The relationship between long-term statin usage and myocardial injury related to percutaneous coronary interventions evaluated by high-sensitivity troponins

Yüksek duyarlılıklı troponin ile değerlendirilen perkütan koroner girişime bağlı miyokart hasarının statin kullanımıyla ilişkisi

Ajar Koçak, M.D.[1] ⓘ**, Serkan Ünlü, M.D.[1]** ⓘ**, Gökhan Gökalp, M.D.[1]** ⓘ**, Niyazi Samet Yılmaz, M.D.[2]** ⓘ**,
Özlem Gülbahar, M.D.[2]** ⓘ**, Adnan Abacı, M.D.[1]** ⓘ

[1]Department of Cardiology, Gazi University School of Medicine, Ankara, Turkey
[2]Department of Medical Biochemistry, Gazi University School of Medicine, Ankara, Turkey

ABSTRACT

Objective: Myocardial injury related to percutaneous coronary interventions (PCI) might adversely affect the prognosis of patients with coronary artery disease. Our study aimed to investigate the effects of long-term statin usage on myocardial injury related to elective PCI.

Methods: In our study, total 102 patients were included and evaluated in 3 groups based on the statin usage before PCI, "potent statin" group (n=26), "weak statin" group (n=23), and "statin free" group (n=53). The occurrence of the procedural complications was identified (n=31). The myocardial injury was determined by serial high-sensitivity troponin T (hsTnT) testing at 0th, 2nd, 4th, and 12th hour of the procedure.

Results: The increase in hsTnT values in the 2nd and 4th hour was significantly lower in the potent statin group than in the other 2 groups (p=0.008 and p=0.009, respectively). In patients with procedural complications, the increase in hsTnT levels at the 2nd, 4th, and 12th hour were also lower in the potent statin group (p=0.032, p=0.019, and p=0.006, respectively). Also, in patients with procedural complications, hsTnT levels exceeding the myocardial infarction limit at the 4th and 12th hour were lower in the potent statin group (p=0.039 and p=0.006, respectively).

Conclusion: These results show that elective PCI related myocardial injury was less frequent in patients who were using high-dose statins. This result was more pronounced in patients who developed complications during the procedure.

ÖZET

Amaç: Perkütan koroner girişimler (PKG) ilişkili miyokardiyal hasar, koroner arter hastalığı olan hastaların prognozunu olumsuz etkileyebilir. Çalışmamızın amacı, uzun süreli statin kullanımının elektif PKG ile ilişkili miyokardiyal hasar üzerine etkilerini araştırmaktır.

Yöntemler: Çalışmamıza toplam 102 hasta dahil edildi ve PKG öncesi statin kullanımına göre üç grupta değerlendirildi, ''potent statin'' grubu (n=26), ''zayıf statin'' grubu (n=23) ve ''statin içermeyen'' grubu (n=53). PKG sırasında komplikasyonu gelişen hastalar belirlendi (n=31). Miyokardiyal hasar, işlemin 0, 2, 4 ve 12. saatlerinde seri yüksek duyarlılıklı troponin T (hsTnT) testi ile belirlendi.

Bulgular: Potent statin grubunda 2. ve 4. saatlerde hsTnT değerlerindeki artış diğer iki gruba göre anlamlı olarak daha düşüktü (sırasıyla p=0.008 ve 0.009). Prosedürel komplikasyon yaşanan hastalarda 2., 4. ve 12. saatlerde hsTnT düzeylerindeki artış potent statin grubunda diğer iki gruba göre daha düşüktü (sırasıyla p=0.032, 0.019 ve 0.006). Ayrıca işlem sırasında komplikasyon yaşanan hastalarda, potent statin grubunda 4. ve 12. saatlerde hsTnT düzeyleri miyokart enfarktüsü sınırını aşan hastalar daha azdı. (p=0.039 ve p=0.006, sırasıyla).

Sonuç: Bu sonuçlar, yüksek doz statin kullanan hastalarda elektif PKG ile ilişkili miyokardiyal hasarın daha az sıklıkta olduğunu göstermektedir. İşlem sırasında komplikasyon gelişen hastalarda bu sonuç daha belirgindi.

Percutaneous coronary intervention (PCI) is a frequently used procedure in the treatment of coronary artery disease (CAD). However, even elective PCI procedures may cause myocardial injury.[1,2] Prolonged balloon inflation time, side-branch occlusion, obstructive coronary dissection, or distal embolization of thrombotic and atherosclerotic materials can lead to myocardial ischemia and result in ischemia-related myocardial injury.[3,4] Regardless of the mechanism, myocardial injury may adversely affect the morbidity and mortality of the patients.[5] The elevated cardiac troponin level is a specific marker for myocardial injury.[6] With the introduction of newly developed high-sensitive troponins (hsTnT), it has

become possible to detect patients with minor myocardial injury earlier by providing prognostic information in various cardiac pathologies.[7]

Statins are the most used lipid-lowering agents in the treatment and prevention of CAD.[8] Beside its lipid-lowering effects, the pleiotropic effects carry importance as well.[9] Previous studies have suggested that statins may be useful in preventing myocardial injury related to PCI.[10,11] Recently, evidence have shown that statins have beneficial effects on reducing endothelial dysfunction, preventing the proliferation of vascular smooth muscle cells, reducing vascular inflammation, and vasoconstriction.[12] The bioavailability of nitric oxide is also increased by administrating statins, which prevents coronary endothelial cell and cardiomyocyte injury, and play a role in inducing collateral blood flow reducing ischemia.[9,13] The lipid-lowering effect of statins also leads to reduced activity of matrix metalloproteinases in the activated macrophages and reduced macrophage accumulation in atherosclerotic lesions. This causes changes in the biochemical characteristics of atherosclerotic plaques, and as a result, it has a plaque-stabilizing effect; thus, plaque rupture and related distal embolization events during PCI may be less frequent in patients with chronic statin use.[9] In a very recent study, statins have also proven to play a role in reducing myocardial injury after reperfusion through regulations on mRNA levels.[14] Although there is no clear evidence that statins have a direct cardioprotective effect, by the above mentioned mechanisms, statins play an important role in decreasing the incidence and degree of myocardial injury related to PCI.[13,15]

In this study, we investigated the impact of long-term statin usage on myocardial injury related to PCI detected by hsTnT in patients with stable CAD undergoing elective PCI.

METHODS

Study population

In this cross-sectional, prospective observational study, 102 patients who underwent elective PCI between May 2015 and July 2017 were enrolled. Patients were assigned to 3 groups based on the statin usage for at least 8 weeks before the procedure. Patients who were receiving atorvastatin 40 mg, rosuvastatin 20 mg or higher doses of these statins were included in the "potent statin" group (26 patients); the rest of statin users were included in the "weak statin" group (23 patients), and patients who were not receiving statins were assigned to "statin free" group (53 patients). Any events that may lead to unwanted changes in the normal physiological coronary hemodynamics are defined as procedural complications; these were distal embolization of plaque debris or thrombus, dissection or spasm of coronary arteries, slow coronary flow or no reflow phenomenon after intervention, atherogenic plaque shift, and new branch occlusion. The occurrence of such events was identified by 2 blinded readers, and detailed information about these types of complications are mentioned in the results section of this manuscript. According to the occurrences of procedural complications, a subgroup analysis was done in terms of 2 groups, patients with and without procedural complications.

Patients of age above 18 and below 80 who planned for elective PCI in our hospital and accepted to be part of the study were included in our research, consecutively. Patients who met the European Society of Cardiology criteria of acute coronary syndromes[16] and those using antihyperlipidemic drugs other than statins or having no clear information about the usage of statin therapy before PCI were excluded from the study. All patients who met the inclusion criteria were informed about the research and written consents were obtained before participation. The study was approved by the ethical committee of the Gazi University School of Medicine on April 13, 2015 (document number 162). The type of the intervention was decided by the treating physician according to the coronary anatomy, and the antithrombotic treatment protocol of the patients followed our clinic's routine of 300 mg acetyl salicylic acid and 300 mg clopidogrel as loading dose, and 100 mg acetyl salicylic acid and 75 mg clopidogrel as maintenance therapy. No changes out of the standard treatment plan were implemented among study participants.

The demographic and clinical characteristics of the patients such as age, gender, height, weight,

Abbreviations:

ARMYDA	Atorvastatin for Reduction of Myocardial Damage during Angioplasty
CABG	Coronary artery bypass grafting
CAD	Coronary artery disease
CK-MB	Creatine kinase-MB
hsTnT	High-sensitive troponin T
LDL	Low-density lipoprotein
PCI	Percutaneous coronary intervention

body mass index, medical history, medication, and results of blood tests were recorded. History of hypertension, hypercholesterolemia, diabetes mellitus, smoking status, and family was carefully noted. Hypertension is defined as a persistent elevation in systolic blood pressure (BP) ≥140 and/or diastolic BP ≥90 mmHg, which is equivalent to a 24-h ambulatory BP monitoring average of ≥130/80 mmHg or home BP monitoring average of ≥135/85 mmHg. Hypercholesterolemia is defined as low-density lipoprotein (LDL)-cholesterol >190 mg/dL, >160 mg/dL with one major risk factor, or >130 mg/dL with 2 cardiovascular risk factors. Participants who smoke any tobacco product, either daily or occasionally, were considered smokers. Participants who were using anti-diabetic treatment or have a fasting blood glucose level ≥126 mg/dL, or by having a non-fasting blood glucose level ≥200 mg/dL was considered diabetic. Patients were considered to have a positive family history of CAD if an immediate family member had fatal/nonfatal myocardial infarction, coronary artery bypass surgery (CABG), or coronary angioplasty before 55 years of age for males and 65 years of age for females.

Blood samples

Blood samples were collected into serum separator tubes (BD Vacutainer VR SSTTM II Advance, Ref: 367953, BD, Plymouth, United Kingdom) at 0th, 2nd, 4th, and 12th hour of PCI. The levels of hsTnT were measured with a hsTnT assay (Elecsys Troponin T high sensitive, Roche Diagnostics, Penzberg, Germany) with lower detection and upper reference (99th percentile) limits of 5 ng/L and 14 ng/L, respectively.

Clinical evaluation of myocardial injury

Myocardial injury was determined by comparing serial hsTnT measurements at 0th, 2nd, 4th, and 12th hour of PCI. Patients were compared in terms of hsTnT elevation rate, exceedance of the 99th percentile upper reference limit and PCI-associated myocardial infarction limit according to the recent guideline of the European Society of Cardiology.[16]

Statistical analysis

Continuous variables were examined by Shapiro-Wilk test to check for the normality of distribution. Continuous variables are presented as a mean±standard deviation or a median and interquartile range. Categorical data are presented as percentages

or frequencies. Student t-test and Mann-Whitney U tests were used to compare parametric and nonparametric continuous variables, respectively. Categorical variables were compared by chi-square (v2) test. One-way analysis of variance was used to investigate differences among more than 2 groups. Bonferroni analysis was used as post-hoc test. A 2-tailed *p* value of <.05 was considered statistically significant. All data were analyzed using SPSS version 23.0 (IBM Corp., Armonk, NY, USA).

RESULTS

The basal demographic and clinical characteristics of the study subjects are presented in Table 1, and the drug history of the patients is presented in Table 2. There was no difference in age, sex, and cardiovascular risk factors among the groups. The groups showed similar laboratory findings and similar drug history other than statins.

The hsTnT values before and after the PCI are shown in Figure 1 and Table 3. The increase in hsTnT values on the 2nd and 4th hour after the procedure were lower in the potent statin group than in other groups (Table 3). The difference among groups continued at the 12th hour but showed no statistical significance (Table 3). The number of patients exceeding the 99th percentile reference limit for 2nd, 4th, and 12th hour hsTnT measurements were also lower in the potent statin group than in the other groups (p=0.014, p=0.002, and p=0.297, respectively) (Table 3).

PCI-related complications were identified in 31 patients. These were distal embolization (n=1), coronary dissection (n=1), coronary spasm (n=2), slow coronary flow (n=5), no reflow phenomenon (n=3), side-branch occlusion (n=3) and plaque shift (n=16). There was no significant increase in hsTnT values after the procedure in patients without complications, and no significant difference was found between the statin subgroups in this category (Table 3). In patients with complications, the increase in hsTnT levels at the 2nd, 4th, and 12th hours were significantly lower in the potent statin subgroup than in the other groups (Table 3).

In patients with complications, there were no significant differences between the statin and control groups in terms of the proportion of the patients exceeding the 99th percentile hsTnT reference limit

Table 1. Baseline characteristics of the participants

Parameters	Patients without procedural complications					Patients with procedural complications					Total (n=102)	p
	Statin free (n=36)	Weak statin (n=16)	Potent statin (n=19)	Total (n=71)	p	Statin free (n=17)	Weak statin (n=7)	Potent statin (n=7)	Total (n=31)	p		
Age (year±SD)	66.3±11.1	69.9±7.5	63.1±9.4	66.2±10.1	0.13	62.7±10.8	60.3±7.3	63±9.9	62.2±9.7	0.84	65±10.1	0.066
Sex (%)					0.09							0.24
Male	29 (80)	11 (68)	10 (52)	50 (70)		13 (76)	2 (28)	4 (57)	19 (61)	0.08	69 (67)	
Female	7 (20)	5 (32)	9 (48)	21 (30)		4 (24%)	5 (72)	3 (43)	12 (39)		33 (33)	
BMI±SD (kg/m^2)	29.2±3.1	27.9±2.9	27.9±3.0	28.2±3.0	0.31	27.1±3.5	31.1±8.5	27.6±2.2	28.1±5.0	0.19	28.1±3.7	0.93
DM (%)	10 (27)	8 (50)	13 (68)	31 (43)	0.01	2 (11)	4 (57)	2 (28)	8 (25)	0.06	39 (38)	0.067
HT (%)	19 (52)	13 (81)	14 (73)	46 (64)	0.08	11 (64)	5 (72)	4 (57)	20 (64)	0.85	66 (64)	0.57
HPL (%)	10 (27)	13 (81)	13 (68)	36 (50)	0.001	3 (17)	3 (42)	6 (85)	12 (39)	0.008	48 (47)	0.18
Smoking (%)	12 (33)	7 (43)	9 (47)	28 (39)	0.54	8 (47)	3 (42)	3 (43)	14 (45)	0.64	42 (41)	0.603
Family history (%)	4 (11)	4 (25)	2 (10)	10 (14)	0.36	4 (23)	2 (28)	2 (28)	8 (25)	0.95	18 (17)	0.12
CAD (%)	10 (27)	12 (75)	12 (63)	34 (47)	0.002	4 (5)	1 (14)	5 (71)	10 (32)	0.038	44 (43)	0.11
Mean EF±SD	57.4±8.7	57.7±8.5	55.2±11.6	56.9±9.5	0.67	53.1±16.7	60±5.9	51.3±9.7	54.5±13.4	0.45	56.1±10.8	0.39
Total chols (mg/dL)	191.8± 61.1	141.3± 39.7	156.3± 61.1	170.5± 60.1	0.01	182.7± 31.9	169.7± 51.7	116.7± 10.3	164.8± 42.7	0.001	168.7± 54.6	0.21
LDL (mg/dL)	128.1± 41.5	103.5± 24.9	113.1± 43.8	118.2± 39.8	0.1	112.1± 31.7	98.4± 24.9	82.4± 13.5	102.2± 29.1	0.067	113.2± 36.4	0.059
HDL (mg/dL)	46.9± 17.4	42.1± 14.3	43.3± 13.8	44.8± 15.7	0.55	42.5± 10.9	39.1± 11.3	38.2± 4.1	40.7± 9.8	0.562	43.5± 13.8	0.12
TGs (mg/dL)	138.9± 89.4	161.4± 104.6	136.7± 66.9	143.5± 87.1	0.65	123.5± 82.2	192.3± 99.1	105.4± 34.6	135.0± 82.7	0.099	140.8± 85.7	0.64

BMI: body mass index; CABG: coronary artery bypass grafting; CAD: coronary artery disease; chols: cholesterol; CVO: cerebrovascular accident; DM: diabetes mellitus; EF: ejection fraction; HDL: high-density lipoprotein; HPL: hyperlipidemia; HT: hypertension; LDL: low-density lipoprotein; SD: standard deviation; TIA: transient ischemic attack; TGs: triglycerides.

(p=0.214, p=0.097, and p=0.143, respectively) (Table 3). However, in patients without complications, the proportion of the patients exceeding the 99th percentile hsTnT reference limit in the 2nd and 4th hour was significantly lower in the potent statin subgroup (p=0.048 and p=0.018, respectively) (Table 3). When patients with complications were compared according to the fourth universal definition of myocardial infarction,[16] the rate of patients who exceeded the hsTnT myocardial infarction limit at the 4th and 12th hour were significantly lower in the potent statin group than in the other groups (p=0.039 and p=0.006, respectively). However, there were no significant differences among groups in patients without complications (Table 3).

DISCUSSION

In this study, we investigated the effects of long-term statin usage on myocardial injury related to PCI assessed by hsTnT. The results of the study showed that hsTnT elevation in the initial hours after elective PCI was less frequent in patients using potent statins. This result was more obvious in patients with complicated procedures.

During PCI procedures, the rate of occurrence of myocardial injury, its possible related causes, effects on patient prognosis, and methods of prevention have been investigated in several studies.[17,18] Regardless of the causes, adverse effects of myocardial injury on patients'

Table 2. Drug history of the participants

Parameters (%)	Patients without procedural complications					Patients with procedural complications					Total (n=102)	p
	Statin free (n=36)	Weak statin (n=16)	Potent statin (n=19)	Total (n=71)	p	Statin free (n=17)	Weak statin (n=7)	Potent statin (n=7)	Total (n=31)	p		
Antiaggregants	14 (38)	10 (62)	16 (84)	40 (56)	0.013	8 (47)	4 (57)	4 (57)	16 (51)	0.846	56 (54)	0.549
Aspirin	13 (36)	9 (56)	11 (57)	33 (46)	0.205	7 (41)	4 (57)	4 (57)	15 (48)	0.676	48 (47)	0.514
Clopidogrel	1 (3)	1 (6)	3 (15)	5 (7)	0.198	0 (0)	0 (0)	0 (0)	0 (0)	-	5 (5)	0.156
Dual antiaggregants	0 (0)	0 (0)	2 (11)	2 (3)	0.060	1 (5)	0 (0)	0 (0)	1 (3)	0.658	3 (2.5)	0.667
ACEI or ARB	21 (58)	9 (56)	12 (63)	42 (59)	0.908	10 (58)	5 (71)	3 (42)	18 (58)	0.554	60 (58)	0.544
Beta-blockers	7 (19)	6 (37)	11 (58)	24 (33)	0.015	5 (29)	2 (28)	4 (57)	11 (35)	0.396	35 (34)	0.521
Calcium channel blockers	4 (11)	3 (18)	2 (12)	9 (12)	0.707	1 (5)	0 (0)	0 (0)	1 (3)	0.653	10 (9.5)	0.130
Statins	0 (0)	16 (100)	19 (100)	35 (49)	<0.001	0 (0)	7(100)	7 (100)	14 (45)	<0.001	49 (48)	0.433
Atorvastatin	0 (0)	12 (75)	13 (68)	25 (35)	-	0 (0)	6 (85)	3 (42)	9 (29)	-	34 (33)	-
Rosuvastatin	0 (%0)	4 (25)	6 (32)	10 (14)	-	0 (0)	1 (14)	4 (57)	5 (16)	-	15 (14)	-

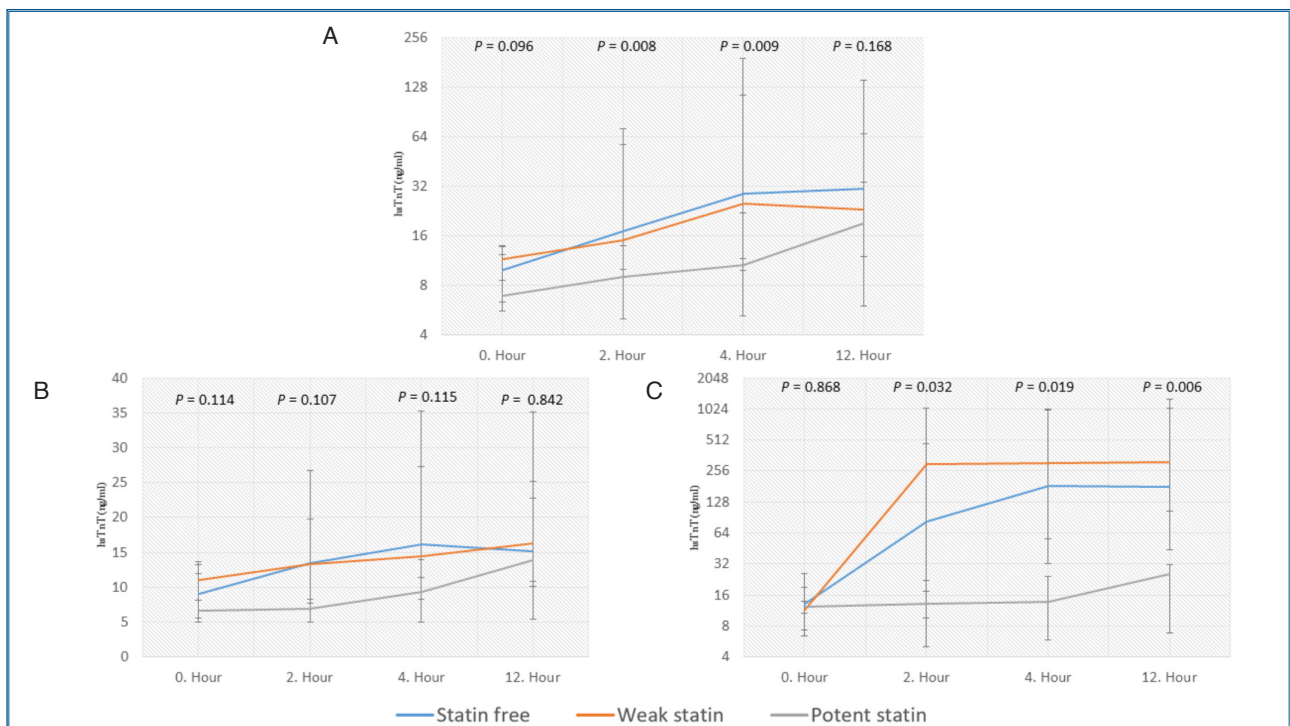ACEI: angiotensin converting enzyme inhibitor; ARB: angiotensin receptor blocker.

Figure 1. Levels of hsTnT at different hours after PCI are demonstrated for the potent statin, weak statin, and statin free groups. The hsTnT values on the 2nd and 4th hours after PCI were lower in the potent statin group than in the other groups. In patients with procedurals complications, hsTnT levels at the 2nd, 4th, and 12th hour after PCI were more significantly lower in the potent statin group. No significant increase was found in hsTnT levels in patients without procedural complications. **(A)** Comparison of overall hsTnT values according to statin usage at different hours, **(B)** Comparison of hsTnT values of the patients without procedural complications, **(C)** Comparison of hsTnT values of the patients with procedural complications.
hsTnT: high-sensitive troponin T; PCI: percutaneous coronary interventions.

Table 3. Comparison of hsTnT (ng/L) values. The hsTnT 99th percentile upper reference limit exceedance rates (%) and hsTnT myocardial infarction limit exceedance rates (%) of patients with different statin usage protocols at different hours after the procedure

Hours	Groups	hsTnT	Statin free (n=53)	Weak statin (n=23)	Potent statin (n=26)	p
0 hour	No complications	Level (ng/L)	9.1 (5.6-13.2)	11.1 (8.1-13.6)	6.6 (5-11.9)	0.114
		>99% URL	0 (0%)	0 (0%)	0 (0%)	-
		> MI limit	0 (0%)	0 (0%)	0 (0%)	-
	Complications	Level (ng/L)	13.2 (7.3-19)	11.6 (10.7-26)	12.3 (6.4-14)	0.868
		>99% URL	4 (23.5%)	3 (42.8%)	0 (0%)	0.157
		> MI limit	0 (0%)	0 (0%)	0 (0%)	-
	Overall	Level (ng/L)	9.9 (6.3-13.7)	11.6 (8.6-14)	6.9 (5.6-12.4)	0.096
		>99% URL	4 (7.5%)	3 (13.1%)	0 (0%)	0.189
		> MI limit	0 (0%)	0 (0%)	0 (0%)	-
2nd hour	No complications	Level (ng/L)	13.4 (8.3-19.8)	13.3 (7.7-26.7)	6.9 (5-13.4)	0.107
		>99% URL	16 (44.4%)	8 (50%)	3 (15.7%)	0.048
		> MI limit	3 (8.3%)	1 (6.25%)	1 (5.2%)	0.907
	Complications	Level (ng/L)	83.2 (9.5-466.1)	297.8 (22.3-1034)	13.3 (5-17.3)	0.032
		>99% URL	12 (70.5)	6 (85.7)	3 (42.8)	0.214
		> MI limit	10 (58.8)	4 (57.1)	1 (14.2)	0.100
	Overall	Level (ng/L)	17 (9-72)	15 (10-57)	9 (5-14)	0.008
		>99% URL	28 (52.8%)	14 (60.8%)	6 (23.1%)	0.014
		> MI limit	13 (24.5%)	5 (21.7%)	2 (7.7%)	0.200
4th hour	No complications	Level (ng/L)	16.1 (11.4-27.3)	14.5 (8.3-35.2)	9.3 (5-14)	0.115
		>99% URL	22 (61.1%)	8 (50%)	4 (21%)	0.018
		> MI limit	4 (11.1%)	1 (6.25%)	3 (15.8%)	0.673
	Complications	Level (ng/L)	182 (32.1-1028)	308 (56-990)	13.7 (5.9-24.3)	0.019
		>99% URL	14 (82.3%)	6 (85.7%)	3 (42.8%)	0.097
		> MI limit	11 (64.7%)	5 (71.4%)	1 (14.2%)	0.039
	Overall	Level (ng/L)	28.8 (11.6-114.9)	25.3 (9.9-191.8)	10.7 (5.2-22)	0.009
		>99% URL	36 (67.9%)	14 (60.8%)	7 (26.9%)	0.002
		> MI limit	15 (28.3%)	6 (26.1%)	4 (15.4%)	0.446
12th hour	No complications	Level (ng/L)	15.1 (10.1-22.8)	16.3 (10.8-25.2)	13.9 (5.5-35.1)	0.842
		>99% URL	20 (55.5%)	10 (62.5%)	9 (47.3%)	0.665
		> MI limit	4 (11.1%)	1 (6.25%)	3 (15.8%)	0.477
	Complications	Level (ng/L)	179.6 (104.8-1047.5)	313.4 (43.7-1289)	25.8 (6.8-31.6)	0.006
		>99% URL	16 (94.1%)	7 (100%)	5 (71.4%)	0.143
		> MI limit	14 (82.3%)	5 (71.4%)	1 (14.2%)	0.006
	Overall	Level (ng/L)	31 (12-142)	23 (120-67)	19 (6-34)	0.168
		>99% URL	36 (67.9%)	17 (73.9%)	14 (53.8%)	0.297
		> MI limit	18 (33.9%)	6 (26.1%)	4 (15.4%)	0.180

hsTnT: high-sensitive troponin T; MI: myocardial infarction; URL: upper reference limit.

morbidity and mortality were demonstrated in clinical trials.[5] Statins are the most used lipid-lowering agents in the treatment and prevention of CAD.[8] Beside its lipid-lowering effects, the pleiotropic effects carry importance as well.[9] There is no clear evidence that statins have a direct cardioprotective effect, but with its lipid-lowering and pleiotropic effects it can be useful in preventing myocardial injury related to PCI.[13,15]

Many retrospective studies showed that starting statins before PCI can be effective in reducing the rate and severity of myocardial injury related to PCI. [13,15] The placebo controlled Atorvastatin for Reduction of Myocardial Damage during Angioplasty (AR-MYDA) study showed that the circulating levels of myocardial injury markers were significantly lower in patients randomized to 40 mg atorvastatin for 7 days before PCI than in the placebo group.[19] In a recent study, the effects of preoperative statin load in off-pump CABG were investigated. In the study, the patients had similar baseline levels of various cardiac biomarkers (cardiac troponin-I, creatine kinase, and B-type natriuretic peptide); all these biomarkers at 8th, 24th, and 48th hour after CABG were significantly lower in the statin-loaded group supporting the idea of the role of statins in reducing myocardial damage during hemodynamic disturbances and ischemia.[20] As in the results of the previous studies, our study also showed that hsTnT elevation was less frequent after elective PCI in patients using statins. However, previous studies have investigated the effect of initiating statin therapy as a loading dose before the procedure, and limited data are available to assess the effects of long-term statin use on these patients.

Auguadro et al.[21] studied the effects of 3-week statin usage before elective PCI, and their results showed that the patients using statins have lower levels of troponin I and creatine kinase-MB (CK-MB) in blood samples taken after PCI than those who were not using statins. In our study, we included patients who were on statins for a longer period (at least 8 weeks before PCI) to examine the chronic effects of statin use. In the study, high-sensitivity troponin assay was used so that it was possible to show relatively small differences in hsTnT levels between statin users in different doses and statin-free patients. Similar results were observed supporting the idea that long-term statin usage also plays a role in decreasing the rates of myocardial injury related to PCI.

The most significant aspect of our study was evaluating the relationship between the intensity of the statin used and the rates of hsTnT increase during PCI. Previous studies have shown that using more potent statins (in terms of the molecule or dose used) leads to further risk reductions of acute coronary events, revascularization, and ischemic stroke among patients with stable CAD.[22] In our study, we aimed to evaluate the effects of using different doses and molecules of statins on myocardial injury related to PCI, during and after the procedure. In the study, the patients were evaluated in different groups according to the statin used. The increase in hsTnT values after the procedure were lower in the potent statin group than in the other 2 groups (weak statin and statin free), and the rate of myocardial injury in the weak statin group was similar to that of the statin free group. These results suggest that relatively weak statins are not as effective as potent statins in terms of reducing rates and significance of myocardial injury related to PCI.

Another aspect of our study is the effects of statins on myocardial injury in relation to the complications that occurred during PCI. In this subgroup analysis, there were 2 main patient groups (according to the presence or absence of procedural complications) and each group was divided into 3 subgroups according to the statin used, as in the main analysis criteria. Even though the group without procedural complications were slightly older and had a higher percentage of diabetic and hyperlipidemic patients, which was the opposite of the normal expectation, these differences were statistically insignificant. It is noteworthy that the protective effect of statin usage in terms of the increase in hsTnT levels was more prominent in patients with procedural complications, especially in the group receiving potent statins.

Within the group without procedural complications, there were no statistically significant differences in the increase in the rates of hsTnT levels between the subgroups, and there were higher rates of beta-blockers and antiaggregant agents' use in the potent statin subgroup, which may affected the study results. Despite all the points mentioned, it is worth to notice that the rates of patients exceeding the 99th percentile reference limit of hsTnT at 2nd and 4th hour were lower in the potent statin subgroup than in the other 2 subgroups of patients with no procedural complications.

Limitations

The most important limitation of our study was the small number of patients involved. Another important limitation was the short follow-up period. By monitoring hsT-nT levels beyond the 12th hour after the procedure, the impact of statins on decreasing the rates of late myocardial injury could be examined. Finally, there was a lack of clinical follow-up of patients in terms of major cardiovascular events; thus, the relationship between different doses of long-term statin usage and major cardiovascular events in long term was not investigated.

Conclusion

The results of our study showed that myocardial injury related to elective PCI was less frequent among patients using long-term potent statins. This result was more pronounced in the group of patients who developed complications during the procedure. In addition, in these patients low-dose statin usages was not as effective as high-dose usage.

The visual summary of the article can be seen in the Appendix 1.

Ethics Committee Approval: Ethics committee approval was received for this study from the Ethics Committee of Gazi University School of Medicine on (Approval Date: April 13, 2015; Approval Number: 162).

Informed Consent: Written informed consent was obtained from the patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - A.A.; Design - A.K., S.Ü., A.A.; Supervision - A.A.; Resources - A.K., S.Ü., A.A.; Materials - A.K., S.Ü., G.G., N.S.Y., Ö.G., A.A.; Data Collection and/or Processing - A.K., S.Ü., G.G., N.S.Y., Ö.G., A.A.; Analysis and/or Interpretation - A.K., S.Ü., G.G., N.S.Y., Ö.G., A.A.; Literature Search - A.K., S.Ü., A.A.; Writing - A.K., S.Ü., A.A.; Critical Revision - A.K., S.Ü., G.G., N.S.Y., Ö.G.

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Conflict of Interest: None.

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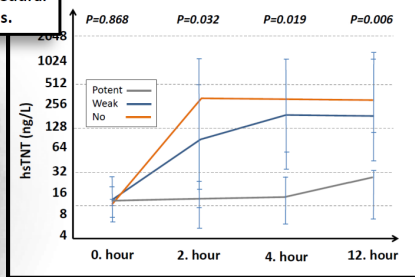
Long term statin usage and elective PCI related myocardial injury

Cross-sectional, prospective, observational study of 102 elective PCI patients
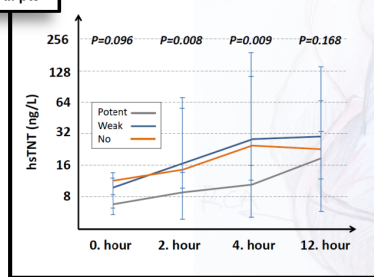
"Potent" statin group, 26 pts
"Weak" statin group 23, pts
"No statin" group, 53 pts

hsTnT testing at
0th, 2nd, 4th, and 12th hours

Pts with procedural complications.

All pts

Elective PCI related myocardial injury was less frequent in patients who were using high dose statins. This result was more pronounced in patients who developed complications during the procedure.

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Appendix 1. Visual summary of the article.