Electrocardiograph Voltage in Fit Young Men

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ABSTRACT: Several criteria exist for the diagnosis for left ventricular hypertrophy as shown by high voltage on the electrocardiograph. This study of 200 healthy young recruits to the Royal Artillery with normal blood pressure and normal left ventricular wall thickness as measured by electrocardiography shows that no matter which criteria are used the false positive rate is approximately 25%. High voltage is a normal phenomenon in young men and its use as a predictor of left ventricular hypertrophy is likely to be misleading in this age group.

Introduction

The most commonly used method of determining left ventricular hypertrophy (LVH) from electrocardiographic voltage is that of Sokolow and Lyon¹ whereby LVH is said to be present if the sum of the S wave voltage in lead V₁ plus the R wave voltage in V₅ or V₆ (whichever is the larger) is greater than 35 millivolts. Murphy et al² found a false positive rate of 2% by this method in a study of 48 cardiologically normal autopsies of mean age 54 years. Grant³ modified this original system by suggesting that the voltage of the deeper S wave of V₁ or V₂ be added to that of the taller R wave of V₅ or V₆. Grubschmidt and Sokolow⁴ recognised that in young people these criteria would have to be modified and

suggested the upper limit of normal should be raised from 35 millivolts to 40 millivolts in the age group 20-30 years. In 1964, Manning and Smiley⁵ studied young Canadian airmen and recommended that this figure be increased to 53 millivolts. Romhilt and Estes⁶ introduced a points system which included parameters other than voltage, and this was later modified by Murphy⁸ (Table 1).

In the army, easily controlled hypertension does not result in medical downgrading unless there is evidence of end-organ pathology. The inference of LVH from voltage criteria is therefore important in the management of young hypertensives in the army.

Table 1:
Modified Romhilt Estes System⁸

1.	SV ₁ + RV ₅ or RV ₆ > 35 mm	= 3 points
2.	Left axis deviation -30°	= 2 points
3.	QRS duration > 0.09 seconds	= 1 point
4.	T wave inversion in V ₆ > 1 mm	= 3 points
5.	Left atrial abnormality	= 3 points
6.	Intrinsicoid deflection in V ₅ or V ₆ > 0.05 seconds	= 3 points

A total of 4 or more indicates left ventricular hypertrophy.

Figure 1: Sum of Voltages according to Sokolow ($SV_1 + RV_5$ or RV_6)

Figure 2: Sum of Voltages according to Grant (SV₁ or SV₂ + RV₅ or RV₆)

Table 2:
Voltage criteria for left ventricular hypertrophy

	no of patients	percentage
$SV_1 + (RV_5 \text{ or } RV_6) > 35 \text{ mm}^1$	48	24
$(SV_1 \text{ or } SV_2) + (RV_5 \text{ or } RV_6) > 40 \text{ mm}^2$	58	29
fulfilling either criterion	64	32
fulfilling both criteria	42	21

1. Sokolow criteria
2. Grant criteria

Subjects and Methods

Two hundred consecutive recruits to the Royal Artillery of mean age 19 years (range 17–25 years) had clinical, electrocardiographic and echocardiographic examinations. All were normotensive, having a systolic blood pressure of less than 145 and a diastolic blood pressure of less than 90 millimeters of mercury when taken with a standard mercury sphygmomanometer. All fulfilled the criteria for enlistment as defined by the Joint Services Pulheems Classification System⁹. Twelve lead electrocardiographs were recorded, in semi-recumbent position, on Hewlett Packard Page Writer equipment (frequency response 0.05–100 Hertz) at 25 millimeters per second paper speed with standard calibration of 1 millimeter per millivolt. Both M-mode and two dimensional echocardiography were carried out using the Hewlett Packard 77020A Ultrasound Imaging System. Thickness of both the interventricular septum and the left ventricular posterior wall was measured, in diastole, on an axis through the chordae tendineae of both mitral cusps. In all cases septal thickness was less than 12 millimeters and posterior wall thickness less than 10 millimeters.

Results

The spectrum of QRS voltage by the Sokolow, and by the Grant method is shown in Figures 1 and 2 respectively. Twenty-four percent fulfilled the Sokolow and 29% the Grant criteria for left ventricular hypertrophy (Table 2), but none satisfied the criteria of the Romhilt Estes system.

Discussion

This study demonstrates that if a single criterion of LVH in the form of high QRS voltage is applied to a young normal population there will be a high incidence of false positive results. In Murphy's study² the upper 97.5 percentile of 33 millivolts is significantly lower than

the 45.4 millivolts found in this study. Even if the Sokolow modification for young people of 40 millivolts is applied, there is still a significant number of false positives. Our figures correspond closely to those of Manning and Smiley⁴ who recorded a mean QRS voltage of 29.6 millivolts with the 97.5 percentile at 46.2 millivolts. The modified Romhilt Estes system⁸ showed no false positives but it is cumbersome and involves more parameters than voltage. The concept that electrocardiographic voltage by itself is an indicator of LVH should be abandoned in our young military population.

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