



IVUS Assessment of Stent Failure

Junko Honye MD, PhD

Director, Cardiovascular Center

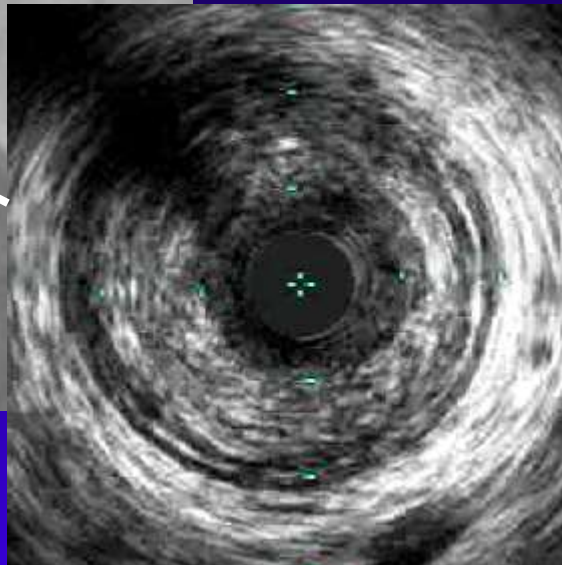
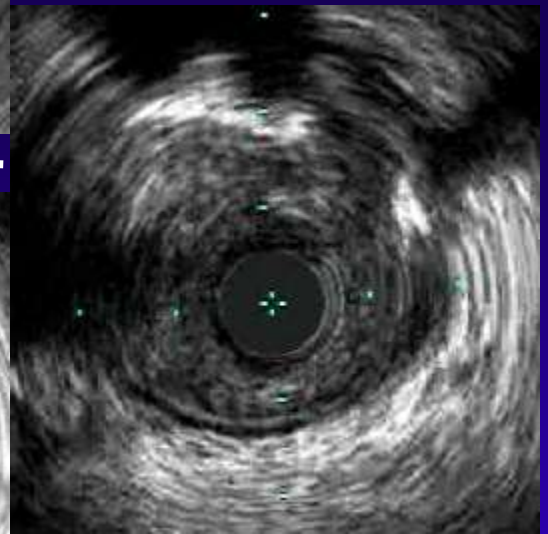
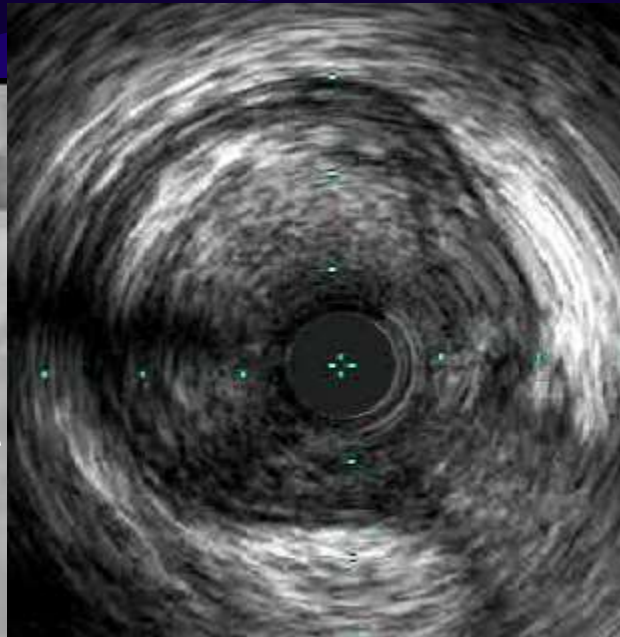
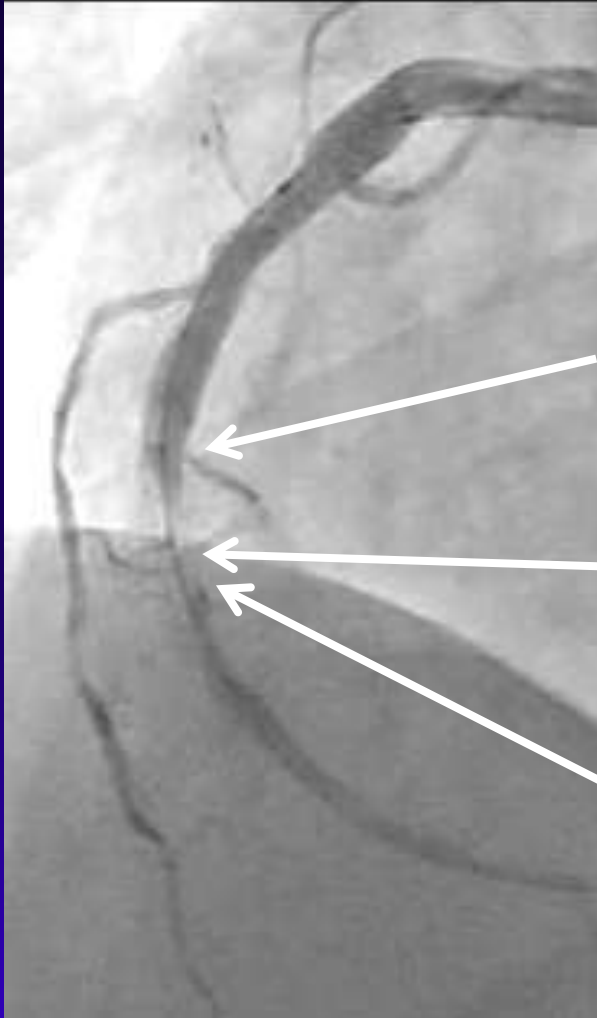
Kikuna Memorial Hospital, Kanagawa

IVUS predictors of early stent thrombosis

- **Stable angina**
 - Small stent area**
 - Residual inflow/outflow disease**

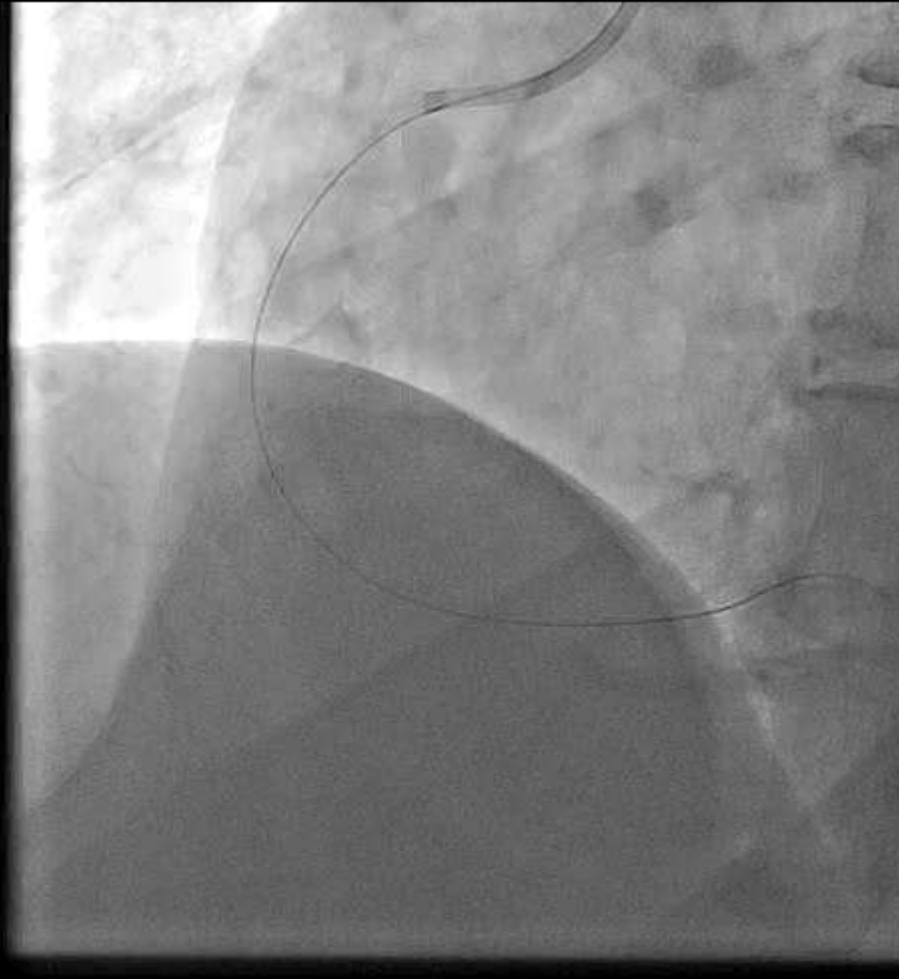
Fujii K, et al JACC 2005; 45: 995

RCA CTO

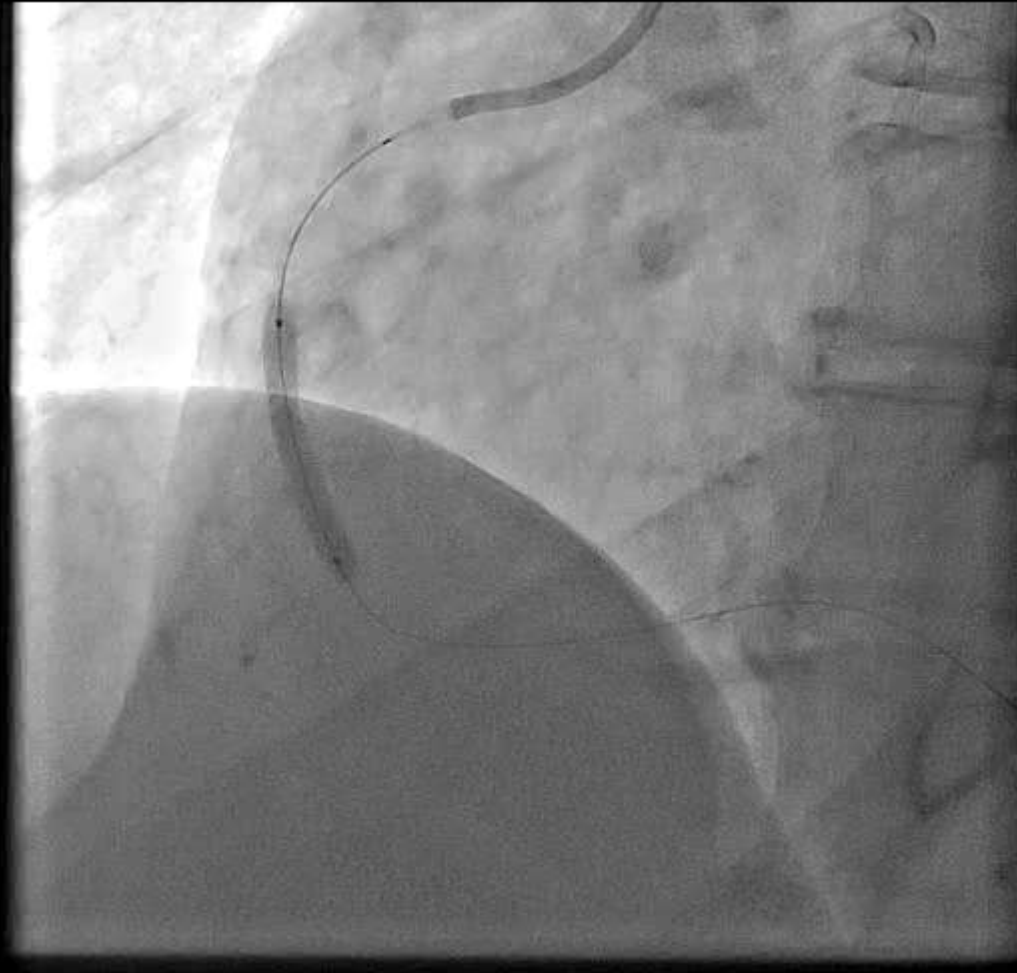


Post POBA

Stenting

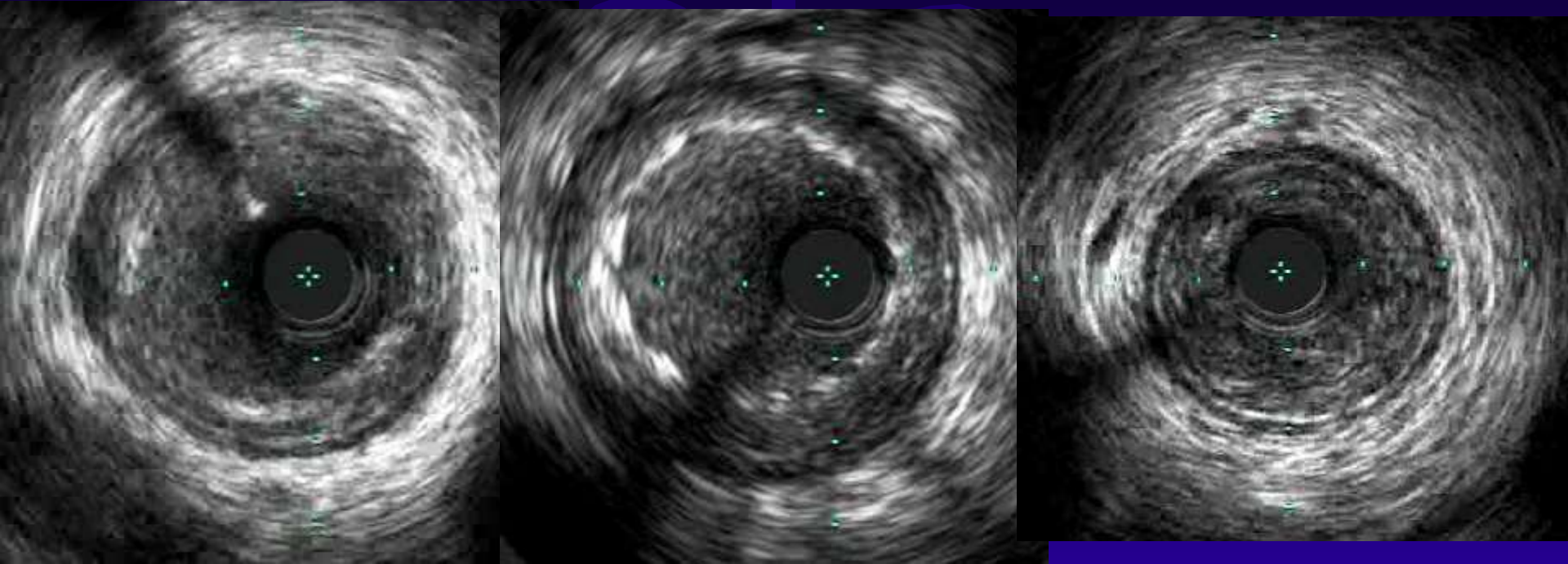


Post POBA 3.0mm



Resolute 3.5/26mm

Immediately after stenting



Distal to the stent

Body of the stent

Proximal to the stent

Residual inflow disease?

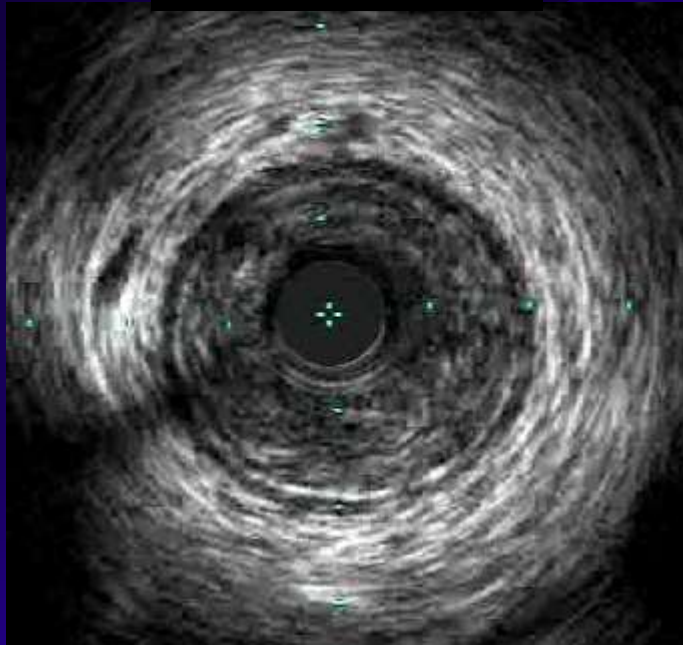
Intracoronary nitroglycerin



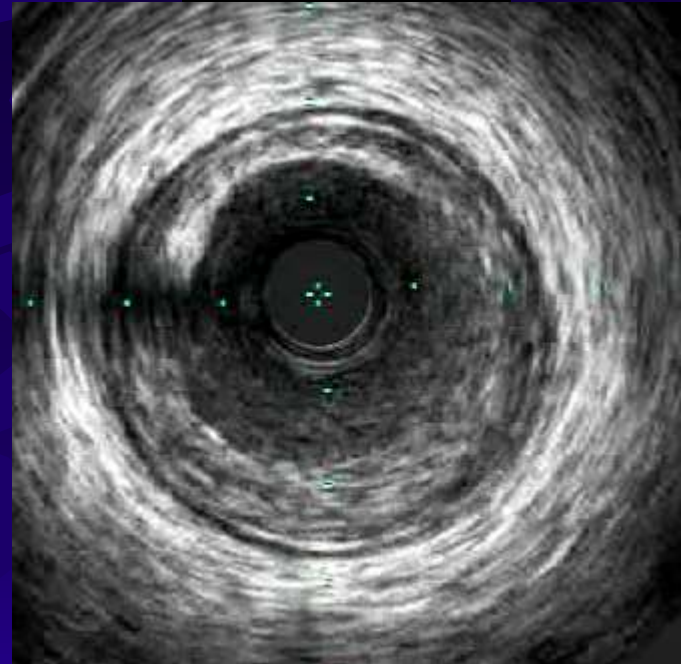
IVUS post ISDN

Coronary spasm

Before ISDN



Post ISDN



Do no misinterpret coronary spasm as inflow/outflow residual stenosis. Always inject nitroglycerin after stent implantation to avoid unnecessary additional stent implantation

IVUS predictors of early stent thrombosis

➤ **Stable angina**

Small stent area

Residual inflow/outflow disease

Fujii K, et al JACC 2005; 45: 995

➤ **Acute myocardial infarction**

Smaller MLA < 5mm²

Significant residual stenosis

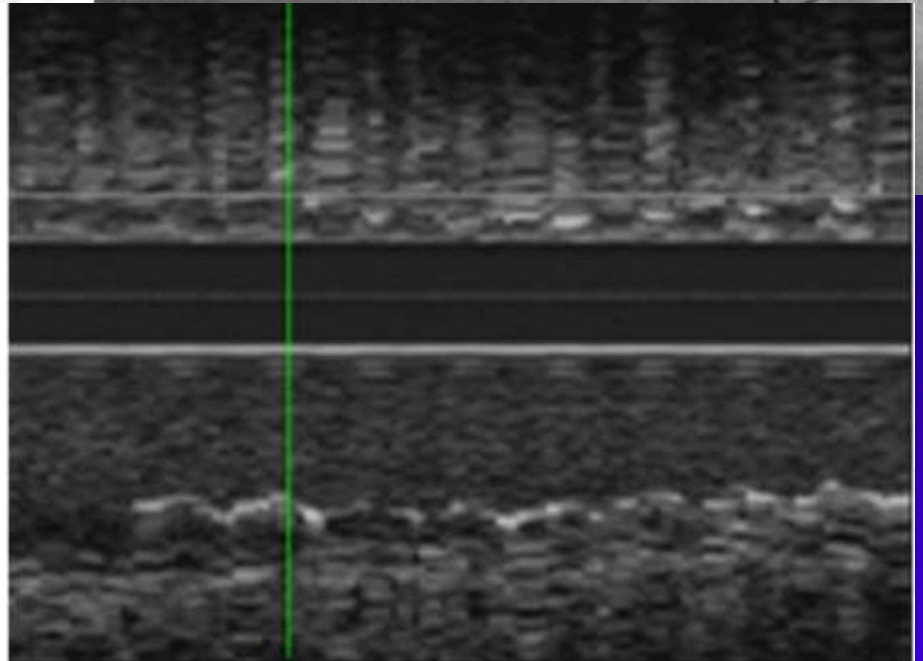
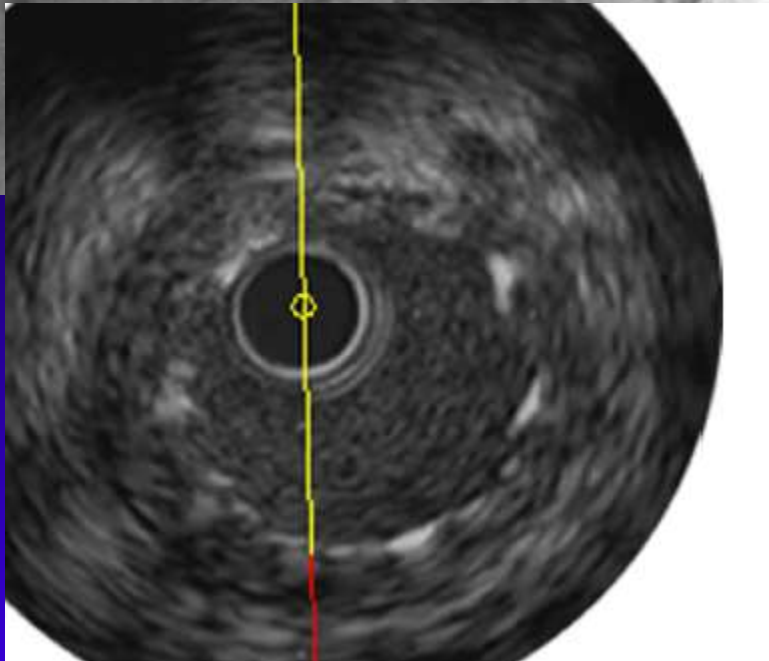
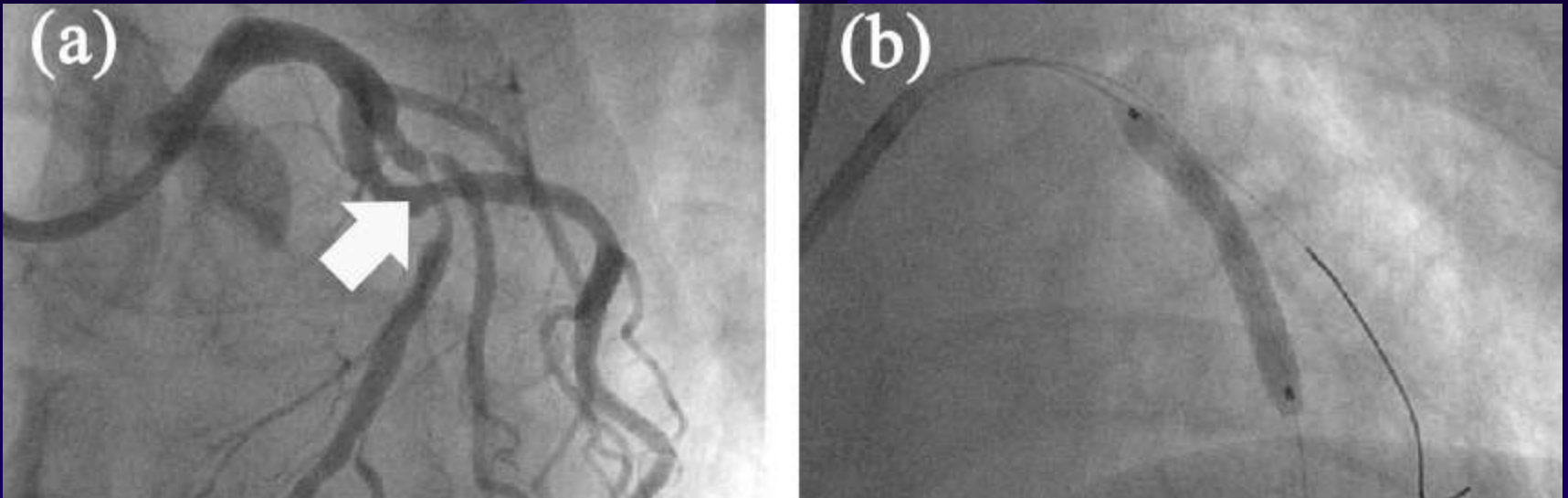
Edge dissection $\geq 60^\circ$ and MLA < 4mm²

Tissue protrusion

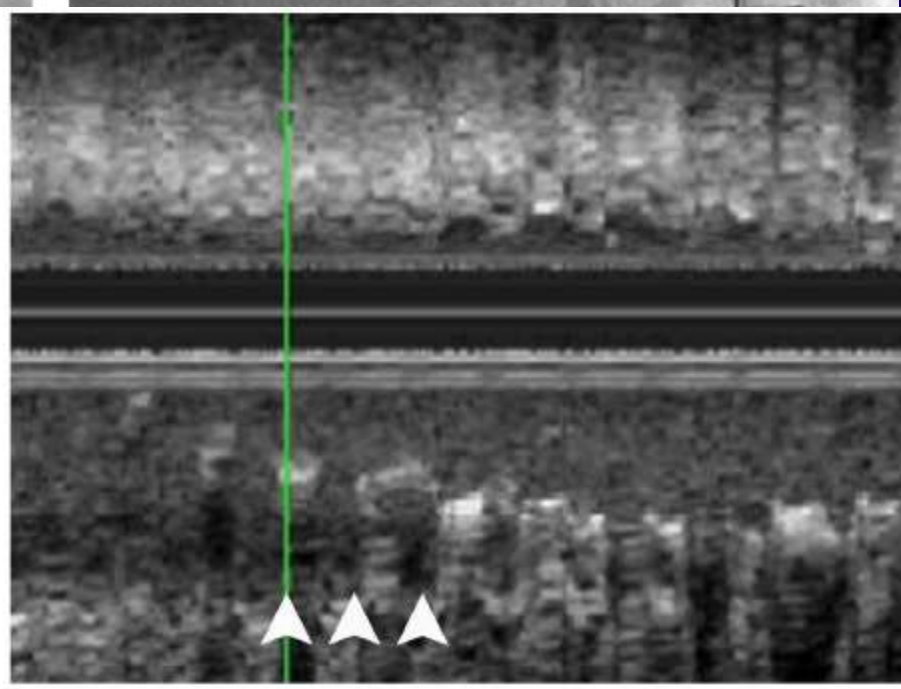
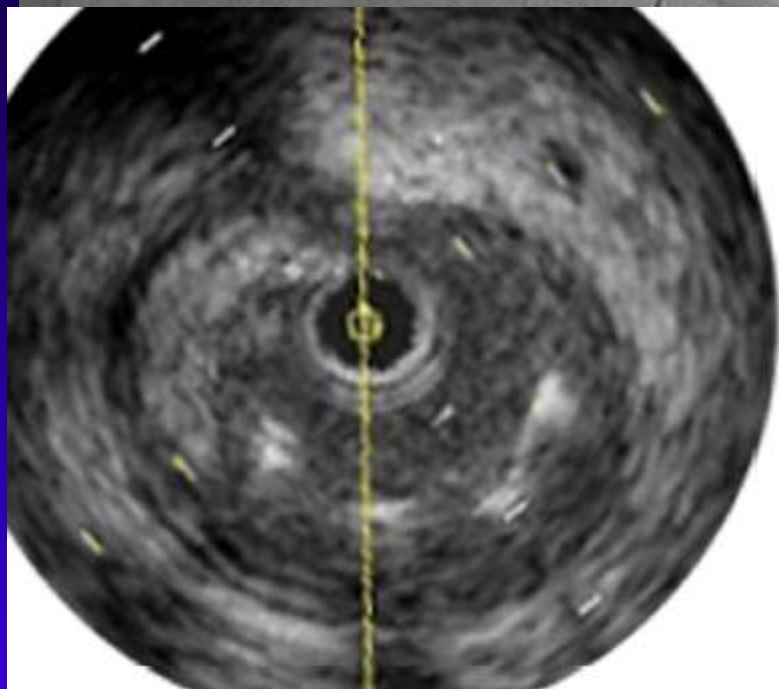
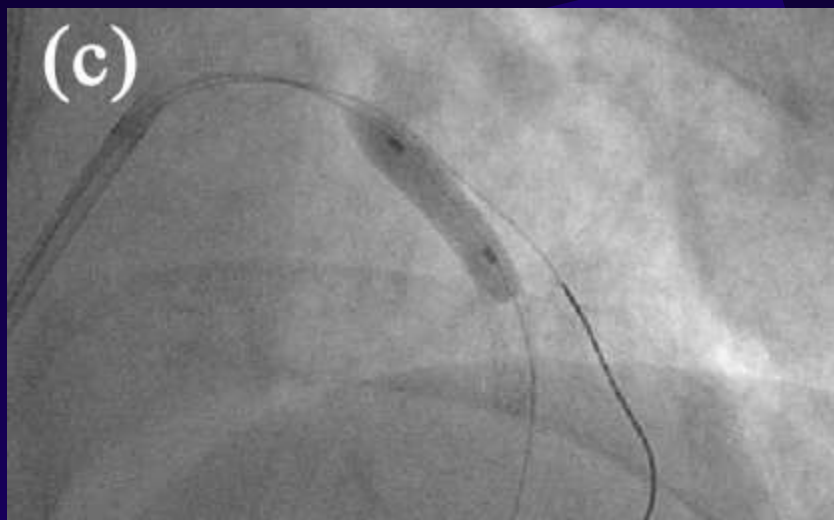
Not acute incomplete apposition

Choi SY, et al Circ Cardiovasc Interv 2011 ; 4: 239

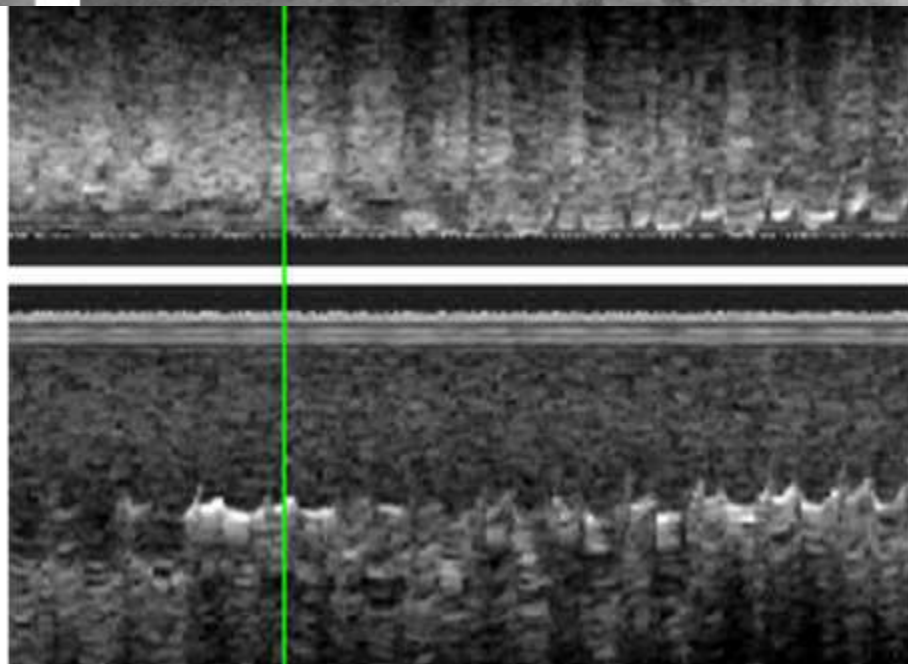
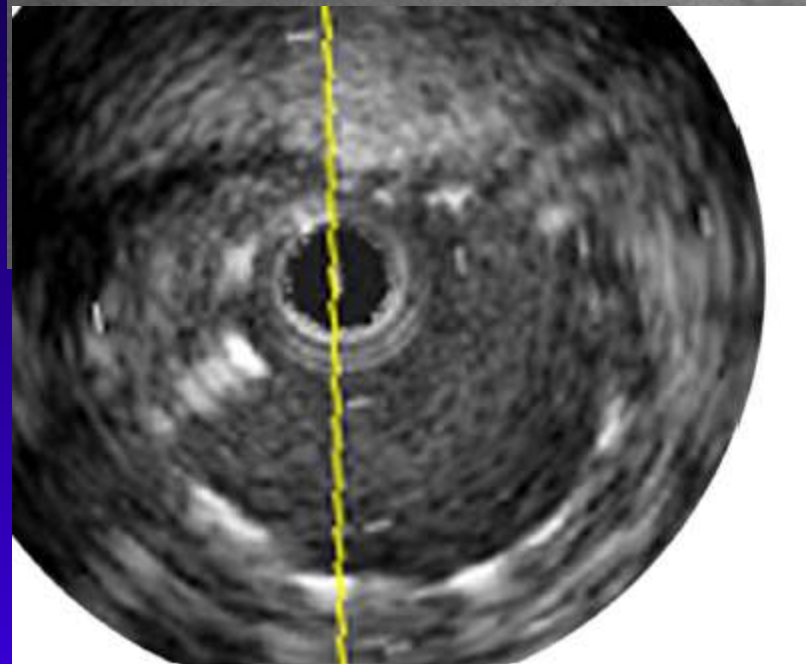
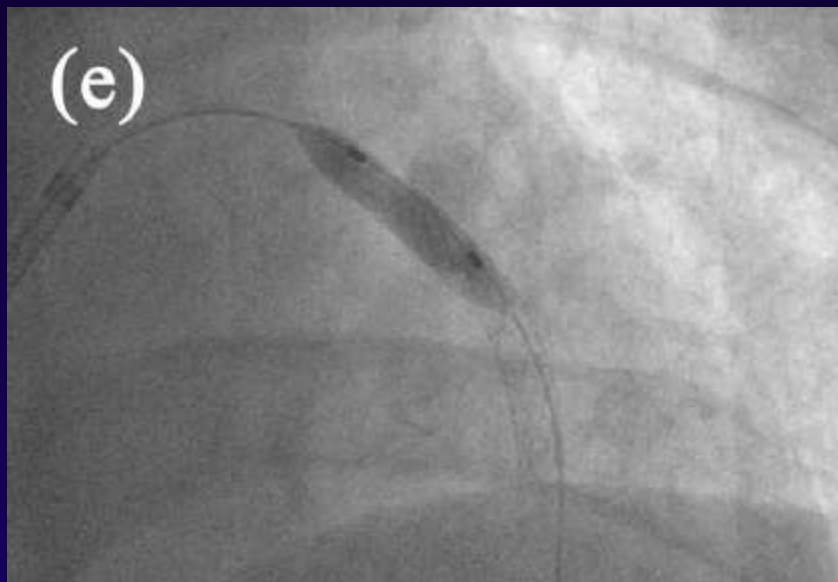
Immediately after stent implantation



Post dilatation 3.5x12 mm



Final



Acute stent malapposition rarely related to MACE

Study	ASM frequency	Clinical outcomes
HORIZON-AMI¹	34% of PES 39% of BMS	39% resolved by negative remodeling No difference in 13-month MACE
TAXUS IV,V,VI²	9.7% of PES 7.2% of BMS	No difference in 9-mo MACE between ASM vs. control (12% vs. 9%, p=0.45)
Hong et al.³	7.2% of DES	No MACE or TLR at 6 months
Kimura et al.⁴	18% of SES	25% of ASM resolved at 6 months No ISR or ST

¹Guo et al. Circulation 2010;122:1077-84

²Steinberg et al. JACC interv 2010;3:486-94

³Hong et al. Circulation 2006;113:414-9

⁴Kimura et al. Am J Cardiol 2006;98:36-42

Stent failute

➤ **Acute**

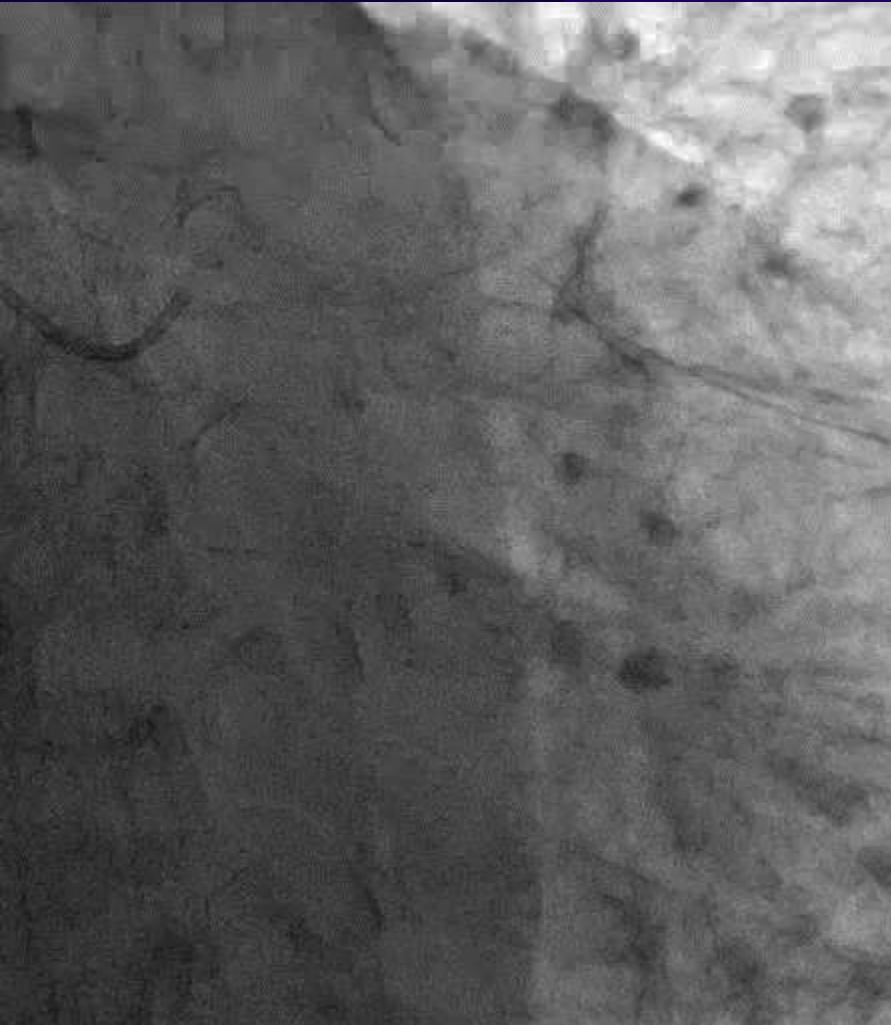
Malapposition

Edge dissection, Hematoma

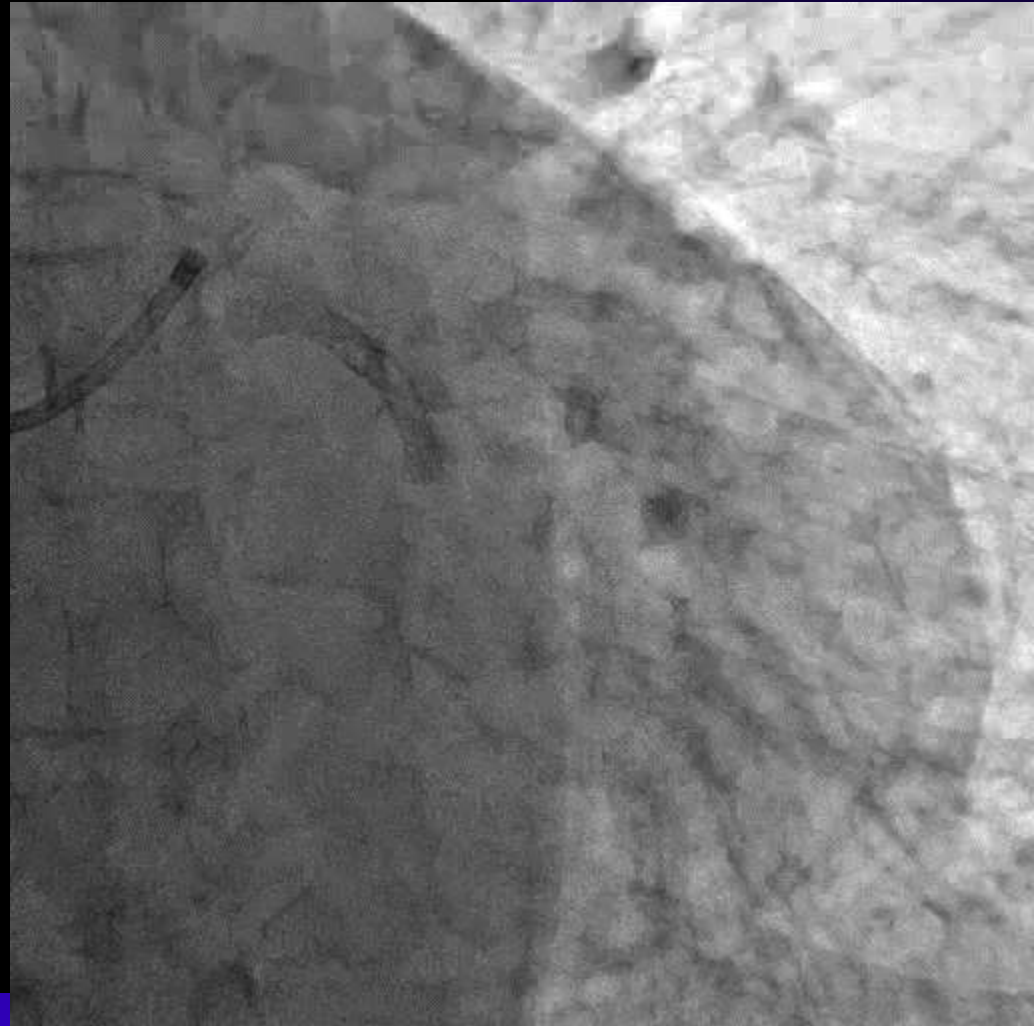
Perforation

Deformation

Case: Edge dissection



Case: Edge dissection



Additional stent




Incidence, Morphology, Angiographic Findings, and Outcomes of Intramural Hematomas After Percutaneous Coronary Interventions

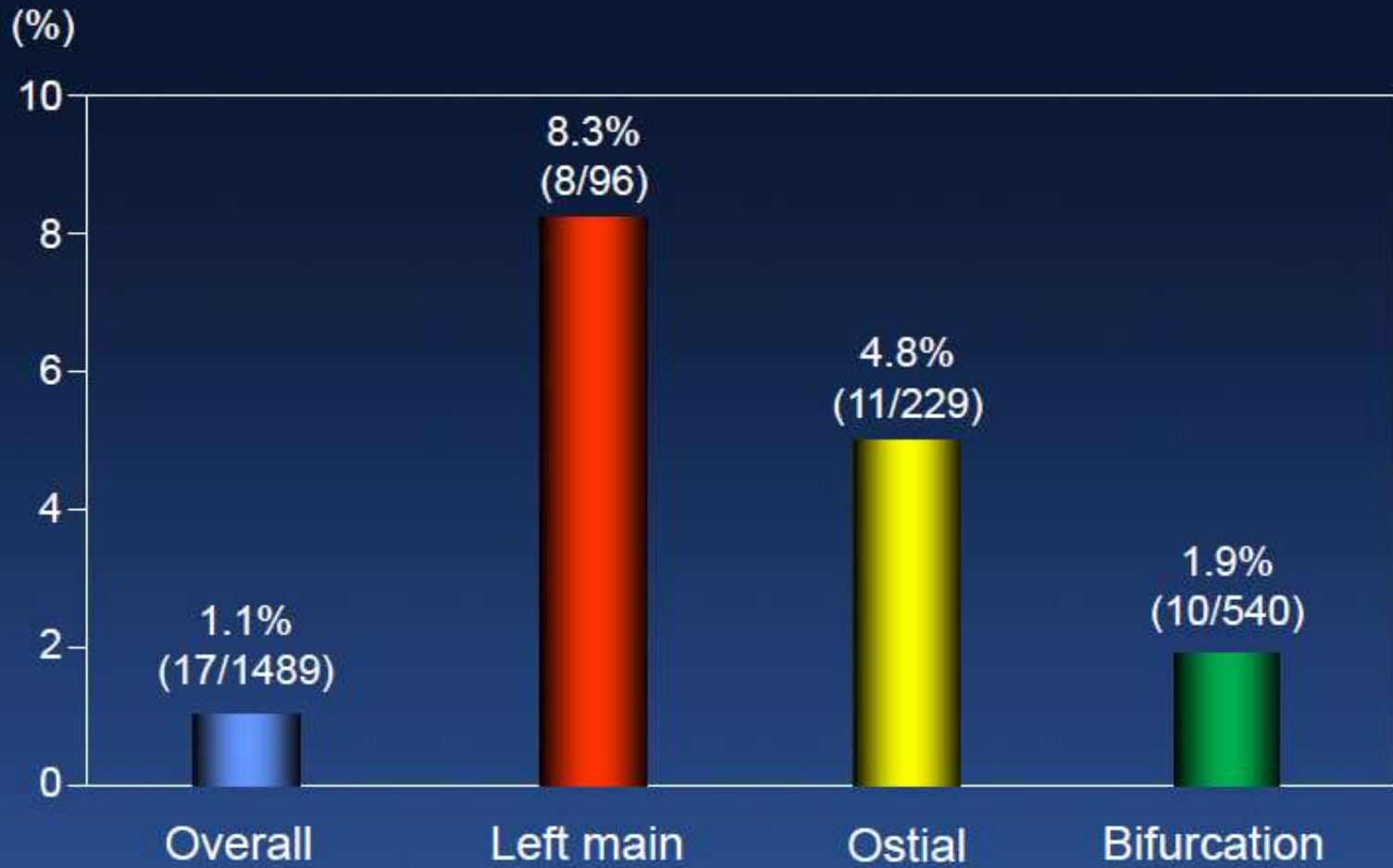
An Intravascular Ultrasound Study

Akiko Maehara, MD; Gary S. Mintz, MD; Anh B. Bui, MD; Marco T. Castagna, MD; Olga R. Walter, RN; Chrysoula Pappas, MD; Ellen E. Pinnow, MS; Augusto D. Pichard, MD; Lowell F. Satler, MD; Ron Waksman, MD; William O. Suddath, MD; John R. Laird, Jr, MD; Kenneth M. Kent, MD, PhD; Neil J. Weissman, MD

Conclusions—Intravascular ultrasound identified intramural hematomas after 6.7% of PCIs. The mechanism appeared to be a dissection into the media where blood accumulated because of a lack of re-entry. A third of ultrasound-identified hematomas showed no angiographic abnormalities. There was a high rate of non-Q-wave myocardial infarction, need for repeat revascularization, and sudden death in patients with hematomas. (*Circulation*. 2002;105:2037-2042.)



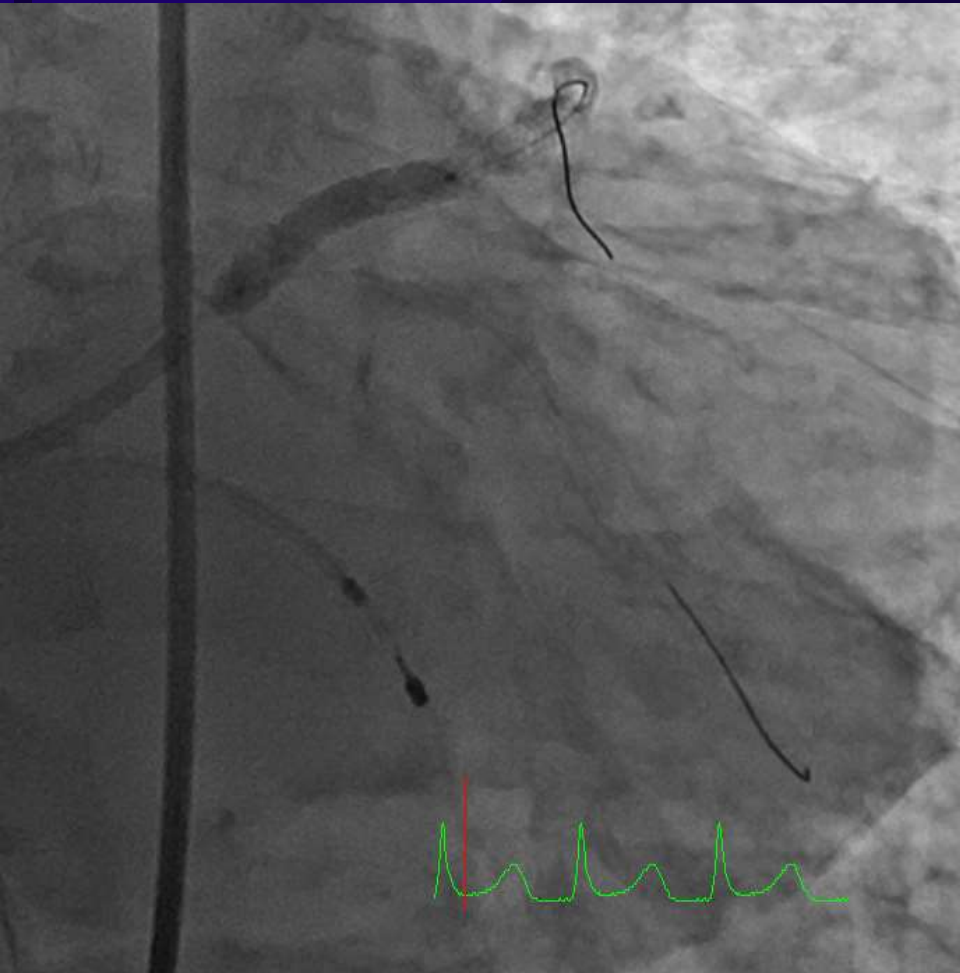
Incidence of stent deformation



Ostial to mid-LAD disease



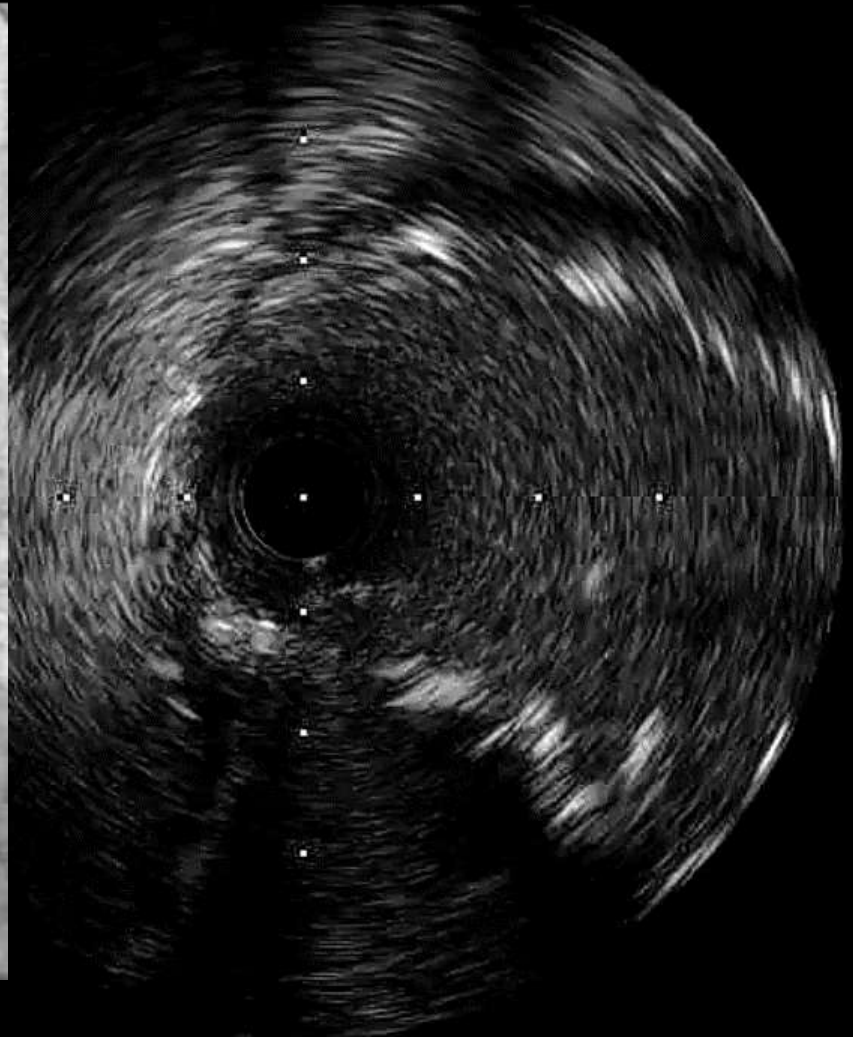
GC: EBU 3.5



Promus Premier 3.5 / 28 to mid-LAD
Promus Premier 4.0 / 20 to LMT-LAD

Stent deformation

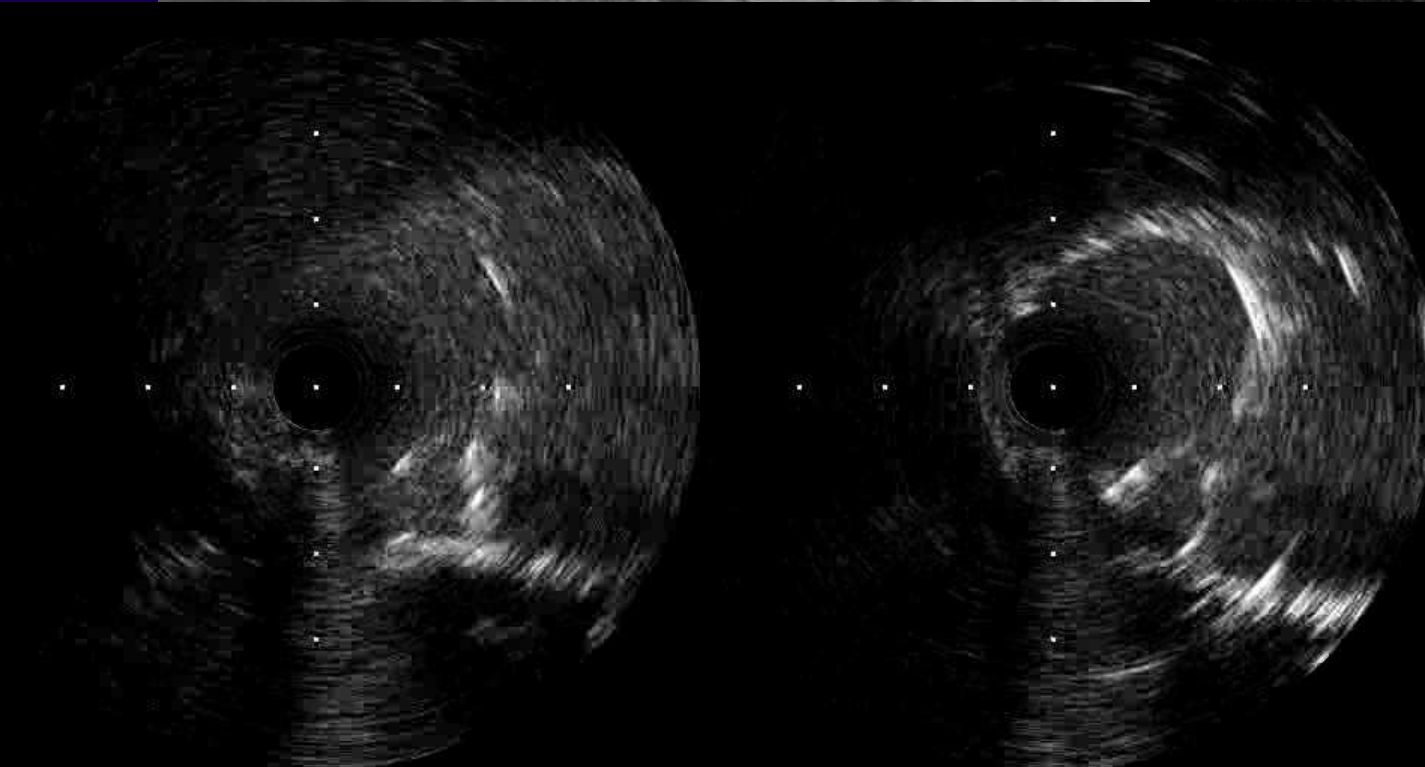
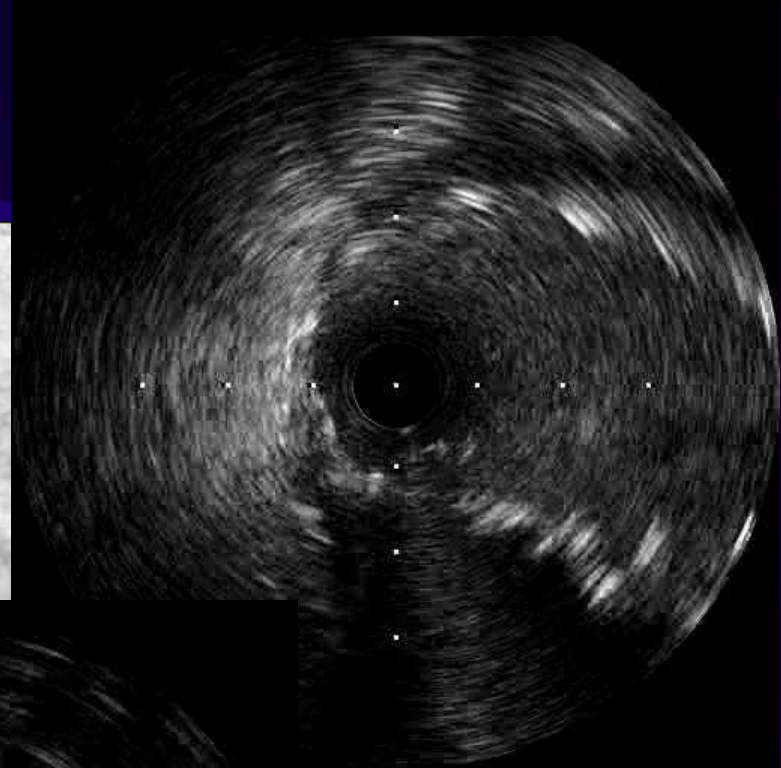
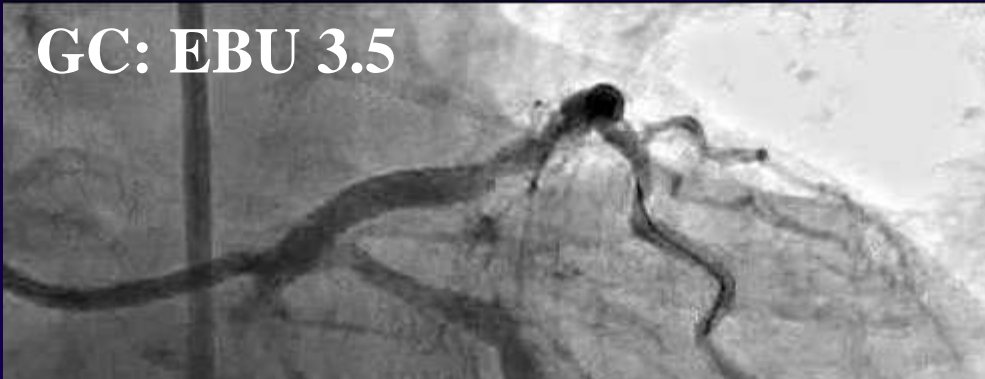
GC: EBU 3.5



Post KBT

Stent deformation

GC: EBU 3.5



Need post-dilatation!

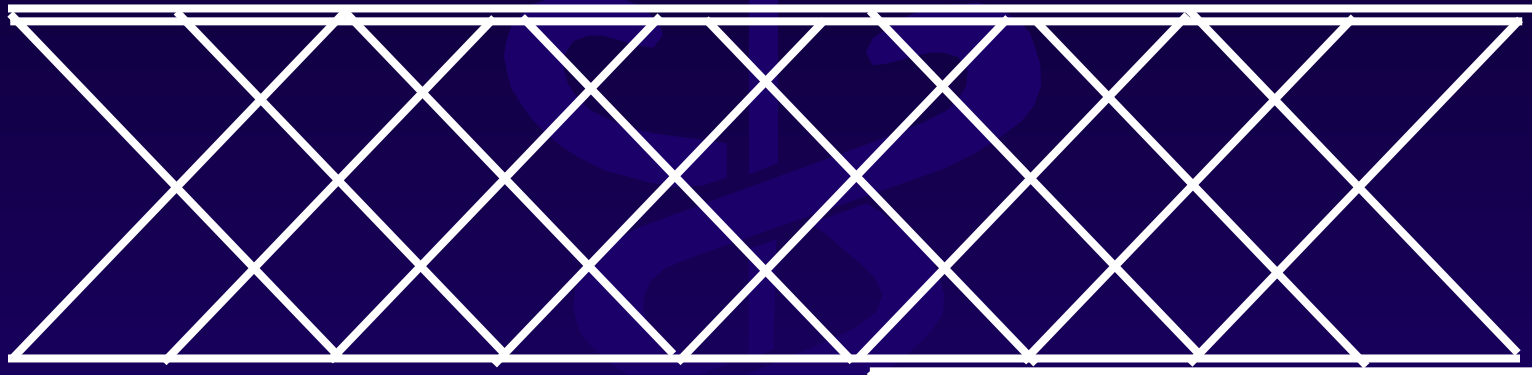
To minimize stent deformation

- **It would better to use short-tip guiding catheter for LM PCI. If you want use back-up type GC for stronger support, always pay attention to the tip of a GC at LM.**
- **Carefully choose stent type (2 link stent)**
- **Proximal optimization technique (POT) would be recommended to obtain better apposition at proximal part of the stent.**
- **Try to obtain complete apposition before proceeding to the next steps, i.e. guidewire crossing to a side branch or retrieval and KBT.**

Immediately after stenting

LMT

LAD



Malapposition



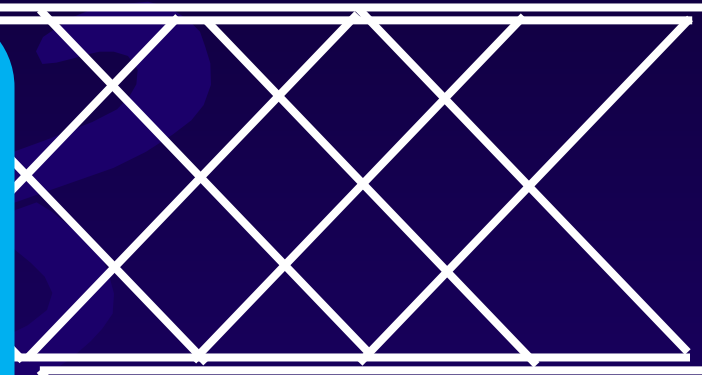
Proximal optimization

LMT

LAD

Ballooning with optimal size

Better apposition
Open stent struts
Better side branch access



Stent failute

➤ **Acute**

Malapposition

Edge dissection, Hematoma

Perforation

Deformation

➤ **Chronic**

Fracture / Deformation related to restenosis

In-stent restenosis (ISR): underexpansion

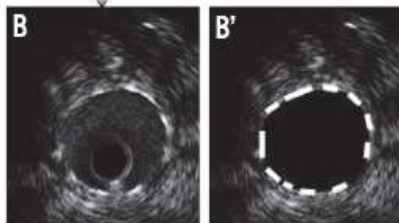
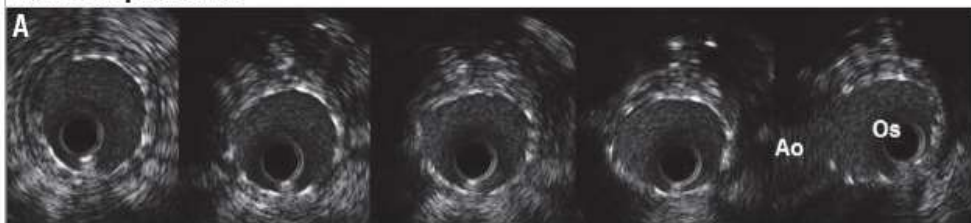
Late stent thrombosis

Fracture, stent unerexpansion

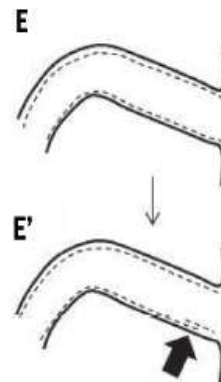
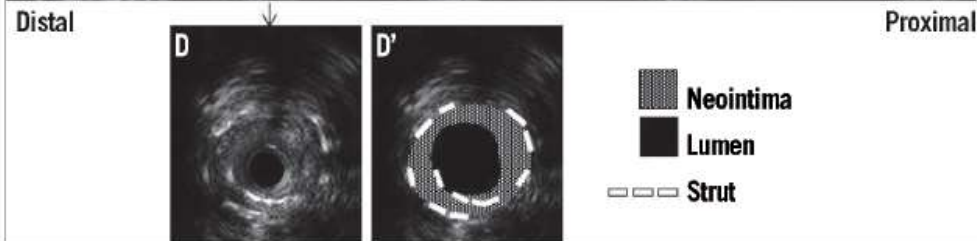
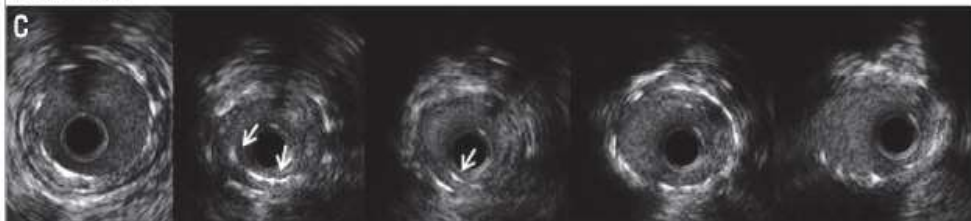
Neointimal hyperplasia / neoatherosclerosis

Fracture/deformation of EES relates to restenosis

Baseline: post-stent



Follow-up

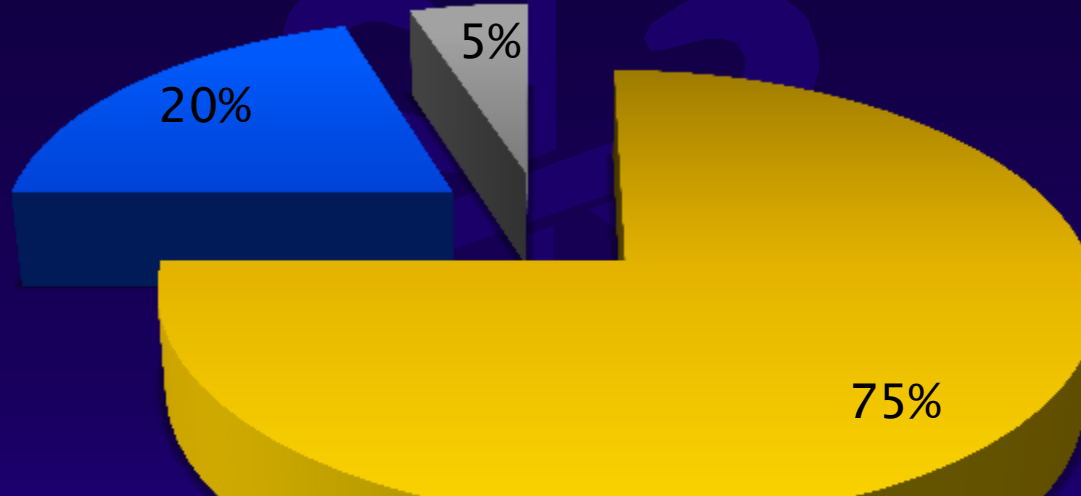


- ✓ 177 EES in 136 pts
- ✓ FU IVUS (1.3yrs)
- ✓ 17 pts with 15 TLR
- ✓ 29% visible fracture
- ✓ 36% smaller stent area

Mechanisms of ISR

Underexpansion is underappreciated contributor to ISR

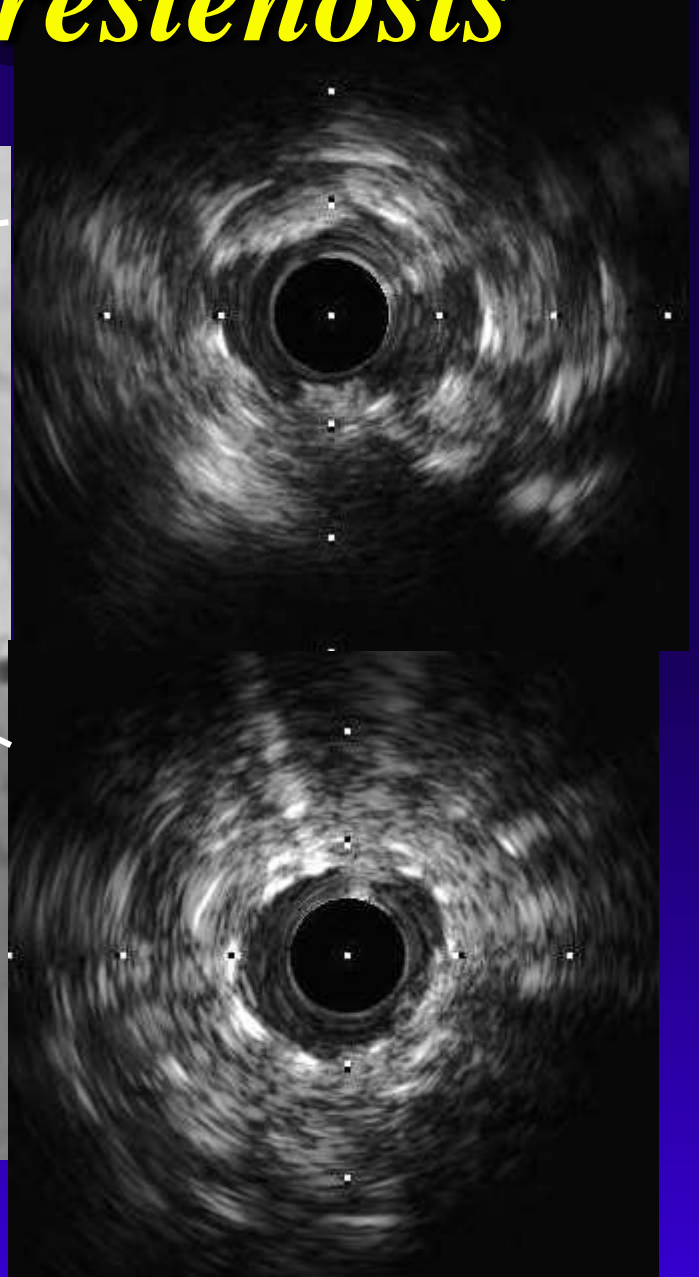
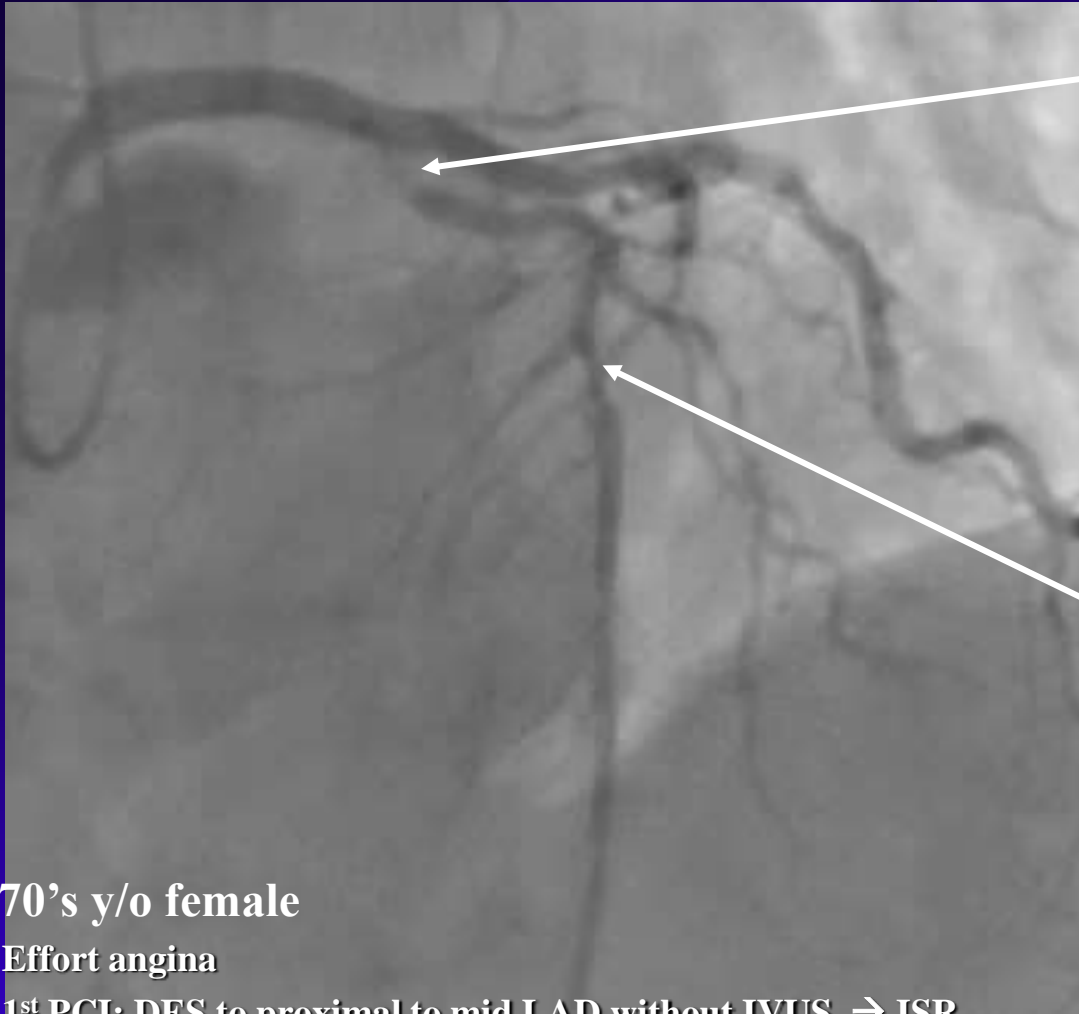
- 1090 ISR lesions referred
- IVUS performed



25% of lesions without significant neointimal hyperplasia

■ NIH ■ Underexpansion ■ Mechanical

Recurrent in-stent restenosis



70's y/o female

Effort angina

1st PCI: DES to proximal to mid LAD without IVUS → ISR

2nd PCI: Another DES to ISR without IVUS again! → ISR

3rd PCI: Planned to use drug-coated balloon to the ISR segment

Stent underexpansion...

Predicts in-stent restenosis of DES

	Population	DES	Endpoint	MSA Cut-off
SIRIUS ¹	72	SES	8 mo, MLA<4.0mm ²	5.0mm²
Hong ²	550	SES	6 mo, Angio-ISR	5.5mm²
TAXUS-Meta ³	1098	PES	9 mo, Angio-ISR	5.7mm²

¹J Am Coll Cardiol 2004;43:1959-63 ² Eur Heart J 2006;27:1305-10 ³ JACC Interv 2009;2:1269-75

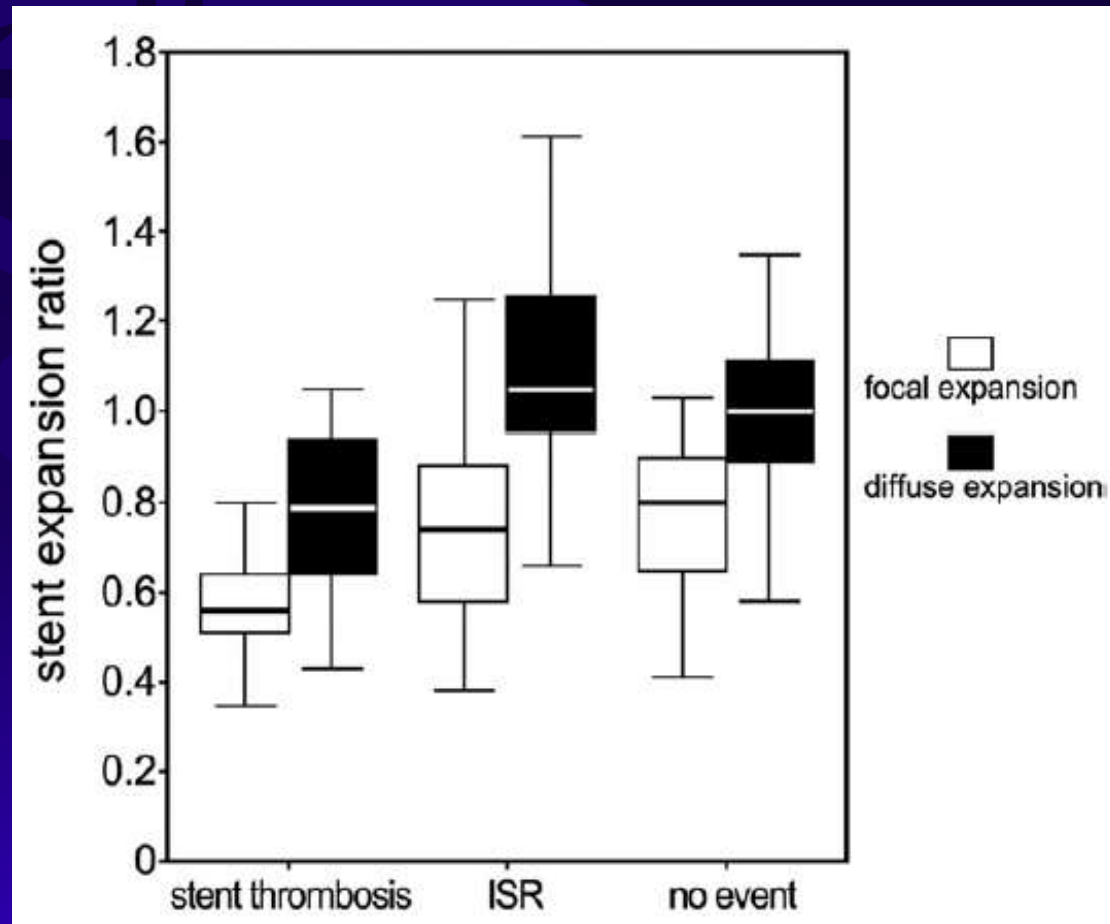
Predicts thrombosis following DES

	Population	DES	Endpoint	Rate of Underexpansion
Fujii ¹	15 ST vs. 45 controls	SES	ST <1 month	<5.0mm ² in 80% vs. 29%
Okabe ²	13 ST vs. 27 controls	DES	ST <1 year	<5.0mm ² in 79% vs. 40%
Liu ³	20 ST vs. 50 controls	DES	ST <1 year	<5.0mm ² in 85% vs. 26%

¹ J Am Coll Cardiol 2005;45:995-8 ² Am J Cardiol 2007;100:615-20 ³ JACC interv 2009;2:428-34

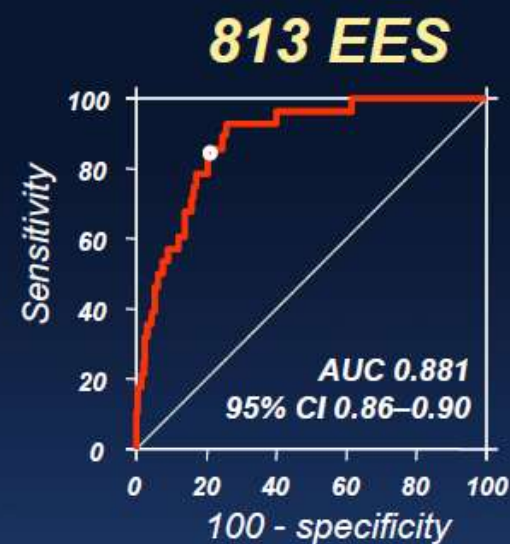
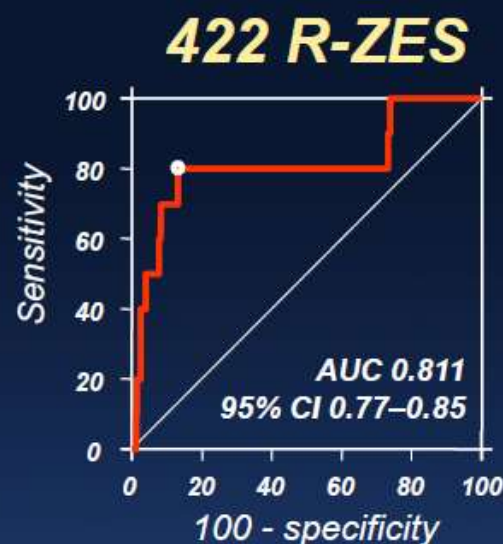
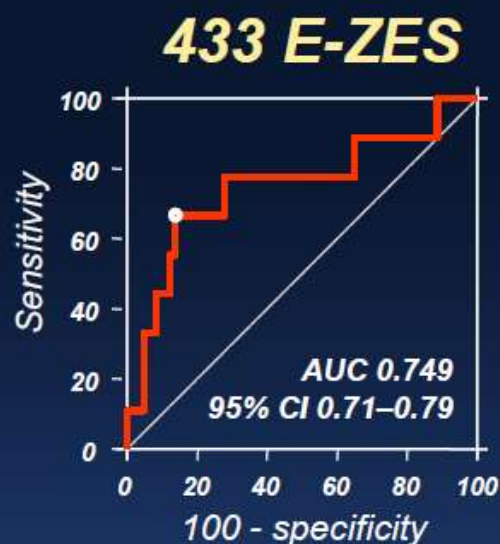
Stent underexpansion

Underexpansion associated with thrombosis is more severe, diffuse and proximal in location.



Intravascular Ultrasound Predictors for Edge Restenosis After Newer Generation Drug-Eluting Stent Implantation

Soo-Jin Kang, MD, PhD^a, Young-Rak Cho, MD^a, Gyung-Min Park, MD^a, Jung-Min Ahn, MD^a, Won-Jang Kim, MD^a, Jong-Young Lee, MD^a, Duk-Woo Park, MD, PhD^a, Seung-Whan Lee, MD, PhD^a, Young-Hak Kim, MD, PhD^a, Cheol Whan Lee, MD, PhD^a, Gary S. Mintz, MD^b, Seong-Wook Park, MD, PhD^a, and Seung-Jung Park, MD, PhD^{a,*}



Plaque burden=56.3%
Sensitivity 67%
Specificity 86%

Plaque burden=57.3%
Sensitivity 80%
Specificity 87%

Plaque Burden=54.2%
Sensitivity 86%
Specificity 80%

→ Find adequate landing zones

Take home message

- **Procedural and technical problems usually contribute acute stent failure such as longitudinal stent deformation.**
- **Stent underexpansion and stent edge problems are the risk factors for acute stent thrombosis as well as in-stent restenosis and late thrombotic event.**
- **Adequate procedure with careful technique with IVUS guidance would be able to minimize acute and chronic stent failure.**