

Incidence of Arrhythmias and Associated Outcome in Patients with Acute ST-Segment Elevation Myocardial Infarction

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ABSTRACT

Objective: To determine the incidence of arrhythmias and its association with outcome among hospitalized patients with acute ST-segment elevation Myocardial Infarction (STEMI).

Methodology: A prospective observational study was conducted at department of Cardiology, Liaquat University Hospital, Hyderabad, during one year from December 2021 to November 2022. Patients aged ≥ 18 years with acute STEMI (clinical presentation, electrocardiographic ST-segment elevation, and elevated cardiac biomarkers), presenting within 24 hours of symptom onset of either gender were included. Proper cardiac monitoring was performed during hospitalization to observe the occurrence of arrhythmias based on continuous ECG monitoring and standard 12-lead ECG recordings. All the cases were followed during hospital stay to evaluate clinical outcomes, including in-hospital mortality, cardiogenic shock, heart failure, and mechanical ventilation requirements. Incidental rate of arrhythmias and their relationship with clinical outcomes were analyzed using SPSS version 23 by applying the appropriate statistical tests and taking p-value of ≤ 0.05 as significant statistically.

Results: The overall mean age of 210 patients was 51.23 ± 14.22 years, with majority of male patients 54.76% compared to females 45.23%. The overall incidence of arrhythmias was 71.90%. Presence of heart failure was most common amongst all (25.23%) followed by cardiac arrest (3.80%) and mortality (2.38%). However, the heart failure and mortality were significantly more prevalent among acute STEMI patients experienced ventricular arrhythmias as compared to atrial arrhythmias ($p < 0.05$).

Conclusion: The arrhythmias were observed highly frequent among patients with acute STEMI, specifically ventricular arrhythmias were significantly associated with higher in-hospital complications, including cerebrovascular events and the mortality.

Key words: Arrhythmias, Atrial, Ventricular, acute STEMI, Heart failure, Mortality

Introduction

Acute myocardial infarction with ST-segment elevation (STEMI) is a serious manifestation among patients with acute coronary syndromes (ACS), which represents a substantial morbidity and mortality throughout the world.^{1,2} Although, early diagnosis and therapeutic strategies have achieved substantial advances, STEMI is yet associated with considerable risk of in-hospital complications.³ Cardiac arrhythmias are the commonly occurring complications of STEMI that significantly contribute to the adverse outcomes and poor prognosis in acute myocardial infarction cases.⁴ Arrhythmias in acute STEMI cases result from complex interplay between myocardial ischemia, autonomic nervous system dysregulation, electrolyte imbalances, reperfusion injury, and structural myocardial damages.

These functional and structural dysregulations disrupt normal cardiac electrical conductions, predisposing the STEMI patients to various arrhythmias abnormalities, which may occur at any stage of STEMI, reflecting the extent of myocardial injury and severity of ischemia.⁵

Atrial arrhythmias and ventricular arrhythmias are the two frequently encountered complications of acute STEMI.⁶ Atrial arrhythmias are associated with increased risk of heart failure, thromboembolic events, prolonged hospitalization, and poor prognosis, which is especially true for atrial fibrillation, a mostly common observed type of atrial arrhythmia.⁷⁻⁹

Ventricular arrhythmias, with two most lethal forms, Ventricular tachycardia and ventricular fibrillation, also remain significantly challenging complications of STEMI. What makes them the most alarming complications, are their capability of causing cardiogenic shock, sudden cardiac arrest, which if not treated immediately can lead to sudden cardiac death, and long-term poor outcomes even among survivors.¹⁰

The overall incidence of arrhythmias has been reported to vary between 16.6% and 89.1% even after the therapeutic intervention for acute STEMI.¹¹

The incidence of arrhythmias among patients with STEMI significantly influence in-hospital outcomes and in-hospital mortality, attributed to several complications such as acute heart failure, cardiac arrest, stroke, cardiogenic shock, and cardiac ischemia observed among patients during hospitalization.¹²

In Pakistan, like other low-and middle-income underdeveloped countries, cardiovascular risk factors including smoking, hypertension, diabetes, and obesity are the major contributors to morbidity and mortality. These risk factors are becoming more prevalent among individuals struggling with AMI. Demographic factors such as age, gender, dietary habits, inactive lifestyle, residential status, poor healthcare access, and awareness status further complicate the cardiovascular conditions.^{14,15} The ischemic heart disease (IHD) burden in South Asian regions is rapidly growing, with 16.49% IHD-associated deaths reported during 2020 in Pakistan.¹⁵ Despite growing burden of IHD, data regarding the incidence and types of arrhythmias, as well as their associated outcomes in patients with acute STEMI remain relatively scarce in our part of the world.

These data are essential for early identification and appropriate management of arrhythmias for improved prognosis and better resource utilization. The acute myocardial ischemia, specifically in the border areas of an evolving MI, begin and the maintain these arrhythmias. Timely and effective revascularization typically through reopening the blocked artery and placing the stent along with appropriate secondary preventive treatment, substantially reduces the risk of these life-threatening events. As the STEMI is a most important cause of mortality in Pakistan, where uncontrolled risk factors and delayed presentation increases the risk of arrhythmias. Though, the local data on their incidence and impact on outcomes are inadequate at local level. Therefore, study may supportive to justify and generate region specific evidence to improve risk stratification, proper patients monitoring, and management strategies, ultimately seeking to reduce the adverse outcomes in these patients.

Methodology

This Prospective observational study, was carried out at Department of Cardiology, Liaquat University Hospital, Hyderabad. Study was done during one year from December 2021 to November 2022. All the patients aged ≥ 18 years of either gender who were diagnosed with acute ST-elevation MI basis on the standard diagnostic criteria as; typical chest pain, electrocardiographic evidence of elevation of ST-segment and raised biomarkers (troponin I/T and CK-MB), who were presented within 24 hours of symptom onset and admitted to the cardiology department for management

were included. All the patients with NSTEMI and unstable angina, patients with pre-existing arrhythmias like as known atrial fibrillation or permanent pacemaker users, patients with prior MI or the known cardiomyopathy, patients with incomplete ECG monitoring records, patients with severe comorbidities like renal impairment or hepatic failure, and those who were died before monitoring were excluded. Patients were selected, after taken informed consent from patients or from their legally authorized care takers. After taking demographic information and medical history, the patients were assessed for clinical presentation, ECG findings, laboratory investigations, reperfusion details, arrhythmic events, and clinical outcomes. Particularly the 12-lead ECG was performed at admission and repeated serially at 1, 6, 12, and 24 hours, and additionally at any point of suspected arrhythmic event. Additionally, the cases underwent continuous bedside cardiac telemetry monitoring for a minimum of 48 hours, with arrhythmias detected, classified, and recorded by the trained CCU nursing staff and researcher. Each arrhythmias event was characterized by type. Transthoracic echocardiography was performed within 24 to 48 hours to assess left ventricular ejection fraction and mechanical complications. The clinical outcomes in terms of cardiogenic shock, heart failure, length of hospital stay and in-hospital mortality were documented. Statistical analysis was performed using SPSS version 26.0, applying appropriate statistical test, with p-value less than 0.05 as statistically significant.

Results

A total of 210 patients were included, with an overall mean age of 51.23 ± 14.22 years. The male participants were more as compared to females, 54.76% versus 45.23%, respectively. Most of our study participants had secondary level of education (42.38%) and illiterates were least prevalent (9.52%). Patients belong to middle class socioeconomic stratum were 58.09% ($n = 122$). Urban areas residents were 60% and rural residents were 40%. The most common risk factor was hypertension (42.38%) followed by cigarette smoking (31.42%), diabetes mellitus (24.28%), dyslipidemia (18.09%), previous history of ischemic heart disease (7.61%), and previous history of cerebrovascular accidents (3.8%). Most of the acute STEMI patients were diagnosed as acute anterior STEMI (31.90%) and followed by acute inferior STEMI (14.76%). Table I

The overall incidence of arrhythmias was found 71.90% ($n = 151$), and among them who developed arrhythmias, atrial origin arrhythmias were more

prevalent 63% than ventricular arrhythmias, 37%. Particularly the most common atrial arrhythmias were sinus tachycardia (35.09%) and least atrial flutter (1.32%), while the most common ventricular arrhythmias were premature ventricular contraction (19.86%) and least common was ventricular flutter (1.32%) as presented in table II.

Table I: Demographic and clinical characteristics of participants (n=210)		
Demographic Variables	N	%
Gender		
Male	115	54.76%
Female	95	45.23%
Level of Education		
Illiterate/non-primary	20	9.52%
Primary	64	30.48%
Secondary	89	42.38%
More than Secondary	37	17.62%
Socioeconomic Status		
Upper	36	17.14%
Middle	122	58.09%
Lower	52	24.76%
Area of Residence		
Urban	126	60%
Rural	84	40%
Acute STEMI Risk Factors		
Hypertension	89	42.38%
Cigarette smoking	66	31.42%
Diabetes	51	24.28%
Dyslipidemia	38	18.09%
History of Ischemic heart disease	16	7.61%
History of Cerebrovascular Accident	8	3.8%
Types of Acute STEMI		
Anterior	67	31.90%
Inferior	31	14.76%
Anterior + Lateral/ Anterior + Septal	54	25.71%
Inferior + Right Ventricular/ Inferior + Posterior	58	27.61%

According to the outcomes the presence of heart failure was most common in (25.23%) of the patients followed by cardiac arrest (3.80%), cerebrovascular accident (0.95%) and mortality (2.38%). Table III

Out of all the majority 142 (67.61%) had uneventful recovery, predominantly from the atrial arrhythmias group 73 (34.76%). Heart failure was the most common complication, occurring in 53 (25.23%) patients, significantly more in the ventricular arrhythmias group

35 (16.66%) than atrial group 18 (8.57%), the cardiac arrest and death were also more frequently associated with ventricular arrhythmias, among 06 (2.85%) and 04 (1.90%) of the cases respectively, compared to 02 (0.95%) and 01 (0.47%) in the atrial group ($p = <0.05$), while the overall, ventricular arrhythmias were significantly associated with worse post-MI outcomes compared to atrial arrhythmias ($p = 0.001$) as presented in table IV.

Table II: Distribution of participants according to Arrhythmias (n=210)		
Variables	N	%
Arrhythmias		
Yes	151	71.90%
No	59	28.09%
Types (n=151)		
Atrial arrhythmias	95	63%
Ventricular arrhythmias	56	37%
Time of Arrhythmias documentation (n=151)		
Atrial arrhythmias	250.72 Minutes	
Ventricular arrhythmias	429.0 Minutes	
Atrial arrhythmia Types		
Sinus Tachycardia	53	35.09%
Atrial premature complexes	08	5.29%
Atrial Fibrillation (AF)	14	9.27%
Atrial Flutter	02	1.32%
Complete Heart Block (CHB)	18	11.92%
Ventricular arrhythmias Types		
Premature Ventricular contractions (PVCs)	30	19.86%
Ventricular Tachycardia (VT)	16	10.59%
Ventricular Fibrillation (VF)	08	5.29%
Ventricular Flutter	02	1.32%

Table 3: Overall outcomes of patients admitted with acute STEMI (n = 210)		
Complications	n	%
CVA (Cerebrovascular Accident)	02	0.95%
Heart Failure	53	25.23%
Cardiac Arrest	08	3.80%
Death	05	2.38%
No Complication	142	67.64%
Total	210	100%

Discussion

The acute STEMI is a life-threatening cardiac emergency correlated with significant myocardial damage and the arrhythmias are the common and serious complication that significantly worsen in-

Table IV: Association between types of arrhythmias with post-MI complications (n = 210)				
Post-MI Complications	Ventricular Arrhythmia n (%)	Atrial Arrhythmia n (%)	Total n (%)	P-value
CVA	01 (0.47%)	01 (0.47%)	02 (0.95%)	>0.05
Heart Failure	35 (16.66%)	18 (8.57%)	53 (25.23%)	<0.05*
Cardiac Arrest	06 (2.85%)	02 (0.95%)	08 (3.80%)	<0.05*
Death	04 (1.90%)	01 (0.47%)	05 (2.38%)	<0.05*
Uneventful Recovery	10 (4.76%)	73 (34.76%)	142 (67.61%)	<0.001*
Total	56 (26.66%)	95 (45.23%)	210 (100%)	

hospital outcomes among affected individuals. However, this study studied the 210 patients with overall mean age of 51.23 ± 14.22 years, with male predominance and majority belongs to middle and poor socioeconomic classes. Comparable characteristics of study participants were observed in the study conducted by Shah JA et al¹⁶ who documented mean age of 59.6 ± 13.1 years, with male predominance (70.9%). Another study conducted by Al Khatib M et al¹⁷ also reported comparable age and gender distribution. Similarly, in the study of Gupta MD et al¹⁸ among the patients aged above 35 years, mean age was 52.38 ± 9.65 years, with male predominance (86.5%), majority had educational level beyond middle school (48.1%) compared to middle school (29.8) and illiterates (22.1%), most were in the socioeconomic categories below middle (53.5%) and Middle 22 (33.3%).

In this study, majority of the patients were hypertensive (42.38%) followed by smokers (31.42%), diabetes mellitus (24.28%), dyslipidemia (18.09%), previous history of ischemic heart disease (7.61%), and previous history of cerebrovascular accidents (3.8%). Aligning with these findings, in the study carried out by Lin CC et al¹⁹ male gender (83%) and hypertension (68%) were the most prominent risk factors of STEMI, followed by smoking (61%), obesity and overweight (49%), dyslipidemia (47%), and diabetes (30%). Consistently, in the study conducted by Shah JA et al¹⁶ the most common risk factor was hypertension (53.6%), followed by diabetes mellitus (46.4%), Smoking (32.7%), Obesity (9.1%)

In this cohort, most of the acute STEMI patients were diagnosed as acute anterior STEMI (31.90%) and least prevalent was acute inferior STEMI (14.76%). In agreement with these findings, in the study of Ambali AP et al²⁰ among STEMI patients, electrocardiography detected anterior wall (37.3%) as the more common involvement, followed by anterolateral (24.7%), Inferolateral (20%), inferior wall involvement (12.7%). Consistently, Gopalakrishnan S et al²¹ reported that Anterior wall (51.27%) infarction was more frequently noted on electrocardiogram than Inferior wall (46.19%) infarction among STEMI cases.

In this study overall incidence of arrhythmias was 71.90% among patients admitted with acute STEMI and among these, atrial origin arrhythmias (were 63%) and ventricular arrhythmias (37%). Aligning with our findings, Mani S et al²² reported that the arrhythmias incidence (77.6%) was slightly higher than that of our findings. Likewise, in the study by Patil PR et al²³ reported arrhythmias among 78.70% of patients. Consistently Shah JA et al¹⁶ also reported higher incidence of arrhythmias among 89.1% of patients compared to our study.

Furthermore, in this study, the most common atrial arrhythmias was sinus tachycardia (35.09%) and least common was atrial flutter (1.32%), while among ventricular arrhythmias, the most common was premature ventricular contraction (19.86%) and least common was ventricular flutter (1.32%). In aligns to this series, Mani S et al²² reported that the sinus tachycardia was in 23.7% was the most common type of arrhythmias, followed by ventricular premature complex in 15.3%, atrial fibrillation in 13.6%, and sinus bradycardia in 11.9%. Consistently Alkatib M et al²⁴ reported that the ventricular fibrillation (26.7%) was the most common form of arrhythmia, followed by atrial fibrillation (20.0%), Sinus tachycardia (3.3%), Sinus bradycardia (1.3%), ventricular tachycardia (8.0%), and atrial tachycardia (1.3%). Constantly, in a study by Shah JA et al.¹⁶ idioventricular rhythm (37.3%) was the most common type of arrhythmias, followed by 36.4% cases of sinus tachycardia, 22.7% cases of ventricular tachycardia, and 20.0% cases of complete heart block, while in 64.5% of cases were found to have Lethal arrhythmias. They further reported new onset arrhythmias among 65.5% of patients while balloon time arrival, 30% developed in the course of procedure, and 53.6% developed arrhythmias within 24 hours post-procedure.

In current study, presence of heart failure was noted in 25.23% of patients admitted with acute STEMI, followed by cardiac arrest (3.80%), death (2.38%), and cerebrovascular accident (0.95%). In line with these findings, in the study of Hillerson D et al²⁵ reported in hospital event as, cardiac arrest in 7.8%, cardiogenic shock in 7.0%, and death among 7.5% of patients. They further reported 13.9% of cases for heart failure at presentation, 15.4% cases of cardiogenic shock, 9.1% cases of cardiac arrest out of hospital and 2.6% cases of cardiac arrest within the hospital, and Death among 7.5% of patients. Comparably in the study of Desta DM et al.²⁶ heart failure (42.4%) was most common complication, followed by cardiogenic shock (29.8%), myocardial re-infarction (14.6%), major arrhythmias (11.3%), and 24.5% of cases were documented with in-hospital mortality, where STEMI was conformed among 67.5% of patients.

In present study, heart failure (16.66%) and death (1.9%) were significantly more prevalent among acute STEMI patients experienced ventricular arrhythmias as compared to atrial arrhythmias. In agreement, in a recent study of Xu X et al¹² in-hospital death was significantly higher in ventricular tachyarrhythmias in 50.7% of patients compared to atrial tachyarrhythmias in 41.4% of patients ($P=0.001$). Another study conducted by

Vallabhajosyula S et al²⁷ also align with these findings. Overall according to the valuable findings of present study, some limitations must be acknowledged, like single-center design and relatively limited sample size study, which may influence the generalizability of results of study, along with the absence of long-term follow-up beyond hospital discharge may influence the arrhythmia-related outcomes during post-discharge period. Hence further multicenter and large-scale studies with extended follow-up periods, are strongly recommended to validate the findings of this study.

Conclusion

Study revealed that the arrhythmias were highly frequent in acute STEMI, specifically with the atrial

arrhythmias being more prevalent compared to the ventricular arrhythmias, along with the sinus tachycardia and premature ventricular complexes most common types in their respective categories. However, the ventricular arrhythmias observed significantly related with more adverse in-hospital outcomes in contrast to atrial arrhythmias, highlighting their higher prognostic severity. Overall findings emphasize the critical importance of continuous cardiac monitoring, early detection of arrhythmias, for quick intervention, and adequate CCU resources to decrease the arrhythmias-related morbidity and mortality among patients with acute STEMI.

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