Effects of Erythrol Tetranitrate and Amotriphene on Exercise Tolerance Tests in Angina Pectoris

By Arthur Ruskin, M.D.

OBJECTIVE EVIDENCES for angina pectoris, in the absence of proved myocardial infarction or grossly abnormal electrocardiograms, are more or less limited to abnormal electrocardiographic changes induced by exercise or hypoxemia. Similarly, while termination or prevention of angina is notoriously unreliable in the evaluation of "coronary dilator" drugs, their effects on provoked abnormalities in the electrocardiogram may be considered objective, if not completely reliable.

Consequently, we compared the effects of sublingual erythrol tetranitrate (Cardilate*) and amotriphene (Myordil†) in selected patients with angina pectoris, who repeatedly showed positive Master exercise tests.

Material and Method

"Standardized" two-step exercise tolerance tests were performed.1 Thirty-six patients with angina pectoris who had repeated (two to four) positive Master tests on placebo corresponding to the two drugs (infra) were selected for the study. Eight of them had had myocardial infarction 6 or more months previously, but showed no electrocardiographic residues beyond Q waves. None was receiving digitalis.

Our strict criteria of a positive exercise tolerance test were (1) flat S-T depressions totaling 3 mm. or more in leads I, II, III, V₂, and V₄ or (2) less marked S-T depressions, plus inversions of the T wave in leads I, II, V₂, and V₄ or with induced arrhythmias or conduction defects or both. Doubtful positive tests included borderline S-T depressions plus low negative changed to positive T-waves.‡

Sublingual erythrol tetranitrate 30 to 45 mg., oral amotriphene 50 to 75 mg., or a corresponding placebo was administered 45 to 60 minutes before the exercise test. These drug dosages were empirically found to cause the greatest number of reversals, i.e., in some cases smaller doses failed to reverse clearly placebo-positive Master tests. Identical drug and placebo tests were repeated from two to four times each on different days at approximately the same time in the afternoon. As a check on the longer acting nitrate, in three patients who had shown positive and three patients who had exhibited negative Master tests following the administration of erythrol tetranitrate the exercise tests were repeated within 5 minutes after 0.6 mg. of nitroglycerin by mouth.

In 20 cases clinical evaluation of the two drugs and placebos was done in 3-week periods each, arranged in varying Latin-square sequences and often repeated, especially in doubtful cases. Records exact as possible were kept by the patients of the number, kind, length, and severity of their pains, and the daily dosage of nitroglycerin tablets required. We thus had two comparative placebo and drug periods for cross-evaluation of their efficacy.

Results

Exercise tolerance tests positive following placebo were reversed by sublingual erythrol tetranitrate in 26 of 36 cases (72 per cent; figs. 1 and 2), while seven continued to be positive and three were doubtful (table 1). Three positive and three negative tests after the drug checked equally so after nitroglycerin (0.6 mg.).

Headache was a side effect in one quarter to one third of the cases, but it occurred infrequently if the patient was placed on a small dose first and this dose was gradually increased to the desired level. Excluding the large doses of the exercise test, it was mild, transient, and annoying in six of the 36 cases. Weakness, nausea, dizziness were fleeting and infrequent (table 2). Intermittent claudication was reduced on exercise in one case, but remained unchanged in another.

Oral Amotriphene resulted in six negative (fig. 2), four doubtful, and 26 positive (fig. 1) tests—a reversal of 16 per cent of the patients...
exhibiting positive Master tests following placebos (table 1). Side effects from amotriphene were perhaps less frequent and severe, consisting primarily of headache, nausea, or dizziness on rare occasions (table 2). Intermittent claudication was unaltered in the two patients showing it.

In cases of reversal of a positive Master test by either drug, subjective symptoms on exercise such as precordial pain and dyspnea were also frequently reduced or eliminated. Daily anginal attacks on sublingual erythrol tetranitrate and oral amotriphene were respectively 0.92 and 0.94 versus placebo 2.17 and 1.94.

Ectopic beats, usually ventricular in origin, were infrequent in the control electrocardiogram, and often appeared or increased greatly on exercise after the placebos. Bigeminy and multifocal beats occurred in many cases. These arrhythmias were generally the same, e.g., in one case—paroxysmal ventricular tachycardia, on repeated exercise tolerance tests.

Premature beats produced or increased by the drug or on exertion were twice as frequent following erythrol tetranitrate as after

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Master Exercise Tests after Placebo, Erythrol Tetranitrate, and Amotriphene</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Placebos</td>
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<tr>
<td>Positive</td>
<td>36</td>
</tr>
<tr>
<td>Doubtful</td>
<td>0</td>
</tr>
<tr>
<td>Negative</td>
<td>0</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Symptoms (Per Cent) Noted after Erythrol Tetranitrate, Amotriphene, and Placebos</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Erythrol tetranitrate</td>
</tr>
<tr>
<td>Headache</td>
<td></td>
</tr>
<tr>
<td>Definite</td>
<td>24</td>
</tr>
<tr>
<td>Mild</td>
<td>14</td>
</tr>
<tr>
<td>Dizziness</td>
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<td>Definite</td>
<td>14</td>
</tr>
<tr>
<td>Mild</td>
<td>4</td>
</tr>
<tr>
<td>Weakness</td>
<td></td>
</tr>
<tr>
<td>Definite</td>
<td>14</td>
</tr>
<tr>
<td>Mild</td>
<td>4</td>
</tr>
<tr>
<td>Nausea</td>
<td>14</td>
</tr>
<tr>
<td>Vomiting</td>
<td>4</td>
</tr>
</tbody>
</table>

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ERYTHROL TETRANITRATE AND AMOTRIPHENE

L. G. 62 yr. W. M. Angina Pectoris

Figure 2

Equal reversal of positive exercise tolerance test by erythrol tetranitrate and amotriphene
—unusual case.

amotriphene. Both drugs equally reduced or abolished premature beats on exercise. Similarly, in about 10 per cent the premature beats following the two drugs or the Master test remained about the same as in the tests following the placebos (table 3). Otherwise, the electrocardiograms were essentially unaltered by either drug.

Discussion

It is evident that sublingual erythrol tetranitrate is potent in reversing the electrocardiographic signs of coronary insufficiency in the majority of cases of angina pectoris (72 per cent). This corroborates previous reports of the efficacy of certain nitrates in coronary disease.2-6

Amotriphene, on the other hand, clearly reversed positive exercise tolerance tests in only 16 per cent. Experimentally7-9 and clinically10 it has been reported to have coronary dilator and anti-arrhythmic effects. It did decrease ectopic beats on exercise about as often as erythrol tetranitrate, but also produced them at times, though less frequently than erythrol tetranitrate. In any case, it would seem that premature beats as such should weigh little in the evaluation of a positive or negative Master test.

Although less definite, the evidence suggests that both erythrol tetranitrate and amotriphene reduce the number of anginal attacks in half. The parallelism between the objective and subjective findings for erythrol tetranitrate does not hold however for amotriphene.

Table 3

<table>
<thead>
<tr>
<th></th>
<th>Induced or increased</th>
<th>Same as placebo</th>
<th>Abolished or decreased</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erythrol tetranitrate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug alone</td>
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<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Exercise</td>
<td>13</td>
<td>10</td>
<td>13</td>
</tr>
<tr>
<td>Amotriphene</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Drug alone</td>
<td>3</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>Exercise</td>
<td>6</td>
<td>9</td>
<td>15</td>
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</table>
and the latter's clinical worth must remain sub judice. Other drugs, especially those producing sedation or monoamine oxidase inhibition, e.g., iproniazid, show the same disparity between apparent alleviation of angina and no objective evidence of abolition of coronary ischemia.\textsuperscript{11, 12} This anti-anginal effect is, of course, hardly consonant with the resulting greater availability of catecholamines, which, despite coronary vasodilatation, produce relative coronary ischemia.

Headache from erythrol tetranitrate was in our experience no more frequent than from nitroglycerin. It recurred infrequently when the dose was reduced and gradually increased to the same level. In fact, the large doses (30 to 45 mg., which are two or three times the usual dose) employed in the exercise tolerance tests did not cause headache in some cases. Only two patients, not included in the 20 cases rotated on the various regimens, were unable finally to tolerate 15 mg. doses of the drug. Nor were angina pectoris or adverse electrocardiographic effects produced or aggravated by the large test doses of erythrol tetranitrate, whereas failure of coronary dilatation\textsuperscript{13, 14} or severe coronary insufficiency\textsuperscript{18} has occurred from heavy doses of the fast-acting nitroglycerin, in part as a result of hypotensive ischemia.

**Summary**

Sublingual erythrol tetranitrate is a potent drug in counteracting coronary insufficiency, as evidenced by reversal of positive electrocardiographic exercise tolerance tests in 72 per cent of 36 cases and reduction of anginal attacks in them by more than 50 per cent.

Comparative studies with amotiphen indicate some subjective alleviation of angina, but objective reversals of the electrocardiographic effects of exercise in only 16 per cent of the cases.

Side effects of erythrol tetranitrate, particularly headache, are seen in a minority of cases and are often circumvented by starting with a small dose and gradually increasing it as necessary.

Alleviation of ectopic beats on exercise occurred equally in a minority of cases on the two drugs.

**References**

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