Prognostic implications of C-reactive protein and troponin following percutaneous coronary intervention

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BACKGROUND: C-reactive protein (CRP), a marker of inflammation, plays a role in the pathophysiology of atherosclerotic events. The relationship between CRP levels and myocardial necrosis assessed by troponin T (TnT) in patients undergoing percutaneous coronary intervention (PCI) has not been established. In addition, the long-term significance of TnT rise following PCI is not clear.

OBJECTIVES: To examine the relationship between CRP and the rise in TnT levels, and evaluate the long-term prognostic implications of TnT rise following PCI.

METHODS: A total of 1208 patients underwent successful nonemergent PCI. Baseline demographic characteristics, CRP and TnT levels were prospectively collected before and 12 h to 18 h following PCI. Long-term follow-up data over two years were available.

RESULTS: Among the patients studied (mean age 62 years), 64% presented with acute coronary syndrome. A PCI procedure was associated with a significant increase in TnT levels (higher than 0.1 µg/L) in 238 patients (20%). Multivariate logistic regression identified presentation with acute coronary syndrome or myocardial infarction, no statin use at the time of the procedure, increased CRP and increasing length of stent as independent predictors of TnT rise following PCI. Periprocedural TnT rise was not associated with adverse events in follow-up examinations (OR 1.09, 95% CI 0.73 to 1.65).

CONCLUSIONS: Myocardial necrosis commonly occurred in otherwise successful PCI and was particularly prevalent in the proinflammatory milieu of a recent myocardial infarction. This response was blunted with statin therapy. However, there was no long-term adverse sequelae of these troponin rises following otherwise uncomplicated PCI.

Key Words: Angioplasty; Inflammation; Myocardial infarction; Statins

Myocardial necrosis following percutaneous coronary intervention (PCI) is associated with an adverse prognosis. There is a continuous relationship between risk and modest elevations of the creatine kinase (CK) and the MB isoform (CK-MB) (1). More recently, cardiac-specific troponin T (TnT) and troponin I have replaced CK-MB as a marker of necrosis in the diagnosis and risk stratification of patients with acute coronary syndrome (ACS) (2). The sensitivity of troponins allows for the detection of even minor

Les répercussions pronostiques de la protéine C réactive et de la troponine après une intervention coronaire percutanée

HISTORIQUE : La protéine C réactive (PCR), un marqueur d'inflammation, joue un rôle dans la physiopathologie des événements athéroscléreux. Le lien entre les taux de PCR et la nécrose myocardique évaluée par la troponine T (TnT) chez les patients qui subissent une intervention coronaire percutanée (ICP) n'est pas établi. En outre, on ne connaît pas la signification à long terme de l'augmentation de la TnT après une ICP.

OBJECTIFS : Examiner le lien entre la PCR et l'augmentation des taux de TnT et évaluer les répercussions pronostiques à long terme de l'augmentation de la TnT après une ICP.

MÉTHODOLOGIE : Au total, 1 208 patients ont subi une ICP non émergente réussie. Les auteurs ont colligé les caractéristiques démographiques en début d'étude, la PCR et les taux de TnT avant, puis de 12 heures à 18 heures après l'ICP. Les données de suivi à long terme sur une période de deux ans étaient disponibles.

RÉSULTATS : Parmi les patients à l'étude (âge moyen de 62 ans), 64 % avaient un syndrome coronarien aigu. Une ICP s'associait à une augmentation significative des taux de TnT (plus de 0,1 µg/L) chez 238 patients (20 %). La régression logistique multivariée a permis d'établir que la présentation avec un syndrome coronarien aigu ou un infarctus aigu du myocarde, la non-utilisation de statines au moment de l'intervention, l'augmentation de la PCR et la longueur de l'endoprothèse sont des prédicteurs indépendants d'augmentation de la TnT après l'ICP. L'augmentation périprocédurale de la TnT ne s'associait pas à des événements indésirables lors des examens de suivi (RRR 1,09, 95 % IC 0,73 à 1,65).

CONCLUSIONS : La nécrose myocardique était fréquente lors d'une ICP autrement réussie et était particulièrement prévalente dans le milieu pro-inflammatoire d'un infarctus du myocarde récent. Les statines atténuaient cette réponse. Cependant, ces augmentations de la TnT n'entraînaient pas de séquelles indésirables à long terme après une ICP autrement sans complication.

myocardial damage. Troponin elevation occurs in up to one-third of subjects undergoing PCI procedures and has been associated with abnormal microvascular perfusion and the presence of necrosis detected by cardiac magnetic resonance imaging (3,4). While procedural complications such as side branch occlusion lead to CK and troponin elevation, nonmechanical factors associated with periprocedural myocardial necrosis without CK elevation remain to be determined.

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During the past few years, we have witnessed a paradigm shift in our understanding of the role of inflammation in atherosclerosis and its complications (5). High-sensitivity C-reactive protein (CRP), a marker of inflammation, has been identified as an independent predictor of adverse cardiac events in healthy populations and in patients with stable coronary artery disease or ACS (6-11). Although it is clear that inflammation plays a role in atherosclerotic complications (12), the relationship between CRP and troponin release following PCI has not been clarified.

Finally, the prognostic significance of troponin elevation at the time of PCI is not definitive. Several studies demonstrated an adverse effect of troponin elevation on post-PCI cardiovascular events (7,13,14). However, more recent data do not support this (1,15). Therefore, the role of troponin as a prognostic marker following PCI is not clear.

In the present study, we examined the relationship between CRP level and the rise in TnT levels following nonemergent and successful PCI. We speculated that a proinflammatory milieu at the time of the PCI procedure would be associated with myocardial necrosis following PCI. In addition, we evaluated the prognostic significance of TnT rise on long-term adverse cardiovascular events.

METHODS

Patient population

Written, informed consent was obtained from all participants and the study was approved by The Conjoint Ethics Committee of the University of Calgary (Calgary, Alberta). All patients undergoing nonemergent PCI at Foothills Hospital (Calgary) between July 2001 and December 2002 were eligible for the prospective study. Patients undergoing primary PCI for ST segment elevation myocardial infarction, and patients in cardiogenic shock and/or with electrical instability or saphenous vein graft PCI were excluded. Subjects with mechanical complications or postprocedural total CK higher than two times the upper limit of normal were also excluded. A total of 1361 subjects with complete data were eligible. Of these, 89 subjects had an unsuccessful PCI or complication, and 64 had data collected on two separate procedures during the study period, leaving a study cohort of 1208 subjects with a successful and uncomplicated procedure (Figure 1). The patient demographics of those excluded were similar to those of the study cohort (data not shown).

Patients admitted with unstable angina or myocardial infarction were classified as having ACS and underwent PCI on the index hospitalization (64%). Elective outpatient procedures were performed for stable angina (36%). Myocardial infarction on presentation was defined as TnT higher than 0.10 µg/L (higher than the 99th percentile of a reference group from the local laboratory) in the setting of appropriate chest pain or electrocardiographic changes before the PCI procedure.

Study design

Baseline demographics, medication use, routine laboratory results and procedural details were prospectively recorded by trained nursing and technical staff. Baseline bloodwork at the time of PCI included measurement of CRP, TnT, CK, lipid profile and glucose levels. TnT and CK were also measured 12 h to 18 h after the procedure. CRP was determined using the Roche Diagnostics Tinaquant CRP (latex) ultra-sensitive assay on a Hitachi 912 platform (Roche Diagnostics, Canada). TnT was measured by a standardized hospital laboratory procedure (Roche Diagnostics).

PCI was performed as per the standard clinical practice. The quantity of heparin, use of glycoprotein IIb/IIIa receptor blocker and the timing of clopidogrel administration were left to the discretion of the operator. All the included patients had a successful PCI procedure based on angiographic success (residual stenosis following a PCI procedure of less than 50%) in the absence of a rise in total CK to more than two times the upper limit of normal, and the development of new Q waves associated with CK elevation consistent with periprocedural

Figure 1) Flow chart for study eligibility. Foothills Hospital is located in Calgary, Alberta. PCI Percutaneous coronary intervention; TnT Troponin T

myocardial infarction, acute closure, emergency coronary artery bypass grafting or death.

Data analysis

Patients were grouped based on the difference between their pre- and postprocedural TnT; those with a rise greater than 0.1 µg/L in TnT were compared with those with a TnT difference of 0.1 µg/L or less. This cut-off point was chosen in concordance with local clinical and laboratory diagnostic criteria for acute myocardial infarction. When the analysis was performed for any rise in TnT following PCI (n=479), the results were not substantially different (data not shown). Baseline demographics were compared overall and by TnT rise using unpaired *t* tests for continuous variables and χ^2 tests for discrete variables. Statistical significance was set at 0.05.

Logistic regression was completed to determine significant predictors of a TnT rise greater than 0.1 µg/L. Backward stepwise elimination was completed, considering all clinical and patient characteristics (Table 1). Statistically significant variables were retained (P=0.05).

Subsequently, long-term clinical outcomes were considered. Mortality and event-free survival (the combined end point of death, subsequent coronary artery bypass grafting and repeat PCI) were considered. The Alberta Provincial Project for Outcomes Assessment in Coronary Heart disease (APPROACH) database was used to capture subsequent events. APPROACH is a prospective cohort study of all Alberta residents undergoing cardiac catheterization for coronary artery disease that has been ongoing since 1995, and contains detailed clinical, catheterization, revascularization and long-term outcome data. The APPROACH follow-up is complete only if an adverse event (death and/or repeat revascularization) occurred in Alberta. The present cohort was linked to the APPROACH database through personal health insurance numbers to ascertain long-term event data. Data were available for all patients for at least one year with a mean follow-up period of 32 months. Therefore, one-year mortality and repeat revascularization rates are also reported. Two-year age, sex and CRP-adjusted event-free survival curves are presented. All risk adjustment was performed using a Cox proportional hazard model.

Subgroup analysis was performed on patients with negative troponin levels before the PCI procedure (TnT lower than 0.03 µg/L) to eliminate the possibility that the rise in troponin was related to the admitting diagnosis and not the PCI. All comparisons and modelling described above are repeated within the subgroups. All statistical analyses were conducted using SAS version 8.1 (SAS Institute Inc, USA).

RESULTS

Patients and periprocedural demographics

Baseline demographics for the study cohort are summarized in Table 1. The population predominantly consisted of men (76%). The mean age was 62 years. The majority of patients underwent PCI for a primary

TABLE 1
Patient demographics

Characteristics	All patients (n=1208)	TnT difference ≤ 0.1 $\mu\text{g/L}$ (n=970)	TnT difference >0.1 $\mu\text{g/L}$ (n=238)	P
Age, years, mean $\pm$ SD	62.4 $\pm$ 11.4	62.4 $\pm$ 11.3	62.3 $\pm$ 11.6	0.46
Male sex, %	75.7	74.5	79.4	0.12
Number of diseased vessels, %				
1	30.5	31.1	28.3	0.09
2	40.0	38.1	48.0	
3	29.4	30.7	23.7	
Multivessel PCI, %	18.8	19.0	18.1	0.79
Admitted with myocardial infarction, %	31.0	25.3	54.6	<0.001
Hypertension, %	55.2	55.3	54.8	0.63
Diabetes, %	21.0	22.5	15.1	0.01
Smoking, %	27.2	26.4	30.7	0.47
Previous CABG, %	4.2	4.0	5.1	0.51
Previous PCI, %	24.9	26.0	20.3	0.12
Ejection fraction, %				
>50	74.8	75.4	71.9	0.07
35–50	13.4	12.4	17.4	
20–35	1.3	1.27	1.5	
<20	0.7	0.9	0.0	
Statin use	65.4	69.5	48.0	<0.001
Acetylsalicylic acid use, %	89.4	90.2	85.9	0.11
GP IIb/IIIa use, %	51.2	49.7	57.1	0.04
Stent length, mm, mean $\pm$ SD	20.6 $\pm$ 10.5	20.0 $\pm$ 10.0	22.9 $\pm$ 12.2	0.003
Pre-CRP, mg/L, mean $\pm$ SD	11.9 $\pm$ 22.3	9.6 $\pm$ 19.3	21.0 $\pm$ 29.9	<0.001
Pre-TnT, $\mu\text{g/L}$, mean $\pm$ SD	0.30 $\pm$ 0.9	0.22 $\pm$ 0.8	0.66 $\pm$ 1.1	<0.001
Post-TnT, $\mu\text{g/L}$, mean $\pm$ SD	0.36 $\pm$ 0.9	0.18 $\pm$ 0.6	1.10 $\pm$ 1.4	<0.001
TnT difference, $\mu\text{g/L}$, mean $\pm$ SD	0.06 $\pm$ 0.4	-0.03 $\pm$ 0.3	0.43 $\pm$ 0.6	<0.001
Total cholesterol, mmol/L, mean $\pm$ SD	4.85 $\pm$ 1.1	4.84 $\pm$ 1.1	4.89 $\pm$ 1.3	0.04
Triglycerides, mmol/L, mean $\pm$ SD	2.08 $\pm$ 1.6	2.07 $\pm$ 1.5	2.13 $\pm$ 2.0	<0.001
HDL, mmol/L, mean $\pm$ SD	1.18 $\pm$ 0.5	1.19 $\pm$ 0.5	1.15 $\pm$ 0.4	0.005
LDL, mmol/L, mean $\pm$ SD	2.76 $\pm$ 0.9	2.75 $\pm$ 0.9	2.81 $\pm$ 1.0	0.37

CABG Coronary artery bypass graft surgery; CRP C-reactive protein; GP IIb/IIIa Glycoprotein IIb/IIIa receptor blocker; HDL High-density lipoprotein; LDL Low-density lipoprotein; PCI Percutaneous coronary intervention; TnT Troponin T

Figure 2 Percentage of patients with a significant increase in troponin T (TnT) levels (>0.1 $\mu\text{g/L}$) based on preprocedural categories of C-reactive protein (CRP). * $P<0.0001$ versus other groups

indication of unstable angina or a myocardial infarction (ACS) on the index hospitalization. Approximately two-thirds of the subjects were taking statins at the time of the PCI but only 43% had low-density lipoprotein (LDL) cholesterol levels lower than 2.5 mmol/L.

Of all patients, 368 (31%) had single-vessel disease and, overall, 19% of patients underwent multivessel PCI. Glycoprotein IIb/IIIa inhibitor (abciximab) was used in approximately one-half (51%) of all patients. Ventricular function was, in general, well preserved (mean $\pm$ SD] left ventricular ejection fraction 64% $\pm$ 13%). The PCI procedure was associated with nonsignificant changes in CK levels. A decrease from 114 U/L at baseline to 105 U/L after the PCI procedure was observed.

Factors associated with troponin rise

Baseline levels of TnT at the time of PCI were elevated (higher than 0.03 $\mu\text{g/L}$) in 37% of patients, and met diagnostic criteria for acute myocardial infarction (higher than 0.10 $\mu\text{g/L}$) in 31% of all patients during admission before PCI. Any TnT rise (difference between post-procedural and preprocedural levels) was observed in 479 patients (40%). An increase from preprocedural levels by more than 0.1 $\mu\text{g/L}$ was observed in 238 patients (20%).

The mean CRP at baseline was substantially higher in subjects who developed a TnT rise of more than 0.1 $\mu\text{g/L}$ following PCI compared with those who did not (9.6 mg/L versus 21.0 mg/L, $P<0.001$). In subjects whose baseline CRP was higher than 10 mg/L, there was a 32% incidence of a post-PCI TnT rise (Figure 2; $P<0.0001$). TnT rise following PCI was related to the baseline troponin level before the PCI procedure, as a result of myocardial infarction being the presenting condition (Figure 3). A rise in TnT was also more common in subjects not on statins, and in patients presenting with ACS. In addition, coronary stenoses requiring the use of multiple stents or longer intracoronary

Figure 3) Percentage of patients with a significant increase in troponin T (TnT) levels (>0.1 µg/L) based on preprocedural TnT levels. * $P < 0.0001$

TABLE 2
Logistic multivariate predictors of postpercutaneous coronary intervention troponin rise

Variable	OR (95% CI)
Preprocedural C-reactive protein*	1.02 (1.01–1.03)
Admitted with myocardial infarction	2.20 (1.42–3.44)
Statin use	0.42 (0.29–0.62)
Acute coronary syndrome	1.75 (1.01–3.07)
Stent length†	1.03 (1.01–1.05)

*Continuous variable, OR per unit change of 1 mg/L; †Continuous variable, OR per unit change of 1 mm of stent inserted

stents were associated with TnT rise. There was no relationship between baseline LDL and TnT rise (2.75 mmol/L for a TnT rise of 0.1 µg/L or less versus 2.81 mmol/L for a TnT rise of more than 0.1 µg/L; $P = 0.37$). However, marginally higher total cholesterol and triglyceride levels, and lower high-density lipoprotein cholesterol were associated with TnT rise ($P < 0.05$). All variables and their association with troponin rise are summarized in Table 1.

Multivariate logistic regression identified presentation with ACS and myocardial infarction, no statin use at the time of admission, increasing preprocedural CRP and increasing length of stent as independent predictors of TnT rise following PCI (Table 2). The most powerful predictor was presentation with myocardial infarction with an OR of 2.2. Although highly statistically significant, the magnitude of the effect of CRP was small. An OR of 1.02 per unit change in CRP indicates that an increase in CRP of 10 mg/L represents an increase in risk of TnT rise of only 20%. Statin use before the procedure was protective, with a significant risk reduction of TnT rise (OR 0.42; 95% CI 0.29 to 0.62).

Troponin rise in subjects with normal baseline troponin levels

To deal with the confounding effect of myocardial infarction on CRP and troponin dynamics, a subgroup analysis was undertaken, excluding subjects with elevated troponin at baseline as the presenting syndrome ($n = 766$). A small number of these subjects ($n = 70$) had an admitting diagnosis of myocardial infarction, but the troponin had returned to normal before the procedure and this remained an important predictor. The other predictors listed below were not different if these subjects were excluded from this subgroup analysis. The most important difference in the subgroup compared with the entire cohort was that CRP was no longer an independent predictor (OR 1.00, 95% CI 0.99 to 1.02). The other predictors included being admitted with myocardial infarction (OR 2.40, 95% CI 1.56 to 3.70), admitted with ACS

TABLE 3
Patient outcomes, overall and by troponin T (TnT) difference

Outcome (%)	Overall (n=1208)	TnT difference		P
		≤0.1 µg/L (n=970)	>0.1 µg/L (n=238)	
30-day mortality	0.2	0.2	0.4	0.55
1-year mortality	1.2	1.1	1.3	0.87
1-year revascularization	8.9	8.5	10.5	0.45
PCI	8.4	8.1	9.7	0.45
Target-vessel PCI	3.6	3.5	4.2	0.61
CABG	0.5	0.4	0.8	0.40

CABG Coronary artery bypass grafting; PCI Percutaneous coronary intervention

Figure 4) Event-free survival, adjusted for age, sex and C-reactive protein, by troponin T (TnT) difference. PCI Percutaneous coronary intervention

(OR 2.08, 95% CI 1.21 to 3.59), statin use (OR 0.42, 95% CI 0.28 to 0.61) and stent length (OR 1.03, 95% CI 1.01 to 1.05). Interestingly, diabetes was inversely related (OR 0.52, 95% CI 0.30 to 0.90), but the numbers were small.

Troponin rise and clinical outcomes

The overall one-year mortality rate in the selected cohort was low (1.2%). There was no significant difference in clinical outcomes at 30 days or one year between those with a TnT difference of greater than 0.1 µg/L and those with a TnT rise of 0.1 µg/L or less (Table 3). When two-year crude event-free survival was considered, again no significant difference was seen between the two groups (OR 1.24, 95% CI 0.78 to 1.98). When adjustment was made for age, sex and CRP, the hazard ratio remained not significant (OR 1.09, 95% CI 0.73 to 1.65). The event-free survival curves, adjusted for age, sex and CRP, are shown in Figure 4.

In a subsequent subgroup analysis that stratified the cohort into those with a preadmission TnT of 0.03 µg/L or less compared with those with an elevated TnT (higher than 0.03) on admission, there was still no significant difference in outcome at two years following PCI. The resulting hazard ratio associated with a periprocedural troponin rise of more than 0.10 µg/L (adjusted for age, sex and CRP) for those patients with a low baseline TnT was 1.58 (95% CI 0.90 to 2.75). For those with an elevated TnT, the hazard ratio was 0.87 (95% CI 0.47 to 1.60).

DISCUSSION

The present study demonstrated that myocardial necrosis detected by troponin rise occurred commonly following otherwise uncomplicated

PCI. This is particularly true for subjects whose TnT was elevated at baseline due to recent myocardial infarction. Given the association between elevated TnT and increasing CRP, and the protective effect of 3-hydroxy-3-methyl-glutaryl coenzyme-A reductase inhibition, we suggest that a proinflammatory milieu had a role in myocardial necrosis following PCI. However, TnT rise was not associated with adjusted event-free survival during a two-year follow-up, limiting the prognostic utility in this patient population.

Myocardial necrosis following PCI has been associated with adverse long-term outcomes. Most of the literature supports a continuous relationship between the rise in CK and CK-MB, and subsequent risk. Cardiac-specific troponins are a more sensitive assay that has become the gold standard for the detection of necrosis, and plays a pivotal role in risk factor assessment in subjects with ACS. Elevation of troponin is common following PCI, occurring in one-third or more of subjects (1,16). A rise in troponin is associated with impairment of microvascular perfusion (3) and necrosis documented by cardiac magnetic resonance imaging (4). The factors leading to myocardial necrosis have included complex lesions, complications at the time of the procedure such as dissection or side branch occlusion, and left ventricular dysfunction (15). In the present study, we extended these observations in a large prospectively collected cohort of subjects without complications at the time of the procedure, and without significant CK rise. Our aim was to evaluate a number of factors, particularly CRP, in subjects in whom the troponin rise could not be attributed to an obvious mechanical event. As in other studies, troponin rise occurred in 40% of subjects and 20% had an increase greater than 0.1 µg/L. The strongest predictor of a rise in TnT was an elevation in troponin before the procedure due to myocardial infarction at the time of admission. The presence of a preprocedural troponin elevation appears to predict a higher-risk situation. This is certainly well established in ACS (17). The association between increasing stent length or multivessel PCI and troponin rise likely represents an increased burden of atherosclerosis and the possibility of microembolization in these individuals, particularly with ACS.

The important role of inflammation in atherosclerosis has been more clearly elucidated in the past few years. Elevated levels of CRP, an inflammatory marker, have been associated with adverse cardiac events, including in patients with stable coronary disease and/or ACS (6-11) and, more recently, in patients undergoing PCI (18-20). However, the relationship between CRP levels and troponin rise following PCI has not been extensively examined. Our observation clearly linked CRP with periprocedural increases in troponin levels. The likelihood of a troponin rise was greatly increased in subjects with a baseline CRP greater than 10 mg/L. This finding is consistent with previous reports that suggest risk is dramatically increased above this level for patients with ACS presentation (7). However, in the present study, the magnitude of the relationship between CRP and myocardial necrosis following PCI was much less important than presentation with myocardial infarction, which is known to acutely increase CRP levels. As such, much of the relationship between a periprocedural troponin rise and high CRP levels is confounded by the milieu of a preprocedural myocardial infarction presentation. Furthermore, we did not observe a relationship between CRP and TnT rise following PCI in patients with normal troponin levels before coronary intervention, further supporting the important role of a higher-risk patient presentation as a risk factor for myocardial necrosis following PCI. Whether CRP is implicated in the pathophysiology or is simply a marker of myocardial necrosis and vessel thrombus, which leads to the procedural troponin rise, cannot be determined.

Statins played a significant role in this relationship. Their absence in the therapeutic regimen before PCI was associated with more than double the risk of a TnT rise following stenting. This observation was independent of total and LDL cholesterol levels and is therefore suggestive of nonlipid-lowering effects (21). Several studies (22-24) have demonstrated a protective effect of statins on periprocedural complications following PCI. We extended these observations and demonstrated attenuation of milder myocardial necrosis as is detected with troponin.

The mechanism of this benefit is likely related to the beneficial effect of statins on the vessel wall and endothelial interactions with platelets and inflammatory cells. Kinlay et al (25) reported that, in patients with ACS, high-dose statin therapy resulted in a significant lowering of CRP and a decrease in events early after presentation. In the present study, this protective effect occurred despite the fact that many of the subjects had only been on statins for 24 h to 72 h before PCI. The intimate relationship between baseline elevation of troponin, statin use and CRP, and the subsequent risk of a troponin rise following PCI implies a role for inflammation in this process, but cause and effect has not been demonstrated.

Long-term follow-up was obtained in the present cohort to determine the clinical use of these pathophysiological observations. We did not observe an increased risk for adverse cardiovascular outcomes defined as the composite end point of mortality and repeat revascularization, in patients with TnT elevations greater than 0.1 µg/L. These observations were independent of the preprocedural TnT level. No adverse effect on mortality was seen in the present study. Several smaller studies (7,13,26) have demonstrated a relationship between troponin rise and both acute and long-term outcomes. Recently, several large studies (1,15,27) have demonstrated results similar to ours. Elevations of troponins up to five times the normal level were not associated with enhanced risk in these studies. The differences observed with troponin and CK-MB probably relate to the magnitude of damage and/or the burden of atherosclerosis responsible for large enzyme elevations and subsequent adverse cardiovascular outcomes. Most large enzyme elevations are due to mechanical complications, failed PCI or profound no-reflow. This type of patient was excluded in the present study. The most recently published observation of Prasad et al (14) demonstrated increased mortality in patients with stable coronary artery disease and elevated TnT following uncomplicated PCI. Compared with this study, our study included a different patient population, namely a significant predominance of patients with ACS.

Limitations

The current results only apply to subjects with uncomplicated PCI. The results may have been different if subjects with larger troponin elevations related to mechanical complications had been included. There were not enough events in our cohort to evaluate different troponin elevation cut-off points and determine whether a larger troponin rise conveys increased risk. Although the study was prospective, data were not available with respect to exact timing of the PCI procedure and the admission date for those with ACS. Our medication data only reflect medication on admission. Therefore, we were unable to differentiate between the effect of chronic statin therapy and treatment initiated on index admission.

CONCLUSION

Myocardial necrosis occurs commonly in otherwise successful coronary intervention and is particularly prevalent in the proinflammatory milieu of a non-ST elevation myocardial infarction. The preprocedural use of statins was associated with an attenuation of this response. While important for understanding pathophysiology, the weak association between TnT rise and long-term cardiovascular events following successful PCI limits its prognostic use in this population.

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