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ORIGINAL RESEARCH ARTICLE

Correlation of ECG changes with LVEF in patients with Myocardial Infarction: An Observational study

Running Title - ECG changes with LVEF in patients with MI

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ABSTRACT

Introduction: Acute myocardial infarction (AMI) is a major cause of morbidity and mortality worldwide. Despite significant improvement in the past decades, still a majority of patients subsequently suffer from LV dysfunction and heart failure. **AIMS AND OBJECTIVES:** To find out correlation between ECG changes and LVEF. Prediction of LVEF from ECG changes. **MATERIALS AND METHODS:** 200 patients of Myocardial Infarction were studied. Detailed history, physical examination was done as per pre-fixed proforma. Relevant haematological, biochemical investigations along with ECG and 2D ECHO were done. LVEF was assessed using 2D ECHO. **RESULT:** The study included patients from 24-85 years age, 170 (85%) were male and 30 (15%) were females. Maximum were noted in 51-64 years (82). 127 cases (63.5 %) were AWMI and 73 cases (36.5%) were IWMI. The commonest risk factor was smoking (20%), alcohol (13%), hypertension (8%), diabetes (6.5%).Among AWMI patients,118 had LVEF 30-45%, 5 had LVEF <30%, 4 had LVEF >45%. Among IWMI patients, 63 had LVEF 30-45%, 1 had LVEF <30%, 9 had LVEF>45%. ECG changes taken for comparison included QS complexes, ST elevation, Loss of R wave. In IWMI patients , 52 had QS complex in II, III ,aVF with mean LVEF of 43.269% and 18 had QS complex in II, III , aVF , V_4-V_6 with mean LVEF of 33.333% . This shows that more the lead involvement in IWMI lesser is the LVEF. Similar findings were observed in AWMI. In AWMI patients, 12 with ST elevation in V_1-V_3 had mean LVEF of 39.583% , 25 with ST elevation in V_1-V_4 had mean LVEF of 39.800 %, 23 with ST elevation in V_1-V_6 had mean LVEF of 36.696 % and 7 with ST elevation in I, aVL, V_1-V_6 had mean LVEF of 31.429 %.Thus, more the lead involvement in AWMI lesser is the LVEF, Similar findings were observed in IWMI also. Loss of R wave also showed a negative correlation with LVEF. **CONCLUSION:** We concluded a negative correlation between QS complex, ST elevation and Loss of R wave with LVEF. Thus we conclude that more the ECG leads showing QS complexes, ST elevations, Loss of R wave lesser is the LVEF and this can be used to predict the LVEF in patients of Myocardial Infarction based on ECG findings. **KEYWORDS:** LVEF (Left ventricular ejection fraction), AWMI (Anterior wall myocardial infarction), IWMI (Inferior wall myocardial infarction)

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 08, 2023

INTRODUCTION

Ischemic heart disease (IHD) is a condition where there is an inadequate supply of blood and oxygen to a portion of the myocardium; it typically occurs when there is an imbalance between myocardial oxygen supply and demand [1.] Ischaemic Heart Disease (IHD) causes 25-30% of mortality in industrialised countries [2] .The 1-year mortality rate after AMI is ~15%. Mortality is fourfold higher in elderly patients (aged >75) as compared with younger patients [3].Myocardial infarction is one of the major manifestation of coronary artery disease, namely stable angina pectoris, unstable angina pectoris, myocardial infarction, heart failure and sudden death [4] .

Acute myocardial infarction (AMI) is a major cause of morbidity and mortality worldwide. Despite significant improvement in the past decades, still a majority of patients subsequently suffer from LV dysfunction and heart failure [5,6]. LVEF is a major predictor of long term prognosis after both ST-elevation and Non ST-elevation myocardial infarction.

The 12-lead electrocardiogram (ECG) is a pivotal diagnostic and triage tool because it is at the centre of the decision pathway for management, allowing distinction of those patients presenting with ST-segment elevation from those presenting without ST-segment elevation [7] .The ECG, due to its wide availability, low cost and simplicity, is useful for the diagnostic and prognostic stratification of ST- segment elevation myocardial infarction (STEMI) [8].

2D-ECHO is excellent for detecting early changes occurring in Acute Myocardial Infarction [9]. 2D-ECHO is used in the management of patients with myocardial infarction. With color flow Doppler it can assess left and right ventricular function and other cardiac parameters. It is the preferred test to measure the LVEF, since it can detect other abnormalities that are associated with a worse prognosis.

AIMS AND OBJECTIVES

- To collect parameters predicted by ECG and ECHOCARDIOGRAPHY in patients with myocardial infarction.
- To find out correlation between ECG changes and LVEF.
- Prediction of LVEF from ECG in patients with Myocardial Infarction.

MATERIALS AND METHODS

The study entitled Correlation of ECG changes with LVEF in patients with Myocardial Infarction: An observational study was carried out in the Department of Medicine and Department of Cardiology in J.A. Group of Hospitals, Gwalior on an in and outpatient basis from January 2021 to August 2022.

The study included patients admitted in JAH Group of Hospitals confirmed to have Myocardial Infarction.

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 08, 2023

Study Place : JAH & KRH and Department of Medicine and Department of Cardiology

Duration of study: January 2021 to August 2022

Study design: The study was a hospital based observational study which included indoor and outdoor patients diagnosed as Myocardial Infarction based on a combination of history, clinical findings, ECG, Cardiac biomarkers and ECHO.

Sample size: The study comprise minimum 200 patients admitted in Department of Medicine and Department of Cardiology, J.A. Group of Hospitals.

Sample size calculation: Sample size was calculated on the basis of the study done by Somani AP et Al [10] by using following formula:

$$\frac{Z^2\ 1-a/2\ p\ (1-p)}{d^2}$$

p = sensitivity of ECG for diagnosing CAD from previous study= 51.5% = 0.515140
d = desired margin of error = 0.07
a = 0.05 (2 sided)
Z0.025 = 1.96

The sample size turned out to be 195.3. Thus, 200 patients were taken in study.

Method of collection of data:-

In all cases written informed consent was obtained from each subject. A detailed clinical history and physical examination was done and findings were recorded. All the patients in the study were subjected to ECG and ECHOCARDIOGRAPHY to confirm the presence of Myocardial Infarction and to record ECG changes and LVEF. ECG was recorded on a standard paper at a speed of 25mm/sec and was taken at the time of admission for the diagnosis of myocardial infarction and at 24 hours. 2D-ECHO was performed at the earliest to calculate LVEF (0, 24 hours). All patients were investigated for exclusion criteria.
ECG changes that were taken for comparison are–

1) QS complex
2) ST elevation
3) Loss of R wave

Inclusion criteria:

1. Patients age 18 years and above and WHO criteria for the diagnosis of acute MI were included -
   - A history of ischaemic type of chest pain
   - Evolutionary changes on serially obtained ECG tracings
   - A rise and fall in serum cardiac markers

Exclusion criteria:

1. Patients with age below 18 years of age.
2. Patients presenting with:
   - Valvular heart disease

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 08, 2023

- Cardiomyopathy
- Pericardial diseases
- Congenital heart disease

3. Previous cardiac surgery were excluded from study
4. Subjects who do not provide consent for the study.
5. Chronic Kidney Disease, Chronic liver disease, Severe anaemia and other co-morbid condition.

Statistical Analysis

Statistical Analysis was done using SPSS 2.0 and graphs were generated by Microsoft Excel and Word. A p value of less than 0.05 was considered significant.

OBSERVATION AND RESULT

Table 1: Gender wise distribution of cases

Gender	Number	Percentage
Male	170	85.00%
Female	30	15.00%
Total	200	100%

Table 2 : Age wise distribution of cases

Age	Number	Percentage
18-35	17	8.5%
36-50	58	29.0%
51-64	82	41.0%
65 and above	43	21.5%

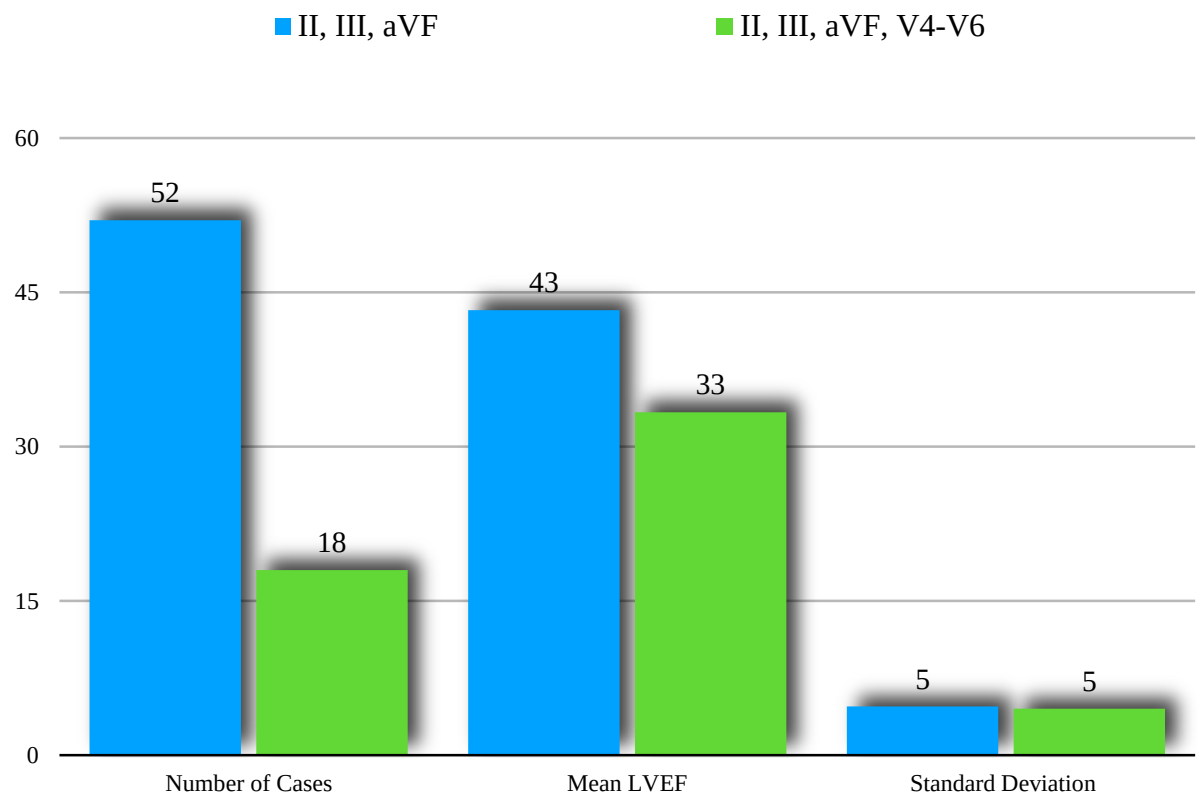
Table 3: Co-morbidities in patients with Myocardial infarction

Type of MI	Comorbidities			
	Diabetes	**Hypertension**	**Smoking**	**Alcohol**
AWMI	8	14	24	16
IWMI	5	2	16	10
Total	13 (6.5%)	16 (8%)	40 (20%)	26 (13%)

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 08, 2023

Table 4 : Correlation of QS complex with LVEF in IWMI

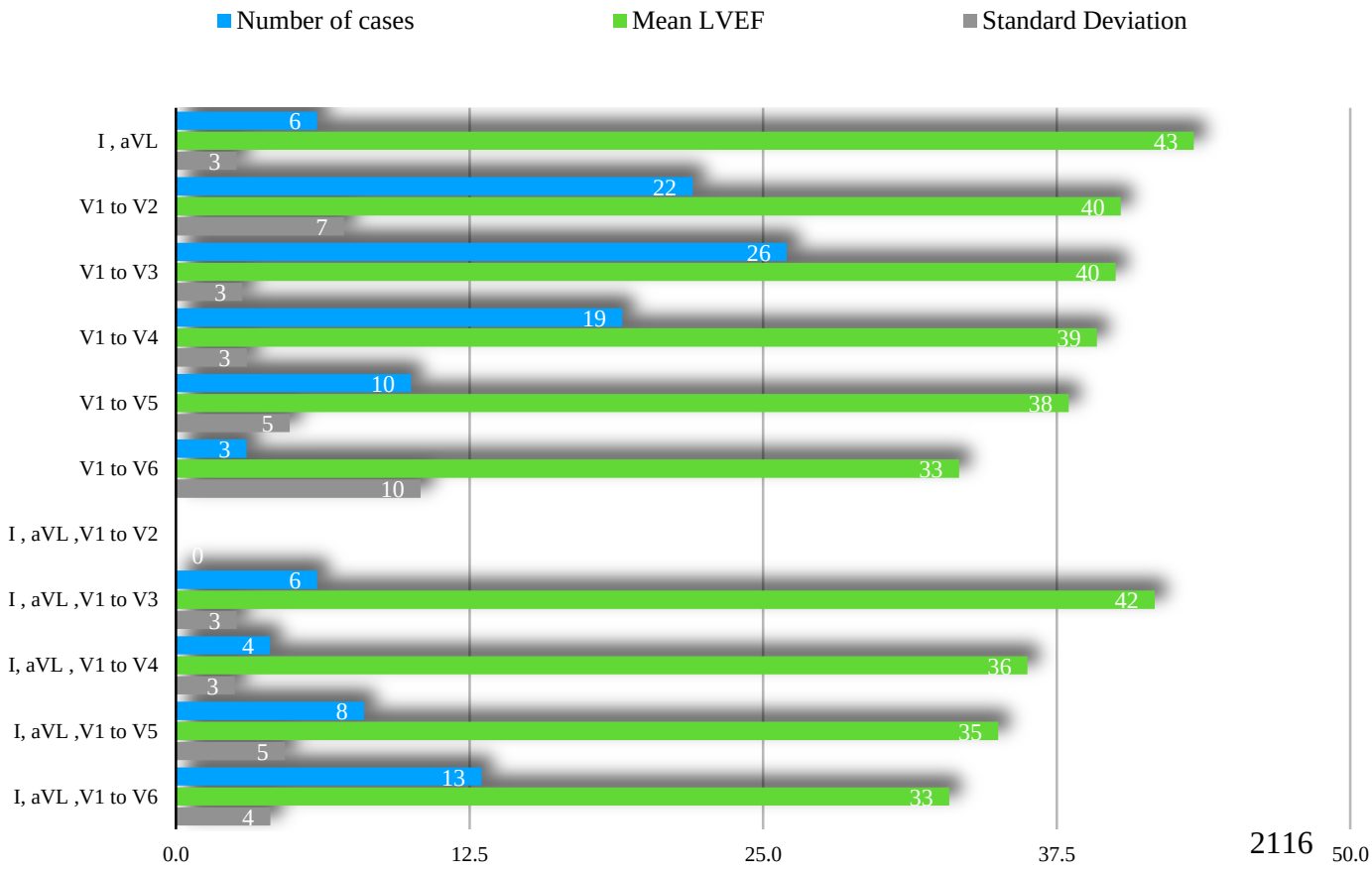
QS complex	Number of cases	Mean LVEF	Standard Deviation	P value
II , III	0	0	0	<0.001
II , aVF	0	0	0	
III , aVF	0	0	0	
II, III, aVF	52	43.269	4.7367	
II, III, aVF , V_4 - V_6	18	33.333	4.5374	



ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 08, 2023

Table 5 : Correlation of QS complex with LVEF in AWMI

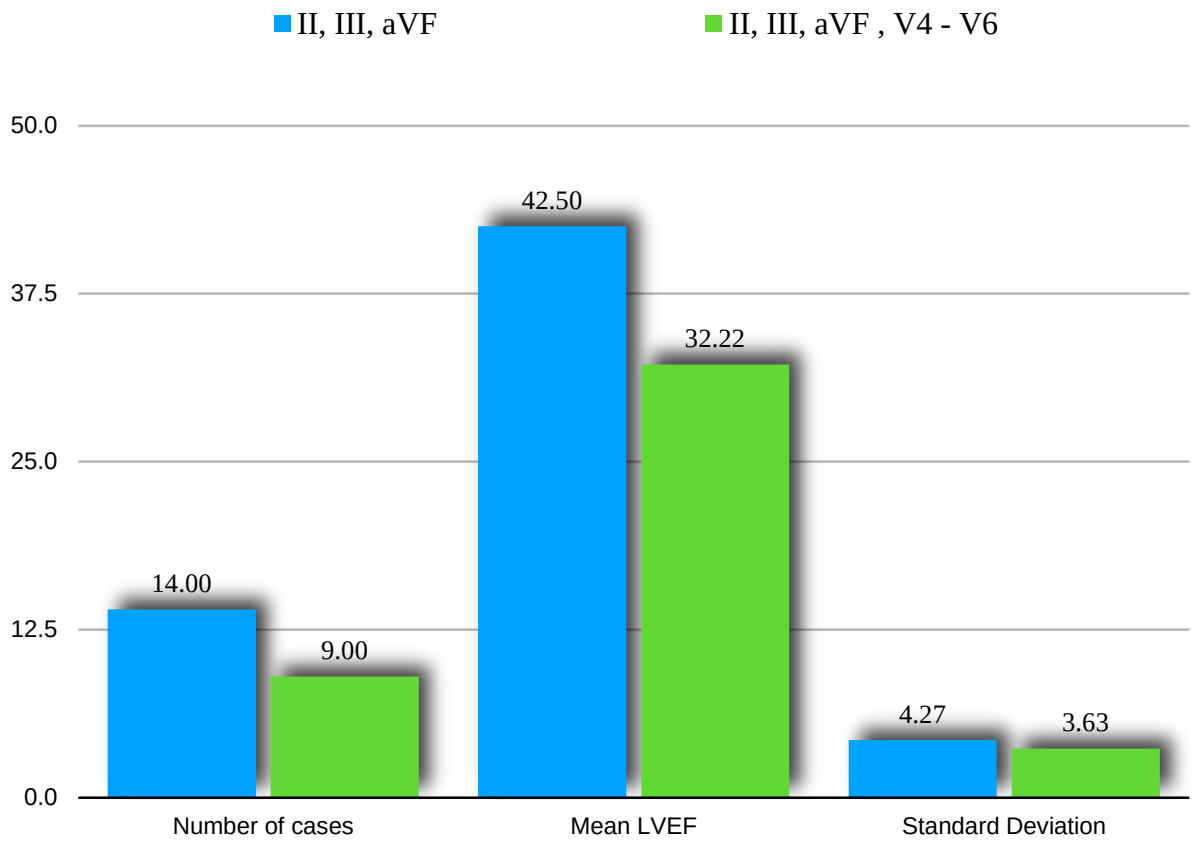
QS complex	Number of cases	Mean LVEF	Standard Deviation	P value
I , aVL	6	43.333	2.5820	<0.001
V_1 to V_2	22	40.227	7.1510	
V_1 to V_3	26	40.000	2.8284	
V_1 to V_4	19	39.211	3.0107	
V_1 to V_5	10	38.000	4.8305	
V_1 to V_6	3	33.333	10.4083	
I , aVL ,V_1 to V_2	0	0	0	
I , aVL ,V_1 to V_3	6	41.667	2.5820	
I, aVL , V_1 to V_4	4	36.250	2.5000	
I, aVL ,V_1 to V_5	8	35.000	4.6291	
I, aVL ,V_1 to V_6	13	32.923	4.0096	



ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 08, 2023

Table 6 : Correlation of ST elevation with LVEF in IWMI

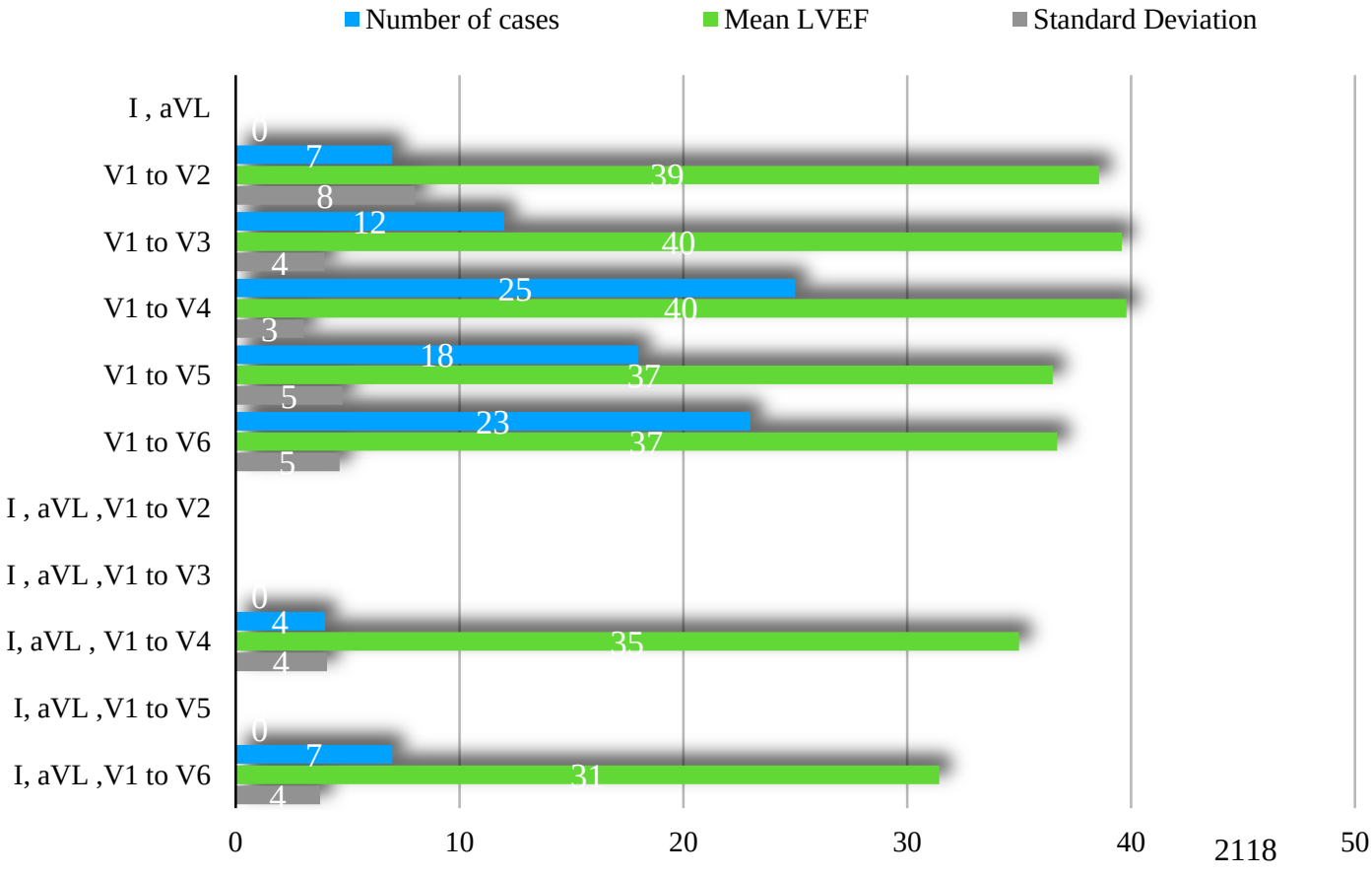
QS complex	Number of cases	Mean LVEF	Standard Deviation	P value
II , III	0	0	0	<0.001
II , aVF	0	0	0	
III , aVF	0	0	0	
II, III, aVF	14	42.500	4.2743	
II, III, aVF , V_4 - V_6	9	32.222	3.6324	



ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 08, 2023

Table 7: Correlation of ST elevation with LVEF in AWMI

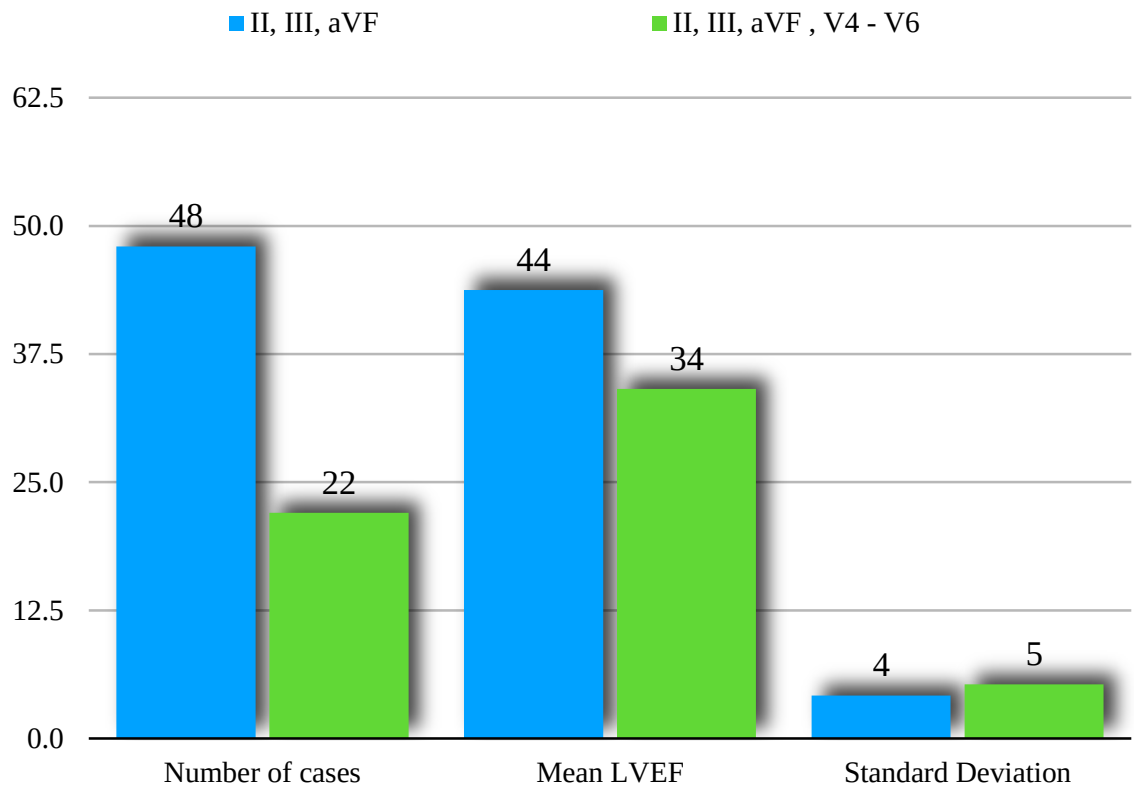
QS complex	Number of cases	Mean LVEF	Standard Deviation	P value
I , aVL	0	0	0	<0.001
V_1 to V_2	7	38.571	8.0178	
V_1 to V_3	12	39.583	3.9648	
V_1 to V_4	25	39.800	3.0551	
V_1 to V_5	18	36.500	4.7805	
V_1 to V_6	23	36.696	4.6460	
I , aVL ,V_1 to V_2	0	0	0	
I , aVL ,V_1 to V_3	0	0	0	
I, aVL , V_1 to V_4	4	35.000	4.0825	
I, aVL ,V_1 to V_5	0	0	0	
I, aVL ,V_1 to V_6	7	31.429	3.7796	



ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 08, 2023

Table 8 : Correlation of Loss of R wave with LVEF in IWMI

QS complex	Number of cases	Mean LVEF	Standard Deviation	P value
II , III	0	0	0	<0.001
II , aVF	0	0	0	
III , aVF	0	0	0	
II, III, aVF	48	43.750	4.1897	
II, III, aVF , V_4 - V_6	22	34.091	5.2636	



ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 08, 2023

Table 9 : Correlation of Loss of R wave with LVEF in AWMI

QS complex	Number of cases	Mean LVEF	Standard Deviation	P value
I , aVL	3	41.667	2.8868	<0.001
V_1 to V_2	11	40.000	7.7460	
V_1 to V_3	33	40.152	4.2362	
V_1 to V_4	30	39.167	3.4947	
V_1 to V_5	13	39.000	4.9666	
V_1 to V_6	3	33.333	10.4083	
I , aVL ,V_1 to V_2	0	0	0	
I , aVL ,V_1 to V_3	5	43.000	2.7386	
I, aVL , V_1 to V_4	3	38.333	2.8868	
I, aVL ,V_1 to V_5	4	31.250	2.5000	
I, aVL ,V_1 to V_6	17	34.294	4.4408	

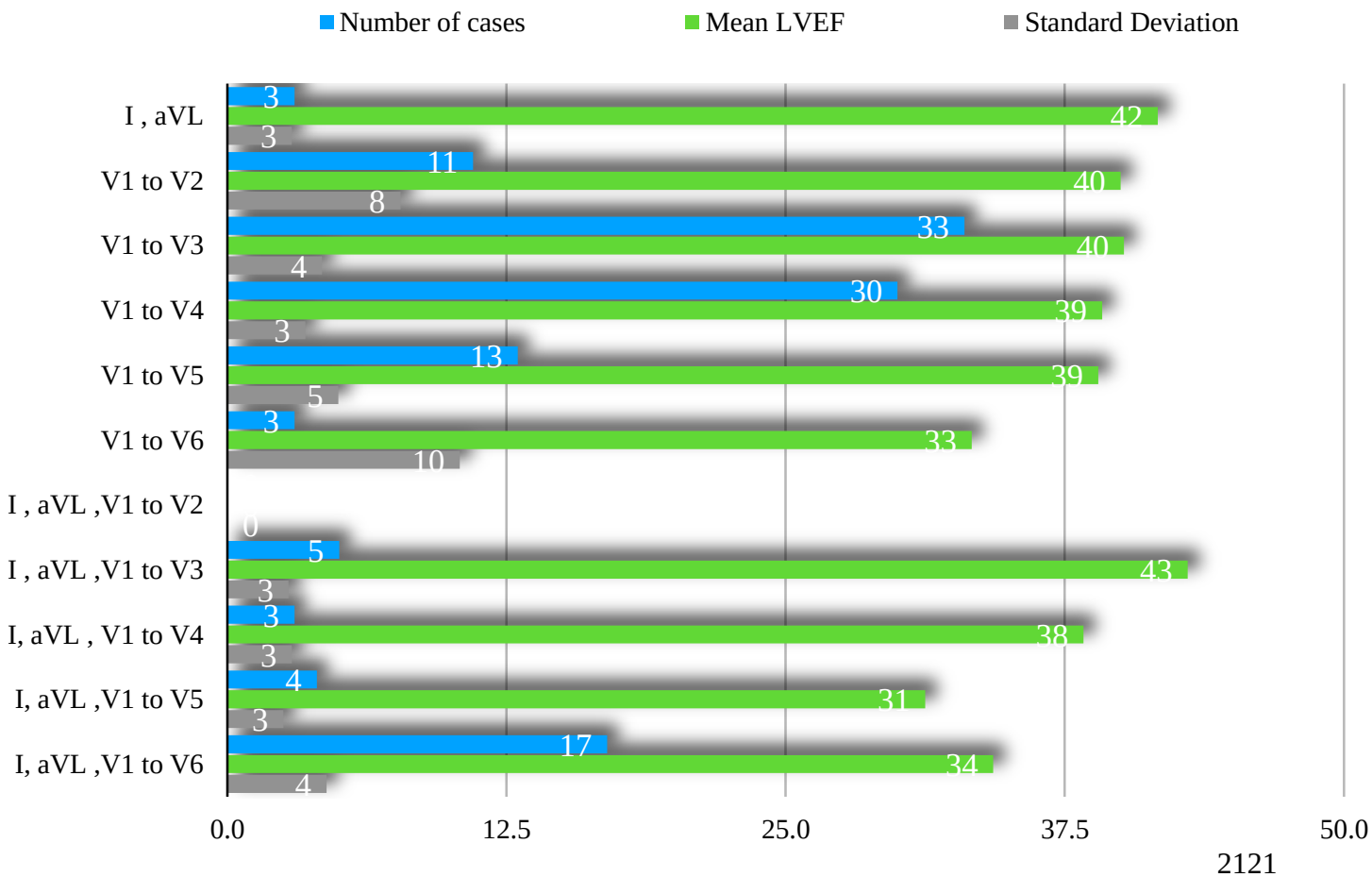
ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 08, 2023

DISCUSSION

In our study 200 patients from OPD as well as IPD were studied. The age ranged from 24-85 years. A total of 170 patients were male (85%) and 30 patients were female (15%) .This is in accordance with many studies that show male preponderance for coronary artery disease[11,12].

This is in accordance with study done by **AC Sanjay Reddy et al.**[13] in which males were 72.7% and females were 27.3 % .The maximum number of cases were noted in 51-64 years (82 cases) . The minimum number of cases were seen in age group 18-35 years (17 cases). This is in accordance with AC Sanjay Reddy et al.[13] In which least cases were noted in 31-40 years (10 cases) .Among risk factors , we found that smoking was the commonest risk factor (20%) followed by alcohol (13%), hypertension (8%), diabetes (6.5%). This is in accordance with **AC Sanjay Reddy et al.**[13] which also shows smoking as the commonest risk factor (52.5%).

The patients were categorised into AWMI and IWMI on the basis of ECG and 2D ECHO



ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 08, 2023

and a comparison was done between ECG changes and LVEF. Among all cases AWMI were 63.5% (127 cases) and IWMI were 36.5% (73 cases). This is in accordance with **AC Sanjay Reddy et al.**[13] In which out of 99 cases 44 had AWMI , 15 has ASMI 35 patients had IWMI , 2 had Anteroinferior MI , 2 had PWMI and 1 had RVMI. In our study LVEF was assessed using 2D ECHO.

Among all cases of AWMI maximum number (118 cases) were having an LVEF between 30-45% , 5 cases had severe LV dysfunction with LVEF <30% and 4 cases had LVEF between 45-55% .

Similarly in IWMI maximum cases (63 cases) were having an LVEF between 30-45%, 9 cases had mild LV dysfunction with LVEF between 45-55% and 1 case had LVEF< 30%. The ECG changes that were taken for comparison included QS complexes, ST elevation, Loss of R wave.

Correlation of QS complex with LVEF in myocardial infarction - In our study as shown in table 4 QS complex was correlated with LVEF in IWMI, out of all cases 52 cases had QS complex in leads II, III, aVF with mean LVEF of 43.269% and 18 cases had QS complex in leads II, III, aVF , V_4-V_6 with mean LVEF of 33.333% . This shows that more the lead involvement in IWMI lesser is the LVEF.

Similarly in Table 5 showing correlation with AWMI. Out of all cases 6 cases with QS complex in lead I, aVL had mean LVEF of 43.333%, 22 cases with QS complex in lead V_1-V_2 had mean LVEF of 40.227%, 26 cases with QS complex in lead V_1-V_3 had mean LVEF of 40.000 %, 3 cases with QS complex in lead V_1-V_6 had mean LVEF of 33.333% and 13 cases with QS complex in lead I, aVL, V_1-V_6 had mean LVEF of 32.923%. This shows that more the lead involvement in AWMI lesser is the LVEF.

Correlation of ST elevation with LVEF in Myocardial Infarction - In our study as shown in table 6 ST elevation was correlated with LVEF in IWMI, out of all cases 14 cases had ST elevation in leads II, III, aVF with mean LVEF of 42.500 % and 9 cases had ST elevation in leads II, III , aVF , V_4-V_6 with mean LVEF of 32.222 % . From this we found that more the lead

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 08, 2023

involvement in IWMI lesser is the LVEF. In a study done by **V Kiron et al.**[14] Correlating cumulative ST elevation with left ventricular ejection fraction and 30- day outcome in patients with STEMI, they found that there was a good inverse correlation between the STE at admission and the LVEF. This correlation was consistent across all types of STEMI and was best among patients with inferior MI. Similarly in a study done by **Jia X et al.**[15] on correlation of ST changes in leads V_4-V_6 to area of ischaemia by CMR in inferior STEMI , they found that in inferior STEMI , ST changes in the precocial leads V_4-V_6 , especially ST elevation, correlated with greater myocardial injury. Similarly patients with ST elevation had lower ejection fraction compared to those without ST changes in these leads.

Similarly in Table 7 showing correlation with AWMI. Out of all cases 12 cases with ST elevation in lead V_1-V_3 had mean LVEF of 39.583 % , 25 cases with ST elevation in lead V_1-V_4 had mean LVEF of 39.800 %, 23 cases with ST elevation in lead V_1-V_6 had mean LVEF of 36.696 % and 7 cases with ST elevation in lead I, aVL, V_1-V_6 had mean LVEF of 31.429 %. From this we found that more the lead involvement in AWMI lesser is the LVEF. This is supported by study done by **Fabiszak T et al.**[16] in which they did assessment of selected baseline and Post PCI ECG parameters as predictors of left ventricular systolic dysfunction after a first STEMI, the study found that anterior location of STEMI , higher baseline number of pathological Q waves were associated with lower values of LVEF.

Correlation of Loss of R wave with LVEF in Myocardial Infarction - In our study as shown in table 8 Loss of R wave was correlated with LVEF in IWMI, out of all cases 48 cases had Loss of R wave in leads II, III, aVF with mean LVEF of 43.750 % and 22 cases had Loss of R wave in leads II, III, aVF , V_4-V_6 with mean LVEF of 34.091 %.This shows that more the lead involvement in IWMI lesser is the LVEF.

Similarly in Table 9 showing correlation with AWMI. Out of all cases 3 cases with Loss of R wave in lead I, aVL had mean LVEF of 41.667 % , 11 cases with Loss of R wave in lead V_1-V_2 had mean LVEF of 40.000 % , 33 cases with Loss of R wave in lead V_1-V_3 had mean LVEF of

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 08, 2023

40.152 %, 30 cases with loss of R wave in V_1-V_4 had mean LVEF of 39.167 %, 3 cases with Loss of R wave in lead V_1-V_6 had mean LVEF of 33.333% and 17 cases with Loss of R wave in lead I, aVL, V_1-V_6 had mean LVEF of 34.294 %. This shows that more the lead involvement in AWMI lesser is the LVEF. In a study done by **Askenazi J et al.**[17] on value of QRS complex in assessing left ventricular ejection fraction , The sum of R waves (in mv) in leads aVL, aVF and V1 to V6 (ΣR) was correlated with left ventricular ejection fraction (EF) and the augmented ejection fraction (EFa). Among patients with ΣR of < 4.0 mv, augmented ejection fraction was less than 0.45 in 73 percent; among patients with ΣR of 4.0 mv or more the augmented ejection fraction was > 0.45 in 93 percent ($P < 0.001$).

Conflict of Interest - Nil

CONCLUSION

1) In our study we collected three ECG parameters in a 12 lead ECG, these include QS complexes, ST elevation, Loss of R wave and LVEF was calculated using 2D ECHO in patients with Myocardial infarction.
2) From our study we concluded a negative correlation between QS complex and ST elevation with Left Ventricular Ejection Fraction. Loss of R wave also showed a negative correlation with Left Ventricular Ejection Fraction but it was not as consistent as observed in cases of QS complex and ST elevation.
3) Thus we conclude that more the ECG leads showing QS complexes, ST elevations, Loss of R wave lesser is the Left Ventricular Ejection Fraction and this can be used to predict the LVEF in patients of Myocardial Infarction based on ECG findings alone in settings where 2D ECHO is not available or can not be used and thus can help in better treatment of the patient.

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 08, 2023

SUMMARY

The present study entitled “Correlation of ECG changes with LVEF in patients with Myocardial Infarction: An observational study” was done in Department of Medicine and Department of Cardiology, JAH and KRH. The study was started after obtaining approval from the Institutional Ethical Committee.

The study consisted of 200 patients of MI attending OPD as well as IPD and serial ECG and 2D ECHO of the patients were done. All patients above 18 years and WHO criteria for MI is fulfilled were taken after ruling out the exclusion criteria. Majority of the patients were male in age group 51-64 years and majority of the cases were AWMI. Smoking was found to be the commonest risk factor followed by alcohol, hypertension and diabetes mellitus. There ECG parameters (QS complexes, ST elevation, Loss of R wave) were taken and correlation was done with left ventricular ejection fraction obtained from 2D ECHO. There was negative correlation between QS complex and LVEF, ST elevation and LVEF also showed a negative correlation, while loss of R wave also showed negative correlation with LVEF but it was not as consistent as seen with the other two.

BIBLIOGRAPHY

1. Elliott M. Antman, Joseph Loscalzo Ischemic Heart Disease - Harrison’s Principles of Internal Medicine , 22nd Edition.
2. Park K Cardiovascular diseases- Park’s Text Book of Preventive and Social Medicine 24th edition.
3. Elliott M. Antman, Joseph Loscalzo ST-Segment Elevation Myocardial Infarction- Harrison’s Principles of Internal Medicine , 22nd Edition.
4. Mendis S, Thygesen K, Kuulasmaa K, Giampoli S, Mähönen M, Blackett KN, et al. World Health Organization definition of myocardial infarction: 2008-09 revision. Int J Epidemiol 2011; 40:139-46.
5. J. Chen, A. F.-C. Hsieh, K. Dharmarajan, F. A. Masoudi, and H. M. Krumholz, “National trends in heart failure hospitalization afer acute myocardial infarction for medicare beneficiaries 1998-2010,” Circulation, vol. 128, no. 24, pp. 2577–2584, 2013.
6. J. Hung, T. K. Teng, J. Finn et al., “Trends From 1996 to 2007 in Incidence and Mortality Outcomes of Heart Failure After Acute Myocardial Infarction: A Population-Based Study of 20812 Patients With First Acute Myocardial Infarction in Western Australia,” Journal of the American Heart Association, vol. 2, no. 5, pp. e000172–e000172, 2013.
7. Elliott M. Antman, Joseph Loscalzo ST-Segment Elevation Myocardial Infarction- Harrison’s Principles of Internal Medicine , 22nd Edition page - 2030 -31.

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 08, 2023

8. Brignole M, Auricchio A, Barón-Esquivias G, Bor-dachar P, Boriani G, Breithardt OA, et al. Guía de práctica clínica de la ESC 2013 sobre estimulación cardiaca y terapia de resincronización cardiaca. Rev Esp Cardiol 2014; 67(1):58.1-60.
9. Lundgren C, Bourdillon PD, Dillon JC, Felgenbaum H. Comparison of contrast angiography and two-dimensional echocardiography for the evaluation of left ventricular regional wall motion abnormalities after acute myocardial Infarction.Am J Cardiol. 1990;65:1071-77.
10. Somani AP, Khadse SR, Kumar S, Acharya S, Gattani SC, Baheti AH. Correlation of ECG Changes with Coronary Angiographic Findings in Patients of Coronary Artery Disease. Journal of Evolution of Medical and Dental Sciences. 2020 Aug 3;9 (31):2212-7.
11. Learner and Kannel. Patterns of coronary heart disease morbidity and mortality in the sexes-A26 year follow up of Framingham study. Am Heart J. 1986; 111:383-9
12. Sudhir B, Abdul Y. Left ventricular thrombi after acture myocardial infarction. Post Graduate Medical Journal. 1983 Aug; 59:495-99.
13. Reddy ACS, Pandiyan TR, Rao S, Reddy YJV, Dhananjaya PE.Correlation of Standard ECG with 2D-Echo and Serum Troponin I in Locating the Site of Myocardial Infarction and its Extent- An Observational StudyJ Clin of Diagn Res.2022; 16(3):OC05-OC09. https://www.doi.org/10.7860/JCDR/2022/53075/16071
14. Kiron V, George PV. Correlation ofcumulative ST elevation with left ventricular ejection fraction and 30-day outcome in patients with ST elevation myocardial infarction. Journal of Postgraduate Medicine. 2019 Jul 1;65(3):146-51.
15. Jia X, Heiberg E, Ripa MS, Engblom H, Halvorsen S, Arheden H, Atar D,Clemmensen P, Birnbaum Y. Correlation of ST changes in leads V4-V6 to area of ischemia by CMR in inferior STEMI .Scandinavian cardiovascular journal: SC.2018 Aug; 52(4):189-95.
16. Fabiszak T, Kasprzak M, Kozinski M, Kubica J. Assessment of Selected Baseline and Post-PCI Electrocardiographic Parameters as Predictors of Left Ventricular Systolic Dysfunction after a First ST-Segment Elevation Myocardial Infarction. Journal of clinical medicine. 2021 Nov 22;10(22):5445.
17. Askenazi J, Parisi AF, Cohn PF, Freedman WB, Braunwald E. Value of the ORS complex in assessing left ventricular ejection fraction. The American journal of cardiology. 1978 Mar; 41 (3):494-9.