Original Article

Prognostic Value of Troponin T after Elective Percutaneous Coronary Intervention

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Background: Cardiac troponin T (cTnT) is a sensitive and specific marker of myocardial necrosis. Prognostic significance of isolated minor elevations of cTnT is a matter of debate .The aim of this study was to assess the impact of minor elevations of cTnT on major adverse cardiac events (MACE) following percutaneous coronary intervention (PCI).
Methods: We measured cTnT levels before and after PCI and evaluated the outcomes of 112 patients with normal baseline cTnT and complex coronary artery disease who required nonemergency PCI.
Results: Elevations (more than 0.03ng/ml) in cTnT were seen in 39 patients (34.8%).The angiographic characteristics of patients with increased cTnT levels had borderline differences compared to those with normal post PCI cTnT levels. Over a mean follow-up duration of 22 months, myocardial infarction ($p<0.01$) and the combined rate of death, myocardial infarction and revascularization ($p<0.001$) were significantly higher in patients with increased levels of post PCI cTnT. Estimated 22-month MACE-free survival for patients with increased and normal cTnT levels were 66.7% and 93.2%, respectively
Conclusions: Isolated minor elevations in cTnT after elective PCI in complex coronary lesions affect long-term prognosis regarding death, myocardial infarction and the need for repeated revascularization procedures.

Keywords: Troponin T, Percutaneous Coronary Intervention, Prognosis

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Introduction

In patients with acute coronary syndromes, the elevation of cardiac troponins has prognostic implications and is a marker of unstable and extensive coronary artery disease.[1,2] Even after uncomplicated and successful percutaneous coronary intervention (PCI) elevations in cardiac enzymes can be observed. The association between troponin elevations after elective PCI and cardiac events is still debated.[3,4] The adverse prognostic significance of cardiac-specific troponins after PCI has been shown in some studies.[5-8]The methodology and results of the previously performed studies vary in some aspects. For example, some of them have neither included the baseline troponin levels in the analysis nor have low cut-off values to maximize prognosis.[5,7-10] Others reported raw data according to the level of raised troponin [11,12] and concluded that a raised troponin 3 times the 99th percentile of the upper reference limit(URL)conferred a higher risk.[12] On the other hand, Prasad et al, reported an isolated minor elevation in cardiac troponin T(cTnT) after PCI that provided long-term prognostic information regarding mortality and myocardial infarction.[4] Interestingly, in another report long-term prognosis was most often related to the baseline pre-PCI troponin value and not the biomarker response to the PCI.[13]

We herein report the results of a prospective study and the short and long term prognostic values of cTnT in patients with stable, native but complex coronary artery disease who underwent elective PCI.

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Patients and Methods

This prospective study followed all patients undergoing PCI at Shafa General Hospital and

Table 1. Comparison of baseline clinical characteristics between groups

		TnT≥0.03 ng/ml N=39	TnT<0.03 ng/ml N=73	P value
Age, yrs		66.3±9.3	65.4±8.1	NS
Male gender		20	38	NS
HTN		28	49	NS
Diabetes		24	42	NS
Current Smoker		9	14	NS
Hypercholesterolemia		21	35	NS
Angina class	**I**	15	27	NS
	II	21	37	
	III	3	9	
Prior MI		4	8	NS
Prior CABG		0	0	
CHF		0	0	
CRF		2	3	NS
Medication				
Aspirin		39	73	NS
Beta-blocker		32	58	NS
Statin		31	57	NS
ACE inhibitors		21	36	NS

TnT=Troponin T; ACE: angiotensin–converting enzyme; HTN: hypertension; CABG: coronary artery bypass graft; CRF=chronic renal failure; NS: Non Significant

Mazandaran Heart Center in Sari. We included records of demographic, clinical and angiographic data. Immediate and in-hospital complications of the procedures were also recorded. All patients were followed on a regular basis after the procedure for at least 1 year.

During one year study period, 421 PCIs were performed by one interventional cardiologist in the two foregoing hospitals. Of these, 112 patients were included in this investigation, taking into account the following criteria. The patients recruited in the study were those with more complex lesions. Therefore, the study included only those with PCI of at least one type C or two type B lesions at one session. Patients with myocardial infarction or symptoms of unstable angina during the last 6 weeks and the subjects with increased baseline biomarker levels (TnT≥0.03ng/ml) were excluded from the study.

Blood samples for cTnT were collected before and at 12 and 24h after PCI. The analysis was performed using Roche Elecsys 2010, chemistry analyser Hitachi, Tokyo, Japan.

Table 2. Baseline angiographic and coronary stents data

		TnT≥0.03 ng/ml N=39	TnT<0.03 ng/ml N=73	P value
Total Vessels treated	Single	8	20	NS
	Double	29	49	
	Three	2	4	
Type of lesion				
B		29	58	NS
C		23	37	NS
Vessels treated				
LAD		19	38	NS
LCX		17	28	NS
RCX		16	29	NS
Left Main		0	0	-
Type & Number of stents				
DES		61	105	NS
BMS		0	0	-

TnT=Troponin T; NS: Non Significant

The upper normal limit for the assay was <0.03 ng/ml. The successful PCI was defined as residual stenosis<30%.

Statistical Analysis

Data were presented as the mean±SD. Comparisons for continuous variables between groups were made using student t-test .Pearson Chi-squared statistics was used for categorical data. Kaplan-Meier methods were applied to estimate survival curves. All analyses were performed using SPSS 17 software.

Results

Baseline and clinical characteristics

In 39 patients (34.8%) cTnT levels were elevated (≥0.03 ng/ml).The demographic and clinical characteristics of patients are presented in Table 1. Patients with cTnT level<0.03 ng/ml had nearly similar baseline characteristics to patients with cTnT≥0.03ng/ml. The anginal class was nearly similar in all patients and none had any signs and symptoms of heart failure. There was no difference found in the use of medications between the two groups.

Angiographic and procedural characteristics

Table 2 shows angiographic characteristics of the lesions. In regard to the patients with TnT≥0.03ng/ml, two- or three-vessel angioplasty was more

Table 3. In-Hospital and Long-term outcome

	TnT≥0.03 ng/ml N=39	TnT<0.03 ng/ml N=73	P value
Emergency CABG	0	0	-
In-Hospital Death	0	0	-
Cardiac Death in first month	1	0	NS
Cardiac Death in 1-6 months	0	0	-
Cardiac Death in (6-12)months	1	0	NS
Stroke	0	0	-
Repeated PCI	6	4	0.06
MI	5	1	<0.01
CABG	1	0	NS
Total	13	5	<0.001

TnT=Troponin T; CABG: coronary artery bypass graft; MI: myocardial infarction; PCI: percutaneous coronary intervention; NS: Non Significant

frequently performed, which was not statistically significant. Totally, in patients with cTnT≥0.03 (39 patients) 52 lesions were treated, while in 73 patients with cTnT<0.03ng/ml, 95 lesions were treated. Type C lesions were more frequent in the first group although it was not statistically significant. The study did not include any left main angioplasty, as involved vessels were nearly the same in the two groups. We only used drug-eluting stents in this study.

Major adverse cardiac events

We did not have any in-hospital death, emergency coronary artery bypass surgery or stroke in our patients (Table 3).Among patients with elevated cTnT levels there was one sudden cardiac death probably due to stent thrombosis, 28 days after the procedure, and another patient died 9 months after the procedure as a result of myocardial infarction. MI occurred more frequently in patients with elevated cTnT levels with a relative risk of 9.4(95% confidence interval 1.14-77.5; P=0.01). However, patients with elevated troponin levels had more revascularization procedures (P=0.06). Finally, patients with TnT≥0.03ng/ml had more major adverse cardiac events during follow-up with a relative risk of 4.89 (95% confidence interval 3.88-6.15; P=0.001).

Our patients were followed for 21.9±5.0 months. Estimated MACE free survival rates for patients with and without cTnT elevations were 66.7% and 93.2%, respectively (Fig. 1).

Discussion

This prospective study showed that in stable patients with normal baseline cTnT following elective PCI of complex lesions, minor elevations in cTnT were frequent and occurred in about 35% of cases. This increase in cTnT is associated with elevated risk of major adverse cardiac events in short and mid to long-term follow-up.

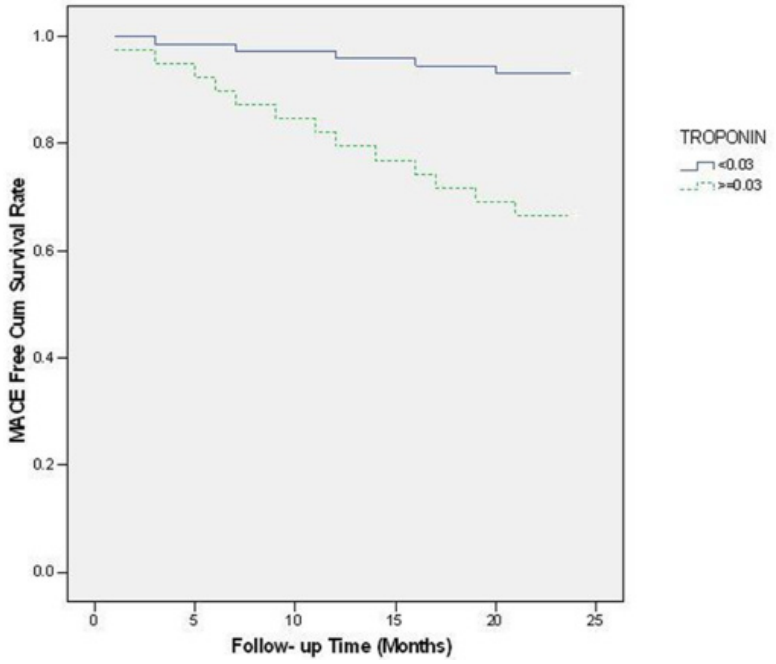

Figure 1. MACE free survival rate using Kaplan-Meier method

Cavallini et al, showed a linear association between 2-year mortality rates and creatine kinase brain isoenzyme (CK-MB) levels, but not for troponin levels after PCI.[9] In contrast to our study, most of their patients had acute coronary syndrome. In another study, pre-PCI troponin levels had more prognostic importance than post procedural troponin elevation where early cTnT peaks were not associated with a greater risk of long-term outcome of death/MI. However, long-term prognosis was most often related to the baseline pre-PCI troponin value.[13] Although in another investigation isolated troponin elevations did not predict cardiac events after hospital discharge.[11] However, in four studies raised troponin above 3 times the URL was associated with an increased risk of MACE in 2359 patients who were followed between 8 and 72 months.[11,12,14,15]

PCI-related MI is defined as patients with normal baseline levels and a rise of troponin three times the 99th percentile of the URL following PCI. [16] Also, according to the ACC/AHA (American College of Cardiology/American Heart Association) guidelines, routine measurements of troponin and/or CK-MB **(**Creatine Kinase-MB**)** seem to be reasonable, whereas it is advised to determine biomarkers in patients with signs or symptoms suggestive of MI or angiographic evidence of complications after PCI.[7] Thus, this definition of PCI-related MI clearly identifies a population of patients at high risk of adverse events.

On the other hand, in some circumstances the procedure seems to be free of complications and the angiography does not show any compromise of small vessels. The troponin elevations in these cases could be related to the embolised atheromatous material. The question is whether a small increase in troponin after PCI has any prognostic significance. Our study and that of Prasad et al.[4] show that even minor elevations in cTnT after PCI affect mid- and long-term prognosis regarding mortality and MI. Fuch et al, also suggested that even a raised troponin I below three times the URL involved a higher risk.[12]The relationship between low levels of cTnT elevation following PCI and MACE denotes that the rise of the biomarker and the myocardial injury have a continuous rather than a threshold relationship. It has been shown that a positive relation exists between the myocardial injury detected by magnetic resonance imaging after PCI and the elevation of troponin.[17]Also, in our study we recruited patients with more type B and C lesions, so minor cTnT elevations in these patients with more severe atherosclerosis, endothelial dysfunction and plaque may have affected increasing rates of MACE.

Our major drawback is due to the limited sample size which could have influenced the inability to estimate the relationship between some possible mechanisms of elevation of cTnT level such as compromised lateral branches and elevation of biomarkers. Furthermore, we have not performed follow-up angiography in our study and patients were subjected to coronary angiography only on the basis of clinical symptoms. Another limitation of our study is that the number of our patients receiving glycoprotein IIb/IIIa inhibitor was too small to be considered.

Elevation of cTnT following PCI in stable patients with complex lesions occurs frequently. This isolated minor elevation is associated with higher rates of MACE on follow-up. So, it seems reasonable to measure troponin levels in stable patients with more complex lesions following nonemergency PCI.

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