ORIGINAL ARTICLE

Diagnostic Accuracy of Electrocardiography in Diagnosis of Left Ventricular Hypertrophy

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ABSTRACT

Objective: To determine diagnostic accuracy (in terms of sensitivity, specificity, positive predictive value and negative predictive value) of electrocardiography for left ventricular hypertrophy (LVH).

Study Design: Cross sectional validation type.

Place and Duration of Study: Pakistan Institute of Medical Sciences (PIMS) from 1st January 2013 to 30th June 2013.

Materials and Methods: A cross-sectional study was conducted at department of cardiology. Two hundred and fifty hypertensive patients, both male and female were included in the study. The data was collected by non-probability, purposive sampling. A performa was filled indicating their bio-data, history and clinical examination. All the patients were then subjected to 12 lead electrocardiogram (ECG) and echocardiography to detect LVH. Sokolow Lyon product index and Cornell product index was calculated on ECG to detect LVH. Data was analysed using SPSS 11.

Results: Out of 250 hypertensive patients, a total of 110 (44%) patients had LVH by echocardiography Out of these 110 patients, 60 (54.5%) patients had both positive Sokolow Lyon and Cornell product indices and 50 (45.5%) had negative both Sokolow Lyon and Cornell product indices. The calculated sensitivity, specificity, positive predictive value, negative predictive value and overall diagnostic accuracy of combined Sokolow Lyon and Cornell product indices were 54.5%, 97.9%, 95.2%, 73.3% and 78.8% respectively.

Conclusion: The ECG criteria of combined Sokolow Lyon and Cornell product indices had a high specificity and PPV for the detection of left ventricular hypertrophy using echocardiography as a gold standard. However ECG has low sensitivity and NPV for LVH and hence is not a reliable screening tool for detection of LVH.

Keywords: *Hypertension, left ventricular hypertrophy, Electrocardiography, Echocardiography, Sokolow Lyon product index, Cornell product index.*

Introduction

Various studies have shown that left ventricular hypertrophy is surely an important possibility factor in individuals having hypertension, resulting in a new fivefold to 10-fold increased throughout cardiovascular events,[1] which is similar to the increase seen in patients with a history of myocardial infarction.[2] Among hypertensive patients the prevalence of LVH is 59%.[3] Left ventricular hypertrophy (LVH) is a strong independent risk factor of cardiovascular morbidity and death.[4] Adverse cardiovascular events have been reduced by reduction of LVH.[5] Accurate and also early analysis regarding remaining ventricular hypertrophy will be for that reason a vital portion of attention regarding people along with hypertension. Two commonly used modalities to diagnose left ventricular hypertrophy are echocardiography and electrocardiogram. The diagnostic sensitivity of ECG is increased with the increased cardiac mass.[6] The

sensitivity of echocardiography for the prediction of anatomical LVH (93%) exceeded that of ECG (54%), while both methods had a high specificity (97%).[7] The sensitivity of various ECG criteria is low (usually below 50%), while the specificity is reasonably high (often in the variety of 85% to help 90%).[8] Electrocardiography can be used as an alternative tool for diagnosis of left ventricular hypertrophy in patients where facilities of echocardiography are not available. The actual composite of various ECG criteria's may be a practical technique to increase the diagnostic power regarding ECG. The actual mixtures with the Cornell product using the Sokolow voltage as well as using the Sokolow product seem to be by far the most effective options. The actual proportion regarding people having LVH in numerous reports discovered simply by Cornell product has been 27. 3% as well as 23. 6% simply by Sokolow-Lyon product, along with combined Cornell as well as Sokolow-Lyon products arrived at 39. 3%.[9] The actual specificities regarding cornell product or service as well as sokolow lyon product or service tend to be 92% as well as 89% for LVH.[10] This research was planned to determine the diagnostic accuracy of combination of Sokolow-Lyon product with Cornell

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product criteria's of ECG for LVH keeping echocardiography as the gold standard and to determine that can ECG be used as a diagnostic modality for assessing LVH in areas where echocardiography may not be available.

Materials and Methods

Our target population was hypertensive patients registered in OPD and Admitted in Cardiology unit, PIMS from 1st January till 30th June 2013. Keeping the prevalence of LVH among hypertensive as 59%, confidence interval at 95% and level of significance at 8%, the calculated sample size by WHO calculator was 250 patients with hypertension. Age above 18 years of either gender with hypertension of any duration was included. Hypertensive Patients with aortic stenosis, hypertrophic obstructive cardiomyopathy, prior myocardial infarction left ventricular aneurysm, atrial fibrillation, right and left bundle branch block, pacemaker, pleural effusion and ascites were excluded. An informed written consent was taken from each patient. A performa was filled indicating their bio-data, history and clinical examination. All the patients were then subjected to a 12 lead electrocardiogram (ECG) and 2.5MHz probe of Toshiba machine of echocardiography to detect LVH. Sokolow Lyon product index and Cornell product index was calculated on ECG to detect LVH.Overall diagnostic accuracy of combined Sokolow-
Lyon and Cornell product was calculated using SPSS 11.0.

LVH on echocardiography

Left ventricular mass (LVM) would be calculated by using Devereux's anatomically validated formula. Diagnostic criteria for LVH for male >108g/m2 and for female >100g/m2.

$LVM = 1.04[(LVIDd + IVS + LVPWT) 3 - (LVIDd) 3 - 13.6$

LVH on ECG

(Cornell product and Sokolow Lyon product criteria's would be used)

12 lead electrocardiography with standard voltage and speed of 10mm/mv and 25 mm/sec respectively.

Cornell product criteria[11] SV3 + RaVL (+8 in women) × QRS duration ($\geq$ 2,440 mm × ms value diagnostic for LVH)

Sokolow-Lyon products [(SV1 + RV5 or RV6) × QRS duration] $\geq$ 2940 mm·ms value diagnostic for LVH).

Diagnostic accuracy

True positive: If the results of ECG (positive or negative) would be in accordance with the echocardiography findings, the result would be considered as a true positive.

Sensitivity: The ability of the ECG to detect individuals with LVH.

Specificity: The probability that an individual who does not have LVH is labelled as negative by ECG.

Positive predictive value (PPV): The probability that a person has LVH given that the ECG is positive.

Negative predictive value (NPV): The probability that a person does not have LVH given that the ECG is negative.

Results

Our study included 250 patients with hypertension. The age of the patients ranged from 18 to 78 years. The mean age of the patients was 50.02±13.07 years. Among the study group 102 (40.8%) were male and 148 (59.2%) were female patients. Out of 250 hypertensive patients, a total of 110 (44%) patients had LVH by echocardiogram. Among the 110 patients with LVH on echocardiography 60 (54.5%, ie true positive) had both positive Sokolow Lyon and Cornell product indices and 50 (45.5%, i.e false negative) had negative both Sokolow Lyon and Cornell product indices. Among the 140 patients with no LVH on echocardiography, 3 (2.1%, i.e false positive) had both positive Sokolow Lyon and Cornell product indices and 137 (97.9%, i.e true negative) had negative both Sokolow Lyon and Cornell product indices. The calculated sensitivity, specificity, PPV and NPV of both Sokolow Lyon and Cornell product indices were 54.5%, 97.9%, 95.2% and 73.3% respectively.

The overall diagnostic accuracy of combined Sokolow Lyon product and Cornell product indices was 78.8%.

Discussion

We conducted this study to determine diagnostic accuracy of combination of Sokolow Lyon product index and Cornell product index and the results suggested a high specificity. However ECG has low sensitivity and NPV for LVH and hence is not a reliable screening tool for detection of LVH. The appropriate diagnostic work-up of suspected left ventricular hypertrophy in patients with hypertension is less

Table I: Diagnostic Accuracy (sensitivity, specificity, PPV, NPV) of combined Sokolow Lyon and Cornell product indices in the diagnosis of LVH taking echocardiograms as gold standard

	Patients with LVH (as confirmed on echocardiography)		
	Positive Echo	Negative Echo	
ECG (Sokolow Lyon product and Cornell voltage product) Positive ECG	TP (60)	FP (3)	PPV= TP / (TP + FP) =60/63 =95.2%
Negative ECG	FN (50)	TN (137)	NPV=TN/ (TN+FN) =137/187 =73.3%
	Sensitivity = TP / (TP + FN) = 60/110 = 54.5%	Specificity = TN / (FP + TN) = 137/140 =97.9%	Diagnostic accuracy = TP + TN × 100 TP+TN+FP+FN = 60+137 × 100 60+137+3+50 = 78.8%

clear, however.[12] In the study by Crow et al[13] correlations between ECG and echocardiographic LV mass index were modest (<0.40). ECG-LV hypertrophy sensitivity at 95% specificity was < 34%. Our study also showed that ECG in diagnosing LVH is less sensitive in comparison to echocardiogram. In the study Waqas Hameed et al[14], comparison between ECG and echocardiogram using Romhilt-Estes score point for diagnosis of LVH reveal that this criteria has 35% sensitivity and 90% specificity and suggested that sensitivity of ECG is low in detecting LVH, however, sensitivity can be improved by combining Sokolow Lyons voltage and Cornell voltage criteria with Romhilt-Estes point score. Whereas in this study combination of sokolow lyon and cornell product do not improve the diagnostic efficacy of ECG for LVH. The sensitivity and specificity of these criteria vary widely depending upon the populations studied, the "gold standard" employed (echocardiographic or magnetic resonance imaging LV mass versus necropsy measurements), and the severity of LVH. Overall, conservative estimates of the sensitivity of the various criteria for moderate to severe LVH is in the 30 to 60 percent range, with specificities in the 80 to 90 percent range.[15] Molloy et al.[16] Suggested that the simple product of voltage and QRS duration is useful to identify LVH more accurately than voltage criteria alone. Keeping these results in view combination of products of both ECG criteria's have been used rather than alone voltage based criteria's in our study and not successful to enhance the overall diagnostic accuracy of ECG for LVH.

Domingos et al [17] compared the efficaciousness of four electrocardiographic criteria: Sokolow, Gubner, Cornell as well as Romhilt, in the particular diagnosis involving left ventricular hypertrophy (LVH) within hypertensive sufferers. Among these 4 criteria's, the Sokolow index with a sensitivity of 40%, diagnostic accuracy of 50% and specificity of 100% was the most accurate than rest of the three abovementioned criterias. When at least one of the indices was positive, the sensitivity was 52% and diagnostic accuracy was 57%. Our study also proved that sensitivity of sokolow product is greater than the cornell product in detection of LVH. Calderón A et al[9] assessed the efficacy of composite form of Cornell product with the Sokolow voltage or with the Sokolow product in detection of LVH, revealed the sensitivities of 27.3% by Cornell product and 23.6% by Sokolow-Lyon product in LVH detection whereas the sensitivity of composite form reached 39.3%. The specificities of cornell product and sokolow lyon product are 92% and 89% for LVH. Whereas our study results do not show an improvement in sensitivity of ECG criteria when use in same composite form. Further research is necessary to evaluate the cost effectiveness of different diagnostic strategies and to create alternative diagnostic technologies for assessment of left ventricular hypertrophy.

Conclusion

The ECG criteria of combined Sokolow Lyon and Cornell product indices has a high specificity and PPV for the diagnosis of left ventricular hypertrophy keeping echocardiography as the gold standard. However these composite criteria have low sensitivity and hence are not reliable screening tools for detection of LVH.

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