

LIST OF PROCEDURES DONE
PROJECT REPORT

TITLE OF THE PROJECT:

EVALUATION OF ELECTROCARDIOGRAPHIC
CRITERIA FOR DIAGNOSIS OF RIGHT
AND LEFT VENTRICULAR HYPERTROPHY.

NAME.....D.R. SHAILENDER SIVSATHI.....

PROGRAMME:.....D.M. CARDIOLOGY.....

MONTH & YEAR
OF SUBMISSION:.....NOV. 1987.....

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- Note:— (i) In the case compilation of procedures done, the contents and the subsequent pages should be made into different sections (a) Procedures done (b) Procedures assisted (c) Procedures participated (d) Procedures attended/participated etc in Other Centres. Each section should be preceded by a leaf carrying the name of the section that is succeeding.
- (ii) The Contents page will carry into. as per model given under

PROCEDURES DONE

Closed Mitral valvotomy.....124 (say)
 Patent ductus arteriosus-ligation.....10
 Atrial septal defects.....20

PROCEDURES ASSISTED

Closed Mitral valvotomy.....100 (say)

- (iii) In the subsequent pages details of each procedure done/assisted should be given in the format given below:—

Heading: **Closed mitral valvotomy**

Date	Name of the patient	Age	Sex	Patient No.
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- (iv) In the case of Project Report in the page immediately following the Certificate page the under-mentioned details should be given:—

- (a) Title
- (b) Duration
- (c) Aim and scope
- (d) 50 word summary of work done

CERTIFICATE

I, Dr. SHALENDER SINGH.....hereby declare that I have actually performed all the procedures listed/carried out the project under report.

Signature.....Shalender Singh.....

Place: TRIVANDRUM.

Name in.....SHALENDER SINGH.....
capital letters

Date: 7/11/87

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INTRODUCTION

The electrocardiographic (ECG) diagnosis of ventricular hypertrophy is rather uncertain on many occasions. Many studies have shown that one criterion may be exceptionally sensitive but very nonspecific while another may be quite specific but insensitive (1). If correlated with autopsy findings, many of them will lead to false positives and false negatives (2). With more sensitive criteria, the number of false positive diagnosis increases (3). Various workers have laid down different criteria for diagnosing left ventricular and right ventricular hypertrophy (LVH, RVH) on the basis of ECG, but some of them are arbitrary and have not been correlated with autopsy findings. In this study, it is being attempted to correlate the various existing ECG criteria with ventricular hypertrophy as demonstrated at autopsy and to determine the ones with high index of specificity and sensitivity.

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MATERIALS AND METHODS

Autopsied hearts of patients who died of cardiac or noncardiac causes were analysed. 97 cases were studied with patient age ranging from 3 to 62 years there were 75 males and 22 females. Methods of examination of the hearts at autopsy were similar to those proposed by Lamb (4) based on that of Fulton et al (5). Formalin preserved hearts were dissected and ventricles were cut out at the atrioventricular groove and Mitral & Tricuspid valves were removed. Thrombi from ventricular cavities were washed out and epicardial fat was removed by blunt dissection and scooped with a blunt scalpel. Left ventricular free wall and Interventricular septum were weighed together and Right ventricular free wall weighed separately. The criteria used for diagnosis of Right and Left ventricular hypertrophy are as follows:

Normal (21 hearts)

Total weight of both ventricles	-	< 250 gms.
Free wall of right ventricles	-	≤ 65 gms.
Left ventricles septum (LV + S)	-	≤ 190 gms.
Ratio of left ventricular + Septum / Right ventricle between		2.3 and 3.3 : 1

Right Ventricular Hypertrophy (61 hearts)

Right Ventricular free wall	=	80 gms. or more
LV + S/RV	=	2.1 or less

Left Ventricular Hypertrophy (8 hearts)

LV + S	=	225 gms. or more
LV + S / RV	=	3.3 or more

Biventricular Hypertrophy (7

LV + S

Right ventricular free wall

LV + S / RV

heart
= 225 gms. or more
= 80 gms. or more
= Normal or high in those with left ventricular preponderance (3.3 or more)

ECG of these patients done within 3 months prior to death were analysed in detail. All these patients had undergone at least one recording of 13 lead ECG (including V₃R lead as a routine). All ECG recording were done with conventional direct writer on a heat sensitive paper or with a direct writer electro cardiograph at a paper speed of 25mm/sec. None had any complete bundle branch block and the QRS duration was less than 120mm/sec.

The ECGs were analysed and voltages computed as per various criteria described in the literature for right and left ventricular hypertrophy without prior knowledge of autopsy diagnosis of right, left or no ventricular hypertrophy. The various criteria for diagnosis of RVH is shown in Table-I and LVH in Table-II.

Sensitivity, specificity and positive predictive accuracy was calculated as

Sensitivity = $\frac{\text{True positive}}{\text{True positive} + \text{false negative}} \times 100$

Specificity = $\frac{\text{True Negative}}{\text{True Negative} + \text{false positive}} \times 100$

Positive predictive accuracy = $\frac{\text{True positive}}{\text{True positive} + \text{false positive}} \times 100$

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Biventricular Hypertrophy (7 hearts)

- LV + S = 225 gms. or more
- Right ventricular free wall = 80 gms. or more
- LV + S / RV = Normal or high in those with left ventricular preponderance (3.3 or more)

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$$\text{Sensitivity} = \frac{\text{True positive}}{\text{True positive} + \text{false negative}} \times 100$$

$$\text{Specificity} = \frac{\text{True Negative}}{\text{True Negative} + \text{false positive}} \times 100$$

$$\text{Positive predictive accuracy} = \frac{\text{True positive}}{\text{True positive} + \text{false positive}} \times 100$$

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TABLE - II

Sensitivity, Specificity and Postive Predictive value of Criteria for
diagnosis of left ventricular hypertrophy

LIMB LEAD CRITERIA	Sensitivity (%)	Specificity (%)	Positive predictive value (%)
R in aVL \geq 7.5mm	53.3	92.7	57.1
R in aVL \geq 11mm	26.6	95.1	50.0
R in aVL \geq 14mm	26.6	97.6	66.6
R in aVL \geq 13mm	26.6	97.6	66.6
R in Lead I \geq 13mm	20.0	96.3	50.0
R in aVF \geq 20mm	26.6	90.2	33.3
R in aVF \geq 19mm	33.3	89.0	35.7
RI + SIII \geq 25mm	26.6	96.3	57.1
Left axis deviation -30 to 90°	13.3	93.9	28.5
Precordial lead criteria	20.0	88.0	23.0
RV ₅ \geq 26mm			
RV ₆ \geq 26mm	40.0	93.9	54.5
R in V ₅ or V ₆ \geq 30mm	40.0	91.4	46.1
SV ₁ \geq 24mm	46.6	95.1	63.6
SV ₂ \geq 25mm	66.6	79.2	37.0
R + S in any V ₁ leads \geq 35mm	86.6	35.3	19.7
R + S in any V leads \geq 45mm	60.0	57.3	20.4
RV ₆ \geq RV ₅	33.3	91.4	41.6
SV ₁ or V ₂ + RV ₅ or V ₆ \geq 40	73.3	70.7	31.4
SV ₁ + RV ₅ or V ₆ \geq 35	66.6	82.9	41.6
SV ₁ + RV ₅ or V ₆ \geq 30	80.0	75.6	37.5
ST-T inversion in I and aVL	26.6	93.9	44.4
ST-T inversion in II, III, aVF	33.3	91.4	41.6
ST-T inversion in V ₄ - V ₆	60.00	90.2	52.8
ST-T inversion in aVL or II, III aVF or V ₄ - V ₆	80.0	84.1	48.0

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TABLE - I

Sensitivity, specificity and Positive Predictive value of criteria
for diagnosis of right ventricular hypertrophy

CRITERIA	Sensitivity (%)	Specificity (%)	Positive predictive accuracy (%)
R in V ₁ ≥ 7mm	61.7	89.6	93.3
R in V _{3R} ≥ 7mm	57.4	89.6	92.8
R/S in V ₁ ≥ 1	70.6	93.1	96.0
R/S in V ₃ ≥ 1	70.6	93.1	96.0
S in V ₁ ≤ 2mm	50.0	96.5	97.0
S in V ₅ ≥ 7mm	64.7	68.9	91.4
S in V ₆ ≥ 7mm	47.0	84.6	91.4
R in V ₅ ≤ 5mm	20.8	96.5	93.3
R in V ₆ ≤ 5mm	30.8	89.6	87.5
R/S in V ₆ < 1	50.0	93.1	94.4
R in V ₁ + S in V ₆ ≥ 10.5mm	73.5	82.7	90.9
R in VR ≥ 5mm	32.3	93.1	91.6
$\frac{R/S V_5}{R/S V_1} < 0.4$	73.5	41.3	74.6
Right axis deviation ≥ + 110°	44.1	96.5	96.7
S ₁ S ₂ S ₃	7.3	96.5	83.3
IRBBB with R/S in V ₁ ≥ 1* with R or R ¹ in V ₁ - 15mm	100.0	100.0	100.0

RESULTS

61 hearts fulfilled the autopsy criteria for RVH. 8 hearts for LVH and 7 hearts for BVH while 21 hearts showed no ventricular hypertrophy

The ECGs were analysed for various criteria for ventricular hypertrophy and these criteria were evaluated and correlated with the presence or absence of hypertrophy in autopsy.

Table - I shows sensitivity, specificity and positive predictive accuracy for RVH and Table-II shows of for LVH. Of the 16 criteria for RVH eleven had positive predictive accuracy of more than 90%. However, the most sensitive criteria for diagnosis of right ventricular hypertrophy were R/S in $V_1 \geq 1$, R/S in $V_3 \geq 1$, $RV_1 + S V_6 \geq 10.5\text{mm}$ and $\frac{R/S \text{ in } V_5}{R/S V_1} = < 0.4$ with sensitivity of above 70% and specificity of 91, 91, 82 and 41% respectively. For the diagnosis of left ventricular hypertrophy R in $aVL \geq 7.5\text{mm}$ has a sensitivity of 53% and a specificity of 93% and among the precordial lead criteria $R + S$ in any leads $\geq 35\text{mm}$, SV_1 or $V_2 + RV_5 \geq 40$, $S V_1 + RV_5 \geq 30$ and $ST - T$ inversions were 73%, 80% and 80% sensitive and 35%, 70%, 76% and 84% specific. However positive predictive accuracy was only 57%, 20%, 31%, 31% and 48% respectively. The best predictive accuracy was for R in $aVL \geq 13\text{mm}$ and S in $V_1 \geq 24\text{mm}$ of 67% and 64% respectively but the sensitivity was only 26% and 46% respectively.

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DISCUSSION

The numerous ECG criteria described in the literature for the diagnosis of ventricular hypertrophy were evaluated and correlated with autopsy findings of ventricular hypertrophy. Normally there is a LV preponderance in ECG as LV is the dominant ventricle. The ECG criteria for LVH are only on exaggeration of normal pattern, while the criteria for RVH are of greater deviation from normal pattern. Hence false positives and false negatives are likely to be low in the diagnosis of RVH resulting in higher degree of sensitivity and specificity which is also the observation in the present study.

The number of hearts showing LVH in autopsy were small and hence even a small increase in false negativity will result in low sensitivity. This would be one of the reasons for low sensitivity in almost all the ECG criterial for LVH in this study.

The diagnosis of right ventricular hypertrophy was more sensitive and specific than diagnosis of left ventricular hypertrophy. In general the limb lead criteria were more specific but less sensitive than precordial lead criteria for diagnosis of left ventricular hypertrophy. The specificity of electrocardiographic diagnosis of left ventricular hypertrophy was low in range of 30-60% where as certain criteria like, $R/S V_1$ or $V_3 R \geq 1$ and R in $V_1 + S V_6 \geq 10.6$ were highly specific (90%) for the diagnosis of right ventricular hypertrophy.

We conclude that electrocardiogram is highly sensitive and specific in diagnosis of right ventricular hypertrophy.

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SUMMARY

Sixteen different electrocardiographic criteria for right ventricular hypertrophy and twenty four different electrocardiographic criteria for left ventricular hypertrophy have been evaluated in 97 autopsied hearts utilizing a chamber dissection technique. There were 61 hearts with right ventricular hypertrophy 8 hearts with left ventricular hypertrophy and 7 hearts with biventricular hypertrophy (21 hearts had no ventricular hypertrophy by weight criteria).

The following four criteria R/S in $V_1 \geq I$, R/S in $V_3 R \geq 1$, R in $V_1 + SV_6 \geq 10.5\text{mm}$ and $\frac{R/SV_5}{R/SV_1} = < 0.4$, have a sensitivity of about 70% with specificity of 91%, 91%, 82% and 41% respectively for the diagnosis of right ventricular hypertrophy. For the diagnosis of left ventricular hypertrophy, among the nine limb lead criteria, R in $aVL \geq 7.5\text{mm}$ was most sensitive (53% sensitive and 93% specific) and among the precordial lead criteria the following $R + S$ in any V leads $\geq 35\text{mm}$, SV_1 or $V_2 + RV_5$ or $V_6 \geq 40$, $SV_1 + RV_5$ or $V_6 \geq 30$ and ST-T inversion in I, aVL or II, III, aVF or $V_4 - V_6$ were 87%, 73%, 85% and 80% sensitive and 35%, 70%, 76% and 84% specific. Overall the precordial leads were considerably more sensitive but less specific than limb lead criteria for the diagnosis of left ventricular hypertrophy. However R in $V_1 \geq 7\text{mm}$, R in $V_3 R \geq 7\text{mm}$, R/S in $V_3 R \geq 1$, R/S in $V_1 \geq 1$, S in $V_1 \leq 2\text{mm}$, S in $V_6 \geq 7\text{mm}$, R in $V_5 < 5\text{mm}$, R/S in $V_6 \leq 1$, R in $V_1 + SV_6 \geq 10.5\text{mm}$, R in $aVR > 5\text{mm}$ and right axis deviation $\geq 110^\circ$ have a positive predictive accuracy of above 90% for diagnosis of right ventricular

hypertrophy where as for diagnosis of left ventricular hypertrophy R in aVL \geq 13mm and S in V₁ \geq 24mm had highest positive predictive accuracy of 67 and 64% respectively. Thus electrocardiography is more sensitive and specific in diagnosis of right ventricular hypertrophy compared to left ventricular hypertrophy.

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