Distribution of Pain in Myocardial Infarction

By Kenneth Kreines, M.D.

In acute myocardial infarction the possible relation of localization and radiation of the pain to the localization and extent of the infarct has engaged the interest of many clinicians. The clinical records, electrocardiograms, and autopsy protocols of 104 cases of myocardial infarction were carefully examined to determine if there is an association between the location and extent of involved myocardium and the radiation of pain to "atypical" sites such as the back and the epigastrium.

The purpose of this study was to determine if the distribution of pain in cases of acute myocardial infarction is influenced by the location and extent of involved myocardium. Specifically, do infarctions of the posterior or diaphragmatic wall of the heart result in a greater frequency of pain radiating to the abdomen and back than do infarctions of the anterior wall? On the other hand, are epigastric and back pain a function of some other factor such as the extensiveness of the area of infarction? Mason in 1950 postulated on embryologic and phylogenetic grounds that the left and right sides of the heart are innervated separately by nerves from the left and right sides of the body respectively. He reasoned, therefore, that pain originating in the left side of the heart is perceived more commonly in the left arm and left half of the body than pain originating in the right side of the heart. No other attempt to correlate distribution of pain with pathologic findings was found in the course of a brief survey of the literature.

Material and Methods

The autopsy protocols between 1946 and 1953 of a large Cincinnati private hospital were reviewed. The clinical records and electrocardiograms of all cases in which acute coronary occlusion or myocardial infarction was the chief cause of death, were carefully examined. During this period, the diagnosis of acute myocardial infarction was made clinically in 960 cases of which 316, or 32 per cent died; of this number, 193 were autopsied. Since this study necessitated accurate descriptions of the location and extent of involved myocardium and of the pain the patients experienced, all records were discarded in which a recent area of infarction was not grossly demonstrable and pinpointed in extent and location. Microscopic localization could not be relied upon, since the sections of myocardium taken at autopsy were not marked as to the locus in the heart from which they were removed. All cases in which no pain was described because of unconsciousness due to surgical anesthesia, terminal uremia, cerebral vascular accident, diabetic acidosis, etc. were also discarded. The cases that fulfilled these criteria were separated into 4 groups: anterolateral or apical, anteroseptal, posterior, and massive myocardial infarctions. An infarction was considered massive if it involved the entire left ventricle, the entire anterior wall, the posterior wall with extension laterally or inferiorly to involve the anterior wall, the anterior wall with extension around the apex to involve the posterior wall or the entire length of the septum with involvement of both the anterior and posterior walls. It was possible by this method to find 104 cases in which the area of myocardium involved could be rather precisely localized and in which it was considered that the patients were competent to describe pain accurately, if any was present.

Results

Location and Extent of Myocardial Infarctions

Twenty-nine massive infarctions were encountered. Of these, 20 were clearly extensive infarctions of the anterior wall only, and 9 involved the anterior and the posterior wall, either by infarction of the entire left ventricle or by extension of an infarction from 1 wall to the other. For purpose of comparison, if the latter 9 cases are not included, it will be seen that the anterior wall was involved in 59 per cent, and the posterior wall in 41 per cent of the 95 remaining cases. Twenty per cent of the 104 cases were anteroseptal, 14 per cent...
anterolateral, 38 per cent posterior, and 28 per cent massive myocardial infarctions.

One hundred and fourteen coronary obstructions were demonstrated at autopsy in 96 cases. In 8 cases severe stenosis of the major coronary arteries without occlusion was found in the face of frank myocardial infarction. The frequency of involvement of the individual arteries is shown below.

Anterior descending branch of the left coronary artery ........................................ 51
Right coronary artery .................................................. 39
Circumflex branch of the left coronary artery ........................................ 17
Left main coronary artery .................................................. 7
Two or more coronary obstructions ........................................ 18
Severe stenosis without occlusion ........................................ 8

Correlation of Radiation of Pain with Pathologic Anatomy of the Heart

Pain was experienced in 26 combinations of 11 sites in 88 cases. The sites were: posterior aspect of the scalp, teeth, lower jaw, throat, neck, anterior chest, back, left arm, right arm, epigastrium, and right upper abdominal quadrant. In 16 of the 104 cases (15 per cent), pain was either absent or of such minor degree that it was not described by the patient. The overshadowing symptom in the latter group was dyspnea. The frequency of occurrence of the various combinations of pain is shown in table 1.

The character or severity of the pain is not recorded, since this variable is considered to be more a function of individual pain susceptibility than of anatomic factors. The notations "left arm" and "right arm" refer only to the respective upper extremity without attempt at subdivision into shoulder, upper arm, forearm, fingers, etc. Similarly, "chest pain" refers to any instance of pain within the anterior chest without breakown into substernal, precordial, etc. No statistically significant total picture of pain radiation was demonstrated for any type of myocardial infarction.

Anterior chest pain was absent in 31 per cent of the cases. Pain radiated to both arms (16 per cent) with slightly greater frequency than to the left arm alone (13 per cent). However, pain in the right arm without pain in the left arm was rarer, occurring in only 5 per cent of the cases. The combination of anterior chest pain radiating through to the back was found in 28 per cent of the massive, in only 3 per cent of the posterior, and in none of the other varieties of myocardial infarction. Back pain alone was found in 2 cases (7 per cent) of massive infarction, but in no other types. In 1 case of anteroseptal and 1 of massive infarction there was back and epigastric pain but no chest pain. In 1 case of posterior myocardial infarction there was pain in both arms and in the back, also without chest pain.

The combination of chest and epigastric pain

Table 1.—Total Radiation of Pain by Infarct Type

<table>
<thead>
<tr>
<th>Location</th>
<th>Antero-septal (21)</th>
<th>Antero-lateral (15)</th>
<th>Massive (29)</th>
<th>Posterior (39)</th>
<th>Total (104)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest</td>
<td>9</td>
<td>6</td>
<td>6</td>
<td>10</td>
<td>31</td>
</tr>
<tr>
<td>Chest and jaw</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Chest and left arm</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td>Chest and both arms</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Chest and both arms and neck</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Chest and both arms and throat</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Chest and both arms and neck post.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Chest and neck and right arm</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Chest and both arms and epigastrum</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Chest and right arm and epigastrum</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Chest and left arm and neck and epigastrum</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Chest and neck and epigastrum and back</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Chest and right arm and back</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Chest and back</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Chest and epigastrium</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Chest and epigastrium and teeth</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Epigastrium and left arm and epigastrum</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Right upper quadrant</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Right arm and jaw</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Both arms and neck</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Both arms and back</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Left arm and epigastrum and back</td>
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<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Epigastrum and back</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Back</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Epigastrum and neck</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>None</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>8</td>
<td>16</td>
</tr>
</tbody>
</table>
was found in 6 cases, of which 4 were massive infarctions and 2 were posterior infarctions. One of the cases of massive infarction had back as well as epigastric and chest pain. In 9 cases (9 per cent) there was epigastric pain without chest pain. Three were cases of massive infarction, 3 of posterior, 2 of anteroseptal, and 1 of anterolateral myocardial infarction. One of these cases of anteroseptal infarction demonstrating epigastric and back pain was previously mentioned.

The frequency of radiation of pain to individual sites expressed in terms of type of infarction is shown in table 2. Back pain was experienced by 13 per cent of the total number of patients. Thirty-eight per cent of the patients with massive infarction, 5 per cent with posterior, 5 per cent with anteroseptal, and none of the patients with anterolateral myocardial infarction had back pain. Epigastric pain was experienced by 15 per cent of the total. As with back pain, but to a less striking degree, the greatest frequency of epigastric pain occurred in the cases of massive myocardial infarction (28 per cent); posterior (13 per cent), anteroseptal (10 per cent), and anterolateral myocardial infarction (7 per cent) less commonly resulted in epigastric pain. It is interesting that of the 16 cases with epigastric pain, 7 had coexisting abdominal pathology capable of producing epigastric pain. Two had chronic cholecystitis and cholelithiasis, 1 choleodocholithiasis, 1 a healing peptic ulcer, 1 chronic gastritis, 1 a low-grade enterocolitis, and 1 appendicitis.

Table 3 contrasts the pain radiation of anterior with that of posterior myocardial infarction. The 9 cases of massive infarction previously mentioned, in which both the anterior and posterior walls were involved, are not included, since they would not influence a statistical comparison significantly. It is clear that no significant differences exist between the pain radiation of anterior and posterior myocardial infarction.

In table 4 the pain radiation of the massive myocardial infarctions is contrasted with that of the smaller infarctions.

Back pain was present in 33 per cent of the larger infarctions but only 4 per cent of the smaller ones. Similarly, but to a less striking degree, epigastric pain was described by 28 per
percent of the patients with the larger infarctions and by only 11 per cent of the remaining patients.

**DISCUSSION**

An attempt to understand and appreciate the “atypical” radiation of pain in myocardial infarction is not purely academic. In this series the correct diagnosis was not made in 14 cases. In 5 of these the diagnosis was probably missed because back or epigastric rather than anterior chest pain was present and therefore myocardial infarction was not suspected.

Despite the fact that the innervation of the heart has been well delineated, the mechanisms determining the radiation of cardiac pain are still a mystery. It is not the purpose of this paper to review the conventional theories of the radiation of cardiac pain as this has already been well described in the literature.2-9

In this study, 38 per cent of the very large infarctions, but only 4 per cent of the smaller infarctions resulted in pain radiating to the back. Similarly, 28 per cent of the larger and only 11 per cent of the smaller infarctions resulted in epigastric pain. Both of these associations are statistically significant when subjected to a \(x^2\) test. It is suggested that larger infarctions, perhaps by creating larger zones of injury, stimulate greater numbers of nerve endings resulting in a total impulse of greater than usual magnitude, which for some unknown reason is perceived in such “atypical” sites as the back and epigastrium. White10 has pointed out that perhaps the radiation of pain in angina pectoris to atypical sites such as the right hand presages a graver prognosis. Could this also mean that these individuals have a more extensive area of diseased myocardium?

**Summary**

The clinical records, electrocardiograms, and autopsy protocols of 104 cases of myocardial infarction were carefully examined to determine if there is an association between the location and extent of involved myocardium and the radiation of pain to “atypical” sites such as the back and epigastrium. No association was found between location of myocardial infarction in the posterior or diaphragmatic wall of the heart and radiation of pain to the back and abdomen. A statistically significant association was found between the occurrence of massive myocardial infarctions and radiation of pain to the back and epigastrium. It is suggested that the size of a myocardial infarction may be 1 of the factors determining the radiation of pain.

**Acknowledgment**

I wish to acknowledge the help and guidance of Dr. Johnson McGuire without whose assistance this work would have been impossible.

**Summario in Interlingua**

Le protocollos clinic, le electrocardiogrammas, e le reportos necroptic de 104 casos de infarcimento myocardial eseva examinate cauteamente pro determinar si il existe un association inter le sito e extension del implication myocardial e le radiation de dolores a sitos “atypic,” como le dorso e le epigastrio.

Nulle association eseva constatate inter le sito del infarcimento myocardial in le parieta posterior o diaphragmatic del corde e le radiation de dolores al dorso e al abdomen. Un statisticamente significative association eseva constatate inter le occurrentia de massive infarcimento myocardial e radiation de dolores al dorso e al epigastrio. Nos opinia que le dimension del infarcimento myocardial es pos-
siblemente un del factores que determina le radiation de dolor.

REFERENCES


The first general criterion for use of left-heart catheterization is that the patient potentially has a surgically remedial valvular lesion and that the clinical and established laboratory methods have been unable to indicate the exact diagnosis. Special anatomic problems may be clarified by left-heart catheterization in a way superior to all other methods. These are: 1. How severe is the aortic stenosis? 2. When mitral stenosis and insufficiency are associated, which is predominant? 3. When aortic stenosis and mitral disease are associated, which is the more important? 4. In some cases of "idiopathic" pulmonary hypertension, is "silent" mitral stenosis present? 5. In some cases of heart failure with valvular disease, which is the more important, the valvular defect or the failure of the myocardium, per se, such as might be associated with a concomitant hypertension or rheumatic myocarditis or both?

Measurements that can be made by the catheter in the left side of the heart, which may accurately designate the nature of the valvular defects, are the measured gradient of pressure, relative to flow, across the valve, as, for instance, pressure difference during diastolic filling between atrium and ventricle, or ventricle and aorta during systole, ventricular diastolic pressures that may indicate myocardial failure, and pressure contours in the left atrium indicating mitral incompetence. Even when such accurate measurements become available, it is important that their interpretation not necessarily be absolute but be tempered with clinical data. For example, it would be an error to consider the absence of an end-diastolic gradient across the mitral valve as prima facie evidence for the exclusion of mitral stenosis, if aortic incompetence were present clinically and allowed some ventricular filling from the aorta. Again, in the presence of clinically evident aortic incompetence, the presence of systolic gradients across the aortic valve should be reviewed with greater circumspection in assessing the orifice of this valve.

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