Variations In Electrocardiographic Changes Across Different Spectrums Of Heart Failure

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Abstract

Objective: Study aims to compare the electrocardiographic (ECG) abnormalities in patients of heart failure presenting with different spectrum of syndrome based upon value o f ejection fraction.

Methods: This was a retrospective cross-sectional study based on previous record and new cases collected from Department of cardiology, Benazir Bhutto Hospital. Consecutive sampling was done and data of patients with HF who were admitted or visited outdoor clinics of hospital was collected. The data was entered and analyzed in SPSS version 25.

Results: The study found that male and female heart failure patients have different EF distributions. EF is more likely to be reduced in men and mildly in women. Age was also associated with cardiomyopathy (p=0.022). There was a significant association between smoking and the development of heart failure. Heart failure patients with reduced ejection fraction (HFrEF) have longer PR and QT intervals, ST segment elevation, and T wave inversion. The study found that arrhythmia distribution differed by ejection fraction. HFrEF patients had a higher rate of atrial fibrillation (3%) and flutter (8%) than HFpEF or HFmrEF patients.

Conclusion: We found that patients with HFrEF are more likely to have ECG abnormalities and arrhythmias than patients with other types of heart failure. Early detection and treatment of arrhythmias can help to prevent serious complications.

Keywords: Heart failure, ECG, Ejection Fraction, Arrhythmia.

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1. Introduction

Heart failure is a condition of progressive nature, marked by a decrease in the heart's capacity to pump blood efficiently, which can cause a number of symptoms, such as fatigue, edema, and shortness of breath.[1] It is considered to be a threat to human on global scale as it is estimated, that there will be 80 million people living with HF by year 2030, which would have surpassed the current prevalence of 64.3 million.[2] At the moment there are around 2.8 million patients of HF in Pakistan, which is thought to increase threefold to almost 8 million in 2030.[3] The incidence and prevalence of HF are on the rise, due in part to an aging population and improved survival rates for people with other chronic cardiovascular diseases. Despite advances in treatment, HF mortality remains high, particularly in older patients with multiple comorbidities.

About half of heart failure patients have an ejection fraction (EF) of 50% or greater, which is considered to be "preserved" (HFpEF).[4] Diastolic dysfunction, a condition that impairs the heart's ability to relax and fill with blood, is thought to be the main cause of HFpEF. Patients with HFpEF are typically aged, more likely to be women, and more likely of having a prior history of uncontrolled blood pressure than patients with HF with reduced EF (HFrEF) with an ejection fraction of less than 40%. (5) They may also have a decreased mortality risk than patients with HFrEF, but this is not always the case.

ECG and echocardiography are two important tools used to diagnose and manage HF patients. ECG provides information about the heart's electrical activity, while echocardiography allows clinicians to visualize the heart's structure and function. The correlation between ECG changes, echocardiographic parameters, and cardiovascular mortality is of paramount importance in risk stratification and patient management. Studies have demonstrated that in HF patients, prolonged QT interval is often observed in HF patients, indicating delayed repolarization.[6] Similarly, ECG may show STsegment depression or elevation in HF patients, indicating myocardial ischemia or injury. These changes can have significant prognostic implications and may guide further management strategies. Additionally, a study indicated that HFrEF patients with QRS prolongation, especially those with LBBB, tend to have worse outcomes. QRS duration ≥ 150 msec is associated with a higher risk of sudden cardiac death and overall mortality.[7]

There is a need for a local study in Pakistan on variations in ECG changes, their correlation with

echocardiographic parameters and cardiovascular mortality across different spectrums of heart failure. This is because the prevalence of heart failure is increasing in Pakistan, and the clinical presentation and management of heart failure may differ from that in other countries. The results obtained from this study could be used to develop more accurate risk stratification tools for heart failure patients.

2. Materials & Methods

This cross-sectional study was conducted at the Department of Cardiology at Benazir Bhutto Hospital Rawalpindi. The study recruited approximately 100 patients with HF who were recruited consecutively over a period of 1 month. The study's inclusion criteria were individuals over the age of 18 years with heart failure from any etiology, classified according to the New York Heart Association (NYHA) functional classes I–IV. Participants with massive pericardial effusion, congenital heart disease, acute coronary syndrome, primary valve disease, severe pulmonary diseases (Cor-pulmonale, pneumothorax), those with pacemakers installed, and individuals with malignancy were excluded from the study. The data collected comprised demographic information, clinical examination results, electrocardiogram readings, and echocardiographic findings. The demographic information covered age, gender, and medication history, while the clinical data included the determination of the NYHA class. ECG was recorded on patients lying supine, when standard 12 leads were applied by a trained clinical assistant. Bionet Cardio care EKG-2000 machine was employed to take the recordings of ECGs. Experienced cardiologist, who were unaware of the echocardiogram results, interpreted the ECGs. The ECG report evaluated heart rate and rhythm, axis of deviation in heart, enlargement of heart chamber, changes in ST-T segment, intraventricular blockage, QT, and QTc intervals and the duration of the QRS complex. Any QRS complex which lasted more than 100 msec was considered wide QRS complex.

Echo was used to information like determination the ejection fraction (which was calculated by using method devised by Simpson) and identification the diastolic dysfunction. Heart failure was categorized into three groups: HF with preserved ejection fraction (HFpEF), HF with mid-range ejection fraction (HF mid-range), and HF with reduced ejection fraction (HFrEF). The diagnostic criteria for HFpEF, HF mid-range EF, and HFrEF were ≥ 50%, 40-49%, and <40% ejection fraction, respectively. The study subjects were then divided into three groups accordingly: the HFpEF group, the HF mid-range group, and the HFrEF group.

Statistical Analysis

The data was analyzed using SPSS version 25.0. Qualitative data like premorbid, gender, NYHA classification was presented in form of percentage and frequency while the Quantitative data like the age, echocardiography parameters and electrocardiography parameters were presented in Mean ± SD). Means were compared using student's t-test while the association and its significance among categorical variables was determined by using Chi-squared test. A P value less than or equal to 0.05 was considered statistically significant.

3. Results

The study included 100 heart failure patients who fulfilled inclusion criteria. The distribution of EF in male patients with heart failure showed that majority of male patients (83.3%) had reduced EF, while 3.3% had mildly reduced EF and 13.3% had severely reduced EF. While in female patients (72.5%) had reduced EF, while 17.5% had mildly reduced EF and 10% had severely reduced EF (Figure-1).

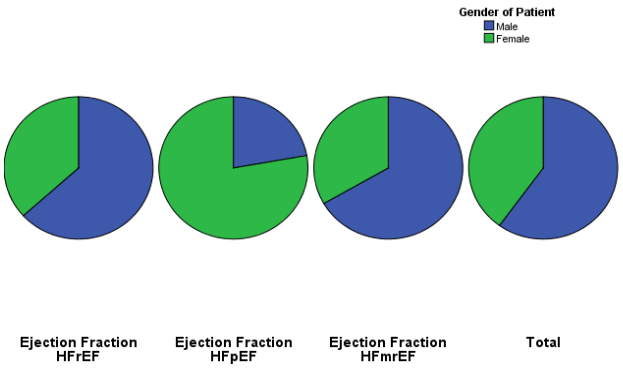

Figure 1: Gender wise distribution with respect to ejection fraction.

There was a significant difference in the distribution of EF between male and female patients with heart failure. Male patients are more likely to have reduced EF, while female patients are more likely to have mildly reduced EF (p value stood at 0.042). Age range for HF patients spanned between 22 to 90 years with mean age being 61.31±11.19 years. Majority of patients lie in age group

between 40-65 with a statistically significant p value of 0.022 (Figure-2).

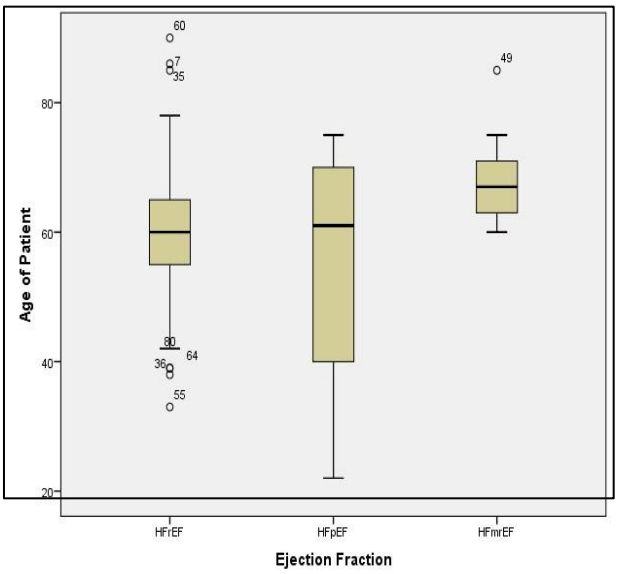

Figure 2: Age -wise distribution with Heart Failure

When patients were classified according to cardiomyopathy, it was discovered that 28% of patients had no cardiomyopathy, compared to 41% who had DCMP and 31% who had ICMP.

60% of the patients had diabetes mellitus, 69% percent had hypertension, and 46% of subjects were found to be smokers upon assessing the data for possible risk factors. A statistically significant association was found between smoking and the development of heart failure (p=0.037). However, both hypertension and diabetes mellitus did not show a significant risk, with p-values of 0.59 and 0.56, respectively.

ECG interpretation revealed that PR and QT interval were prolonged in 4% and 5% of patients, respectively, all of whom belonged to heart failure with reduced ejection fraction (HFrEF). The findings of study indicate that out of 16 patients (12 with HFrEF, 2 with HFpEF, and 2 with HFmrEF) displayed ST segment elevation, while the remaining 63 patients (50 with HFrEF, 7 with HFpEF, and 6 with HFmrEF) did not exhibit this feature. Among these 2 patients (both with HFrEF) had an elevation of 3 mm, 12 patients (8 with HFrEF, 2 with HFpEF, and 2 with HFmrEF) had an elevation of 1 mm, 1 patient (with HFrEF) had an elevation of 0.5 mm, and 1 patient (with HFrEF) had an elevation of 2.5 mm. The ST segment elevation was most commonly localized in V1, V2, and V3, in 12 patients.

There were 19% of cases which showed STdepression and their distribution was 13 cases in HFrEF, 2 cases in HFpEF, and 4 cases in HFmrEF. Most of times depression noted up-to 1 mm, with 63.3% showing depression belonging to HFrEF, group. The inversion of T -wave was shown by 51% of total cases. Patients with reduced ejection fraction contributed most with 39 cases (76.74%) of total incidence. Patients who had medium range and preserved ejection fraction contributed with 13.72 and 9.8% respectively. This phenomenon was mostly depicted in leads V1-V6 (23.52%) and V4, V5, V6 (19.6%).

Of all patients, 56% had no axis deviation, 40% had left axis deviation, and 4% patients had right axis deviation. For the patients with left axis deviation, 34 had a HFrEF, 2 had a HFpEF, and 4 had a HFmrEF. Finally, for the patients with right axis deviation, 2 had a HFrEF and 2 had a HFpEF. In addition to axis deviation, the patients were also evaluated for left bundle branch block, right bundle branch block, and fascicular block. 16% of patients had left bundle branch block, 4% had right bundle branch block, and 8% had fascicular block. Of the patients with left bundle branch block, 15 had a HFrEF and 1 had a HFmrEF. For the patients with right bundle branch block, 3 had a HFrEF and 1 had a HFmrEF. Finally, for the patients with fascicular block, all 8 had a HFrEF.

3% of patients had atrial fibrillation, and all three had heart failure with reduced ejection fraction, 8% had atrial flutter, distributed as 6 patients with HFrEF, 1 with HFpEF, and 1 with HFmrEF. Only 2% of patients had atrial and ventricular tachycardia each, with all of them having reduced ejection fraction.

4. Discussion

This retrospective cross-sectional study investigated 100 cases of heart failure and provides valuable insights into variations in ECG changes, their correlation with echocardiographic parameters across different spectrums in Rawalpindi. The findings of study suggest that there is a significant difference in the distribution of EF between male and female patients with heart failure. Male patients are more likely to have reduced EF, while female patients are more likely to have mildly reduced EF. This difference in EF distribution may be due to a number of factors, including hormonal differences, differences in body size, and differences in the prevalence of risk factors for heart failure.(8) The study

also found that there was a statistically significant association between age and cardiomyopathy (p=0.022). This means that older patients are more likely to have cardiomyopathy.

According to our study, smoking significantly increased the risk of developing heart failure. According to the review of the literature, smoking and the onset of heart failure have a direct correlation. Smoking is a significant risk factor for heart failure and can multiply the likelihood of developing HF by 2 times. (9) In a literature review of 26 prospective studies, it was found that heart failure risk is increased by 75% for current smokers, 16% for former smokers, and 44% for ever smokers when compared with never smokers. (10) Furthermore, a 59% increase in heart failure risk was observed for current smokers when compared with non-current smokers. The study you mentioned revealed a significant association between smoking and the development of heart failure, as well as a decline in ejection fraction, which is a measure of how well the heart pumps blood and serves as a sign of heart failure.

The ECG findings in our study suggest that patients with HFrEF are more likely to have prolonged PR and QT intervals, ST segment elevation, and T wave inversion than patients with other types of heart failure. PR and QT intervals were found to be prolonged in 4% and 5% of patients, respectively, all of these patients had HFrEF. 6 patients (12 with HFrEF, 2 with HFpEF, and 2 with HFmrEF) had ST segment elevation. 19% of patients had ST segment depression. Of these, 13 patients had HFrEF, 2 patients had HFpEF, and 4 patients had HFmrEF. 51% of patients had T wave inversion. Of these, 39 patients had HFrEF, 7 patients had HFmrEF, and 5 patients had HFpEF. The most common ECG finding in patients with HFrEF was T wave inversion. ST segment elevation was also seen in a significant number of patients with HFrEF, but it was less common than T wave inversion. Prolonged PR and QT intervals were seen in a small number of patients with HFrEF. These ECG abnormalities are thought to be caused by the underlying structural and functional changes that occur in the heart in HFrEF. For example, prolonged PR interval and QRS duration are thought to be due to delayed conduction through the heart, which can occur as a result of myocardial hypertrophy or fibrosis. ST-segment depression and T-wave inversion are thought to be due to decreased myocardial perfusion, which can occur as a result of coronary artery disease. QT prolongation is thought to be due to a combination of factors, including electrolyte imbalance, medications, and underlying heart disease.[11,12]

The study found that the distribution of arrhythmias was different in patients with different ejection fractions. Patients with HFrEF had an elevated prevalence of atrial fibrillation (3%) and atrial flutter (8%) than patients with HFpEF or HFmrEF. Only 2% of patients in each group had atrial or ventricular tachycardia. These results of our findings are similar to previously published data showing an association between HFrEF and an increased risk of arrhythmias. In 2018, the Journal of the American College of Cardiology published a study indicating that patients with HFrEF had a higher likelihood of experiencing atrial fibrillation compared to patients with heart failure with preserved ejection fraction.(13) The increased risk of arrhythmias in patients with HFrEF is likely due to a number of factors, including: left ventricular remodeling, ischemic heart disease and patients with HFrEF often experience symptoms such as shortness of breath and fatigue.(13) These symptoms can lead to anxiety and stress, which can also trigger arrhythmias. The findings of this study highlight the importance of screening patients with HFrEF for arrhythmias. Early detection and treatment of arrhythmias can help to prevent serious complications, such as stroke and sudden cardiac death.

In addition to the findings mentioned above, the study also found that the mean septal wall thickness was 9.25±2.53. This suggests that the patients in the study had a relatively high degree of left ventricular hypertrophy, which is a common finding in patients with HFrEF. Left ventricular hypertrophy can also increase the risk of arrhythmias, so it is important to monitor patients with HFrEF for this condition.

Our study has different limitations as study was conducted in a single center, so the results may not be generalizable to other populations. The study was relatively small, so the results may not be statistically significant. Moreover, due to the absence of a control group in the study, it is not possible to definitively conclude that the observed ECG changes were solely attributed to heart failure. Despite these limitations, the study provides valuable insights into the ECG changes that are associated with heart failure. These findings can be used to help diagnose and manage patients with heart failure.

5. Conclusion

We found that patients with HFrEF are more likely to have ECG abnormalities and arrhythmias than patients with other types of heart failure. Early detection and treatment of arrhythmias can help to prevent serious complications.

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