Significance of the QX/QT Ratio and the QT Ratio (QTr) in the Exercise Electrocardiogram

By Laurian Roman, M.D., and Samuel Bellet, M.D.

The exercise electrocardiogram is a fairly well established and frequently used procedure as an adjunct in the diagnosis of symptomatic or latent coronary insufficiency. Many authors have confirmed its value.1-6 The criteria for a positive test, however, still remain somewhat controversial.

The value of "ischemic" type ST-segment depression is well documented, but the problem of the significance of various degrees of junctional-type depression is still controversial. Recently, Master and Rosenfeld3-6 introduced among their criteria the QX/QT ratio and QT ratio (QTr). They state that a J depression of less than 2 mm., but with a QX/QT ratio of 50 per cent or more, represents a positive or an equivocal test.4,6 The possible value of the QX/QT ratio was first advanced by Lepeschkin and Surawicz.7,8 X represents the point where the depressed ST segment returns to the baseline. In order to express the ST-segment depression in a quantitative manner independent of the heart rate, these authors studied the ratio QX/QT in an attempt to distinguish a "true-positive" from a "false-positive" ST-segment depression. It was assumed that the duration of the ST depression due to a current of injury produced by subendocardial ischemia should persist longer than the depression associated with simple tachycardia or with changes in the ventricular gradient. These authors proposed a QX/QT ratio of 50 per cent or more as a relatively reliable criterion for the differentiation of a "true-positive" from a "false-positive" test. However, they found QX/QT ≥ 50 per cent in 13 per cent of a control normal group.

An additional criterion is the QT ratio (QTr).4,6 The QTr is determined by dividing the actual QT by the ideal QT calculated for the respective heart rate by the formula proposed by Bazett.9 Master and Rosenfeld6 assume that in an ischemic heart, the electrical systole, measured by the QT interval, is prolonged and therefore the QTr is increased in coronary heart disease, especially after exercise. In the postexercise test, they consider a QTr ≥ 1.08 as a significant finding reflecting myocardial ischemia.

Since these relatively recent criteria have been considered controversial, we thought it of interest to study the QX/QT ratio and the QTr in the electrocardiogram after exercise in 150 normal young subjects. In this group, coronary arteriosclerosis, even latent, has the least probability of existing and is therefore most suitable for studying the normal electrocardiographic response to exercise.

Methods and Material

A double two-step exercise test was performed on a total of 150 normal, young college students and nursing students between 17 and 21 years of age, with no clinical evidence of heart disease; all of them had normal resting electrocardiograms.

The electrocardiograms were recorded by the technic of radioelectrocardiography during and after exercise. The principle involved, the apparatus, the type of electrodes used and their placement have been discussed in previous communications.10-12 Studies have shown that our apparatus, with proper standardization of the electrocardiogram, is comparable to that of the conventional electrocardiogram.12,14 Leads L2, V4, and V6 were studied; these were taken immediately after and at 1, 3, and 5 minutes after exercise. All of these
patients had a negative exercise test according to our criteria.\textsuperscript{12}

### Results

Of the 150 persons studied, there were 83 males and 67 females; the ages varied between 17 and 21 years. From this total of 150 subjects, 86 (57.7 per cent) displayed a junctional depression of less than 2 mm. The findings in these 86 subjects are given in table 1.

Therefore, according to the most recent criteria of Master and Rosenfeld, for this group of 86 young, normal individuals with postexercise J depression (which represent 57.3 per cent of the total of the normal subjects studied), the results can be interpreted as follows: in 61.6 per cent the test was clearly negative according to these criteria, and in 38.4 per cent of the group with a J depression there was a positive or equivocal result. In other words, as the group with J depression represents 57.3 per cent of the total of 150 subjects studied, 22 per cent of the total group of 150 normal, young subjects have a positive or equivocal exercise test.

### Discussion

Initially, Master and Rosenfeld\textsuperscript{3, 4} considered a small J depression, of less than 2 mm., to be representative of a positive criterion for the exercise test if the QX/QT ratio was $\geq 50$ per cent or if the QTr was $\geq 1.08$. More recently, in their latest publication\textsuperscript{6} they have changed their criteria and now consider a positive result for the exercise test a J depression that fulfills both conditions, having a QX/QT ratio $\geq 50$ per cent and a QTr $\geq 1.08$; the J depression in which only one of these ratios is increased, the other being below the critical level, is considered “equivocal”; the J depression with both QX/QT ratio less than 50 per cent and QTr less than 1.08 is considered a negative finding.

The accurate measurement of the QT interval, particularly at high rates, is often difficult. With tachycardia, which usually appears immediately after the exercise test, the end of the T wave is often difficult to determine, since it may not reach the baseline and may be followed by a superimposed “U” wave or “P” wave. Furthermore, exercise is nearly always accompanied by hyperventilation, which may produce considerable T-wave changes, particularly QT prolongation and ST-segment depression even in normal subjects. These changes add to the difficulty in determining the significance of slight grades of ST-segment depression and QT-segment prolongation.

There is no general agreement concerning the significance of QTr prolongation in coronary heart disease. Yu et al.\textsuperscript{15} found that the QTr is slightly diminished in patients with coronary heart disease after exercise in comparison with the resting value. Friedberg et al.,\textsuperscript{13} using the QX/QT ratio and QTr as proposed by Rosenfeld and Master, found 32 per cent “false-positive” or equivocal results in their noncardiac patients. In addition, Robb and Marks\textsuperscript{1} from their long-term study, concluded that the QX/QT and QT ratios are unreliable methods of evaluating the electrocardiogram after exercise.

In contrast with our results and with those of Robb and Marks\textsuperscript{1} and Friedberg et al.,\textsuperscript{13} Rosenfeld and Master,\textsuperscript{6} according to their latest criteria, observed only 13.2 per cent positive or equivocal results in their functional (noncardiac) patients with J depression in the electrocardiogram after exercise.

In conclusion, our data, like those of other authors who studied the problem, do not support the validity of the assumption that a small J depression (of less than 2 mm.) associated with a QX/QT ratio $\geq 50$ per cent or a QT ratio $\geq 1.08$, or both, should be considered a positive or equivocal result for an electrocardiographic exercise test.

Table 1

**Junctional Depression in the Postexercise Electrocardiogram for Normal Subjects**

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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Total with J depression</td>
<td>86</td>
</tr>
<tr>
<td>Normal QX/QT and QT ratio $\geq 50$ per cent</td>
<td>53 (61.6%)</td>
</tr>
<tr>
<td>Abnormal QX/QT or QT (QTr $\geq 1.08$)</td>
<td>22 (25.5%)</td>
</tr>
<tr>
<td>Abnormal QT ratio and QT ratio</td>
<td>20 (23.2%)</td>
</tr>
<tr>
<td>Abnormal QX/QT or QT (equivocal)</td>
<td>9 (10.5%)</td>
</tr>
<tr>
<td>Abnormal QX/QT or QT (equivocal)</td>
<td>24 (27.9%)</td>
</tr>
</tbody>
</table>

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EXERCISE ELECTROCARDIOGRAM

Summary
Recently, a junctional depression of small amplitude (less than 2 mm.) of the ST segment was considered to be a positive or equivocal result for the electrocardiographic exercise test if the QX/QT ratio was \(>50\) per cent or the QTr \(\geq 1.08\).

In 150 normal, young students with no clinical evidence of heart disease, a junctional depression of the ST segment with a QX/QT ratio \(>50\) per cent or a QTr \(\geq 1.08\) or both, was observed in 22 per cent.

These observations, supported by other published reports concerning the QX/QT ratio and the QTr, indicate that these criteria are not reliable for the determination of a positive electrocardiographic exercise test.

References

Cumulative Knowledge

Our debt to tradition through reading and conversation is so massive, our protest or private addition so rare and insignificant—and this commonly on the ground of other reading or hearing—that in a large sense, one would say there is no pure originality. All minds quote.—RALPH WALDO EMERSON.
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