

Prognosis of “Yellow” Plaque in NIRS

Akiko Maehara, MD

*Cardiovascular Research Foundation
Columbia University Medical Center*

Disclosure Statement of Financial Interest

Within the past 12 months, I or my spouse/partner have had a financial interest/arrangement or affiliation with the organization(s) listed below.

Affiliation/Financial Relationship

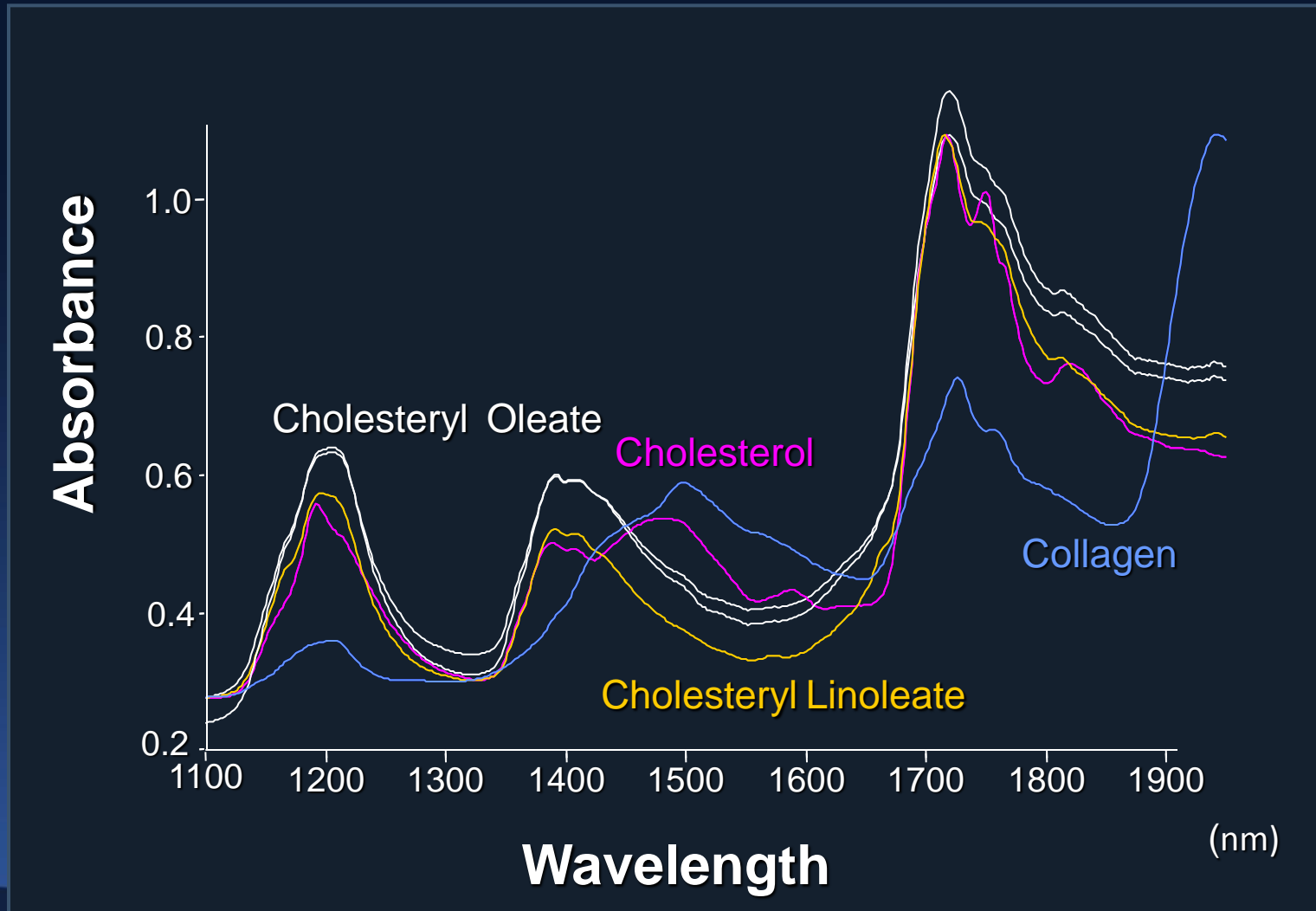
- Grant/Research Support
- Consulting Fees/Honoraria

Company

- Boston Scientific, Abbott Vascular
- Boston Scientific, OCT Medical Imaging Inc.

NIR Spectroscopy

- Necrotic Core $>0.2\text{mm}$ thick, $>60^\circ$, Cap $<0.45\text{mm}$

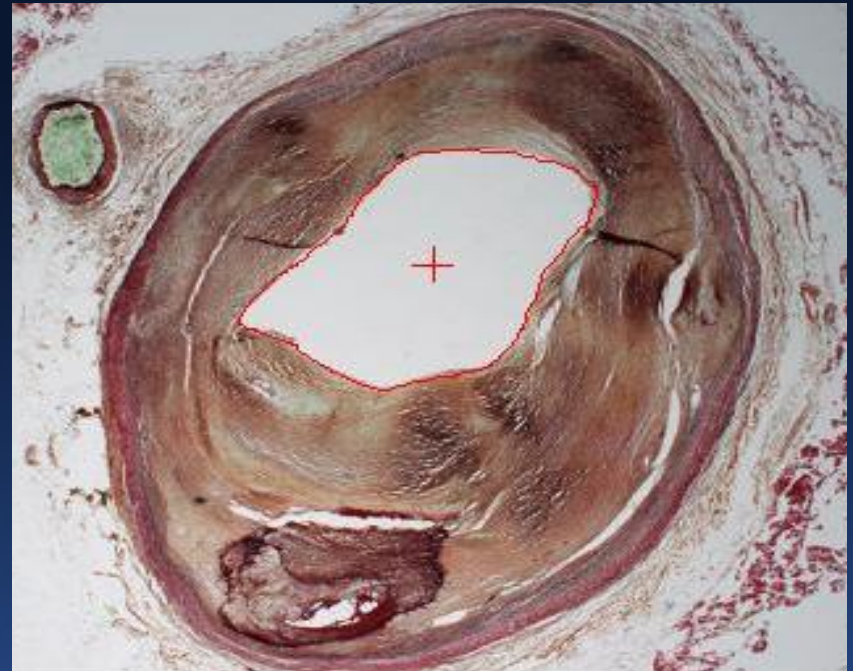


NIRS Can Differentiate Lesions with Large Plaque Burden + Large Lipid Core

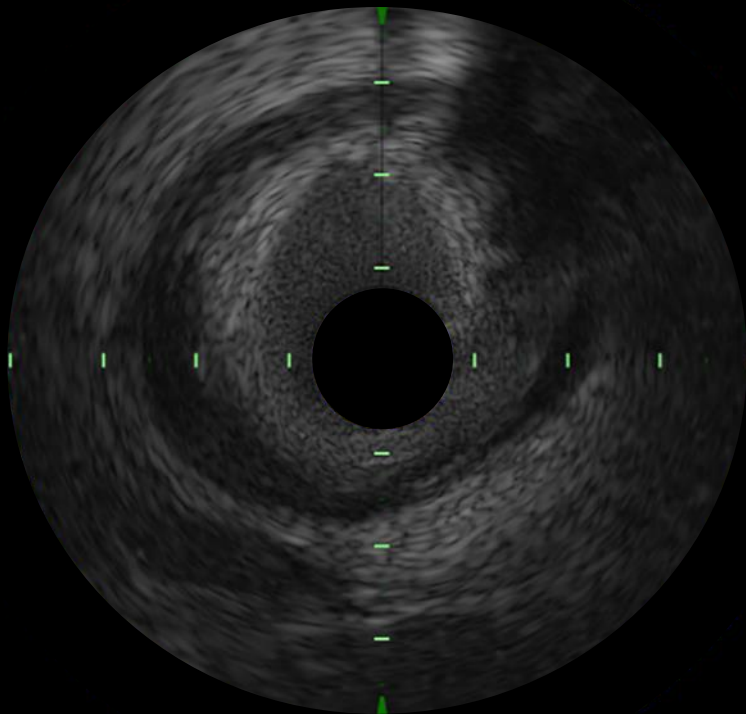
Large Plaque Burden +
Large Lipid Core



Large Plaque Burden +
No Lipid Core

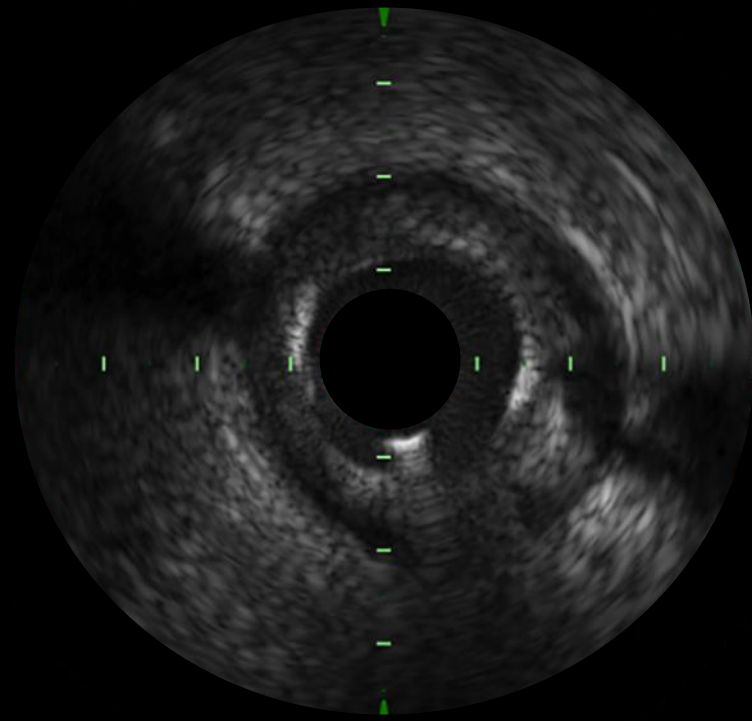


Not all Lesions with Large Plaque Burden Contain Substantial Lipid



Plaque Burden = 71%

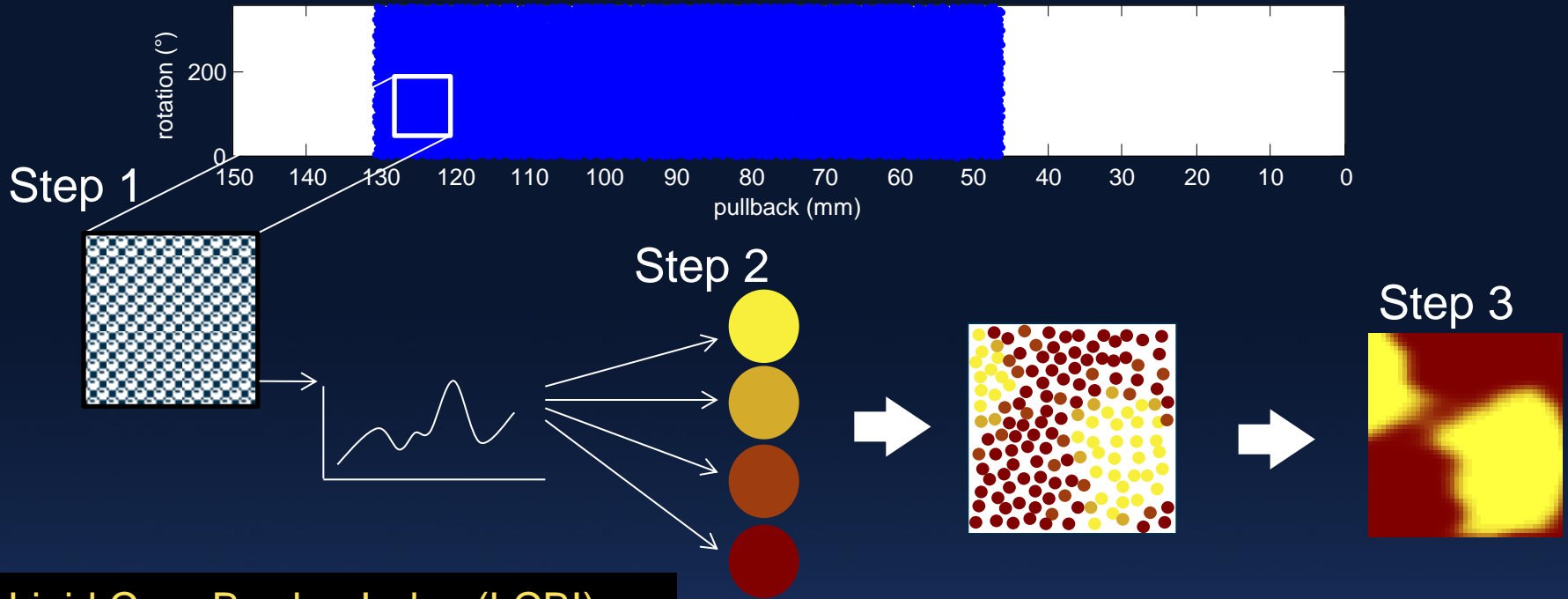
MaxLCBI_{4mm} = 694



Plaque Burden = 72%

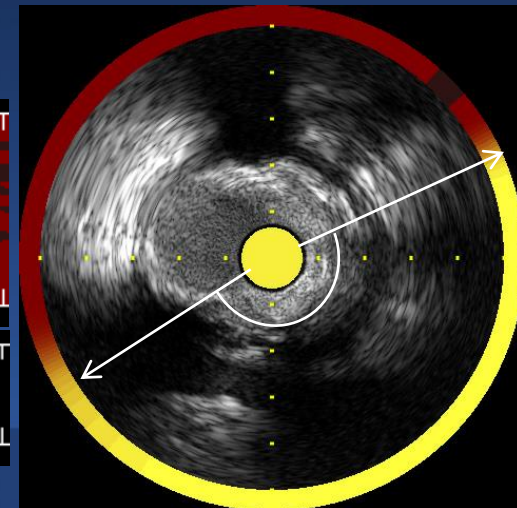
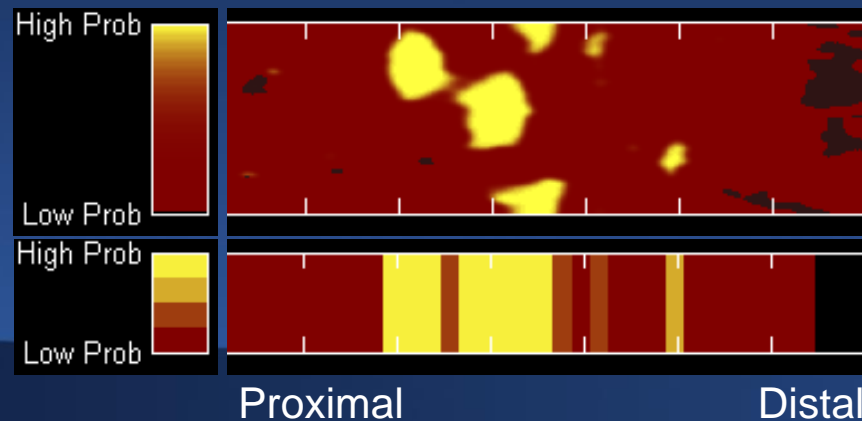
MaxLCBI_{4mm} = 22

Near Infrared Spectroscopy

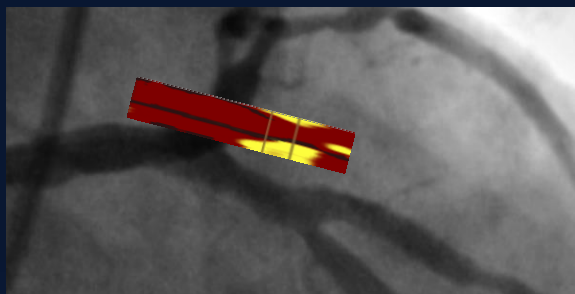


Lipid Core Burden Index (LCBI)
= Yellow pixel / All variable pixel
× 1000

Lesion
LCBI Max_{4mm}



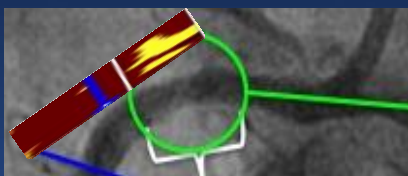
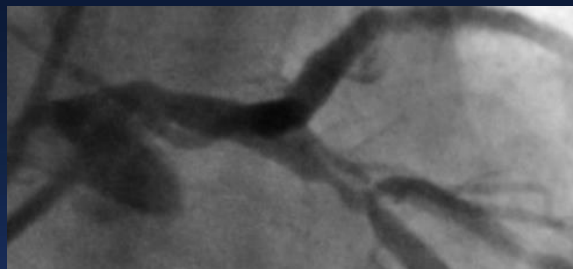
NIRS Cases with Rapid Lesion Progression and MACE, with a Pre- or Post-event Chemogram



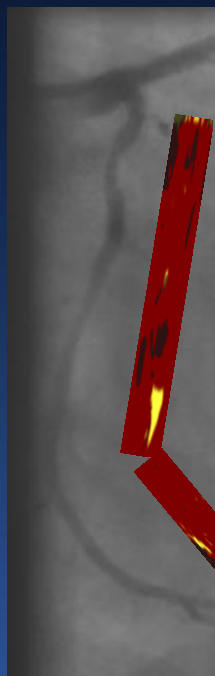
↓ c/o D. Erlinge



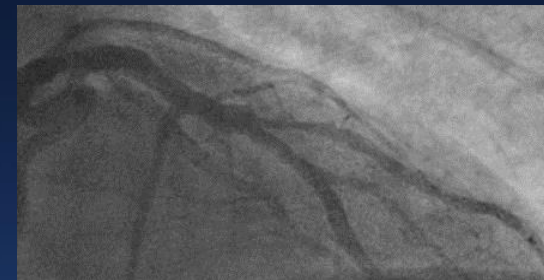
c/o D. Rizik



↓ c/o R. Madder



c/o K. Petersen

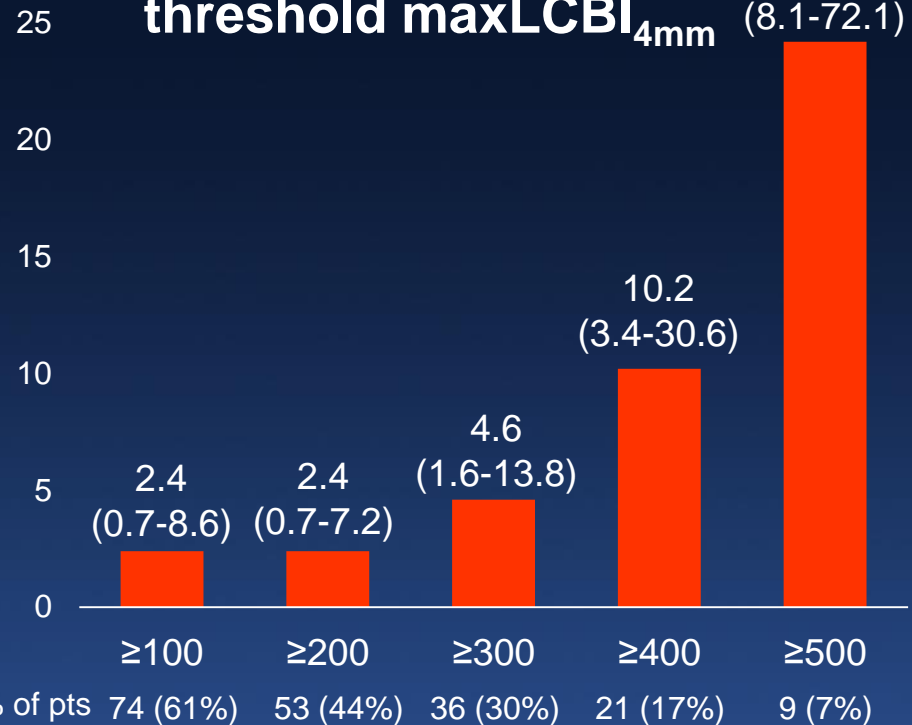
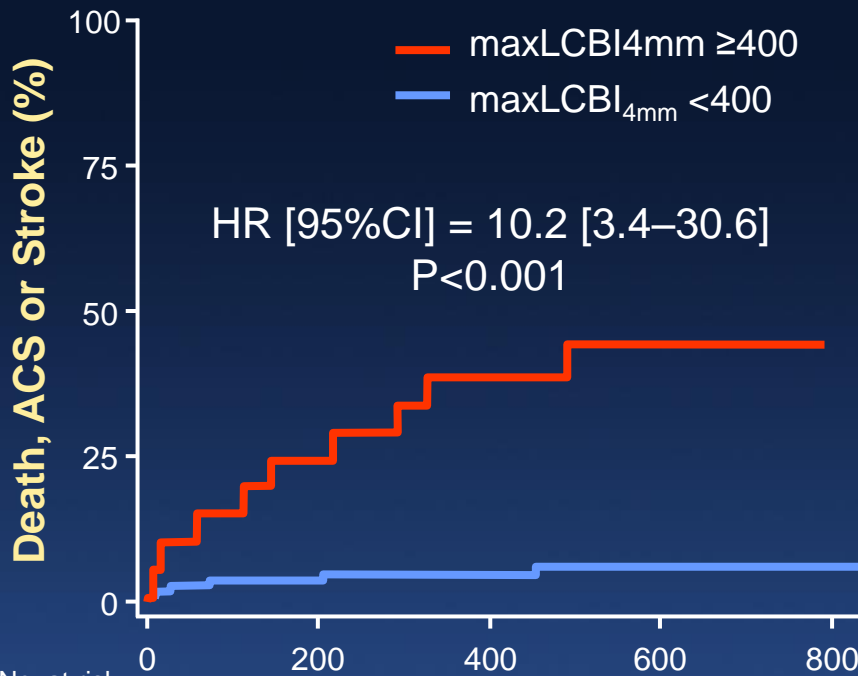


c/o J. Goldstein and S. Dixon

Relationship between Lipid Rich Plaque detected by NIRS and Outcomes

- Non-target segment in culprit vessel in 121 patients, >1 year follow-up
- 14 MACCE: 5 all-cause mortality, 8 non-fatal ACS, 1 acute cerebrovascular events

Hazard ratios for various threshold maxLCBI_{4mm}

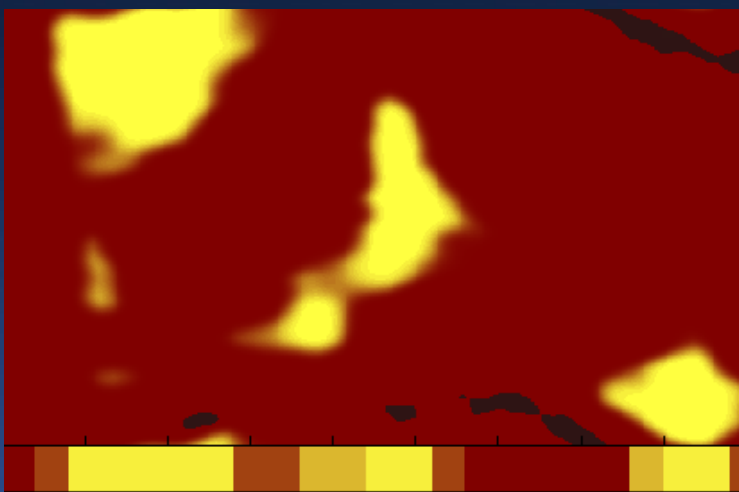


No. at risk:	0	200	400	600	800
maxLCBI _{4mm} ≥400	21	16	12	5	0
maxLCBI _{4mm} <400	100	97	87	47	13

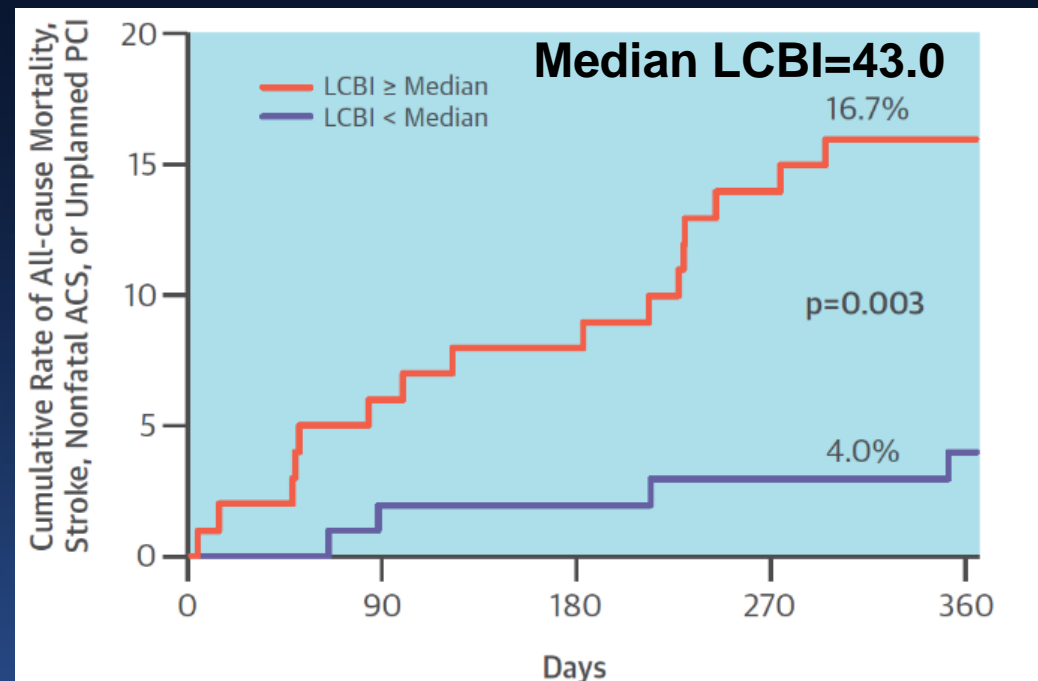
Neither plaque burden ≥70% by IVUS (HR 1.30 [0.41-4.16], P=0.65) nor MLA ≤4.0 mm² (HR 0.80 [0.28-2.38], P=0.69) was significantly associated with MACCE

Relationship between Lipidic Plaque detected by NIRS and Outcomes

- Prospective Single Center Study, 206 patients (ACS47%)
- Primary Endpoint: Composite of all-cause mortality, non-fatal ACS, stroke and unplanned PCI during one-year FU
- >40mm non culprit segment of NIRS



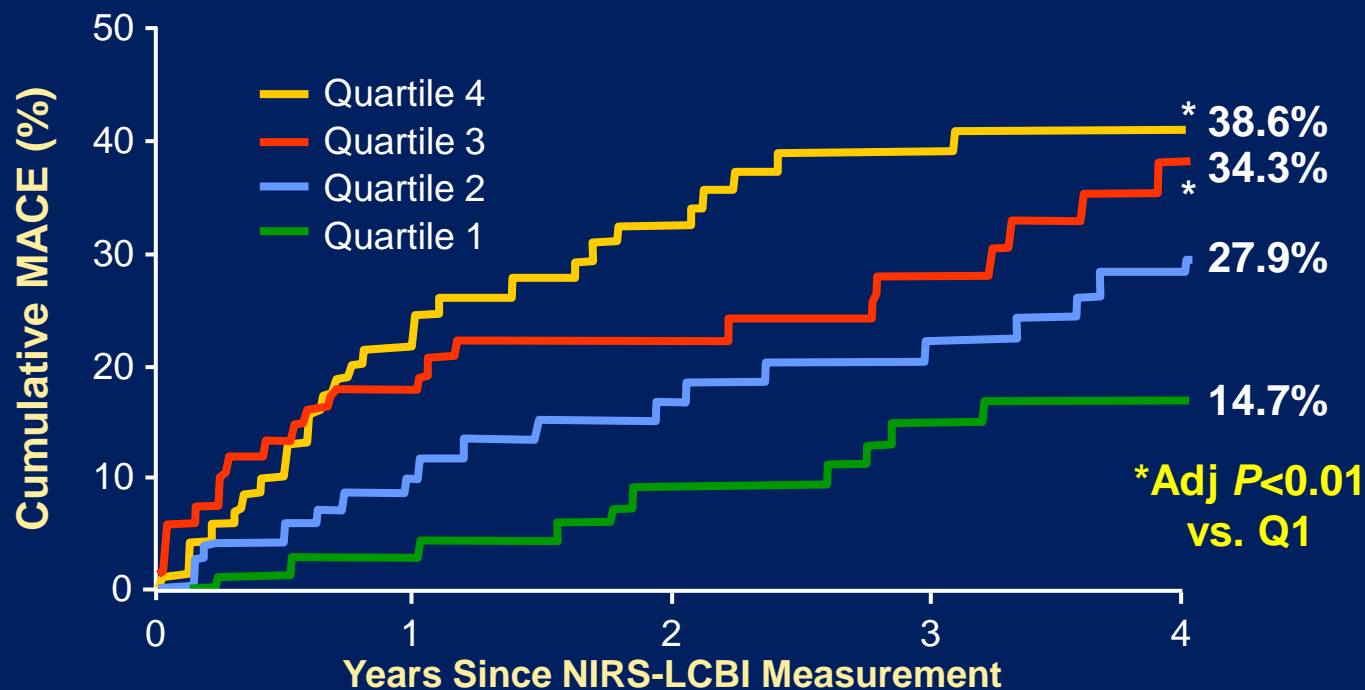
Primary Endpoint: Adjusted Hazard Ratio = 4.0 (1.3-12.3), $p=0.01$



Oemrawsingh RM et al, *JACC* 2015

Predictive Value of NIRS: ATHEROMO-NIRS (n=203) and and IBS 3 (n=131)

- Total 286 patients, 43% ACS at Index, median FU=4.2 yrs
- Primary endpoint: All cause death, non-fatal ACS, or unplanned revascularization
- Image in non-culprit segment, median imaged length= 56.4 mm



No. at risk:

MaxLCBI _{4mm} Quartile	0	1	2	3	4
MaxLCBI _{4mm} Q1 (<83.0)	68	66	52	43	29
MaxLCBI _{4mm} Q2 (≥83.0-227.0)	68	61	47	40	31
MaxLCBI _{4mm} Q3 (≥227.0-360.0)	67	55	42	35	22
MaxLCBI _{4mm} Q4 (≥360.0)	70	53	41	30	25

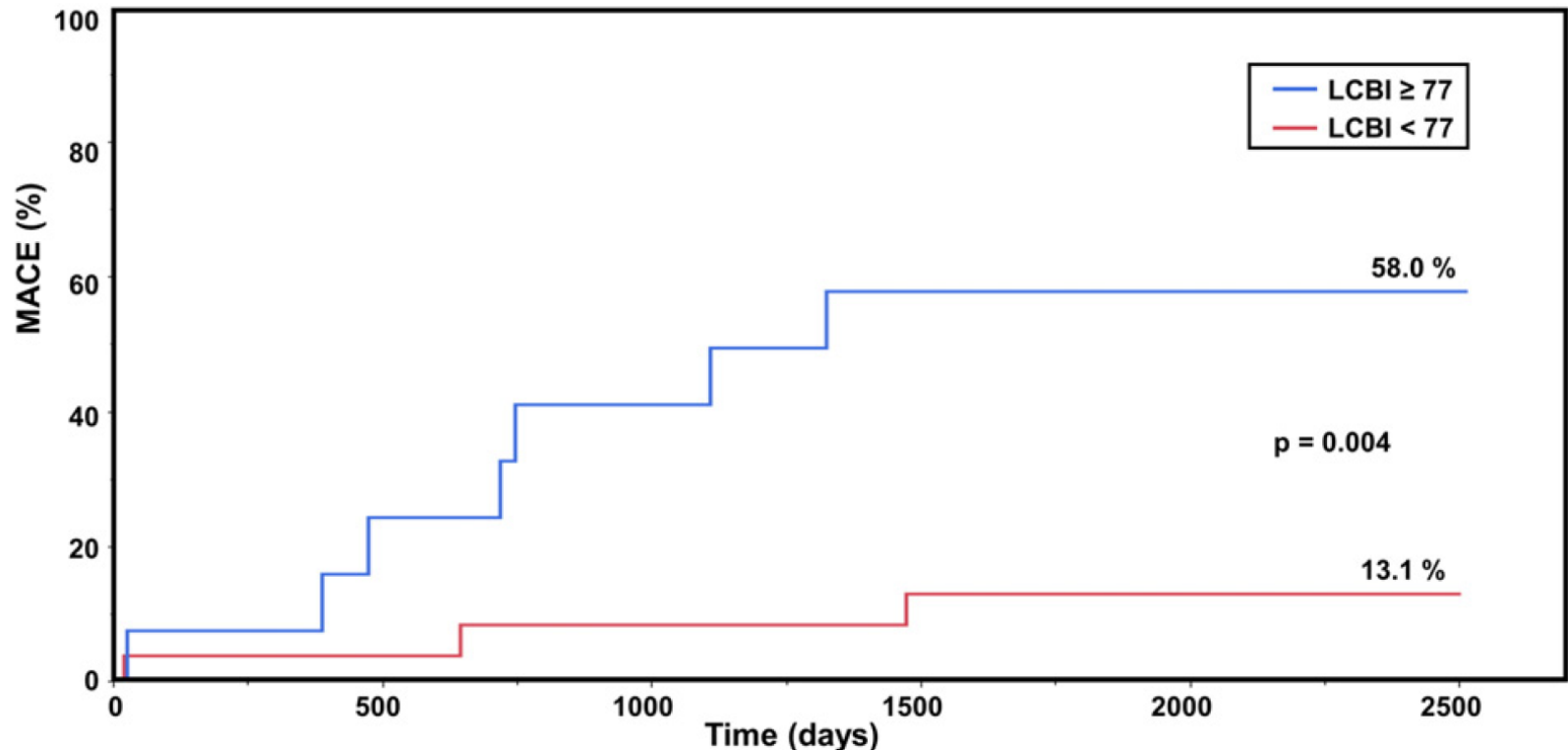
LCBI and Risk of Composite of Cardiac Death, Non-Fatal ACS, and Revascularization at 4 years

Tested Variable	Adjusted HR (95%CI)	P-value
All MACE		
MaxLCBI _{4mm}	1.21 (1.08, 1.35)	0.001
MaxLCBI _{10mm}	1.20 (1.05, 1.37)	0.007
Lesion LCBI	1.29 (0.98, 1.70)	0.06
MACE without TLR events		
MaxLCBI _{4mm}	1.24 (1.10, 1.39)	<0.001
MaxLCBI _{10mm}	1.25 (1.09, 1.44)	0.002
Lesion LCBI	1.38 (1.04, 1.83)	0.03

Adjusted for: Age, sex, ACS vs. stable CAD, diabetes, history of stroke, history of PVD, and IVUS-derived segmental plaque burden

ORACLE-NIRS Registry

- Total 239 patients, 39% ACS at Index, median FU=5.3 (1.8, 6.4) yrs
- Primary endpoint: Cardiac death, ACS, unplanned revascularization, or stroke
- Image in pre/post target vessel and non-target vessel



Number at risk

LCBI ≥ 77	13	9	8	6	5	1
LCBI < 77	26	23	21	20	17	1

LCBI and Risk of Composite of Cardiac Death, ACS, Revascularization, and Stroke

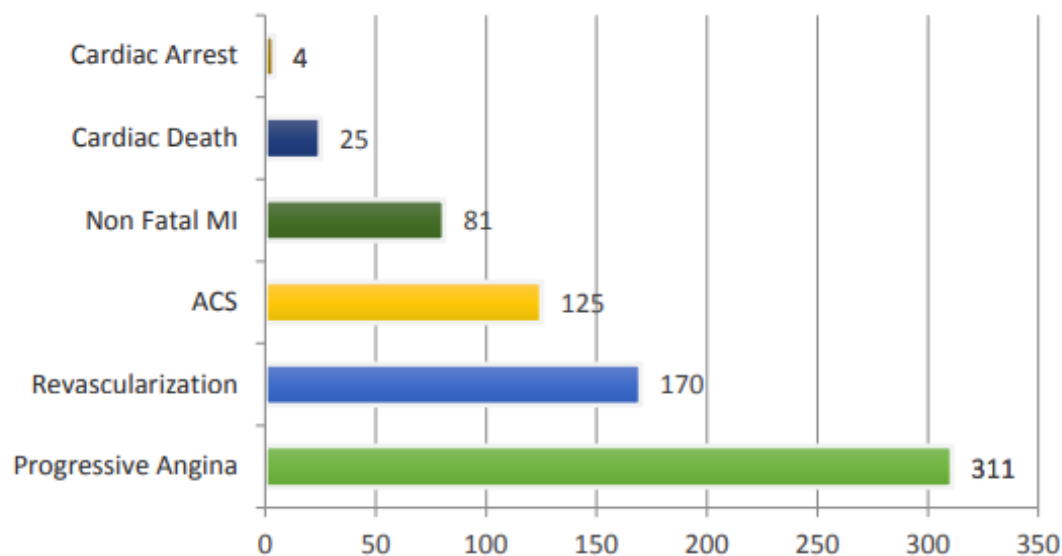
Tested Variable	HR (95%CI)	P-value
Univariate Cox Model		
Pre-stent target vessel LCBI	1.00 (1.0, 1.0)	0.69
Post-stent target vessel LCBI	0.98 (0.99, 1.0)	0.47
Non-target vessel LCBI	1.01 (1.0, 1.02)	0.083
Multivariable Cox Model		
Non-target vessel LCBI	1.03 (1.01, 1.07)	0.007
DM	12.5 (2.0, 112.7)	0.006
Prior MI	11.6 (1.9, 103.0)	0.007
Index PCI	20.0 (2.5, 261)	0.004

Cut off of Non-target vessel LCBI=77, Adjusted HR for MACE=14.1 (2.5, 133.5), p=0.002, Adjusted HR for MACE without target vessel related events= 10.7 (1.7, 204.2), p=0.007.

LRP Study - 1562 patients with 2Y FU - Planned to report study results in Fall 2018

LRP Events Distribution

Accumulation of MACE Events



PROSPECT II Study PROSPECT ABSORB RCT

900 pts with ACS after su

3 vessel IVUS + N

≥1 IVUS lesion

ment?

**Enrollment closed in
Dec 2017 with 901 patients!
Follow-up is ongoing**

**GDMT
alone**

Routine an... IVUS-NIRS FU at 2 years

Clinical FU for 15+ years

COLOR Registry

Patients with Clinical Indication for Coronary Angiography and Possible Revascularization

N=1899

NIRS only n=705
NIRS/IVUS n=1194

Excluded:
No NIRS or poor quality n=185
Planned CABG n=7

Pre-PCI Culprit NIRS
(1265 lesions in 1168 pts)

Non-culprit NIRS
(1072 lesions in 927 pts)

Median Follow-up 731d (IQR 711, 746)

Primary Endpoint

MACE (cardiac death, myocardial infarction, stent thrombosis, revascularization, hospitalization)



COLOR Registry

Patients with Clinical Indication for Coronary Angiogram and Possible Revascularization

N=1899

**Pre-PCI Culprit NIRS
(1265 lesions in 1168 pts)**

Median Follow-up 731d (IQR 711, 746)

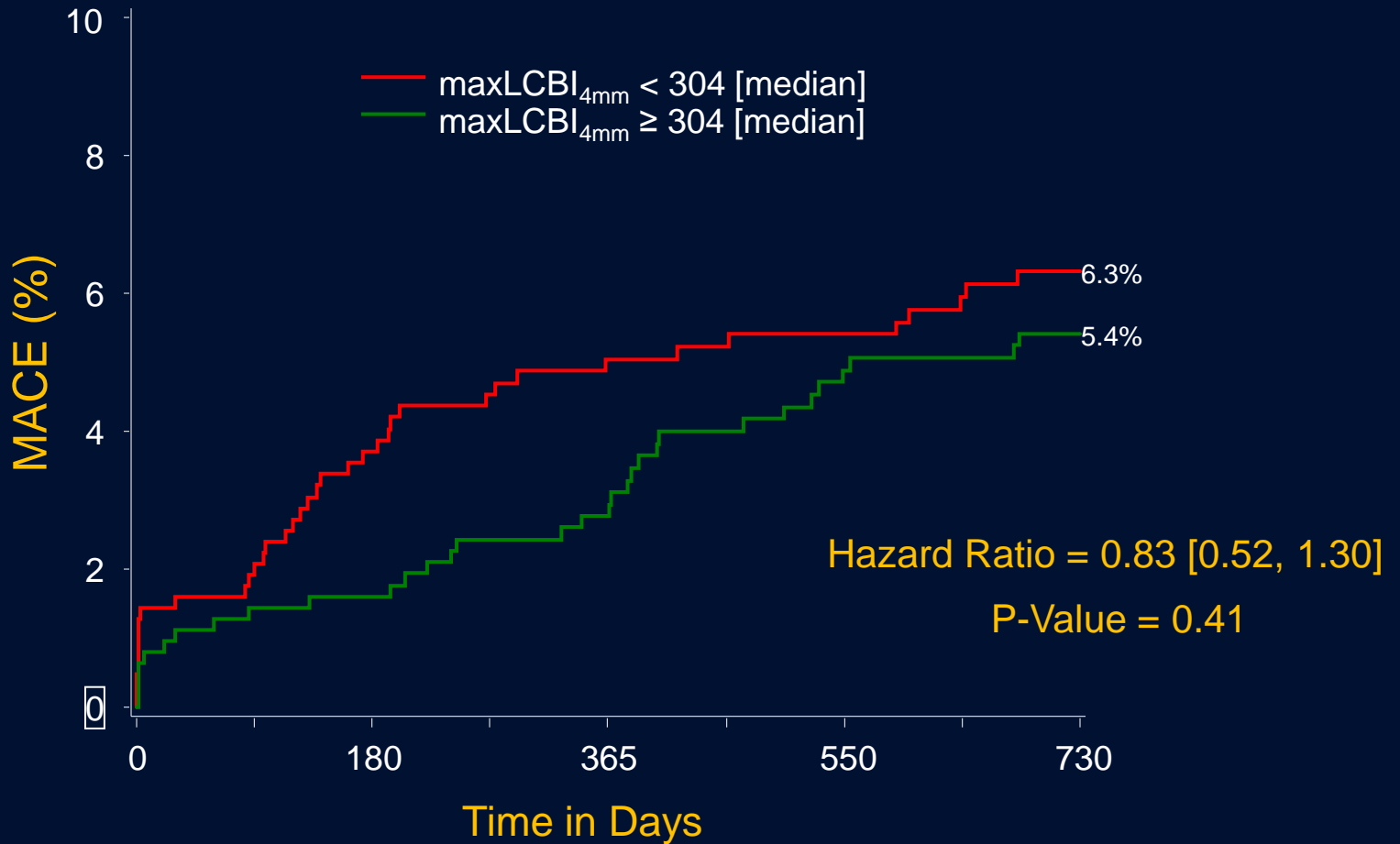
Primary Endpoint: Culprit PCI segment imaged by NIRS

MACE (cardiac death, myocardial infarction, stent thrombosis, revascularization, hospitalization)

PCI Patient Characteristics

	Event	No-event	p-value
Age, years	61.4±7.9	63.9±10.6	<0.01
Female	19.5%	23.2%	0.45
Hypertension	94.8%	90.2%	0.18
Diabetes Mellitus	48.1%	38.7%	0.10
- IDDM	9.1%	6.1%	0.32
- NIDDM	39.0%	32.6%	0.25
Dyslipidemia	96.1%	91.5%	0.16
Current Smoking	34.7%	21.4%	<0.01
PVD	16.9%	9.0%	0.02
Family history	63.6%	54.1%	0.10
Prior MI	32.5%	29.5%	0.58
Prior PCI	59.7%	53.4%	0.28
Prior CABG	18.2%	9.2%	0.01
Laboratory data			
Total cholesterol	155.4±42.0	153.0±44.1	0.67
LDL	86.8±38.0	85.6±36.7	0.81
HDL	38.3±12.4	39.6±11.6	0.45
TG	157.8±104.9	143.0±111.5	0.30

Culprit lesion related MACE by maxLCBI_{4mm}



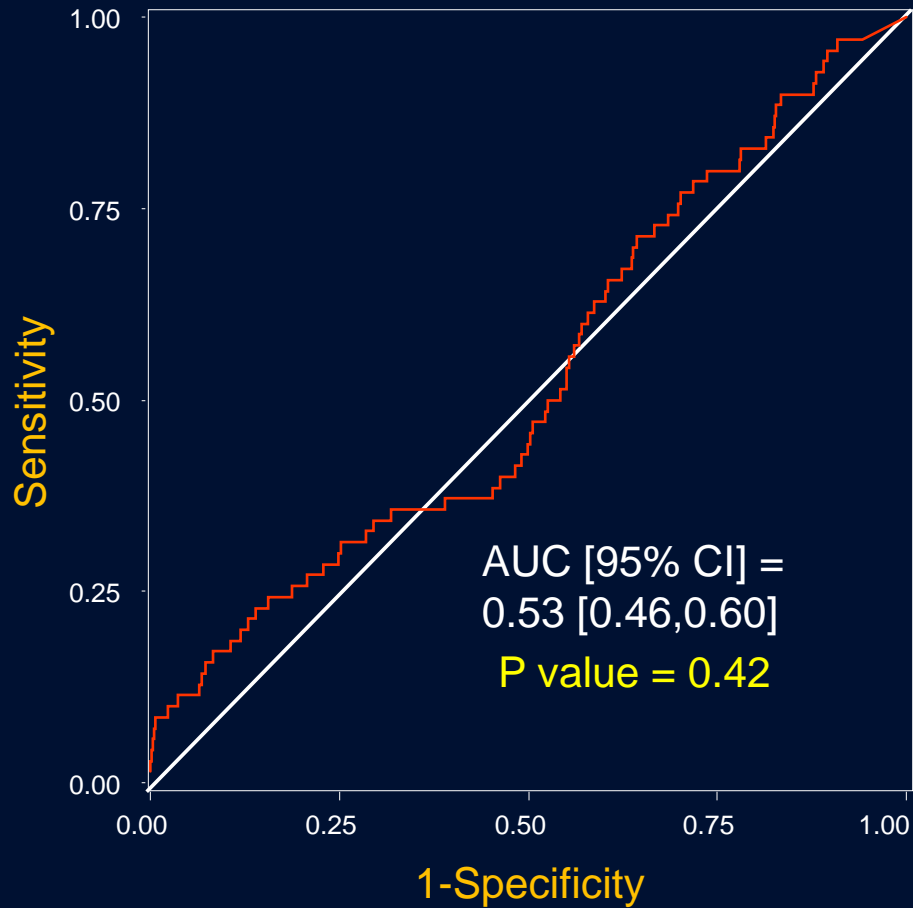
Number at risk:

< 304	632	605	584	571	544	524	521	514	313
≥ 304	633	606	600	584	571	538	532	531	356

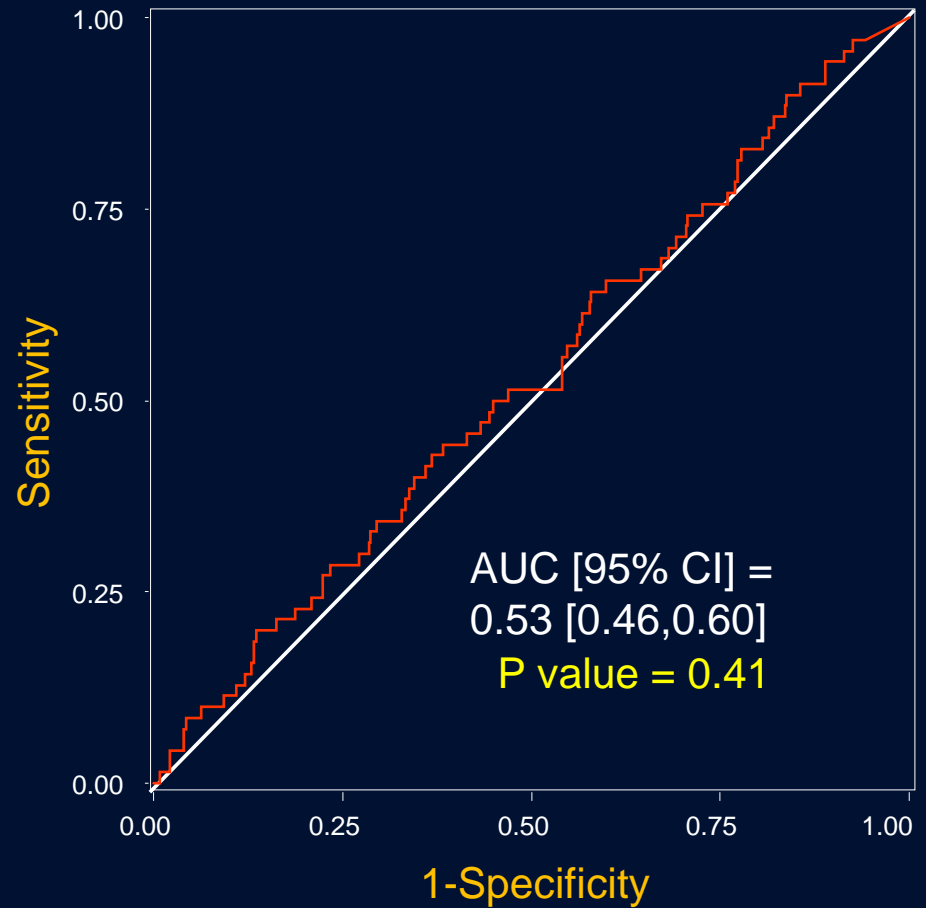


Relationship Between NIRS and Culprit-lesion related MACE

maxLCBI_{4mm}



Total lesion LCBI



Lesion Level Multivariable Model

Culprit-lesion related MACE

	HR [95% CI]	P-value
Max LCBI _{4mm} (per 100)	1.08 [0.97, 1.20]	0.17
Diabetes mellitus	1.31 [0.80, 2.12]	0.28
ACS	0.91 [0.43, 1.91]	0.80
Lesion length (per mm)	1.02 [1.00, 1.04]	0.02
RVD (per mm)	0.66 [0.41, 1.06]	0.08
In-stent restenosis lesion	1.02 [0.55, 1.88]	0.96
2 nd generation DES	0.58 [0.34, 0.99]	0.046
Prasugrel or ticagrelor	0.85 [0.41, 1.78]	0.67

Summary

- 1. NIRS can detect lipid rich plaque and differentiate higher risk plaque in addition to plaque burden.**
- 2. In non-treated segment NIRS detected lipidic plaque predict future cardiac event at patient level (and lesion level).**
- 3. In culprit segment, NIRS detected lipidic plaque did not predict future culprit related event. It is safe to implant stent in lipid rich plaque.**