Original Article

CORNELL PRODUCT INDEX FOR LEFT VENTRICULAR HYPERTROPHY. DOES IT PERFORM BETTER?

HABIB-UR-RAHMAN QADRI[1†], HAKIM ALI ABRO[2], SAEED AHMED SANGI[3], NAHEED SHAIKH[4], SHABANA LAKHO[4], SHEERAZ BURIRO[4]

ABSTRACT

Objective: To determine the sensitivity and specificity of cornell product index for left ventricualr hypertrophy with reference to echocardiography.

Design: Descriptive study.

Setting: Medical Unit III, Jinnah Post-graduate Medical Centre Karachi.

Duration: June 1998- February 1999.

Methods: 50 patients with echocardiographic left ventricular hypertrophy (LVH) and 25 normal healthy persons without echocardiographic LVH were included in this study. All patients and control subjects were examined clinically and their ECGs were taken on that same day. Echo LVH was defined if Left Ventricular Mass Index exceeded 118 g/m2 in males and 104 g/m2 in females. Data was preserved and now it is analyzed for Electrocardiographic LVH in view of cornell voltage and cornell product index. Sensitivity and specificity was calculated by standard formula and P value derived by chi square test.

Results: 50 patients which were included in the study, 21(42%) were male and 29 (58%) were females; while 25 healthy persons without LVH, 12 (48%) were males and 13 (52%) were females. Cornell voltage criterion was having sensitivity of 48% as over-all, 48% in males and also 48% in females. It was 96% specific. Cornell product index was the higher sensitive criteria by scoringing 57% in males, 62% in females and 60% in all patients.

Conclusion: Although electrocardiography is less sensitive than echocardiography, but can perform better in certain groups and with improved criterion. Cornell product criterion has the highest sensitivity as compared to other criteria.

Key Words: Left – Ventricular – hypertrophy – Electrocardiography – Echocardiography – Sensitivity – Specificity – Criteria – Cornell product – cornell product index.

INTRODUCTION

The normal human heart weighs 280-340 (average 300) grams in males and from 230-280 (average 250) grams in females during adult life[1], out of which left ventricle is 200 grams. In abnormal condition heart may become enlarged resulting in hypertrophy. Left ventricular hypertrophy (LVH) is the manifestation of reserve mechanism of the heart resulting form adaptation to acute or chronic, pressure or volume overload to left ventricle.[2] LVH may be useful in early stage but is deleterious as the time passes and discrepancy between muscle mass and nutritional supply arises.[2,3] Hypertension is more common cause of LVH[4] as compared to other causes e.g. Mitral regurgitation, Aortic Stenosis or regurgitation, Cardiomyopathies etc. Hypertension is more common in blacks.[5] Hypertension is closely related to obesity and both have been involved in coronary artery

1 *Assistant Professor Medicine Medical Unit-III Chandka Medical College, Larkana*

2 *Associate Professor Medicine Medical Unit-III Chandka Medical College Larkana*

3 *Professor of Cardiology Chandka Medical College Larkana*

4 *Post Graduate Student Medical Unit-III CMC Larkana*

† ***Correspondence***
Dr. Habib-ur-Rahman Qadri
Assistant Professor Medical Unit-III
CMC, Teaching Hospital Larkana
Email: drhrqadri@yahoo.com

disease (CAD) and cardiovascular death.[4,6,7] Therefore LVH is a strong predictor of cardiovascular morbidity and mortility resulting from hypertension[8], aortic stenosis / regurgitation[9], cardiomyopathy with or without CAD.[4,10] Therefore detection of LVH is an important early step to prevent dangerous consequences. LVH can be detected by electrocardiography, echocardiography, CT scan and MRI. Electrocardiography is cheep, easily available, easy to perform and interpret. It is being used since 1914 for LVH despite low sensitivity i.e 20-60% for different criteria but highly specific i.e >95%.[11,12] Other techniques require high cost, expertise & technique. Therefore ECG is still recommended for detection of LVH in a population of high prevalence.[13,14] Electrocardiographic LVH is associated with 3 fold increased risk of CAD.[7,15] Various commonly used criteria for LVH, with better sensitivity and specificity are:

i. Cornell voltage criterion $R_{avL} + S_{V3} \geq 20$ in females and ≥ 28 in males.[16]

ii. Cornell product index.[17]

So this study is intended to determine the sensitivity and specificity of above mentioned electrocardiographic criteria for LVH in our population.

MATERIAL AND METHODS

This descriptive study was conducted at Medical Unit-III of Jinnah Postgraduate Medical Centre Karachi from June 1998 to February 1999. Where ECG machine and echocardiography machine are available.

SUBJECT

Inclusion criteria: All patients, who came for echocardiography for various reasons and proved to have left ventricular hypertrophy were included in this study.

Exclusion criteria: Patients having the following problems were excluded from the study though they were having LVH.

I. Right bundle branch block.
II. Left bundle branch block.
III. Pre-excitation syndromes.
IV. Atrial fibrillation.
V. Myocardial infraction.
VI. Asymmetric hypertrophic cardiomyopathy.
VII. Pericarditis or pericardial effusion
VIII. Chronic obstruction pulmonary disease.
IX. Massive pleural effusion
X. Clinical hypothyroidism.
XI. Left ventricular aneurysm
XII. Female patients with mastectomy.

Control cases: 25 healthy subjects matched with age, sex and built from medical & paramedical staff of JPMC and from persons referred for echocardiography but not having LVH or any other apparent clinical disorders were included in control group.

Echocardiography: It was performed by an experienced cardiologist on Toshiba model SSA 270 A and patients were examined by 2.5 MHz probe in a partial Left lateral decubitus position according to recommendation of American society of Echocardiography. Left ventricular mass was calculated by modified Penn Cube formula and then indexed to body surface area.

LVH was defined if left ventricular mass index (LVMI) exceeded 118 g/m^2 in males and 104 g/m^2 in females.

Electrocardiography: It was performed on 6 channel automatic computerized Siemens cicard 440 machine with paper speed of 25 mm/sec and amplitude standard of 1 mv = 10 mm.

The ECGs were taken on the same day of echocardiographic and clinical examination. ECGs were examined for the following 6 criteria for LVH.

i. Cornell voltage criterion $R_{avL} + S_{V3} \geq 20$ in females and ≥ 28 in males.[16]

ii. Cornell product index.[17]

In males $(R_{avL} + S_{V3}) \times QRS_{(msec)} > 2440$.

In females $(R_{avL} + S_{V3} + 8) \times QRS_{(msec)} > 2440$.

Sensitivity & specificity were determined by standard

formula and compared to echocardiography by chi square test.

RESULTS

62 Patiens with echocardiographic criteria were initially included; but 12 patients were excluded due to above mentioned exclusion criteria. So, 50 patients, 21 male (42%) and 29 female (58%) were included in this study. Their ages were between 17 and 75 years (mean age 41.26 ± 15.94) and body surface area ranged between 1.2 and 1.9 m^2 (mean 1.57 ± 0.15) 28 patients were hypertensive (56%) , 12 patients (24%) with aortic/ mitral regurgitation and 10 patients (20%) were having cadiomyopathy. Their left ventricular mass index was from 107 to 349 g/m^2 mean 178.14 ± 56.53 g/m^2 in males 122-349 (mean 200.14 ± 60.32) with in females 107-307 (mean 162.2 ± 49.81) g/m^2.

Out of 25 persons without (LVH), 12(48%) were male and 13(52%) were females. Their ages were between 20 and 63 year (mean 38.52 ± 12.7). Their LVMI was below 118 g/m^2 in males and 104 g/m^2 in females.

Sensitivity and specificity of both ECG criteria are presented in Table I, (all patients), Table II (male patients), Table III (female patients). Specificity is presented in Table IV and Table V.

DISCUSSION

Left ventricular hypertrophy is currently thought as an important and strong predictor of cardiovascular morbidity. Hypertension is its common cause. LVH once established is associated with significant increased morbidity and mortality. ECG is an important tool for detecting LVH since 1914 with varying sensitivity but high specificity. Gubner Ungerleider criterion presented in 1943, was 50% sensitive in original study but not confirmed yet with such high sensitivity. Cornell voltage criterion was achieving higher sensitivity in the original study and maintaining its status over time . This cornell voltage criterion , in our study was equally sensitive in males and females achieving 48% in each sex and also over all 48% sensitivity (P <.001) but 96% specific.

Figure-1 : Gender Distribution of Patients

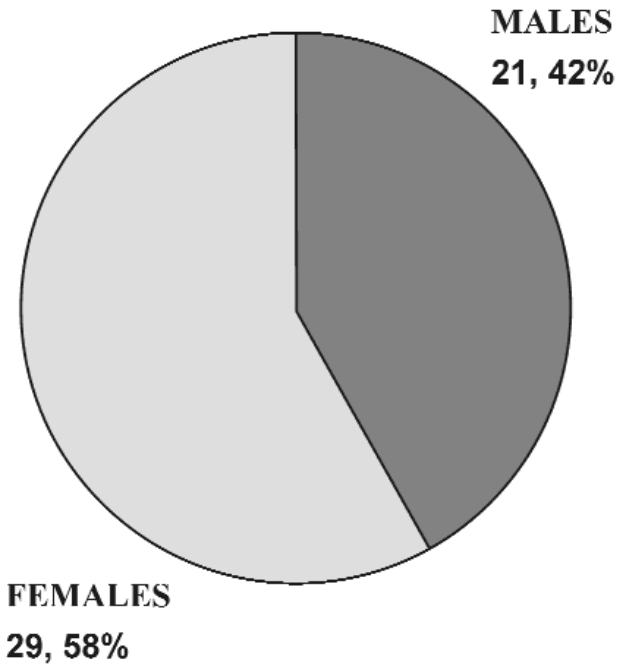
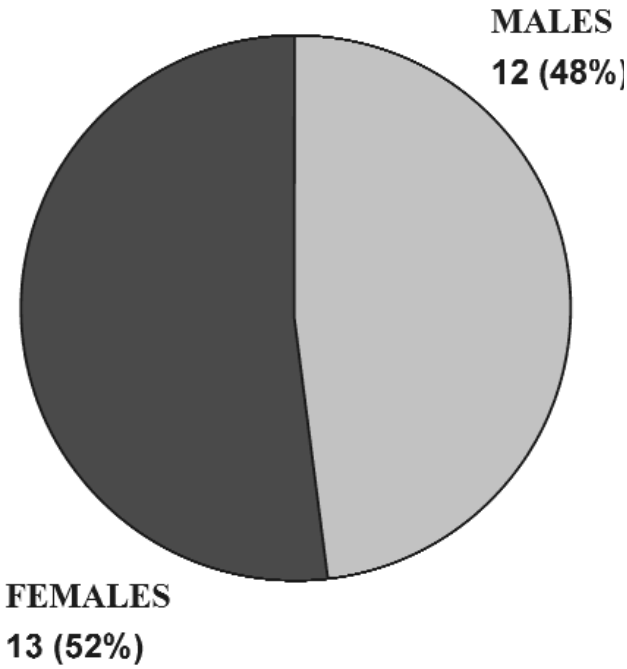


Figure-2 : Gender Distribution of Control Subjects



This may be its sex specific value. In their original study it was 41% sensitive and 95% specific. Saulat Siddiqui et al have proved it. 50% sensitive and 93% specific.[22]

Cornell product index has performed as the better criteria by achieving 60% sensitivity (p < .001) in all the patients with 96% specificity, while 62%

Table-I : Sensitivity in all Patients
(n 50)

S#	Name of Criteria	No. of patients detected	Sensitivity	Confidence Interval	P value
1	Cornell voltage	24	48%	34-62	<.001
2	Cornell product index	30	60%	45-75	<.001

Table-II : Sensitivity in Male Patients
(n 21)

S#	Name of Criteria	No. of patients detected	Sensitivity	Confidence Interval	P value
1	Cornell voltage	10	48%	26-70	< 0.05
2	Cornell product index	12	57%	37-80	

Table-III : Sensitivity in Female Patients
(n 29)

S#	Name of Criteria	No. of patients detected	Sensitivity	Confidence Interval	P- value
1	Cornell voltage	14	48%	30-67	< 0.05
2	Cornell product index	18	62%	42-85	

Table-IV: Specificity of ECG Criteria in Males and Females

S#	Name of Criteria	Male (n 12)			Female (n 13)		
		No. of patients detected	Specificity	Confidence Interval	No. of patients detected	Specificity	Confidence Interval
1	Cornell voltage	1	92	60-99.6	0	100	72-100
2	Cornell product index	1	92	60-99.6	0	100	72-100

Table V: Specificity of ECG Criteria
(n 25)

S#	Name of Criteria	All (n 25)		
		No. of patients detected	Specificity	Confidence Interval
1	Cornell voltage	1	96	78-99.8
2	Cornell product index	1	96	78-99.8

sensitivity in female population and 57% sensitive in male population. Such results have been achieved in other studies.[23,24,25] when the sensitivity of both cornell voltage and cornell product index criteria's were compared with each other the difference was statistically significant that is P-value is < 0.05.

Therefore it is evidentS from this study that Cornell voltage criteria performs better than any other criteria for detecting LVH.

CONCLUSION

Although ECG is less sensitive than echocardiography for detecting LVH but highly specific; but can perform better in certain groups of individuals. Cornell voltage index is performing good but Cornell product Criterion is enjoying higher sensitivity; but still efforts are needed to improve the sensitivity and specificity of electrocardiography for left ventricular hypertrophy.

REFERENCES

1. Susan standring, (editor in chief). Gray's anatomy 39th edition 2005; Elsevier Churchill Livingstone pp: 997.

2. Badeer HS. Biological significance of Cardiac hypertrophy. Am. J. cardiol, 1964; 14: 133-38.

3. Ganua A, Devereux RB, Roman MJ, et al. Patterns of left ventricular hypertrophy and geometric remodeling in essential hypertension. J. Am. Coll. Cardiol., 1992; 19: 1550-58.

4. Verdecchia P, Schillaci G, Borgioni C, Ciucci A, Gattobigio R, Zampi I, et al. Prognostic value of a new electrocardiographic method for diagnosis of left ventricular hypertrophy in essential hypertension. J Am Coll Cardiol 1998; 31:383-90.

5. Eugene Braunwald. Heart Diseases. 5th edition, 1997. WB Saunders Company USA, pp. 807-12.

6. De Simon G, Devereux RB, Roman MJ, et al. Relation of obesity and gender to left ventricular hypertrophy in normotensive and hypertensive adults. Hypertension 1994; 23 (5): 600-06.

7. Sundström J, Lind L, Arnlöv J, Zethelius B, Andrén B, Lithell HO. Echocardiographic and electrocardiographic diagnoses of left ventricular hypertrophy predictmortality independently of each other in a population of elderly men. Circulation 2001; 103:2346-51.

8. Hammond IW, Devereux RB, Alderman MH, Laragh JH. Relation of blood pressure and body build to left ventricular mass in normotensive and hypertensive employed adults. J. Am. Coll. Cardiol., 1988; 12: 996-1004.

9. Roman MJ, Kilgfield P, Devereux RB, et al. Geometric and functional correlates of electrocardiographic repolarization and voltage abnormalities in aortic regurgitation. J. Am. Coll. Cardiol., 1987; 9:500-8.

10. Dunn FG, Pringle SD. Sudden cardiac death. Ventricular arrhythmias and hypertensive left ventricular hypertrophy (editorial). J. Hypertens., 1993; 11 (10): 1003-10.

11. Levy D, Labib SB, Anderson KM, et al. Determinants of sensitivity and specificity of electrocardiographic criteria for left ventricular hypertrophy. Circulation, 1990; 81:815-20.

12. Lee DK, Marantz PR, Devereux RB, et al. Left ventricular hypertrophy in black and white hypertensives. JAMA, 1992; 267: 3294-99.

13. Schillaci G, Verdechhia P, Borgioni C, et al. Improved electrocardiographic diagnosis of left ventricular hypertrophy. Am. J. Cardiol., 1994; 74: 714-19.

14. Abergel E, Tase M, Menard J, Chatellier G. Influence of obesity on the diagnostic value of electrocardiographic criteria for detecting left ventricular hypertrophy. Am. J. Cardiol. 1996; 77: 739-44.

15. Kannel WB, Gordon T, Castelli WP, Margolis JR. Electrocardiographic left ventricular hypertrophy and risk of coronary heart disease. The Framingham Heart Study. Ann. Intern. Med., 1970; 72: 813-22.

16. Casale PN, Devereux RB, Kligfield P, et al. Electrocardiographic detection of left ventricular hypertrophy. Development and prospective validation of improved criteria. J. Am. Coll. Cardiol.; 1985; 6(3): 572-80.

17. Norman JE Jr, Levy D. Adjustment of ECG left ventricular hypertrophy criteria for body mass index and age improves classification accuracy: the effects of hypertension and obesity. J

Electrocardiol 1996; 29 (suppl):241-7.

18. Abass S. Detection of left ventricular hypertrophy in hypertension by echocardiography vs electrocardiography. Pak Armed Forces Med. J., 1995; 45(2): 47-50.

19. Romhilt DW, Bove KE, Noris RJ, et al. A Critical appraisal of the elctrocardiographic criteria for the diagnosis of left ventricular hypertrophy. Circulation, 1969; 40: 185-95.

20. Douglas PS, O Toole ML, et al. Electrocardiographic diagnosis of exercise induced left ventricular hypertrophy. Am. Heart J., 1988; 116: 784-90.

21. Casale PN, Devereux RB, Allonso DR, et al. Improved sex specific criteria of left ventricular hypertrophy for clinical and computer interpretation of electrocardiograms. Validation with autopsy findings. Circulation, 1987; 75(3): 565-72.

22. Siddique S, Nadeemullah, Khan AA. Comparision of various criteria used to determine left ventricular hypertrophy by electrocardiography, validation with echocardiography. Proc. Sh. Zayed PGMI, 1996; 10: 15-18.

23. Warner, Robert A; Ariel, Yoram; Gasperina, Marco Dalla; Okin, Peter M. Improved electrocardiographic detection of left ventricular hypertrophy. Journal of Electrocardiology. 35 Suppl: 111-5, 2002.

24. Maciej Sosnowski, Barbara Korzeniowska and Michał Tendera Left ventricular mass and hypertrophy assessment by means of the QRS complex voltage-independent measurements International Journal of Cardiology Volume 106, Issue 3, 26 January 2006, Pages 382-389

25. Daniel Pewsner, Peter Jüni, Matthias Egger, Markus Battaglia, et al. Accuracy of electrocardiography in diagnosis of left ventricular hypertrophy in arterial hypertension: systematic review BMJ 2007;335;711