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Association of preprocedural low-density lipoprotein cholesterol levels with myocardial injury after elective percutaneous coronary intervention

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BACKGROUND: Lower levels of low-density lipoprotein cholesterol (LDL-C) are associated with less cardiovascular risk in patients with coronary artery disease.

OBJECTIVES: To assess whether lower preprocedural LDL-C levels are associated with less risk of periprocedural myocardial injury in patients undergoing elective percutaneous coronary intervention (PCI).

METHODS: We enrolled 2529 consecutive patients with normal preprocedural cardiac troponin I (cTnI) who successfully underwent elective PCI. The association between preprocedural LDL-C levels and peak cTnI levels within 24 hours after PCI was evaluated.

RESULTS: Preprocedural LDL-C levels were correlated to postprocedural cTnI levels ($r = 0.059$, $P = .003$). In the multivariable model, preprocedural LDL-C levels between 70 and 99 mg/dL were associated with less risk of postprocedural cTnI elevation above 1 × upper limit of normal (ULN) (odds ratio [OR]: 0.804; 95% confidence interval [CI]: 0.663–0.975; $P = .027$) up to 15 × ULN (OR: 0.709; 95% CI: 0.530–0.949; $P = .021$) compared with preprocedural LDL-C levels ≥100 mg/dL. Moreover, preprocedural LDL-C levels <70 mg/dL were more strongly associated with less risk of postprocedural cTnI elevation above 1 × ULN (OR: 0.736; 95% CI: 0.584–0.927; $P = .009$) up to 15 × ULN (OR: 0.655; 95% CI: 0.452–0.950; $P = .026$).

CONCLUSIONS: Lower preprocedural LDL-C levels were associated with less risk of periprocedural myocardial injury in patients undergoing elective PCI.

Percutaneous coronary intervention (PCI) has become an important strategy for patients with both stable and unstable coronary artery disease (CAD). During the past 2 decades, advances in PCI techniques and medication have resulted in a better and safer therapeutic procedure with fewer procedural complications, such as abrupt vessel closure, stent thrombosis, and large side branch occlusion. However, the elevation of cardiac marker after PCI or periprocedural myocardial injury is still common, especially with the use of high-sensitivity troponin.[1] The elevation of cardiac marker

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after PCI mainly results from incidental minor side-branch occlusion around target lesions and distal embolization of plaque debris or thrombus from the target lesion.[2–4] The elevation of cardiac marker after PCI would directly impact prognosis.[2,5] Recently, the diagnostic criteria for PCI-related myocardial infarction have been arbitrarily increased from the elevation of cardiac troponin above 3 times upper limit of normal (ULN) to the elevation above 5 times ULN.[2]

Low-density lipoprotein cholesterol (LDL-C) is the primary measure of the atherogenic risk of the apolipoprotein B lipoproteins. Epidemiological studies and clinical trials with statins have shown that lower levels of LDL-C are associated with less cardiovascular risk,[6,7] and the reduction of cardiovascular risk with statin treatment is a function of the extent of LDL-C lowering.[8] However, whether lower preprocedural LDL-C levels are associated with less risk of periprocedural myocardial infarction in patients undergoing elective PCI especially in the era of statins is not well-characterized. Thus, we sought to investigate the association of LDL-C levels with the risk of periprocedural myocardial injury.

Methods

Study population

Patients with CAD and an indication for elective PCI at our institution were screened for eligibility. Inclusion criteria were (1) patients undergoing elective PCI with stable CAD or unstable angina; (2) normal levels of cardiac troponin I (cTnI) and creatine kinase-MB (CK-MB) before PCI; (3) without ST-elevation or non–ST-elevation acute myocardial infarction within 4 weeks before intervention. Exclusion criteria were (1) angiographic failure or death $<$24 hours after PCI; (2) patients treated with atheroablative distal protection devices and aspiration thrombectomy. Angiographic success of PCI was defined as residual stenosis $<$20% with stenting and residual stenosis $<$50% with balloon angioplasty only by visual estimation. Unstable angina was defined as rest angina, new-onset severe angina and increasing angina within 2 months.

Between December 2010 and December 2012, 2646 consecutive patients who underwent elective PCI at our center were eligible for this study. Of these patients, 96 patients were excluded because a total chronic occlusion could not be crossed with a wire, 2 patients were excluded because a subtotal chronic occlusion could not be crossed with a wire, 4 patients were excluded because a severely calcified or tortuous lesion could not be crossed with a balloon, 10 patients were excluded because treated with atheroablative distal protection devices or aspiration thrombectomy, and 5 patients were excluded because of residual stenosis more than 50% with angioplasty only. None of the patients died in the hospital. Thus, 2529 patients were eventually included in the present study. The study complies with the Declaration of Helsinki, and all of these studies were approved by the Fu Wai ethics committee; all patients gave their informed consent for participation in this study.

Percutaneous coronary artery intervention

The indication for PCI was based on the American College of Cardiology/American Heart Association recommendations and all procedures were performed by experienced interventional cardiologists. Before the procedure, all patients without contraindications received aspirin 100 mg daily or a loading dose of 300 mg depending on whether they were already on daily aspirin therapy, and received clopidogrel 75 mg daily or a loading dose of 300 mg depending on whether already taken daily long-term clopidogrel therapy before intervention. All patients received either 5000 U or 70 U/kg bolus of unfractionated heparin just before procedure and an additional bolus of 2000 to 3000 U was given every hour if the procedure lasted for more than 1 hour. Vascular access and PCI type (angioplasty only, angioplasty and stenting, or primary stenting) were determined by the interventional cardiologist according to the patient's characteristics. Total balloon inflation times and inflation pressures were determined by the interventional cardiologist according to the technical properties of the balloon and the stent. After the procedure, all patients continued with aspirin and clopidogrel therapy daily. Use of glycoprotein IIb/IIIa receptor antagonists or anticoagulants was at the discretion of the interventional cardiologist.

Electrocardiogram monitoring

In all patients, a 12-lead electrocardiogram was recorded before, immediately after PCI, and in the case of the occurrence of symptoms, which were interpreted as a post-procedural ischemic event. All patients received continuous electrocardiogram monitoring using wireless technology after PCI during hospitalization.

Lipid profile and plasma markers

Fasting venous blood samples were obtained before intervention for measurement of lipid profile. cTnI levels were determined in venous blood samples before PCI, 24 hours after PCI, and in the event of the occurrence of symptoms or signs suggestive of myocardial ischemia. The LDL-C concentration was analyzed by selective solubilization method (low-density lipid cholesterol test kit, Kyowa Medex, Tokyo). The high-density lipoprotein cholesterol concentration was determined by a homogeneous method (Determiner L HDL, Kyowa Medex, Tokyo). cTnI was analyzed by an immunochemiluminometric assay (Access AccuTnI, Beckman Coulter, CA, USA). The upper limit of normal (ULN) was defined as the 99th percentile of normal population with a total imprecision of $<$10%. The ULN of this test was 0.04 ng/mL. The CK-MB activity was determined in venous blood samples before PCI by an immunoinhibition assay (creatine kinase-MB kit, Biosino, Beijing) with