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Effect of Heart Rate at Admission on Outcome of Patients Undergoing Primary Percutaneous Coronary Intervention

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ABSTRACT
Background: Several studies showed that there is high correlation between heart rate and high adverse outcomes rates.
Objective: The aim of the current study is to investigate the effect of heart rate on admission in hospital-outcome of patients undergoing primary percutaneous coronary intervention.
Patients and methods: Over the course of 7 months, from July 2019 to January 2020, 63 patients were enrolled in a prospective comparative study at the Cardiology Department of Zagazig University Hospitals. Enrolled patients were diagnosed with acute ST-elevation myocardial infarction (STEMI) and then treated with primary percutaneous coronary intervention. Ejection fraction and coronary angioplasty were assessed in all patients.
Results: Significant positive correlations were found between age and heart rate above 100 bpm, also between systolic blood pressure and diastolic blood pressure, with significant negative correlations between systolic blood pressure and left ventricular end-diastolic volume (LVEDV), between diastolic blood pressure and LVEDV, and also between ejection fraction and LVEDV and left ventricular end-systolic volume (LVESV). Among group with heart rate above 100 bpm a significant positive correlation between LVEDV and LVESV was found.
Conclusion: The presence of admission tachycardia was linked to increased risk of severe adverse cardiac events in patients with STEMI following primary percutaneous coronary intervention, despite the lack of an association between admission bradycardia and serious cardiac outcomes. Further studies with large sample size are recommended to confirm the current results.
Keywords: Percutaneous Coronary Intervention, Heart Rate, Coronary artery disease, myocardial infarction, ST-elevation myocardial infarction.

INTRODUCTION

Acute myocardial infarction and other consequences of coronary artery disease continue to be among the leading causes of death and disability worldwide [1]**.** Several factors influence heart rate (HR) during the initial stages of acute myocardial infarction, which may have consequences for clinical outcome [2]**.**

At admission, heart rates of patients with inferior ST-elevation myocardial infarction (STEMI) were less than 60 beats per minute, while only 15% of those of anterior STEMI have sinus bradycardia (HR <60/min) [3]**.** On the other hand, it has been concluded from previous studies that admission tachycardia could have an impact on both short and long term prognosis after acute myocardial infarction [4]**.**

Impact on clinical outcome that is expected from admission high heart rates (tachycardia patients) could be concluded from direct link between tachycardia as a compensatory mechanism of acute heart failure [5]**.**

On the other hand, admission HR during acute MI could be simply a reflex change secondary to acute chest pain for which patients respond by tachycardia and in case of severe pain by reflex bradycardia. Whether the grouping of STEMI patients according to full range of admission heart rate (AHR) would have a significant impact on further risk stratification and in-hospital outcome is not fully clear [6]

The current study objective was to investigate the effect of heart rate on admission in hospital-outcome of patients undergoing primary percutaneous coronary intervention (PCI).

PATIENTS AND METHODS

Between July 2019 and January 2020, 63 patients were enrolled in a prospective comparative study at the Cardiology Department of Zagazig University Hospitals. Enrolled patients were diagnosed with acute STEMI and then treated with primary percutaneous coronary intervention.

Inclusion criteria: Patients with acute STEMI undergoing primary PCI, Definition of acute STEMI: ST segment elevation >2 mm in more than 2 contiguous leads or fresh beginning of left bundle branch block (LBBB) with characteristic ischemic chest pain lasting >20 minutes [7].

Exclusion criteria:

Thrombolytic reperfusion therapy. Patients who presented >12 hours onset of chest pain. Patients with Mobitz II, III, or 2:1 Atrioventricular Block (AVB) were not included. Patients who refused to participate in the study. Those who suffer from cardiomyopathy or valvular heart disease, and patient with end stage renal failure or severe liver disease or systemic.

The studied subjects were divided into 3 groups; ***Group 1*** included 21 patients with heart rate less than 60 b/min on admission, ***Group 2*** included 21 patients with heart rate between 60 to 100 b/min on admission, and ***Group 3*** included 21 patients with heart rate more than 100 beats/ minute on admission.

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All Patients were subjected to the following:

- **Full history taking** including age, previous myocardial infarction, hypertension.
- **Clinical examination** including blood pressure, heart rate, basal rales and Killip classification, signs of shock.
- **Laboratory investigations** including on admission cardiac enzymes troponine, CKMB, serum creatinine, hemoglobin, and platelets. Laboratory studies were assessed during CCU stay after primary PCI.
- **Twelve lead surface ECG** on admission and serially in CCU for evidence and site of myocardial infarction.
- **Echocardiography** was done to all patients; machine was used within 72 hours of admission on left lateral position. Left ventricular (LV) function was evaluated using two-dimensional echocardiography, with the ejection fraction (EF) as the primary outcome measure. EF and LV volume were measured.
- **Coronary angioplasty** assessed coronary anatomy and lesion. Standard angiographic projections were used to minimize foreshortening.

Use of aspiration thrombectomy, antiplatelets, anticoagulants (as heparin and GP IIb IIIa inhibitors were left to the discretion of the interventional cardiologist).

Mortality, heart failure, reinfarction, cardiogenic shock, and malignant arrhythmia were among the major adverse cardiac events evaluated. Sustained ventricular tachycardia is defined as a ventricular arrhythmia that lasts for more than 30 seconds or causes hemodynamic instability in less than 30 seconds.

Medication and dosage on CCU was left to the discretion of the attending physician and residents, but was in line with the most recent STEMI treatment recommendations.

Ethical consent:

An approval of the study was obtained from Zagazig University Academic and Ethical Committee. Every patient signed an informed written consent for acceptance of participation in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical analysis

The collected data were coded, processed and analyzed using the SPSS (Statistical Package for Social Sciences) version 20 for Windows® (IBM SPSS Inc, Chicago, IL, USA). In order to convey the findings, tables and graphs were employed. The quantitative data was presented in the form of the mean, median, standard deviation, and confidence intervals. The information was presented using qualitative statistics such as frequency and percentage. The student's t-test (T) is used to assess the data while dealing with quantitative independent variables. Pearson Chi-Square and Chi-Square for Linear Trend (X^2) were used to assess qualitatively independent data. P-value <0.05 was considered significant.

RESULTS

Table 1 revealed that age of the studied *Group 1* with heart rate less than 60 Bpm ranging from 36-75 years old with mean 62.14 (SD 8.42) years old and most of them are male (85.7%), and age of the studied group with heart rate HR 60-100 group ranging from 41-76 years old with mean 59.9 (SD 9.57) years old and 90.5% of them are male, while in the patients group with HR>100 Bpm their age ranging from 36-76 years old with mean 58.8 (SD 9.7) years old, with no statistical difference between all groups regarding age and sex distribution. Table 1 summarizes the sociodemographic characteristics of the studied patients in every group.

Table (1): Sociodemographic characters of the studied groups.

Variable	Heart rate						P-value
	HR<60 bpm Group I (N=21)		HR 60-100 Group II (N=21)		HR>100 Group III (N=21)		
	No.	%	No.	%	No.	%	
Age (years)							
Mean ± SD	62.14 ± 8.42		59.9 ± 9.57		58.8±9.7		# 0.543 (NS)
Median (Range)	64 (36 – 75)		64 (41 – 76)		62(36-76)		
Sex							
Male	18	85.7	19	90.5	18	85.7	0.867
Female	3	14.3	2	9.5	3	14.3	
Diabetes Mellitus	7	33.3	12	57.1	15	71.4	0.044*
Hypertension	7	33.3	11	52.4	16	76.1	0.020*
Dyslipidemia	2	9.5	2	9.5	10	47.6	0.002*
Smoking							
• Not smoker	4	19.0	9	42.8	1	4.7	0.011* (S)
• Smoker	17	81.0	12	54.2	20	95.3	

Table 2 shows that those whose heart rates are over 100 beats per minute typically have greater systolic and diastolic blood pressure than those whose heart rates are lower.

Table (2): Blood pressure in relation to heart rate among the 3 studied groups.

Blood pressure	HR<60 bpm Group I (N=21)	HR 60-100 Group II (N=21)	HR>100 Group III (N=21)	P-value
Systolic BP (mmgh) Mean ± SD	107.6 ± 24.06	117.4 ± 20.28	137.6 ± 30.8	0.001* (S)
Diastolic BP (mmgh) Mean ± SD	70.48 ± 13.22	73.3 ± 12.78	82.3 ± 15.4	0.020* (S)

Table 3 shows that the presence of ST-elevation in the anterior, inferior, and lateral leads differs significantly across the three groups at a statistically significant level.

Table (3): Electrocardiographic findings among the study groups

ECG	HR<60 bpm Group I (N=21)		HR 60-100 Group II (N=21)		HR>100 Group III (N=21)		P-value
	No.	**%**	**No.**	**%**	**No.**	**%**	
Anterior	9	42.9	15	71.4	21	100.0	0.000*
Inferior	12	57.1	7	33.3	2	9.5	0.005*
Lateral	3	14.3	5	23.8	10	47.6	0.048*
Posterior	1	4.8	3	14.3	0	0.0	0.154

Table 4 shows that among the study groups, there is no statistically significant difference in the ECHO findings in connection to the heart rate.

Table (4): Echocardiographic finding in relation to heart rate among the study groups.

Variable	HR<60 bpm Group I (N=21)	HR 60-100 Group II (N=21)	HR>100 Group III (N=21)	P-value
EF% Mean ± SD	56.25 ± 6.6	56.95 ± 7.07	52.29 ± 10.4	0.477 (NS)
LVEDD (mm) Mean ± SD	58.29 ± 10.27	57.62 ± 12.19	63.14 ± 14.06	0.377 (NS)
LVESD Mean ± SD	39.05 ± 8.54	37.24 ± 9.15	40.52 ± 9.8	0.634 (NS)

Table 6 shows that patients with an HR>100 have greater levels of troponin and CKMB compared to the other groups. When comparing creatinine levels, there was no discernible difference.

Table (5): Laboratory findings among the studied groups.

Variable	HR<60 bpm Group I (N=21)		HR 60-100 Group II (N=21)		HR>100 Group III (N=21)		P-value
Troponin (ng/l) peak Mean ± SD	1860 ± 47.1		2250.2 ± 52.4		3614 ± 87.6		**0.002*** (S)
CKMB (ng/l) peak Mean ± SD	203.1 ± 48.2		221.5 ± 48.1		250.6 ± 46.2		**0.003*** (S)
Renal impairment	**N**	**%**	**N**	**%**	**N**	**%**	0.678 (NS)
	2	9.5	3	14.3	4	19	

Table 6 shows that complications are statistically more common in patients with HR >100bpm than patients with HR <100bpm, these complications are in the form of cardiogenic shock in 23.8% and no mortality from cardiogenic shock but regarding other complications in the form of HF with LV dysfunction in 23.8%, Sustained VT in 9.5%, Non sustained VT in 4.8%, Papillary muscle rupture, MR in 14.3% and atrial Fibrillation in 4.8% of patients with HR >100bpm, there was no statistically significance.

Table (6): Complications of STEMI (major adverse cardiac events) in relation to heart rate among the study groups during hospital admission course

Complications	HR<60 bpm Group I (N=21)		HR 60-100 Group II (N=21)		HR>100 Group III (N=21)		P-value
	No.	%	No.	%	No.	%	
No complications	15	71.4	16	76.2	4	19.0	**0.0001***
HF with LV dysfunction	1	4.8	1	4.8	8	23.8	0.076
Sustained VT	1	4.8	2	9.5	2	9.5	0.804
Non sustained VT	1	4.8	0	0.0	1	4.8	0.596
Papillary muscle rupture, MR	1	4.8	1	4.8	3	14.3	0.419
Cardiogenic shock	2	9.5	1	4.8	5	23.8	**0.04***
Atrial fibrillation	0	0.0	0	0.0	1	4.8	0.362
Mortality from cardiogenic shock	0	0.0	0	0.0	0	0	> **0.05**

Table 7 represents the optimal tachycardia logistic regression model. The risk that a person had tachycardia was analyzed using a logistic regression, with adjustments made for age, gender, body mass index, hypertension, and diabetes.

Table (7): Logistic regression of HR above 100bpm depending on presence of risk factors among the studied groups.

Risk factors	B coefficient	S.E.	P-value	Exp(B)
Age	21.167	1050.1	**0.04***	1558238943.907
Sex	-262.312	14146.9	.985	.000
DM	361.025	17892.381	**0.03***	6.180E+156
HTN	147.823	8697.023	**0.02***	1.580E+64
Dyslipidemia	24.970	6391.788	**0.001****	69847081314.991
Smoking	-319.615	16224.981	**0.04***	.000
SBP	16.502	836.763	**0.04***	14680261.442
DBP	-32.220	1632.311	**0.04***	.000
EF	2.754	234.352	.991	15.701
LVEDD	-8.609	872.608	.992	.000
LVESD	21.777	1258.611	.986	2868834461.136
PCI LAD	497.216	3159504.50	1.000	8.673E+215
RCA	-218.153	46360.099	.996	.000
LCX	160.277	41486.209	.997	4.051E+69
Diseased vessel	160.776	41516.624	.997	6.672E+69
Constant	-776.482	86804.209	.993	.000

DISCUSSION

Several studies have shown that reducing the resting heart rate of persons with coronary artery disease improves cardiovascular outcomes. Patients with STEMI who have a high AHR during the acute phase have a worse short- and long-term prognosis than those with a lower AHR who are handled with thrombolytic treatment or PCI. Although an increased AHR is typically related to anterior infarcts, it is uncertain if the frequently observed sinus or junctional bradycardic response in the presence of inferior STEMI imparts therapeutic benefit or hazard in that patient population [(8)].

The present findings demonstrated a favorable connection between age and a HR more than 100 bpm (r=0.489). Significant positive correlations were found between age and HR above 100 bpm, also between systolic blood pressure and diastolic blood pressure, but significant negative correlations were found between SBP and LVEDV, between DBP and LVEDV, and also between Ejection fraction and LVEDV and LVESV, above 100 bpm there is significant positive correlation between LVEDV and LVESV.

The current results showed that age of the studied group 1 with heart rate less than 60 bpm ranging from 36-75 years old with mean 62.14 (SD 8.42) years old and most of them are male (85.7%),and age of the studied group with heart rate HR 60-100 group ranging from 41-76 years old with mean 59.9 (SD 9.57) years old and 90.5% of them are male, while in the patients group with HR>100 bpm their age ranging from 36-76 years old with mean 58.8±9.7 years old, with no statistical difference between all groups regarding age and sex distribution. Which in agreement with the study of **Kosmidou *et al.*** [(6)], who found in his study on 1460 patients (75.5% men; mean age 59.6 years), heart rate less than 60 bpm ranging from 54.1-70.1 years and (76.8%) were males, and age rate HR 60-100 group ranging from 51-69 years old and 83.7% were males, HR>100 bpm their age ranging from 42-71 years old with mean 55.4 (SD 7.6) years old, without statistical difference between studied group.

The current results showed that diabetes mellitus was statistically higher in patients with HR >100 bpm and HR 60-100 bpm versus patients with HR <60 bpm (71.4% and 57.1% Vs 33.3%) respectively, also there is significant difference between groups regarding presence of hypertension or dyslipidemia. Which in agreement also, with the study of **Kosmidou *et al.*** [(6)], who found that Diabetes mellitus was statistically higher in patients with HR >100 bpm and HR 60-100 bpm versus patients with HR <60 bpm (23.6% and 17.5%Vs 16.3%) and no statistical difference for hypertension or dyslipidemia.

Statistical analysis of the current results revealed a considerable disparity in smoking rates between the groups that were compared. Freeman Hospital in Newcastle upon Tyne, United Kingdom, performed PPCI for STEMI on a total of 2571 patients between March 2008 and June 2011; these results are consistent with those found in the study by **Koshy *et al.*** [(9)]. And they found a statistically significant difference in smoking rates between the groups they compared.

Patients with heart rates more than 100 bpm had higher systolic and diastolic blood pressure, consistent with the findings of the present investigation and those of **Alapati *et al.*** [(10)].

Anterior, inferior, and lateral ECG changes were significantly different across the groups, as shown by the present data. These findings corroborate those of **Zahran's** [(11)] investigation, in which he found a statistically significant difference in ECG alterations between the two groups of patients.

The current results showed that there was no statistical difference between ECHO finding in relation to heart rate among the study groups, which agree with the study of **Islam *et al.*** [(12)] who found no significant change in LVEDD or LVEDV between groups on baseline echocardiographic examination but did find a statistically significant rise in LV ESD and LV ESV.

The current results showed that troponin was positive in 100% of patients among the 3 different groups; there is significant difference between groups regarding positive CKMB laboratory findings. The same results were obtained by **Brett *et al.*** [(13)] who reported that troponin was normal with significant statistical significant difference regarding CKMB between studied groups.

The current results demonstrated a large statistically significant difference between the 3 groups for PCI in the LAD artery, but no change for the RCA or LCX, which is consistent with the findings of a previous study by **Xianghua *et al.*** [(14)].

In contrast to the findings of **Alidoosti *et al.*** [(15)], who found no significant difference between cases and controls in terms of the number of vessels in relation to HR, the current results demonstrated a highly statistically significant difference between the three groups.

The current results showed that complications is statistically more common in patients with HR >100bpm than patients with HR <100, these complications are in the form of HF with LV dysfunction in 23.8% , Sustained VT in 9.5% , Non sustained VT in 4.8%, Cardiogenic shock in 23.8% and atrial Fibrillation in 4.8% of patients with HR >100 bpm. These results coincided with the results of **Mylotte *et al.*** [(16)], who reported that patients with HR >100bpm more complications such as HF with LV dysfunction in 21.9%, sustained VT in 10.7%, non-sustained VT in 5.3% of studied groups.

Our results were in agreement with the study of **Diana *et al.*** [(17)] who reported a significant positive correlation between systolic and diastolic blood pressure and significant negative correlation between

SBP and DBP with LVEDV and LVESV and also between LVEDV and LVESV.

The current results showed that there was a significant positive correlation between Age and Heart rate above 100 bpm (r=0.489), also there is significant positive correlation between systolic blood pressure and diastolic blood pressure (r=0.891), but there is significant negative correlation between SBP and LVEDV also there is significant negative correlation between DBP and LVEDV also there is significant negative correlation between Ejection fraction and LVEDV and LVESV (r=-0.502 , p=0.020*), (r=-0.562, p=0.008*) also among group with HR above 100 bpm there is significant positive correlation between LVEDV and LVESV (r=0.975), which is in agreement with the study of **Bhave *et al.*** [18] who found a similar results in their study.

LIMITATIONS

Limitation of our study include that it was performed in a single referral unit and the studied patients numbers were relatively limited which could compromise the generalize ability of our findings.

In conclusion, the presence of admission tachycardia was linked to increased risk of severe adverse cardiac events in patients with STEMI following primary PCI, despite the lack of an association between admission bradycardia and serious cardiac outcomes. Further studies with large sample size are recommended to confirm the current results.

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