Case study

The correlation between QRS dispersion and severity of coronary Artery Disease in Patients with non ST Elevation Myocardial Infraction

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 were women and 14 were men). Age ranged from 56 to 74 years with an average of 64.6 ± 9.3. Data was collected and analyzed by SPSS, the level of significance set at $p < 0.05$.
Results: In our study, we found 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.

1. INTRODUCTION:

Coronary artery disease (CAD) is the most common cause of mortality among adults in the in both developed, and developing countries [1]. Therefore, all patients, especially with non-ST elevation myocardial infarction (NSTEMI), should undergo early risk stratification. This process impacts decision making regarding treatment and provides the patient with some sense of what the future holds.

Various risk stratification scores have been developed. Moreover, the assessment of severity of coronary artery lesion has gained major concern.

Prognostic markers derived from standard ECG have always been intriguing. Dispersion of surface ECG wave durations or intervals (P wave, QRS, QT interval, JT interval) has been studied in the search for non-invasive cardiac markers useful in predicting the risk of arrythmias and sudden cardiac death, and also as nonspecific prognosis markers. However, these latter have intrinsic and methodological issues that question their utility. [2]

This paper presents data supporting the utility of QRS dispersion as a simple electrocardiographic marker with potential value in the assessment of risk stratification in patients presenting with NSTEMI.

2. MATERIAL AND METHODS:

2.1 Patients:

This study included 30 consecutive patients presented with NSTEMI, who were admitted to the Cardiology Care Unit for NSTEMI in university hospital of Marrakech, during the period between January 2022 to March 2022, they were 14 males and 16 females, their age ranged between 56 and 74 years with a mean of 64.6 ± 9.3).

The work has been carried out according to The Code of Ethics of the World Medical Association for studied involving humans.

Patients were divided into 2 groups:

- Group (I): QRS dispersion ≤ 20 ms (n=18 patients)
- Group (II): QRS dispersion > 20 ms (n=12 patients)

2.2 Inclusion criteria (diagnosis of NSTEMI):

- Typical ischemic chest pain
- Absent ST segment elevation 1 mV in limb leads or 2 mV in precordial leads
- Positive troponin levels.

2.3 Exclusion criteria (known confounders of QRS prolongation):

- Previous myocardial infarction,
- History of previous revascularization,
- Patients with previous diagnosis of cardiomyopathy, congenital heart diseases or significant valvular heart diseases, with paced rhythm, bundle branch blocks, AV blocks, Wolff–Parkinson–White Syndrome,
- Patients taking medications that could affect QRS interval such as amiodarone and digitalis,
- Patients with electrolyte disturbances,
- Patients with cerebrovascular disease or significant renal impairment

2.4 Patients Data:

2.4.1 cardio-vascular risk factors:

smoking, diabetes mellitus, hypercholesterolemia and hypertension, Obesity. A patient was assigned to be a current smoker (when he or she smoked any cigarettes on a regular basis within 3 weeks before the index event) or non-smoker. Diabetes mellitus was identified when HbA1c levels exceed 6.5%. Dyslipidemia was defined as serum total cholesterol levels of 200 mg/dl or more, low density cholesterol more than 130 mg/dl, HDL less than 40 and triglycerides equal or more than 150 mg/dl or use of statin medication. Hypertension is defined as office systolic BP value ≥140 mmHg and/or diastolic BP value ≥90 mmHg or use of antihypertensive medication.

2.4.2 Clinical examination:

heart rate (HR), systolic blood pressure (SBP), signs of heart failure (Killip class) and pulmonary oedema.

2.4.3 Resting 12-lead surface electrocardiography (ECG) at admission :

- Heart rate: was calculated from the ECG strip.
- QRS measurements: QRS duration was measured as the time, expressed in ms, elapsed between the initiation of the Q or R waves until the end of the R or S waves. QRS dispersion was calculated as the difference between the maximum QRS duration and the minimum QRS duration of the 12 lead ECG.
- QT measurements: QT duration was measured as the time, expressed in ms, elapsed from the beginning of the QRS until the end of the T wave, defined as the T wave return point to the isoelectric line. QTc (corrected QT duration) was done using Bazett's formula (QTC = QT/√**)**.

2.4.4 Laboratory Workup:

- High Sensitive-Troponin T level on admission and 1 hour later to determine the peak level. A 20% or greater elevation of high-sensitive troponin level from the previous sample is considered reinfarction when associated with chest pain with or without dynamic ECG changes.
- Serum creatinine.
- Electrolyte (serum Na and K) level

2.4.5 Trans–thoracic echocardiographic examination:

- was done using GE, Vivid machine equipped with a 4 MHz transducer. The examination was performed within 24 hours of admission. The following measurements were obtained:
- **2D echocardiography**: LV end-systolic (LVESD) and end-diastolic (LVEDD) dimensions and myocardial wall thickness were measured from the left parasternal long-axis view using 2D recordings with the cursor positioned at the tips of the mitral valve leaflets and perpendicular to the posterior wall. LV volumes and ejection fraction were calculated from the apical four-chamber view using the modified Simpson's method.
- **Conventional and tissue-Doppler imaging** included early (E) and atrial (A) peak velocities of the mitral valve, myocardial systolic velocity (S') and early (E') and atrial (A') myocardial diastolic velocities obtained from the lateral mitral annulus. The ratio of trans-mitral E peak velocity to E' peak velocity of lateral mitral annulus (E/E' ratio) was determined as an index of LV end diastolic pressure (LVEDP). Increased LVEDP was defined as an E/E' ratio >14, whereas an E/E' ratio <8 was considered to be normal.

2.4.6 Coronary angiography (CAG):

All patients underwent coronary angiography within the month after NSTEMI. All of the angiograms were recorded to compact discs in DICOM format and evaluated later. Gensini score is equal to the sum of all segment scores (each segment score equals segment weighting factor multiplied by a severity score). Segment weighting factors are between 0.5 and 5.0. Severity scores reflecting the specific percentage luminal diameter reduction of the coronary artery segment are 32, 16, 8, 4, 2, and 1, respectivel, for 100%, 99%, 90%, 75%, 50%, and 25%. A multiplying factor is applied to each lesion score based upon its location in the coronary tree, depending on the functional significance of the area supplied by that segment (Fig. 1). If a segment is totally occluded or 99% stenosed and receiving collaterals, a collateral adjustment factor is used, and the adjustment is reduced by the extent of disease in thevessel that is the source of collaterals (Fig. 1). The final GS is the sum of all the lesion scores.

Calculation was done by two observers. In case of disagreement, opinion was obtained from a third observer, and the final calculation was made by consensus. [3]

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.

2.5 Statistical analysis:

Data were collected, tabulated and analyzed by SPSS 16.0, software for Windows. The significance level was set at $P < 0.05$.

3. RESULTS:

Table (1), showed the main characteristics of the population: 30 patients in total (14 males and 16 females) were included in the study, their age ranged 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 pourcentage of 80%, then diabetes mellitus and obesity in 3rd and 4th place with an incidence of 60% and 33% respectively.

Table (2), showed that there was a highly significant positive correlation between admission heart rate, maximum troponin level, OTc lenght and Gensini score, a significant positive correlation between age, QRS dispersion, Grace score and Gensini score and a significant negative correlation between LVEF and Gensini score was found.

Table (3), showed that the echocardiographic differences between both groups demonstrating higher incidence of LV diastolic and systolic dysfunction in patients with QRS dispersion >20ms. **It** showed also that there was a significant difference between subgroups regarding maximum QRS dispersion QTc durations. It also showed regarding systolic blood pressure there was significant difference between subgroups, regarding white blood cells there was significant difference between subgroups **Table (4),** showed that regarding Initial troponin level there was significant difference between subgroups. Regarding Grace score there was significant difference between subgroups.

Table 1: Population characteristics and cardio-vascular risk factors

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: Univariate analysis for 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)
QTc lenght	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 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	Moyenne	94,5 +/- 29,5	83,77+/- 17	0,003(HS)
	Médiane	92,5 (50-124)	82 (66-101)	
SBP	Moyenne	142,8 +/- 43,1	132,5 +/- 21,4	0,0001(HS)
	médiane	135,5 (130-186)	132 (118-150)	
WC	Moyenne	11156,6 +/-8133	10391,11+/-3608	0,083(S)
	Médiane	10515 (6230-19290)	11020 (5660-14000)	
K+	Moyenne	4,5 +/- 0,56	4,63+/-1,16	0,19
	Médiane	4,65 (3,9-5,1)	4,6 (3,7-5,8)	
Initial Troponin level	Moyenne	13271,6+/-52028	4633,11+/-9636,8	0,003(HS)
	Médiane	1885 (187-65300)	2636(220-14270)	
E/E'		7,97+/-5,02	7,84+/-4,15	0,24
LVEF	Moyenne	44,33+/-5,6	53,88+/-10,1	0,51
	Médiane	45,5(32-55)	58(37-64)	
Corrected QT	Moyenne	448+/-49	411+/-49,1	0,005(HS)
	Médiane	461(341-497)	410(371-461)	
GRACE score	Moyenne	150,83+/-11,16	97,7+/-30,2	0,065(S)
	Médiane	153(138-162)	113(17-128)	

Table 4: Comparaison of subgroups regarding severity of ischemia

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 stratification of NSTEMI patients is a key priority in emergency medicine: It particularly improves the selection of higher-risk patients for invasive management. After evaluation of several risk predictors and risk scores, it was found that estimating risk based on clinical characteristics only is challenging and imprecise [4]. Whereas, prognostic markers derived from standard ECG have always been seductive; Dispersion of surface ECG wave durations or intervals (P wave, QRS, QT interval, JT interval) has been assiduously studied in the search for non-invasive cardiac markers useful in predicting the risk of atrial fibrillation, ventricular arrhythmia, and sudden cardiac death, and also as nonspecific prognosis markers. The largest body of data refers to QT dispersion (QTd), but, after an initial flurry of positive results, the potential significance of QT dispersion slowly entered into obscurity, due to a number of fundamental issues [2]. Some authors have extended the same issues to P wave dispersion [5], but the question arises as to whether they also affect QRS dispersion.

Because QT dispersion has been taken to represent regional inhomogeneity of repolarization times, QRS dispersion is likely to represent regional inhomogeneity of depolarization times, as a consequence of a ventricular conduction defect.

In NSTEMI, regional intra-myocardial conduction delay is expected with resulting QRS prolongation and dispersion. So far, little data are available on the correlation between QRS duration and dispersion and in-hospital outcome and CAD severity especially in NSTEMI patients. [6]

Some few studies focused on the correlation between the QRS dispersion and the severity of myocardial infarction: Perkiömäki et al [7] studied a set of 100 patients: 30 healthy subjects, 40 patients with a history of myocardial infarction (MI), without arrhythmic events or inducible ventricular tachycardia (VT) at electrophysiological study (EPS), and 30 patients with prior MI and history of cardiac arrest (12 patients) or VT (18 subjects) and inducible monomorphic VT at electrophysiological study [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 and minimal QRS duration were also higher in patients with prior MI compared to healthy subjects ($p < 0.001$).

Mozos et al [8] studied 16 patients (13 men, 3 women) with prior MI (occurring at least one year prior), searching for correlations between signal-averaged late ventricular potentials (LVP) and 12-lead ECG dispersion indices (QRS, QT and JT intervals). Patients with hypokalemia, hypocalcemia, or hypomagnesaemia and those not in sinus rhythm were excluded. There were 6 patients in class III NYHA heart failure. QRS dispersion was measured manually using at least 8 leads for each patient. The QRS dispersion were compared in two groups of patients: with and without LVP (62.5% had LVP+). QRSd = 120 ± 90 ms (110.4 ms in LVP+ vs. 56.8 ms in LVP-, $p= 0.05$).

In our study on NSTEMI patients, we found that age was a significant predictor of complex coronary anatomy. Similarly, Steg et al. [9]found that age is correlated with left main or three vessel disease in NSTEMI. In general, the increased severity of CAD with the progression of

age has been previously reported. The rate of this increase was, however, more prominent in men between 30 and 49 years of age, whereas a steady increase by age was encountered in women.

In our study, we found highly significant positive correlation between *admission high-sensitive troponin T level* and Gensini score. Frey et al., [10] found in the setting of NSTEMI, troponin elevations were associated with a higher incidence of multi-vessel disease, complex lesions, and visible thrombus. In the era of high-sensitive troponin T, Altun et al. [11] found that it was significantly correlated with SYNTAX score in NSTEMI and STEMI patients. Frere et al. [12] found also a highly significant positive correlation between maximum high-sensitive troponin t level and Gensini score>20.

In our study, we found that QRS dispersion showed significant positive correlation with high Gensini score. Significantly higher troponin levels were encountered in patients with QRS dispersion > 20 ms. This was in agreement with the study of Frere et al. [12] who studied 96 patients with NSTE-ACS and found that patients with Gensini score >20 were associated with significant QRS dispersion >20 ms as well as Higher troponin levels in this subgroup.

In our study, we found that the group with QRS dispersion > 20 ms had higher GRACE score with very significant statistical power and was in agreement with the study of Frere et al [12] who found similar results.

The QRS dispersion is a simple electrocardiographic marker with potential value in the assessment of patients in different clinical settings, mainly in NSTEMI.

We recommend measuring QRS dispersion at time of admission in NSTEMI patients. This helps gauging therapeutic plans: clopidogrel loading, timing of intervention, level of care (intensive versus intermediate care unit). In patients with QRS dispersion > 20 ms, it is justifiable to delay clopidogrel loading and to perform early coronary angiography. As well, these patients are recommended to receive intensive level of care with continuous monitoring.

5. CONCLUSION:

This current study presents data supporting the utility of QRS dispersion in clinical practice to assess patients with higher ischemic risk: the correlation was highly significant between QRS dispersion>20 ms and higher admission troponin level and Gensini score.

Given the small number of patients, the significance of the results to the larger population remains unclear. More studies are needed to validate its clinical utility in larger groups of patients.

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