Estimation of Left Ventricular Ejection Fraction From 12 Lead E.C.G.-A Simple aid to Prediction of Prognosis in Myocardial Infarction.

GHULAM MOHEUD DIN CHAUDHARY
MBBS (PB) AND*
*A. HAFEEZ AKHTAR ***
M.B., FRCP., FCPS, D. CARD, FACC.

SUMMARY

40 patients with acute myocardial infarction were studied in the coronary care unit of Rawalpindi General Hospital. They were divided into two groups i.e. group-A or high risk group and group-B or low risk group on the basis of LVEF calculated from ER and QRS scoring system. They were followed up for one year and five end points (death, recurrence of myocardial infarction, angina pectoris, left ventricular failure and no complication) were noted in each patient at the end of the study.

There were eight deaths (29.62%) in group-A but no in group-B. Morbidity rate for recurrence of myocardial infarction, angina pectoris and heart failure was quite high in group-A as compared to group-B. Both groups were compared for end points by X^2 method and there was seen significant statistical difference between two groups.

ER and QRS scoring system are useful procedures and can be used reliably to predict the prognosis after acute myocardial infarction. After acute myocardial infarction, an ECG can provide important indirect quantitative information about left ventricular function and hence can predict prognosis.

The clinical course after acute myocardial infarction is variable. Of people who survive the first 24 hours of acute myocardial infarction about 6% die in the following month and about 8% die in the subsequent five months. After about six months, the incidence rate of cardiac death is almost comparable with cardiac death rate for patients with chronic ischaemic heart disease (1,2,3,4). With the advent of methods offering more definitive forms of prevention of recurrence of myocardial infarction the assessment of prognosis in this disease is becoming increasingly important.

Patients with acute myocardial infarction can be differentiated into High Risk and Low Risk groups. These prognostically different subgroups can be differentiated by various methods which are based on parameters influencing directly or indirectly left ventricular function. At present following methods are available (5).

1. Ventriculography and coronary arteriography.
2. Two dimensional Echocardiography.
3. Radionuclide myocardial perfusion studies.
4. Positron Emission Transaxial Tomography.
5. Enzymatic methods viz CPK-MB indices.
6. Electrocardiographic methods like TQ-ST

*Registrar Coronary Care/Intensive Care Unit, Rawalpindi General Hospital Rawalpindi.

** Head of Department of Medicine & Cardiology, Central Government Polyclinics Islamabad.

segment maps, Δ Q,ER, AND QRS scoring system.

It is needless to stress that majority of these methods are not universally available, thus countries like Pakistan have to fall back upon simpler and cheaper measures. Recently there has been emphasis on the value of the ordinary 12-Lead ECG, which can give a fairly accurate idea of left ventricular function. This has been subject of the numerous publications in the recent past and now the methods are available to evaluate left ventricular function (LVF) from the 12-Lead, ECG, like ER and QRS scoring system (6,7).

With this background a study was undertaken to evaluate the significance of ER and QRS scoring system in our own settings, so that practical significance can be assessed.

MATERIALS AND METHODS

All patients of acute myocardial infarction, irrespective of age and sex, admitted in coronary care unit of Rawalpindi General Hospital, Rawalpindi during the period of 1st January, to 30th April, 1982, who fulfiled the criteria for selection, were included in the study.

Criteria for Selection

1. A typical history suggestive of myocardial infarction.
2. Electrocardiographic evolutionary changes of acute transmural myocardial infarction.
3. Elevated serum enzyme levels of SGOT, CPK and LDH.

Patients with the following criteria were excluded from the study.

i. Patients who died during the hospital stay.
ii. Patients with concurrent disease such as chronic Renal failure requiring dialysis or neoplasm.
iii. ECG showing left ventricular hypertrophy, left fascicular block (QRS axis > -- 60) right or left bundle branch block, delta wave suggesting ventricular pre-exitation or non-specific intraventricular conduction delay (QRS > 11 Om sec).

From the selected patients a detailed account of present, past and personal history was taken, alongwith physical examination. Values of Hemoglobin, total leucocyte count and differential count, erythrocyte sedimentation rate, routine urine examination, blood sugar and blood urea were obtained. Serum creatine phosphokinase (CPK), Glutamic Oxaloacetate transaminase (SGOT) and Lactic Dehydrogenase (LDH) were also obtained.

X-ray chest of all patients were done. Standard 12 lead surface ECG was performed on a single channel recorder at a paper speed of 25mm/Sec. at least once daily for the first three days of hospitalization and then as clinically indicated. The localization of infarction was made by evolutionary changes of STT and development of new Q-waves equal or more than 30 m sec. or criteria for true posterior infarction (8,9).

All patients were given routine treatment for ischaemic heart disease used in coronary care unit of this hospital i.e. persantin 300 mg. (Dipyridamole), Isordil 30 mg (sosorbide Dinitrate-Ayerst), Aspirin 600 mg. daily, and Angised (Glyceryl-Trinitrate). 0.5 mg. sublingually as required. Injection Avafortan (Metamizol) 5.0 c.c. i.v. were given for pain routinely, while opium derivatives were only used if patient died not respond to Avafortan. Additional medicines were prescribed if clinically indicated. Complications during hospitalization like recurrent chest pain, hypotension, left ventricular failure and arrhythmias were noted.

1. Electrocardiographic Evaluation.

Q. Waves: Each ECG was evaluated for the total number of abnormal Q-waves in the standard 12 lead ECG (Except lead a VR) of 40 m sec. duration or at least 0.2 mV amplitude.

2. E.R.

The sum of R-waves (expressed in mV) in leads aVL, aVF, and V1 to V6 was calculated (6).

3. QRS Scoring System

Each ECG was scored according to 29 point QRS scoring system. The criteria for scoring applied to each of 10 leads (I, II, aVL, aVF, and V1 to V6), are derived from the durations and amplitude ratios of the deflections of the QRS complex, as shown in Table No. I(7).

The primary observation in each lead is the duration in msec, of the initial Q or R-wave. When single lead meets several criteria for either the duration or the amplitude ratio, only the criterion with the greatest number of points is considered.

Criterion involving amplitude ratio is not considered if it includes an observation of a Q or R wave that has not met the minimal criterion for duration in that lead. However, an amplitude ratio criterion that does not include observation of a Q-wave or an initial R-wave, such as the R/S amplitude ratio in leads V4 to V6 is applied regardless of whether the duration criterion is satisfied in that lead.

For calculations, interpretation and comparison purposes, the ECG tracing obtained a day before discharge from the hospital, was chosen as prototype.

4. Left Ventricular Function

The left ventricular ejection fraction (LVEF) at the time of discharge from the hospital was calculated by the following formulae (6,7).

1. LVEF% = 6.6 X ER mV + 9.4.
2. LVEFa% = 8.6 x ER mV + 11.0.
3. LVEF% = 60 - (3xQRS score).

LVEFa — Augmented LVEF after a premature ventricular contraction. On the basis of LVEF, patients were differentiated into following two groups.

1. GROUP A or HIGH RISK GROUP which includes patients who have LVEFa less than 45% (formula 2) or LVEF less than 50% (formula 3). Where the two findings do not agree more weight was given to the calculations derived from formula 3.

2. GROUP B or LOW RISK GROUP: Patients who have LVEFa more than 45% (Formula 2) or LVEF more than 50% (Formula 3).

Follow up

Irrespective of their attendance to medical outdoor department, follow up was started in January, 1983. Follow up includes a standard 12 lead ECG, history and physical examination. ECG was interpreted as before and compared with initial ECG. Following 5 end-points of the study was noted in each patient.

1. Death.
2. Recurrence of myocardial infarction.
3. Angina Pectoris.
4. Left Ventricular failure or CCF.
5. No complication.

Statistical Methods

All the variables i.e. Demographic, clinical, laboratory and Electrocardiographic, were interpreted and their mean with standard deviation was found. Group A & B was compared in relation to end points by χ^2-method, and statistical significance determined (10).

RESULTS

40 patients fulfiled the criteria for selection and were included in the study. They were categorised into two groups i.e. group A or High risk group containing 27 patients and group B having 13 patients, on the basis of LVEF determined by ER and QRS scoring system.

The age range in male patients was from 28-71 years and in Females it was 48-70 years. The distribution of patients according to age and sex in each group is shown in figure No. 1. The mean hospital stay was 14.89 ± 8.91 14.59 ± 8.74, 14.46 ± 10.07 days respectively for total, group A and group B patients. The range of hospital stay was from 5—46 days.

The average duration of symptoms was 12.07 ± 14.40, 14.22 ± 19.01 and 12.23 ± 12.72 hours respectively for total, group A and group B patients, while the range was from 1-72 hours. Data regarding personnel and past history is presented in table No. II.

Electrocardiographic Findings

1. Site of Infarction

The site of infarction as determined from 12 lead ECG is shown in Table No. III. There was no patient with isolated true posterior or lateral infarction. One patient has Anterior and inferior infarction. Group A patients have predominantly Anterior or Anterolateral infarction, while group B have inferior infarction.

2. Q-Waves

Number of Q-waves in the ECG taken before discharge from hospital and one year after follow-up were counted and there was no significant difference.

3. E.R.

The ER values determined from the ECG before discharge from the hospital and after follow up are shown in table. No. IV. The distribution of patients according to ER values in each group are presented in Figure No. 2.

4. LVEF Determined from ER Values.

The LVEF (Formula 1) calculated from ER was 35.16% ± 16.79, 28.93% ± 16.52 and 46.33% ± 10.07 at the time to discharge from the hospital for total, group A and group B patients respectively. While LVEFa (Formula 2) values calculated from ER before discharge from hospital and after follow-up are given in table No. IV. The distribution of patients according to values of LVEFa in each group is depicted in Figure No. 3.

5. QRS Scores

The values are shown in table No. IV. and Figure No. 4.

6. LVEF Determined from QRS Scores.

The LVEF (Formula 3) determined from QRS score at the time of discharge from the hospital and after follow up are shown in table No. IV and the distribution of patients according to these values in each group are shown in the Figure No. 5.

The apparent difference in values of all these variables as shown in table No. IV, before discharge from the hospital and after one year follow up, may be due to the fact that, eight patients who died (all belong to group A) have low values in the initial ECG, were excluded from the second calculations.

7. Comparison of LVEF Determined from ER and QRS Scores.

LVEFa (Formula 2) was not able to recognise four patients who were considered to be at high risk on the basis of LVEF (Formula 3) from QRS score. These patients have inferior (one patient) or inferior and true posterior infarction (three patients). Among them two patients died during follow up and other two have one or the other complication. In all other (36 patients) both the methods can differentiate patients into low risk and high risk groups, although LVEF determined by each method may vary in individual cases.

Follow-up

1. DURATION – The mean duration of follow up was 9.96 ± 3.41, 8.95 ± 3.60 and 12.07 ± 1.63 months respectively in total, group A and group B patients. Excluding the dead patients, the mean duration of follow up was 11.36 ± 1.73, 10.88 ± 1.66 and 12.07 ± 1.63 months.
2. END POINTS OF STUDY – Summary of the end points of study after follow up in each group is presented in Figure No. 6.

The mortality rate after follow up in total patients was 20% and in group A 29.62%. There was no death in group B. Seven out of eight deaths (87.5%) occured during first six months of follow up, only one patient died 9.5 months after discharge from hospital. Male, Female death rate was 17.1% and 40%, and 25% and 66.67% in total and group A patients respectively.

The mortality and morbidity in patients according to the findings in ECG and calculated LVEF before discharge from Hospital is shown in Table No. V.

X^2 Test of Significance

It was calculated for four end points i.e. mortality, recurrence of myocardial infarction, left ventricular failure and angina pectoris observed after one year follow up in group A and B. The calculated value of X^2 (13.51) was found to be higher than the tabulated value of X^2 (11.34) at 1% level of significance and for three degrees of freedom, but when the fifth variable i.e. patients with no complication was included in the calculations then the calculated value of X^2 (35.4) was found to be much higher than the tabulated value of X^2 (13.28) at 1% level of significance and for four degrees of freedom.

Thus there was significant statistical difference between group A and group B patients, who were separated on the basis of LVEF determined from ER and QRS scoring system to evaluate the long term prognosis after acute muocardiac infarction.

DISCUSSION

The literature regarding acute myocardial

infarction is limited in Pakistan, especially its incidence in the general population (Urban and Rural) and its long term prognosis. Whatever literature (11,12,13) is available, indicates that the incidence of this disease is progressively increasing and is almost comparable to its incidence in the U.S.A. or U.K.

The mean age, sex and smoking habits of the patients in this study are in accordance to the literature (14,15,16,17). Distribution of patients according to residence (Rural/Urban) is similar to one study (15) but is different to another study (16) of Pakistani literature.

40 patients were divided into two groups i.e. group A or High Risk Group comprising 27 patients and group B or low risk group comprising 13 patients. Although the number of patients were different in each group, both groups were comparable in the following parameters :—

1. Age.
2. Sex.
3. Occupation except Government Service or farmer.
4. Hospital Stay.
5. Presenting Symptoms.
6. Personal and past history like smoking, ischaemic heart disease, heart failure, etc.
7. Pulse, Blood Pressure, Temperature, Signs of Heart failure or shock at the time of hospitalization.
8. Haemoglobin, total and differential leucocyte count, ESR, Blood Urea, Blood Sugar, Cardiac Enzyme estimations, etc.
9. Treatment used and complications observed during hospital stay.

All the findings noted above can influence the long term prognosis of the patients after acute myocardial infarction (14,18,19,20,21,22,30). But these variables are comparable in the two groups as shown in different tables. So these variables cannot influence the differentiating criteria for prognosis which is based on electrocardiographic QRS complex in this study.

Hypertension was not associated with poor prognosis in this study which is against the Whitehall study (23) but is supported by other authors (14,30). Diabets Mellitus was discarded by Norris, et al (30) for long term prognosis as a poor prognostic factor but this study showed association between poor prognosis and diabetes mellitus as in other series (14,23,24).

Inferior or inferior and true posterior infarction was associated with better prognosis (two deaths), while Anterior or antero-lateral infarction was associated with poorer prognosis (six deaths) as supported by other authors (25,14). Pathological abnormal Q-waves which had been associated with akinesis or dyskinesis of the ventricular wall (6,7,26) affects the LVF significantly and the number of Q-waves is associated with poorer prognosis as shown in table No. IV.

ER AND QRS SCORING SYSTEM

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ER AND QRS SCORING SYSTEM

Askenazi, et al (6) investigated the relationship between electrocardiographic findings (ER) and the angiographic LVEF and the augumented ejection fraction (LVEFa) after a premature ventricular contraction in 73 patients, with documented coronary artery diseases. Among patients with ER less than 4.0 MV, LVEFa was less than 45% in 73%, among patients with ER of 4.0 mV or more the LVEFa was greater than 45% in 93%. So a ER of 4.0 mV or LVEFa 45% was useful in separating patients into those with and without moderately severe depressed left ventricular function. The best correlation occured in patients with anterior myocardial infarction and the poorest in the patients with inferior myocardial infarction, because inferior aspect of the heart is underweighted in the calculations, as it is represented only by one Lead (aVF). This fact has been confirmed by our study.

Selvester and his colleagues in 1965, developed a computer simulation of normal ventricular activation, employing 20 dipoles to represent various segments of the heart (27). This computer model was subsequently expanded to generate the 12 Lead ECG and the body surface map in a male human torso criteria for measuring myocardial infarct on the ECG. The scoring system was developed and simplified, then further modified by Wagner, et al to meet requirements for sensitivity and specificity (7,27).

QRS scoring system was evaluated to estimate the size of infarcts predominantly within the anterior third of the left ventricle, in 2, patients with a single infarct documented by post-mortem examination. Each QRS point was found to represent approximately 3.5% of the left ventricle infarcted (28).

Palmeri ST, et al (7) evaluated the QRS scoring system in 55 patients. Serial 12 Lead surface ECG was scored. The scores were proportional to the severity of wall motion abnormalities, which was documented by Radionuclide blood pool scanning and which correlated inversely with Radionuclide determined LVEF. A score more than 3 was 93% sensitive and 88% specific for both servere regional dyssyvergy and major depression of the global left ventricular function. The QRS score correlates well with LVEF determined by Radionuclide angiography three weeks, eight weeks and one year after infarction. During one year period, there was no change in the linear regression slopes that would suggest a changing relation between QRS complex and myocardial function. These methods when applied to individual patients may show differences in LVEF assessed from ECG and LVEF assessed from angiography (7,29), as these are not so accurate methods, but when they are applied to differentiate patients into low risk and high risk groups they are useful and effective methods. With this background, ER and QRS scoring system was used to evaluate the LVEF and thence to differentiate the total 40 patients into high risk (Group-A) and low risk (Group-B). After one year of follow-up efficacy of the method is evident from the fact that all the deaths occurred in high risk patients, whereas there was no death in group-B patients. All other complications are also more prevalent in group-A patients as shown in Table No. 5. The significant difference in mortality is the single, most effective proof of the efficacy of the method, which encompasses all other clinical criteria of long term prognosis including coronary prognostic index (30).

This study showed that ER and QRS SCORING SYSTEM are effective methods, and QRS scoring system is more reliable than ER. So ER and QRS scoring system are very useful for screening purposes in patient with acute myocardial infarction, especially in circumstances where better facilities are not available. In countries like Pakistan, where sophisticated and costly procedures are available in just a few centres and only for a limited number of patients; such a simple, cheap, easily interpretable and quite reliable methods are a great advantage. For further assessment of these methods, a detailed study on a large scale or a collaborative study in national level is required.

All the physicians even at District or Tehsil level can use this method, and they should use it to differentiate patients into low risk and high risk groups, so that high risk patients can be treated energetically or referred to coronary care centres to minimize the mortality as well as morbidity in these poor risk patients.

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