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(RESEARCH ARTICLE)

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Assessment of prognostic value of heart rate response to single deep breath in cases of acute myocardial infarction involving anterior wall or inferior wall within first 12 hours of admission

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Abstract

Introduction: The sympatho-vagal balance on the SA node produces beat to beat variation in heart rate which is markedly increased in normal subjects on deep breathing cycles. Heart rate variability testing gives an estimation of altered vagal-sympathetic balance and is a marker of low vagal tone on the heart. This study assesses a simple bedside test involving a single cycle of deep breathing to assess heart rate variability response.

Methods: A prospective observational study was done from May 2018 to September 2018 in the department of cardiology in 52 subjects diagnosed as suffering from acute myocardial infarction. For this test, ECG recording in all limb leads was taken while the patient was asked to perform deep breathing for ten seconds. The difference between the maximum and minimum R-R interval was recorded as an index of heart rate variability. The patient was then followed up till discharge for improvement or deterioration in clinical condition.

Results: Forty-one subjects (78.8%) had a heart variability response of less than 10 beats per minute and the rest eleven (20.2%) individuals had a variability response of >10 beats per minute. Patients who had low heart rate variability (n=41) showed higher incidence of acute left ventricular failure (75%), arrhythmia (17.5%) as compared to patients who had normal heart rate variability.

Conclusions: This test can serve as an inexpensive, feasible and bedside alternative to conventional methods and can be correlated with negative prognosis in patients with acute MI.

Keywords: HRV; Cardiovascular physiology; MI; Bedside tests

1. Introduction

Role of cardiovagal innervation and its response in acute myocardial injury has been a subject of interest since 1972 when Webb[1] and later Sheilds[2] explored the potential of assessing heart rate response to deep breathing (HRV db) as a reliable tool for early detection of loss of parasympathetic cardiac control. Although different tests are available to assess autonomic cardiac function during times of compromise in cardiac function, HRVdb is a reliable, simple, non-invasive, bedside test to rapidly assess the cardiovagal control. Increased sympathetic activity as a compensation to deterioration in effective output as well as decreased vagal tone has been documented to be the culprits in inducing arrhythmias, worsening ischemia, failure and sometimes leading to sudden death in patients with acute MI or loss of autonomic cardiac control[3,4]. There are studies done to assess differences in heart rate variability (HRV) measured between anterior and nonanterior infarctions occurring within the first 24 hours. These studies suggested that anterior wall MI have greater impairment of HRV than inferior wall MI[5,6] and that these changes occur earlier[7] in onset of a

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coronary event. It was generally believed that since anterior MI is likely to involve myocardial damage, the decreased HRV or absence of sinus arrhythmia would be due to enhanced activity of adrenosympathetic and renin angiotensin systems. However, such observations of differences between decreased heart rate response to breathing cycles in anterior and inferior wall MI have not been consistent.[8,9] It is well known that a decreased response in heart rate to breathing cycles is associated with acute myocardial infarction leading to considerably reduced long term survival independent of other known risk factors. The potentially fatal arrhythmias associated with extensive MI are also thought to be due to patchy autonomic denervation making the heart more vulnerable to complications [10,11]. Various methods for measurement of autonomic activity in patients after MI have been in vogue which include HRV analysis on 24 hours holter monitor, HRV measurement over 2-15 minutes and assessment of baroreflex activity[12]. All these methods require sophisticated equipment, software for analysis adding up to the cost. Sinus Arrhythmia (HRV) or its absence serves as an excellent predictor of death or arrhythmia events after MI. It is also understood that in the present times the protocols of prevalent management of MI demand that not much time be wasted in bedside evaluation once the diagnosis of acute MI has been established on ECG. We therefore explore the significance of even quicker tests as quantification of sinus arrhythmia (heart rate response to breathing) over single deep breath as difference between maximum and minimum RR interval in one breath cycle lasting for 10 seconds.

2. Material and methods

After obtaining clearance from the institutional research and ethics committee, this study was conducted in the department of Cardiology from March 2018 to August 2018.

The study included 52 consecutive patients with anterior or inferior myocardial infarction. Inclusion criteria included first time presentation of myocardial infarction, clinically examined and diagnosed via ECG. Exclusion criteria included patients with symptoms exceeding 12 hours of presentation. Single breath deep breathing test was employed once the patient had been stabilized.

Each patient was demonstrated the technique of single deep breath involving 5 seconds of inspiration and 5 seconds of expiration while the patient's standard limb lead II was being recorded simultaneously on BPL cardiart 6481 T machine with patient in supine posture in ambient environment. All test measurements were performed by a single examiner who raised his hand to begin inhalation and lower the hand to signal exhalation.

The R-R intervals between adjacent QRS complexes resulting from sinus nodal origin were measured and HRV was calculated as the difference been the shortest and the longest R-R interval excluding premature/ectopic ventricular beats.

The patients were followed up once in 24 hours till they were discharged to document the course of events during their stay or complications leading to death if any. The observations were documented in terms of development of heart failure or arrhythmias during hospitalization, duration of hospital stay and outcome.

The data was analysed using chi-square test to evaluate the significance of association between HRV and other variables as mentioned above. Means of continuous variable were compared by t test. Results will be expressed as mean with standard deviation.

3. Results

Out of 52 patients, 34(65.4%) were males and the rest 18(34.6%) were females . The mean age group was 59 years with a majority above 50(71.5%) (table 1). Comorbidities present were Hypertension (59.6%), Diabetes Mellitus (44.2%) and Coronary Artery Disease (15.4%).

30 were diagnosed with Anterior Wall MI (57.6%) and 22 were diagnosed with Inferior Wall MI (42.4%) (Table 1).

41 (78.8%) had a HRV of less than 10 beats per minute and were classified as low HRV and the rest 11(20.2%) had >10 beats per minute as high HRV. (Table 1).

35 (67.3%) developed acute left ventricular failure (LVF), 8 (15.3%) developed arrhythmia during their stay and 2 patients (3.8%) went into cardiogenic shock. The rest 7(13.4%) had no complications. (table 1).

In the group with low HRV(n=41) there was higher incidence of acute LVF (75%) as compared to high HRV (50%), p=0.030(table 1). They also had a higher incidence of arrhythmias (17.5%), than the patients with high HRV (10%).

Death rate was higher in patients with low HRV (88%) compared to only 12% in the patients with low HRV.

Table 1 Cardiac predictors vs heart rate variability

Predictors	**Heart Rate Variability**			
	Total (n= 52)	**< 10 (n= 41)**	**≥ 10 (n= 11)**	
		n (%)	**n (%)**	**p-value**
Complications				
Acute left ventricular failure	35	30 (75.0)	5 (50.0)	0.030
Arrythmias	8	7 (17.5)	1 (10.0)	
None	7	3 (7.5)	4 (40.0)	
Site of myocardial infarction				
Anterior Wall	30	24 (58.5)	6 (54.5)	0.812
Inferior Wall	22	17 (41.5)	5 (45.5)	
Status				
Alive	43	33 (80.5)	10 (90.9)	0.417
Death	9	8 (19.5)	1 (9.1)	

4. Discussion

Previous studies have indicated the importance of HRV in response to deep breathing in cases of various pathologies such as diabetic neuropathy, acute coronary syndrome etc. [12,13] where HRV in normal subjects is higher (10 beats per minute or more)[14] as compared to individuals with various co-morbidities.

The response in beat to beat variation on deep breathing is an independent marker in complications after an acute myocardial ischemia[15]. Various studies have linked development of acute left ventricular failure, arrhythmia, even death with low HRV[16]. Studies done through the years have suggested a strong relation between low HRV and a bad prognosis in cases of Myocardial infarction[1,2,13].

The present study used the time domain method to calculate HRV like a one-minute bed side test done by earlier researchers[13] but limiting observation to a shorter duration of 10 seconds while the subject took a single deep breath. There was significance between low HRV and development of complications such as acute left ventricular failure(p=0.030).

5. Conclusion

The study design is unique as it signifies the importance of a single deep breath response to HRV and its association to bad prognosis in cases of acute MI as an alternative to multiple deep breathing cycles in clinical assessment of HRV.

Compliance with ethical standards

Acknowledgments

Department of Cardiology, Christian Medical College, Ludhiana.

Disclosure of conflict of interest

No conflict of interest.

Statement of ethical approval

The present study was given ethical approval by the Institutional Research Board, CMC Ludhiana.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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