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Relationship between location of chest pain and site of coronary artery occlusion

Chest pain characteristics and site of coronary artery occlusion were evaluated in 148 patients having single-vessel coronary angioplasty and in 95 patients having double-vessel angioplasty. The locations of chest pain included substernal and left precordium, right precordium and epigastric. The possible sites of pain radiation were limited to neck/jaw, left arm, right arm, and interscapular. The patient described whether or not the pain was typical of previous angina, and the presence of ST segment deviation was noted to be certain that ischemia was present. The analysis showed that the occluded artery could not be reliably identified. However, it was possible to say which artery was most likely not diseased. Patients presenting with substernal or left chest pain with radiation to the left arm had a less than 10% chance of having right coronary artery disease. A patient presenting with epigastric pain radiating to the neck or jaw had a less than 13% chance of having left anterior descending disease. It is concluded that in patients with single- and double-vessel coronary disease, there is some relationship between chest pain pattern and disease location. (Am Heart J 1988;115:564.)

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Angina pectoris has been a well-known clinical entity since Heberden's description in 1768.[1] The pain is usually present in the left precordium or substernal area and may radiate to the left arm. Occasionally, the pain is located in the epigastric region and may radiate to the neck or jaw. The location of pain and its radiation have not previously been used to identify the occluded vessel. The temporary occlusion of vessels during balloon angioplasty provides a unique opportunity to study the relationship of pain characteristics and disease loca-

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Table I. Location and radiation of pain for all patients

	Location												
	Sub/L				*Right*				*Epi*				
Radiation	*N/J*	*L*	*R*	*I*	*N/J*	*L*	*R*	*I*	*N/J*	*L*	*R*	*I*	*Total*
Single-vessel													
LAD	6 (+3)*	34 (+4)	0(+1)	22	0	4	0	0	0	5	0	0	75
RCA	9	1	0	2	3	1(+1)	0(+1)	4	17	6	0	1	45
LCA	1	7	0	8	1	1	0	2	4	0	0	4	28
Total		94				17					37		148
Double-vessel													
LAD	2	22	0	6	0	0	0	2	1	1	1	0	35
RCA	1	3	0	0	5	3	0	2	14	2	0	1	31
LCA	0	15	0	0	0	0	0	0	0	2	0	12	29
Total		49				12				34			95

Definition for all tables: Sub/L = substernal/left precordial; N/J = neck/jaw; L = left arm; R = right arm; I = interscapular; Epi = epigastric; LAD = left anterior descending; RCA = right coronary artery; LCA = left circumflex artery.
*Three patients were in more than one category.

Table II. Patients with ST shifts and typical chest pain

	Location												
	Sub/L				*Right*				*Epi*				
Radiation	*N/J*	*L*	*R*	*I*	*N/J*	*L*	*R*	*I*	*N/J*	*L*	*R*	*I*	*Total*
Single-vessel													
LAD	5(+2)	25(+3)	0(+1)	14	0	2	0	0	0	2	0	51	
RCA	7	1	0	1	2	1(+1)	0	4	11	0	0	1	29
LCA	1	2	0	5	1	0	0	2	1	0	0	3	15
Total		64				13				18			95
Double-vessel													
LAD	0	14	0	4	0	0	0	2	1	1	0	0	22
RCA	1	0	0	0	4	1	0	1	9	1	0	0	17
LCA	0	11	0	0	0	0	0	0	0	2	0	6	19
Total		30				8				20			58

Abbreviations and symbols as in Table I.

tion. This study describes the relationship between chest pain location and radiation to disease location in patients undergoing percutaneous transluminal coronary angioplasty.

METHODS

Patients undergoing balloon angioplasty for single- and double-vessel disease were studied. At the time of angioplasty, a questionnaire was completed that asked the patient to describe any discomfort that developed during the balloon inflation. Two hundred and forty-three patients developed pain during angioplasty and are included in this study (Table I). Specifically, the patient was asked to indicate the location and the radiation of the pain. The area of most severe pain or where the pain originated was listed as the location, while the area of less severe or later occurring pain was listed as radiation. Substernal and left precordial were regarded as one location, as was neck and jaw. The list of possible locations and radiations of pain was kept at a minimum in order to improve analysis. The locations included substernal/left precordial, right precordial and epigastric. The possible sites of radiation were limited to neck/jaw, left arm, right arm, and interscapular. The patient was asked to describe whether or not the pain was typical of previous angina. The presence of ST segment elevation or depression ≥ 1 mm during balloon inflation was noted (Table II). Information concerning quality and intensity of pain was gathered, but was not used in the analysis, since it was felt to be too subjective.

Statistics. The methods used will be explained using data from Table III as an example. A chi-square analysis was performed (Table IV) to test if there was a relationship between disease location and pain pattern (see Table).

The χ^2 value is highly significant to find specific rela-

Table III. Probabilities for patients with ST shifts and typical pain

	95% confidence interval
With no information Prob. LAD = 0.48	
Prob. RCA = 0.30	
Prob. LCA = 0.22	
Prob. LAD given Sub/L = 0.69 (65/94)*	0.59-0.79
Prob. LAD given Right = 0.19 (4/21)*	<0.38
Prob. LAD given Epi = 0.11 (4/38)*	<0.23
Prob. RCA given Sub/L = 0.11 (10/94)*	0.045-0.175
Prob. RCA given Right = 0.67 (14/21)*	0.047-0.087
Prob. RCA given Epi = 0.58 (22/38)*	0.42-0.74
Prob. LCA given Sub/L = 0.20 (19/94)	0.12-0.28
Prob. LCA given Right = 0.14 (3/21)	<0.33
Prob. LCA given Epi = 0.32 (12/38)	0.17-0.47

Prob. = probabilities; other abbreviations as in Table I.
*$p < 0.05$.

Table IV. Chi square analysis of data from Table III

	Sub/L	*Right*	*Epi*	*Total*
LAD	65	4	4	73
RCA	10	14	22	46
LCA	19	3	12	34
Total	94	21	38	153

Abbreviations as in Table I.
$\chi^2 = 54.3$.
$p < 0.01$.

tionships. In order to translate the result into a practical application, each disease location was analyzed separately. We were interested in predicting vessel location given a pain pattern. For example, if a patient had a pain pattern of substernal/left precordial (Sub/L), the probability that the patient had left anterior descending (LAD) pain was 65/94 (0.69) in this study. The question was, is this probability different from what would be expected by chance (i.e., 0.48 × 94). One way of testing this for statistical significance was to compare 65/94 (the proportion of LAD patients with Sub/L) to 8/59 (the proportion of LAD patients with right and epigastric pain) with the use of a two-sample binomial test:

$$Z = 65/94-8/59$$

$$\frac{73}{153} \times \frac{80}{153} \times \frac{1}{153} = 13.8 \ (p < 0.01)$$

Thus, in this example, it is highly probable that LAD and Sub/L are related. Confidence intervals for the proportions were calculated by means of the normal approximation to binomial where appropriate, or by means of the exact binomial distribution for small sample sizes.[2]

RESULTS

There were 148 patients with single-vessel disease who developed chest pain during angioplasty, and 95 patients with double-vessel disease who developed chest pain. The location and radiation of pain for both of these groups are shown in Table I. In order to be certain that the pain being evaluated was ischemic in origin, we did a separate analysis that included only patients whose pain was typical of their previous angina and who had ST segment shifts during balloon inflation. There were 153 patients with these characteristics; the location and radiation of their pain are shown in Table II.

The probability of predicting vessel location given location of chest pain for all patients studied is shown in Fig. 1. The probability of predicting vessel location with no information is obtained simply by looking at the anatomy that was found at catheterization. The probabilities that are given following this are determined by the various combinations of pain location and radiation. The significance of these probabilities is calculated by comparing the probability of predicting the vessel correctly with no information vs the probability of predicting it correctly given chest pain information. That is, a comparison was made of the proportion of patients with a given vessel location with given pain characteristics vs the proportion of patients with the same vessel location with other pain characteristics. For example, in Table III, 73 of 153 patients (48%) had a location of left anterior descending disease. Of 94 patients who had Sub/L pain, 65 had left anterior descending disease (69%). Of the remaining 59 patients, only eight had left anterior descending disease; the statistical comparison was 65/94 vs 8/59. The probability data for patients with pain typical of their angina and ST segment abnormalities are shown in Table III.

These results indicate the highest probability of left anterior descending disease when the patient has Sub/L pain radiating to the left arm. There is a less than 10% chance of finding right coronary artery disease with this pain pattern. Patients presenting with epigastric pain radiating to their jaw had an 86% chance of right coronary artery disease and were very unlikely to have left anterior descending disease. Patients with left circumflex disease were more likely to have epigastric pain, but this was not as likely as with right coronary artery disease.

DISCUSSION

Angina pectoris is an important warning symptom of ischemic heart disease. The term was introduced

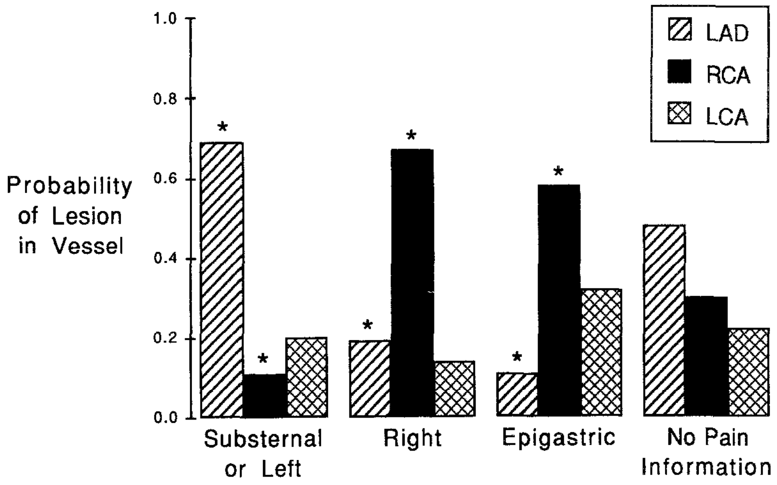

Fig. 1. Probability of predicting chest pain location for all patients. The advantage of chest pain information is shown when statistical significance is reached when patients with pain information are compared with patients with no pain information. *LAD* = left anterior descending; *RCA* = right coronary artery; *LCA* = left circumflex artery.

by Heberden in 1768 and was intended to describe a sensation of strangling (angina) and anxiety. Typical anginal pain is usually located in the left precordial or left substernal area and radiates to the left arm. Pain may occur in other areas, including the epigastrium and may radiate to the neck or jaw.[1]

Since patterns of pain vary, it would be useful clinically if relationships could be found between pattern of pain and disease location. Proudfit et al.[3] examined the coronary angiograms of a group of patients with pain in the back, right arm, and right side of the chest. Although these authors felt their group was too small to permit definite conclusions, they did note that most of the patients with pain confined to the right chest had disease in either the circumflex or right coronary artery.

To determine if it is likely that a relationship between chest pain and location should exist, it is necessary to understand the mechanisms of ischemic pain. Gorlin[4] describes two networks of sensory fibers in the heart. There is a perivascular network around the arteries and a paravascular network running between the vessels and terminating in the muscle fibers. Ischemia causes substances such as plasma kinins to be released. These substances are concentrated by stagnation of blood flow and their action is increased by H^+ and K^+, which are produced by hypoxia. These chemical substances stimulate sensory receptors that send the information to the central nervous system through the eighth cervical and first four thoracic ganglia. Malliani and Lombardi[5] describe an additional role of vagal afferent fibers. Anginal pain that is referred to the neck or jaw may indicate an additional central site where the mechanism for referred pain may be activated by vagal afferent fibers.[6] Longhurst[7] indicates that the greatest number of receptors with vagal afferent fibers are located on the posterior-inferior surface of the heart. Stimulation of these vagal afferent fibers by chemicals or ischemia has been noted to cause gastric relaxation[8] and may explain why injury to the inferior-posterior surface of the heart is associated with epigastric pain.

Our results indicate that occlusion of the left anterior descending artery does produce a different pain pattern than occlusion of the right coronary artery. This may be caused by stimulation primarily of sympathetic fibers with left anterior descending disease, and of vagal fibers with right coronary artery disease. The pain pattern of circumflex disease is less clear because of its anatomic distribution.

This information may have clinical value in detecting the probability of a diseased artery. Although it is difficult to say with certainty which artery is diseased, it is possible to say which artery is *not* involved. For example, if a patient presents with substernal or left chest pain with radiation to the left arm, there is a less than 10% chance that the right coronary artery is involved. A patient presenting with epigastric pain radiating to the neck or jaw has a less than 13% chance of having left anterior descending disease. In order to make this information clinically relevant, we included patients with both single- and double-vessel disease. The data for each vessel are similar regardless of whether they were recorded in patients having single- or double-vessel involvement. In order to be certain that we were recording the characteristics of true anginal-type chest pain produced by ischemia, we did a separate analysis confined to patients whose pain was typical of their angina and in whom ST segment changes were documented. This more stringent criterion decreased the number of patients available for analysis, but did not appreciably alter the conclusions.

We conclude that in patients with single- and double-vessel disease there is some relationship between pain pattern and disease location. This information may shed some light on the origin of cardiac pain and may have some limited clinical use.

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