Prognostic Implications of Diagnostic Q Waves After Myocardial Infarction

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with the technical assistance of Daniel Bogaty, B.S.

SUMMARY The long-term prognostic implications of the electrocardiographic location of a myocardial infarction and the subsequent retention or disappearance of diagnostic Q waves were examined in patients enrolled in the Aspirin Myocardial Infarction Study (AMIS). The 4524 participants, ages 30–69 years, had sustained a myocardial infarction 8 weeks to 60 months before randomization to aspirin and placebo groups. Subjects were followed for at least 3 years (average 38.2 months). Using the Minnesota Code, myocardial infarctions were classified according to three electrocardiographic locations: lateral, inferior and anterior, with further subdivision into major, moderate and minor criteria based on Q-wave duration and Q/R ratios. Total mortality was not significantly different among patients with single infarct sites: lateral 11.8%, inferior 8.0% and anterior 9.4%. Patients with multiple electrocardiographic infarct locations had a significantly higher mortality (14.6%, p < 0.0002). Participants with Minnesota Code major criteria of infarction also had a significantly higher mortality (10.6%) than those with moderate (7.2%) or minor (7.4%) criteria (p < 0.01). Loss of a previously documented diagnostic Q wave occurred in 14.2% of participants. Mortality among patients who lost Q waves (6.5%) was not significantly different from that among those with persistent Q waves in a single infarct location (8.7%).

No long-term prognostic significance can be attributed to the site of infarction or loss of Q wave on the resting ECG. However, major Q-wave criteria and extent of infarction based on multiple coded sites are associated with a higher 3-year mortality.

THE ABSENCE or disappearance of diagnostic Q waves after a myocardial infarction (MI) and the electrocardiographic location of the infarction reportedly have long-term prognostic implications.1,2 The Coronary Drug Project data suggest an improved prognosis for patients with a previous inferior wall MI as well as for patients with no diagnostic Q waves on the ECG.1 To test these hypotheses, we examined the records of all patients in the Aspirin Myocardial Infarction Study (AMIS) who were followed for at least 3 years.

Material and Methods

AMIS was designed to investigate whether aspirin therapy would reduce mortality over a 3-year period among patients who had survived a documented MI. Sample size, dosage and eligibility criteria have been published.4 The participants were 30–69 years old, were in New York Heart Association class I or II and had sustained an MI 8 weeks to 60 months before randomization. MIs were documented by specific criteria, including diagnostic ECG changes, elevated serum enzymes and typical symptoms.4 Of 4524 patients in the study, 2257 were in the placebo group and 2267 were in the aspirin group. Each patient was followed for at least 3 years (average 38.2 months). Total mortality was 10.8% in the aspirin group and 9.7% in the placebo group; noncardiovascular mortality was 1.4% and 0.9%, respectively. These differences were not statistically significant.8 Because aspirin had no significant effect on mortality, we pooled the data from both groups.

Because participants who entered the trial more than 1 year after MI might represent a preselected group with a favorable prognosis, we designated a subgroup of 1268 patients who entered the trial within 12 months of MI. Results are expressed for this subgroup as well as the total cohort.

Resting ECGs recorded at the time of the qualifying MI, those recorded at time of entry into the study (baseline ECG) and those from follow-up annual examinations were forwarded to the ECG center at the George Washington University Medical Center. Each ECG was coded by two specially trained technicians, working independently, using the Minnesota Code.6,7 Disagreements were resolved by one of the investigators. The readings were made without knowledge of source, treatment group or previous ECGs. Transmural infarctions were coded in one of three locations based on Q-wave amplitude and duration: lateral (leads I, aVL, V6), inferior (leads II, III, aVF) and anterior (leads V1 to V6). Infarcts were coded as single, multiple or, in the absence of diagnostic Q waves, "no codable location." Criteria for the infarction were based on major (Minnesota Code 1.1), moderate (1.2) or minor (1.3) electrocardiographic findings as deter-

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mined by duration and depth of Q waves and the leads in which they appeared.* †

Contingency-table analysis using chi-square tests of significance was used to test individually the effect of multiple variables against mortality. Significance was assumed if the probability level was less than 0.05.

Results

Baseline ECGs

Of the 4524 patients, 4475 had a coded baseline ECG suitable for evaluation. Forty-nine patients were excluded for various reasons: 29 because of left bundle branch block, 15 because of lead misplacement and five because of other technical problems. Eight hundred forty-seven patients (18.9%) had no diagnostic Q waves on the baseline ECG. Two hundred forty-five patients had no Q waves on either the qualifying or the baseline ECG; they entered the study on the basis of ST-T changes, elevated enzymes and clinical history. Of the 1268 patients in the 1-year subgroup, 211 (16.5%) had no Q waves at baseline and 60 had none on the qualifying ECG.

Baseline Infarct Location

Table 1 shows the location of Q waves at baseline in terms of mortality. Mortality did not differ significantly among patients who had a single infarct (lateral 11.8%, inferior 8.0%, anterior 9.4%) or among patients with no Q waves at baseline compared with those who had residual Q waves in a single infarct location (p > 0.1). Subjects who had multiple infarcts had significantly increased mortality (14.6%) compared with all other patients (p < 0.0002) (table 1).

In the subgroup recruited within 1 year of infarction, there was no difference between patients who had no significant Q wave and those with single infarct sites; nor did mortality differ according to location of single infarct. Patients in this subgroup who had multiple infarct sites also had significantly augmented mortality (p < 0.002) (table 1).

Loss of Q Waves

Six hundred two patients had diagnostic Q waves (major, moderate or minor criteria) on the qualifying ECG, but not on the baseline ECG. Table 2 shows the interval from the acute MI to the baseline ECG that documented loss of Q waves. None of the differences were statistically significant, which suggests that Q waves are lost soon after MI, if at all. The electrocardiographic location of a single infarction bears little relationship to the persistence or disappearance of Q waves (table 3). Loss occurred in 20.4% of those with lateral sites, 19.1% of the inferior sites and 18.0% of anterior sites. If the infarction involved a more extensive area, with more than one ECG site coded, then Q loss occurred 3.9% of the time (p < 0.01).

The relationship between Q-wave loss and mortality is shown in table 4. Total mortality among the 602 patients who had Q waves on the qualifying ECG but not on the baseline ECG was 6.5% (39 of 602). There is no statistically significant difference in their mortality compared with that among patients with persistence of Q waves in a single infarct location. This is true for the total study group as well as for the 1-year subgroup.

Coding Criteria

The Minnesota Code allows for different degrees of significance for the criteria used in coding. Criteria for MI were considered by either minor, moderate or

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<tbody>
<tr>
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</tr>
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<td>3-6 months</td>
<td>360</td>
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<td>46 (12.8%)</td>
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* †: p < 0.01 (3 degrees of freedom).

TABLE 3. Disappearance of Q Wave

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<th>No. of pts</th>
<th>Retained Q waves</th>
<th>Lost Q waves</th>
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<tr>
<td>Lateral</td>
<td>265</td>
<td>211</td>
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<tr>
<td>Inferior</td>
<td>1950</td>
<td>1578</td>
</tr>
<tr>
<td>Anterior</td>
<td>689</td>
<td>565</td>
</tr>
<tr>
<td>Multiple sites</td>
<td>1326</td>
<td>1274</td>
</tr>
<tr>
<td>Total</td>
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* †: p < 0.01 (3 degrees of freedom).

TABLE 4. Relationship Between Mortality and Loss of Q Waves: Single Infarct Site

| Total mortality |
|---|---|---|
| Q waves present | 205/2354 (8.7%)* | 61/679 (9.0%)† |
| Q waves lost | 39/602 (6.5%) | 11/151 (7.3%) |

* †: p > 0.09.

†: p > 0.1.
major ECG findings. Table 5 shows that in patients with Q waves in a single infarct location, mortality is significantly higher among patients with major ECG criteria than among those with moderate or minor criteria ($p < 0.01$). There was no significant difference between those with no Q waves and those with moderate or minor criteria. A similar trend was seen in the 1-year subgroup (NS).

### Discussion

These data are derived from the largest and most carefully followed cohorts of MI survivors whose outcome addresses the controversy over the prognostic significance of lost Q waves and Q-wave location. Aspirin and placebo data were pooled because there was no statistically significant difference in overall mortality rates for the two groups. We did, however, compare aspirin and placebo patients in terms of infarct location and loss of Q wave as they relate to follow-up data. There were no differences in those two groups based upon treatment assignment.

#### Loss of Q Waves

Before the Coronary Drug Project (CDP) report in 1972,1 loss of Q waves was reported infrequently. However, studies that retrospectively evaluated loss of Q waves and survival showed no significant difference in mortality in patients who retained and those who lost their Q waves.

Kaplan and Berks$^{2}$ reviewed serial ECGs from 251 men. Two hundred eight patients had transmural infarctions and documented Q waves. After a mean of 40.9 months (range 2–84 months), 15% of the men had no significant remaining Q waves. Disappearance of Q waves was slightly more common from inferior (18 of 117, 15.4%) than from anterior infarcts (11 of 76, 14.5%), but this difference was not statistically significant. The differences in mortality during the follow-up period in patients whose Q waves disappeared (20.7%) and those whose Q waves persisted (29.9%) was not significantly different. Kalbfleisch et al.$^{3}$ reviewed the records of 775 patients who had an MI and significant Q-wave abnormalities (at least 0.04-second duration). Fifty-two (6.7%) of those patients showed complete disappearance of Q waves. The cardiovascular mortality rate among patients who lost Q waves (21%) was not significantly different from the mortality for the entire group (23%).

The CDP data therefore conflicted with data from previous studies. In the CDP study, the 2035 men in the placebo group were followed for at least 3 years.$^{4}$ Although the exact number of patients who lost significant Q waves during their follow-up period is not mentioned, 748 patients (36.8%) had no diagnostic Q waves at entry into the study. Because the resting ECG was coded using the Minnesota Code, Q waves could be classified as major, moderate or minor. Infarct survivors with major Q patterns on the baseline resting ECG had twice the mortality of those with no residual recordable Q waves after infarction (18.4% vs 8.4%, $p < 0.01$). The presence of moderate and minor Q waves was also significantly related to mortality compared with the absence of Q waves. The CDP study led to the generally held impression that absence or disappearance of a diagnostic Q wave after MI carries favorable prognostic implications.

The present report agrees with earlier publications concerning patients in whom significant Q waves were lost. In the AMIS cohort, the mortality associated with the absence or loss of Q waves did not differ from that in patients who had a single infarct location and persistent Q waves. Those with extensive areas of infarction, however, as indicated by multiple infarct sites or major coding criteria, had a significantly higher total mortality than patients who lost Q waves.

One reason for the discrepancy between the CDP study and other studies may be that earlier studies specifically referred to loss of Q waves, while the CDP study referred only to the fact that there was no Q wave present at baseline. This difference may be secondary to major differences in the population studied, because a large portion of the CDP patients had nontransmural infarction and no Q waves at the time of qualification.

Only 18.9% of the AMIS population (compared with 36.8% in the CDP study) had no Q wave at entry into the study and only 1.8% actually lost Q waves that were present on the qualifying ECG. Q loss occurred most frequently in patients with moderate (35.6%) or minor (39.7%) coding criteria and least commonly in those with major (16.1%) or multiple (8.6%) criteria.

#### Location of Infarction

The prognostic implications of the locations of the MI by Q-wave distribution are controversial. Among men in the CDP study who survived 3 months after MI, those with inferior MI had a significantly lower mortality than those with anterior or lateral infarctions.1 The Framingham Study$^{2}$ and Kennedy et al.$^{3}$ also found poorer long-term survival for patients with anterior infarctions than for those with inferior infarctions.

Geltman and co-workers$^{8}$ also found a significantly lower mortality (mean follow-up 21.7 months) in their inferior infarction subgroup. They postulate that this difference depended on the larger infarct size of the anterior subgroup as estimated by serum enzymes.

Weinberg$^{9}$ reported no significant difference in 6-year mortality in patients with anterior (29 of 77, 38%)
and those with inferior MI (24 of 74, 32%), although there was a significantly higher immediate mortality in the anterior subgroup. These findings of higher immediate mortality with comparable long-term survival are similar to other reported results.14-19

The AMIS data show that among patients who lived at least 2 months after MI, mortality did not differ for the three locations. However, the magnitude of infarctions is a significant predictor of mortality, as reflected in the worsened prognosis in patients with multiple infarct sites and those with major Q-wave criteria.

Limitations of the Study
Our data only apply to patients who are stable (New York Heart Association functional class I or II) and have survived at least 2 months after their acute event.

Horan et al.20 reported that significant Q waves or Q waves greater than 30 msec in a single electrocardiographic zone alone may be unreliable predictors of necrosis, with a sensitivity in one autopsy study of only 61% and a specificity of 89%.20 The accuracy of predicting infarction increased significantly when Q waves were found in both anterior and inferior leads. However, the AMIS investigators emphasized Q waves knowing that the patients had met multiple criteria for MI, including serial ECG changes, enzyme elevation and symptoms.

Localization of the infarct using Q waves was also shown to be unreliable by the study of Horan et al.20 in which anatomic infarct sites frequently overlapped. This is consistent with our findings of no mortality difference in single site infarct groups; however, these groups (lateral, inferior and anterior) refer to ECG rather than anatomic localization.

Finally, the difference in our results from those of the CDP may reflect more than differences in populations. The 3-year mortality in the CDP placebo subgroup was 12.6%,3 compared with the 3-year mortality of 9.6% in the AMIS aspirin group and 8.8% in the placebo group.6 The lower mortality rate in similar, stable MI patients is significant. The reason for the lowered mortality is multifactorial and beyond the scope of this analysis, but may account for at least some of the difference in the results of our analysis and those of the CDP.

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