OCT Assessment of Stent Failure

Jung-Sun Kim, MD, Ph D

Division of Cardiology, Severance Cardiovascular Hospital
Yonsei University College of Medicine

The author have no financial conflicts of interest to disclose concerning the presentation.

Recent ESC Guideline

Restenosis		
Repeat PCI is recommended, if technically feasible.	I	C
DES are recommended for the treatment of in-stent re-stenosis (within BMS or DES).	I	A
Drug-coated balloons are recommended for the treatment of in-stent restenosis (within BMS or DES).	I	A
IVUS and/or OCT should be considered to detect stent-related mechanical problems	IIa	

Stent thrombosis		
Emergency PCI is recommended to restore stent and vessel patency and myocardial reperfusion.	I	C
DAPT with use of potent $P2Y_{12}$ inhibitors (prasugrel or ticagrelor) is recommended over clopidogrel	I	C
Adjunctive thrombus aspiration and high-pressure balloon dilation should be considered.	IIa	C
IVUS and/or OCT should be considered to detect stent-related mechanical problems	IIa	

2014 ESC/EACTS/EAPCI guidelines for myocardial revascularization

Windecker S, et al. Eur Heart J 2014

Agenda

- The Role of OCT to Assess an ***In-Stent Restenosis***

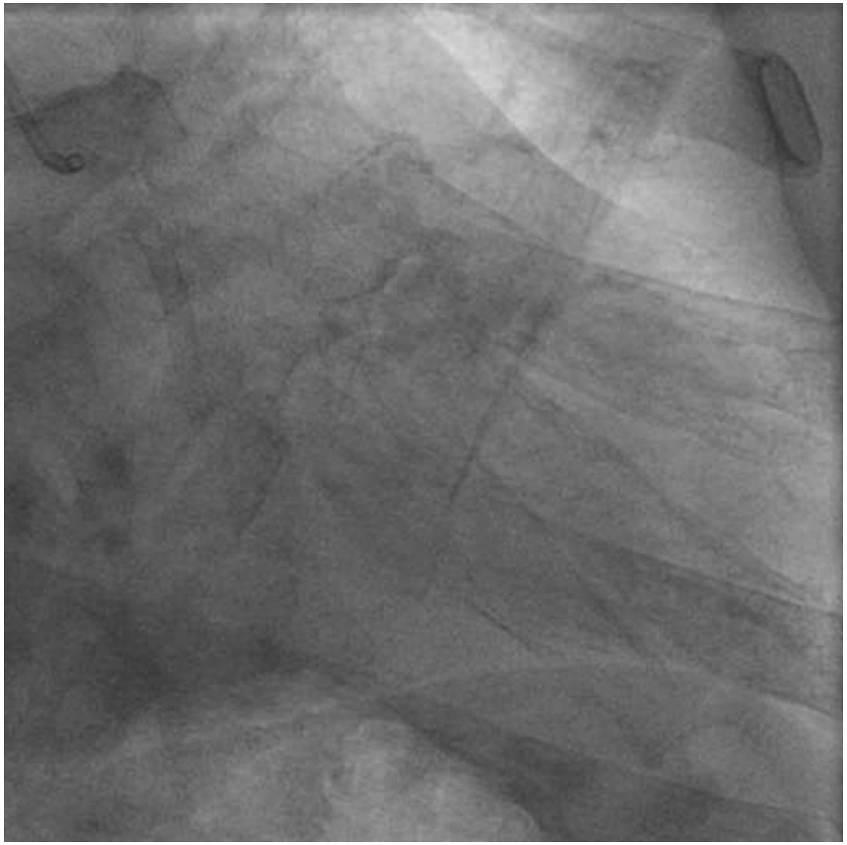
- The Role of OCT to Assess a ***Stent Thrombosis***

Agenda

- **The Role of OCT to Assess an *In-Stent Restenosis***
- The Role of OCT to Assess a *Stent Thrombosis*

In-Stent Restenosis

- **PCI at dRCA (Cypher 3.5 x 18mm) 18 month ago**
- **PCI with stent at dLCx (BMS 3.0x30) 10 years ago**



Agenda

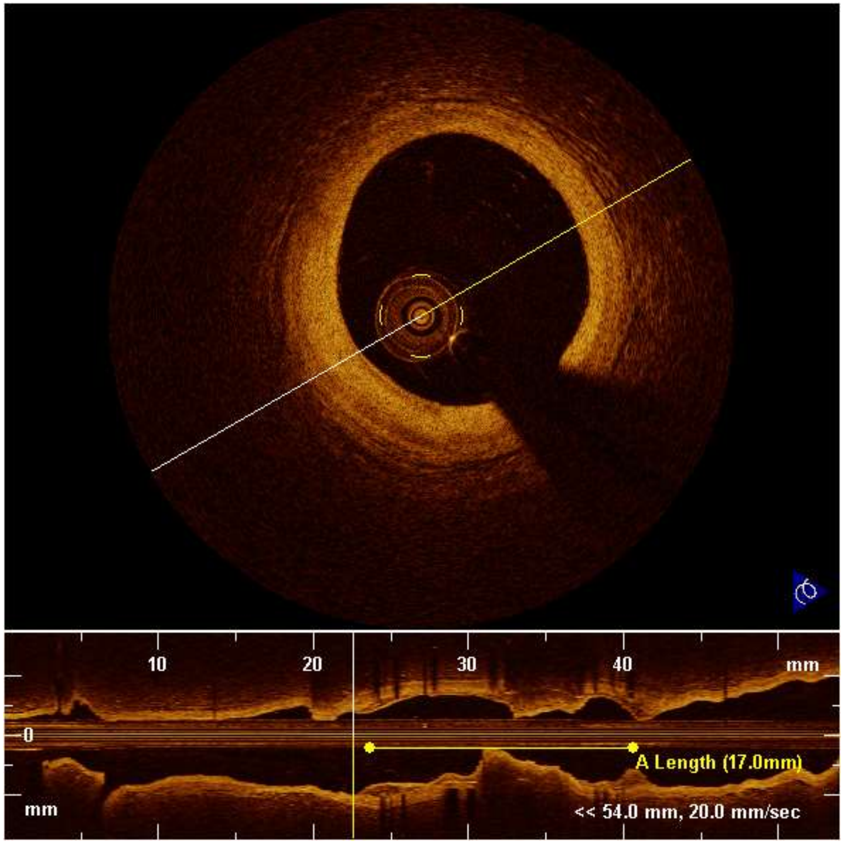
- The Role of OCT to Assess an ***In-Stent Restenosis***

Quantitative evaluation for degree of stenosis with higher resolution

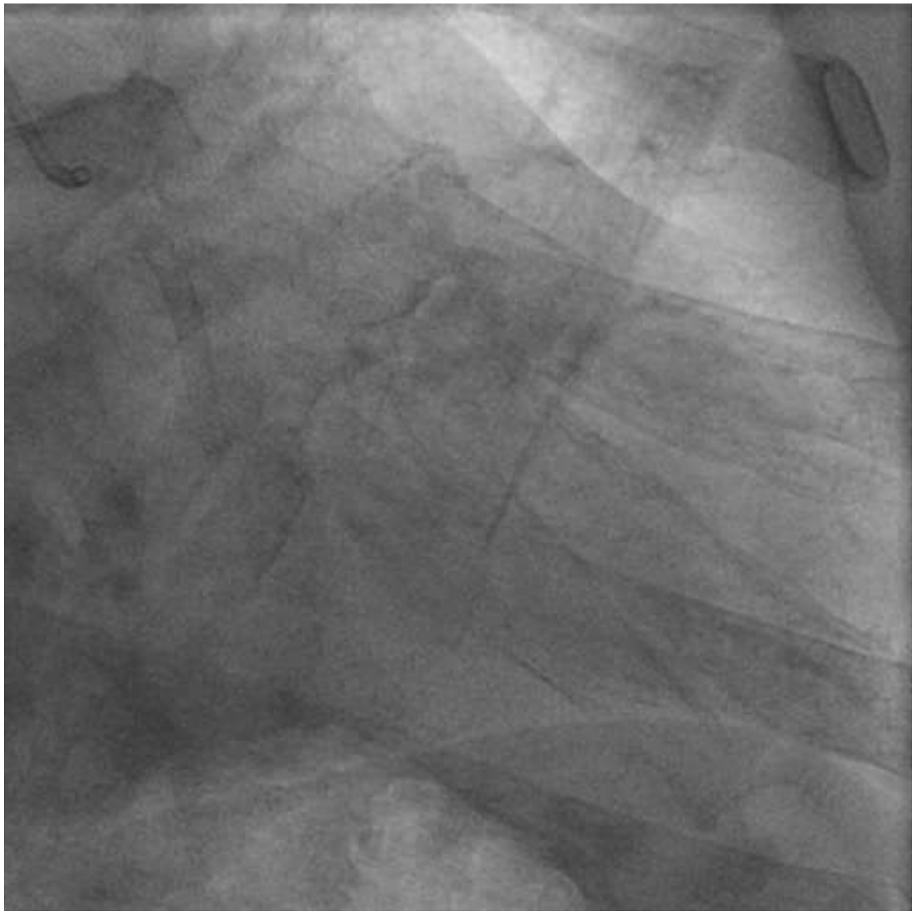
What can get more information with

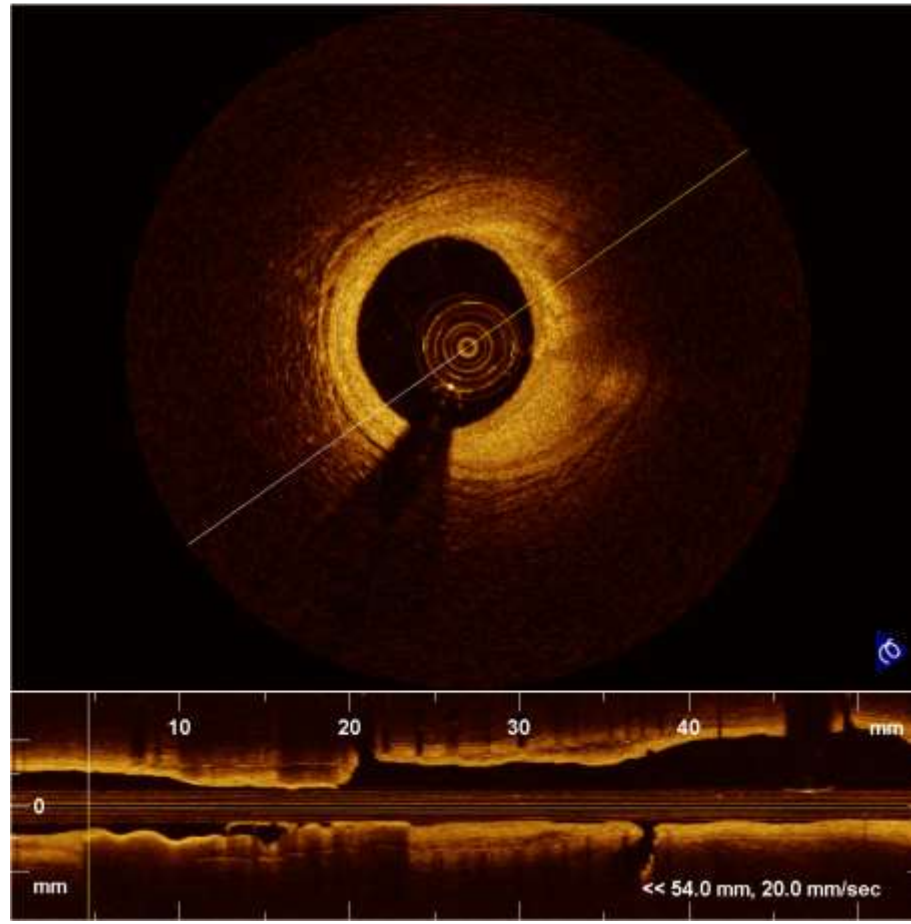
OCT than IVUS ?

OCT Can Provide Qualitative Information of Neointima

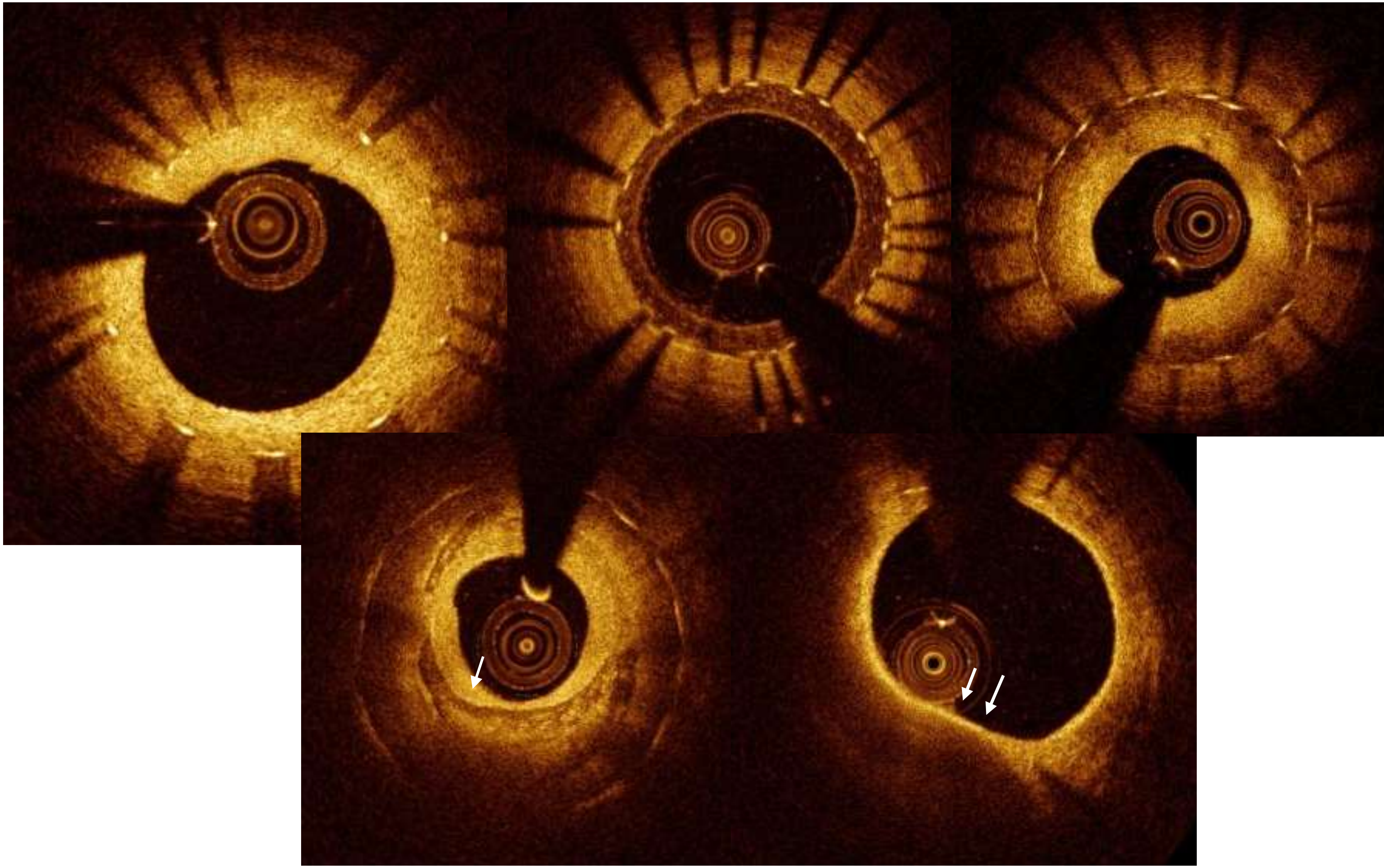


OCT Can Provide Qualitative Information of Neointima

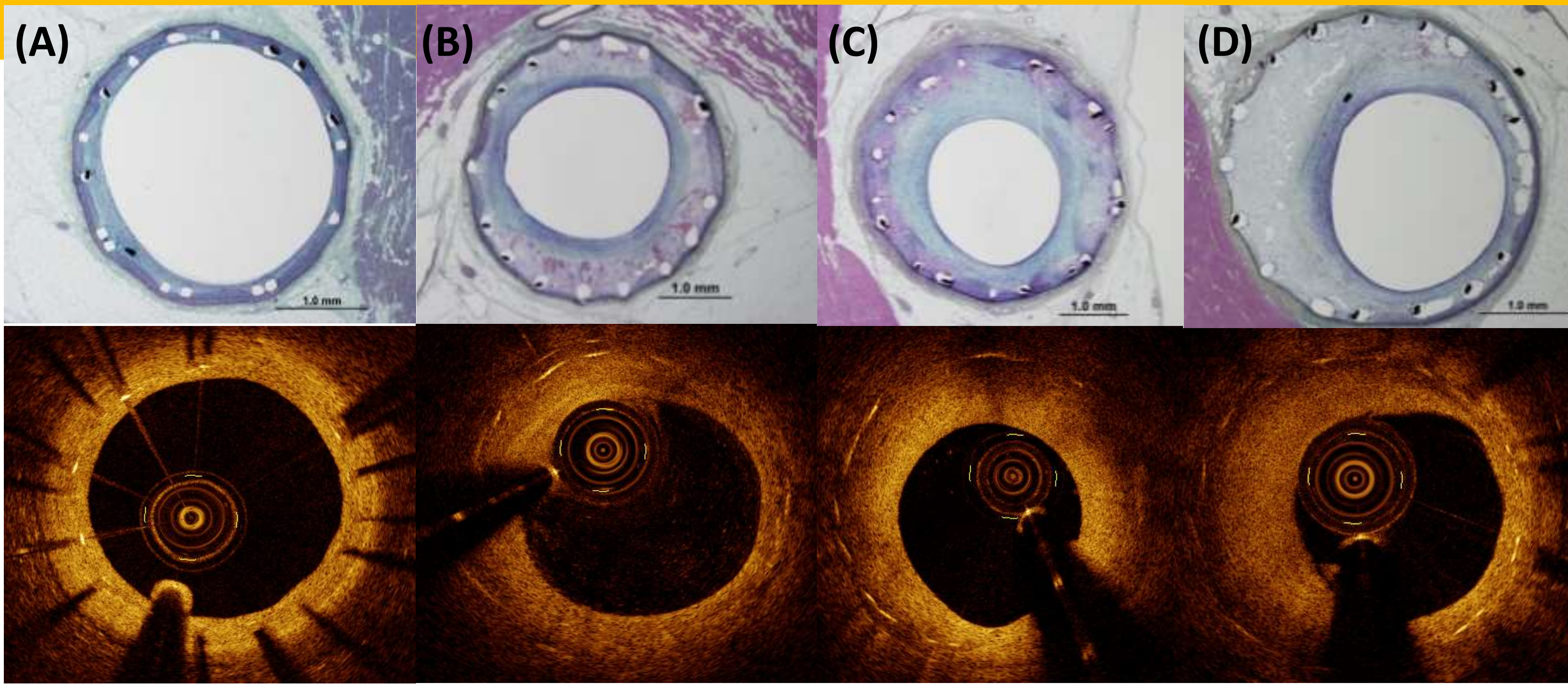




Abnormal Neointima



Text Book; Cardiovascular OCT Imaging: Late stent change, Kim JS, Hong MK, Jang Y



Representative images of OCT and histologic sections.

(A) **Homogeneous** neointimal pattern in OCT has a collagen rich neointima (bluish color) (B) **heterogeneous** neointimal pattern shows lots of loose connective tissue (grey color) and fibrin (pink color) (C) **layered neointimal** pattern shows thick neointima, external elastic laminal rupture and peristrut inflammation (D) **neovascularization** is shown in the middle of neointima.

Kim JS, Granada JF, et al. Eur Heart J Cardiovasc Imaging 2013

Neointimal tissue of In-stent Restenosis

Restenotic tissue structure

This study demonstrated that the incidence of heterogeneous neointima in patients presenting with stable angina was 6.7% (1/15) versus 40.0 % (4/10) in patients with unstable angina.

show focal variations in backscattering pattern.

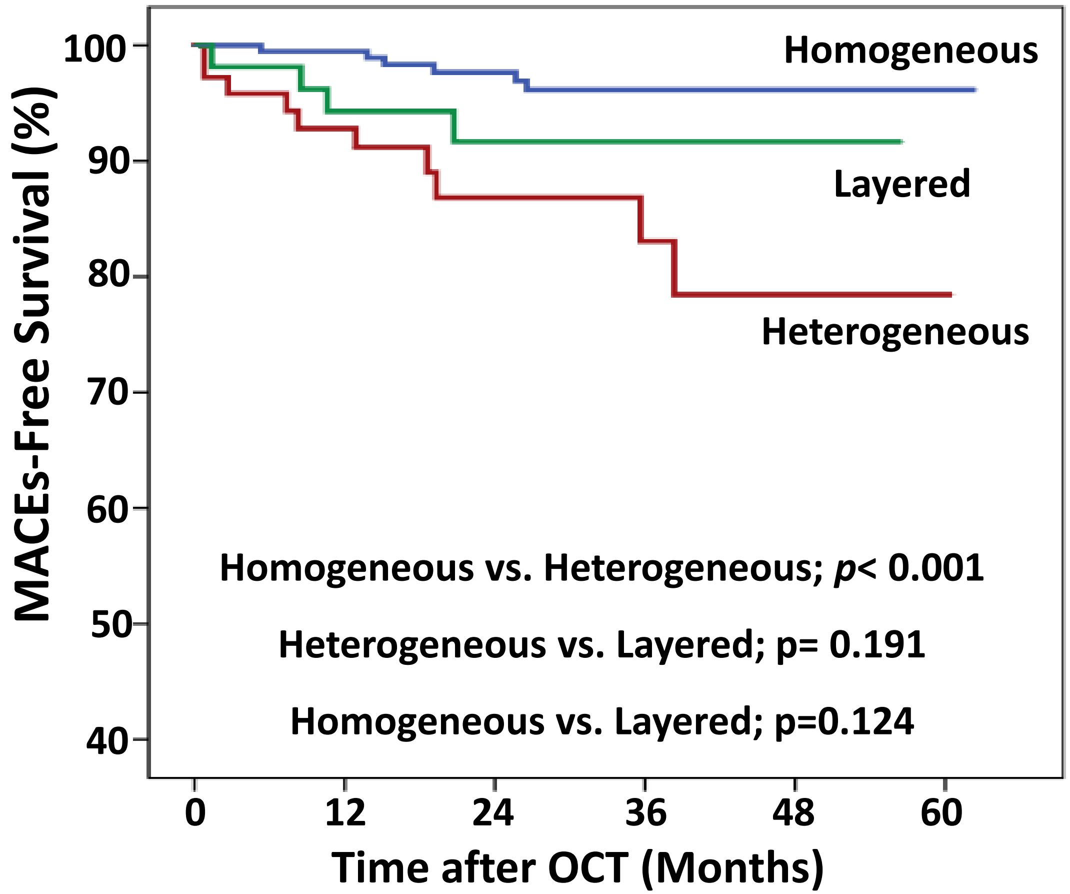
shows various backscattering patterns

optical properties: an adluminal high scattering layer and an abluminal low scattering layer

	Angiographic classification			
	Diffuse (n = 9)	Focal (n = 11)	Margin (n = 5)	p
Layered	7 (77.8%)	5 (45.5%)	1 (20%)	0.005
Homogeneous	2 (22.2%)	1 (9.1%)	4 (80%)	
Heterogeneous	0	5 (45.5%)	0	

Gonzalo N, et al. Am Heart J 2009;158:284-93

Heterogeneous Pattern of Neointima has adverse clinical outcome



Homogeneous (n)	208	187	132	100	49	2
Layered (n)	55	49	33	22	6	0
Hetero (n)	73	59	34	22	8	1

Kim JS, Lee JH, Hong MK, et al. J Am Coll Cardiol Imag 2014

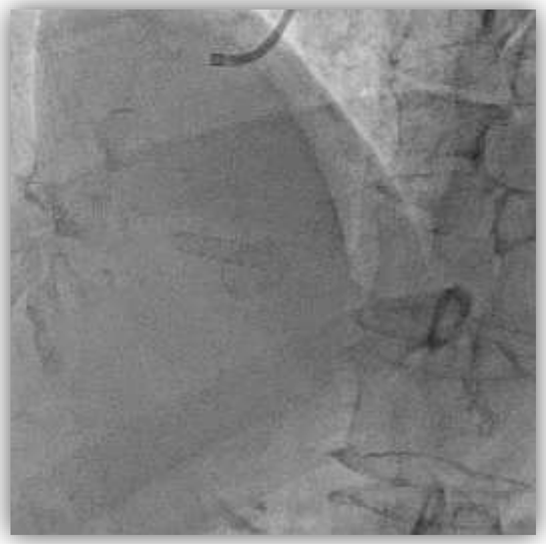
Agenda

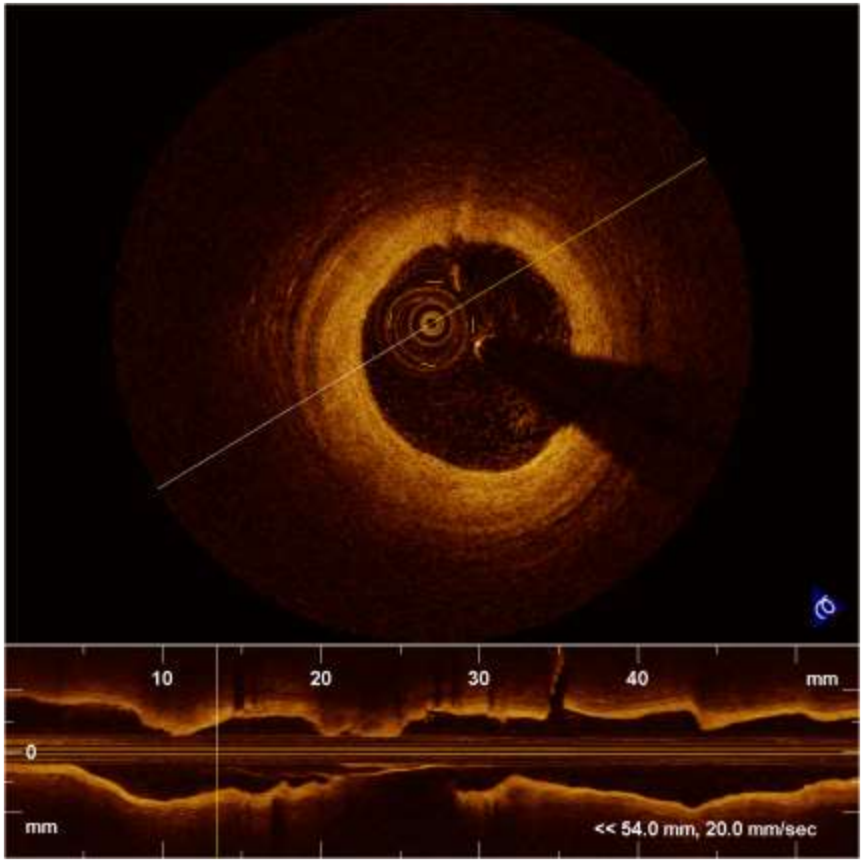
- The Role of OCT to Assess an ***In-Stent Restenosis***

Can Provide Further Information to Guide a Treatment Option for ISR ?

ISR Treatment with DEB

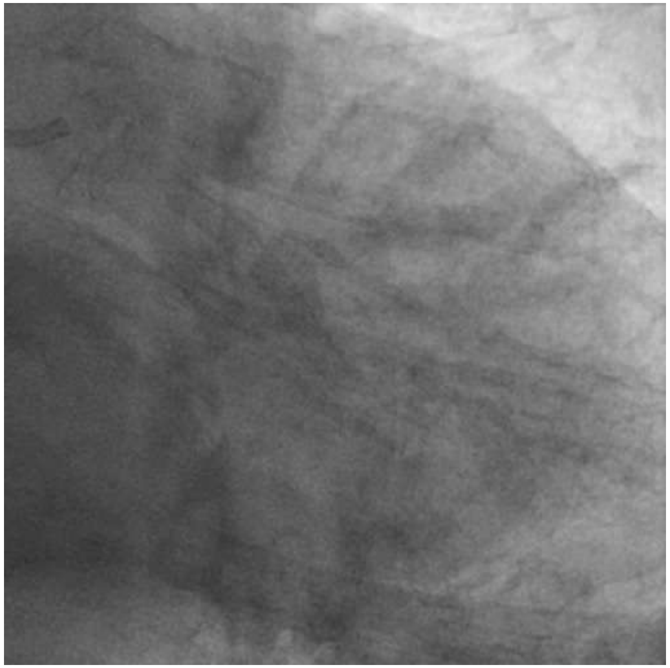
- **Follow up angiogram d/t chest discomfort**
  →PTCA c DEB at dRCA (Sequent please 3.5 x 15)

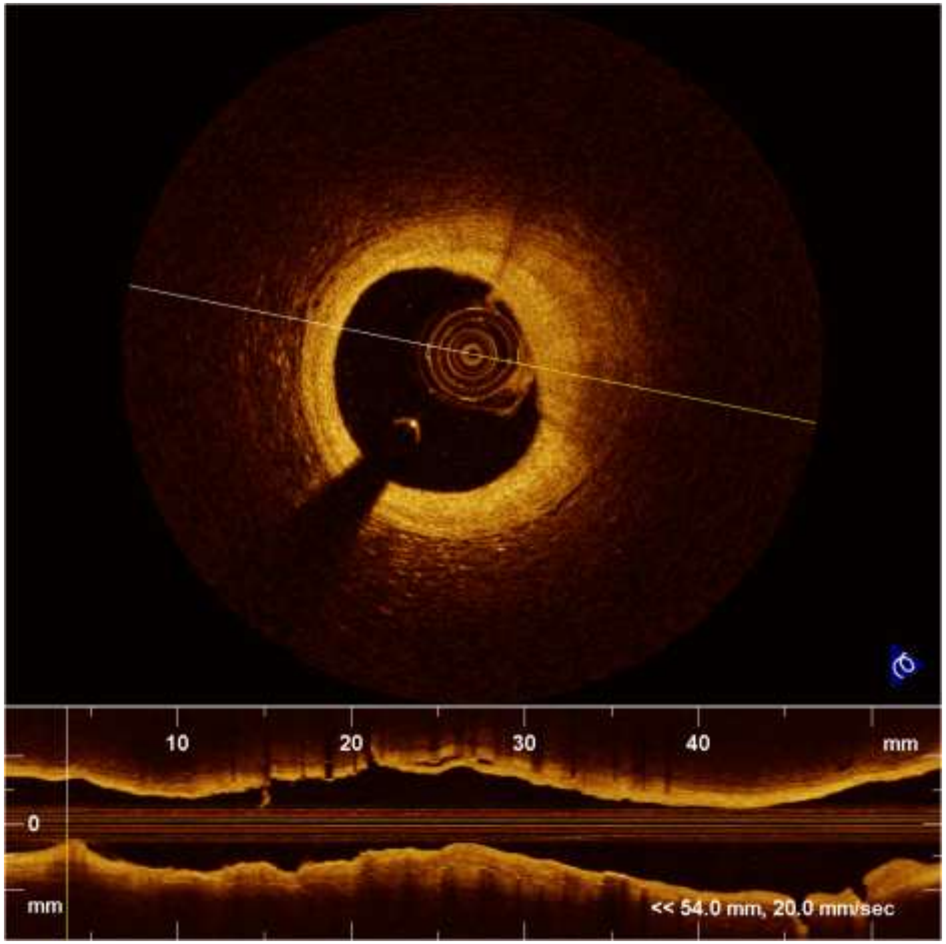




ISR Treatment with DEB

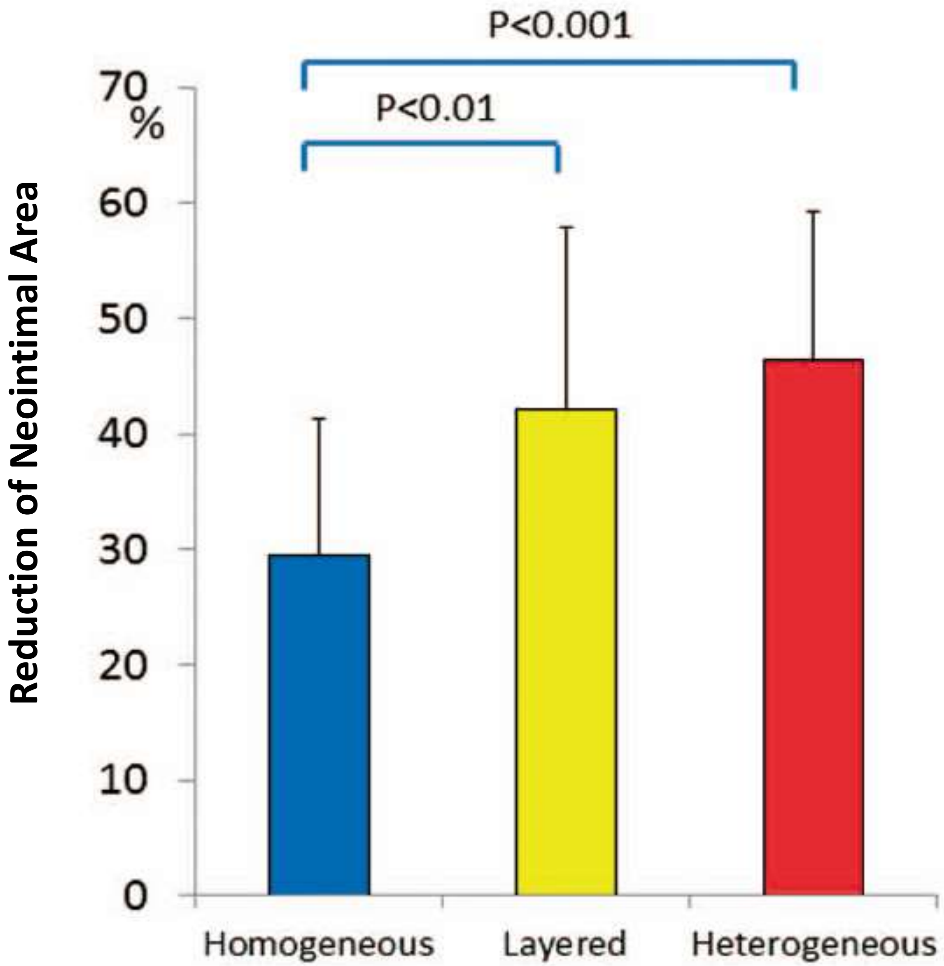
DEB 3.0 x 30 mm





Final angiography and OCT

Possible direction for OCT-based ISR treatment strategies

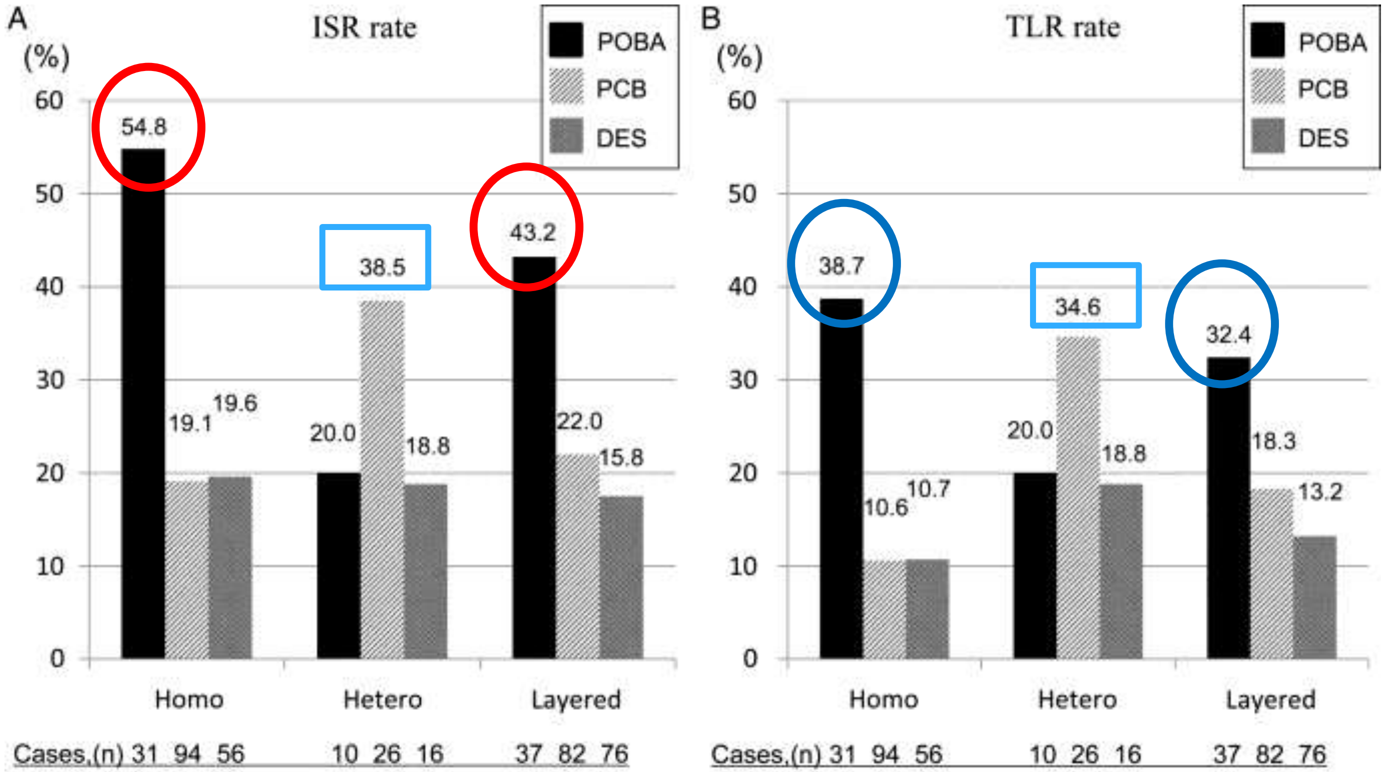


Immediate results after POBA

Layered and heterogeneous tissues might respond better than homogeneous tissue to simple balloon dilatation

Nagoshi R, et al. Cir J 2013;3:652-660

Associations between Restenotic Pattern and mid-term results



p value	Homo	Hetero	Layered
POBA vs. PCB	<0.001	0.438	0.027
POBA vs. DES	0.002	1.000	0.002
PCB vs. DES	1.000	0.303	0.417

p value	Homo	Hetero	Layered
POBA vs. PCB	<0.001	0.688	0.102
POBA vs. DES	0.005	1.000	0.022
PCB vs. DES	1.000	0.316	0.394

Tada T, et al. Eur Hear J Cardiovasc Img 2015;16:1101-11

Summary for In-Stent Restenosis

What can get more information with

OCT than IVUS ?

<u>OCT clearly differentiate the tissue characteristics of neotintima.</u>

assess the mechanism

predict the clinical outcomes

suggest the best treatment option

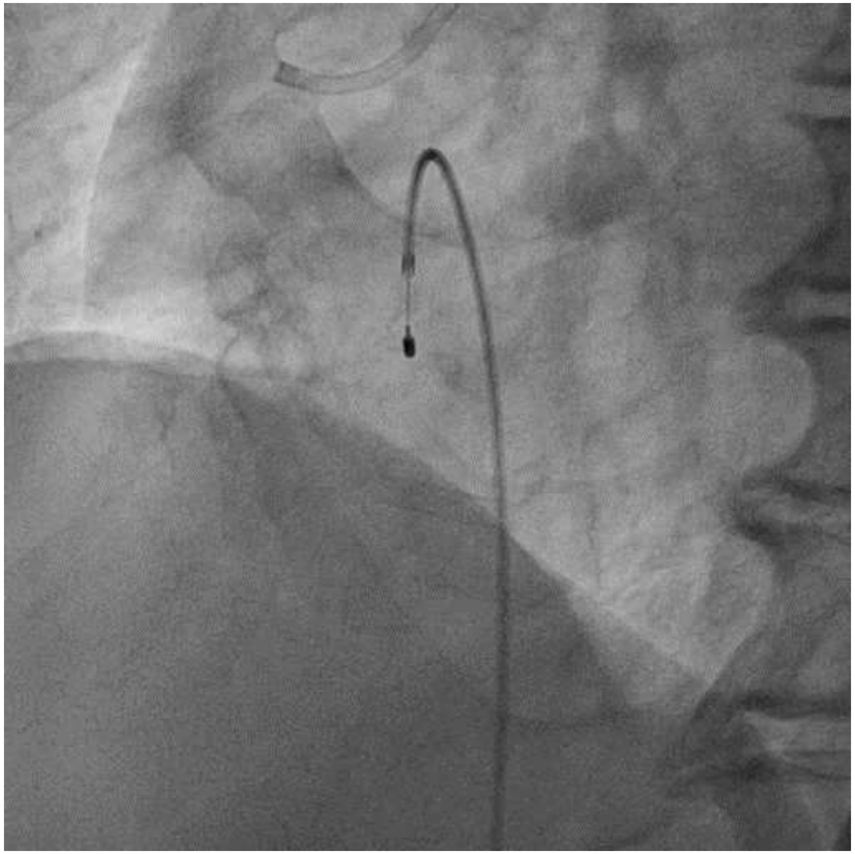
Agenda

- The Role of OCT to Assess an ***In-Stent Restenosis***

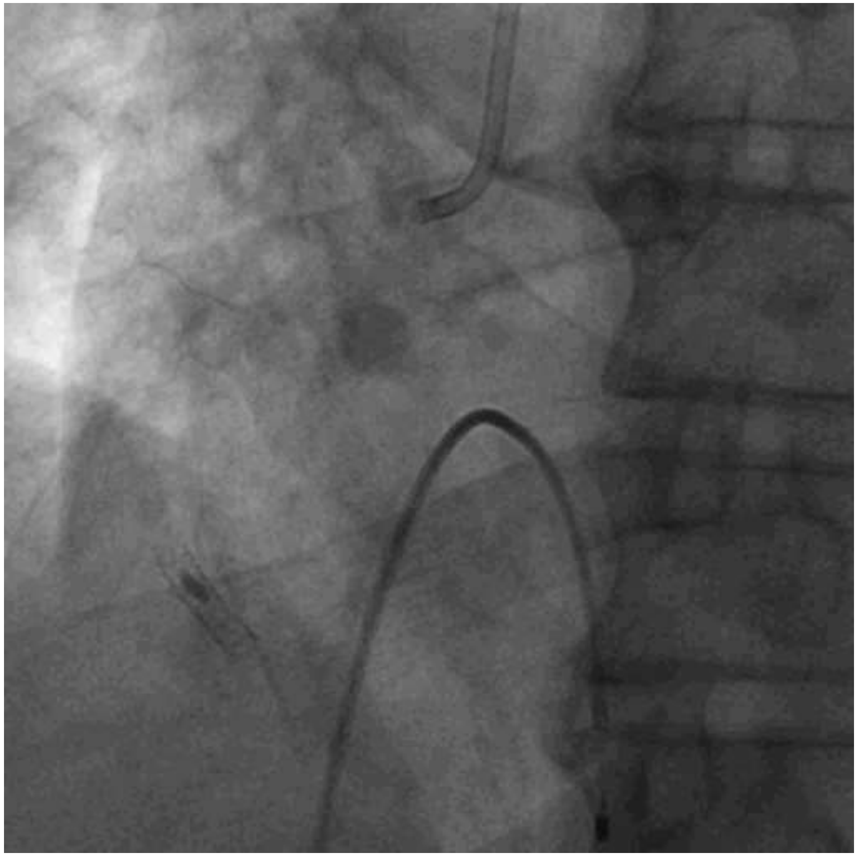
- The Role of OCT to Assess a ***Stent Thrombosis***

Stent Thrombosis

- **PCI at dRCA (Nobori 3.5 x 18mm) 24 month ago**



- **PCI with stent at dLCx (BMS 3.0x15) 11 years ago**



Agenda

- **The Role of OCT to Assess an *In-Stent Restenosis***

Quantitative evaluation for relationship between stent and vessel wall

JACC: CARDIOVASCULAR INTERVENTIONS
VOL. 5, NO. 1, 2012

ISSN 1936-8798/$36.00
PUBLISHED BY ELSEVIER INC.
DOI: 10.1016/j.jcin.2011.09.018

Stent Coverage

CLINICAL RESEARCH

CME

Examination of the In Vivo Mechanisms of Late Drug-Eluting Stent Thrombosis

Findings From Optical Coherence Tomography and Intravascular Ultrasound Imaging

Giulio Guagliumi, MD,* Vasile Sirbu, MD,* Giuseppe Musumeci, MD,* Robert Gerber, MD,† Giuseppe Biondi-Zoccai, MD,* Hideyuki Ikejima, MD,* Elena Ladich, MD,‡ Nikoloz Lortkipanidze, MD,* Aleksandre Matiashvili, MD,* Orazio Valsecchi, MD,* Renu Virmani, MD,‡ Gregg W. Stone, MD§

Bergamo, Italy; London, United Kingdom; Gaithersburg, Maryland; and New York, New York

Variable	OR (95% CI)	p Value
Maximum length of segments with uncovered struts at OCT, mm	2.45 (1.27–4.73)	0.007
Remodeling index at IVUS*	1.05 (1.01–1.11)	0.019

Only the 2 covariates with strongest association at univariate analysis were included in the model, given the limited number of cases. *Per 0.01-increase.

CI = confidence interval; IVUS = intravascular ultrasound; OCT = optimal coherence tomography; OR = odds ratio.

Int J Cardiovasc Imaging
DOI 10.1007/s10554-011-9905-3

ORIGINAL PAPER

Stent Coverage

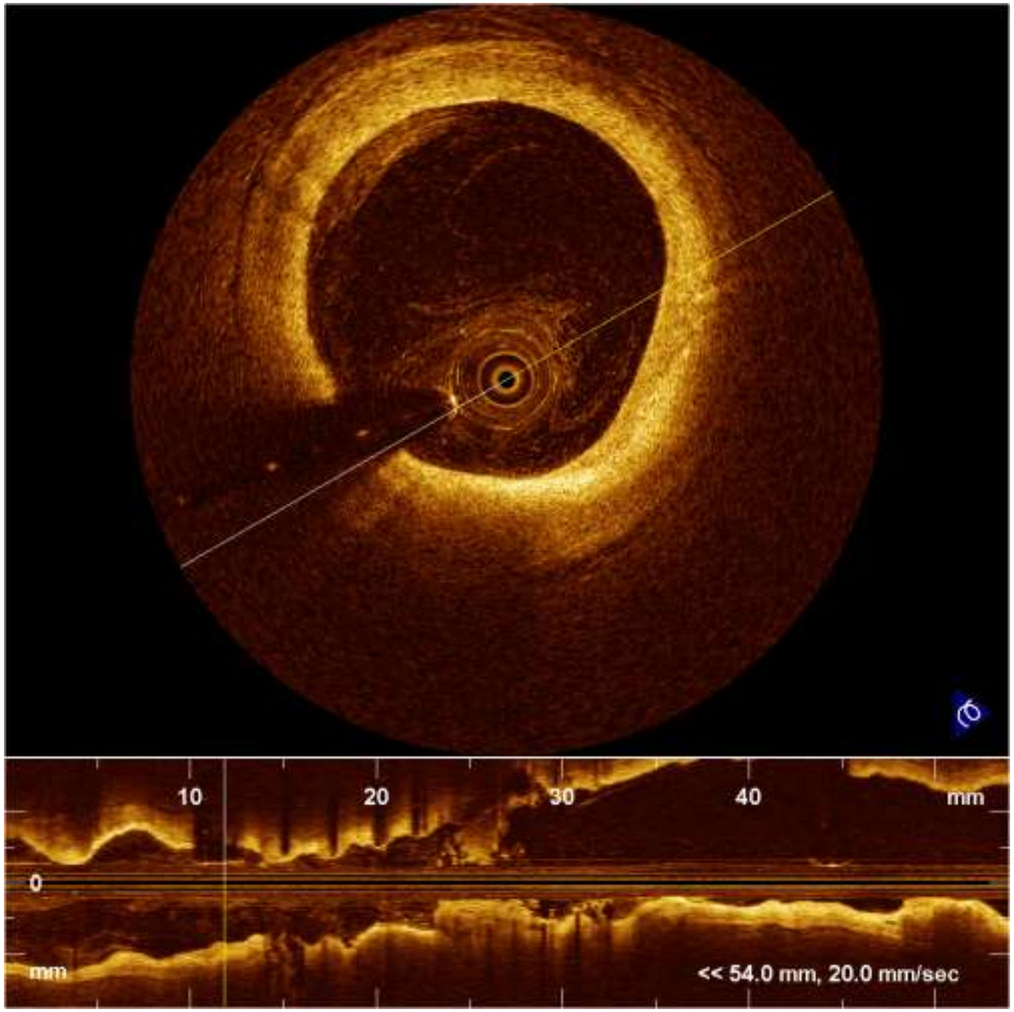
Optical coherence tomography findings of very late stent thrombosis after drug-eluting stent implantation

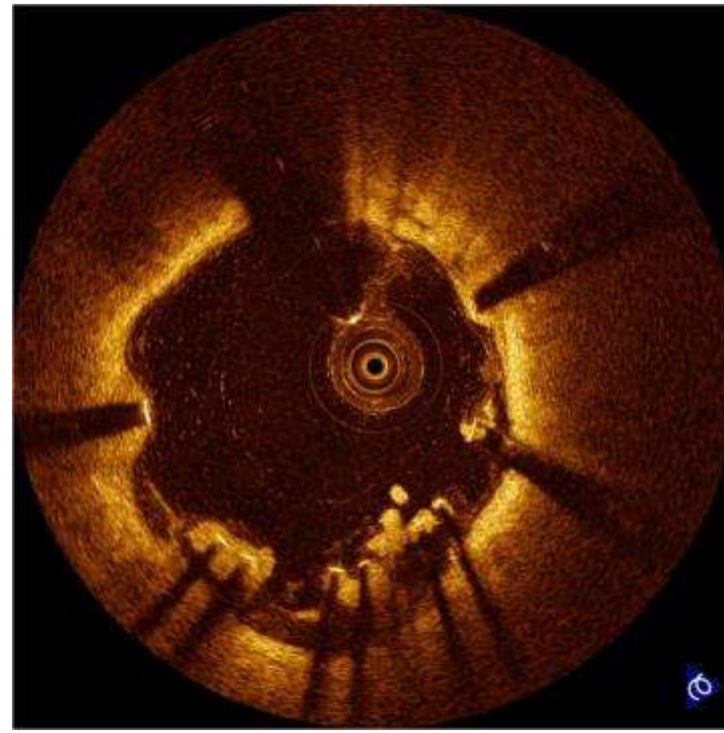
Young-Guk Ko · Dong-Min Kim · Jin Man Cho · So Yeon Choi · Jung Han Yoon · Jung-Sun Kim · Byeong-Keuk Kim · Donghoon Choi · Yangsoo Jang · Myeong-Ki Hong

Four **(22.2%)** of 18 patients with VLST had **ruptured and lipid-laden neointima** inside DESs ***without uncovered or malapposed stent struts.***

In the remaining 14 patients who developed VLST ***without neointimal rupture***, **uncovered** **(64.2 %)** and **malapposed** struts **(50%)** were observed in nine and seven patients.

Stent malapposition and incomplete coverage





Stent malapposition and incomplete coverage

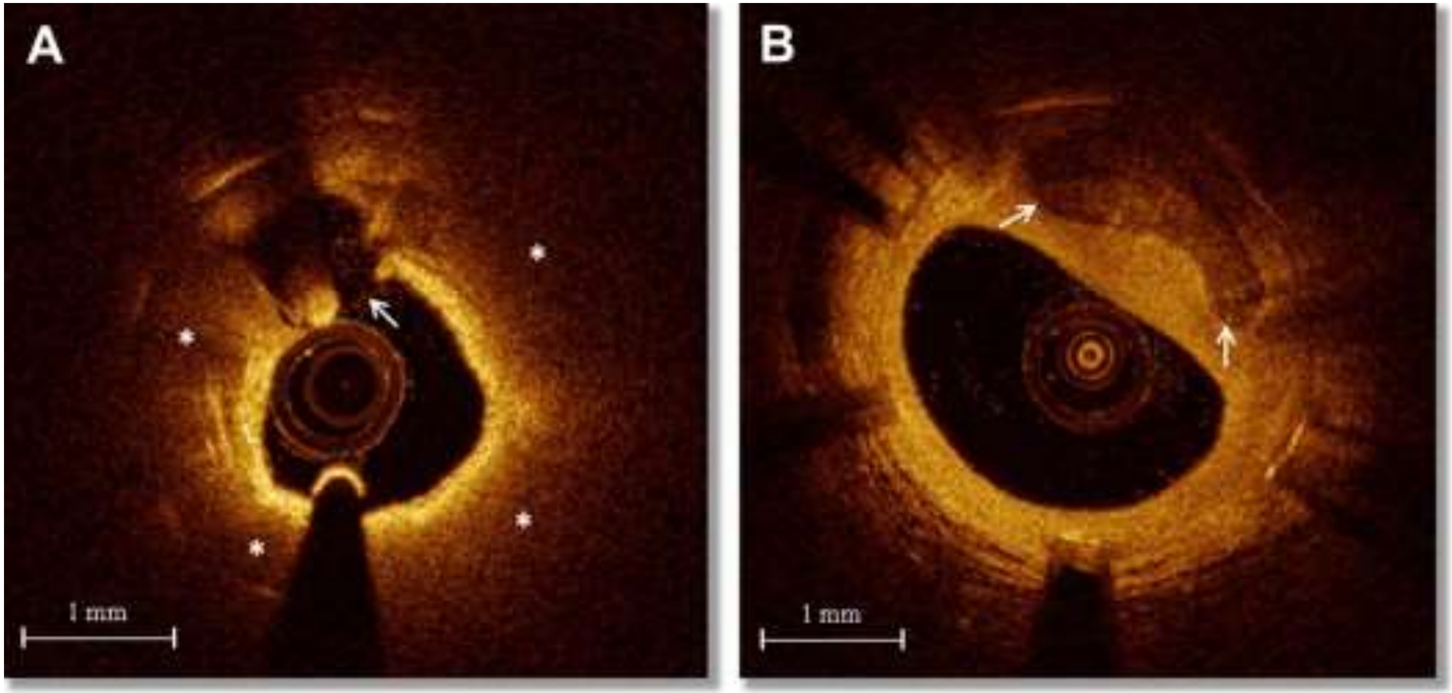
Agenda

- The Role of OCT to Assess an ***In-Stent Restenosis***

Qualitative Evaluation for Neointimal Characteristics

Neoatherosclerosis

MGH OCT Registry by IK Jang



(A) Lipid-laden intima, appearing as a signal-poor region with diffuse borders *(asterisks)*, with disruption of the fibrous cap *(arrow)*. *(B)* In-stent calcification: signal-poor area with sharp borders

Vergallo R, et al. Am J Cardiol 2013;112:1315-21

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DOI 10.1007/s10554-011-9905-3

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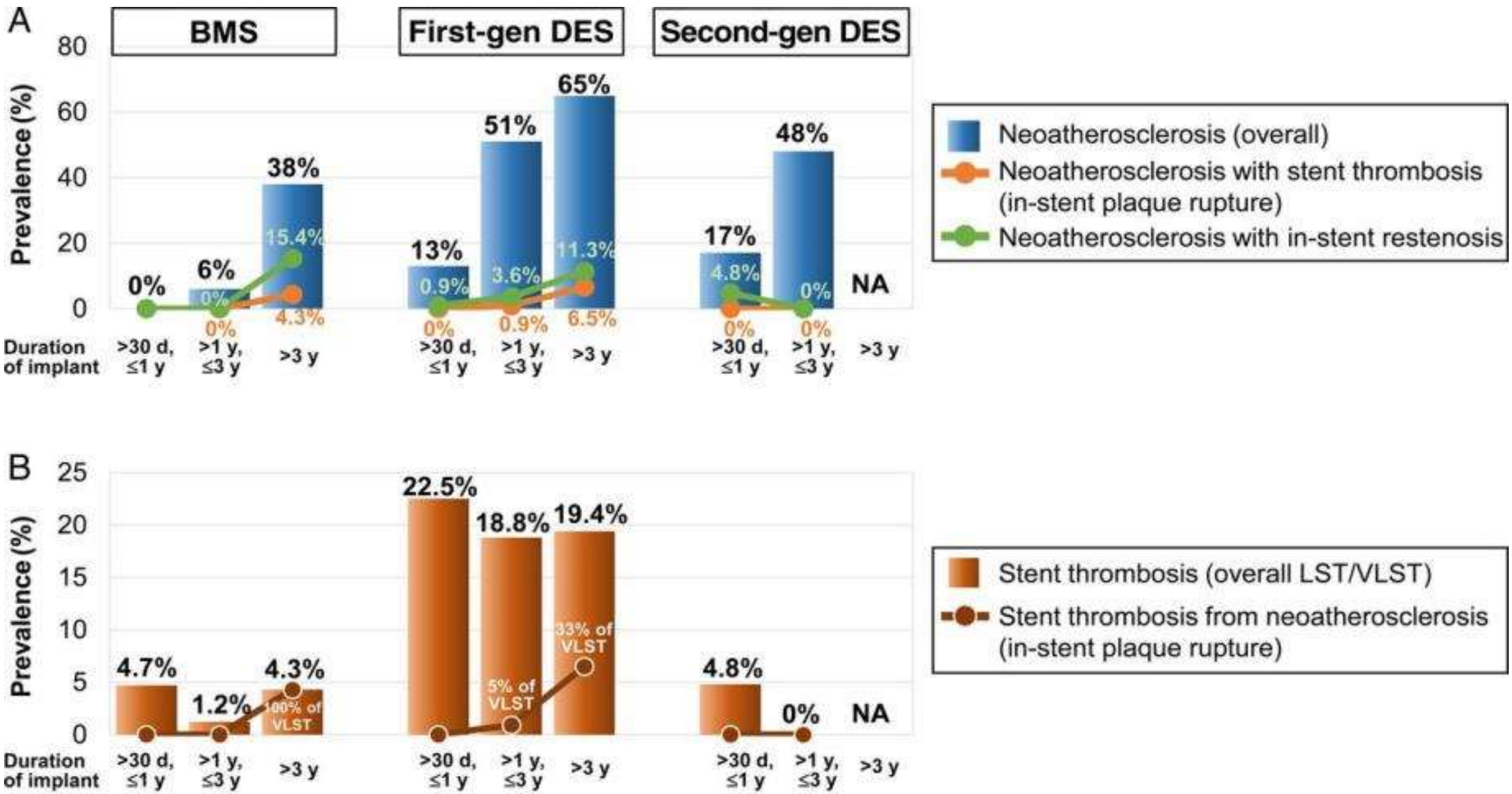
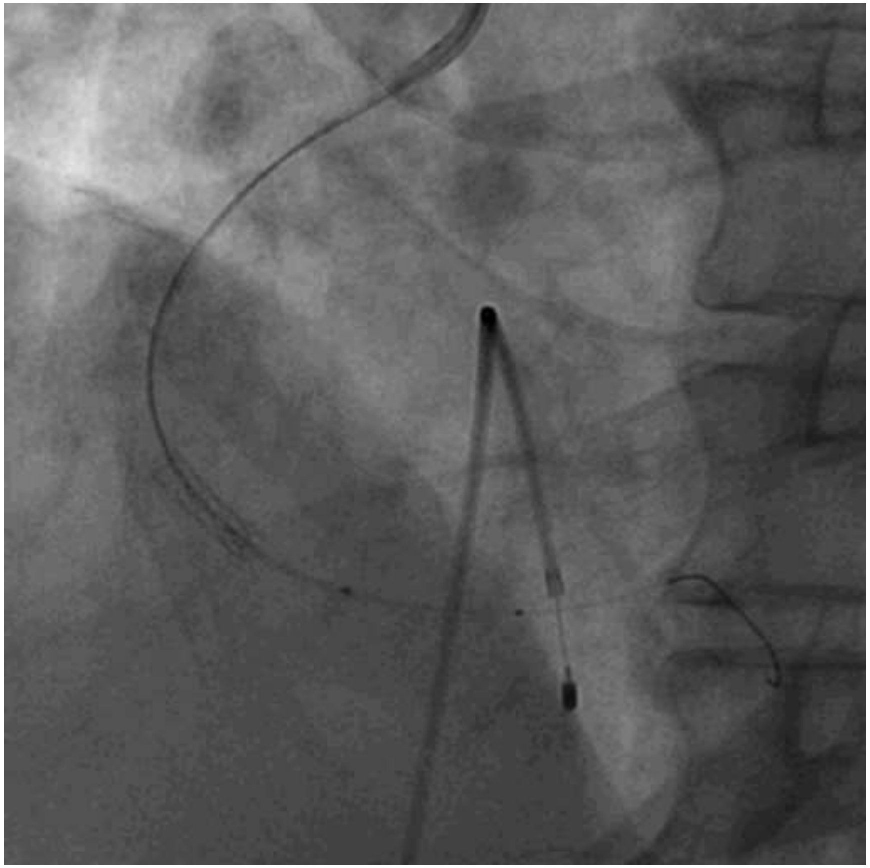
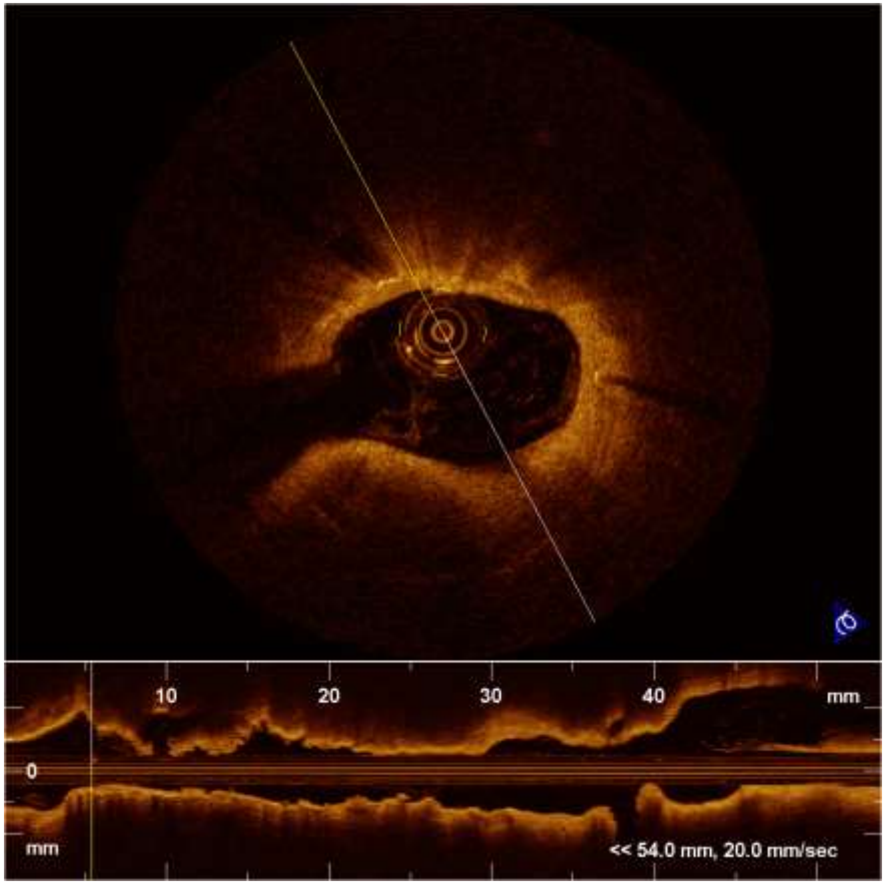
Prevalence of neoatherosclerosis



Otsuka F, et al. Eur Heart J 2015;36:2147–2159

Neoatherosclerosis



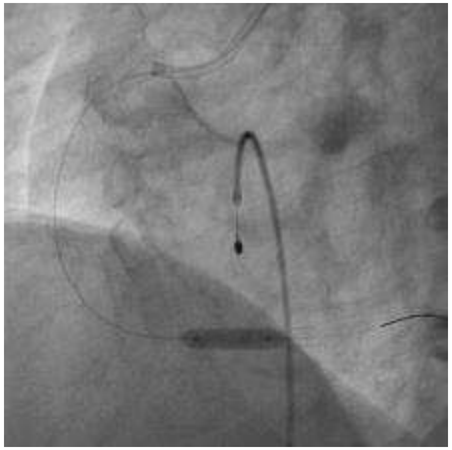


Agenda

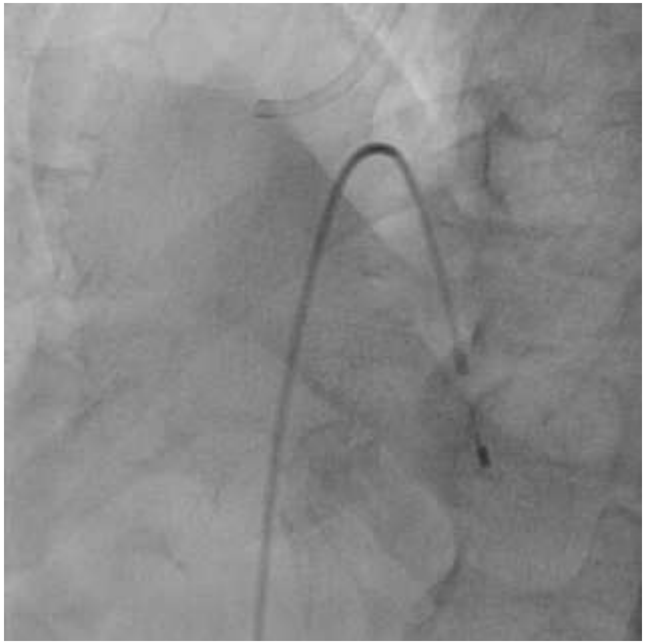
- The Role of OCT to Assess an ***Stent Thrombosis***

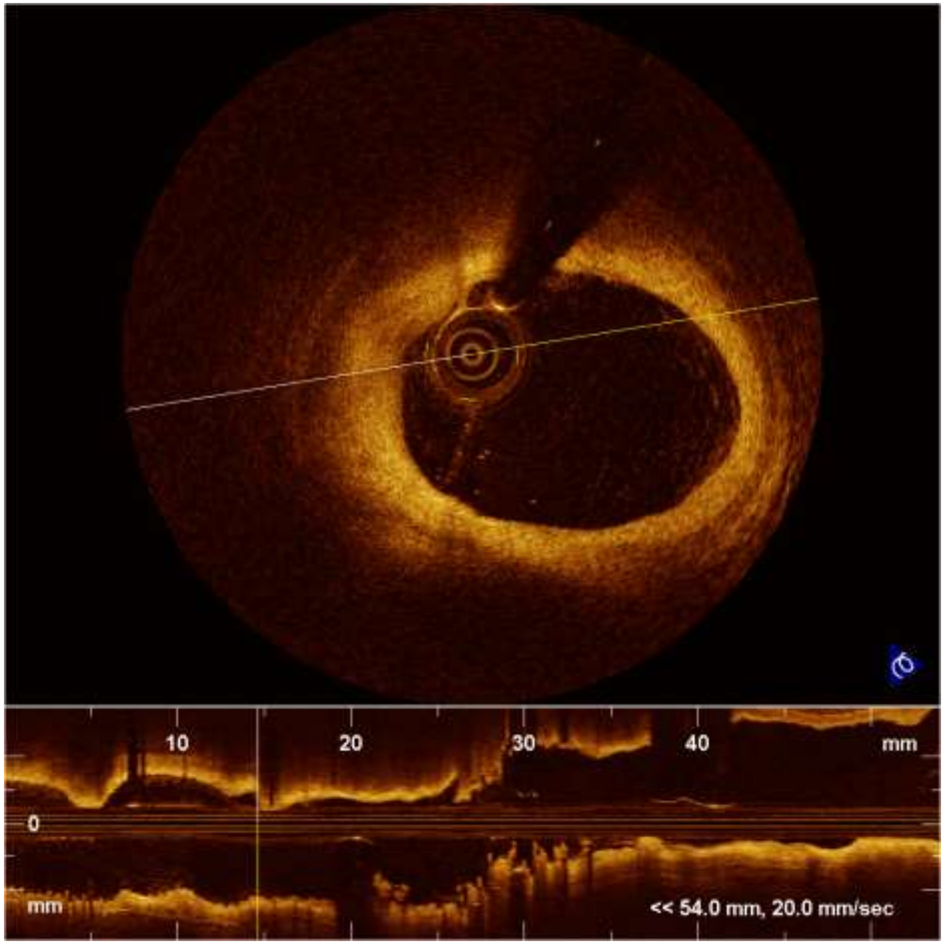
Can Provide Further Information to Guide a Treatment Strategy for Stent Thrombosis ?

Stent Malapposition



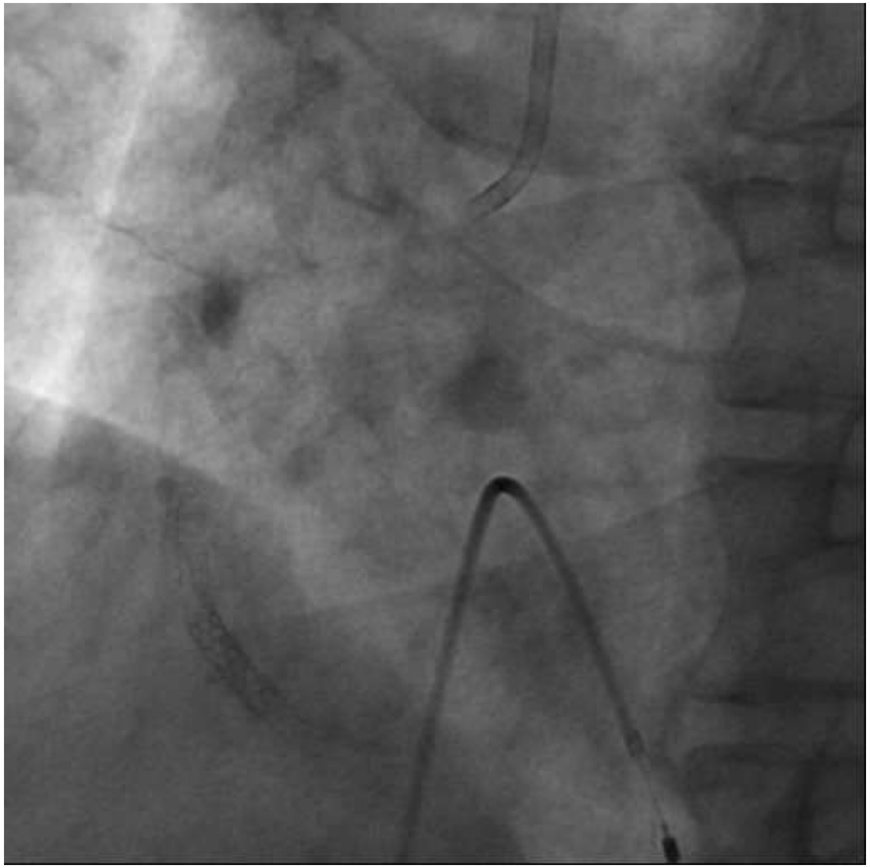
NC balloon 4.0 x 15 mm



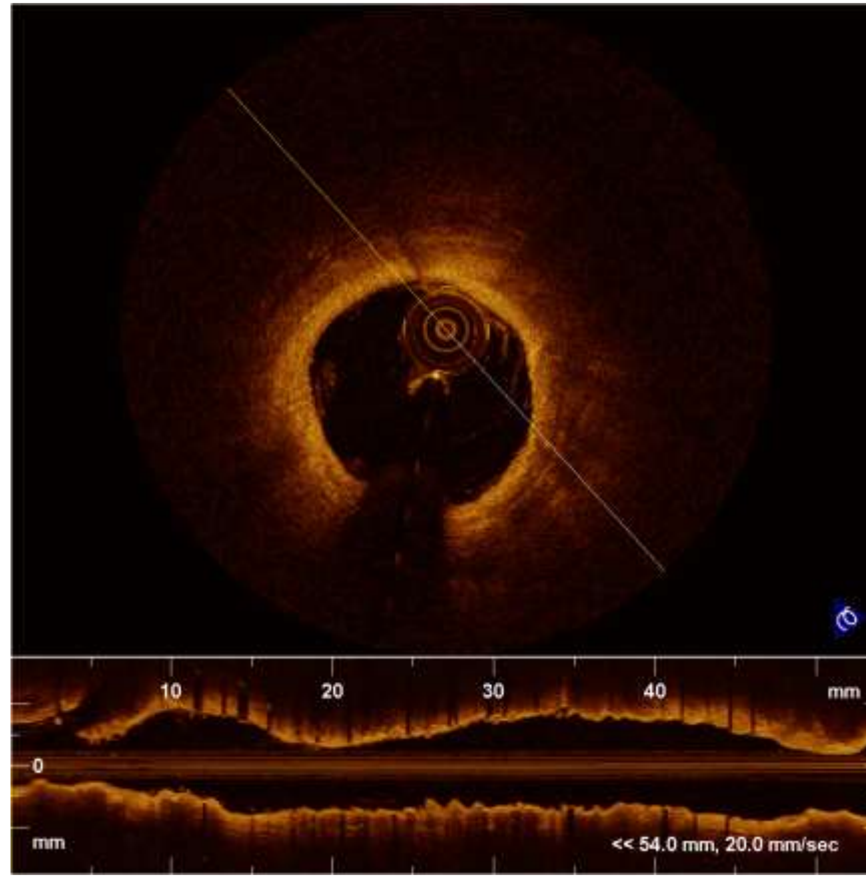


Final angiography and OCT

Neoatherosclerosis



Xience Prime 3.0*38mm



OCT after stenting

Summary for Stent Thrombosis

What can get more information with

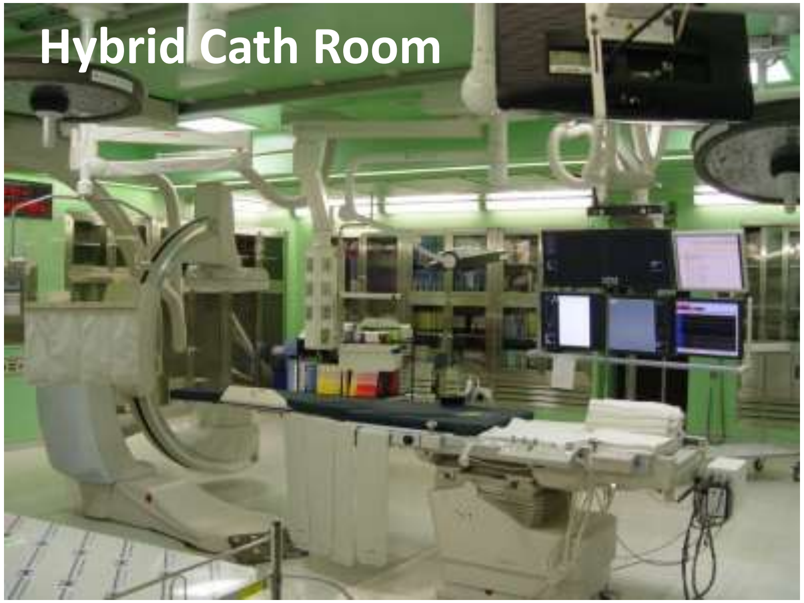
OCT than IVUS ?

OCT clearly show the relationship between stent and vessel wall and the tissue characteristics of neotintima.

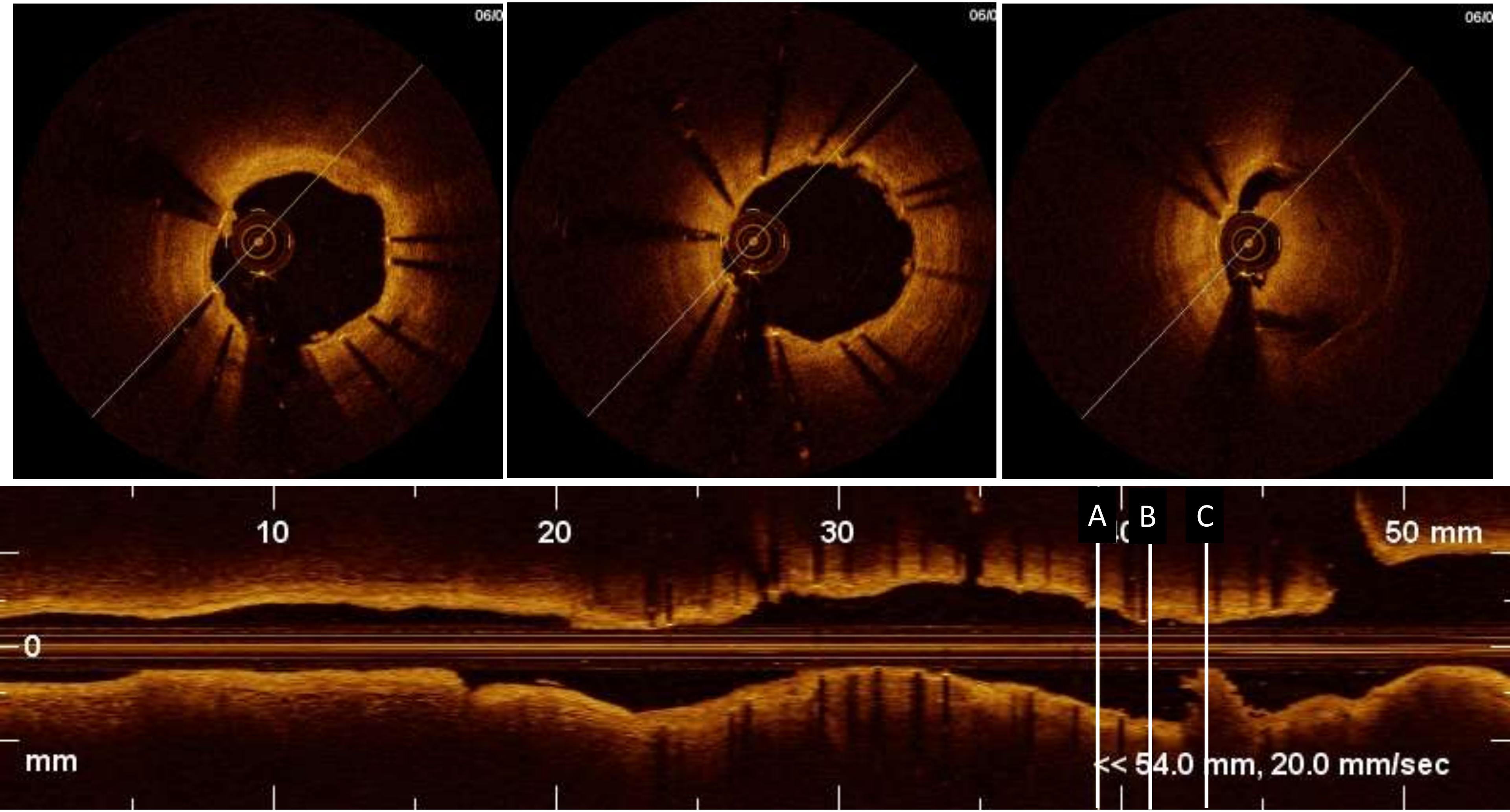
Assess the mechanism

Suggest the best treatment strategy

Thanks for your Attention

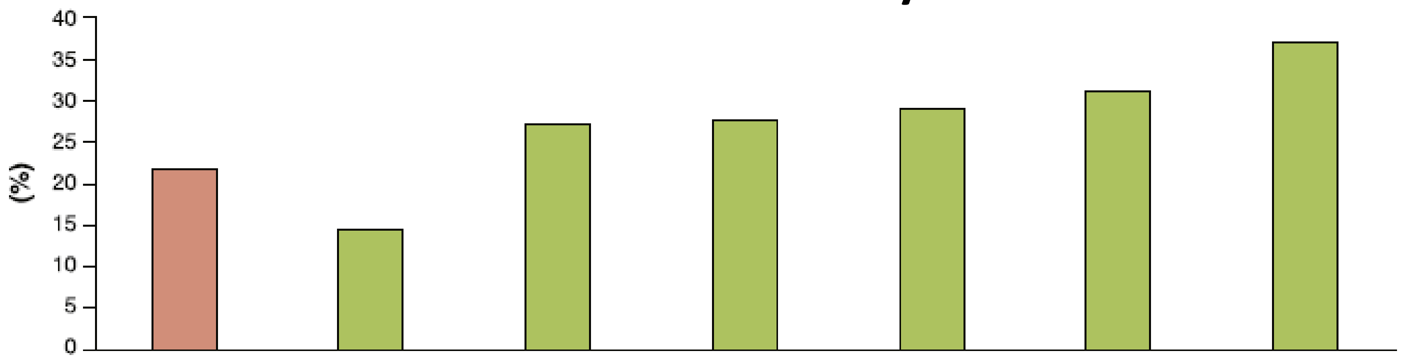


OCT after thrombosuction



Prevalence of Heterogeneous Neointima & Neoatherosclerosis

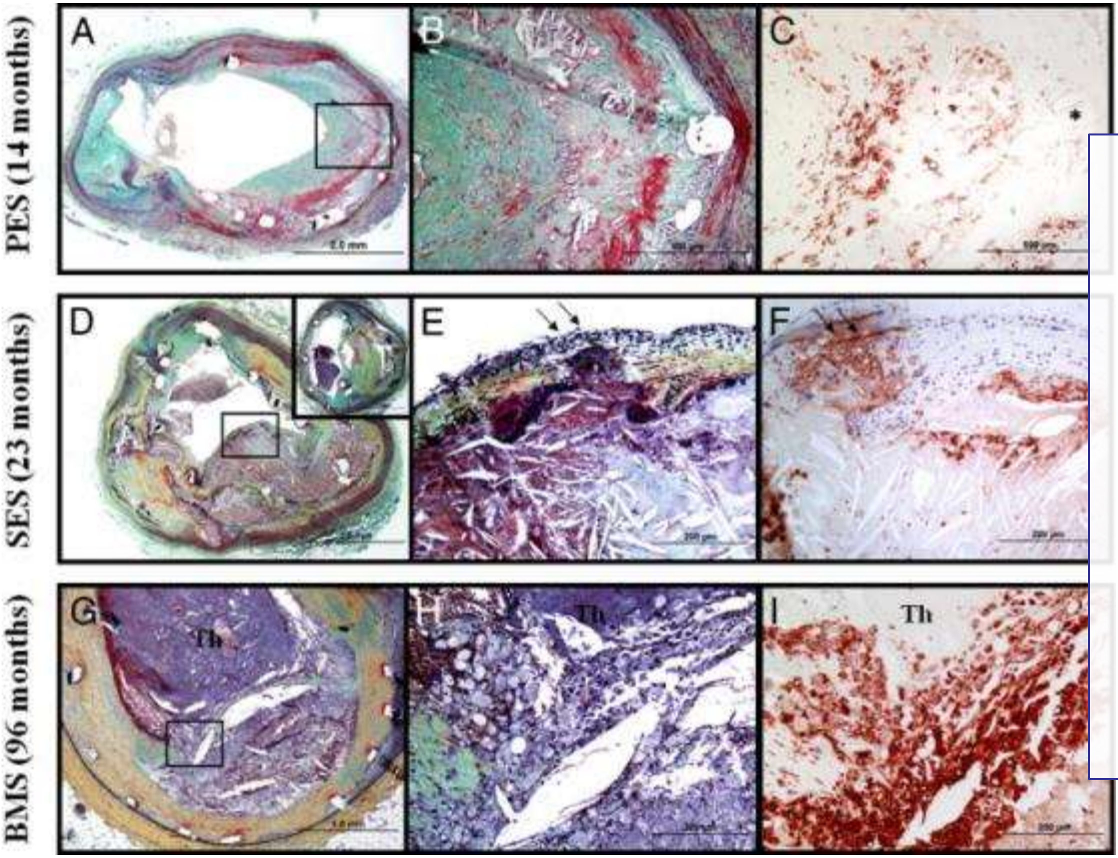
Prevalence 20-30 % according to clinical population of patients, stent age or definition of each study



Duration	8-9 Months	9 Months	22 Months (median)	24 Months	7 Months (median)	12 Months (median)	<9 Months
Type of DES	1st & 2nd Generation	1st & 2nd Generation	1st & 2nd Generation	1st & 2nd Generation	2nd Generation	1st Generation	1st & 2nd Generation
Type of Study	OCT	OCT	OCT	OCT	Histology	Histology	OCT
Definition of Neoathero-sclerosis or OCT Heterogeneous Pattern	Heterogeneous neointima, focally changing optical properties and various backscattering patterns	Lipid laden neointima	Lipid laden neointima calcification, or TCFA	Lipid laden neointima	Clusters of foamy macrophages within the neointima with/without necrotic core formation	Clusters of foamy macrophages within the neointima with/without necrotic core formation	Lipid laden neointima
Type of Lesion	Percent NIH CSA 18.8%	Percent NIH CSA 18.7±11.3%	>50 stenosis	Percent NIH CSA 23.4±14.5%	Autopsy	Autopsy	Stable AP (73%) & NSTEMI (27%)
Published Year	2014	2012	2013	2012	2013	2011	2012
Reference	Kim et al. (9)	Kim at al. (8)	Lee et al. (12)	Kim et al. (8)	Otsuka et al. (10)	Nakazawa et al. (4)	Yonetsu et al. (11)

Kenichi S, Virmani R, et al. J Am Coll Cardiol Img 2014

Pathology: neoatherosclerosis



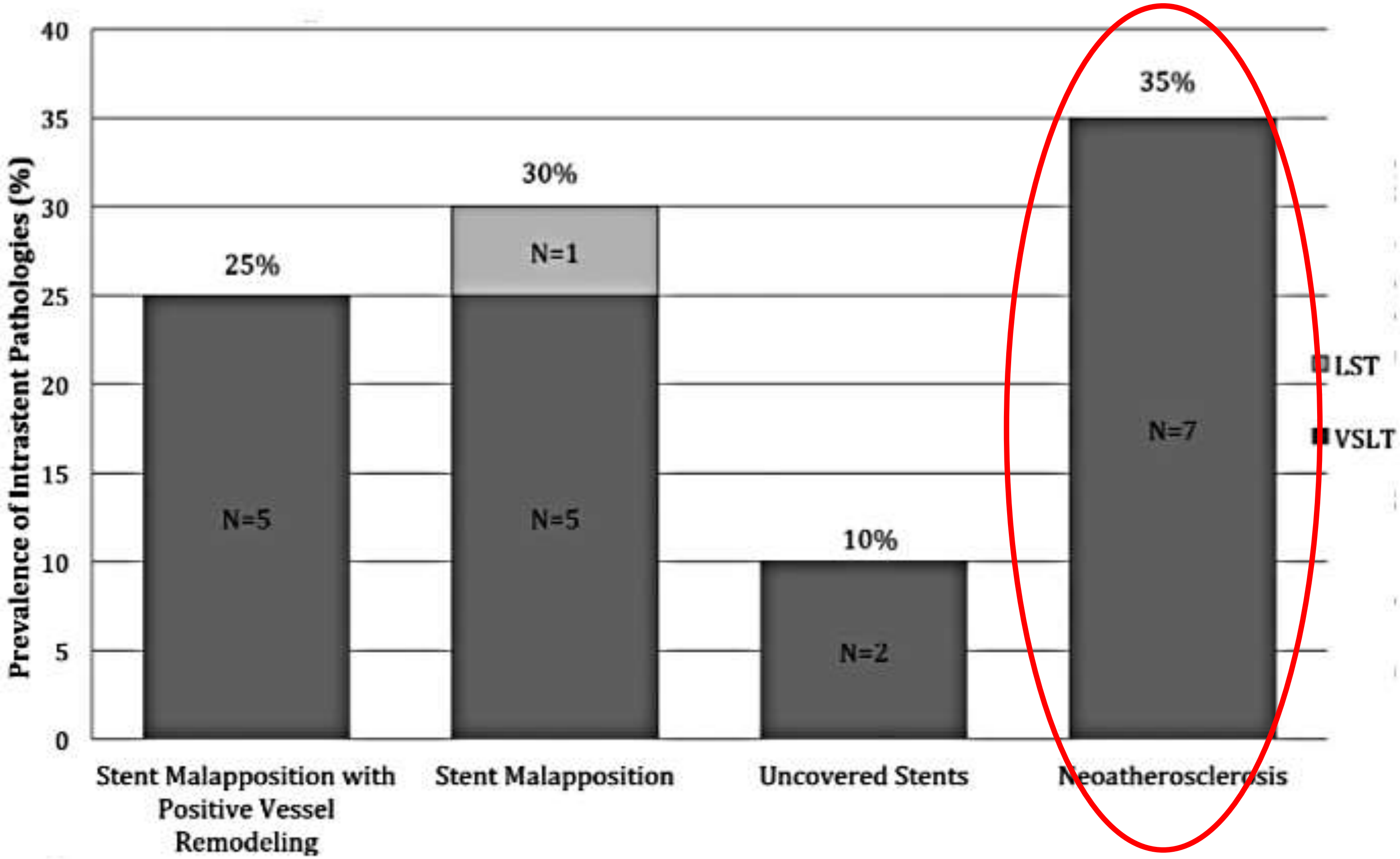
Neoatherosclerosis

- peristrut foamy macrophage cluster
- fibroatheroma
- thin-cap fibroatheroma
- rupture with thrombosis

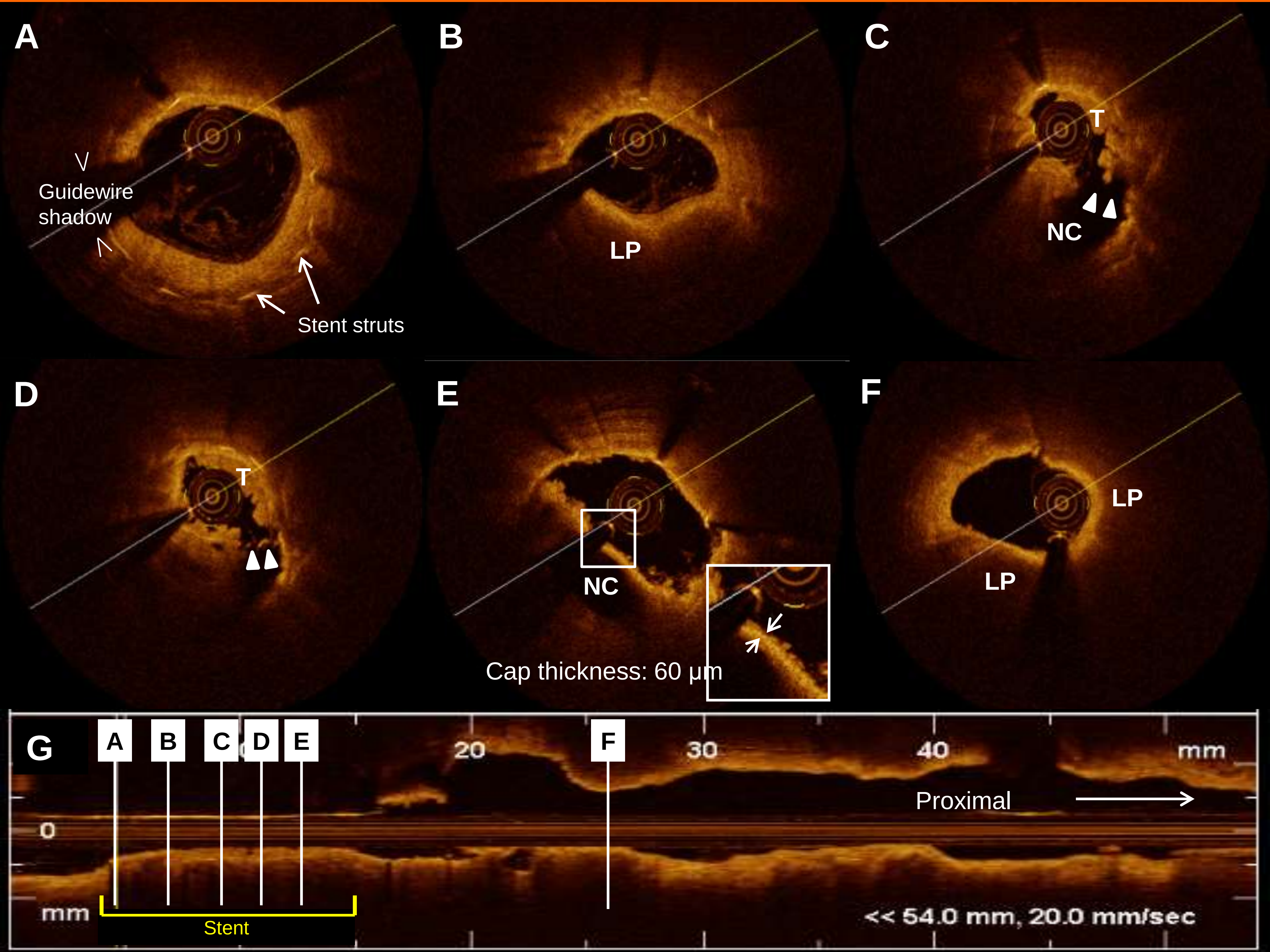
The Pathology of Neoatherosclerosis in Human Coronary Implants : Bare-Metal and Drug-Eluting Stents

Nakazawa G, et al, JACC, 2011;57:1314-1322

Identification of Intrastent Pathology Associated With Late Stent Thrombosis Using Optical Coherence Tomography

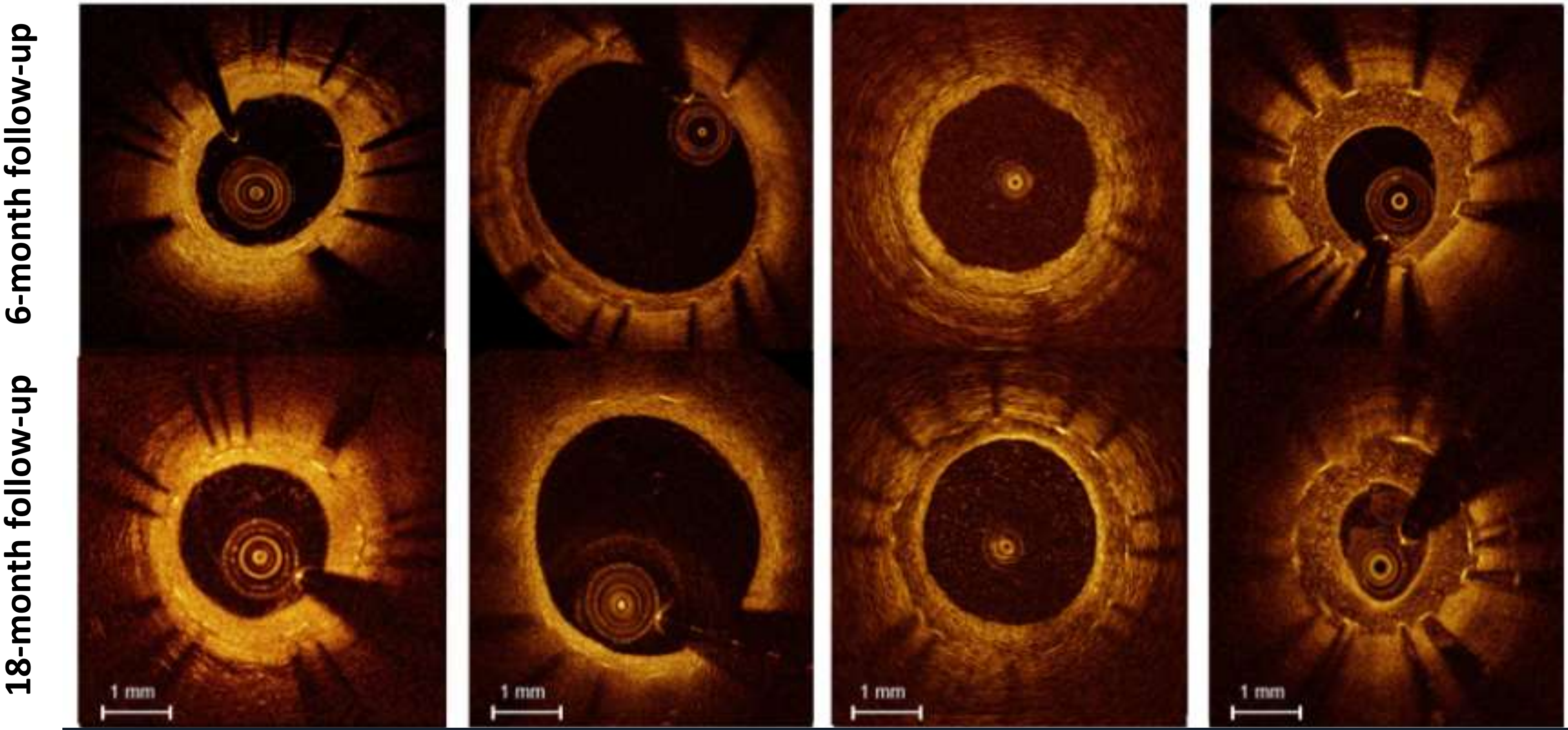


Jones CR, et al J Interven Cardiol 2015:28;439-448


A
Guidewire
shadow
Stent struts
B
LP
C
T
NC
D
T
E
NC
Cap thickness: 60 μm
F
LP
LP
G
A
B
C
D
E
F
20
30
40
mm
0
mm
Proximal
Stent
<< 54.0 mm, 20.0 mm/sec

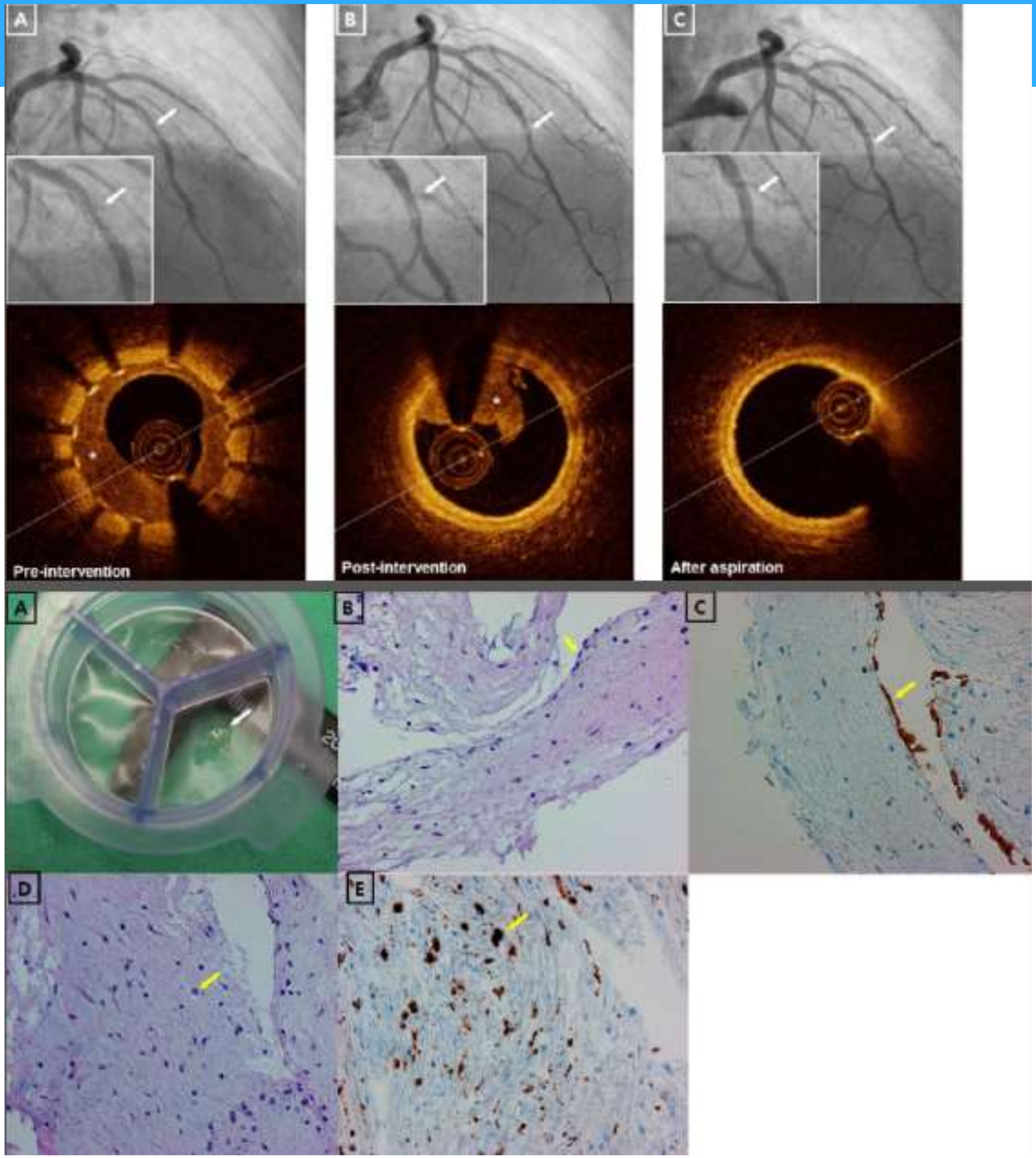
Statin may prevent the degeneration of neointima

Optimal LDL treatment | Conventional treatment



(A) There were **no changes in homogeneous** neointimal characteristics in the optimal lipid-lowering group. **(B) Changes from the non-homogeneous to homogeneous** neointima were observed in the optimal lipid-lowering group. **(C)** Changes from the **homogeneous to non-homogeneous** neointima were observed in the conventional group. **(D)** There were **no changes in non-homogeneous** neointimal characteristics in the conventional group

Jang JY, Kim JS, Hong MK, et al. Atherosclerosis 2015

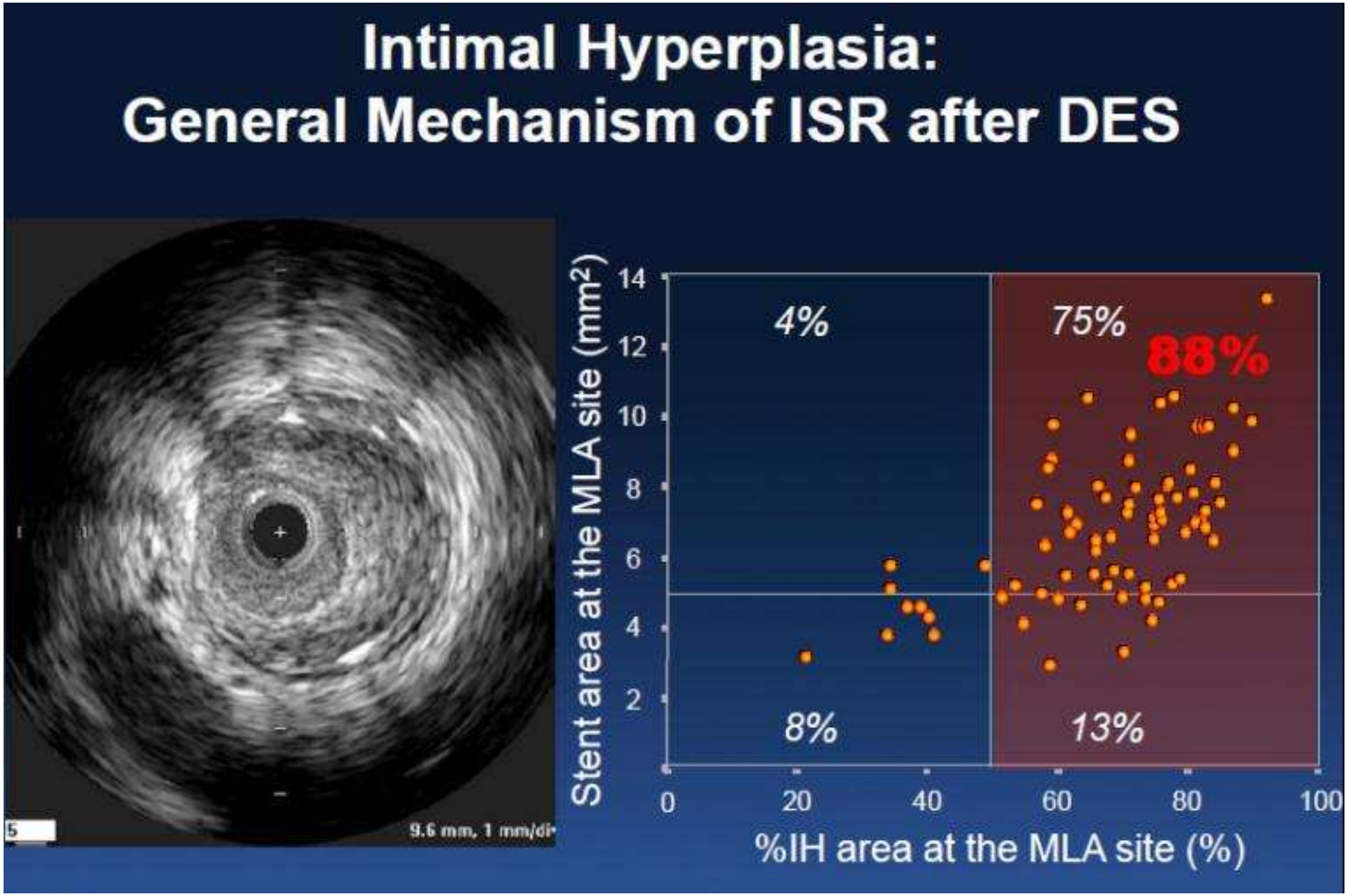


Heterogeneous Pattern of Neointima

- loose tissue containing scattered short spindle cells in the myxoid stroma on pathologic examination

Cho SS, et al Circulation 2015

Mechanism of DES ISR



Kang SJ, et al. Cir Cardiovasc Interv 2011;4:9-14