Relationship between QRS Score and the Extent of Coronary Artery Disease

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SUMMARY

We studied 92 patients to determine the relationship between the QRS treadmill score (QTS) and extent of coronary artery disease. The results were compared to those of ST segment deviation in a $< (+) \text{QRS score} >$ population. A cut off point of < 5 mm was used for mild to moderate risk patients whereas a QTS of < 3 was considered high risk for the patients.⁵⁾ 43% of the patients had high risk QTS and 57% mild to moderate QTS. A highly significant correlation was observed between the extent of coronary artery disease and the high risk group of patients, whereas nonsignificant changes were observed in the control group ($p < 0.001$). Finally, the results indicate that in patients with a (+) QTS score (< 5 mm), coronary artery disease was significant and accordingly extensive during coronary angiography. On the other hand, a (+) QRS score proved to be superior to ST deviation in predicting critical coronary stenoses in the same population (F ratio; 41 vs 24). (Jpn Heart J 1997; 38: 787-792)

Key words: QRS score, Coronary artery disease, Coronary arteriography

THE treadmill exercise stress test is still the most commonly used diagnostic tool for detecting coronary artery disease. So far, only ST segment deviation has been considered for positivity despite its low sensitivity and specificity^{1,2)} (68% sensitivity, 77% specificity).

Recently, Michaelidis and Van Campen^{3,4)} have reported a substantial correlation between the QRS score (a score of the differences between the Q,R,S wave amplitudes) and coronary artery ischemia, in which the diagnostic value of the QRS score was better than that of ST segment deviation.

Therefore, the aim of the present study was to investigate the relationship between a positive QRS score and the extent of coronary artery disease, as well as compare the predictive value of QRS scoring versus ST segment changes, according to the coronary angiographic findings, which remain to be determined in literature.

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METHODS

Seventy subjects with chest pain (50 males, 20 females, mean age 57 ± 10 years) and 22 other subjects (12 males, 10 females, mean age 54 ± 7 , control group with a normal QRS score) who underwent a treadmill stress test as well as selective coronary angiography were enrolled in the study. Patients with acute myocardial infarction, rest angina, previous bypass graft surgery, valvular heart disease, primary or secondary cardiomyopathy or congenital heart disease were excluded. Thus, a precise clinical history, 12 lead surface ECG, transthoracic echocardiography and chest X rays were obtained. Each patient gave his or her informed consent.

The treadmill test was performed using the standard, symptom limited Bruce protocol, having observed the conventional ST segment changes at the same setting. Stress test was terminated and considered positive in cases of exhaustion with a < 6 METs on the treadmill test, dyspnea, light headedness, hypotension, significant angina, ST segment deviation of > 1 mm or a QRS score of < 5 mm.

The QRS score was calculated with the formula proposed by Van Campen *et al.*,⁴⁾ using a pre-programmed, computer assisted, Marquette 5000 ECG device as follows: QRS score = (dR-dQ-dS) AVF + (dR-dQ-dS) V5 (d = difference). QS complex was treated as either a Q or S wave. A cut off point of 5 was used for the positivity as proposed by Michaelidis and Van Campen *et al.*,^{3,4)} since 5 appeared to be the threshold for ischemia in studies using Tl 201 perfusion scintigraphy. dQ > 0 , dR < 0 and dS > 0 were considered to be abnormal, separately in leads AVF and V5, which proved to be the most obvious leads for QRS wave changes,⁴⁾ as was dR + dS > 0 . Patients with a QRS score of 3 to 5 mm were arbitrarily classified as mild to moderate risk whereas those with a score of < 3 mm were considered high risk patients.

Antianginal medication (nitrates, B blockers, calcium channel blockers) were withdrawn at least 48 hrs prior to the treadmill stress test. Patients with bundle branch block, left ventricular hypertrophy or significant ST depression (> 1 mm) at rest were excluded, as were patients using digitalis.

Coronary arteriography was performed by standard techniques in multiple visual projections. Assessment of stenotic lesion was conducted by 2 experienced cardiologists at separate times. Stenosis of greater than 70% luminal diameter was considered significant. 50% luminal narrowing was considered significant in the case of left main coronary artery lesions.

Statistics: Data are expressed as mean $\pm$ standard deviation. Student's t-test was used for continuous variables. The χ^2 square test was used to compare discrete variables of the exercise test and to compare the extent of coronary artery

disease. A p value of < 0.05 was considered statistically significant.

The sensitivity was defined by the number of patients with critical coronary artery stenosis involving related parameter divided by the total number of critical coronary artery stenoses, specificity was defined as the total number of patients with noncritical stenoses involving related parameters, divided by the total number of patients with noncritical stenoses. The predictive accuracy was calculated by dividing the sum of the true positives and true negatives by the total number of patients studied. A stepwise logistic regression analysis with F ratios, was performed to compare the predictive values of QRS scoring and ST segment changes.

RESULTS

Overall data concerning the patients are shown in Table I. 57% of the patients had a score of mild to moderate risk (3 to 5 mm) while 43% had a high risk score (0 to 2 mm). It is noteworthy that only 52 out of 70 had a significant ST segment change of > 1 mm and various degrees of vessel involvement.

When the angiograms of the patients were examined, 60% were found to have single vessel disease, 28.5% multivessel disease (> 2) and 11.5% had normal angiograms (87% in the control group). 53.3% of the high risk patients had

Table I. General Characteristics of Patients

	Patients ($n = 70$)	Control ($n = 22$)
Male	50	12
Female	20	10
Mean age	57 ± 10	54 ± 7
QRS score (3 to 5 mm)	40 (57%)	—
QRS score (< 3 mm)	30 (43%)	—
Single vessel (total)	42 (60%)	3 (13%)
Multi vessel (total)	20 (28.5%)	—
Normal angiography	8 (11.5%)	19 (87%)
ST deviation (> 1 mm)	52	—
Single vessel*	24	
Multi vessel*	10	

*According to (+) ST changes.

Table II. QRS Score vs Extent of CAD*

	QRS score (< 3 mm)	QRS score (3 to 5 mm)	Control (QRS sc. > 5 mm)
Single vessel	9	33	3
Multi vessel	16	4	—
p value	< 0.001	< 0.001	N.S.

*CAD = coronary artery disease; N.S = Not significant.

Table III. (+) QRS Score vs Control Group Regarding Overall Coronary Angiography

	(+) QRS score (< 5 mm) ($n = 70$)	Control Group (> 5 mm) ($n = 22$)
No involvement	8	19
Vessel involvement	62	3
p value	< 0.001	< 0.001

Table IV. Predictive Values and Stepwise Logistic Regression Analysis of QRS Score in Identifying Critical Stenoses in Coronary Angiogram, Compared to Those of ST Deviation

	Sensitivity	Specificity	Predic. acc.	F ratio
QRS score (< 5 mm)	95.4%	70.4%	88.1%	41
ST deviation (> 1 mm)	76%	55%	62%	24

multivessel disease and 85% of the mild to moderate risk group had single vessel disease. This correlation was not observed in the control group with a total number of 3 single vessel involvements (Table II). Accordingly, a significant correlation was found between the QRS score and extent of coronary artery disease ($p < 0.001$).

When the overall coronary angiographic findings were considered as an index of extent of the coronary artery disease, patients with a (+) QRS score showed a significant (+) correlation with regard to vessel involvement, while the control group demonstrated a (+) correlation regarding no vessel involvement (Table III) ($p < 0.001$).

The predictive values of both criteria in identifying coronary artery stenoses in angiography are shown in Table IV. Regression analysis revealed a superior predictive F ratio, favoring QRS scoring (41 vs 24).

DISCUSSION

The diagnostic value of the QRS score has been extensively studied by Michaelidis and Van Campen *et al.*^{3,4)} Both reported similar specificity, sensitivity and predictive values for ischemia (78 to 82%, 75 to 80%, 77 to 81%, respectively). Meanwhile Van Campen has shown a significant relationship between the QRS score and myocardial ischemia for the first time, although the extent of the disease was unknown. On the other hand, meta analysis compiled by Gianrossi has demonstrated that the diagnostic value of ST segment based ischemia criteria is inadequate and inferior, compared to the QRS wave changes.⁵⁾ When the relationship between ST changes and the extent of the disease was studied, only overt changes, indicating poor prognosis, have been of value.⁶⁾ These findings are consistent with ours, demonstrating superior predictive values and F ratios in

QRS scoring (Table IV) (41 vs 24).

In this study, the relationship between QRS score and the extent of coronary disease was investigated for the first time. In contrast with the aforementioned ST segment changes of > 1 mm, both the lower and the upper risk groups for the QRS score have demonstrated one to one correlation and the control group has showed nonsignificant changes regarding vessel involvement (high risk and low risk groups were associated with multiple and single vessel involvement, respectively). Overall, the QRS score appeared to be sufficient and statistically different, compared to the control group, with respect to identifying coronary artery disease of any extent in coronary angiography (Table III).

Several attempts have previously been made, to identify Q and R wave changes and their clinical correlation, although most failed to establish a significant relationship.^{7,9-12)} The present study and some others^{3,4)} have demonstrated that the overall formula proposed by Michaelidis *et al.* rather than separate Q,R,S wave amplitude changes, demonstrates a better correlation with clinical and angiographic data.

Our study also aimed to overcome the major limitations of Van Campen's study, working in a prospective manner and using coronary arteriography. The only pitfall was the small number of patients in the control group, even though a statistically significant correlation has been demonstrated.

CONCLUSION

This preliminary study has demonstrated a significant relationship between a new criterion (QRS score) for exercise stress testing and the extent of coronary artery disease, which is better than ST segment deviation.⁸⁾ However calculation of the QRS score is time consuming compared to reading the ST segment deviation. Computer assisted calculation, as was used in this study can overcome this problem. Nevertheless, more studies are necessary to support these preliminary results.

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