Arrhythmias and Electrocardiographic Changes in Systolic Heart Failure

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Abstract

Background: Heart failure is a common condition that that leads to hospitalization. It is associated with various atrial and ventricular arrhythmias. **Aim:** The aim of this study is to find common arrhythmias and electrocardiographic changes in hospitalized patients who have systolic heart failure. **Materials and Methods:** This is a retrospective study of medical records, and electrocardiograms (EKGs) of 157 patients admitted to our hospital who had systolic heart failure with ejection fraction (EF) <50% on echocardiogram. Based on EF, the patients were divided into two groups; one with EF ≤ 35% and the other with EF > 35%. Twelve-lead EKG of these patients was studied to identify common arrhythmia and demographic variables; laboratory results were compared to identify the differences. **Results:** A total of 157 patients with systolic heart failure, 63.7% had an EF ≤ 35%. Hypertension 82.8%, diabetes 49%, coronary artery disease 40.8%, chronic obstructive pulmonary disease or bronchial asthma 22.3%, and stroke 12.1% were common associated co-morbidities. On analysis of EKG, 28.6% had tachycardia, 21.9% had prolonged PR > 200 ms, 16.3% had wide QRS > 120 ms, 70.7% had prolonged corrected QT (QTc), and 42.2% had left axis deviation. The most common arrhythmias were sinus tachycardia and atrial fibrillation/flutter which were found in 14.6% and 13.4%, respectively. The left ventricular hypertrophy was a common abnormality found in 22.4% followed by ventricular premature contractions 18.4%, atrial premature contractions 9.5%, and left bundle branch block 6.1%. Patients with severe systolic heart failure had prolonged QRS ($P = 0.02$) and prolonged QTc ($P = 0.01$) as compared to the other group. **Conclusions:** Sinus tachycardia and atrial fibrillation/flutter were common arrhythmias in patients with systolic heart failure. Patients with severe systolic heart failure had statistically significant prolongation of the QRS duration and QTc interval.

Keywords: Atrial fibrillation, corrected QT interval, electrocardiogram, QRS duration, systolic heart failure

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Introduction

An estimated 5.7 million American adults have heart failure, and the annual incidence is 10 per 1000 population in people above 65 years age.[1] Survival estimates for heart failure are 50% at 5 years and 10% at 10 years, respectively. The incidence of heart failure has remained stable, but survival has increased resulting in an increased prevalence among the elderly. Heart failure patients have frequent exacerbations requiring hospitalization and nearly 1 million hospitalizations for heart failure occur each year.[2] It is estimated that 20–50% of patients with heart failure have normal left ventricular ejection fraction (EF).[3] Atrial and ventricular arrhythmias occur commonly in patients with heart failure.[4] This study aims to study the hospitalized patients who have systolic heart failure to determine

common electrocardiogram (EKG) changes and arrhythmias among them.

Materials and Methods

This is a retrospective analysis of patients with systolic heart failure admitted to our hospital. We selected all admitted patients in our hospital with an EF < 50% based on echocardiography done at our hospital between January and July 2014. The ethical approval was obtained from hospital ethical committee. A total of 157 patients with systolic heart failure were identified. We then retrospectively reviewed the medical records of those patients and analyzed different variables such as age, sex, length of hospital stay, outcome, body mass index (BMI), co-morbid conditions, vital signs, hematocrit, chemistry, lipid panel, and EKG abnormalities. Twelve-lead EKGs were studied and different variables such as PR, QRS, and corrected QT (QTc) intervals, rate, rhythm, and arrhythmias were analyzed. Intervals were automatically calculated by MUSE electrocardiographic system. EF was determined during an echocardiogram (ECHO) by visual estimation. Patients with systolic heart failure defined as EF < 50% were characterized into two groups; group one with an EF ≤ 35% and group two with an EF > 35%.

Statistical analysis

Data analysis were done by SPSS 22 software (IBM). The demographic, baseline disease characteristics and EKG abnormalities of the study groups were compared with the Chi-squared test for categorical and independent samples *t*-test for continuous variable. For each analysis, a two-sided alpha level of 0.05 was considered statistically significant.

Results

Patient characteristics

Of total 157 patients with systolic heart failure 60.5% (*n* = 95) were male and 63.7% (*n* = 100) had an EF ≤ 35. The average BMI was 27.6 Kg/m^2 and 28.8% (*n* = 45) were obese; 25.8% (*n* = 16) were female and 30.5% (*n* = 29) were male.

On admission, 35% (*n* = 55) had acute decompensation of heart failure, and decompensated heart failure was more common in patients with severe systolic heart failure (*P* < 0.001). Other common cardiac problems during admission were non-ST-elevation myocardial infarction and atrial fibrillation/flutter and chest pain 7.6% (*n* = 12) each. About 2.5% (*n* = 4) of patients presented with cardiac arrest and 30% (*n* = 47) were admitted for noncardiac problems. Among all patients, 10.8% (*n* = 17) had automatic implantable cardioverter defibrillator and 3.8% (*n* = 6) had cardiac resynchronizing therapy device.

Associated conditions and outcome

Hypertension 82.8% (*n* = 130), diabetes mellitus 49% (*n* = 77), coronary artery disease 40.8% (*n* = 64), chronic obstructive pulmonary disease/asthma 22.3% (*n* = 35), stroke 12.1% (*n* = 19), peripheral artery disease 8.9% (*n* = 14), and human immunodeficiency virus 6.4% (*n* = 10) were common co-morbidities. About 65.6% (*n* = 103) had the past or current history of smoking and 28% consumed alcohol.

About 85.5% (*n* = 134) of patients were discharged and 12.7% (*n* = 20) expired. Mortality was more common among females, 17% (*n* = 11) than males, 9.5% (*n* = 9). Moreover, among patients who had acute decompensated heart failure on admission, 3.6% (*n* = 2) expired. All four patients who had cardiac arrest on presentation expired.

Analysis of clinical and laboratory findings

About 42% (*n* = 66) had increased systolic or diastolic blood pressure on presentation and on analysis of laboratory values, 63.7% (*n* = 100) were anemic, 51.4% (*n* = 72) had elevated troponin, 43.9% (*n* = 69) had elevated creatinine, 26% (*n* = 41) had hyponatremia, and 12.7% (*n* = 12) had hypokalemia. In addition, 24.3% (*n* = 34) had acetylated hemoglobin (HbgA1C) >7, 18% (*n* = 26) had cholesterol above 200 mg/dL, and 27.7% (*n* = 39) had low-density lipoprotein above 100 mg/dL.

The study groups were similar in many aspects; however, group one with severe heart failure had significantly higher rate of hypokalemia, elevated values of brain natriuretic peptide (BNP), and acute decompensation [Table 1].

Electrocardiogram changes

A total of 147 EKGs were reviewed, 10 (6.3%) were excluded from further analysis because they had electronic ventricular paced rhythm. On analysis, 28.6% (*n* = 42) had tachycardia, 21.9% (*n* = 14) had prolonged PR more than 200 ms, 16.3% (*n* = 24) had wide QRS > 120 ms, 70.7% (*n* = 111) had prolonged QTc (reference range QTc < 440 for male and QTc < 460 for female), 42.2% (*n* = 62) had left axis, and 47.9% (*n* = 70) had normal axis.

Most common arrhythmias were sinus tachycardia which was found in 14.6% (*n* = 23) and atrial fibrillation/flutter which was found in 13.4% (*n* = 21). Among patients with atrial fibrillation/flutter, 57% (*n* = 12) had rapid ventricular rate. The left ventricular hypertrophy was a common abnormality found in 22.4% (*n* = 33) followed by ventricular premature contraction (VPC) 18.4% (*n* = 27), atrial premature contraction (APC) 9.5% (*n* = 14), left bundle branch block (LBBB) 6.1% (*n* = 9), and right bundle branch block (RBBB) 4.8% (*n* = 7).

The two groups had statistically significant differences in QRS and QTc duration and occurrence of LBBB and VPCs [Table 2].

Discussion

In our study, a statistically significant prolongation of the QRS duration and QTc was seen in patients with severe systolic heart failure. In a Swedish Heart Failure Registry, QRS prolongation ≥120 ms was present in 31% of patients with heart failure. QRS prolongation was more common in patients with reduced than with

Table 1: Characteristics of patients based on ejection fraction

	EF ≤35% (*n*=100)	EF >35-49% (*n*=57)	*P*
Age	63 (14)	64 (16)	0.80
Male	64 (64)	31 (54)	0.23
BMI ≥30 kg/m²	29 (24)	16 (28)	0.90
Length of stay (days)	10 (14)	12 (23)	0.35
Death	13 (13)	7 (12)	0.89
Systolic BP >140 mmHg	34 (34)	27 (47)	0.09
Diastolic BP >90 mmHg	28 (28)	17 (30)	0.80
Anemia	62 (62)	38 (67)	0.55
Hyponatremia	26 (26)	15 (26)	0.96
Hypokalemia	17 (17)	3 (5)	0.03
Creatinine >1.3 mg/dl	44 (44)	25 (44)	0.98
Hypocalcemia	10 (10)	5 (9)	0.80
Troponin I >0.05 ng/ml	52 (56)	20 (41)	0.09
BNP (pg/ml)	1448 (1363)	801 (964)	0.008
Acute decompensation	47 (34)	8 (20)	<0.001

The values are reported as number (percentage) or mean (SD). BMI = Body mass index, BP = Blood pressure, BNP = Brain natriuretic peptide, SD = Standard deviation, EF = Ejection fraction

Table 2: Electrocardiogram changes based on ejection fractions

	EF ≤35% (*n*=92)	EF >35-49% (*n*=55)	*P*
HR >100/min	25 (27)	17 (31)	0.63
PR >200 ms	9 (13)	5 (11)	0.74
QRS >120 ms	20 (22)	4 (7)	0.02
Prolonged QTc	76 (83)	35 (64)	0.01
Left axis	41 (45)	21 (38)	0.38
Right axis	9 (10)	4 (7)	0.57
Atrial fibrillation/flutter	15 (16)	6 (11)	0.79
LVH	23 (25)	10 (18)	0.42
VPC	22 (24)	5 (9)	0.04
APC	9 (10)	5 (9)	0.96
LBBB	9 (10)	0 (0)	0.02
RBBB	3 (3)	4 (7)	0.24

The values are reported as number (percentage). HR = Heart rate, LVH = Left ventricular hypertrophy, VPC = Ventricular premature contractions, APC = Atrial premature contractions, LBBB = Left bundle branch block, RBBB = Right bundle branch block, EF = Ejection fraction, QTc = Corrected QT

preserved EF and was an independent risk factor for mortality.[5] In heart failure, neurohormonal, adrenergic, and cytokine systems are activated, and there is an alteration in ventricular architecture which leads to depressed left ventricular systolic function.[6] In systolic heart failure, the left ventricular dyssynchrony manifests as prolonged QRS on surface EKG and is associated with a worse prognosis. Prolongation of the QRS duration is associated with lower left ventricular EF and larger end-systolic and end-diastolic volumes,[7] and is strong predictor of both pump failure and sudden death.[8]

In our study, the left bundle branch block and VPCs were more common in patients with severe systolic heart failure. In LBBB, the normal sequence of electric activation is reversed, and the right ventricle is depolarized before the left ventricle. Dyssynchronous electrical activation results in dyssynchronous and mechanically inefficient contraction. Previous literature shows that LBBB is far more common than RBBB in patients with heart failure[9] and among the patients with severe cardiomyopathy with EF < 30, prolonged QRS and LBBB are independent predictors of increased total mortality.[10] Studies have shown a high prevalence of VPC (82%) in patients with heart failure, and they are associated with increased overall mortality.[11]

In our study, atrial fibrillation was found in 13.4% of patients, but ventricular arrhythmia was not observed. Previous studies have reported atrial fibrillation in 15–30% of patients with heart failure. Over 80% of patients with congestive heart failure have frequent and complex ventricular arrhythmias documented on Holter monitoring, and almost 50% demonstrate runs of nonsustained ventricular tachycardia.[12] In our study, it is possible that we were not able to find ventricular tachycardia because we used EKGs on admission which might have missed ventricular arrhythmias.

The length of hospital stay and the outcome did not differ among the two groups; however, potassium and BNP levels differed significantly among both groups. In a previous study of patients hospitalized for worsening systolic heart failure, serum potassium abnormalities were common at baseline. However, it was not associated with all-cause or cardiovascular mortality.[13] Elevated BNP has diagnostic, and prognostic significance in heart failure and some reports indicate that a BNP-guided strategy reduced the risk of heart failure-related death or hospital stay in patients with systolic heart failure.[14]

Limitations of study

This is a retrospective study and includes only those patients admitted to our hospital. The reported EF was a visual estimation on ECHO, which might be

operator dependent. Furthermore, the EKG and ECHO demonstrate the cardiac picture at a given point of time and may fail to capture variability at different times.

Conclusions

In patients admitted with systolic heart failure, sinus tachycardia, and atrial fibrillation were a common arrhythmia. Prolonged QRS and QTc on EKG was present in patient with severely depressed left ventricular systolic function. Further studies are needed to investigate arrhythmias in systolic heart failure and their prognostic significance.

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Conflicts of interest

There are no conflicts of interest.

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