

OCT Evaluation of Neointimal Coverage and Malapposition

Kenichi Fujii, MD

Hyogo College of Medicine

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Hyogo College of Medicine



Neointimal Coverage After DES

Pathological Correlates of Late Drug-Eluting Stent Thrombosis

Strut Coverage as a Marker of Endothelialization

Aloke V. Finn, MD*; Michael Joner, MD*; Gaku Nakazawa, MD; Frank Kolodgie, PhD;
John Newell, AB; Mike C. John, MPH; Herman K. Gold, MD; Renu Virmani, MD

Background—Late stent thrombosis (LST) after Cypher and Taxus drug-eluting stent placement has emerged as a major

The most powerful histological predictor of stent thrombosis was endothelial coverage.

The best morphometric predictor of LST was the ratio of uncovered to total stent struts.

to 22).

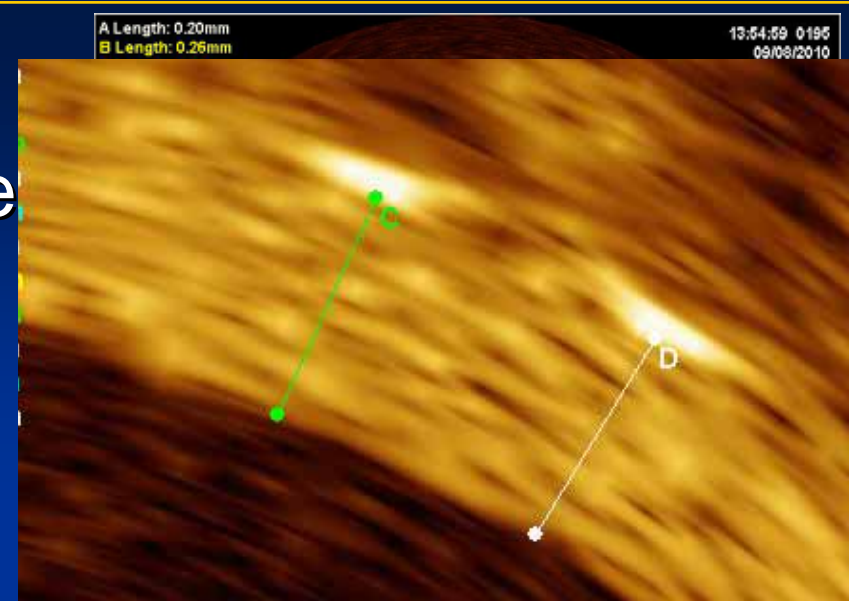
Conclusions—The most powerful histological predictor of stent thrombosis was endothelial coverage. The best morphometric predictor of LST was the ratio of uncovered to total stent struts. Heterogeneity of healing is a common finding in drug-eluting stents with evidence of LST and demonstrates the importance of incomplete healing of the stented segment in the pathophysiology of LST. (*Circulation*. 2007;115:2435-2441.)



NIH Thickness & Malapposition

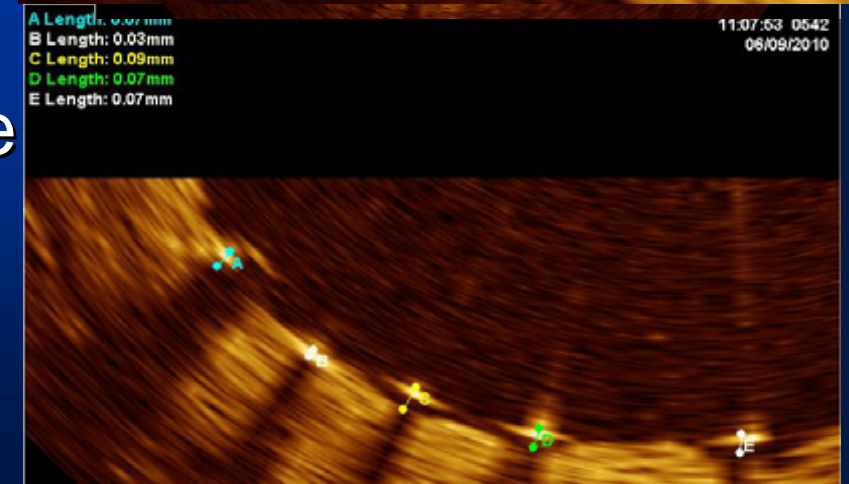
1. Neointimal thickness

The distances between the endoluminal surface of neointimal and the strut reflection

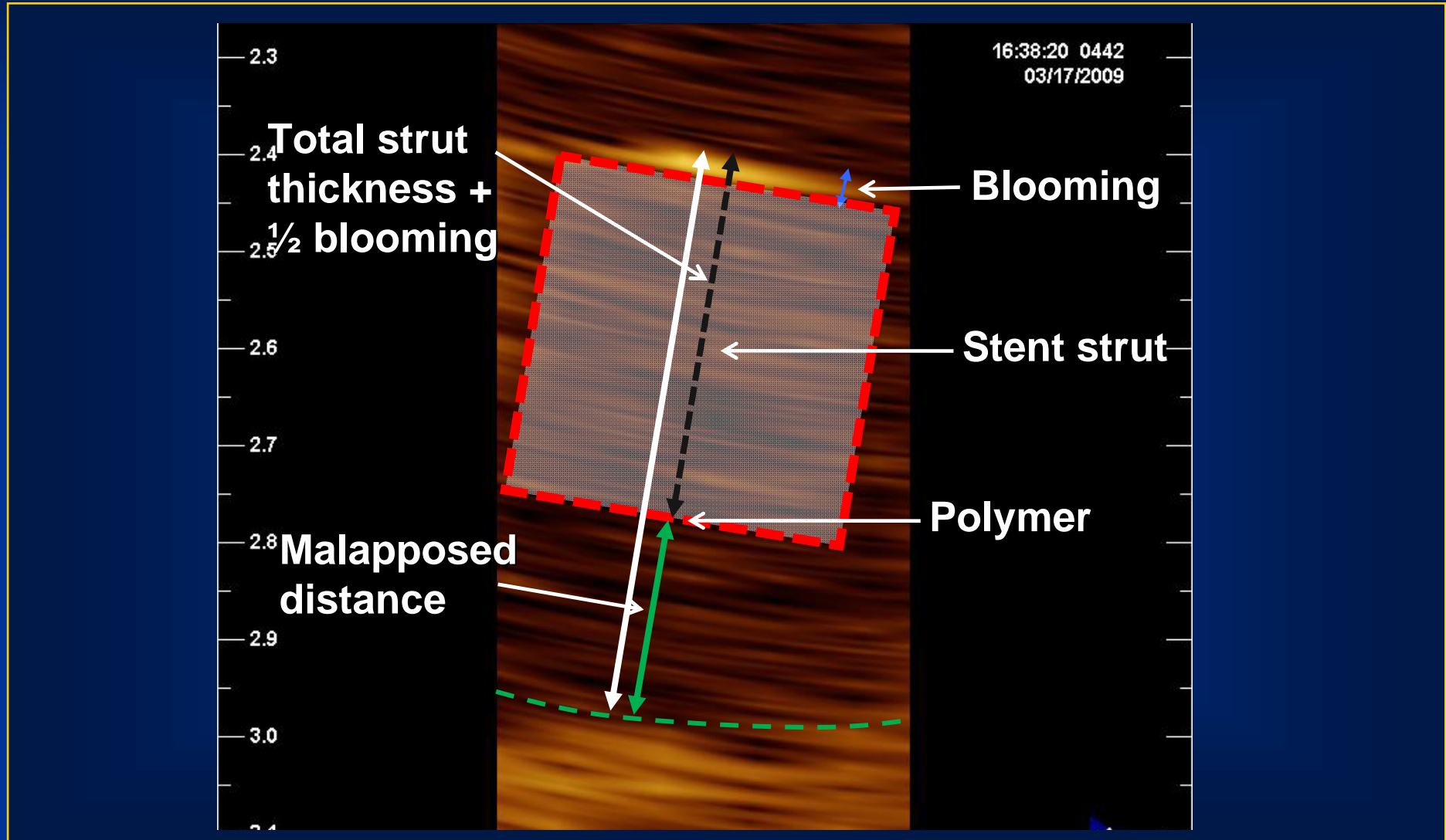


2. Stent apposition

The distances between the endoluminal surface of the strut reflection and the vessel wall



Apposition Analysis



Apposition Analysis

1. Malapposition

Stent malappositions were defined as struts with detachment from the vessel wall $\geq 160 \mu\text{m}$ for SES, $\geq 130 \mu\text{m}$ for PES, $\geq 110 \mu\text{m}$ for ZES and $\geq 100 \mu\text{m}$ for EES

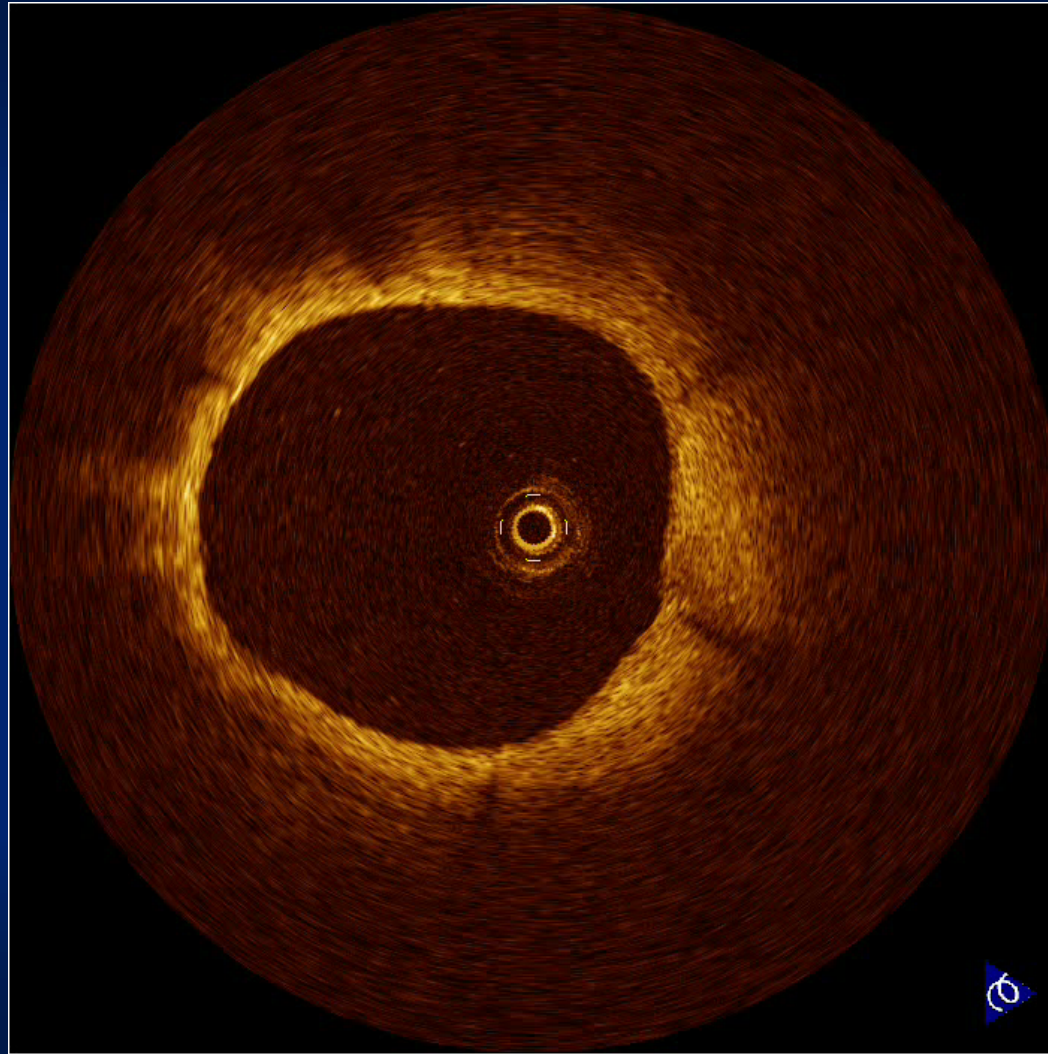
Tanigawa J, et al. EuroInterv 2007; 3:127-36.

2. Covered strut

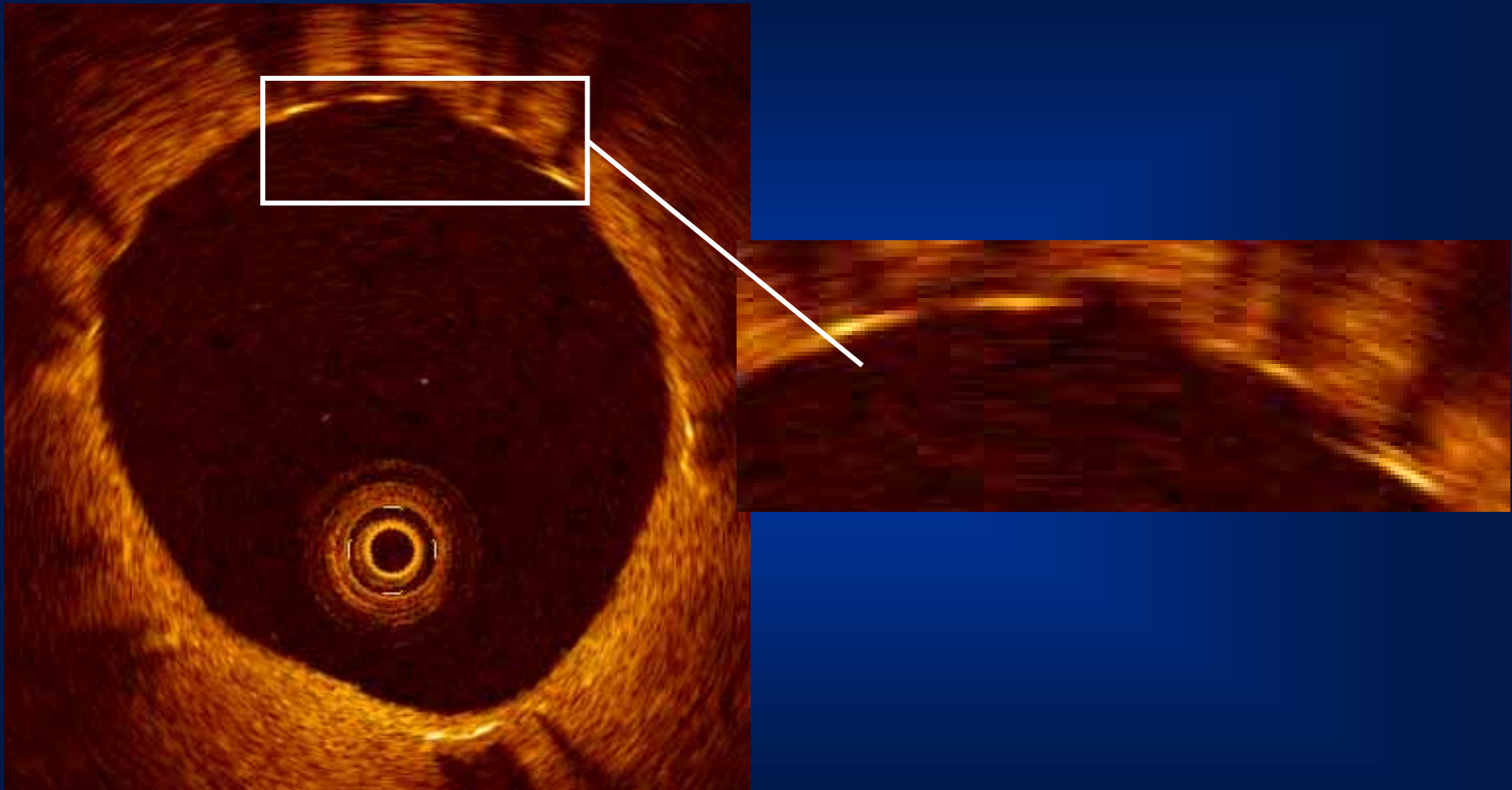
Covered strut defined as stent strut with detectable neointima by OCT

Takano M, et al. Am J Cardiol 2007;99:1033-8.

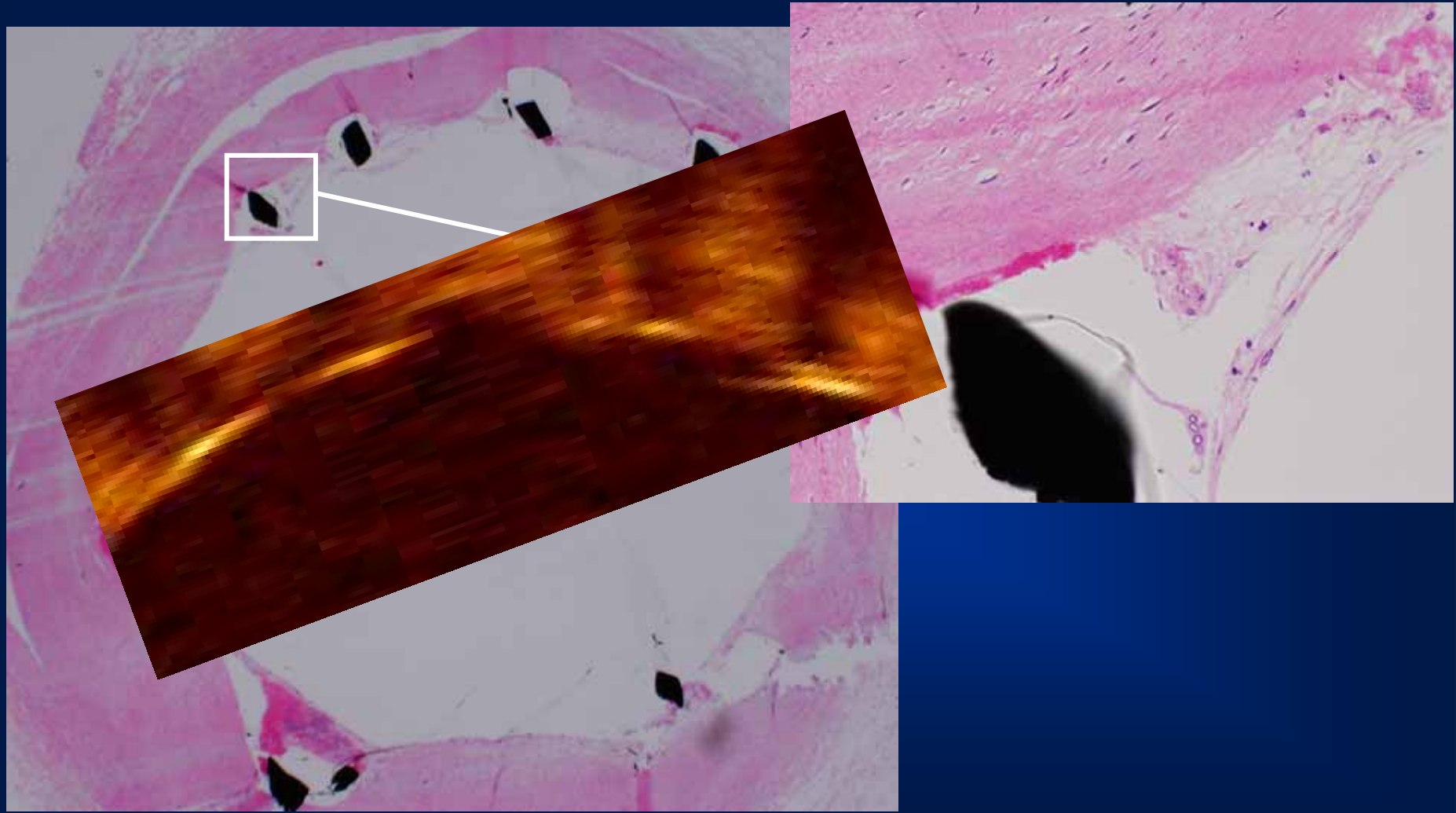
Case 1: Sirolimus stent @2M



Case 1: Sirolimus stent uncovered



Case 1: Sirolimus stent uncovered



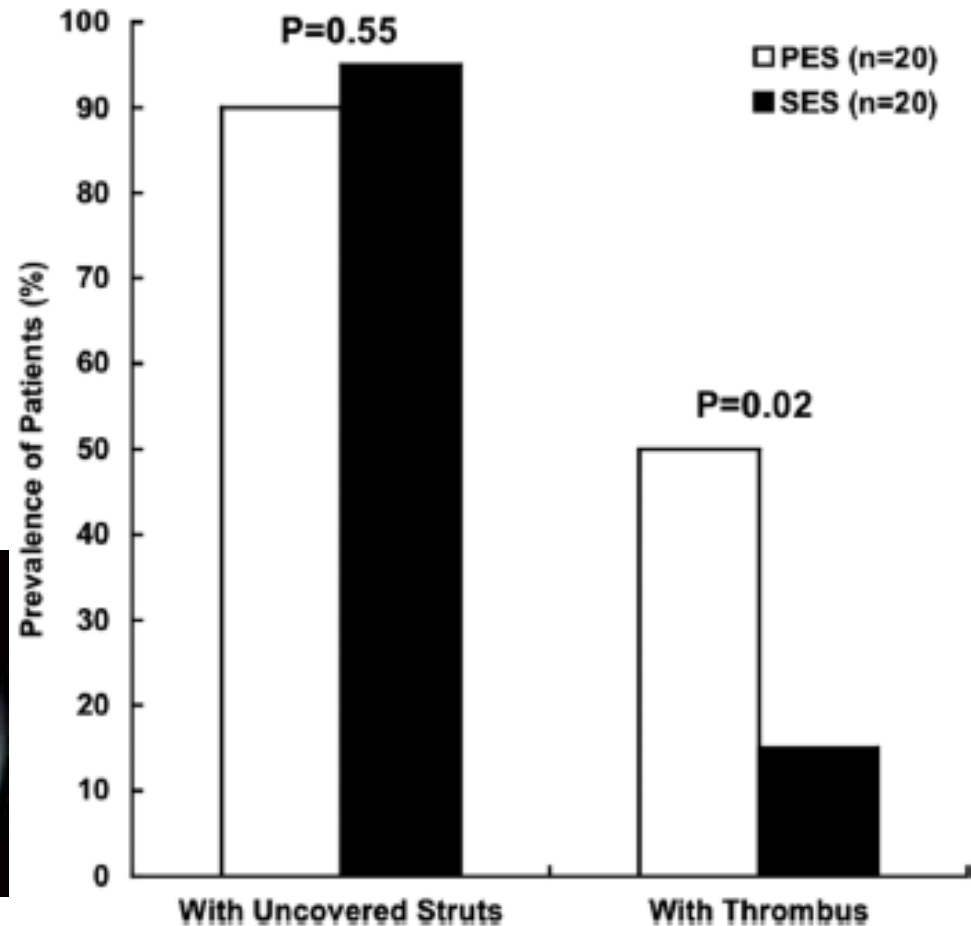
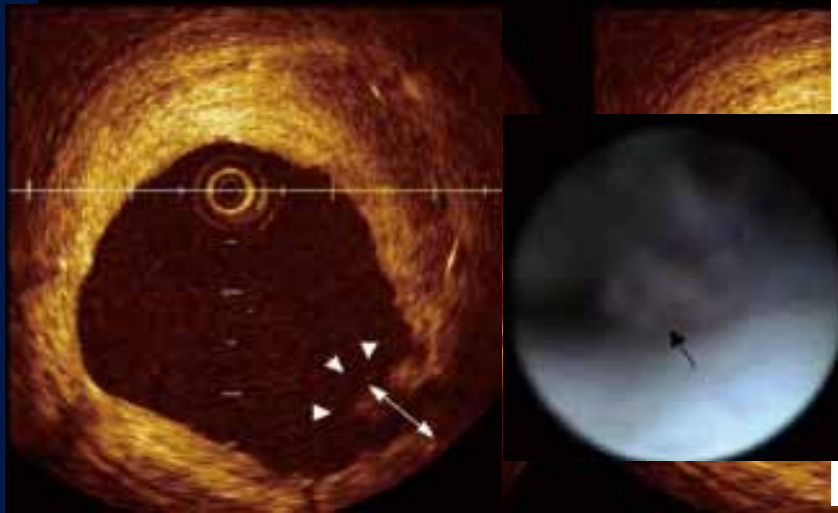
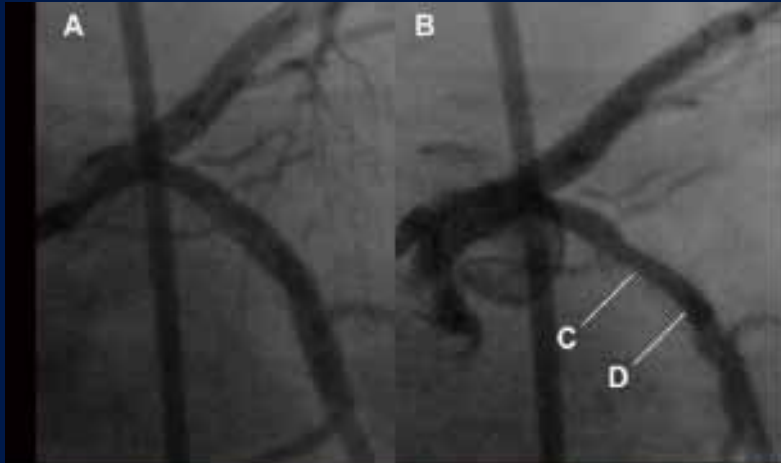
OCT Assessment of Strut Coverage

Uncovered stent strut

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Lack of re-endothelialization

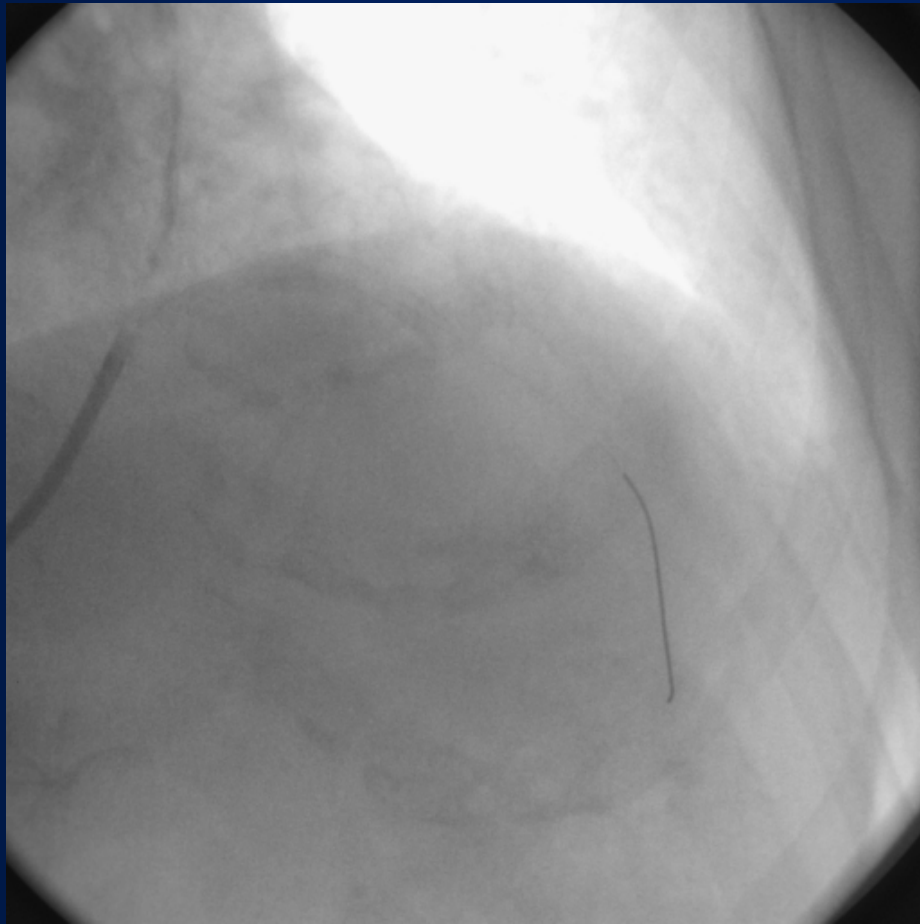
Thrombus Appearance on Covered Stent Struts



Murakami D, et al. *Circ J.* 2009;73:1627-34.

Case 2: Zotarolimus stent

Post-intervention

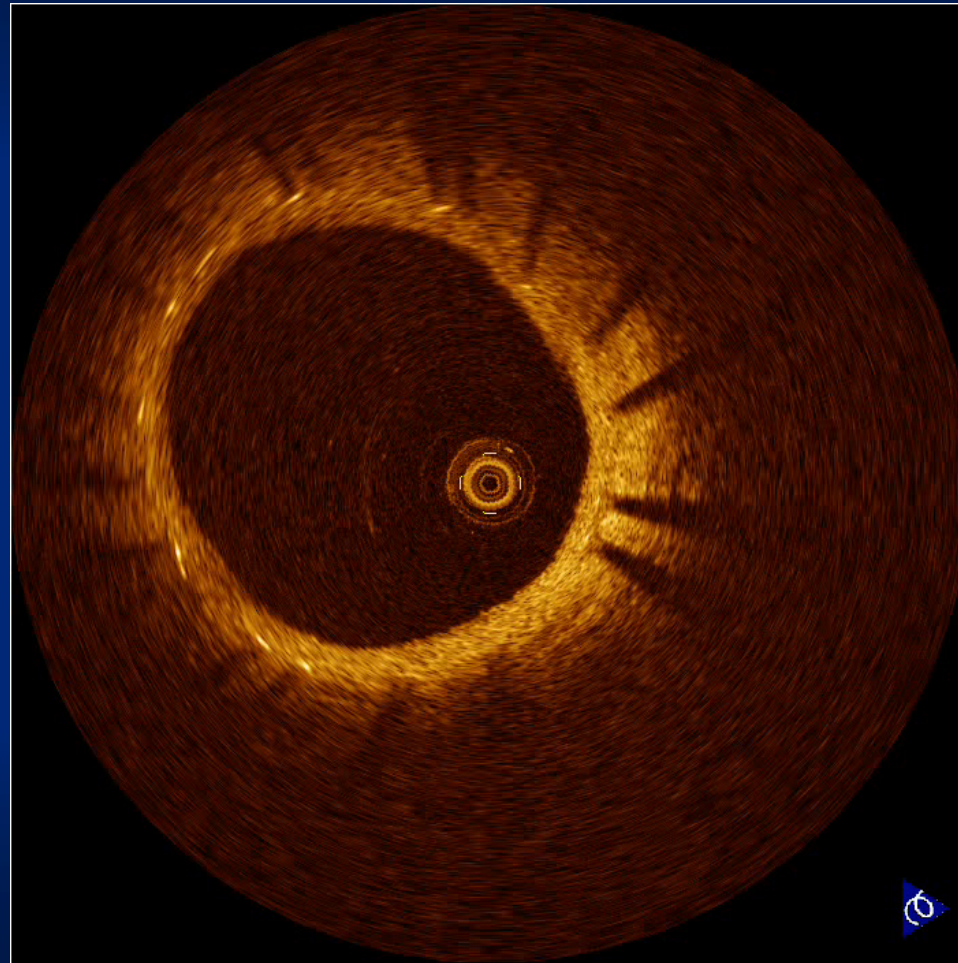


3 months later

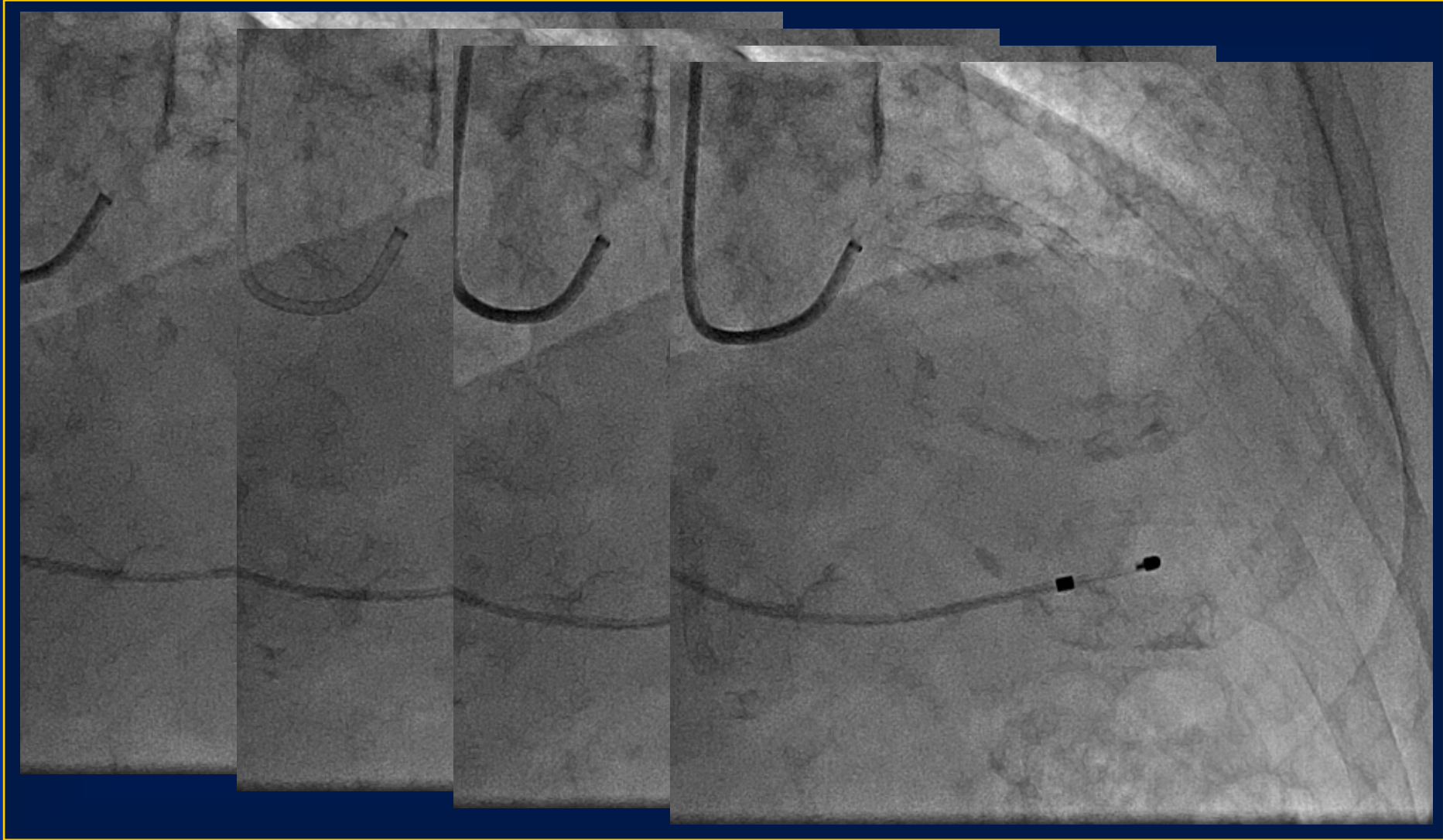


Case 2: Zotarolimus stent @3M

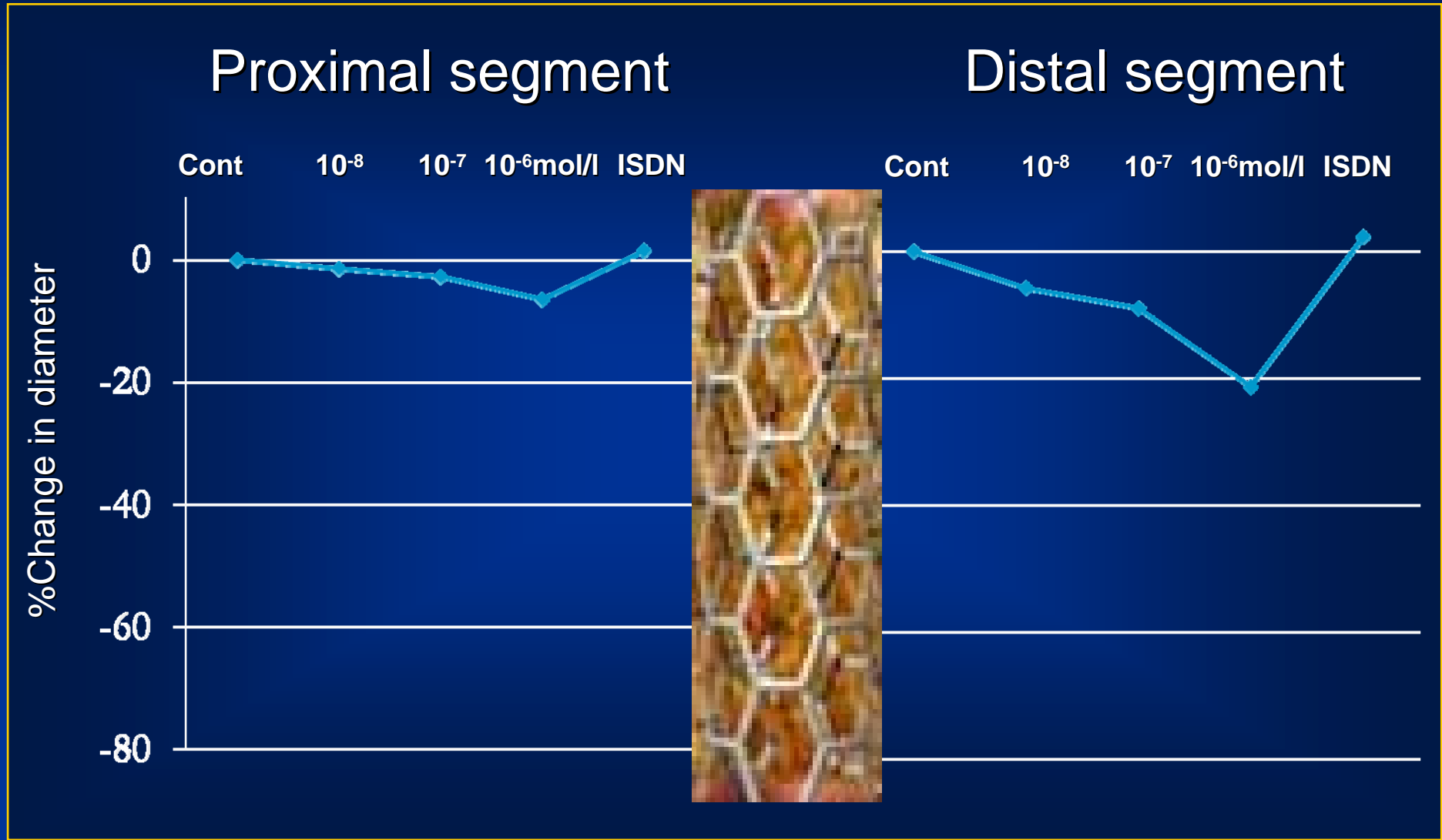
OCT



Case 2: Zotarolimus stent @3M



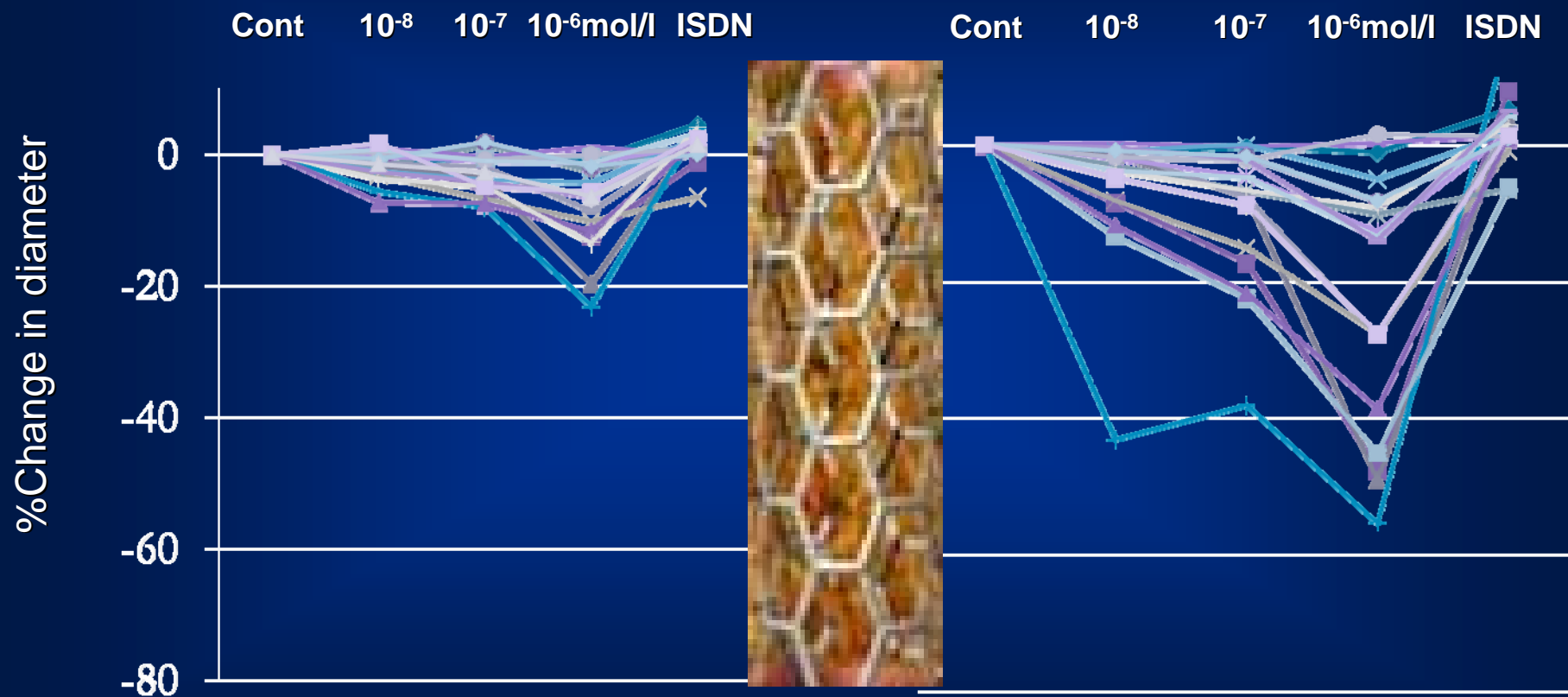
Vasomotor Response: ZES@3M



Vasomotor response: ZES@3M

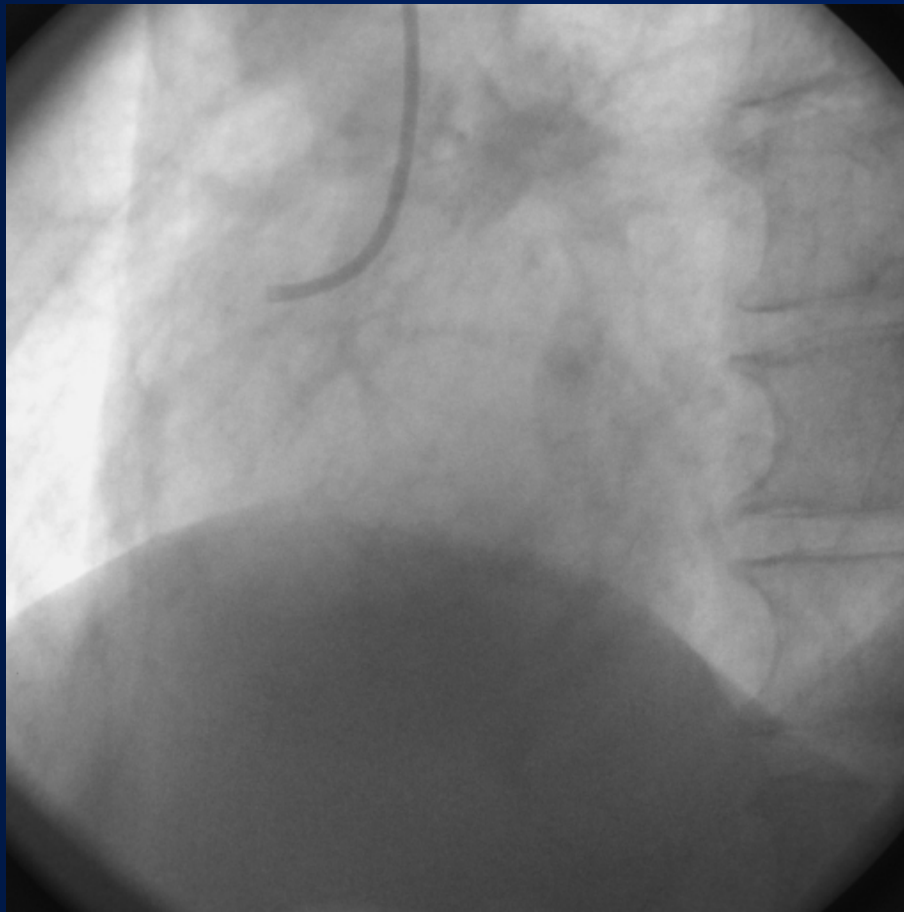
Proximal segment

Distal segment



Case 3: Zotarolimus stent

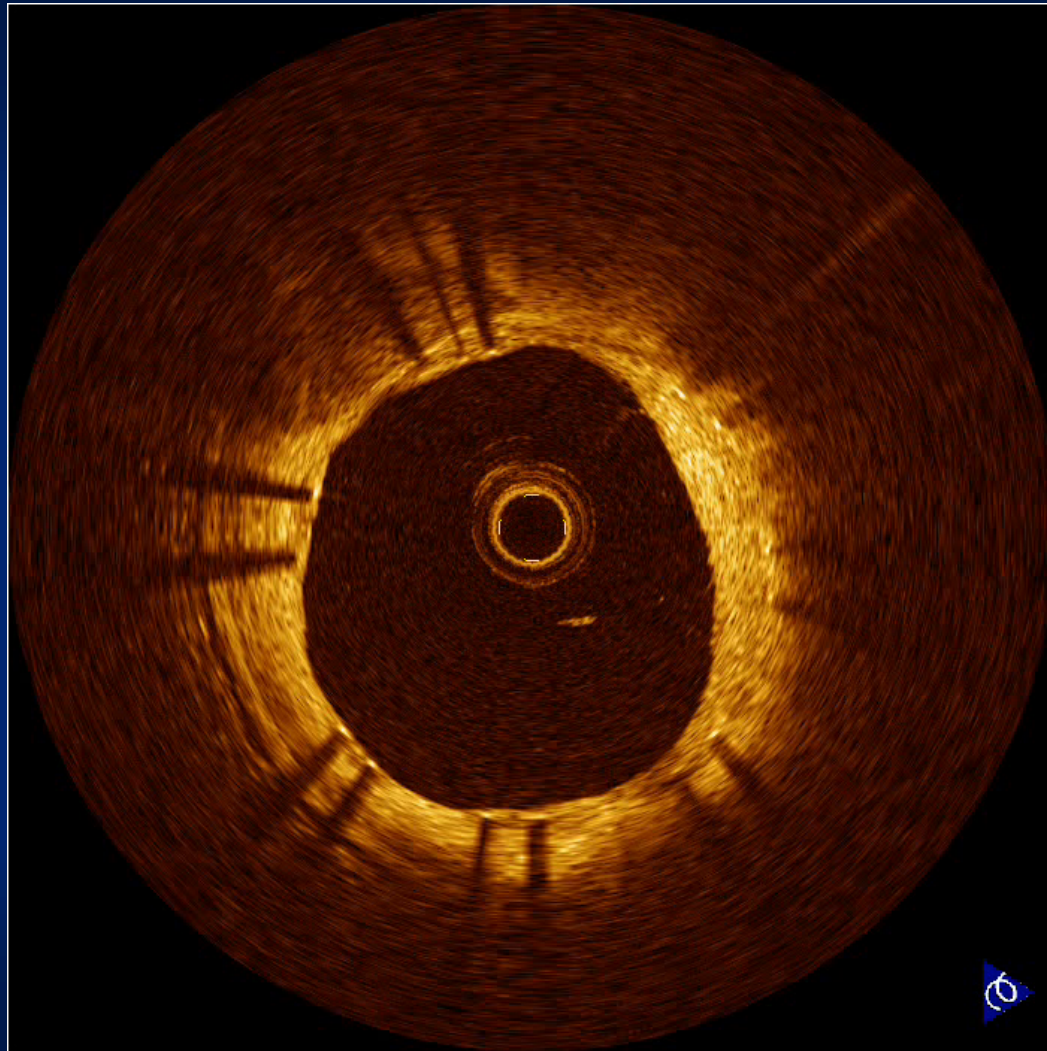
Post-intervention



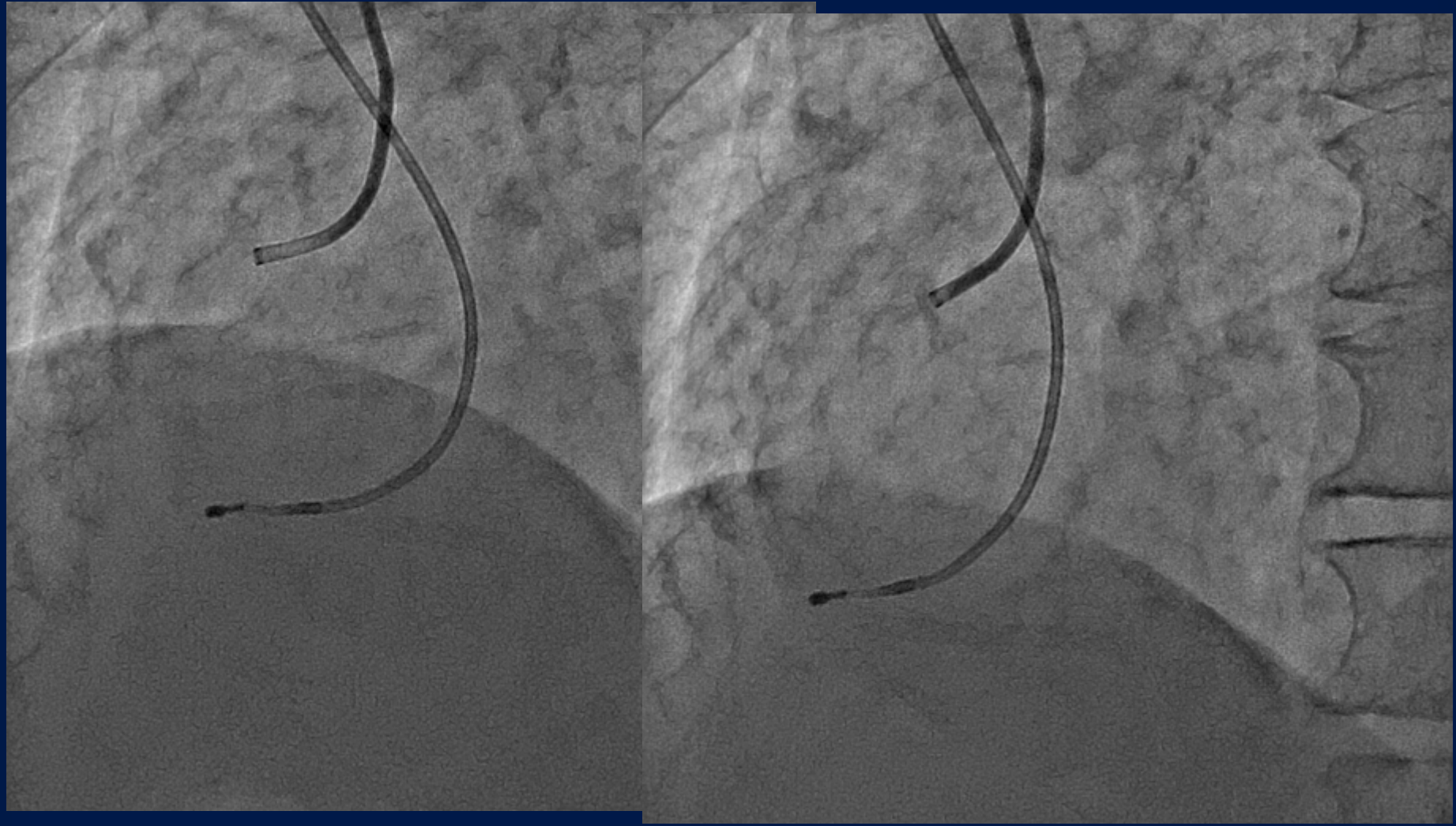
3-month later



Case 3: Zotarolimus stent @3M



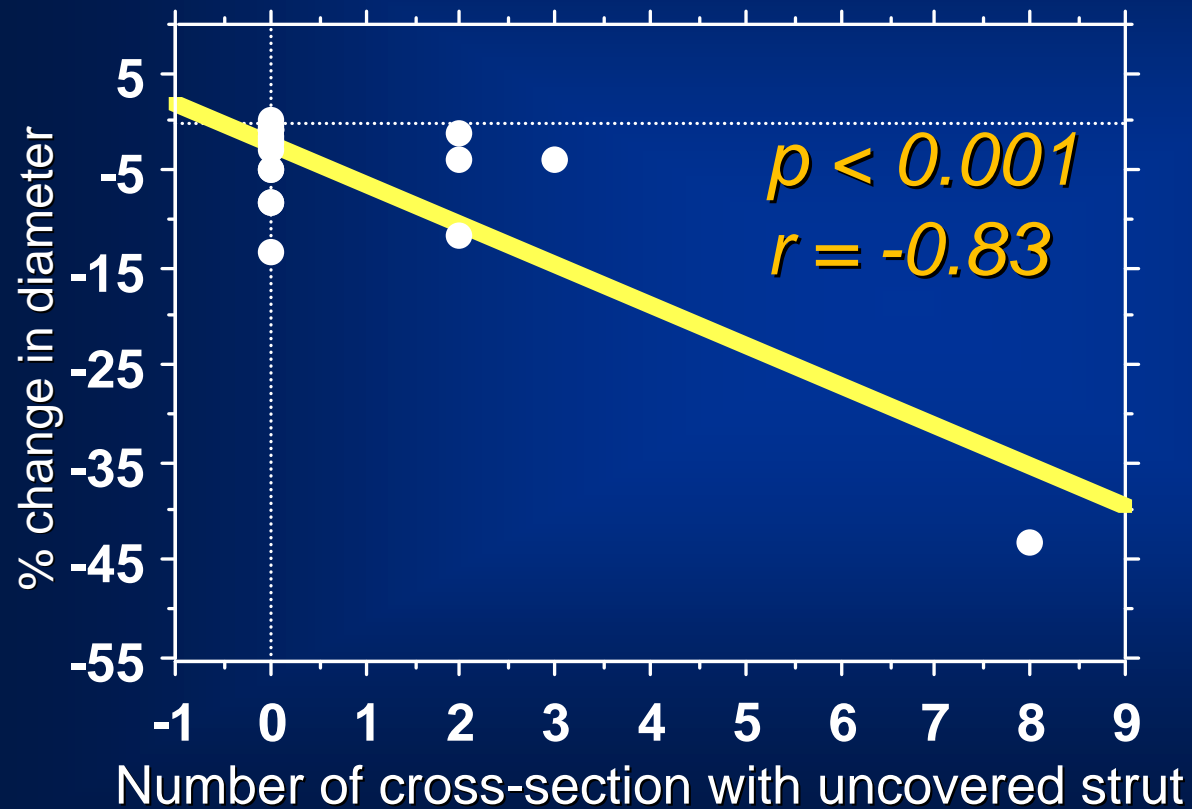
Case 3: Zotarolimus stent @3M



Vasomotor response: ZES @3M

OCT NIH & vasomotor response(distal to stent)

Ach $10^{-6}M$



grades;

Grade 0: exposed strut

Grade 1: NIH thickness

< 100 μm ,

Grade 2: NIH thickness

bet 100 and 200

μm

Grade 3: NIH thickness

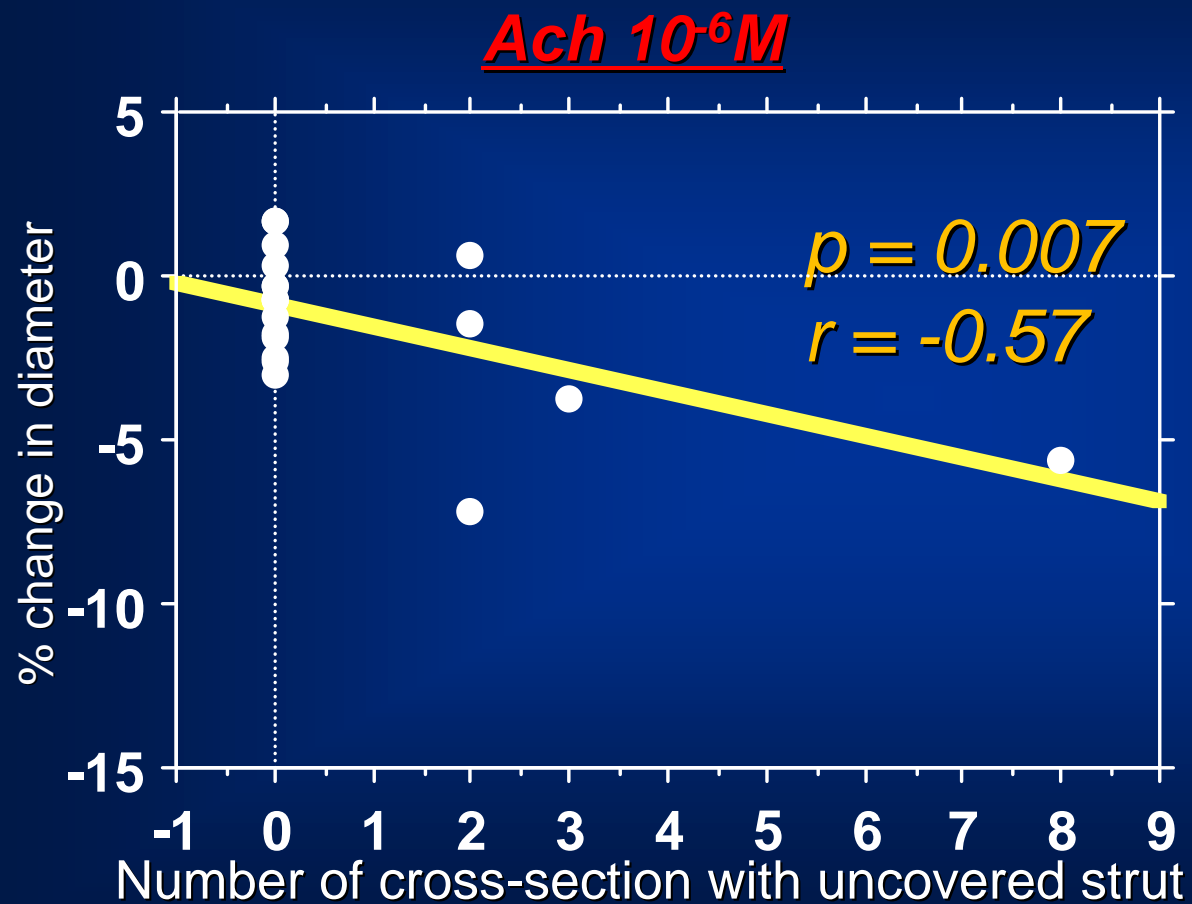
> 200 μm .

The grade was determined as minimal grade including $\geq 10\%$ of stent struts at each cross section



Vasomotor response: ZES @3M

OCT NIH & vasomotor response(proximal to stent)



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< 100 μ m ,

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bet 100 and 200

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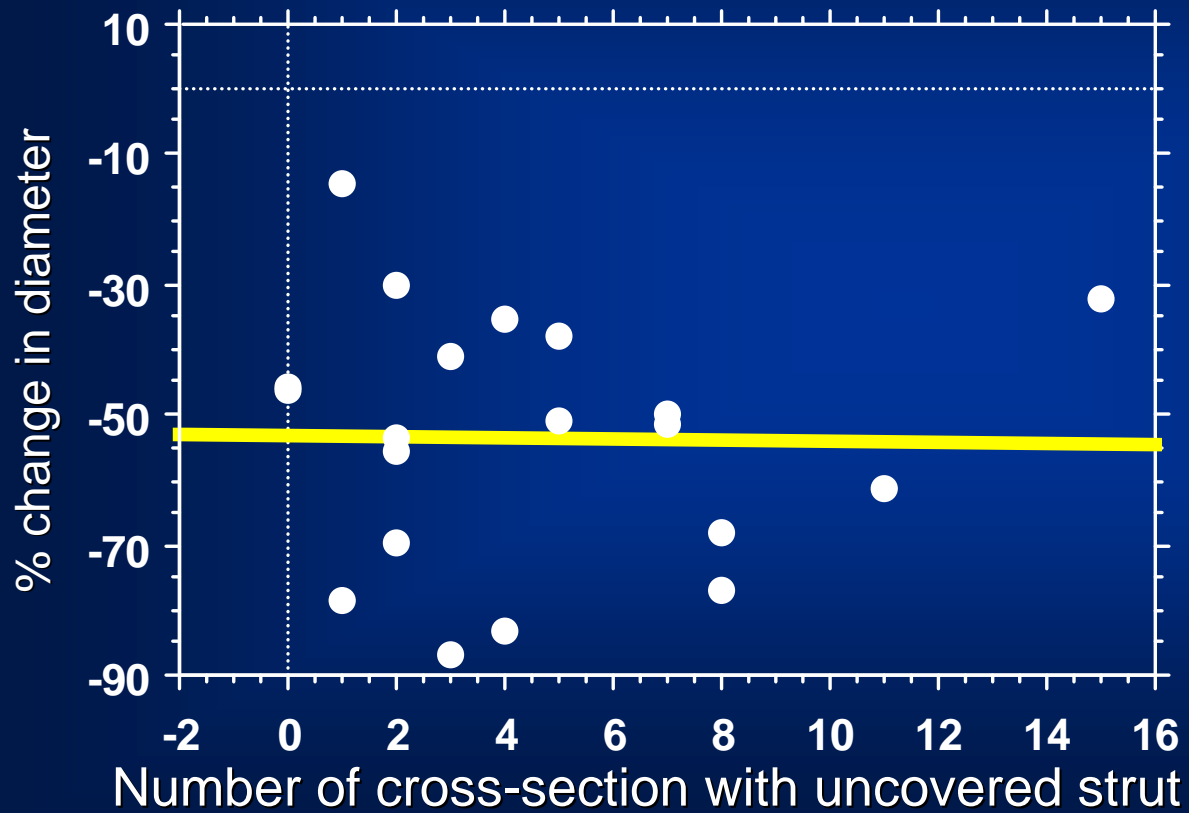
> 200 μ m.

The grade was determined as minimal grade including \geq 10 % of stent struts at each cross section

Vasomotor response: SES @3M

OCT NIH & vasomotor response(distal to stent)

Ach $10^{-6}M$



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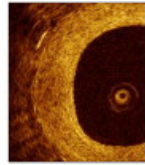
> 200 μm .

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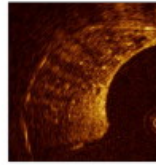


OCT Qualitative Assessment of Neointimal Tissue

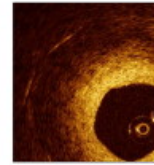
Restenotic tissue structure



Homogeneous: restenotic tissue has uniform optical properties and does not show focal variations in backscattering pattern.

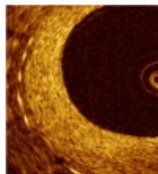


Heterogeneous: restenotic tissue has focally changing optical properties and shows various backscattering patterns

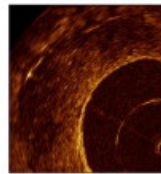


Layered: restenotic tissue consists of concentric layers with different optical properties: an abluminal high scattering layer and an abluminal low scattering layer

Restenotic tissue backscatter

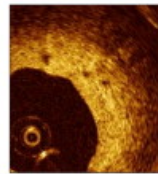


High: the majority of the tissue shows high backscatter and appears bright

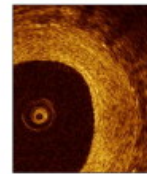


Low: the majority of the tissue shows low backscatter and appears dark or black

Microvessels visible

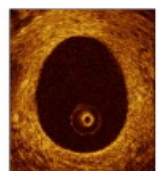


Yes: microvessels appear as well delineated low backscattering structures less than 200 micron in diameter that show a trajectory within the vessel

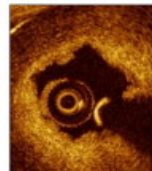


No

Lumen shape



Regular: lumen border is sharply delineated, smooth and circular

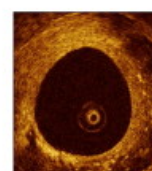


Irregular: lumen border irregular with tissue protrusions from the vessel wall into the lumen

Presence of intraluminal material



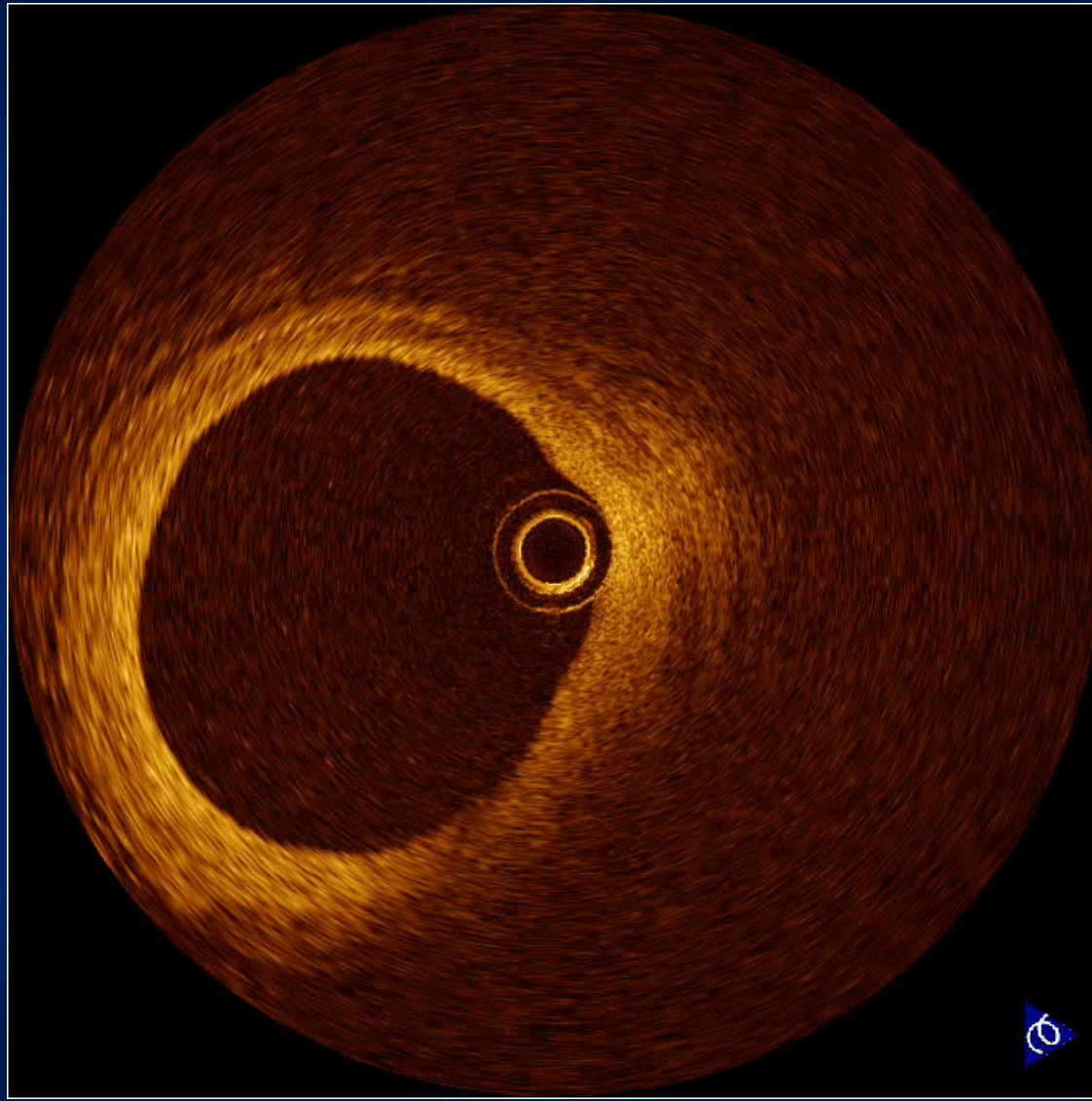
Yes: there is visible material inside the vessel lumen.



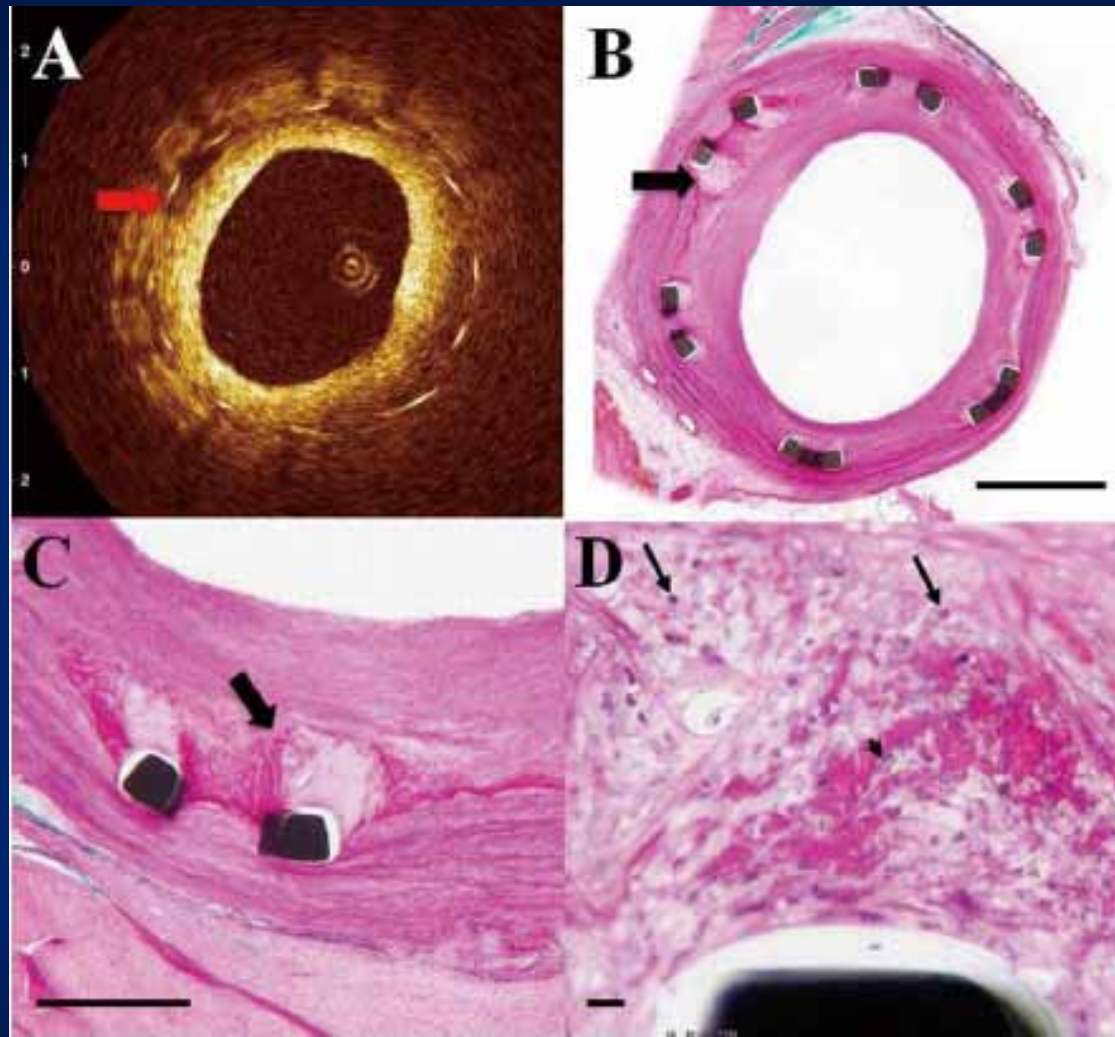
No

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

Case 4: Paclitaxel stent @6M

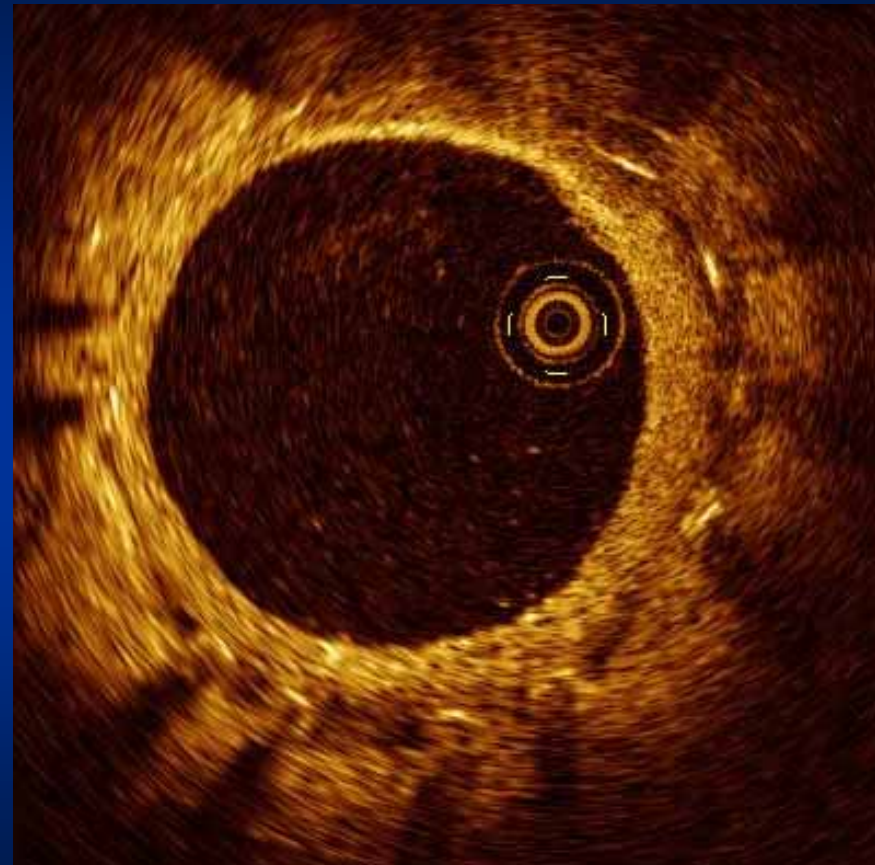
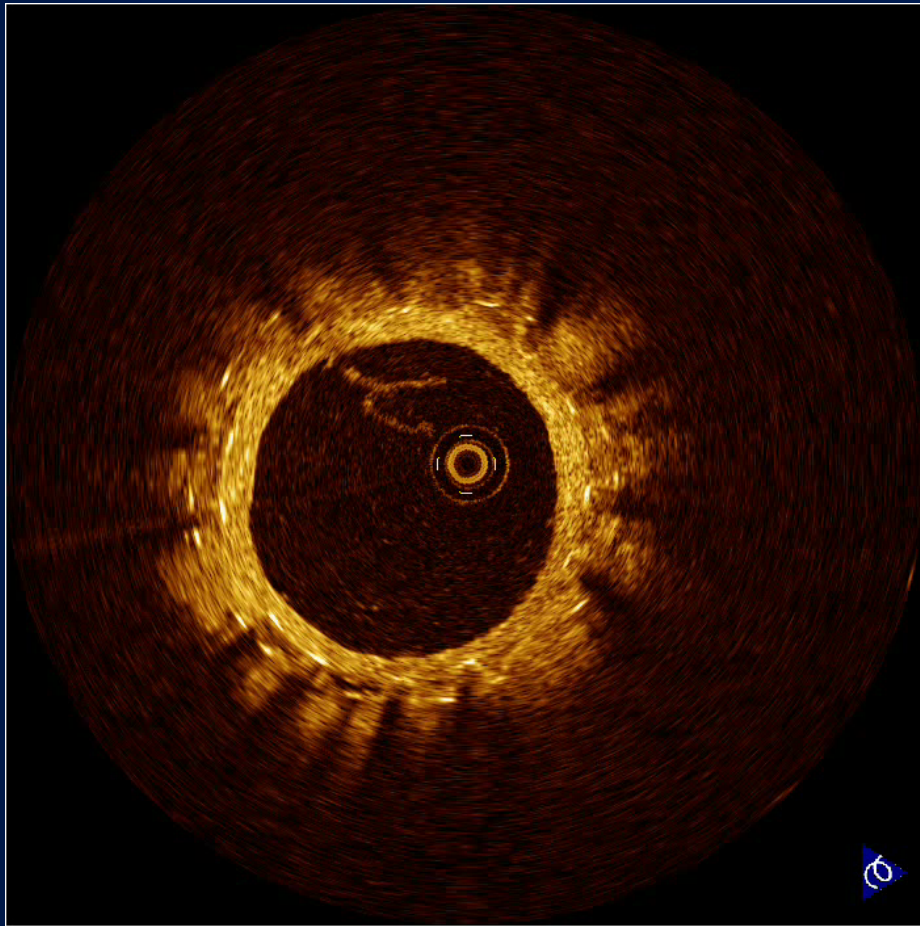


Peri-strut low-intensity area: DES

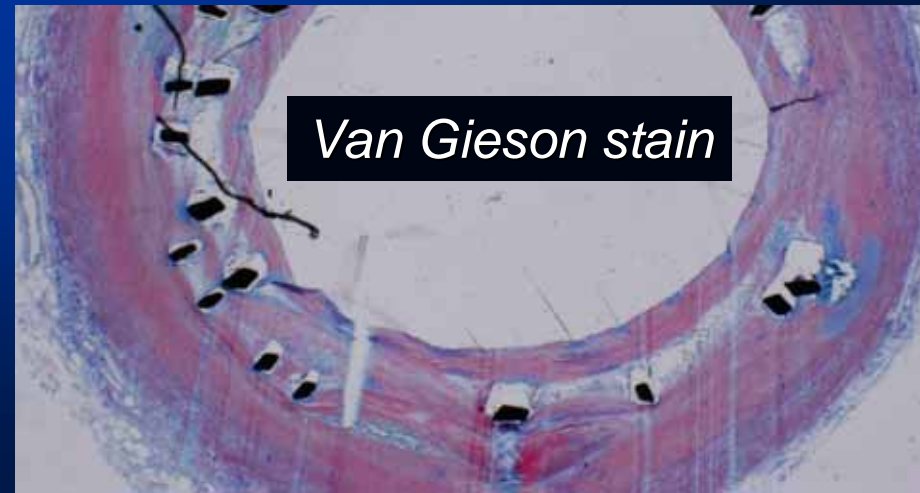
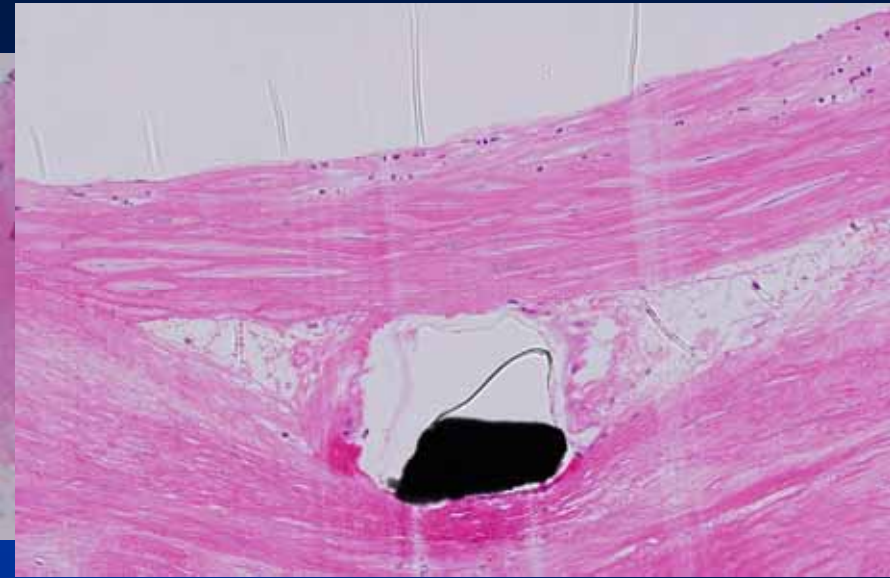


Teramoto T, et al. *Circ J.* 2010;74:1257-9.

Peri-strut low-intensity area: BMS @10Y



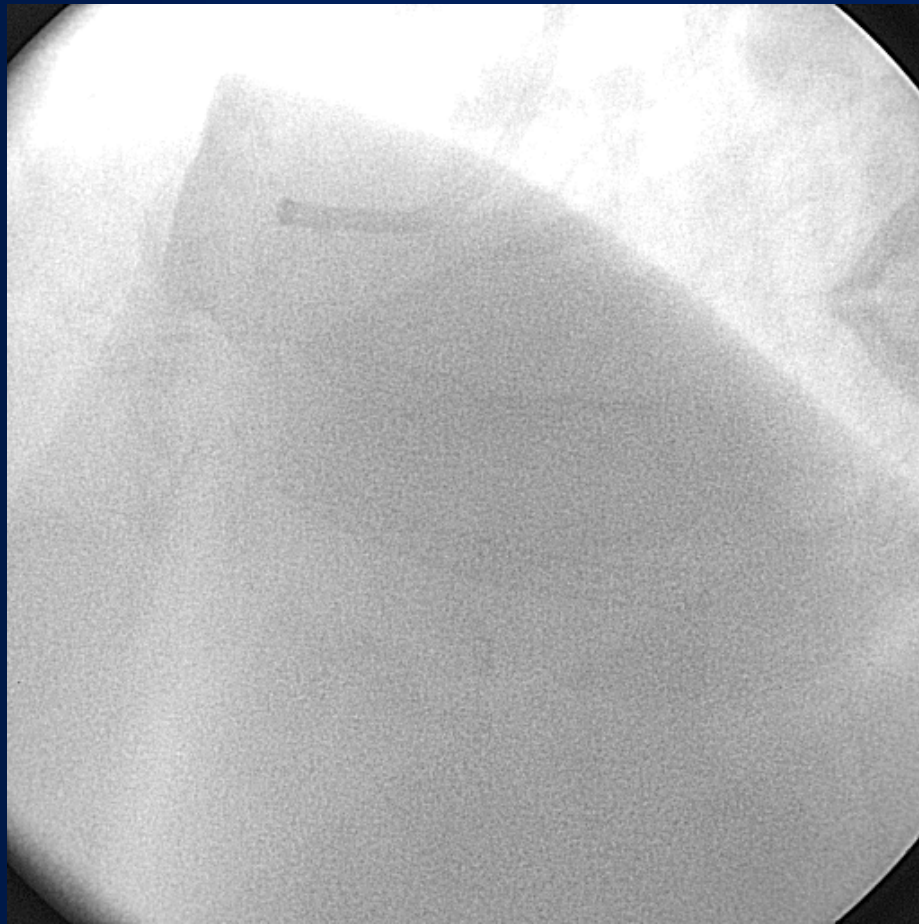
Peri-strut low-intensity area: BMS @10Y



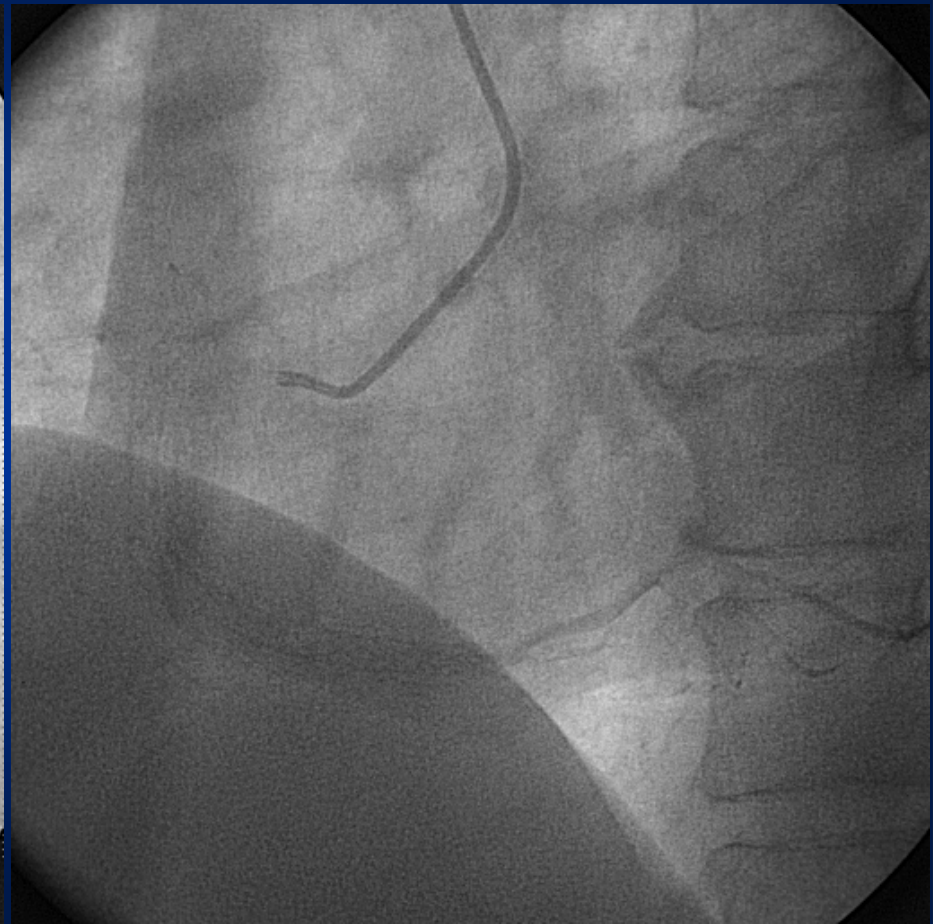
Van Gieson stain

Case 5: Sirolimus stent @12M

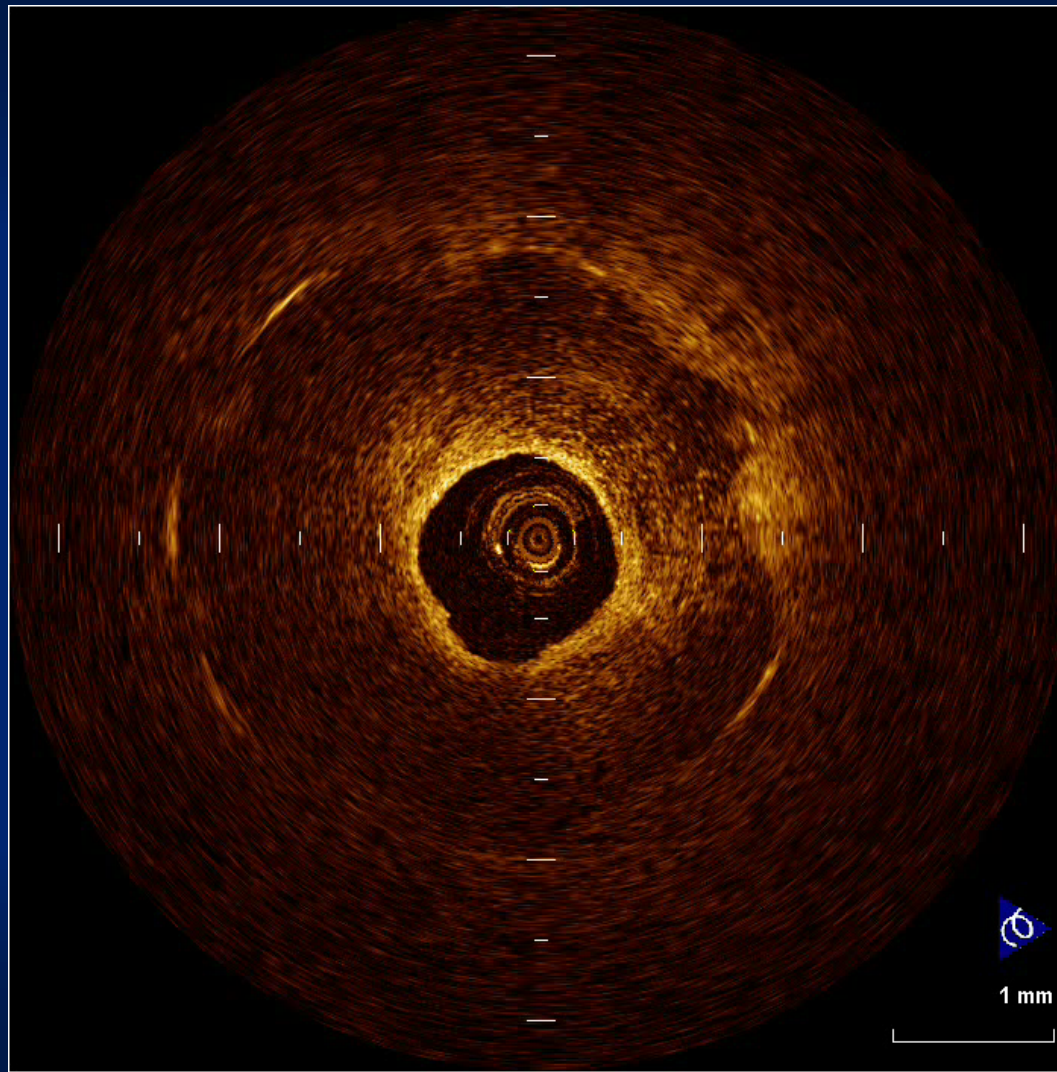
Post-intervention



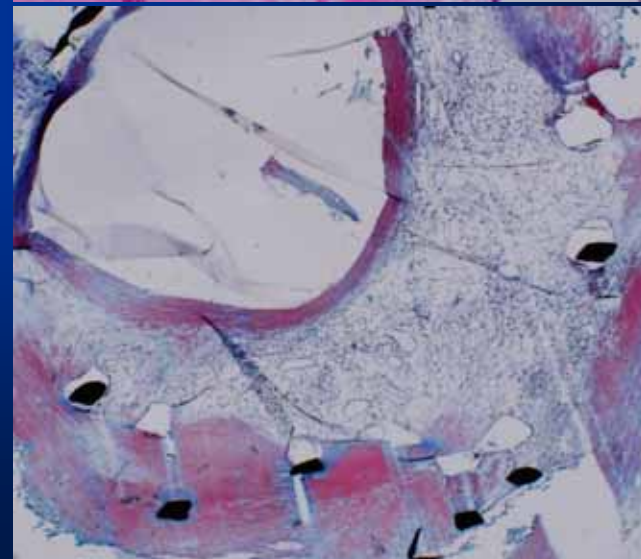
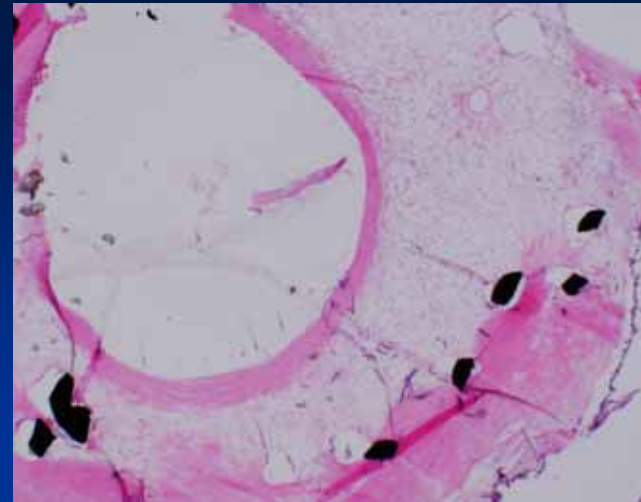
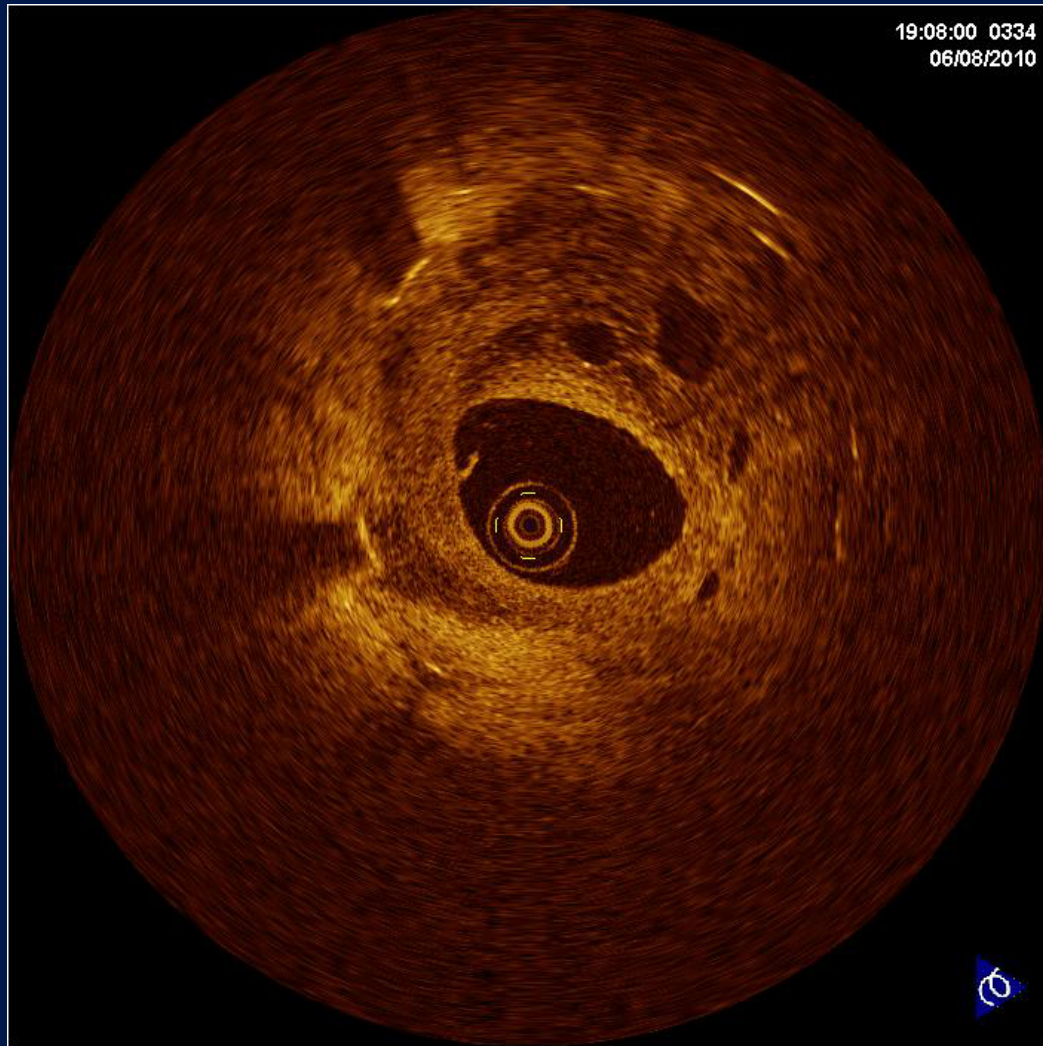
1-year Follow-up



Case 5: Sirolimus stent @12M



Microvessel Appearance: BMS @9Y



Summary

- ✓ Although OCT image did not detect strut coverage, one layer endothelium (about 600 nm) was observed with histopathological finding.
- ✓ Some case reports suggested that the degree of neointimal growth in DES was not associated with coronary endothelial function.
- ✓ Linear relationship was observed between neointimal coverage of stent struts assessed by OCT and vasomotor response to acetylcholine in ZESs, but not in SESs.

Summary

- ✓ Although abnormal morphological findings (i.e. uncovered and malapposed struts, peri-strut low-intensity area, microvessel appearance) were common in DESs, it unclear whether these stents lead to acute thrombotic event (the incidence of stent thrombosis is low).
- ✓ There were no data on clinical implications of abnormal intimal tissue morphology detected by OCT.

Thank you for your attention



Hyogo College of Medicine

Cardiovascular Catheterization Laboratory