Clinical Outcomes of Acute Myocardial Infarction Arising from Non-lipid-rich Plaque determined by NIRS-IVUS

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Article

Keywords: Acute myocardial infarction, Clinical outcomes, Intravascular ultrasound, Lipid-rich plaque, Near-infrared spectroscopy.

Posted Date: November 28th, 2022

DOI: https://doi.org/10.21203/rs.3.rs-2295000/v1

Abstract

Aims. Pathological studies have suggested that acute myocardial infarction (AMI) can be caused by plaque erosion with small or no evidence of a lipid-core. This study sought to compare the clinical outcomes after percutaneous coronary intervention (PCI) between AMI showing maximum lipid-core burden index in 4 mm (maxLCBI4mm) <400 and ≥400 in the infarct-related lesions assessed by near-infrared spectroscopy-intravascular ultrasound (NIRS-IVUS).

Methods and results. We investigated 426 AMI patients who underwent NIRS-IVUS in the infarct-related lesions before PCI. Major adverse cardiovascular events (MACE) were defined as the composite of cardiac death, non-fatal MI, clinically driven target lesion revascularization (TLR), clinically driven non-TLR, and congestive heart failure requiring hospitalization. 107 (25%) patients had infarct-related lesions of maxLCBI4mm<400, and 319 (75%) patients had those of maxLCBI4mm≥400. The maxLCBI4mm<400 group had a younger median age at onset (68years [IQR: 57–78years] vs. 73years [IQR: 64–80years], P=0.007), less frequent multi-vessel disease (39% vs. 51%, P=0.029), less frequent TIMI flow grade 0 or 1 before PCI (62% vs. 75%, P=0.007), and less frequent no-reflow immediately after PCI (5% vs. 11%, P=0.039). During a median follow-up period of 31 months [IQR: 19–48 months], the frequency of MACE was significantly lower in the maxLCBI4mm<400 group compared with the maxLCBI4mm≥400 group (4.7% vs. 17.2%, P=0.001). MaxLCBI4mm<400 was an independent predictor of absence of MACE at multivariable analysis (hazard ratio: 0.30 [confidence interval: 0.11-0.82], P=0.018).

Conclusion. MaxLCBI4mm<400 measured by NIRS in the infract-related lesions before PCI was associated with better long-term clinical outcomes in AMI patients.

Condensed Abstract

The present study investigated clinical outcomes of acute myocardial infarction arising from a lipid-free or small lipid-containing plaque determined by near-infrared spectroscopy combined with intravascular ultrasound (NIRS-IVUS). The frequency of major adverse cardiovascular events (MACE) was significantly lower in the maximum lipid-core burden index in 4 mm (maxLCBI4mm) <400 group compared with the maxLCBI4mm≥400 group. MaxLCBI4mm<400 was an independent predictor of absence of MACE at multivariable analysis.

Introduction

Most acute myocardial infarctions (AMI) are caused by thrombotic occlusion of coronary atherosclerotic lesions. Atherosclerotic lesions have lipid deposits in the core region of the plaque. Previous autopsy studies have demonstrated that 50-70% of coronary thrombosis resulted from the rupture of a plaque with a large lipid-core (1). However, 20-40% of coronary thrombosis resulted from the erosion of a plaque with small or no evidence of a lipid-core (1). Compared with AMI arising from the lipid-rich plaque,

AMI arising from the non-lipid-rich plaque (defined as a lipid-free or small lipid-containing plaque) may have different clinical features and prognosis.

Developments of intravascular imaging have enabled detailed evaluation of infarct-related coronary lesions of AMI in the clinical setting. However, no technology can directly detect endothelial erosion of plaques. In addition, intracoronary thrombi can obscure underlying rupture sites thereby interfering with accurately excluding a plaque rupture. Recently, near-infrared spectroscopy (NIRS) combined with intravascular ultrasound (IVUS) has emerged as an imaging technique that can accurately identify lipids in the coronary artery wall even in the presence of thrombi (2). In NIRS, maximum lipid-core burden index in 4mm (maxLCBI4mm) <400 in the infarct-related lesions of AMI is significantly associated with plaque erosion rather than plaque rupture (3). The present study sought to compare the clinical outcomes after percutaneous coronary intervention (PCI) between AMI with maxLCBI4mm <400 and ≥400 in the infarct-related lesions assessed by NIRS.

Methods

Study population. This was a study based on a multicentre NIRS-IVUS registry for AMI patients. Between May 2016 and March 2021, 997 AMI patients underwent PCI for de novo native coronary artery lesions. NIRS-IVUS before PCI using a second-generation drug-eluting stent was performed in 461 patients (Supplementary table 1). Of these, 35 patients were excluded due to technical failure to deliver NIRS-IVUS catheter (n=20) and poor NIRS-IVUS images (n=15). Thus, 426 patients constituted the final study population. AMI was defined as a type 1 MI according to the universal definition (4). The infarct-related lesion was identified by the operator at the time of angiography on the basis of angiographic lesion morphology, such as total or subtotal occlusion, as well as electrocardiographic findings and echocardiographic results. This study was approved by the institutional review board at each participating centre. The requirement for written informed consent was waived because of the retrospective design of the study. All methods were carried out in accordance with relevant guidelines and regulations.

NIRS-IVUS imaging. NIRS-IVUS was performed before PCI at the operator's discretion using the TVC Imaging System (MC8 with a 40-MHz TVC Insight catheter [n=146] or MC10 with a 50-MHz Dualpro catheter [n=280], InfraReDx, Burlington, Massachusetts, USA). In case with TIMI (Thrombolysis in Myocardial Infarction) flow grade 0 or 1 (5), balloon angioplasty with a small balloon ≤2.0 mm in diameter (n=319 [75%]) and / or aspiration thrombectomy with a 5.1-F aspiration catheter (n=132 [31%]) was performed prior to the NIRS-IVUS imaging. The NIRS-IVUS catheter was advanced distally to the infarct-related lesion over a 0.014-inch conventional angioplasty guidewire. The NIRS-IVUS imaging core was retracted to the coronary ostia at a rate of 0.5 mm/s for the 40-MHz TVC Insight catheter or 2.0 mm/s for the 50-MHz Dualpro catheter using an automatic pullback device. Color-coded NIRS spectral

data co-registered with IVUS images were acquired during pullback and stored digitally for offline analysis.

NIRS-IVUS analysis. NIRS-IVUS analysis was performed using CAAS Intra Vascular (Pie Medical Imaging, Maastricht, the Netherlands) in an independent core laboratory (Wakayama Medical University, Wakayama, Japan), blinded to clinical information and angiography findings. In IVUS, presence of plaque rupture (defined by a cavity in the vessel wall with disruption of the intima), attenuated plaque (defined by a signal reduction behind hypoechoic plaque without calcium), and convex calcium (defined by an intraluminal protrusion >0.5mm in thickness, with a bright echo, convex shape, irregular surface, and acoustic shadowing) were evaluated (3). External elastic membrane (EEM), lumen, and plaque burden (defined as [EEM area - lumen area] / EEM area x 100) were measured on a cross-section at 1-mm longitudinal intervals (6). Minimum lumen area (MLA) was determined in the infarct-related lesion. Reference site was set at a cross-section adjacent to the infarct-related lesion that had the largest lumen and plaque burden of <50% (6). Lesion length was defined as a distance between the proximal and distal reference sites. Positive remodelling was defined by a remodelling index (calculated as EEM area at the MLA site / the average of the proximal and distal reference EEM area) >1.05 (6).

NIRS data were automatically displayed on a chemogram demonstrating the distribution of lipid within the coronary artery in a longitudinal view. In the chemogram, lipid content was quantified as the LCBI, defined as the fraction of valid pixels indicating lipid at the probability >0.6 within the scanned region multiplied by 1000. The maxLCBI4mm was defined as the maximum value of the LCBI for any 4mm region in the infarct-related lesion (2).

PCI. PCI was performed in a standard manner using a second-generation drug-eluting stent (Supplementary Table 2). During PCI, patients received intravenous heparin (a bolus of 100 IU/kg and additional doses aimed at achieving activated clotting time of 250–300 s). Thrombolysis was not performed for any patient. Glycoprotein IIb/IIIa inhibitors were not used because they were not approved in Japan. Dual antiplatelet therapy with aspirin and a thienopyridine (clopidogrel or prasugrel) was continued at least 6 months after PCI.

Angiography. Angiograms before and immediately after PCI were analysed using QAngio XA ver 7.1 (Medis, Leiden, the Netherlands) in an independent core laboratory (Wakayama Medical University, Wakayama, Japan), blinded to clinical information and NIRS-IVUS findings. Quantitative coronary angiography included the reference lumen diameter, minimum lumen diameter, percent diameter stenosis, and lesion length. Multivessel disease was defined as having angiographical stenoses with more than 50% diameter stenosis in two or three major epicardial coronary arteries. TIMI flow grade before PCI, no-reflow (defined as TIMI flow grade 0, 1 or 2) immediately after PCI and distal embolization (defined as a distal filling defect with an abrupt cut-off in the infarct-related artery) immediately after PCI were evaluated according to established definitions (5). Balloon-to-artery ratio was defined as maximum balloon diameter divided by reference lumen diameter.

Clinical outcomes. Clinical follow-up data of patients were collected from their medical records. The adjudication of major adverse cardiovascular events (MACE) was based on the discussions with three experienced cardiologists (Y.S, T.Ku, and S.F) who were blinded to the NIRS-IVUS results. MACE was defined as the composite of cardiac death (7), non-fatal MI (including culprit plaque [CP] -related MI and non-culprit plaque [NCP] -related MI) (4), clinically driven target lesion revascularization (TLR) (7), clinically driven non-TLR (7), or congestive heart failure (CHF) requiring hospitalization (8). TLR was defined as a repeat revascularization for the lesions treated with baseline PCI. Non-TLR was defined as a revascularization for non-infarct-related lesions that were identified in baseline coronary angiography. Scheduled revascularization for non-infarct-related lesions was not considered as an adverse event. TLR/non-TLR was considered to be clinically-driven if revascularization was performed on a patient who had a positive result on a functional ischemia study and ischemic symptoms such as chest pain (7).

Statistical analysis. Statistical analysis was performed by using JMP 13.0 (SAS Institute, Cary, North Carolina, USA). Categorical variables were presented as frequency and percentages, with comparison with chi-square statistics or the Fisher exact test (if the expected cell value was <5). Continuous variables were presented as median and interquartile range (IQR) and compared using the Mann-Whitney U test. The Kaplan-Meier method and log-rank test was used to compare the cumulative rate of MACE between the groups. Univariate Cox regression analysis was performed to evaluate for clinical, angiographic and NIRS-IVUS variables before PCI that were associated with MACE. The variables with P-values <0.1 in the univariate analysis and medications at discharge that may have affected the outcomes as covariates were then included in multivariable Cox regression analysis. Results were reported as hazard ratios (HRs) with 95% confidence intervals (CIs). A P-value <0.05 was considered statistically significant.

Results

Patient clinical characteristics. In NIRS before PCI, 107 (25%) patients had infarct-related lesions with maxLCBI4mm<400, and 319 (75%) patients had infarct-related lesions with maxLCBI4mm≥400. Patient clinical characteristics at baseline were not different between the maxLCBI4mm<400 group and the maxLCBI4mm≥400 group, except for age (68 years [IQR: 57–78 years] vs. 73 years [IQR: 64–80 years], P=0.007) (Table 1, and Supplementary Table 3 and 4).

Angiographic findings and procedural characteristics. Angiographic findings and procedural characteristics are shown in Table 2. The distribution of infarct-related coronary artery was not different between the two groups. Reference lumen diameter, minimum lumen diameter, and percent diameter stenosis before PCI were similar between the two groups. Lesion length was significantly shorter in the maxLCBI4mm<400 group compared with the maxLCBI4mm≥400 group (18mm [IQR: 15–25mm] vs. 23mm [IQR: 18–30mm], P<0.001). The frequency of TIMI flow grade 0 or 1 before PCI (62% vs. 75%, P=0.007) and multivessel disease (39% vs. 51%, P=0.029) was significantly lower in the maxLCBI4mm<400 group compared with the maxLCBI4mm≥400 group.

Stent diameter was not different between the two groups. Stent length was significantly shorter in the maxLCBI4mm<400 group compared with the maxLCBI4mm≥400 group (18mm [IQR: 16–24mm] vs. 24mm [IQR: 18–33mm], P<0.001). Maximum balloon diameter and balloon-to-artery ratio were similar between the two groups. Minimum lumen diameter and percent diameter stenosis immediately after PCI were not different between the two groups. The frequency of no-reflow was significantly lower in the maxLCBI4mm<400 group compared with the maxLCBI4mm≥400 group (5% vs. 11%, P=0.039). The frequency of distal embolization was similar between the two groups.

IVUS findings. IVUS findings before PCI are shown in Table 3. The frequency of plaque rupture (4% vs. 59%, P<0.001) and attenuated plaque (23% vs. 77%, P<0.001) was significantly lower in the maxLCBI4mm<400 group compared with the maxLCBI4mm≥400 group. The frequency of convex calcium was significantly higher in the maxLCBI4mm<400 group compared with the maxLCBI4mm≥400 group (14% vs. 6%, P=0.008). Lesion length was significantly shorter in the maxLCBI4mm<400 group compared with the maxLCBI4mm≥400 group (17mm [IQR: 14–22mm] vs. 22mm [IQR: 16–30mm], P<0.001). Reference EEM area was similar between the two groups. MLA was significantly larger in the maxLCBI4mm<400 group compared with the maxLCBI4mm≥400 group (2.5mm^2 [IQR: 2.1–3.2mm^2] vs. 2.2mm^2 [IQR: 1.9–2.6mm^2], P<0.001). At the MLA site, EEM area (15.4 [IQR: 11.9–19.0] vs. 16.5 [IQR: 13.2–19.7], P=0.039) and plaque burden (84% [IQR: 79–86%] vs. 87% [IQR: 83–89%], P<0.001) were significantly smaller in the maxLCBI4mm<400 group compared with the maxLCBI4mm≥400 group. The frequency of positive remodelling (23% vs. 71%, P<0.001) was significantly lower in the maxLCBI4mm<400 group compared with the maxLCBI4mm≥400 group.

Clinical outcomes. Clinical outcomes are shown in Table 4. Follow-up duration in the maxLCBI4mm<400 group and the maxLCBI4mm≥400 group was 35 months [IQR: 18–52 months] and 30 months [IQR: 19–46 months], respectively (P=0.222). The frequency of MACE was significantly lower in the maxLCBI4mm<400 group compared with the maxLCBI4mm≥400 group (4.7% vs. 17.2%, P=0.001) (Figure 1). The frequency of cardiac death (0% vs. 5.0%, P=0.018) and non-fatal MI (0% vs. 4.4%, P=0.028) was significantly lower in the maxLCBI4mm<400 group compared with the maxLCBI4mm≥400 group. The frequency of CP-related MI was not different between the two groups (0% vs. 1.3%, P=0.245). The frequency of NCP-related MI was numerically lower in the maxLCBI4mm<400 group compared with the maxLCBI4mm≥400 group, but the differences did not reach statistical significance. (0% vs. 3.1%, P=0.064). The frequency of TLR, non-TLR, and CHF requiring hospitalization was not different between the two groups.

Regarding the prediction of MACE, diabetes mellitus, prior MI, multivessel disease, maxLCBI4mm<400, attenuated plaque, IVUS-measured lesion length, and positive remodelling were variables with a p-value <0.10 in univariate Cox regression analysis (Supplementary Table 5). The multivariable analysis including these variables revealed that multivessel disease was an independent predictor of MACE (HR: 1.75, [CI: 1.01-3.02], P=0.045) and maxLCBI4mm<400 was an independent predictor of absence of MACE (HR: 0.30, [CI: 0.11-0.82], P=0.018) (Table 5).

Discussion

The major findings in the present NIRS-IVUS study were that the AMI patients with maxLCBI4mm<400 in infarct-related coronary lesions had a younger median age at onset, less frequent multi-vessel disease, less frequent TIMI flow grade 0 or 1 before PCI, less frequent no-reflow immediately after PCI, and better long-term clinical outcomes compared with those with maxLCBI4mm≥400. In addition, maxLCBI4mm<400 in infarct-related coronary lesions was an independent predictor of absence of MACE.

Infarct-related lesions with low LCBI. Most infarct-related lesions of AMI show high LCBI in NIRS.A previous NIRS study demonstrated that the infarct-related plaques had a median maxLCBI4mm of 523 (IQR: 445–821) and a threshold of maxLCBI4mm >400 distinguished infarct-related plaques from non-infarct-related plaques with a sensitivity of 85% and specificity of 98% (2).Infarct-related plaques with low maxLCBI4mm are likely to have different pathologies compared with those with high maxLCBI4mm.An autopsy study demonstrated that pathological intimal thickening without lipid-core is the basis of plaque erosion rather than plaque rupture (1). Our recent clinical study showed that maxLCBI4mm was significantly smaller in plaque erosion compared with plaque rupture and maxLCBI4mm <426 identified plaque erosion with sensitivity 92%, specificity 97% (3). Therefore, the maxLCBI4mm<400 group in the present study may consist mostly of plaque erosion.

Acute results of PCI. Acute results of PCI for a lipid-free or small lipid-containing plaques in AMI appears to be associated with better clinical outcomes than those for lipid-rich plaques.A NIRS-IVUS study showed that lower maxLCBI4mm in the infarct-related lesions was associated with smaller infarction size and less frequent coronary microvascular obstruction assessed by magnetic resonance imaging after PCI (9).An optical coherence tomography (OCT) study demonstrated that a lipid-free or small lipid-containing plaques without rupture had a lower frequency of no-reflow phenomenon during PCI than lipid-rich plaques with rupture (10). These favourable acute results of PCI for a lipid-free or small lipid-containing plaques in AMI might have a positive effect on long-term outcomes.

Long-term clinical outcomes. Pathohistological characteristics of infarct-related lesions are associated with long-term clinical outcomes in AMI patients treated with PCI.Previous OCT studies have demonstrated that AMI arising from a lipid-free or small lipid-containing plaque with intact fibrous cap (i.e. OCT-derived plaque erosion) had a lower frequency of MACE (including death, MI, revascularization, and CHF during a follow-up period of >1 year compared with AMI arising from lipid-rich plaque with disrupted fibrous-cap (11, 12). In line with these OCT studies, the present NIRS-IVUS study showed that low maxLCBI4mm in the infarct-related plaques was associated with better long-term clinical outcomes in AMI patients.Compared with OCT, NIRS-IVUS is more practical in clinical use because this technique does not require intracoronary contrast injection for imaging and can automatically and accurately measure lipid content in the infarct-related plaques with abundant thrombi. NIRS-IVUS will help risk stratification and management of AMI patients in daily clinical practice. Our results suggest that the patients with maxLCBI4mm ≥400 in the infarct-related plaques might require stricter clinical follow-up and aggressive treatment of coronary risk factors to prevent future MACE.

Limitations. There are several limitations that should be acknowledged. First, NIRS-IVUS was performed at the operator's discretion, which might have led to selection bias. Second, there are limits to diagnosing plaque erosion using only LCBI in NIRS. Plaques with maxLCBI4mm <400 are not necessarily plaque erosion. Third, the present study did not use OCT. OCT allows accurate assessment of the morphological characteristics of the lesion responsible for the AMI. The combined imaging of OCT and NIRS will be a promising technique for identifying plaque erosion. Fourth, coronary computed tomography angiography (CCTA) might also allow the identification of plaque erosion. A previous study using OCT and CCTA in acute coronary syndrome demonstrated that OCT-derived plaque erosion had a lower frequency of CCTA-derived low attenuation plaque (i.e., CCTA-derived lipid-rich plaque) associated with future coronary events (13). Fifth, there were no data on NIRS-IVUS immediately after PCI. Therefore, the present study was unable to evaluate the clinical significance of changes in maxLCBI4mm during PCI. Sixth, there were no data on NIRS-IVUS in the non-infarct-related vessel. The presence or absence of lipid-rich plaque in non-infarct-related vessels might affect the prognosis of the patient.Finally, different types of stents were used in the present study. However, all were current generation drug-eluting stents, 80% of which were everolimus-eluting stent, and there were no statistical differences in stent type between the two groups.

Conclusions

MaxLCBI4mm<400 measured by NIRS in the infract-related lesions before PCI was associated with better long-term clinical outcomes in AMI patients.

Clinical Perspectives

Competency in medical knowledge:

MaxLCBI4mm<400 measured by NIRS in the infract-related lesions before PCI was associated with better long-term clinical outcomes in AMI patients.

Translational outlook:

NIRS might be useful in the risk stratification of AMI patients undergoing PPCI, because MaxLCBI4mm<400 measured by NIRS in the infract-related lesions before PCI is associated with better long-term clinical outcomes in AMI patients.

Abbreviations

AMI: acute myocardial infarction

CHF: congestive heart failure

EEM: external elastic membrane

IVUS: intravascular ultrasound

LCBI: lipid core burden index

MaxLCBI4mm: maximum lipid core burden index in 4mm

MLA: minimum lumen area

NIRS: near-infrared spectroscopy

PCI: percutaneous coronary intervention

TLR: target lesion revascularization

Declarations

Funding: This work was partially supported by JSPS KAKENHI Grant Number JP17K01417.

Conflicts of interest: Dr. Madder has received speaker honoraria and research support from Infraredx and serves on the advisory board of SpectraWave. All other authors have no relationships relevant to the contents of this paper to disclose.

Author contributions: KT performed data analysis and wrote the first draft of the manuscript. MT, NW, and TKa collected clinical data and images. AK and YI performed image analysis. TKu, YS, and SF adjudicated the adverse cardiovascular events. RM reviewed and revised the manuscript. All authors approved the final manuscript.

Acknowledgement: none

Data availability:

All data generated or analyzed during this study are included in this published article and its supplementary file.

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Tables

Table 1. Patient clinical characteristics

	MaxLCBI4mm < 400 (n=107)	MaxLCBI4mm ≥ 400 (n=319)	P-value
Age, y	68 (57-78)	73 (64-80)	0.007
Male sex	83 (78)	243 (76)	0.768
Hypertension	81 (76)	224 (70)	0.277
Diabetes mellitus	38 (36)	119 (37)	0.740
Dyslipidaemia	39 (36)	116 (36)	0.987
Current smoking	32 (30)	105 (33)	0.564
Prior MI	6 (6)	21 (7)	0.720
Clinical presentation			
STEMI	79 (74)	232 (73)	0.824
NSTEMI	28 (26)	87 (27)	
Clinical test data			
Peak CK-MB, IU/L	135 (33-277)	163 (52-337)	0.094
LVEF, %	48 (42-53)	45 (40-53)	0.212
Medications at discharge			
Aspirin	105 (98)	308 (97)	0.412
Thienopyridine	107 (100)	315 (99)	0.245
ACEI or ARB	96 (90)	280 (88)	0.589
β-blocker	78 (73)	237 (74)	0.776
Statin	103 (96)	303 (95)	0.589
Insulin	6 (6)	13 (4)	0.515

Values are presented as median (interquartile range) or number (%). ACEI: angiotensin converting enzyme inhibitor, ARB: angiotensin II receptor blocker, CK-MB: creatine kinase myocardial band, LVEF: Left ventricular ejection fraction measured by transthoracic echocardiography on the date of discharge, LCBI: lipid core burden index, NSTEMI: non-ST-segment elevation myocardial infarction, STEMI: ST-segment elevation myocardial infarction.

Table 2. Angiographic findings and procedural characteristics

	MaxLCBI4mm < 400 (n=107)	MaxLCBI4mm ≥ 400 (n=319)	P-value
Angiography before PCI			
LAD / LCX / RCA	53 / 14 / 40	163 / 49 / 107	0.718
Reference lumen diameter, mm	3.20 (2.85-3.63)	3.15 (2.79-3.50)	0.219
Minimal lumen diameter, mm	0 (0.09-0.30)	0 (0-0.20)	0.116
Percent diameter stenosis, %	99 (92-100)	100 (94-100)	0.062
Lesion length, mm	18 (15-25)	23 (18-30)	<0.001
TIMI flow grade 0/1/2/3, %	55 (51) / 11 (10) / 23 (21) / 18 (17)	181 (57) / 59 (18) / 54 (17) / 25 (8)	0.012
Multivessel disease	42 (39)	164 (51)	0.029
Procedures			
Stent diameter, mm	3.50 (3.00-3.50)	3.25 (2.75-3.50)	0.100
Stent length, mm	18 (16-24)	24 (18-33)	<0.001
Max. balloon diameter, mm	3.50 (3.00-3.50)	3.25 (2.75-3.50)	0.076
Balloon-to-artery ratio	1.00 (0.96-1.07)	1.00 (0.94-1.06)	0.510
Angiography immediately after PCI			
Reference lumen diameter, mm	3.30 (3.00-3.72)	3.25 (3.00-3.50)	0.085
Minimal lumen diameter, mm	3.13 (2.78-3.45)	3.05 (2.75-3.40)	0.149
Percent diameter stenosis, %	5 (3-7)	4 (3-8)	0.723
No-reflow	5 (5)	35 (11)	0.039
Distal embolization	4 (4)	16 (5)	0.590

Values are presented as median (interquartile range) or number (%). LAD: left anterior descending artery, LCX: left circumflex artery, PCI: percutaneous coronary intervention, RCA: right coronary artery, TIMI:

thrombolysis in myocardial infarction trial, other abbreviations as in Table 1.

Table 3. IVUS findings before PCI

	MaxLCBI4mm < 400 (n=107)	MaxLCBI4mm ≥ 400 (n=319)	P-value
Plaque rupture, %	4 (4)	188 (59)	<0.001
Attenuated plaque, %	25 (23)	245 (77)	<0.001
Convex calcium, %	15 (14)	19 (6)	0.008
Lesion length, mm	17 (14-22)	22 (16-30)	<0.001
Reference EEM area, mm^2	15.8 (12.8-18.3)	14.4 (11.8-18.0)	0.072
MLA, mm^2	2.5 (2.1-3.2)	2.2 (1.9-2.6)	<0.001
EEM area at MLA site, mm^2	15.4 (11.9-19.0)	16.5 (13.2-19.7)	0.039
Plaque burden at MLA site, %	84 (79-86)	87 (83-89)	<0.001
Positive remodelling, %	25 (23)	228 (71)	<0.001

Values are presented as median (interquartile range) or number (%). EEM: external elastic membrane, MLA: minimum lumen area, other abbreviations as in Table 1.

Table 4. MACE

	MaxLCBI4mm < 400 (n=107)	MaxLCBI4mm ≥ 400 (n=319)	P-value
MACE, %	5 (4.7)	55 (17.2)	0.001
Cardiac death	0 (0)	16 (5.0)	0.018
Non-fatal MI, %	0 (0)	14 (4.4)	0.028
CP-related MI, %	0 (0)	4 (1.3)	0.245
NCP-related MI, %	0 (0)	10 (3.1)	0.064
TLR, %	1 (0.9)	2 (0.6)	0.742
Non-TLR, %	1 (0.9)	8 (2.5)	0.327
CHF, %	3 (2.8)	15 (4.7)	0.398

Values are presented as number (%). CHF: congestive heart failure requiring hospitalization, CP: culprit plaque, MACE: major adverse cardiovascular event, NCP: non-culprit plaque, TLR: target lesion revascularization, other abbreviations as in Table 1.

Table 5. Multivariable Cox regression analysis for MACE

	HR	95% CI	P-value
Diabetes mellitus	1.33	0.79-2.24	0.285
Prior MI	1.85	0.83-4.14	0.133
Multivessel disease	1.75	1.01-3.02	0.045
MaxLCBI4mm <400	0.30	0.11-0.82	0.018
Attenuated plaque	1.11	0.58-2.13	0.747
IVUS-lesion length	1.02	1.00-1.05	0.079
Positive remodelling	1.03	0.58-1.84	0.927

CI: confidence interval, HR: hazard ratio. Other abbreviations as in Table 1.

Figures

Figure 1.

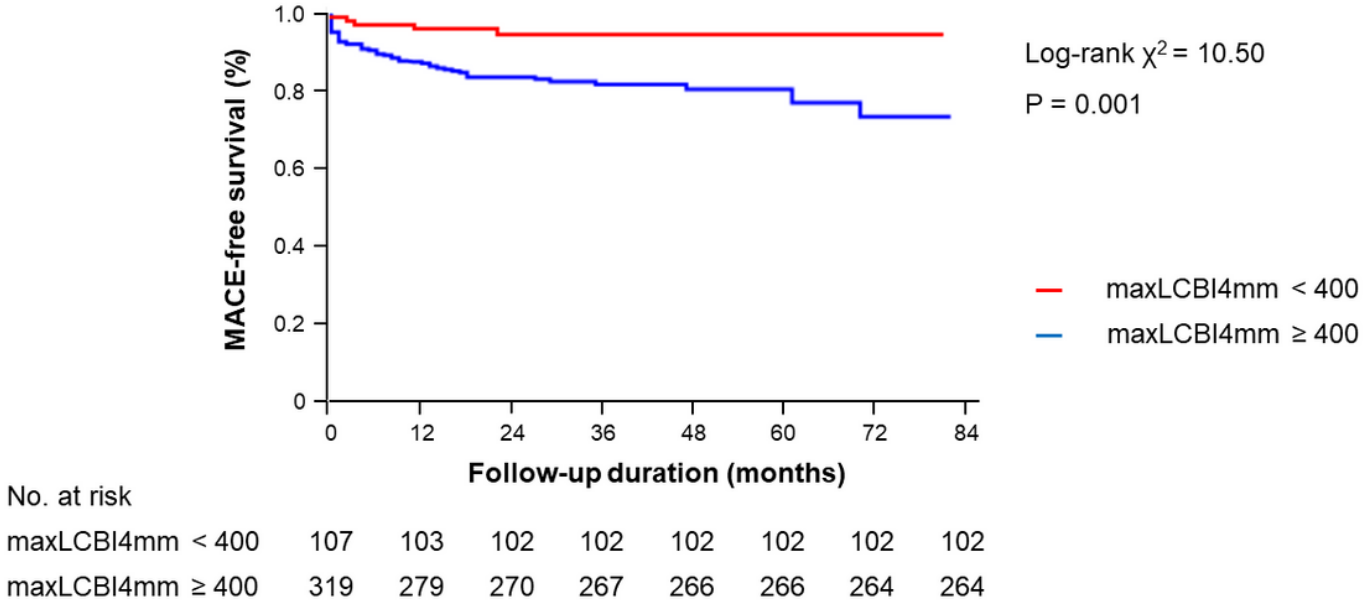

Figure 1

Kaplan-Meier curves of MACE-free survival.

MACE-free survival was significantly better in the maxLCBI4mm<400 group (red line) compared with the maxLCBI4mm≥400 group (blue line) (P=0.001). MACE: major adverse cardiovascular events.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Supplementaryappendix.docx