Percentage (100%)**
Gender	Male	14 (46,6%)
	Female	16 (53,3%)
Smoking		8 (26,6%)
Diabetes mellitus		18 (60%)
Hypertension		24 (80%)
dyslipidemia		26 (86%)
Obesity		10 (33%)

Table 2. Analysis for significant Gensini score

		Gensini Score
Age (years)	P-value	0,014 (S)
HR (beats/min)	P-value	0,002 (HS)
QRS dispersion	P-value	0,015 (S)
QTclength	P-value	0,005 (HS)
LVEF (%)	P-value	-0,03 (S)
Initial troponin level	P-value	0,003 (HS)
Grace Score	P-value	0,016 (S)

Table 3. Clinical, biological and echocardiographic differences between subgroups

Variables		QRS dispersion>20 (n=12)	QRS dispersion <20 (n=18)	P value
Age		65,16 +/- 5,8	64,33 +/-9,6	0,115
Gender	F	4 (33,3%)	12 (77,7%)	0,295
	M	8 (66,6%)	6 (22,2%)	
Hypertension		8 (66,6%)	16 (88,8%)	0,227
smoking		4 (33,3%)	4 (22,2%)	0,448
Diabetes mellitus		4 (33,3%)	14 (77,7%)	0,365
HR	Mean	94,5 +/- 29,5	83,77+/- 17	0,003(HS)
	Median	92,5 (50-124)	82 (66-101)	
SBP	Mean	142,8 +/- 43,1	132,5 +/- 21,4	0,0001(HS)
	median	135,5 (130-186)	132 (118-150)	
WC	Mean	11156,6 +/-8133	10391,11+/-3608	0,083(S)
	Median	10515 (6230-19290)	11020 (5660-14000)	
K+	Mean	4,5 +/- 0,56	4,63+/-1,16	0,19
	Median	4,65 (3,9-5,1)	4,6 (3,7-5,8)	
Initial Troponin level	Mean	13271,6+/-52028	4633,11+/- 9636,8	0,003(HS)
	Median	1885 (187-65300)	2636(220-14270)	
E/E’		7,97+/-5,02	7,84+/-4,15	0,24
LVEF	Mean	44,33+/-5,6	53,88+/-10,1	0,51
	Median	45,5(32-55)	58(37-64)	
Corrected QT	Mean	448+/-49	411+/-49,1	0,005(HS)
	Median	461(341-497)	410(371-461)	
GRACE score	Mean	150,83+/-11,16	97,7+/-30,2	0,065(S)
	Median	153(138-162)	113(17-128)	

Table 4. Comparison of ischemia severity in both subgroups

Variables (Mean+/- SD)	QRS dipersion≤20ms (60%)	QRS dispersion>20 ms (40%)	p-value
Initial troponin level	4633,11+/- 9636,8	13271,6+/-52028	0,003 (HS)
Gensini Score	29,6 +/- 18,3	54 +/- 30	<0,0001 (HS)

4. DISCUSSION

The optimal risk assessment for patients who have been diagnosed with NSTEMI is very important in cardiovascular emergency: It particularly improves the selection of people who should benefit from early management invasive strategies. Multiple risk scores have been evaluated in the last few years. it was found that those based on clinical features only were very imprecise and inconclusive [5]. Therefore, other studies focused on markers derived from ECG; “As a matter of fact, dispersion of ECG wave durations or intervals like P wave, QRS, QT interval, JT interval have been previously studied in the search for non-invasive cardiac markers that can be used to assess the risk of atrial fibrillation, ventricular tachycardia, and sudden cardiac death. Most studies refer to QT dispersion (QTd), but, after abrief success, the

potential significance of QT dispersion slowly sank into obscurity, due to a number of fundamental and technical issues" [2]. Some authors have expanded the same technicality problems to P wave dispersion [6], but the question that arises here is whether they affect QRS dispersion too or not.

Since, electrophysiology, QT dispersion represents regional inhomogeneity of repolarization times, QRS dispersion is likely to be representative of regional inhomogeneity of depolarization times, as an outcome of a ventricular conduction delay.

Pathophysiology of NSTEMI have shown that, regional intra-myocardial conduction delay can cause QRS prolongation and dispersion. However, up to this point, few articles are available on the relationship between QRS dispersion and CAD severity [7].

Some few studies focused on the relationship between QRS dispersion and myocardial infarction severity: Perkiömäki et al. [8] studied a set of 100 patients: "First group = normal group formed of 30 healthy patients with no myocardial infarction (MI), 40 patients with a history of MI, without ventricular arrhythmic events at electrophysiological study (EPS), and 30 patients with prior MI and history of cardiac arrest (12 patients) or ventricular tachycardia (VT) (18 patients) [8]. QRS dispersion was 28 ± 11 ms in the normal group, 46 ± 13 ms in the group with MI and no VT, and 48 ± 16 ms in the group with MI and VT ($p < 0.001$). The maximal QRS duration were also higher in patients with prior MI compared to healthy subjects ($p < 0.001$)".

Mozos et al. [9] studied 16 patients with history of MI. Patients with electrolyte imbalance and those not in atrial fibrillation were excluded. The aim of the study was to evaluate the link between signal-averaged late ventricular potentials (LVP) and QRS dispersion. The latter was measured using at least 8 leads. The QRS dispersion were compared in two groups of patients: with and without LVP (62.5% had LVP+). Results showed that QRS dispersion was significantly higher in the subgroup with LVP compared to the other subgroup (110.4 ms in LVP+ vs. 56.8 ms in LVP, $p= 0.05$).

In our study. We found that age was a significant forecaster of coronary lesions anatomy's complexity. "Steg et al. [10] also found that age is correlated with more complex and significant coronary lesions (left main or three vessel disease in NSTEMI)". In general, the increased prevalence and severity of CAD in older people has been previously reported;

We also found highly significant positive correlation between admission high-sensitive troponin T level and Gensini score. "Frey et al. [11] found in the setting of NSTEMI, troponin elevations were a predictor of higher incidence of multi-vessel disease, complex lesions, and visible thrombus". Finally, Altun et al. [12] prooved that it was significantly correlated with SYNTAX score in NSTEMI and STEMI patients.

People with QRS dispersion > 20 ms were found to have in our study a higher Gensini score, Grace risk score and troponin levels. This was in harmony with other studies, especially Frere et al [13].

The QRS dispersion might be an accessible, non-complicated electrocardiographic marker, however it has a great value to define patients with the risk of future adverse cardiovascular events in many clinical settings, including NSTEMI.

The determination of QRS dispersion in routine ECG when patients with NSTEMI are admitted to the emergency, might be time-saving and very helpful to the initial therapeutic plan: pretreatment with P2Y12 inhibitor, timing of percutaneous intervention, critical care level. In patients with QRS dispersion > 20 ms, it might bevalid to delay pretreatment with P2Y12 inhibitor and to go for early invasive strategy instead. As well, justifies hospitalization in intensive care unit with continuous monitoring.

5. CONCLUSION

This papersupports the benefit of QRS dispersion in daily emergency practice to assess patients with higher ischemic risk in a simple way: As in our study, the correlation was very significant between QRS dispersion>20 ms and elevated admission troponin level and with Gensini score also.

Considering the small group of patients, the relevance of the results to abiggerscale is unclear. More studies should be conducted to validate its clinical benefit in larger groups of patients.

CONSENT AND ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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