Lowering the repeat unplanned revascularization rate after coronary stenting by focusing on the long-term stable control of low-density lipoprotein cholesterol

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Patients with coronary artery disease (CAD), after first percutaneous coronary intervention (PCI), often need repeat unplanned percutaneous revascularization due to plaque progression in culprit or non-culprit lesions, including target lesion revascularization (TLR), target vessel revascularization (TVR), and other vessel revascularization (OVR).[1] Low-density lipoprotein cholesterol (LDL-C) levels are controllable and its reduction is integral to reducing major adverse cardiac events after PCI. In this study, active lipid-lowering therapy was widely appreciated early after coronary stenting, showing an initial decline in levels of LDL-C, while its emphasis and recognition was attenuated over time with an increased risk of revascularization due to higher levels of LDL-C.

The study was conducted in accordance with the *Declaration of Helsinki* and was approved by the Ethics Committee of the Affiliated Hospital of Dalian Medical University. From January 2013 to January 2017, a total of 621 consecutive patients who survived successful PCI with stent implantation on initial admission to our institution, received a second coronary angiography examination due to "suspected/defined myocardial ischemia." Interval time was recorded between the first PCI and admission for suspected myocardial ischemia. To further explore LDL-C changes in unplanned revascularization following PCI, 111 patients, rehospitalized for any cause, including staged revascularization within 6 months after hospital discharge, were excluded. A total of 510 patients were selected, comprising 101 patients without *de novo* coronary artery lesions (control group) and 409 patients with repeat unplanned percutaneous revascularization (repeat PCI group). Of the patients with unplanned repeat procedures, 10% ($n = 41$) were treated for ST-elevation myocardial infarction and 90% ($n = 368$) for non-ST-segment elevation acute coronary syndromes. A total of 183 of these patients were treated with TLR and 272 with TVR/OVR, of whom 46 were treated with both.

For statistical analyses, we used SPSS 21.0 (SPSS Inc., Chicago, IL, USA). Continuous data were described by mean ± standard deviation and categorical data by median and interquartile range (25th to 75th percentile). We used *t* tests for comparisons between the two groups of continuous data and Chi-squared tests for comparisons of categorical data. Multivariate Cox regression analyses were performed and adjusted for all relevant clinical variables including the demographics, coronary risk factors, baseline factors, and procedural characteristics. We calculated risk ratios and 95% confidence intervals (CIs) and considered *P* values less than 0.05 to represent statistical significance.

Baseline characteristics including LDL-C levels were well balanced between the two groups, at the time of first PCI. Patients in the control group had shorter interval times when compared with patients with unplanned repeat PCI (2.0 ± 1.4 years *vs.* 4.1 ± 3.3 years, $P < 0.001$). Reduction of LDL-C goals in the control group led to an initial decrease from 108.04 ± 30.77 mg/dL to 87.93 ± 25.62 mg/dL. However, mean LDL-C in patients with unplanned repeat PCI decreased from 108.83 ± 30.05 mg/dL to 96.07 ± 29.10 mg/dL, indicating attenuation of LDL-C control over time. Readmitted patients who had unplanned PCI had higher LDL-C levels compared with controls ($P = 0.006$). The proportion of LDL-C ≥100 mg/dL with unplanned PCI was also higher (37.4% *vs.* 25.7%, $P = 0.02$). Patients who underwent TLR and TVR/OVR had similar LDL-C characteristics to patients who experienced unplanned PCI overall, compared with controls. After multivariable adjustment, LDL-C ≥100 mg/dL during readmission was an independent risk factor for all repeat unplanned PCI, as well as for TLR and TVR/OVR individually [Figure 1].

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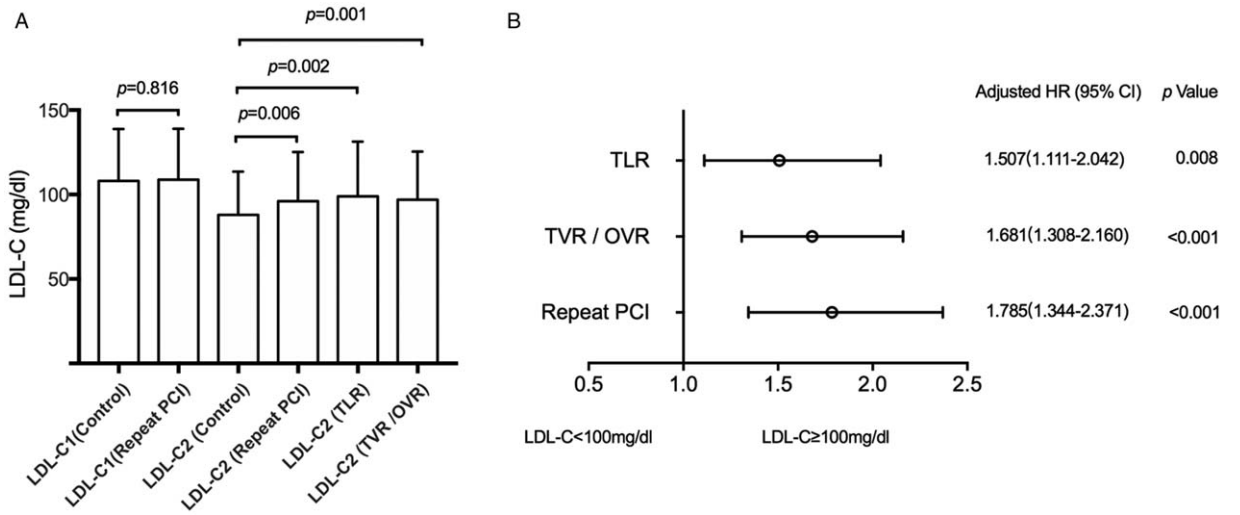

Figure 1: (A) Comparisons between control and repeat PCI groups for LDL-C levels. (B) The hazard ratios of LDL-C during readmission for repeat unplanned percutaneous revascularization. LDL-C1: Low-density lipoprotein cholesterol on initial admission; LDL-C2: Low-density lipoprotein cholesterol during readmission; TLR: Target lesion revascularization; TVR: Target vessel revascularization; OVR: Other vessel revascularization; PCI: Percutaneous coronary intervention; HR: Hazard ratios; CI: Confidence interval.

More than 20% of patients with CAD continue to demonstrate atheroma progression even after achieving very low LDL-C levels.[2] Current lipid-lowering guidelines still recommend LDL-C reduction as a principal target for primary and secondary prevention of cardiovascular disease, especially for patients who have had PCI. In clinical practice, active lipid-lowering therapy with statins is often a focus during the first year after PCI; however, its emphasis and recognition is often diluted over time,[3] with an increase in patients with PCI on low statin doses or without statin therapy observed. Going in hand, we observed the changes in type of statin over time. In our study, after multivariable adjustment, an LDL-C level ≥100 mg/dL during readmission was an independent risk factor for all repeat unplanned PCI as well as for TLR and TVR/OVR. The results further highlighted the importance of maintaining low lipid levels for a prolonged follow-up period in patients with CAD after PCI.

Several study limitations should be considered. This was a single-centered, analytical retrospective study. The samples were restricted to patients discharged from our hospital with successful follow-up and repeat angioplasty, which may have resulted in selection biases and conclusions with limited generalizability. The interval times in the repeat revascularization group and controls were different, which may have affected the final comparison and analyses. However, we chose interval time as a survival time variable in the multivariate Cox regression analyses to examine how related risk factors influenced interval time. The study excluded patients with repeat unplanned revascularization of coronary artery bypass grafting, which may have affected the final results. Finally, the study did not investigate the types of lipid-lowering drugs and other variables that may have influenced lesions and PCI procedures. This may have marginally affected our results.

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Conflicts of interest

None.

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