Re-evaluation of the Vectorcardiographic Criteria for Inferior Myocardial Infarction

Correlation between Vectorcardiograms and Left Ventriculograms

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SUMMARY

In 72 patients satisfying the vectorcardiographic criteria described by Young et al,²⁾ vectorcardiographic findings were compared between a group of patients with an inferior myocardial infarction and a false positive group to increase the specificity of the vectorcardiographic diagnosis of inferior myocardial infarction. The first group was composed of 18 cases, with angiographic findings of inferior myocardial infarction and the false positive group was composed of 54 cases which had no significant narrowing of coronary arteries.

Vectorcardiographic parameters such as the angle between the X axis and maximal QRS vector, the duration of initial superior force, the maximal superior deviation (QY) and the maximal inferior deviation (RY) were analyzed and only QY and QY/RY showed statistically significant differences between the 2 groups. Of these two parameters, QY/RY indicated a more definite difference. In addition, the rate of false positive cases was reduced prominently if the criterion of QY/RY above or equal to 0.2 was added to the criteria of Young et al. The direction of the maximal T vector was downward in 2 cases (11%) in the inferior myocardial infarction group, but downward in 44 cases (81%) in the false positive group.

Additional Indexing Words:

Vectorcardiogram Inferior myocardial infarction Left ventriculogram
Young's criteria Maximal superior deviation
and maximal inferior deviation Direction of maximal T vector

A number of vectorcardiographic (VCG) criteria have been used for the diagnosis of inferior myocardial infarction.¹⁾⁻³⁾ While these criteria are generally considered to be more sensitive than conventional electrocardio-

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Received for publication December 18, 1981.

graphic criteria, it is not uncommon to encounter false positive cases in which, despite a positive VCG pattern, neither the clinical history nor angiographic examination reveals an infarction. In the present study attempts were made to define more specific VCG criteria by comparing the VCG patterns between patients with and without definitive inferior myocardial infarction, diagnosed on the basis of coronary arteriography, left ventriculography and one of the most popular VCG criteria.

SUBJECTS AND METHODS

Two groups of patients were selected from 1,000 consecutive cases who underwent both selective coronary arteriography and left ventriculography. Group A was composed of 18 patients (15 male and 3 female; mean age 50.2) and represents a positive inferior myocardial infarction group. The criteria for selecting this group were:

- 1) Either the right coronary artery (RCA) or the left circumflex artery (LCX) had a narrowing of more than 75%;
- 2) Neither the left main trunk (LMT) nor the left anterior descending artery (LAD) showed a narrowing of more than 50%;
- 3) The left ventricle showed akinesis⁴⁾ in its inferior segment in right anterior oblique (RAO) ventriculography;
- 4) The vectorcardiographic criteria for the diagnosis of inferior myocardial infarction of Young et al²⁾ were fulfilled.

Group B, a "false positive" group, included 54 patients (37 male and 17 female; mean age 51.2) and was composed of 16 cases with left ventricular hypertrophy on the left ventriculogram (as defined below), 9 cases with congenital or valvular heart diseases, 6 cases with congestive cardiomyopathy and 23 cases with no abnormal angiographic findings. This group was selected according to the following criteria:

- 1) None of the major coronary arteries had luminal narrowings of greater than 50%;
- 2) No local asynergies were seen on the RAO left ventriculogram;
- 3) Satisfied criterion 4) for group A.

Cases with prominent deformities of the thorax or with a maximal QRS vector in the frontal plane directed upward were excluded from the present study.

Vectorcardiograms were recorded using the Frank lead system on the day before the angiographic study. The angle formed by the X axis and the maximal QRS vector in the frontal plane (F° of maximal QRS) were measured in the QRS loop (Fig. 1). In addition, the direction of maximal T vector was analyzed. The duration of the initial superior force (duration of QY), left-

Fig. 1. Measurement of vectorcardiographic parameters. LDSF=leftward deviation of superior force; RY=maximal inferior deviation; QY=maximal superior deviation; Duration of QY=duration of initial superior force; F° of maximal QRS=the angle formed by the X axis and the maximal QRS vector in the frontal plane.

Fig. 2. Measurement of left ventricular thickness in right anterior oblique left ventriculography.

ward deviation of superior force (LDSF), maximal superior deviation (QY), and maximal inferior deviation (RY) were measured from the scalar XYZ leads, recorded at a paper speed of 10 cm/sec (Fig. 1). Leftward and downward deflections were expressed as positive in this study.

Left ventriculography was performed in the 30° RAO projection after the administration of nitroglycerin and was recorded at 30 frames per second using 35 mm cine film (Kodak CFS or CFX). Left ventricular asynergies were analyzed qualitatively and classified into hypokinesis, akinesis, and dyskinesis.⁴⁾ Left ventricular hypertrophy was defined as a free wall thickness of greater than 12 mm at the apical one-third of the wall (Fig. 2). The ejection fraction was calculated by Greene's method,⁵⁾ and was defined as reduced when less than 0.60. Statistical analyses were performed with either Student's *t*-test or the chi-square test.

RESULTS

The VCG parameters obtained from groups A and B are summarized in Table I. Of these parameters, only QY and QY/RY showed a statistically significant difference between the 2 groups. Thus these 2 parameters were significantly lower in group B than in group A. Fig. 3 shows the QY/RY values from individual cases in each group. As illustrated in the figure, 16 out of 18 cases in group A showed a QY/RY ratio greater than or equal to 0.2, while, in group B, the value remained below 0.2 in 63% of the cases. The

Table I. Summary of All Vectorcardiographic Parameters in Both Groups

	Duration of QY (msec) mean $\pm$ SD	LDSF (mV) mean $\pm$ SD	QY (mV) mean $\pm$ SD	QY/RY mean $\pm$ SD	LDSF/RY mean $\pm$ SD	F° of maximal QRS (°) mean $\pm$ SD
True Positive 18 cases	31.6 $\pm$ 6.7	0.92 $\pm$ 0.60	0.24 $\pm$ 0.18	0.53 $\pm$ 0.37	2.37 $\pm$ 1.78	23.6 $\pm$ 22.0
False Positive 54 cases	28.0 $\pm$ 5.2	0.73 $\pm$ 0.39	0.11 $\pm$ 0.06	0.20 $\pm$ 0.16	1.50 $\pm$ 1.17	27.5 $\pm$ 24.1
	p > 0.05	p > 0.05	p < 0.01	p < 0.01	p > 0.05	p > 0.05

QY and QY/RY differ statistically between the 2 groups.

Fig. 3. QY/RY of individual cases in each group.

value of QY (Fig. 4) in both groups showed much greater individual variability and it was impossible to separate the 2 groups arbitrarily. Table II summarizes the direction of the maximal T vector in both groups. The maximal T vector was negative (upward) in 16 of 18 group A patients (89%), while 44 of 54 group B patients (81%) showed a positive (downward) T vector. This difference is significant ($\chi^2=26$, $p<0.001$).

DISCUSSION

It is generally accepted that VCG is superior to conventional 12 lead

Fig. 4. QY of individual cases in each group.

Table II. Direction of Maximal T Vector

	Cases	Upward or horizontal	Downward
True Positive	18	16	2
False Positive	54	10	44

Ten patients are falsely defined as having an infarction and 2 cases with infarctions are diagnosed as having no infarction.

ECG for the diagnosis of inferior myocardial infarction because the initial stage of ventricular activation can be analyzed more accurately with the former method. In particular, the criteria of Young et al²⁾ are based on the VCG patterns from 100 clinically evident inferior myocardial infarction patients and 315 healthy individuals, and are considered to have both high sensitivity and sufficient specificity for diagnosis of inferior myocardial infarctions. In our patients, the criteria gave rise to a false positive rate of 5.4%. When one adopts the criterion of a QY/RV ratio greater than or equal to 0.2 in combination with Young's criteria, the false positive rate is reduced to 2.0% (20/1,000) without significantly affecting the sensitivity. This is consistent with previous studies^{3),4)} in which the QY/RV criterion has been found to be useful in the diagnosis of inferior myocardial infarction. In addition, more recent studies have reported that QY/RV has been of value in estimating the infarcted area quantitatively.⁷⁾ This has been based on a reasonable assumption that the larger the infarcted area in the inferior wall, the larger the loss of electromotive force, which in turn elevates the QY/RV ratio.

The greater sensitivity and specificity of QY/RV in the diagnosis of inferior myocardial infarction in the present study than in previous reports may be due, in part, to the patient selection process. We restricted the group A to patients having both akinesis on the left ventriculogram and a significant narrowing in either RCA or LCX. Thus, those having hypokinesis of the inferior wall or a concomitant lesion in LAD or LMT have been excluded. It is quite possible that the latter group of patients has a smaller QY/RV ratio than the group A patients, because the loss of electromotive force in the inferior wall would probably be less in cases with hypokinesis than with akinesis. In addition, it might be cancelled by a concomitant loss of electromotive force in the anterolateral segments, which may be associated with a LAD or LMT lesion. Hence, it is important to examine the possibility that relative electrical changes in other segments of the ventricle contribute to an apparently small QY/RV value.

In addition to the QY/RV ratio, our study indicates that the direction of the maximal T vector can assist in the diagnosis of inferior myocardial infarction (Table II). With this criterion (upward or horizontal direction of maximal T vector), only 10 patients were falsely defined as having an infarction, resulting in a significant reduction of the false positive rate. The sensitivity of this criterion was as high as the QY/RV ratio, since only 2 cases with an infarction were diagnosed as having no infarction.

Finally, although it has generally been recognized that some patients with cardiomyopathy, left ventricular hypertrophy or cor pulmonale may show ECG or VCG patterns similar to those seen in anterior myocardial in-

farction, there is little documentation of non-ischemic patients who show VCG patterns compatible with inferior myocardial infarction. In the present series of patients, 31 of 54 false positive cases had a hypertrophic or an enlarged left ventricle due to valvular disorders, congenital heart diseases or cardiomyopathy. It appears possible that the pseudo-infarction pattern in these patients may be a reflection of increased electromotive force in the anterolateral wall of the left ventricle.

REFERENCES

1. Hugenholtz PG, Forkner CE Jr, Levine HD: A clinical appraisal of the vectorcardiogram in myocardial infarction. II. The Frank system. *Circulation* **24**: 825, 1961
2. Young E, Williams C: The frontal plane vectorcardiogram in old inferior myocardial infarction. *Circulation* **37**: 604, 1968
3. Starr JW, Wagner GS, Behar VS, Walston AI, Greenfield J Jr: Vectorcardiographic criteria for the diagnosis of inferior myocardial infarction. *Circulation* **49**: 829, 1974
4. Hermann MV, Heinle RA, Klein MD, Gorlin R: Localized disorders in myocardial contraction: asynergy and its role in congestive heart failure. *New Engl J Med* **277**: 222, 1967
5. Greene DG, Carlisle R, Grant C, Bunnell IL: Estimation of left ventricular volume by one-plane cineangiography. *Circulation* **35**: 61, 1967
6. Toutouzas P, Avgoustakis D, Koroxenides G, Athanassiou V: The electrocardiogram and vectorcardiogram in the diagnosis of the old inferior myocardial infarction. *J Electrocardiol* **6**: 319, 1973
7. Zacharoulis A, Toutouzas P, Petropoulos D, Tsitouris G, Avgoustakis D: Extent of inferior myocardial infarction assessed by the frontal plane of the vectorcardiogram. *Acta Cardiologica* **33**: 279, 1978