Print ISSN: 2321-6379
Online ISSN: 2321-595X
DOI: 10.17354/ijss/2016/514

Original Article

Prognostic Significance of Posturally Induced Crackles as a Predictor of in - Hospital Mortality and Morbidity in Patients with Acute Myocardial Infarction

Bairam Balaji[1], G Ravi Kiran[2]

[1]Assistant Professor, Department of Medicine, MGM Hospital, Warangal, Telangana, India, [2]Post Graduate, Department of Medicine, MGM Hospital, Warangal, Telangana, India

Abstract

Background: Myocardial infarction (MI) is a major cause of morbidity and mortality in contemporary populations. Several 2-dimensional echocardiographic biochemical electrophysiological predictors of mortality have been described. However, significance of clinical examination in estimating the prognosis of patients with MI is understudied.

Materials and Methods: This is a prospective cross-sectional study that included adult patients (age >25 years) who had been diagnosed with acute MI and were treated at our hospital between January 2016 and June 2016. All consecutive patients with acute MI admitted during the study period were included in the study.

Results: A total of 302 patients were diagnosed as acute MI (144 - ST-segment elevation MI [STEMI] and 158 - non-STEMI) treated during this period in our hospital. 167 patients are excluded from the study (30 = known case of coronary artery disease 26 = history of lung disease 11 = did not give their consent for study 12 = already on diuretics for various indications 88 = patients with persistent crackles). A total of 135 patients are included in the study (64 are posturally induced crackles [PIC] positive = study group, and 71 are PIC negative = control group).

Conclusion: In conclusion, the presence of PIC is a simple bedside examination finding which helps us determining the prognosis of patients admitted with acute MI. It is independent predictor of in hospital death and significantly associated with longer hospital stay. Thus, Killip class 1 group of patients is heterogeneous group prognostically.

Key words: Morbidity, Mortality, Myocardial infarction, Posturally induced crackles, Predictor

INTRODUCTION

Myocardial infarction (MI) is a major cause of morbidity and mortality in contemporary populations. Several 2-dimensional (2D) echocardiographic[1,2] biochemical,[3-5] electrophysiological (ECG)[6-8] predictors of mortality have been described. However, significance of clinical examination in estimating the prognosis of patients with MI is understudied.

Access this article online

www.ijss-sn.com

Month of Submission : 08-2016
Month of Peer Review : 08-2016
Month of Acceptance : 09-2016
Month of Publishing : 10-2016

Crackles are rare in healthy persons during normal tidal breathing[9,10] Fine crackling sounds, however, may appear in up to 60% of healthy persons, especially over the anterior chest, if the person first exhales as much as possible and breathes in the from residual volume instead of functional residual capacity.[11] Bilateral fine crackles are discontinuous adventitious lung sounds and are important in the clinical detection of left-sided heart failure (HF). Killip and Kimball have classified the severity of acute MI according to the extent of fine crackles.[12]

Baseline demographic characteristics of population are shown in Table 1. The mean age in the study group is 55.2 ± 12.3 years and in control group is 56.6 ± 13.1 years.

Corresponding Author: G Ravi Kiran, Department of Medicine, MGM Hospital, Warangal, Telangana, India. E-mail: haritv2002@gmail.com

Table 1: Definition of PIC*

	Sitting	Supine	Leg Elv
PIC negative	−ve	−ve	−ve
PIC positive	−ve−ve	+ve−ve	+ve+ve
Persistent crackles	+ve	+ve	+ve

*+ve: Crackles heard and−ve: Crackles not heard. PIC: Posturally induced crackles

The study group has 62.5% males (40) as compared to control group 59.2 (42). There were no significant differences ($P > 0.05$) between the two groups in age, sex distribution, and in comorbid conditions.

The term posturally induced crackles (PIC) describes crackles that appear when the patient is in the supine position disappear when the patient is in the sitting position. They are produced mainly due to airway closure at the base of the lungs secondary to increased pulmonary capillary wedge (PCW) pressure which in turn correlates with left ventricular filling pressures.[13]

Therefore, this study aimed to evaluate the in hospital prognostic significance (i.e. length of hospital stay, for death and in hospital adverse clinical events) of postural crackles in patients with acute MI.

MATERIALS AND METHODS

Study Population

This is a prospective cross-sectional study that included adult patients (age >25 years) who had been diagnosed with acute MI and were treated at our hospital between January 2016 and June 2016. All consecutive patients with acute MI admitted during the study period were included. Inclusion criteria were (a) history of chest pain at rest or other symptoms suggestive of an ACS with the most recent episode occurring within 24 h of admission and (b) compatible ECG changes and positive cardiac biomarkers.

The patients were excluded if they have (a) history of lung disease, (b) valvular heart disease, (c) already on diuretics for various indications, and (d) known the case of coronary heart disease.

Baseline variables

Anthropometric measures such as blood pressure, weight, height, and body mass index were measured. Fasting blood was tested for blood glucose, serum lipid levels. Chest X-ray, 2D echocardiography, and ECG parameters were recorded.

Examination technique for PIC

To elicit the finding, the clinician listens to the lower chest wall near the posterior axillary line with the patient in three sequential positions: Sitting, supine, and supine with legs elevated 30 degrees.[14,15] At first the patient is seated on a bed for 3 mm. Then, the lungs are auscultated by stethoscope at the 8th, 9th, and 10th intercostal spaces along the posterior axillary line and the presence or absence of fine crackles is noted during at least five consecutive breaths during which special attention is paid to the end-inspiratory phase of deep respiration without forced expiration. Then, the patient assumes the supine position. 3 min after the patient has maintained the supine position, the patient's lungs are again auscultated. Then, the patient has both legs elevated passively to an angle of about 30 after 3 min in this position, the patient's lungs are auscultated again. If crackles are absent when the patient is upright but appear when the patient either is supine or has the legs elevated, the test is positive (i.e., the patient has PIC).

Definition of In-hospital Adverse Clinical Events

The adverse clinical events were defined as any one of the followings: (a) Development of any malignant ventricular arrhythmias (ventricular tachycardia or ventricular fibrillation) (b) development of hemodynamic instability needing catecholamine or ionotropic support and/or ventilatory support (noninvasive or invasive positive pressure ventilation).

Ethical Approval

Ethical approval was obtained by the Ethics Review Committee of MGM Hospital, Warangal. An informed consent was obtained from all study participants and those who did not give consent were excluded in the study.

Study Design

All the patients presenting to cardiology department with a diagnosis of acute MI (ST-segment elevation MI [STEMI] or non- STEMI [NSTEMI]) are considered for study and patients are examined at admission. Patients having persistent crackles are excluded from the study, patients with PIC negative are selected as control population and patients with PIC positive are selected as case population.

All auscultatory findings were performed by two independent internal medicine residents who were blinded to patient information. To estimate intra- and inter-observer variability, 30 randomized patients were re-examined by second, independent investigator who was blinded to the results obtained by the first investigators, the inter- and intra-observer coefficients of variation were 2.1% and 1.3%, respectively. Patients baseline demographic characteristics, chest X-ray, 2D echocardiography parameters, and daily ECGs are recorded and analyzed for statistical analysis.

Statistical Analysis

Statistical analyses were performed using SPSS 17.0 (IBM, Armonk, NY). Categorical and numerical variables were expressed in percentage and mean (±standard deviation), respectively. Numerical variables were tested with

independent samples *t*-test, and categorical variables were tested using Fisher's exact test or Chi-square test, whichever was suitable. Multivariate logistic regression analysis was performed to determine the predictors of in-hospital outcomes. This analysis included variables with statistical significance in the univariate logistic regression analysis and those with a known clinical impact. The statistical significance was considered for a $P < 0.05$.

RESULTS

A total of 302 patients were diagnosed as acute MI (144 - STEMI and 158 - NSTEMI) treated during this period in our hospital. 167 patients are excluded from the study (30 = known case of coronary artery disease 26 = history of lung disease 11 = didn't give their consent for study 12 = already on diuretics for various indications 88 = patients with persistent crackles). A total of 135 patients are included in the study (64 are PIC positive = study group and 71 are PIC negative = control group). Baseline demographic characteristics of population are shown in Table 2. The mean age in the study group is 55.2 ± 12.3 years and in control group is 56.6 ± 13.1 years. The study group has 62.5% males (40) as compared to control group 59.2 (42). There were no significant differences ($P > 0.05$) between the two groups in age, sex distribution and in comorbid conditions.

Table 2: Baseline demographic characteristics of control (PIC–ve) and case population (PIC+ve)

Variable	Case/PIC+ve population *n*=64 (%)	Control/PIC−ve population *n*=71 (%)	*P* (NS)
Age			
40 years	21 (32.8)	21 (29.6)	0.7130
40 years	43 (67.2)	50 (70.4)	0.7130
Mean (in years)	55.2±12.3	56.6±13.1	0.5245
Sex			
Male	40 (62.5)	42 (59.2)	0.7266
Female	24 (37.5)	29 (40.8)	0.7266
Comorbid conditions			
Hypertension	21 (32.8)	22 (31)	0.8548
Diabetes mellitus	33 (51.2)	30 (42.2)	0.3038
Alcohol	21 (32.8)	28 (39.4)	0.4758
Smoking	18 (28.1)	15 (21.1)	0.4234
Obesity	5 (7.8)	6 (8.4)	1

NS=Not significant statistically. PIC: Posturally induced crackles

Clinical, electrocardiographic and biochemical parameters in two groups are depicted in Table 3. The proportion of the type of acute MI does not vary significantly ($P > 0.05$) between the two groups, as is the management (conservative vs. thrombolysis [$P > 0.05$]). Biochemical parameters, such as random blood glucose and total leukocyte count, are also significantly higher ($P < 0.001$) in study (PIC +ve) group compared to control (PIC −ve) group.

Even the ejection fraction of patients in the study (PIC +ve) group is significantly lower than control (PIC −ve) group. Other serum biochemical findings, such as serum lipid levels and serum creatine kinase MB levels, did not differ significantly in both groups ($P > 0.05$). However, diastolic blood pressure and heart rate at admission differ significantly in both groups ($P < 0.05$).

Table 3: Clinical, electrocardiographic, echocardiographic and biochemical characteristics of both groups

Variable	Case/PIC+ve population (*n*=64)	Control/PIC−ve population (*n*=71)	*P*
Hemodynamic variables*			
SBP (mmHg)	122.5±14.7	126.8±16.8	0.11
DBP (mmHg)	78.5±7.4	81.4±8.9	0.04
HR (bpm)	87.1±8.2	81.6±9.1	<0.001
Acute MI group			
NSTEMI (%)	35 (54.7)	32 (45)	0.3030 (NS)
Thrombolysed STEMI (%)	18 (28.1)	26 (36.7)	0.3587 (NS)
Not thrombolysed STEMI (%)	11 (17.2)	13 (18.3)	1 (NS)
Lab findings*			
TLC	10439±1210.2	8243.6±1450.5	<0.001
Random glucose	179.8±14.1	163.3±19.6	<0.001
Hemoglobin	10.6±1.8	11.2±2.1	0.0786 (NS)
CK-MB	76±4.5	75±5.6	0.2445
ECG variables			
NSTEMI (%)	35 (54.7)	32 (45)	0.3030 (NS)
AW-STEMI (%)	17 (26.5)	23 (32.4)	0.5716 (NS)
IW-STEMI (%)	6 (9)	9 (12.6)	0.5937 (NS)
PW-STEMI (%)	2 (3)	2 (2.8)	1 (NS)
Global STEMI (%)	4 (6)	5 (7)	1 (NS)
2D echo variables			
LVEF	50.2±7.4	55.9±6.3	<0.001
E/A ratio	1.02±0.35	0.99±0.40	0.6452 (NS)

E/A ratio: Ratio of mitral E and A wave diastolic velocities at discharge. *Findings at admission. AW: Anterior wall, IW: Inferior wall, PW: Posterior wall, Global: More than one territory, NS: Not significant, ECG: Electrophysiological, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, HR: Heart rate, LVEF: Left ventricular ejection fraction

As seen in Table 4, significantly higher proportion ($P < 0.05$) of PIC +ve patients suffer with in hospital adverse events compared to PIC −ve patients.

Duration of hospital stay is significantly higher ($P < 0.001$) in PIC +ve patients than compared to PIC −ve patients, even in hospital mortality is significantly higher ($P < 0.05$) in PIC +ve group compared to control group as shown in Figures 1 and 2.

In binary univariate logistic regression analysis diastolic blood pressure, heart rate, white blood cell (WBC), random plasma glucose, left ventricular ejection fraction (LVEF), presence of PIC, increased the risk angiotensin converting enzyme (ACE). However, only LVEF and presence of PIC increased the risk of in hospital ACE as shown in Tables 5 and 6. On multivariate logistic regression analysis WBC, random plasma glucose, presence of PIC, reduced LVEF are independent predictors of in hospital mortality.

DISCUSSION

This study showed that presence of PIC is an independent predictor of in hospital adverse clinical effects and death.

Table 4: Comparison of in-hospital adverse events (ACE) in study and control groups

ACE	PIC+ve *n*=64 (%)	PIC−ve *n*=71 (%)	*P*
Malignant ventricular arrhythmias	7 (10.9)	4 (5.6)	0.3490 (NS)
Ionotropic support	9 (14)	2 (2.8)	0.0250
Ventilator support	4 (6.2)	2 (2.8)	0.4222 (NS)
Total number of patients	15 (23.4)	4 (5.6)	0.0053

1 patient may experience>1 ACE. PIC: Posturally induced crackles, ACE: Angiotensin converting enzyme, NS: Not significant

Table 5: Multivariate regression analyses for the predictors of ACE in the entire population

Variable	OR (95% CI)	*P*
LVEF	0.87 (0.65-1.04)	0.02
Presence of PIC (*n*)	1.94 (1.7-2.18)	0.001

PIC: Posturally induced crackles, ACE: Angiotensin converting enzyme, LVEF: Left ventricular ejection fraction, OR: Odds ratio, CI: Confidence interval

Table 6: Multivariate regression analyses for the predictors of mortality in the entire population

Variable	OR (95% CI)	*P*
TLC	2.8 (2.6-2.9)	0.001
RPG	1.34 (1.2-1.45)	0.012
Presence of PIC	2.1 (1.9-2.2)	0.014
LVEF	0.87 (0.66-1.04)	0.02

RPG: Random plasma glucose, PIC: Posturally induced crackles, OR: Odds ratio, CI: Confidence interval, TLC: Total leukocyte count, LVEF: Left ventricular ejection fraction

The length of hospital stay is also significantly higher in this group of patients. In addition to PIC, WBC and random plasma glucose levels are also found to be independent predictors of morbidity in patients with acute MI in accordance to previous studies.[16-18] An extensive study done by Yasuda *et al.*[19] found that PIC crackles are predictor of latent congestive HF and associated with increased mortality in patient with HF. In another study by Deguchi *et al.* found that PIC was the third most important prognosticator after recovery from MI and the number of diseased coronary vessels and the PCW pressure ranked first and second, respectively. Hemodynamically Iida *et al.*[20] found that PCW pressure is significantly higher in the PIC-positive group than in the PIC negative group thus causing alveolar collapse and reducing lung compliance. Hence, the patients presenting with acute MI can be prognostically separated by

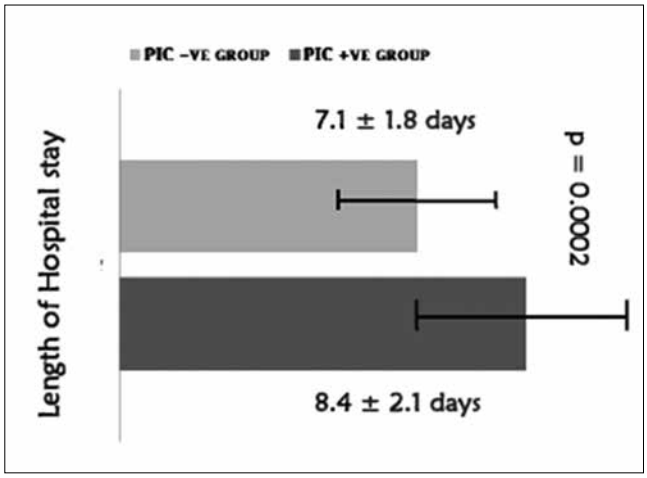

Figure 1: Showing difference in length of stay in study group (posturally induced crackles [PIC] +ve) and control group (PIC –ve) group is statistically significant ($P < 0.001$), higher in PIC +ve group

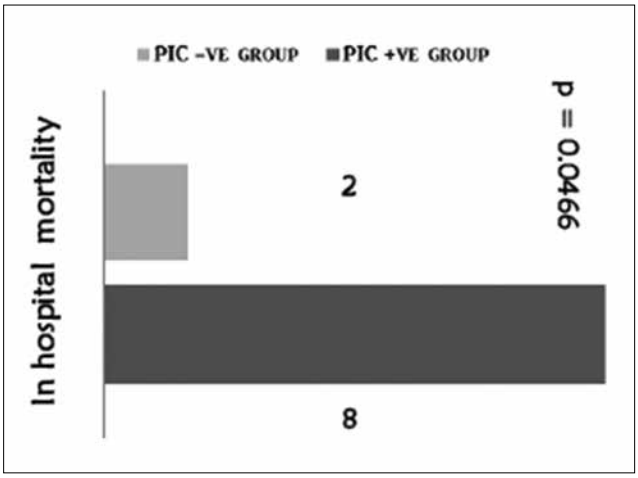

Figure 2: Showing difference in "in-hospital mortality" in study group (posturally induced crackles [PIC] +ve) and control group (PIC –ve) group is statistically significant ($P < 0.05$), higher in PIC +ve group

examining for the presence of PIC, thus helps is delivering improved medical care and reducing in hospital mortality. This study in fact proves that Killip class 1 population is a heterogeneous group prognostically.

Limitation

The primary limitations of this study are that it was a single-centred study and that it examined a limited number of patients in a specific period (no long-term follow-up of patients is done).

CONCLUSION

In conclusion, the presence of PIC is a simple bedside examination finding which helps us determining the prognosis of patients admitted with acute MI. It is independent predictor of in hospital death and significantly associated with longer hospital stay. Thus Killip class 1 group of patients are heterogeneous group prognostically.

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How to cite this article: Balaji B, Kiran GR. Prognostic Significance of Posturally Induced Crackles as a Predictor of in - Hospital Mortality and Morbidity in Patients with Acute Myocardial Infarction. Int J Sci Stud 2016;4(7):1-5.

Source of Support: Nil, **Conflict of Interest:** None declared.