Comparison of Amount and Extent of Coronary Narrowing by Atherosclerotic Plaque and of Myocardial Scarring at Necropsy in Anterior and Posterior Healed Transmural Myocardial Infarction

HENRY SCOTT CABLE, M.D., AND WILLIAM C. ROBERTS, M.D.

SUMMARY The amount of cross-sectional area narrowing by atherosclerotic plaque in each 5-mm-long segment from the entire lengths of the right, left main, left anterior descending and left circumflex coronary arteries and the size, predominant location and extent of myocardial scarring were determined in 59 necropsy patients with a healed transmural myocardial infarct (MI). The mean number of the four major epicardial coronary arteries narrowed severely (76–100% in cross-sectional area) was 3.0 in the 37 patients with posterior MI and 2.6 in the 22 patients with anterior MI (p < .025). The mean percent of severely narrowed 5-mm segments from all four major coronary arteries was similar in the anterior and posterior MI groups, 38% vs 46%. The patients with anterior MI, however, had a higher percentage of severely narrowed 5-mm segments of the left anterior descending than of the left circumflex but not the right coronary artery, 46% vs 25% (p < 0.001) and 40% (NS). The patients with posterior MI had a higher percentage of severely narrowed segments of the right and left circumflex coronary arteries than of the left anterior descending artery, 55% and 51% vs 32% (p < 0.05). The anterior MI group had, on the average, larger left ventricular scars than the posterior MI group (20% vs 9%, p > 0.002) and more frequent scarring of the ventricular septum, 16 patients (73%) vs six patients (16%) (p < 0.001).

IN A RECENT REPORT, the amount and extent of coronary narrowing at necropsy were determined in a quantitative fashion in 22 patients with an acute anterior myocardial infarct (MI) and in 28 patients with an acute posterior ("inferior") MI. In the present study, the amount and extent of coronary arterial narrowing and of myocardial scarring at necropsy in 22 patients with a healed anterior MI were compared with those in 37 patients with a healed posterior MI.

Patients and Methods

Of the 59 patients with a healed transmural MI, 37 had a posterior left ventricular scar and 22 an anterior scar, with or without involvement of the adjacent lateral wall or ventricular septum. In some of the patients the MI involved only the anterior or posterior wall in the basal portion of left ventricle, but involved most or all of the left ventricle at the apex. The designation of anterior or posterior was determined by examining the basal half of the heart. Certain clinical and necropsy findings for each of the two groups of patients are summarized in tables 1 and 2. The ages and sex distribution were similar in the two groups. An acute MI was clinically diagnosed in 17 patients (77%) with an anterior MI and in 15 (41%) with a posterior MI (p < 0.05); one anterior MI patient (5%) and four posterior MI patients (11%) had two clinical episodes of acute MI (NS). The interval from the first clinical episode of acute MI to death was 2–204 months (mean 76 months) in the anterior MI patients and 4–276 months (mean 76 months) in the posterior MI patients (NS).

There was no significant difference between the two groups in the frequency of angina pectoris, chronic congestive heart failure, systemic hypertension, diabetes mellitus, sudden coronary death, fatal acute MI or noncardiac modes of death. In each of the 59 patients, the entire lengths of the right, left main, left anterior descending and left circumflex coronary arteries were removed from the heart intact, fixed in an unpressurized state in formalin for about 48 hours, radiographed, and decalcified if calcific deposits were present. Then, each of the four major arteries were cut transversely into 5-mm segments, processed in alcohol and xylene and cut. At least one 6-μ-thick section from each 5-mm segment was prepared for histologic study; it was stained by the Movat method, which stains the internal elastic membrane black, fibrous tissue tan, mucoid material light green, smooth muscle red, erythrocytes red and nuclei black. The degree of luminal narrowing in each 5-mm segment was determined by examination under the microscope (magnification × 25–50). The percent of cross-sectional area narrowing by atherosclerotic plaque was separated into five categories: 0–25%, 26–50%, 51–75%, 76–95% and 96–100%. The accuracy of these determinations was verified by video planimetry and had an error of less than 5%. The amount of myocardium replaced by scar was determined by tracing the grossly visible areas of scar and the total left ventricular area, including ventricular septum, from the apical surfaces of each of five or six 1-cm-thick transverse ventricular slices cut from apex to base. The area of scar and the total left ventricular area were then determined by a video planimetry system. The sum of the areas of fibrosis from each slice divided by the sum of the left ventricular areas from all the slices provided the MI size, expressed as a percent of the total left ventricular area.
### Table 1. Clinical and Necropsy Findings in Each of 22 Necropsy Patients with a Healed Anterior Wall Myocardial Infarct

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<th>CHF</th>
<th>Mode of death</th>
<th>Heart weight (g)</th>
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*Left ventricular aneurysmectomy.
†LM narrowed > 75%.
‡Dominant posterior is the LC.
§See Results section for explanation of scoring system.

Abbreviations: AMI = acute MI; AP = angina pectoris; Ath = atherosclerotic plaque; CA = coronary arteries; CABG = coronary artery bypass grafting; CC = cardiac catheterization; CHF = chronic congestive heart failure; Hx = history of; L = lateral wall; LAD = left anterior descending; LC = left circumflex; LM = left main; MI = myocardial infarct; NC = noncardiac; Op = operation; R = right; SCD = sudden coronary death; VS = ventricular septum.

### Results

Among the 59 patients, 236 major epicardial coronary arteries were examined (tables 3 and 4). Of the 88 arteries from the anterior MI group, at least one 5-mm segment in 57 arteries (65%) was narrowed severely (76–100% in cross-sectional area) by atherosclerotic plaque, an average of 2.6 coronary arteries per patient; of the 148 major epicardial coronary arteries examined in the posterior MI group, 112 (76%) were severely narrowed, an average of 3.0 coronary arteries per patient ($p < 0.05$).

All four arteries were severely narrowed in one of 22 anterior MI patients (4%) and in eight of 37 posterior MI patients (22%) (NS); three arteries were severely narrowed in 12 anterior MI patients (55%) and in 24 posterior MI patients (65%) (NS); two arteries were severely narrowed in eight anterior MI patients (36%) and in three posterior MI patients (8%) ($p < 0.05$); one artery was severely narrowed in one anterior MI patient (4%) and in two posterior MI patients (5%) (NS).

The left main coronary artery was severely narrowed in four of 22 anterior MI patients (18%) and in nine of 37 posterior MI patients (24%) (NS); the left anterior descending was severely narrowed in 21 of 22 anterior MI patients (95%) and in 33 of 37 posterior MI patients (89%) (NS); the left circumflex was severely narrowed in 11 of 22 anterior MI patients (50%) and in 33 of 37 posterior MI patients (89%) ($p < 0.001$); the right circumflex was severely narrowed in 21 of 22 anterior MI patients (95%) and in all 37 posterior MI patients (NS).

The results of the quantitative analysis of the amount of narrowing in each of the 2608 5-mm segments of right, left anterior descending and left circumflex coronary arteries from the 59 patients are summarized in figures 1 and 2. Of the 895 5-mm segments from the 22 anterior MI patients, 67 (7%) were narrowed 96–100% in cross-sectional area by atherosclerotic plaque; 273 (31%) were narrowed 76–95%; 303 (34%), 51–75%; 173 (19%), 26–50%; and 79 (9%), 0–25%. Of the
TABLE 1. (Continued)

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<th>No. of CAs narrowed</th>
<th>Totals</th>
<th>No. LAD, LC or R (No. 76–95%) [No. 96–100%]</th>
<th>Mean score</th>
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<td>No. (%) 76–95%</td>
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1713 5-mm segments of coronary artery from the 37 posterior MI patients, 186 (11%) were narrowed 96–
100%; 604 (35%), 76–95%; 560 (33%), 51–75%; 229
(13%), 26–50%; and 134 (8%), 0–25%. There were no
significant differences between the two groups of pa-

**FIGURE 1.** Percent of 5-mm segments of the right (R), left anterior descending (LAD), and left circumflex (LC) coronary arteries narrowed to various degrees by atherosclerotic plaques in 22 patients with an anterior and 37 with a posterior wall transmural healed myocardial infarct (MI).

**FIGURE 2.** Percent of 5-mm segments of the right (R), left anterior descending (LAD), and left circumflex (LC) coronary arteries narrowed 76–100% in cross-sectional area by athero-
sclerotic plaques in 22 patients with an anterior and 37 with a posterior wall transmural healed myocardial infarct (MI).
### Table 2. Clinical and Necropsy Findings in Each of 37 Necropsy Patients with a Healed Posterior Wall Myocardial Infarct

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*LM narrowed > 75%.
†Dominant posterior CA is the LC.
‡See results section for explanation of CA scoring system.
Abbreviations: See table 1.

Patients in any of the five categories of cross-sectional area narrowing.

A scoring system was used to indicate both the severity and extent of coronary arterial narrowing. Every 5-mm segment of coronary artery from each patient was assigned a score of 1–4, based on the amount of cross-sectional area narrowing by aththerosclerotic plaque: 1 = 0–25% narrowing; 2 = 26–50%; 3 = 51–75%; and 4 = 76–100%. A total score was obtained for each patient and the score per 5-mm segment was then calculated by dividing the total score per patient by the number of 5-mm segments examined from that patient. The scores were 1.8–3.8 (mean 3.0) in the anterior MI group and 1.9–3.9 (mean 3.2) in the posterior MI group (NS).

The mean percent of 5-mm segments narrowed 76–
100% in cross-sectional area by atherosclerotic plaque in the right, left anterior descending and left circumflex coronary arteries for each of the two study groups is shown in Figure 2. The right (p < 0.05) and left circumflex (p < 0.005) coronary arteries had a greater mean percentage of segments narrowed 76–100% in the posterior MI patients than in the anterior MI patients; the left anterior descending coronary artery had a similar percentage of severe narrowing in both groups. Within the anterior MI group, the left anterior descending had a greater mean percentage of severely narrowed segments than the left circumflex coronary artery (p < 0.001) and a mean percentage similar to that in the right coronary artery. Within the posterior MI group, the left anterior descending had less severe narrowing than the right (p < 0.001) and left circumflex (p < 0.05) coronary arteries.

The amount of left ventricular (including ventricular septum) myocardium replaced by fibrous tissue was 5–55% (mean 20%) in the anterior MI patients and 1–48% (mean 9%) in the posterior MI patients (p < 0.002). The ventricular septum was included in the

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<th>5-mm segments of 3 CAs (LM excluded)</th>
<th>Mean score CA†</th>
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<td></td>
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<td>No. (%)</td>
<td>No. (%)</td>
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area of MI in 16 of 22 anterior MI patients (73%) and in six of 37 posterior MI patients (16%) \((p < 0.001)\). The lateral wall was involved in eight anterior MI patients (36%) and in 14 posterior MI patients (38%) \(\text{NS}\). Portions of the posterior wall (predominantly in the apical half of the heart) were replaced by fibrous tissue in eight of 22 anterior MI patients (36%), and areas of the anterior wall (predominantly apical half) were scarred in four of 37 posterior MI patients (11%). Division of the left ventricle into four quadrants (anterior, septal, posterior and lateral) revealed that on the average, 2.5 quadrants contained areas of scarring in the anterior MI patients, compared with 1.6 quadrants in the posterior MI patients \(p < 0.05\).

**Discussion**

Although it is often assumed that patients with an anterior wall myocardial infarct (MI) have severe coronary narrowing primarily in the anterior circulation (left anterior descending coronary artery) and those with a posterior wall (inferior) MI have severe narrowing in the posterior circulation (right or left circumflex coronary arteries), little anatomic information is available to determine the validity of this hypothesis. In a recent report, the amount and location of coronary arterial narrowing by atherosclerotic plaque was determined in patients whose first acute MI was fatal. The patients with a posterior acute MI had more overall severe (76–100% cross-sectional area) narrowing, as well as more severe narrowing in the left anterior descending, right and left circumflex coronary arteries, than the patients with an anterior acute MI. Although there was quantitatively more severe narrowing in these arteries in the posterior MI patients, all but one patient in both groups had severe narrowing of at least two of the three arteries and there was no significant difference between the two groups in the number of arteries with severe narrowing. Thus, the location of severe coronary artery narrowing by atherosclerotic plaques did not appear to determine the location of the acute MI.

We performed a similar type of quantitative analysis of coronary arterial narrowing in patients who died up to 23 years after healing of an anterior or posterior MI. In contrast to the findings in the study of patients with fatal first acute MI, the patients with a healed posterior or anterior MI had a similar overall percentage of 5-mm segments of coronary artery narrowed 76–100% (46% and 38%), but the posterior MI patients had significantly more coronary arteries per patient severely narrowed. Additionally, the posterior compared to the anterior MI patients had a similar number of segments of left anterior descending coronary artery narrowed severely but more segments narrowed severely in the left circumflex and right coronary arteries. Thus, although most patients in both groups had at least two major coronary arteries narrowed severely, the patients with a posterior healed MI had more severe narrowing in the posterior circulation than those with an anterior MI, but the anterior and posterior MI patients had a similar amount of severe narrowing in the ‘anterior’ circulation. Both groups of patients with a healed MI had a far greater percentage of 5-mm segments severely narrowed than previously reported control subjects who had no symptoms of myocardial ischemia and died from noncardiac conditions (46% and 38% vs 4%).

In the previously reported patients with an anterior, fatal, first acute MI, there was quantitatively more severe narrowing of the left anterior descending than of the right or left circumflex coronary arteries, but in those with a posterior MI there was a similar amount of narrowing in all three arteries. Of our patients with healed MI, however, those with anterior MI had similar amounts of severe narrowing in the left anterior descending and right coronary arteries but less severe narrowing in the left circumflex than in the left anterior descending coronary artery. Those with a posterior healed MI had more severe narrowing in the right and

---

**Table 3. Number of 22 Patients with an Anterior and 37 with a Posterior Transmural, Healed Myocardial Infarct (MI) with One to Four Major Coronary Arteries Narrowed 76–100% in Cross-sectional Area**

<table>
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<th>Posterior</th>
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<th>Totals</th>
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<td>8</td>
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<td>0</td>
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</tr>
<tr>
<td>Total</td>
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<td>37 (100%)</td>
<td>59 (100%)</td>
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**Table 4. Numbers of Each Major Epicardial Coronary Artery Narrowed 76–100% in Cross-sectional Area by Atherosclerotic Plaques in 22 Patients with an Anterior and 37 with a Posterior Wall Transmural Healed Myocardial Infarct**

<table>
<thead>
<tr>
<th>Location of MI</th>
<th>No. of pts</th>
<th>Total no. of CAs</th>
<th>No. of pts with CA narrowed 76–100%</th>
<th>Mean no. of CAs per patient narrowed 76–100%</th>
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<tr>
<td>Anterior</td>
<td>22</td>
<td>88</td>
<td>LM 4 (18%) LAD 21 (95%) LC 11 (50%) R 21 (95%) Totals 57 (65%)</td>
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<td>Posterior</td>
<td>37</td>
<td>148</td>
<td>LM 9 (24%) LAD 33 (89%) LC 33 (89%) R 37 (100%) Totals 112 (76%)</td>
<td>3.0</td>
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<td>(p)</td>
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<td>NS NS &lt; 0.001 NS NS</td>
<td>&lt; 0.05</td>
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Abbreviations: MI = myocardial infarction; CA = coronary artery; LAD = left anterior descending; LC = left circumflex; LM = left main; R = right.
left circumflex than in the left anterior descending coronary artery.

Although these results suggest that the location of the MI and the location of the most severe coronary arterial narrowing for patients with healed posterior MI are related, exceptions were frequent: eight of the 37 posterior MI patients (22%) had a greater percentage of severely narrowed segments in the left anterior descending than in the dominant posterior artery (right coronary artery in all but two patients). For the anterior MI group, seven of the 22 patients (32%) had a greater percentage of severely narrowed segments in the dominant posterior artery (right coronary in all but two patients) than in the left anterior descending coronary artery.

The patients with an anterior MI had significantly larger areas of scarring and more frequent involvement of the ventricular septum and of the opposite wall (posterior for those with anterior MI) than patients with a posterior healed MI. Despite the larger, more extensive infarcts in patients with a healed anterior MI, the anterior MI compared with the posterior MI patients had significantly fewer severely narrowed coronary arteries and less severe narrowing in the right and left circumflex coronary arteries, and a similar amount of severe narrowing in the left anterior descending and left main coronary arteries.

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Comparison of amount of extent of coronary narrowing by atherosclerotic plaque and of myocardial scarring at necropsy in anterior and posterior healed transmural myocardial infarction.

H S Cabin and W C Roberts

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