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The Utility of Gestures in Patients with Chest Discomfort

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ABSTRACT

PURPOSE: Patient gestures are thought to be useful in determining the etiology of chest discomfort. We sought to determine the utility of certain patient gestures in the diagnosis of ischemic chest discomfort or myocardial infarction.

METHODS: We performed a prospective observational study of 202 patients admitted with chest discomfort. Patients were observed for the Levine Sign (clenched fist to the chest), the Palm Sign (palm of the hand to the chest), the Arm Sign (touching the left arm), and, as an indicator of nonischemic chest discomfort, the Pointing Sign (pointing with 1 finger).

RESULTS: Prevalences of the Levine, Palm, Arm, and Pointing Signs were 11%, 35%, 16%, and 4%, respectively. Using troponin levels and results of functional studies and coronary angiograms as reference standards, none of the sensitivities of the signs exceeded 38%. Specificities of the Levine and Arm Signs ranged between 78% and 86%, but the positive predictive values did not exceed 55%. The Pointing Sign had a specificity of 98% for evidence of nonischemic chest discomfort, and the positive predictive value of a negative troponin was 88%. The diameter of discomfort significantly correlated with certain gestures. Larger chest pain diameters were associated with evidence of myocardial ischemia.

CONCLUSIONS: Although certain gestures are exhibited by patients presenting with chest discomfort, they generally have poor test characteristics. The Pointing Sign has a high specificity for nonischemic chest discomfort, but a low prevalence. The gestures may communicate the size of the chest discomfort, with larger areas suggestive of ischemia.

KEYWORDS: Chest discomfort; Levine sign; Myocardial infarction; Cardiac ischemia; Patient gestures

Although chest pain accounts for a substantial proportion of all emergency medical admissions, the pain is frequently not due to ischemic heart disease.[1] At the same time, approximately 2% of patients having a myocardial infarction and approximately 2% of patients with unstable angina are mistakenly discharged from the hospital.[2] To improve the efficiency and safety of the selection of chest pain patients for admission, new biomarkers and clinical protocols are continually being investigated.[3] In addition, a thorough examination of our current practices and traditional teachings is warranted.

The cornerstone of the evaluation of the patient with chest pain is the history and physical examination. Traditional medical education teaches that patient gestures are useful in determining the etiology of chest pain: specific references to the utility of the Levine Sign in making the diagnosis of ischemic chest pain are found in several prominent cardiology textbooks,[4-6] and both textbooks and American College of Cardiology/American Heart Association guidelines suggest that nonischemic pain should be considered when a patient points to a specific area on the chest with one finger.[4-7] However, to our knowledge, the accuracy of the Levine Sign and other patient gestures in the diagnosis of ischemic heart disease has not been formally studied.

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We sought to determine the prevalence and test characteristics of 4 prospectively defined gestures for the diagnosis of ischemic chest discomfort or myocardial infarction using diagnostic tests germane to clinical practice as criterion (or "gold") standards. To determine if the gestures were displayed as a way to communicate the size of the chest discomfort, the relationship between the exhibited signs, the reported diameter of the chest discomfort, and evidence of myocardial ischemia or infarction was also examined.

CLINICAL SIGNIFICANCE

- The Levine Sign has a poor sensitivity for chest pain related to myocardial ischemia or infarction.
- A patient pointing to a specific point on the chest likely does not have discomfort due to cardiac ischemia or myocardial infarction.
- Larger areas of chest discomfort correlate with a greater likelihood of cardiac ischemia or myocardial infarction.

METHODS

The study was approved by the University of California, San Francisco Committee on Human Research. Written informed consent was obtained from all subjects.

Study Design and Population

This prospective observational study enrolled a convenience sample of English-speaking patients admitted to 3 teaching hospitals in San Francisco (a University Hospital, a County Hospital, and a Veterans Affairs Medical Center) over a 1-year period. Inclusion criteria included age >18 years and a chief complaint of chest pain or chest discomfort. Patients were excluded if they had end-stage renal disease requiring chronic dialysis therapy or any of the following diseases that had been previously diagnosed or were diagnosed within the first 24 hours of admission: severe aortic stenosis or regurgitation, pulmonary embolism, aortic dissection, severe pulmonary hypertension (mean pulmonary artery pressure >50 mm Hg), pneumonia, pericarditis, or chest trauma.

Definitions and Details of the Interview

The "Levine Sign" was defined as a clenched fist of either hand brought to the chest wall with the thumb aspect of the fist positioned towards the chest or superiorly (Figure 1). The "Palm Sign" was defined as an extended palm of either hand touching the chest. The "Arm Sign" was defined as deliberately touching the left arm with the right hand, and the "Pointing Sign" was defined as pointing to a single specific point with 1 or 2 fingers. The Levine, Palm, and Arm Signs were each prospectively specified as indicative of chest pain or discomfort due to cardiac ischemia. The Pointing Sign was prospectively specified as indicative of nonischemic chest pain.

Interviews were conducted by at least 1 of 3 observers (G.M.M., J.C., and J.V.). All interviewers were blinded to the patients' ultimate diagnosis whenever possible, and interobserver agreement was examined from the simultaneous observation of patients. A uniform interview was performed, introduced with, "I'm going to ask you a few questions about your chest discomfort." Subsequently, patients were asked Question 1: "How does it feel?" Question 2: "Can you show me where it is?" and Question 3: "Can you show me what it feels like?" The interviewer observed each patient for any of the prespecified Signs in response to each question. The patient was then asked to provide a diameter of the area of the chest discomfort in inches: either a verbal answer or measurement from any clear delineation of the diameter was recorded.

Outcome Measurements

Peak troponin I levels obtained during the first 24 hours of admission were recorded and categorized as definitively negative (normal), indicative of increased risk, or indicative of myocardial infarction. The University Hospital used a microparticle enzyme immunoassay (Abbott, Abbott Park, Ill), with negative <0.5 μg/L, increased risk = 0.5-2.0 μg/L, and myocardial infarction >2.0 μg/L; the County Hospital used a chemiluminescent assay (Beckman Coulter, Fullerton, Calif), with negative <0.06 ng/L, increased risk = 0.06-0.40 ng/L, and myocardial infarction >0.40 ng/L; the Veterans Affairs Medical Center used a chemiluminescent assay (Bayer, Tarrytown, NY), with negative <0.5 ng/L, increased risk = 0.5-1.5 ng/L, and myocardial infarction >1.5 ng/L.

Results of coronary angiography performed after admission and within 4 months were recorded as positive or negative. A positive designation required the presence of at least one major coronary artery with a ≥70% stenosis. If the patient had a history of coronary artery bypass grafting, a positive designation required a ≥70% stenosis in at least 1 major vessel (either native or graft) that was the sole supplier of an area of myocardium. If coronary angiography was not performed, the results of a functional study performed after and within 4 months of admission were used. A positive designation required a definitive interpretation by either a board-certified cardiologist or board-certified nuclear medicine physician. Functional studies included results from exercise treadmill testing (ETT) with or without Single Positron Emission Tomography (SPECT) or echocardiography and pharmacologic stress testing with SPECT or echocardiography. A positive or negative "diagnostic test" was defined by the results of coronary angiography, or, if coronary angiography was not performed, the results of a functional study.

Other past medical history was obtained by chart review and patient interview.

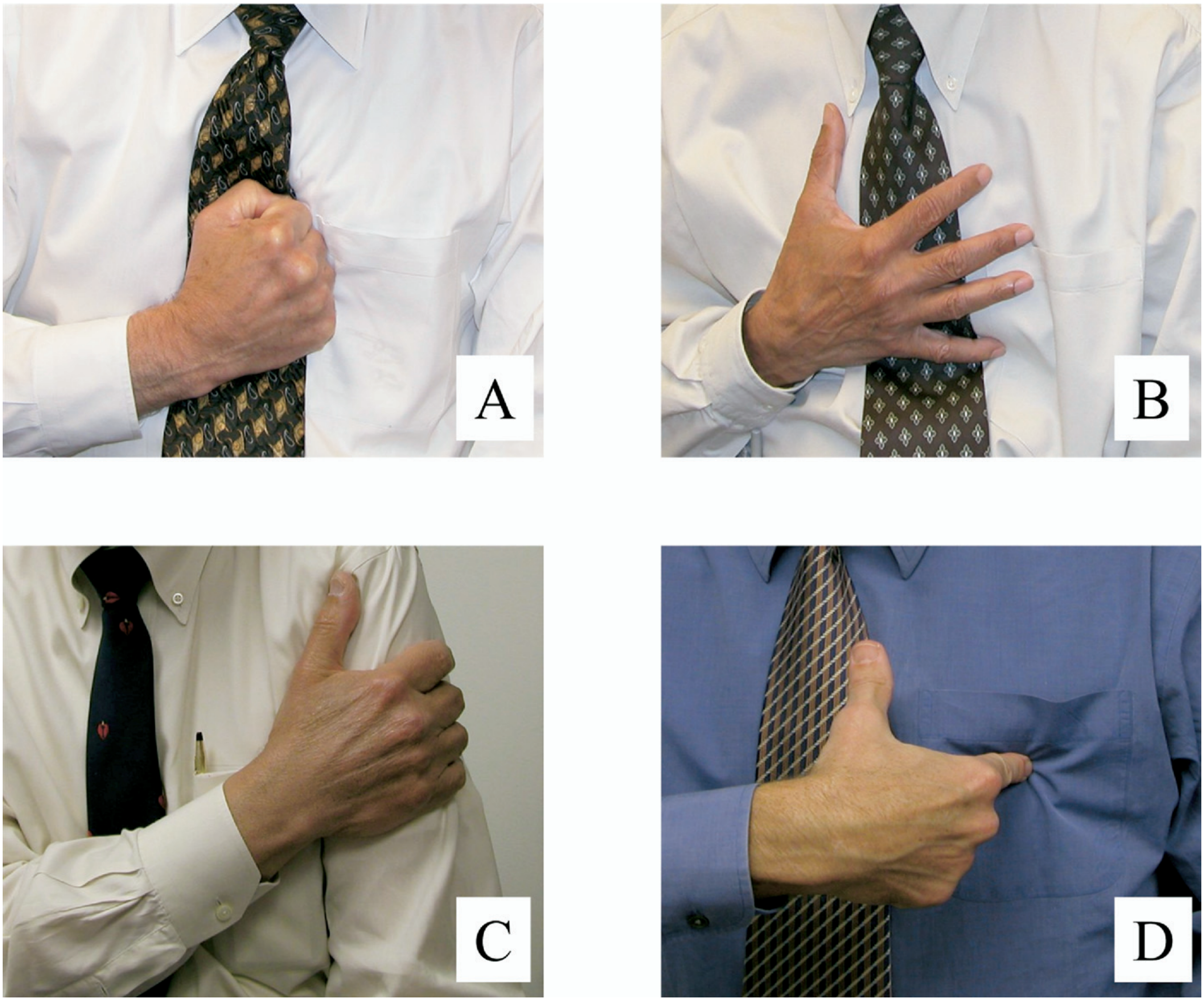

Figure 1 (**A**) The Levine Sign. (**B**) The Palm Sign. (**C**) The Arm Sign. (**D**) The Pointing Sign.

Statistical Analysis

Baseline characteristics of study subjects are expressed as means ± standard deviation (SD) or medians. Interobserver agreement between interviewers was determined by calculation of a kappa statistic, with kappa >0.7 identified as representative of good agreement. Test characteristics of each sign were examined using the following as criterion standards either alone or in combination: a normal (negative) troponin, an abnormal troponin (troponin I in the elevated risk or myocardial infarction range), and a positive or negative diagnostic test. Differences were assessed by the chi-squared test as well as by logistic regression analysis. Differences in test characteristics by various subgroups were assessed by calculating and comparing test characteristics for each sign within each stratum. In addition to visual inspection of the estimates, testing for differences by subgroup was performed by constructing logistic models with the criterion standard as the outcome variable, and with the result of the sign, the stratification variable, and their 2-way multiplicative interaction term included as predictors in the models. The diameter of the chest pain was examined and compared with the criterion standards as both a continuous variable and as categorical variables determined by visual inspection of the data. All analyses were performed using Stata SE 7.0 (College Station, Tex). Two-sided P values <.05 were considered statistically significant.

RESULTS

There were 202 patients enrolled; mean age was 59 ± 13 years; 48 were (24%) women, 107 (53%) white, 49 (24%) black, 29 (14%) Asian, and 14 (7%) Latino. Sixty-two (31%) were admitted to the University Hospital, 52 (26%) to the County Hospital, and 88 (44%) to the Veterans Administration Hospital. The interviewer was blinded to the ultimate diagnosis in 169 (84%) cases, and the interview was performed a mean 1 day after the most recent episode of chest discomfort. Forty-seven (23%) patients were not

Table 1 Prevalence of Any and Each Sign

Sign	Overall n = 202	Women n = 48	Diabetes n = 55	Black n = 49	Asian n = 29	Latino n = 14	Foreign-born n = 47
Any	107 (53%)	32 (67%)*	28 (50%)	22 (45%)	17 (58%)	10 (71%)	29 (62%)
Levine	23 (11%)	7 (14%)	6 (12%)	7 (14%)	2 (7%)	1 (7%)	4 (9%)
Palm	72 (35%)	23 (48%)†	20 (36%)	15 (31%)	14 (49%)	6 (43%)	22 (47%)
Arm	34 (16%)	11 (23%)	10 (6%)	5 (10%)	2 (7%)	5 (35%)‡	7 (15%)
Pointing	8 (4%)	1 (2%)	1 (2%)	0	1 (3%)	1 (7%)	2 (4%)

*$P = .029$ compared with 49% prevalence among men.
†$P = .042$ compared with 32% prevalence among men.
‡Significantly more prevalent than other ethnicities ($P = .042$).

born in the United States, representing 13 different countries and 4 different continents of origin.

One hundred (50%) patients had a history of coronary artery disease, 57 (28%) had a history of coronary artery bypass grafting, and 30 (15%) had a history of myocardial infarction. Fifty-five (27%) had diabetes mellitus (all had type 2 diabetes).

The prevalence of each sign is shown in Table 1. With more than half of all patients exhibiting at least 1 gesture, the Palm Sign was the most prevalent and the Pointing sign was the least prevalent. Prevalences were not significantly different across the 3 hospitals or among patients with a history of coronary artery disease, coronary artery bypass grafting, or myocardial infarction. Table 2 shows how often each sign was exhibited for each question. Although individual patients exhibited every combination of the Levine, Palm, and Arm Signs in small numbers, no patient that exhibited the Pointing Sign displayed any of the other signs.

Interobserver variability was assessed between 2 investigators while simultaneously observing 22 patients: there was 100% agreement (kappa = 1.000) for the Levine and Arm Signs, there was 100% agreement regarding the Pointing Sign (however, a kappa statistic could not be calculated because none of the simultaneously observed patients exhibited a Pointing Sign), and there was 95% agreement (kappa = 0.9014) regarding the Palm Sign.

All patients had troponin I levels obtained within 24 hours of admission; 138 peak troponin I levels were negative, 19 were in the increased risk range, and 44 were in the myocardial infarction range. One hundred eleven patients underwent a coronary angiogram a mean 1.5 days after the interview, and 52 patients that did not undergo coronary angiography underwent a functional study a mean 7 days after the interview. Ninety-one patients had a positive diagnostic test. The functional studies were comprised of 7 ETTs without imaging, 8 ETTs with SPECT, 2 ETTs with echocardiography, and 34 pharmacologic SPECT studies. Of the 17 that involved an ETT, 10 patients achieved ≥85% maximum predicted heart rate by age.

Test characteristics for each of the signs prospectively specified as indicative of chest discomfort due to cardiac ischemia are shown in Table 3. In analyzing differences in test characteristics by subgroup, the sensitivity of the Palm Sign exhibited by diabetics (53%) was statistically significantly different from that in those without diabetes (31%), $P = .028$. There was no other statistical evidence of differences in women, diabetics, foreign-born patients, patients with coronary artery disease, a history of coronary artery bypass grafting, or a history of myocardial infarction. No differences in test characteristics were observed for patients exhibiting a given Sign in response to more than one question, and no significant differences in test characteristics were noted in the 16% of patients for whom the interviewer was not blinded to the diagnosis.

Fifteen patients had an ST segment elevation myocardial infarction (STEMI), all with evidence of significant coronary artery disease by coronary angiography and all with significant troponin elevations. One was a 56-year-old white man who exhibited the Levine sign, showing it in response to 2 of the 3 questions. Four STEMI patients had the Palm Sign (3 exhibited it more than once). One STEMI patient

Table 2 Signs Exhibited in Response to Each Question

>Sign	Question 1: How does it feel?	Question 2: Can you show me where it is?	Question 3: Can you show me how it feels?	Exhibited more than once
Levine, n = 23	16 (70%)	3 (13%)	14 (61%)	9 (39%)
Palm, n = 72	48 (67%)	47 (65%)	17 (24%)	31 (43%)
Arm, n = 34	21 (62%)	20 (59%)	4 (12%)	1 (2%)
Pointing, n = 8	1 (14%)	7 (88%)	1 (14%)	1 (14%)

Table 3 Test Characteristics of the Levine, Palm, Arm, and Pointing Signs

Sign	Test Characteristic	Criterion Standard: Abnormal Troponin or Positive DiagnosticTest (95% CI)	Abnormal Troponin (95% CI)	Troponin in the Myocardial Infarction Range (95% CI)
Levine				
	Sensitivity (%)	9 (5-17)	6 (2-15)	6 (2-19)
	Specificity (%)	84 (72-92)	86 (79-91)	87 (81-92)
	Positive predictive value (%)	50 (27-73)	17 (5-39)	13 (3-34)
	Negative predictive value (%)	31 (28-44)	66 (59-73)	77 (70-82)
Palm				
	Sensitivity (%)	38 (28-48)	31 (20-44)	32 (19-48)
	Specificity (%)	67 (54-78)	62 (53-70)	63 (55-71)
	Positive predictive value (%)	65 (52-77)	28 (18-40)	19 (11-31)
	Negative predictive value (%)	39 (30-49)	66 (57-74)	77 (69-84)
Arm				
	Sensitivity (%)	16 (10-25)	15 (8-27)	18 (8-33)
	Specificity (%)	78 (66-87)	83 (75-89)	83 (77-89)
	Positive predictive value (%)	55 (36-73)	29 (15-48)	25 (11-41)
	Negative predictive value (%)	36 (28-45)	68 (60-75)	78 (72-84)
Pointing		Negative Troponin and a Negative Diagnostic Test (95% CI)		Negative Troponin (95% CI)
	Sensitivity (%)	6 (2-26)		5 (2-10)
	Specificity (%)	98 (93-100)		98 (92-100)
	Positive predictive value (%)	67 (22-96)		88 (47-100)
	Negative predictive value (%)	62 (54-70)		33 (26-40)

Abbreviation: CI = confidence interval.

showed the Arm Sign twice, and none of the STEMI patients exhibited the Pointing Sign.

Forty-one patients were unable to provide an exact diameter of the area of their chest discomfort, and these patients were no more likely to have an abnormal troponin or positive diagnostic test. The mean diameter of chest discomfort of those that exhibited the Palm Sign was significantly larger than that of those who did not, and the mean diameter of chest discomfort of those that exhibited the Pointing Sign was significantly smaller than that of those who did not (Figure 2). Treating the area of chest pain as a continuous variable, for every 1 inch increase in size, there was a 1.13-fold increase in the odds of an abnormal troponin or functional study ($P = .015$), a 1.06-fold increase in the odds for an abnormal troponin ($P = .051$), and a 1.07-fold increase in the odds for a troponin in the myocardial infarction range ($P = .039$). Similar relationships were observed if the diameter of chest pain was divided into 0-2 inches, >2-10 inches, and >10 inches (Figure 3).

DISCUSSION

The utility of the bedside evaluation of the patient with chest pain has been proven largely in relation to the history: a previous history of myocardial infarction, exertional pain, and pain radiating to the shoulder or both arms is associated with a greater likelihood of coronary artery disease or myocardial infarction.[8,9] Pleuritic or positional pain, sharp or stabbing pain, and pain duration >30 minutes argue against the presence of coronary heart disease.[8,10,11] Physical examination findings associated with myocardial infarction include hypotension and a third heart sound, and chest wall tenderness has been shown to be indicative of nonischemic chest pain.[8,9,11] None of these analyses included patient gestures. Although the utility of these gestures is informally taught in medical training and more formally described in

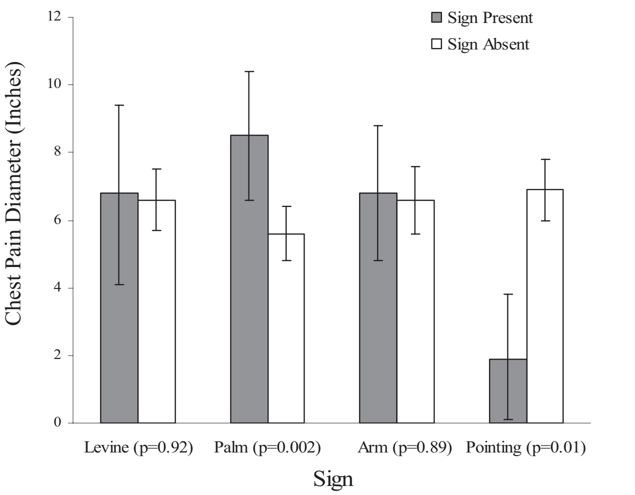

Figure 2 Mean chest pain diameters (in inches) described by patients that did and did not exhibit each sign. Error bars denote 95% confidence intervals.

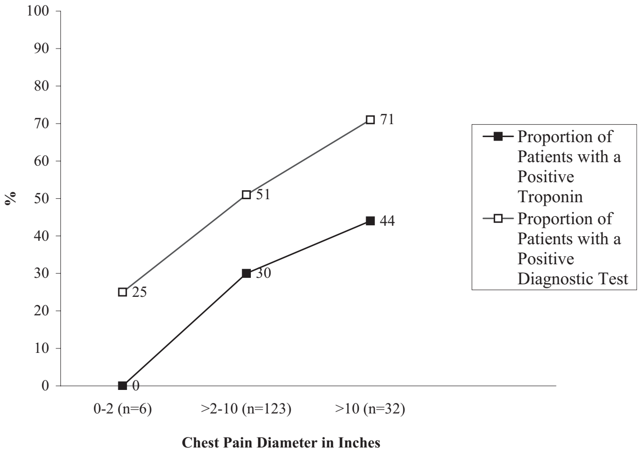

Figure 3 For each one-stratum increase in chest pain diameter in inches (<2, >2-10, and >10), there is a 2.2-fold increase in the odds that there is a positive troponin ($P = .036$) and a 2.5-fold increase in the odds that there is a positive diagnostic test ($P = .030$).

the medical literature,[4-7] an examination of the prevalence or utility of these gestures has not been reported.

Studying patients admitted to the hospital with chest discomfort, we found 4 prespecified gestures to be present with the same prevalence across different types of hospitals (a University Hospital, a County Hospital, and a VA Hospital) and regardless of a history of coronary heart disease. The fact that the prevalence of the gestures did not differ across ethnicities nor between patients born in or outside the United States suggests that the gestures may not be specific to any particular culture. Although Latinos were more likely to exhibit the Arm Sign, the low numbers involved makes this statistically significant finding questionable. Approximately half of all patients exhibited at least one sign. The Palm Sign, an open palm touching the chest, was the most common, and the Pointing Sign, pointing to a specific area on the chest wall with 1 or 2 fingers, was the least common. Women were more likely to exhibit at least one of the Signs and more likely to exhibit the Palm Sign. Otherwise, despite previous data that women and diabetics often present with chest discomfort in an atypical fashion, we found no other differences in women and none in diabetics related to the prevalence of the gestures.

Using a positive troponin or positive diagnostic test, a positive troponin alone, or a troponin in the myocardial infarction range as different criterion standards, none of the sensitivies of any of the gestures exceeded 38%. The negative predictive values were generally less than 68%. The higher negative predictive values only reached 77%-78% for the Levine, Palm, and Arm Signs when using troponin in the myocardial infarction range as a criterion standard, the least common outcome standard used. In general, the absence of any one of the gestures does not appear to be useful to rule out the diagnosis of myocardial ischemia or infarction.

Although the specificities of the gestures prospectively identified as indicative of ischemic chest pain (the Levine, Palm, and Arm Signs) ranged between 67% and 84%, none of the positive predictive values exceeded 65%. Therefore, these gestures do not appear to be useful to rule in a diagnosis of myocardial ischemia or infarction.

The Pointing Sign appears more promising, with specificities of 98% for either a negative troponin and normal diagnostic test or a negative troponin alone, and the 88% positive predictive value for a negative troponin suggests it may be somewhat useful to rule in a diagnosis of nonischemic chest pain. However, the low prevalence of this sign (4% of our cohort) likely limits clinical utility.

The utility of the gestures may be related to a communication of the size of the chest pain. Although neither the Levine nor the Arm Signs correlated with a particular chest pain size, the Palm Sign was associated with a significantly larger and the Pointing Sign a significantly smaller mean diameter of the area of the chest discomfort. Because the Palm Sign involves covering the largest area of the chest with one hand (by definition, an open palm) and the Pointing Sign involves the designation of a specific, small area (by definition, using only 1 or 2 fingers to point to a single, specific area), it makes sense that these 2 particular gestures might be used as ways to communicate the size of the chest discomfort. Moreover, the size of the pain correlated well with the presence of ischemic heart disease: using the mean diameter of chest pain as a continuous variable or categorizing the diameter into 0-2 inches, >2-10 inches, and >10 inches, a larger size was consistently associated with evidence of myocardial ischemia or infarction.

This study has several limitations: the patient population was limited to patients admitted to the hospital for their chest discomfort (for example, we cannot exclude the possibility that the Pointing Sign might be more common, and therefore more useful, in the outpatient setting), patients did not all undergo the same diagnostic tests by the same operators, and patients were in general not interviewed while having chest pain.

CONCLUSIONS

Certain gestures are exhibited by patients admitted with chest discomfort as described in the medical literature. Contrary to traditional clinical teaching, direct examination of these gestures fails to demonstrate clinical utility. However, the clinical value of the gestures may be related to a communication of the size of the chest discomfort, with larger diameters more indicative of cardiac ischemia.

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