The Influence of Q-wave Acute Anteroseptal Myocardial Infarction on the Voltage Criteria for Left Ventricular Hypertrophy

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Abstract

The influence of Q wave acute anteroseptal myocardial infarction (MI) on the sensitivity of the voltage electrocardiographic criteria of left ventricular hypertrophy (LVH) was assessed in this study. Patients with Q wave acute anteroseptal myocardial infarction but without echocardiographic (echo) LVH, showed augmentation of QS deflections in leads V1 and / or V2 , and of R waves in V6. Utilization of the criteria RI > 1.3mV, R aVL >1.1 mV and SV1 + RV5 / RV6 ≥ 3.5 mV resulted in 30% false positive voltage criteria of LVH. However, compared to age and sex dependent normal limits, the voltages of RI and R aVL were not augmented by acute Q wave acute anteroseptal MI. These results inevitably influence the accuracy of the standard electrocardiographic (ECG) criteria for the diagnosis of LVH and therefore there is a need to consider whether or not they should be used alone or as a part of a point scoring system.

1. Introduction

It is well recognized that there are numerous physiological and pathological factors that affect the ECG criteria of left ventricular hypertrophy (LVH) [1]. In 1960, Allenstein and Mori evaluated the ECG criteria that had been introduced for the diagnosis of LVH and they found that the literature at that time included over 30 ECG criteria [2]. However, in clinical practice, the voltage criteria are the most commonly used despite evidence that voltage ECG-LVH criteria are influenced by many factors that might commonly co-exist with LVH. A possible factor that might influence QRS voltages is the simultaneous presence of myocardial infarction (MI) and LVH. It is well known that MI affects the QRS voltages by either decreasing the amplitude of the R waves or through development of new Q waves [3]. Furthermore, Murphy et al [4] demonstrated that MI increased the sensitivity of ECG - LVH criteria. Theoretically, it is possible that deep QS deflections of anteroseptal MI might lead to potentiation of the amplitudes of R waves in leads V5 and/or V6 due to the lack of the cancellation of the oppositely directed electrical forces and thereby may produce false positive precordial voltage criteria of LVH. This study was designed to assess the influence of Q wave acute anteroseptal MI, in the absence of echo LVH, on the commonly used precordial and limb lead voltage criteria.

2. Methods

This study included patients with acute MI who were admitted to our coronary care unit and who exhibited QS deflections in the leads V1 and V2 (with or without additional Q waves in other precordial leads) but who had normal left ventricular mass (LVM) on echocardiography. Exclusion criteria included hypertrophic obstructive cardiomyopathy, bundle branch block, pericardial disease, kyphoscoliosis or emphysema. The diagnosis of acute MI was made retrospectively according to the W.H.O. criteria based on serial ECG and cardiac enzymes on three consecutive days [5].

3. Electrocardiography

The ECGs were recorded on a Siemens Mingorec 4 or by a computer compatible electrocardiograph designed locally [6]. The amplitudes of the QRS voltages were measured by a computer program described elsewhere [7]. All the amplitudes were also checked manually and were compared to age and sex dependent normal limits that were derived from an earlier study in our department [8]. The ECG analysis included:

1. Comparison of the voltages of R waves in leads I, aVL, V5, and V6 along with the amplitudes of S wave in leads V1, V2 with the age and sex dependent normal upper limits [8] as shown in table 1.
2. The sensitivity of the voltage criteria of LVH including RI > 1.3mV [9], RaVL >1.1 mV [10] and the Sokolow-Lyon precordial index ; SV1 + RV5 or RV6 ≥ 3.5 mV [10].

4. Echocardiography

The echocardiographic examinations were undertaken with a Diasonics 3400 Cardiovue phased imaging system as described in a previous study [11]. The M-mode echo dimensions of the left ventricle (LV) were used to calculate left ventricular masses (LVM) according to the Penn convention [12] and were indexed to body surface area (BSA) according to the formula of DuBois and DuBois [13]. Patients were defined as having echo LVH when echo LVM indexed to BSA > 131 g/m^2 in men and > 109g/m^2 in women [14]. In addition to these echocardiographic measurements, anteroseptal akinesia was confirmed in all patients.

Table 1: Age and sex dependent upper normal voltages in millivolts (mV) used for comparison in this study (8) .

Age (years)	Sex	RI	RaVL	SV1/SV2	RV5/RV6
17-29	male	1.5	1.1	4.0	4.0
	female	1.5	0.9	3.5	2.4
30-39	male	1.6	1.2	3.5	3.0
	female	1.4	1.0	3.0	2.2
40-49	male	1.6	1.3	2.5	2.5
	female	1.4	1.2	2.5	2.2
>50	male	1.6	1.3	2.0	2.5
	female	1.4	1.2	2.0	2.2

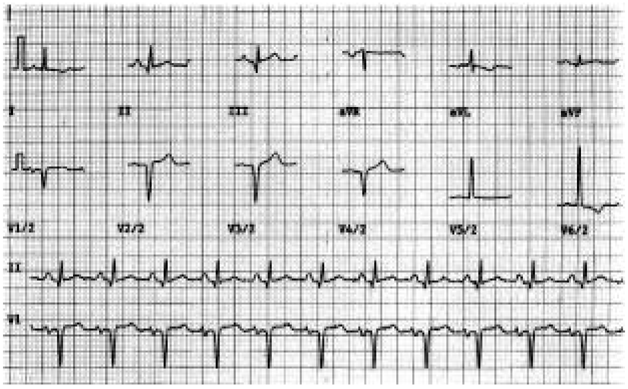

Figure 1. An electrocardiogram of a *58* year old man with an acute Q wave anteroseptal myocardial infarction and normal echocardiographic mass index (101 g/m^2). It shows false positive Sokolow-Lyon precordial criterion (SV1 + RV5/RV6 $\geq$ 3.5 mV).

5. Results

13 consecutive patients with Q wave acute anteroseptal MI and normal echo LVM were recruited to the study. They included 8 men and 5 women with a mean age of 53.4 $\pm$ 8.6 years (range of 36-66 years). Their mean echo LVM indexed to BSA was 100.6 $\pm$ 21.5 g/m^2 with a range of 58-127g/m^2. The results are shown in Table 2 and summarized as follows:

a. 4/13(30%) of the patients showed deep QS deflections in leads V1 and/or V2 beyond the age and sex dependent upper limits of normal, and 1/13 (7.5%) patient had a tall R wave in lead V6. This phenomenon resulted in false positive Sokolow-Lyon precordial voltages SV1 + RV5 / RV6 $\geq$ 3.5 mV in 2/13 (15%) of the patients. Figure 1 shows a tall R wave in lead V6 in a patient with acute anteroseptal MI with echo LVM of 101 g/m^2 who had proven acute anteroseptal MI. His ECG showed false positive Sokolow-Lyon precordial criteria of LVH.
b. One patient showed R I > 1.3 mV and one other had R aVL > 1.1 mV
c. No patient showed augmentation of the R waves in leads I and aVL above the age and sex dependent upper normal limits.

Table 2. Electrocardiographic voltage findings in 13 patients with Q wave anteroseptal myocardial infarction

Voltage criteria for diagnosis of LVH	Number of patients (%)
SV1 + RV5 or RV6 > 3.5 mV [10]	2/13 (15%)
RI > 1.3 mV ([10]	1/13 (7.5%)
R aVL > 1.1 mV [9]	1/13 (7.5%)
Voltages augmented beyond age and sex dependent normal limits	
QS in V1 and / or V2	4/13 (30%)
RV6	1/13 (7.5%)

6. Discussion

The diagnosis of ECG-LVH inherently has many limitations, one of which is the coexistence of MI which may adversely affect the predictive value of the ECG-LVH criteria. Murphy et al [4] reported that MI in general increases sensitivity but decreases the specificity of the ECG-LVH criteria. Our study clearly shows that Q wave acute anteroseptal MI results in potentiation of the precordial voltages. As mentioned earlier, theoretically it is possible that QS deflections of anteroseptal MI might produce tall R waves in leads V5 and/orV6 but the latter was observed only in 1/13 (7.6%) of the patients studied while 4/13 (30%) of patients exhibited potentiation of S waves in leads V1 and/or V2 greater than the age and sex dependent upper limits of normal. The reasons for greater potentiation of S waves in right precordial leads than R deflections in the left precordial leads remain unclear. However, the fact that 2/13 (15%) of the patients showed SV1+ RV5 / RV6 $\geq$ 3.5 mV indicates that the augmentation of the precordial voltages by Q wave anteroseptal MI is expressed variably as deep QS in leads V1 or V2, and as a tall R in lead V6. However, we did not observe augmentation of the R waves in leads I or aVL beyond our age and sex dependent normal upper limits. Furthermore, the criteria R I > 1.3 mV [9] and R aVL > 1.1 mV [10] were positive in 2/13 (15%) of the patients. This also confirms that these criteria, without adjustment for age and sex, have their limitations and may produce false positive voltage ECG-LVH criteria. In total, if the voltages were not age and sex adjusted, there would have been 4/13 (30%) false positive voltage ECG-LVH criteria. The latter result confirms the finding of Murphy et al [4] that MI increases the sensitivity for ECG-LVH.

This study has some limitations. Firstly, the number of the patients recruited was small but it was obvious that Q wave acute anteroseptal MI potentiated voltages which if not adjusted for age and sex, resulted in false positive LVH criteria. For this reason, we were satisfied with the number of the patients. Secondly, it is arguable that M-mode echo dimensions and estimated LVM may not be reliable in the presence of MI due to altered LV geometry. However, Woythaler et al [15] reported that M-mode derived echo LVM correlated better with autopsy LVM in comparison with 2D echo derived LVM. For the latter reason, we utilized M-mode derived echo. In conclusion, this study shows that Q wave acute anteroseptal MI may potentiate precordial voltages and in particular SV1/SV2 which may contribute to false positive Sokolow-Lyon criteria. Furthermore, utilization of the limb lead voltage criteria such as R I > 1.3 mV [9] and R aVL > 1.1 mV [10] are also unreliable in the presence of Q wave acute anteroseptal MI as they were falsely positive in 15% of the patients. However, Q wave acute anteroseptal MI did not potentiate the R wave amplitudes in the leads I and aVL beyond age and sex dependent upper normal limits.

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