ORIGINAL ARTICLE

Impact of Functional Class of Heart Failure on Severity of Ventricular Arrhythmia

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ABSTRACT

Objective: To study the impact offunctional class of heart failure (NYHA) on the severity of ventricular arrhythmias in patients with heart failurebased upon 48 hours ambulatory ECG (Holter) recordings.

Study Design: Descriptive cross sectional study.

Place and Duration of Study: Study was conducted at Armed Forces Institute of Cardiology/National Institute of Heart Diseases, from April 2013 to August 2013.

Materials and Methods: A descriptive cross sectional study was conducted at Armed Forces Institute of Cardiology/National Institute of Heart Diseases, from April 2013 to August 2013. In 53 heart failure patients' detailed history and 2 dimensional echocardiography were recordedto assess the functional class and left ventricular ejection fraction. Patients were then subjected to 48-hour Holter monitoring using ambulatory (Holter) electrocardiography recorders. Digital ECG data was acquired and manually edited. Arrhythmias were analyzed for frequency, type and severity. Statistical analysis was done to determine associations between arrhythmia severity and NYHA class of heart failure.

Results: Male: female ratio was 3.4: 1with mean age of 60 years. Mean ejection fraction was 21.69% and 86% patients had NYHA class III and IV. 57% of these patients also had severe cardiac arrhythmias.

Conclusion: Prevalence and severity of arrhythmias in heart failure is dependent upon degree of ventricular dysfunction and presenting NYHA functional class.There is a significantly higher prevalence of severe ventriculararrhythmias amongst patients with reduced ejection fraction and advanced NYHA functional class.

Keywords: *Arrhythmias, ambulatory ECG recording, NYHA, holter monitoring.*

Introduction

Heart failure is a complex clinical syndrome leading to the development of potentially worsening illness. Severity of disease is reflected by relatively high morbidity and mortality rates after the onset of symptomatic heart failure.[1] Most challenging feature in the management of heart failure is the meticulous identification of the patients with a poor prognosis who could benefit from intensive medical therapy or cardiac transplantation. There are number of factors responsible for development of potentially lethal arrhythmias and reduced survival rate in heart failure patients.[2] Early evaluation of sign and symptoms and ejection fraction are the primary assessments tools employed to determine cardiac dysfunction in heart failure patients. Cardiologists can predict survival in heart failure patients by evaluating the severity of cardiac dysfunction by assessing New York Heart Association (NYHA) functional class and left ventricular ejection fraction. Left ventricular ejection fraction not only helps in distinguishing diastolic heart failure from systolic heart failure it also assists in planning and monitoring of treatment in heart failure. Clinically evident heart failure due to systolic dysfunction is characterized by a significant reduction in left ventricular ejection fraction. It is generally not apparent until the left ventricular ejection fraction falls below 35 to 40 percent. However, some patients are asymptomatic even with left ventricular ejection fraction below 20 percent, while others are moribund with left ventricular ejection fraction above 30 percent.[3,4] In general reduced left ventricular ejection fraction is typically associated with poor survival due to both hemodynamic and electrical instability and mostly these patients are considered eligible for cardiac transplantation.[5] The NYHA classification is frequently used method to assess the functional class of heart failure patients. It has been employed in pharmacological studies to evaluate medical therapy and to establish mortality rates in heart failure. In various clinical trials high mortality rates were observed among patients with advanced NYHA functional class of heart failure.[6,7] It has been postulated that in heart failure mechanical factors such as dilated left ventricle and increased wall strain due to decreased ejection fraction can change the

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electrophysiological properties of cardiac tissue.[8,9] In advanced stages of heart failure ventricular dysfunction results in functional modifications of cardiac cells resulting in abnormal impulse formation and propagation leading to fatal arrhythmias and re hospitalization.[10] In animal model of heart failure it has been observed that mechanical stretch caused significant prolongation of action potential duration and membrane recovery time thus, increasing the incidence of arrhythmias.[11] In SOLVD (Studies of Left Ventricular Dysfunction) trial a direct correlation was found between increase in left ventricular end-diastolic volume, decrease left ventricular ejection fraction and the prevalence of ventricular arrhythmias.[12] Prolonged ambulatory ECG recordings are generally employed to evaluate myocardial weakness, autonomic nervous system imbalance and arrhythmias thus; it helps to predict mortality in progressive heart failure.[13] It has proved to be one of the most cost-effective clinical tools in the assessment of ventricular and supra-ventricular arrhythmias. The severity of arrhythmias is assessed using modified Lown grade classification system. It is based upon presence and number of premature ventricular contractions (PVCs) on Holter ECG recordings.[14,15]

Early recognition and management of acutely ill patients, aid in reducing the progression to severe disease and fatal arrhythmic complications.[16] Measurement of left ventricular ejection fraction or assessment of NYHA class is considered as an important tool in determining prognosis and estimating survival in heart failure. Keeping these in view present study was planned to study the association of electrical instability i.e. arrhythmogenesis with the severity of heart failure considering both the functional class and left ventricular ejection fraction with an objective to highlight the importance of early detection and timely management in improving the overall outcome of heart failure patients.

Materials and Methods

A descriptive, cross sectional study was conducted at Armed Forces Institute of Cardiology/National Institute of Heart Diseases, Rawalpindi (AFIC/NIHD), from April 2013 to August 2013. A formal approval was taken from Medical Ethics Committee of Army Medical College and Institutional Review Board of AFIC/NIHD, followed by an informed written consent from all the patients.53 patients with a diagnosis of chronic heart failure from either sex, having left ventricular ejection fraction $\leqslant$ 40 % were included in the study based upon convenience sampling. Careful history and clinical examination were recorded to assess the exact functional class of heart failure. For all the patients two dimensional echocardiography was carried out to confirm left ventricular ejection fraction. Patients fulfilling the inclusion criteria underwent ambulatory ECG recording for 48 hours using Holter monitors. Three different types of Holter recorders Life Card CF, DMS 300-4A and DMS 300-7A, available at AFIC/ NIHD, were used in this study. After 48 hours of recording, the digital ECG data was transferred from Holter recorders to the computer having compatible software. Out of three channels, the one which displayed best ECG recording and with least artifacts was selected. The data was edited with extreme care using visual checks and manual correction of all QRS complexes (individual beats). All the erroneous beats were identified and edited from data. After editing, the Holter ECG data was analyzed for site of origin, various types and severity of cardiac arrhythmias using 'Life card CF Holter software (pathfinder 700)'and 'DMS serial Holter software premier 12' compatible with Life Card CF and DMS 300-4A/DMS 300-7A respectively. Data was statistical analyzed using IBM SPSS version 21. Frequency and percentages were calculated for qualitative variables. Mean and standard deviation (SD) were calculated for quantitative variables. Chi-square test was applied to study association between ejection fraction, NYHA class and ventricular arrhythmias. P-value of < 0.05 was considered as significant.

Results

The mean age of patients was 57.68 ± 16.41 years and male to female ratio was 3.4:1.Mean ejection fraction (%) on 2 dimensional echocardiography 21.69 ± 6.3(Mean ± SD).42 out of 53 patients displayed evidence of ventricular arrhythmias during 48 hours Holter recording. Descriptive analysis of functional class of heart failure revealed 54.8 % patients had NYHA class III and 31% had NYHA class IV (Fig1). Most of the patients had advanced heart failure, evident by statistically significant correlation between NYHA and ejection fraction (p value < 0.05).

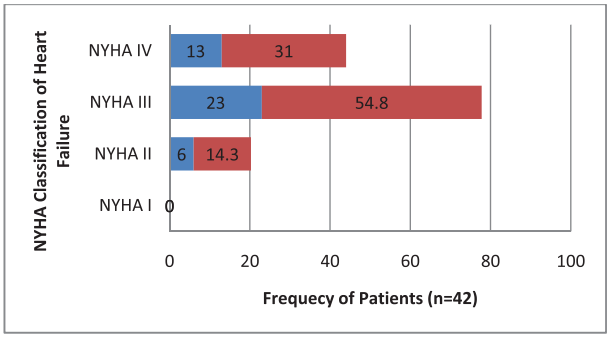

Fig 1: Frequency of heart failure patients according to NYHA Classification

Patients having arrhythmias were classified on the basis of severity of arrhythmias in accordance with modified lown grading system as described by Rayan et al., and adopted by many others[17-20] Lown grades 0 (no PVC) and 1 (< 30 PVCs/hour) were classified as mild arrhythmias, Lown grades 2 (⩾ 30 PVCs/hour) and 3 (multiform/multifocal PVCs) as moderate and Lown grades 4a (2 consecutive PVCs), 4b (multiform/multifocal PCVs and couplets) and 5 (3 or more consecutive PVCs) were classified as severe arrhythmias. Descriptive analysis of arrhythmias severity revealed 57.14% of patients (24 out of 42) had severe arrhythmias according to Lown grade classification.

Statistically significant association was seen between severity of ventricular arrhythmias and functional class of heart failure. Most of the patients with severe arrhythmias had NYHA class III and IV (Table I), indicating severity of heart failure is related with the high risk of developing fatal ventricular arrhythmias

Table I: Association of NYHA classification with severity of ventricular arrhythmia

NYHA classification	Severity of arrhythmia			Total	p-value
	Mild	Moderate	Severe		
NYHA II	6	0	0	6	0.001*
NYHA III	0	12	11	23	
NYHA IV	0	0	13	13	
Total	6 (14.28%)	12 (28.57%)	24 (57.14%)	42 (100%)	

*p-value is significant (< 0.05)

Discussion

Sudden cardiac death either due to electrical or mechanical instability is the major cause of deaths among heart failure patients. More than half of deaths in advanced heart failure are sudden, mostly due to ventricular tachycardia degenerating into ventricular fibrillation.[21] Despite all the advancement in modern therapeutic measures the mortality and morbidity rates remain high in patients with heart failure.[22] In the current study we analysed ventricular arrhythmias on the basis of severity of arrhythmia according to modified lown grading system.[19,23] Six of our patients (14.28%) had mild arrhythmias (lown grade 0 and 1), 12 (28.57%) had moderate arrhythmias (lown grade 2) and 24 patients (57.14%) had severe complex ventricular arrhythmias (lown grade 4a, 4b and 5). In a multicenter cohort study, Liu et al., analyzed the impact of potentially lethal ventricular arrhythmias on long term outcome in patients with chronic heart failure. In their study, data of 1080 patients were utilized to determine the presence of potentially lethal ventricular arrhythmias (severe arrhythmias). The results showed that 33.5% patients in the age group of 45 to 65 years had severe ventricular arrhythmias. In our study the percentage of patients with severe arrhythmias was higher (57.14%) as compared to the results of Liu. This variation in results may be due to a very important difference in the inclusion criteria of the two studies. We included heart failure patients in our study with ejection fraction equal to or below 40% with mean ejection fraction of 22.5% whereas the ejection fraction of patients in the study conducted by Liu,[24] was equal to or below 45%. Due to better ejection fraction, the percentageof severe arrhythmias might have been reduced in their study. Bounhoure et al studied severity of ventricular arrhythmias and sudden death in heart failure patients.[25] They reported that about 60% of their patients had severe arrhythmias. Deaths among their patients resulted from ventricular tachycardia degenerating into ventricular fibrillation. Tedesco et al., studied sudden cardiac death in patients with chronic heart failure.[26] Results of their study showed that approximately 50% of deaths in patients with chronic heart failure were sudden and were due to severe ventricular arrhythmias. As we could not do follow up of our patients, we could not gather data regarding mortality rate in our study population. However, mortality can indirectly be predicted by considering statistics regarding severity of ventricular arrhythmias. In our study, 57.14%patients were found to have severe

arrhythmias. The results of our study are comparable to those of Bounhoure et al., and Tedesco et al., who reported incidence of sudden death in heart failure patients as 60% and 50% respectively. This could be concluded from results that more than half (57.14%) of our patients with chronic heart failure were at the risk of sudden arrhythmogenic cardiac deathdue to severe ventricular arrhythmias. Based upon this data, patients with chronic heart failure who are at high risk of sudden cardiac death can be screened out for further specific management. The severity of heart failure influences the type and mechanism of arrhythmias. Sudden cardiac death due to ventricular tachyarrhythmia is very common in patients with symptomatic acute or chronic heart failure and left ventricular systolic dysfunction.[14,27] In the last decade predictive parameters for tachyarrhythmias were identified and revealed decreased left ventricular ejection fraction to be a significant predictor of arrhythmia risk in the patients diagnosed with heart failure and dilated cardiomyopathy.[28-30] Most of the studies identified ventricular dysfunction to be the major cause of ventricular arrhythmia and considered them to be responsible for sudden death.[31-33] In current study we evaluated the severity of heart failure on the basis of NYHA classification and ejection fraction. Most of our patients had advanced heart failure as evident by lowness of ejection fraction. Mean ejection fraction of our patients was 21.69 ± 6.3(Mean ± SD). Most of the patients had significant cardiac dysfunction as 54.8% patients had NHYA class III and 31% were short of breath even at rest (NYHA class IV). Statistically significant correlation was seen between reduced ejection fraction and advanced functional class of heart failure. p value was <0.05.

In general, survival is shorter in patients with lower left ventricular ejection fraction. In a study the relationship between left ventricular ejection fraction and outcome was evaluated in 5010 patients. Baseline echocardiograms were obtained. The patients were studied over 23 months. It was observed that decreasing left ventricular ejection fraction was associated with increasing mortality. Patients with mean left ventricular ejection fraction of 35 percent had a significantly lower mortality rate than those having mean left ventricular ejection fraction of 17 percent.[34] Left ventricular ejection fraction below 20 percent was typically associated with worst survival. In heart failure with severe ventricular dysfunction ventricular premature contractions are frequent and complex and occur in 70 to 95% of patients.[35] According to lown grade system increased frequency of ventricular premature contractions is associated with severe arrhythmias. Studies have shown that frequent premature contractions can cause or exacerbate left ventricular dysfunction. Treatment with standard medical therapy for heart failure along with anti-arrhythmic drugs and catheter ablation results in significant reduction in ventricular premature contractions and marked improvement in left ventricular function.[36]

Frequency of heart failure is continuously on rise in our population. Most of the patients experience sudden cardiac death due to severe arrhythmias. Genesis of arrhythmias in heart failure is dependent upon degree of ventricular dysfunction and presenting NYHA functional class, causing electrophysiological changes in heart, thus leading to arrhythmias.

Conclusion

The patients with severe left ventricular dysfunction are at high risk of developing potentially lethal and fatal arrhythmias leading to sudden cardiac death. Therefore a thorough assessment of the functional class of heart failure based upon history and clinical examination and vigilant assessment of ejection fraction should be the part of the initial evaluation of heart failure patients.

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