Original Article

Elevated Serum Level of Cardiac Troponin After Coronary Intervention and Its Association With the Clinical Outcome of Patients

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ABSTRACT

Background: An elevation in the levels of troponin I and T is more frequent than a rise in CK-MB levels after percutaneous coronary intervention (PCI). Nevertheless, the prognostic value of elevated troponin I and T levels has yet to be compared with that of elevated CK-MB levels. Given the more specific role of troponin in cardiac incidents, we sought both to investigate the factors and elevated levels of cardiac troponin in patients having undergone PCI and to examine the predictive value of elevated cardiac troponin levels in comparison with that of elevated levels of CK-MB.

Methods: This case-series study was conducted in Rajaie Cardiovascular, Medical, and Research Center in 2011. The inclusion criteria comprised patients with coronary artery disease and stable hemodynamic who were selectively candidated for nonemergency coronary angiography in the hospital. Five hundred patients were included via convenient sampling within a year. Troponin and CK-MB levels were checked after PCI. In data analysis, the *t*-test, χ^2 test, and Fisher exact test were used. The results were analyzed using SPSS, version 17.

Results: The troponin level was elevated in 26.8% of the patients following PCI. The troponin assay was negative and positive in 73.2% and 26.8% of the patients, respectively. The mean age of the patients was 56.6 ± 9.9 years (71.8% male and 28.2% female). Totally, 68.2% of the patients' lesions were non-C patent type. There was a significant relationship between increased levels of troponin I and re-PCI (1 year after PCI) and also between gender and troponin elevation. Serum troponin was higher in the male patients after PCI.

Conclusions: A significant relationship was observed between elevated troponin I levels and redo-PCI a year after PCI. Increased levels of troponin I following PCI were not correlated with major cardiac events. ***(Iranian Heart Journal 2017; 18(3):13-20)***

Keywords: Coronary artery disease, Percutaneous coronary intervention, Troponin, Postprocedural myocardial Infarction

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Coronary arteries supply blood to the myocardium and the other components of the heart. The heart muscle is constantly working and needs oxygen and nutrients. For this reason, any symptom that causes coronary artery blockage immediately causes problems in the blood of a normal heart. Atherosclerosis is the most common cause of coronary artery disease (CAD). The disease is chronic and progressive and causes buildup of plaques in cholesterol, calcium, and abnormal cells. Inflammation plays an important role in CAD. Considerable evidence has been gathered vis-à-vis the implications of an increased troponin level after percutaneous coronary intervention (PCI). Studies have demonstrated that an elevation in postprocedural serum cardiac troponin is moderately common and that elevated levels of troponin after PCI are prognostically significant. [1]

In atherosclerotic lesions, inflammatory cells result in the progress of lesions and activated inflammation leads to acute coronary syndrome. Cardiovascular disease is currently the leading cause of death in most parts of the world, and its prevalence is increasing rapidly—especially in developing countries. [2]

In CAD patients with stable hemodynamic, PCI is a valuable initial way for revascularization in patients with large ischemia in the presence of almost every lesion subset—with only 1 exception: a chronic total atherosclerosis that cannot be crossed. PCI has revolutionized the treatment of CAD and is deemed a unique accomplishment in medicine. About one million PCI procedures are now performed annually in America, which is more frequent than coronary artery bypass grafting (CABG). [3] This modality has become the healthiest and safest non-drug treatment for coronary heart disease in most centers and has been accepted as the best non-drug method by patients as well. Cardiovascular diseases cause 38% of all mortalities in North America. Thus, a better understanding of heart disease, its treatment, and preventive measures is considered among health care strategies in many countries. [4, 5] Some studies have been carried out to assess the success as well as short-term and long-term consequences and the frequency of PCI complications the world over in order to prove the acceptability of this approach and to tackle the causes of its failure. [3] In recent decades, the advent of stents (particularly drug-eluting stents), use of catheters with a low profile (enabling the operator to pull the vessel more easily), and pharmaceutical strategies (such as Plavix and glycoprotein inhibitors ⅡⅠb/ⅢⅠa) has boosted the success rates of PCI. [3, 6] In patients undergoing PCI, the myocardial area at risk, morphology of the lesion, underlying cardiac function, renal failure, and associated comorbidities are vital. The extent of the viable myocardium, whose blood is supplied by the coronary artery, is the main consideration in the PCI risk assessment. PCI interrupts the coronary blood flow for a period of several seconds to minutes, and the patient's ability to tolerate the hemodynamic status depends on the extent of the viable myocardium and the collaterals in the ischemic area. [7] The risk of an abrupt closure of a coronary artery during procedures has been significantly reduced with the advent of coronary stents. [8] The predictors of cardio-vascular collapse with a failed PCI include the diameter of the stenosis before the procedure and the extent of the involvement of the other vessels. The type of PCI and the morphology of the lesion are other factors playing a role in the success rate. [9] The use of coronary stents fails to relieve the risk of periprocedural myocardial infarction, stent thrombosis, distal embolism, and no-reflow. The type of the lesion is one of the important predictors of PCI success. [10] The success rates of PCI in chronic total occlusion, saphenous vein grafts, bifurcation lesions, and thrombotic lesions are less. [3]

The classification of lesions by the Society for Cardiovascular Angiography and Interventions (SCAI) is served for PCI risk assessment. [11] The success of the PCI procedure is determined based on the absence of major complications (eg, mortality, myocardial infarction, CABG, and PCI). Periprocedural myocardial infarction is a common problem in PCI. Myocardial infarction occurs after PCI when there is a rise greater than 3 times the CK-MB level (in the first 24 hours after the procedure and on the basis of 3 CPK-MB controls). In the normal definition based on the assay kit in hospitals, CK-MB is less than 24 mg/dL. [12] Increased levels of troponin I and T after PCI are more frequent than elevated levels of CK-MB; however, the prognostic significance of elevated cardiac troponin has not been shown relative to a rise in CK-MB. [3] In the study by Amitsegen et al [13] in Toronto in 2004, the patients with an increased troponin I level after PCI had a higher number of vascular involvement. In 40% of the patients, troponin I was approximately higher following PCI and the probability of multi lesions and an angulated or long lesion incidence was high as well. In a study by Kini et al, [14] the predictive values of troponin I, troponin T, and CK-MB markers after successful angioplasty were examined and a 40% increase in troponin I and a 15% elevation in CK-MB were observed.

Objectives

A few studies have been conducted to assess the risk factors associated with the increased level of cardiac-specific troponin I and its predictive value in short- and long-term side effects. Given the more specific role of troponin in cardiac incidents, we endeavored both to investigate the factors and elevated levels of cardiac troponin in patients undergoing PCI and to examine the predictive value of elevated levels of cardiac troponin by comparison with elevated levels of CK-MB.

METHODS

The present case-series study was conducted in Rajaie Cardiovascular, Medical, and Research Center (a tertiary care center for cardiovascular patients in Tehran, Iran) in 2011. The sample consisted of patients with CAD and stable hemodynamic selectively candidated for non-emergency coronary angiography in the hospital. Patients were enrolled in the study if they had undergone PCI. Based on convenient sampling and according to the inclusion and exclusion criteria within a year, a sample of 500 patients was obtained. The exclusion criteria were comprised of having no-reflow phenomenon after coronary interventions, abrupt closure of a coronary intervention, dissection of the coronary arteries after coronary interventions of up to type B, glomerular filtration rates below 20 before coronary interventions, acute coronary syndrome, and cardiogenic shock after PCI.

Based on the clinical records of the patients, some information such as demographic characteristics, risk factors for coronary disease, types of the vascular lesions, lesion characteristics, and troponin serum levels was collected. Additionally, clinical outcome data were collected via interviews and clinical examinations of the patients. The patients' demographic data consisted of age, sex, and blood pressure. The patients' risk factors encompassed hypertension, smoking, hyperlipidemia, and diabetes. Apropos the coronary arteries, the number of the vessels involved and the type of the vessels subjected to PCI (ie, right coronary artery, left circumflex, and left anterior descending) were recorded.

The characteristics of the lesions were comprised of non-C, patent; non-C, occluded; type C, patent; and type C, occluded.

The clinical outcomes comprised death, myocardial infarction, revascularization with PCI, revascularization with CABG, and cerebrovascular accident (CVA).

The patients were evaluated within a year. The level of troponin I after PCI and the patients' clinical outcomes following PCI were evaluated within a short-term period (1 mon) and a long-term period (1 y). This assessment was based on the patients' medical records and telephone interviews, and the data were recorded in a data collection table.

Statistical Analysis

The results of the assessment of the cardiac enzymes (ie, troponin I and CK-MB) were merged with the database of the main study at Rajaie Cardiovascular, Medical, and Research Center, where the statistical analyses were done. IBM SPSS Statistics, version 17.0 for Windows (IBM Corp, Armonk, NY, USA), was used. The Kolmogorov–Smirnov test was utilized to evaluate normal distributions. The qualitative (categorical and numeral) variables were expressed as numbers and percentages, and the quantitative variables were expressed as means and standard deviations (SDs). The categorical data were compared using the χ^2 test and the Student *t*-test, and the quantitative variables were compared using an analysis of variance (ANOVA) or the Mann–Whitney test, as appropriate. A *P* value less than 0.05 was considered statistically significant.

The patients with elevated cardiac troponin I levels were compared with those who had lower levels using the paired *t*-test in the case of continuous variables and using the χ^2 test in the case of dichotomous variables. The relation between the patients' mortality (after 1 mon and after 1 y) and the presence or absence of cardiac troponin I assessment at enrollment was evaluated by constructing contingency tables.

RESULTS

Patients' characteristics

Among the 500 patients with CAD (for selective coronary angiography) between October 2010 and March 2011, 471 (942%) met the inclusion criteria for this research. The mean age of those who were examined in this study was 56.6 ± 9.99 years (71.8% male and 28.2% female). The majority of the patients (46.7%) had 1 coronary artery occlusion. Totally, 68.2% of the coronary lesions in the subjects were non-C, patent (Table 1).

Table 1. Prevalence of the different variables related to the patients' risk factors

Types of Variables	Number	Percentage
Male	338	71.8 %
Female	133	28.2%
Hypertension	216	45.9%
Hyperlipidemia	191	40.6%
Smoking	207	43.9%
Diabetes mellitus	145	30. 8%
Coronary artery occlusion		
One	220	46/7
Two	174	36/9
Three	77	16/3
Troponin assay		
Positive	345	73.2%
Negative	126	26.8 %

Troponin assay

The troponin assay was negative and positive in 73.2% and 26.8% of the patients (> 0.1 ng/mL), respectively, after PCI.

Correlation between the troponin level elevation and the patients' clinical outcomes

There was no correlation between troponin increase due to myocardial infarction or PCI with re-PCI in the first month after intervention ($P > 0.05$). The patients had no myocardial infarction in the first year following PCI. No correlation was observed between troponin I increase and re-PCI within 1 month after PCI ($P = 0.1$). However, a significant correlation was observed between troponin I increase and re-PCI 1 year after PCI ($P = 0.038$).

There was no association between the serum level of troponin and CABG within 1 month ($P = 0.426$) and 1 year ($P = 0.491$) after PCI. Among the 126 patients with high troponin levels, there was no relationship between the

troponin increase and CVA within 1 month after PCI. No significant difference was seen between the troponin level and CVA after PCI within a year (P = 0.68).

No mortality occurred within 1 month after PCI, and nor was there a correlation between the troponin level and the incidence of death within 1 year following PCI (P = 0.1). The results of assessment of the relationship between the troponin level and the type of the vascular lesions after PCI, depicted in the following table, were not statistically significant (Table 2).

Table 2. Correlation between increased levels of troponin I after PCI and the other clinical outcomes

Troponin	Positive	Negative	Month	*P*
(-) Re-PCI1	99.2%	100%	1month	0.106
(+) Re-PCI1	0.8%	0%		
(-) Re-PCI2	95.2%	98.5%	12 month	0.038
(+) Re-PCI2	4.8%	1.5%		
(-) CABG1	100%	99.7%	1month	0.426
(+) CABG1	0%	0.3%		
(-) CABG2	99.2%	99.7%	12 month	0.491
(+) CABG2	0.8%	0.3%		
(-) CVA_1	100%	100%	1month	-
(+) CVA_1	0%	0%		
(-) CVA_2	100%	99.7%	12 month	0.688
(+) CVA_2	0%	0.3%		
(-) $Death_1$	100%	100%	1 month	-
(+) $Death_1$	0%	0%		
(-) $Death_2$	99.2%	100%	12 month	0.106
(+) $Death_2$	0.8%	0%		

PCI, Percutaneous coronary intervention; Re-PCI, Repeat percutaneous coronary intervention; CABG, Coronary artery bypass graft surgery; CVA, Cerebrovascular accident

Correlation between increased levels of troponin I after PCI and the other factors

According to this study, there was a statistically significant difference between gender and troponin elevation: serum troponin was higher in the males after PCI (Table 3). The correlations between elevated troponin levels and hypertension, smoking, hyperlipidemia, and diabetes had P values of 0.5, 0.332, 0.848, and 0.529—correspondingly. No statistically significant difference was found between troponin and the number of vessels involved in the study groups (Table 3).

Table 3. Correlation between increased levels of troponin I after PCI and the other variables

Variable	Type	Troponin (+)	Troponin (-)	*P*
Sex	Female	21.4%	30.7%	0.047
	Male	76.6%	69.3%	
Hypertension	(-)	51.6%	55.1%	0.052
	(+)	48.4%	44.9%	
Smoking	(-)	52.4%	57.4%	0.332
	(+)	47.6%	42.6%	
Hyperlipidemia	(-)	58.7%	59.7%	0.848
	(+)	41.3%	40.3%	
Diabetes	(-)	71.4%	68.4%	0.529
	(+)	28.6%	31.6%	
Number of vessels	One	41.3%	48.7%	0.351
	Two	41.3%	35.4%	
	Three	17.4%	15.9%	
Type of vascular lesion	Non-C, Patent	69%	67.8%	0.193
	Non-C, occluded	6.3%	3.2%	
	Type C, patent	19%	18.6%	
	Type C, occluded	5.6%	10.4%	

DISCUSSION

In this study, we assessed the correlation between cardiac troponin after PCI and the association between elevated levels of cardiac troponin and the clinical outcome of patients.

Approximately, 26.8% of our patients had positive troponin after PCI. In other studies, the frequency of the increased level of troponin I ranged from 13% to 40%, which is different based on the populations studied. The troponin elevation in this study is in line with other studies. [1, 15] In several studies, an increased level of troponin in patients undergoing PCI was correlated with the number of occluded coronary vessels and the vascular lesion type (SCAI category). [13, 16, 17] In our research, we observed no significant correlation between troponin elevation and the number of vessels involved or the type of the vascular lesion. Perhaps this phenomenon is due to the low percentage of vascular disease and complex lesions in most of our patients.

Selvanayagam et al [1] in 2005 reported that in the setting of PCI, their patients with a postprocedural increase in troponin I had signs of new irreversible myocardial injury on delayed-enhancement magnetic resonance imaging. The eminence of this insult correlates directly with the amount of troponin elevation. In the present study, we did not find such association because of the low number of our patients.

With respect to the correlation between increased levels of troponin I after PCI and the other clinical outcomes, Sung-Won et al [18] in Korea in 2008 showed that there was no correlation between an increased troponin I level and major cardiovascular outcomes (ie, death, acute myocardial infarction, revascularization with PCI, and CABG). In similar studies, we found paradoxical results between the troponin level and major cardiovascular events after PCI in patients.[15, 16] Kini et al [14] in 2004 found that troponin I was frequently increased after PCI, but it did not predict death in their CAD patients. A periprocedural CK-MB elevation more than 5 times the normal range is an independent predictor of midterm death and an important marker for PCI prognosis in patients. Our finding in this regard chimes in with global research. Despite the rise in the troponin I level after PCI in the short term (1 mon) and long term (1 y), no similar result was observed. [14, 19]

Ricciardi et al [19] in 2003 found that a 3-fold troponin I elevation after successful PCI independently predicted mortality and myocardial infarction with PCI and revascularization with CABG. Additionally, they reported that a 3-fold elevation in troponin levels had a correlation with myocardial infarction, mortality, revascularization with PCI, and CABG. In the current study, apropos the number of patients with a 3-fold serum level, we were not able to evaluate this relationship.

Our findings demonstrated no correlation between mortality, CVA, and CABG after PCI in those with increased troponin levels. According to some studies, a 3-fold elevation in the troponin serum level is not significantly associated with patient mortality. [8, 19]

In our study, the frequencies of PCI and CABG were not significantly higher in the patients with high troponin levels in the first post-PCI month. Nonetheless, we found a significant correlation in the first year after PCI.

Our results showed no effects by the variables of age and the risk factors of hypertension, hyperlipidemia, smoking, and diabetes on the frequency of elevated troponin levels. Nevertheless, the male gender (as a risk factor) was correlated with increased troponin levels after PCI.

In light of the results of the current study and previous studies, we can conclude that troponin I elevation after PCI in a healthy individual (in terms of noncardiac conditions)

is not correlated with any major cardiac event. In addition, according to this study, the typical risk factors for CAD had an eminent role in this increase. PCI is, therefore, a safe method for treating CAD.

Study Limitations

That some of our patients refused to refer for follow-up and failed to respond to our phone calls for the assessment of their clinical status constitutes the salient drawback of the current investigation.

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