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Original Article

Correlation of Cardiac Troponin I with Left Ventricular Systolic Function in Patients with Acute ST-segment Elevated Myocardial Infarction

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Abstract:

Myocardial infarction is one of the leading cause of death globally and following acute myocardial infarction prognosis depends on extent of myocardial damage. This study was aimed to correlate cardiac troponin I level with the left ventricular systolic function in patients with acute ST-elevated myocardial infarction. A total of 104 patients of acute ST-segment elevated myocardial infarction receiving streptokinase therapy within 12 hours of onset of chest pain were studied. Cardiac troponin I concentration was measured by immunometric assay and echocardiographic left ventricular ejection fraction was calculated by modified biplane Simpson's method. Left ventricular ejection fraction (LVEF) was compared with serum cardiac troponin I concentration. Study subjects were divided into two groups on the basis of LVEF. In group I, there were 54 patients with LVEF < 50% and in group II, there were 50 patients with LVEF ≥50%. The mean cTnI within 12 hours of onset was 129 ± 8.7 ng/ml in group I and11 ± 2.1 ng/ml group II and the difference was statistically significant (p<0.001). Serum cardiac troponin I concentration has a strong negative correlation with left ventricular ejection fraction after first acute myocardial infarction. A level of serum cardiac troponin I ≥6.6 ng/ml provided a good indication for LVEF <50% and this can be used to detect patients with higher risk.

Key words: Cardiac troponin I, Left ventricular ejection fraction, Myocardial infarction.

Introduction:

Coronary heart disease (CHD) is a major cause of death and is a global health problem reaching epidemic in both developed as well as in developing countries[1]. Ischaemic heart disease was the leading cause of death in developed countries and second leading cause of death in developing countries and by the year 2020 ischaemic heart disease will hold first place in the World Heath Organization's list of leading cause of disability[2].

Following acute myocardial infarction prognosis depends on extent of myocardial damage with a larger infarction leading a worse prognosis[3]. In routine clinical practice, infarct size is estimated non-invasively by electrocardiography, imaging techniques (such as myocardial radionuclide imaging and echocardiography), and serological tests[4].

Cardiac troponins are regulatory proteins that control the calcium mediated interaction of actin and myosin, which results in contraction and relaxation of striated muscle[5,6]. Cardiac troponin is a class I indicator for risk stratification in patients with acute coronary syndrome (ACS)[7]. Several studies have demonstrated that in patients with ACS, increased concentrations of troponin closely correlate with the presence, complexity, and severity of epicardial coronary artery disease, as well as decreased microvascular myocardial perfusion[8].

Ventricular function is the best predictor of death after an acute coronary syndrome[5]. The evaluation of ventricular systolic function is among the most common indications for a transthoracic echocardiographic examination, and is important in the management and risk assessment of patients with primary ventricular dysfunction[9-12].

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Materials and Methods:

This hospital based cross sectional analytic study was performed in the department of cardiology, National Institute of Cardiovascular Diseases, Dhaka, during the period from July 2011 to June 2012. Patients with first acute ST elevation myocardial infarction (STEMI), within 12 hours onset of chest pain who received streptokinase therapy were enrolled with informed written consent. Patients with Old myocardial infarction (old MI), valvular heart disease, congenital heart disease, cardiomyopathy and significant renal impairment (serum creatinine> 1.4 mg/dl) were excluded. Heart causes are excluded by taking history. clinical examination, electrocardiography and echocardiography. Significant renal impairment patients were excluded by measurement of serum creatinine. Demographic data such as age, sex, occupation, height (cm), weight (Kg) and socioeconomic status were also recorded. Risk factors such as smoking, hypertension, diabetes mellitus, dyslipidaemia and family history of coronary artery diseases were also taken under consideration.

Serum troponin I concentration was determined by immunometric assay (Immulite turbo-troponin I; DPC;Los Angeles, USA). Serum troponin I value was measured at admission and between 12-48 hours after the onset of chest pain. The troponin kit reagent used in this study has a cut-off value of 1.0 ng/ml for diagnosis of acute myocardial infarction.

Echocardiograms were done using a GE vivid S5N echocardiographic machine (GE-Vingmed ultrasound, Horten, Norway) with a 3 mHZ multiphase array probe in subjects lying in the left lateral decubitus and supine positions. The echocardiographic techniques and calculations of different cardiac dimensions were performed according to the recommendations of the American Society of Echocardiography. The ejection fraction were obtained using a modified biplane Simpson's method from apical two chamber and four chamber views. Measurements were made from three consecutive beats, and the average of three beats were used for analysis. The ejection fraction was then calculated using left ventricular end-diastolic volume and end-systolic volume estimates.

Study subjects were divided into two groups on the basis of LVEF. In group I, there were 50 patients with LVEF < 50% and in group II, there were 54 patients with LVEF ≥ 50%. All the variables like baseline characteristics and outcome variables were compared between these two groups. After processing of all available information, statistical analysis of their significance were done by using SPSS (Statistical Package for Social Science) software. The significance of differences between the two groups were determined by using appropriate test formula. A p-value <0.05 was considered as significant.

Results:

A total of 104 patients with 54 patients in group I (LVEF < 50%) and 50 patients in group II (LVEF ≥ 50%), were with first acute ST elevation myocardial infarction (STEMI), within 12 hours onset of chest pain who received streptokinase therapy were studied. Out of 104 patients 90 were male and 14 were female with a male to female ratio of 6.42: 1. The majority of the study subjects were 50-60 years of age in both groups with the mean age of 52.9±11.3 years in group I and that of 52.7±9.9 years in group II. A male preponderance was observed in both groups with no statistically significant difference between the groups in respect of age (p=0.915) and sex (p=0.320) (Table I).

Table I: Comparison of the study subjects by age and sex. (n=104)

Demographic characteristics	Study subjects		p-value
	Group-I (n = 54)	Group-II (n = 50)	
Age* (years)			
<40	7 (13.0)	3 (6.0)	
40-50	17 (31.5)	20 (40.0)	
51-60	20 (37.0)	20 (40.0)	
61-70	8 (14.8)	5 (10.0)	
>70	2 (3.7)	2 (4.0)	
Mean ± SD	52.9 ± 11.3	52.7 ± 9.9	0.915^{ns}
Sex#			
Male	45 (83.3)	45 (90.0)	0.320^{ns}
Female	9 (16.7)	5 (10.0)	

Figures in the parentheses denote corresponding percentage

* Data were analysed using unpaired t-test and were presented as mean ± SD.

Data were analysed using Chi-square (χ^2) test.

ns= Not significant.

According to body mass index (BMI)

According to comparison of patients by body mass index (BMI), the mean BMI was higher in group I (28±3.0) than that of group II (26.1±2.3) with statistically significant difference (p=0.002). Prevalence of all the cardiovascular risk factors except family history of IHD were relatively low in the group-I than those in group-II, but the difference between the two groups with respect to risk factors distribution was not significant (p > 0.05 in each case), (Figure I) (Table II).

Table II: Comparison of patients by Body Mass Index (BMI) (n=104)

BMI#	Study subjects		p-value
	Group-I (n = 54)	Group-II (n = 50)	
Normal	6 (11.1)	16 (32.0)	
Overweight	31 (57.4)	30 (60.0)	
Obese	57 (31.5)	4 (8.0)	
Mean ± SD	28.2 ± 3.0	26.1 ± 2.3	0.002

Figures in the parentheses denote corresponding percentage

Data were analysed using Chi-square (χ^2) test.

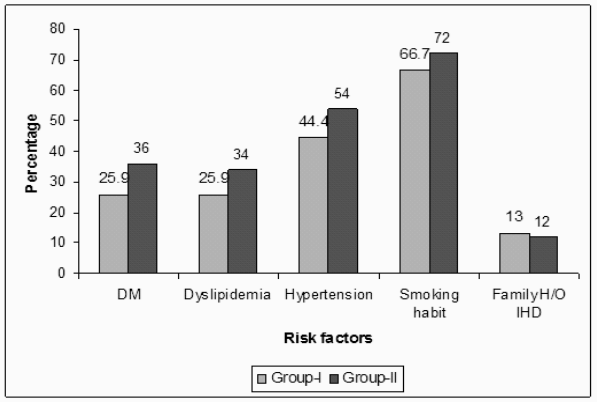

Fig 1: Distribution of study subjects by cardiovascular risk factors. (n=104)

Comparison of cardiac biomarkers and enzyme showed the mean cTnI on admission was 38.8 ± 8.4 ng/ml in group I and 6.1 ± 3.5 ng/ml in group II and the mean cTnI between 12-48 hours after onset of chest pain was 129±68.7 ng/ml in group I and 11.0±2.1 ng/ml in group II. Data showed significant (p<0.001) difference of cTnI between two groups (Table III).

Table III: Comparison of cardiac biomarkers and enzyme between groups. (n=104)

Cardiac biomarkers	Study subjects		p-value
	Group-I (n = 54)	Group-II (n = 50)	
cTnI on admission (ng/ml)	38.8 ± 8.4	6.1 ± 3.5	< 0.001
cTnI between 12-48 hrs (ng/ml)	129.6 ± 8.7	11.0 ± 2.1	< 0.001
CK-MB on admission (U/L)	107.8 ± 12.8	61.4 ± 7.8	0.003

* Data were analysed using unpaired t-test and were presented as mean ± SD

Estimation of cardiac troponin I and LVEF on admission revealed that among 54 patients with LVEF <50%, 25 patients had serum troponin I ≥6.6 ng/ml and 29 patients had <6.6 ng/ml. On the other hand, out of 50 patients with LVEF ≥50%, 6 patients had serum troponin I ≥ 6.6 ng/ml and 44 patients had <6.6 ng/ml (Table IV).

Table IV: Cardiac troponin I on admission and LVEF. (n=104)

Troponin I on admission (ng/ml)	Ejection Fraction		Total
	< 50% (Reduced)	50% (Preserved)	
6.6	25 (46.30%)	06 (12.0%)	31
< 6.6	29 (53.70%)	44 (88.0%)	73
Total	54 (100%)	50 (100%)	104

The sensitivity of cardiac troponin I on admission in predicting reduced LVEF of those who had it was (25/54) 100 = 46.3%, while the specificity of the test in correctly detecting those who did not have reduced LVEF was (44/50) 100 = 88%. The positive predictive value (PPV) of the test was (25/31) 100 = 80.6% and the negative predictive value (NPV) of the test was (44/73) 100 = 60.3%. The percentage of false positive and false negative as yielded by test were 06/31 100 = 19.4% and 29/73 100 = 39.7% respectively. The overall diagnostic accuracy of Troponin I in correctly detecting LVEF is (25 + 44)/104 100 = 66.3% (Table V).

Table V: Performance of cTnI on admission in predicting LVEF <50%.

cTnI	Sensitivity	Specificity	Positive predictive value (PPV)	Negative predictive value (NPV)
Prediction of LVEF	46.3%	88%	80.6%	60.3%

Estimation of cardiac troponin I between 12-48 hours of onset of chest pain and LVEF showed that among 54 patients with LVEF <50%, 53 patients had serum troponin I ≥ 6.6 ng/ml and 1 patient had <6.6 ng/ml. On the other hand, out of 50 patients with LVEF ≥50%, 29 patients had serum troponin I ≥ 6.6 ng/ml and 21 patients had <6.6 ng/ml (Table VI).

The sensitivity and specificity of Troponin I after 12 hours of admission in predicting reduced LVEF were 98.1% and 42% respectively, while PPV and NPV of the tests were 64.6% and 95.5% respectively. False positive and false negatives as yielded by the tests were 35.4% and 4.5% respectively. The diagnostic accuracy of the test was 71.2%.

Table VI: Cardiac troponin I between 12-48 hours of onset of chest pain and LVEF. (n=104)

Troponin I between 12-48 hours (ng/ml)	Ejection Fraction		Total
	< 50% (Reduced)	50% (Preserved)	
6.6	53 (98.15%)	29 (58.0%)	82
< 6.6	01 (1.85%)	21 (42.0%)	22
Total	**54 (100%)**	**50 (100%)**	**104**

The sensitivity and specificity of Troponin I after 12 hours of admission in predicting reduced LVEF were 98.1% and 42% respectively, while PPV and NPV of the tests were 64.6% and 95.5% respectively. False positive and false negatives as yielded by the tests were 35.4% and 4.5% respectively. The diagnostic accuracy of the test was 71.2%.

Table VII: Performance of cardiac troponin I between 12-48 hours of onset of chest pain in predicting LVEF <50%

cTnI	Sensitivity	Specificity	Positive predictive value (PPV)	Negative predictive value (NPV)
Prediction of LVEF	98.1%	42%	64.6%	95.5%

The Spearman correlation between cardiac troponin-I (cTnI) and left ventricular ejection fraction showed that as cTnI increases the LVEF decrease bearing a negative correlation between the two variables (r=-0.517, p < 0.001) (Figure 2).

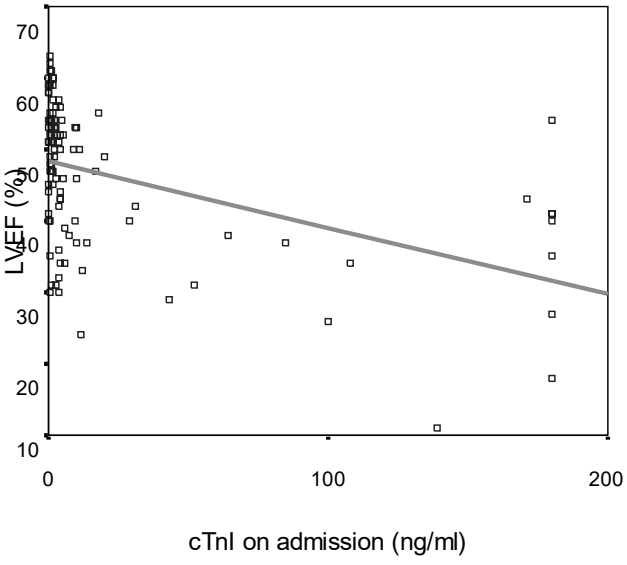

Fig 2: Correlation between cTnI on admission and LVEF

The Spearman correlation between cardiac troponin-I (cTnI) between 12-48 hrs of onset of pain and left ventricular ejection fraction. The two variables bearing a negative correlation suggesting that the higher the level of cTnI the lower is the LVEF (r = -0.827, p < 0.001) (Figure 3).

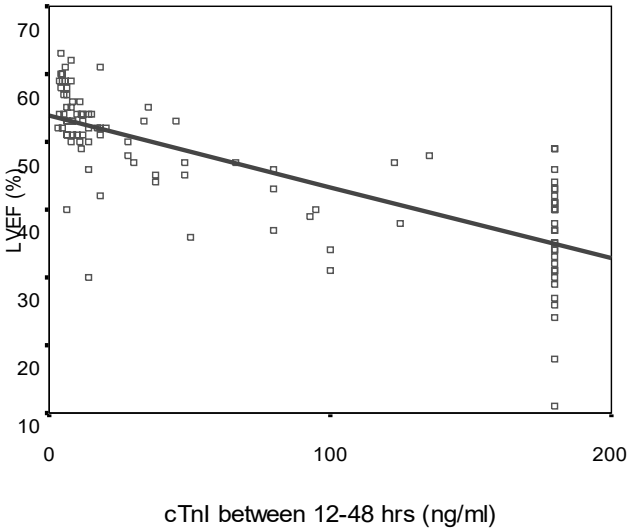

Fig 3. Correlation between cTnI between 12-48 hrs of onset of pain and LVEF.

Discussion:

cTnI is accepted as a highly reliable biochemical marker for detecting myocardial damage, and its use in the diagnosis of acute myocardial infarction is increasing[11,12]. Data shows that cTnI is related to the amount of myocardial damage, but there are very few studies to substantiate the claim[13-15]. cTnI release closely relates to infarct size and therefore inversely correlates with left ventricular ejection fraction, as there is inverse relation between infarct size and left ventricular ejection fraction[16-18].

In this study it was found that 46.3% of patients of group I and 12% of patients of group II had ≥ 6.6 ng/ml cTnI on admission. On the other hand 53.7% of patients in group I and 88% of patients in group II had cardiac troponin I < 6 ng/ml. The mean troponin I level was 38.8 ± 8.4 and 6.6 ± 3.5 ng/ml in group I and group II respectively. The difference was statistically significant (p< 0.001). The peak troponin I i.e., cTnI between 12-48 hours of onset of chest pain was ≥ 6.6 ng/ml in 98.15% of patients in group I and 58% of patients in group II, whereas cTnI < 6 ng/ml was only 1.85% and 42% of patients in group I and group II respectively. The mean troponin was 129 ± 8.7 ng/ml in group I and 11.0 ± 2.1 ng/ml in group II. The difference was also statistically significant (p <0.001).

In their study somani et al[4] found that peak troponin was ≥ 6.6 ng/ml in 100% of patients in group I and 11.63% of patients in group II, on the other hand cTnI < 6.6 ng/ml was 0% in group I but 88.37% in group II patients. They also found mean troponin was 11.49 ± 6.94 ng/ml and 5.07 ± 1.48 ng/ml in group I and group II respectively. These disparity between the results were due to selection of only acute STEMI patients.

In a study Rao et al[6] showed troponin peak value provide information on systolic function. In patients with ST segment elevation and in whom ejection fraction analysis was developed. They observed that troponin was a good indicator of depressed ejection fraction.

Our study showed strong negative correlation between cTnI concentration measured between 12 to 48 hours post-myocardial infarction and echocardiographic left ventricular ejection fraction (r= -0.827, p< 0.001). Cardiac troponin I measured at admission also showed a negative correlation with LVEF (r= -0.517, p< 0.001). The study also found that cTnI concentration ≥ 6.6 ng/ml was a sensitive (98.1%) and specific (42%) indicator of left ventricular ejection fraction of <50% after first acute myocardial infarction.

These results were similar to the results obtained by Somani et al[4]. They evaluated 50 consecutive patients of AMI presenting within 48 hours of onset of chest pain. They showed a strong negative correlation between cTnI concentration measured 12-48 hours post myocardial infarction and echocardiographic left ventricular ejection fraction (r= -0.69, p< 0.0001). They also found that cTnI concentration > 6.6 ng/ml predicted LVEF < 50% with a sensitivity of 100% and specificity of 92.4%. Apple et al[9] also found similar results. They evaluated 39 consecutive patients of AMI presenting 4.5 hours (range 0.7- 12.1 hours) after onset of chest pain.

Thus the above discussion found that cTnI measured between 12-48 hours after onset of chest pain in patients with acute ST segment elevated MI had a negative correlation with left ventricular ejection fraction. So based on the above findings, cTnI showed excellent promise as a marker for the assessment of LVEF. This marker provides a simple, quick and non-invasive methods of identifying such patients.

Conclusion:

The present study concludes that serum troponin I concentration has a strong negative correlation with left ventricular ejection fraction after first acute ST-elevated myocardial infarction and hence can be used to assess the LVEF in this setting. Serum troponin I concentration ≥ 6.6 ng/ml predicts LVEF < 50% with a sensitivity of 98.15% and specificity of 46%. Besides this, higher troponin I concentration is associated with anterior infarct location and increased incidence of in hospital complications. Estimation of Troponin I offers a simple, inexpensive, quick noninvasive method of identifying such high risk patients who need further interventions.

References :

1. Chaturvedi V, Bhargava B. Health care delivery for coronary heart disease in India- Where are we headed? Am Heart Hosp J. 2007; 5(1):32-7.
2. Murray CJL, Lopez AD. Global health statistics: Global burden of disease and injury series. Boston: Harvard School of Public Health; 1996.
3. Christian TF, Gibbons RJ, Chements IP, Berger PB, Selverster RH, Wagner GS. Estimates of myocardium at risk and collateral flow in acute myocardial infarction using electrocardiographic indexes with comparison to radionuclide and angiographic measures. J Am Coll Cardiol. 1995; 26(2):388-93.
4. Somani D, Gahlot RS, Lakhotia M, Choudhary CR, Sangavi S. Troponin I measurement after myocardial infarction and its correlation with left ventricular ejection fraction. JIACM. 2005; 6(1):38-41.
5. Bodi V, Nunez J, Sanchis J, Llacer A, Facila L,Chorro FJ. Usefulness of troponin I for predicting systolic dysfunction in acute coronary syndromes. Rev Esp Cardiol. 2003; 56(7):738-41.
6. Rao AC, Collinson PO, Canepa-Anson R, Joseph SP. Troponin T measurement after myocardial infarction can identify left ventricular ejection of less than 40%. Heart 1998; 80(3):223-25.
7. Morrow DA, Antman EM. Evaluation of high sensitivity assays for cardiac troponin. Clin Chem. 2009; 55(1):5-8.
8. Wilson SR, Sabatine MS, Braunwald E, Sloan S, Murphy SA, Morrow DA. Detection of myocardial injury in patients with unstable angina using a novel nanoparticle cardiac troponin I assay: observations from the PROTECT-TIMI 30 trial. Am Heart J. 2009; 158(8):386-91.
9. Apple FS, Sharkey SW, Falahari A, Murakami M, Mitha N, Christensen D. Assessment of left ventricular function using serum cTnI measurement following myocardial infarction. Clin Chim Acta. 1998; 272(1):59-67.
10. Hass EE, Yang EH, Gersh BJ, ORourke RA. ST-segment elevation myocardial infarction. In: Fuster V, Walsh RA, Harrington RA, editors. 13th ed. Hurst's The Heart. New York: McGraw Hill; 2011. p. 1354-85.
11. Hartner KT, Pette D. Fast and Slow isoforms of troponin I and troponin C. Distribution in normal rabbit muscles and effects of chronic stimulation. Eur J Biochem. 1990; 188(2):261-65.
12. Kreulen TH, Bove AA, McDonough MT, Sands MJ, Spann JF. The evaluation of left ventricular function in man: a comparison of methods. Circulation. 1975; 51(6):677-88.
13. Kubo T, Kitaoka H, Okawa, M, Tamanaka S, Hirota T, Hoshikawa E, et al. Serum cardiac troponin I is related to increased left ventricular wall thickness, left ventricular dysfunction, and male gender in hypertrophic cardiomyopathy. Clin. Cardiol. 2010; 33(2):E1-7.
14. Morrow DA, Antman EM. Evaluation of high sensitivity assays for cardiac troponin. Clin Chem. 2009; 55(1):5- 8.
15. Ottani F, Galvani M, Nicolini FA, Ferrini D, Pozzati A, Pasquale GD, et al. Elevated cardiac troponin levels predict the risk of adverse outcome in patients with acute coronary syndromes. Am Heart J. 2000; 140(6):917-27.
16. Mair J, Wagner I, Morass B, Lechleitner P, Friendrich L, Galzolari C, et al. Cardiac troponin I release correlates wth myocardial infarction size. Eur J Clin Biochem. 1995; 33(11):869-72.
17. Thygesen K, Alpert JS, White HD. Universal definition of myocardial infarction. J Am Coll Cardiol. 2007; 50(22):2173-95.
18. Wu AH, Apple FS, Gibler WB, Jesser RL, Warshoni MM, Valdes R. National academy of clinical biochemistry standards of laboratory practice: recommendations for the use of cardiac markers in coronary artery diseases. Clin Chem. 1999; 45(9):1104-21.