

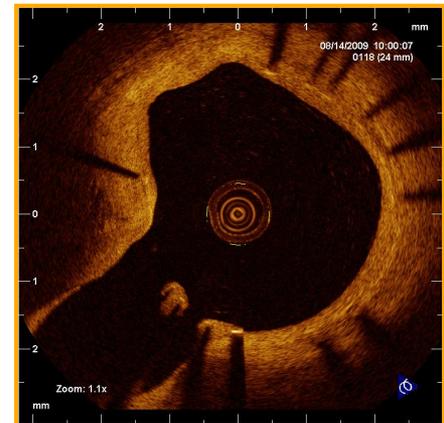
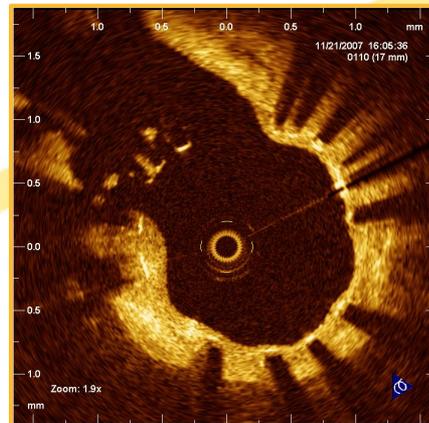
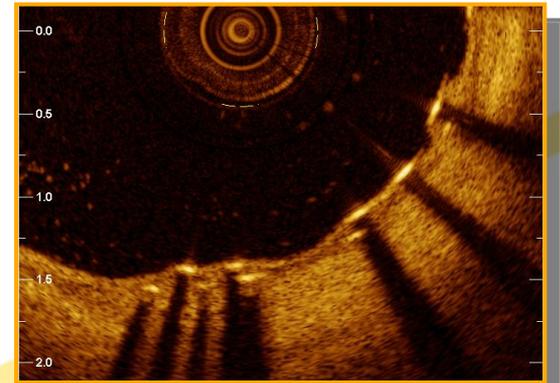
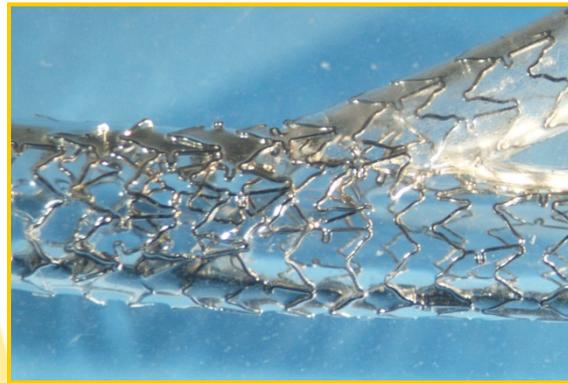
Dr. Juan Luis Gutiérrez-Chico

OCT and long term bifurcation evolution

European Bifurcation Club



Barcelona, 12th of October 2012



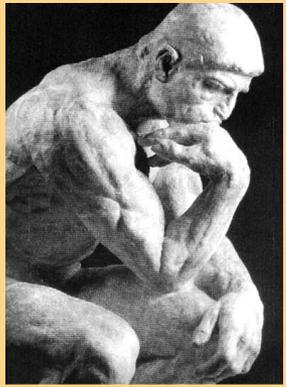


Disclosures



- **Consultant and member of the advisory board of CONIC Vascular, Lugano, CH**

Starting question



What should we assess with OCT in stented bifurcations in the long term?



You cannot assess neointimal healing

Yes, we can!



Pathologists



Intervent cardiologists

Neointimal healing process



- **Healing in Pathology**

- **Neointimal coverage**
- **Fibrin / thrombus**
- **Endothelialization**
- **Granulation tissue**

Inflammation

You cannot assess

neointimal healing

granulation tissue

lesions <14µm remain undetectable

with current conventional OCT analysis, CE & Doppler

techniques to improve coverage

of coverage

Yes, we can!



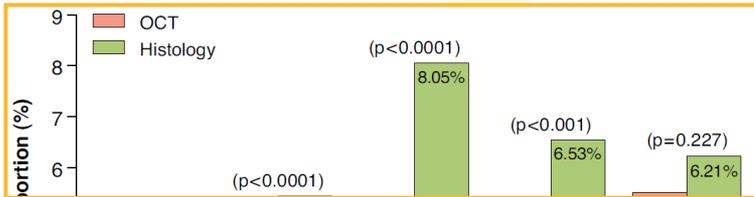
Pathologists

Intervent cardiologists

in current conventional OCT analysis, CE & Doppler

of coverage Neointimal healing process are <100%

- **Coverage detected by OCT in a stented segment correlates with neointimal coverage in Histology**
 - **Experimental evidence**
 - **After maximal healing reaction**



OFDI

| | Reviewer 1 | | Reviewer 2 | |
|--------------------------------------|-------------------|----------------|-------------------|----------------|
| | Uncovered Struts | Covered Struts | Uncovered Struts | Covered Struts |
| Histology | | | | |
| Uncovered struts n = 43 | 34 | 9 | 33 | 10 |
| Covered struts n = 97 | 3 | 94 | 4 | 93 |
| Detection of uncovered struts | | | | |
| Sensitivity | 79.1% [70.3–85.6] | | 76.7% [67.5–82.0] | |
| Specificity | 96.9% [93.0–98.9] | | 95.9% [91.8–98.2] | |

Does optical coherence tomography predict neointimal healing and histology?

F Prati,¹ M Zinetti,² J Pizzicannella,³ et al.

In Vivo Tomographic Assessment of Neointimal Coverage

Ex Vivo Assessment of Vascular Response to Coronary Stents by Optical Frequency Domain Imaging J Am Coll Cardiol Img 2012;5:71–82

Masataka Nakano, MD,* Marc Vorpahl, MD,* Fumiyuki Otsuka, MD,* Masanori Taniwaki, MD,† Saami K. Yazdani, PHD,* Alope V. Finn, MD,‡ Elena R. Ladich, MD,* Frank D. Kolodgie, PHD,* Renu Virmani, MD*



Neointimal Coverage and Neointimal Coverage

Bradley, BS,* Armando Tellez, MD,* et al.

BS,* Alexander Sheehy, MS,† et al.

erkins, DVM, PHD,† Gaku Nakazawa, MD,‡ et al.

D, PHD,* Renu Virmani, MD,‡ et al.

J Am Coll Cardiol Img 2010;3:76–84

Coverage in OCT is a good in vivo proxy for neointimal healing in a stented segment

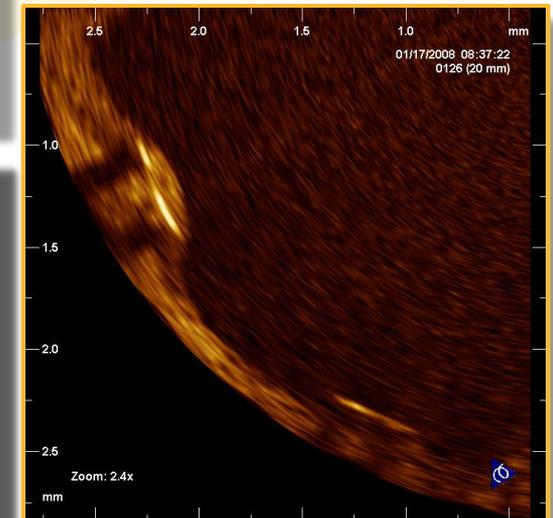
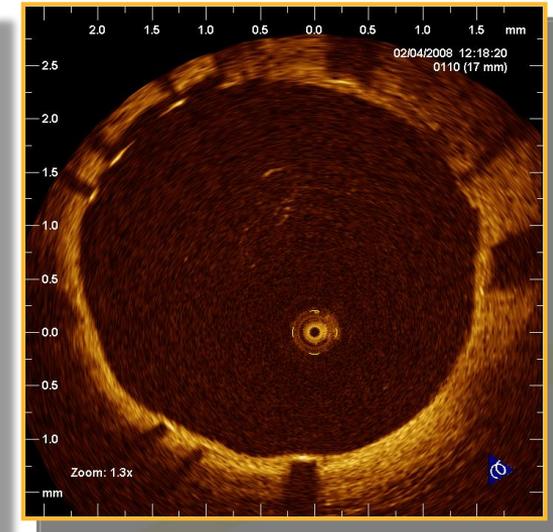
- **Coverage**
- **Apposition**
- **Technique dependent features**
 - **Double / triple layers**
 - **NASB struts**
- **Specific evidence on bifurcations
(long term results)**



- **Coverage**
- **Apposition**
- **Technique dependent features**
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- **Specific evidence on bifurcations
(long term results)**

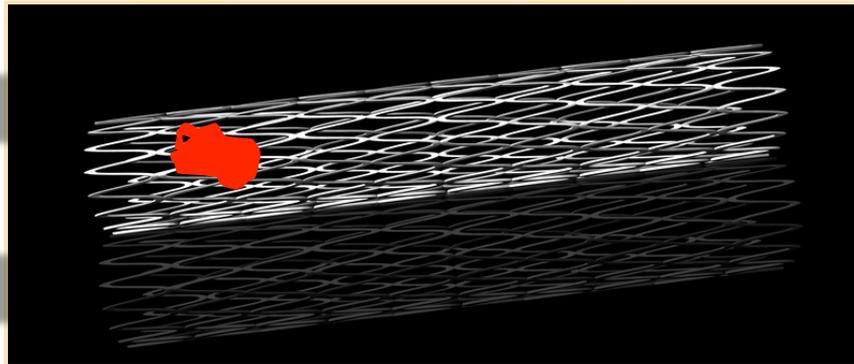


- **In vivo proxy for neointimal healing**
 - % **uncovered struts**
- **Validated after completion of the neointimal healing process**
 - **Uncertainty at earlier stages**
- **Huge amount of information**
 - **Tiny methodological details, big impact**
 - **Clustered data:**
 - **Complex statistical analysis**
 - **% of uncovered struts???**

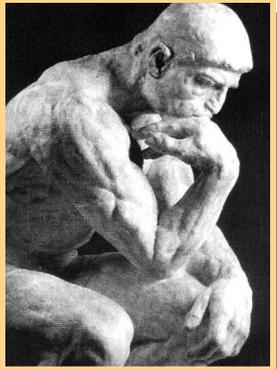


Equally relevant?

More relevant?

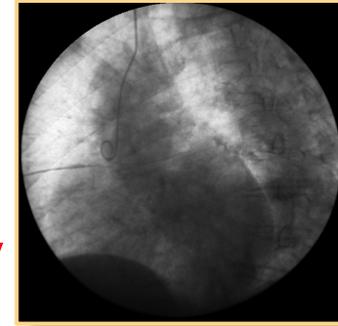


Coverage



What is the interest of assessing coverage?

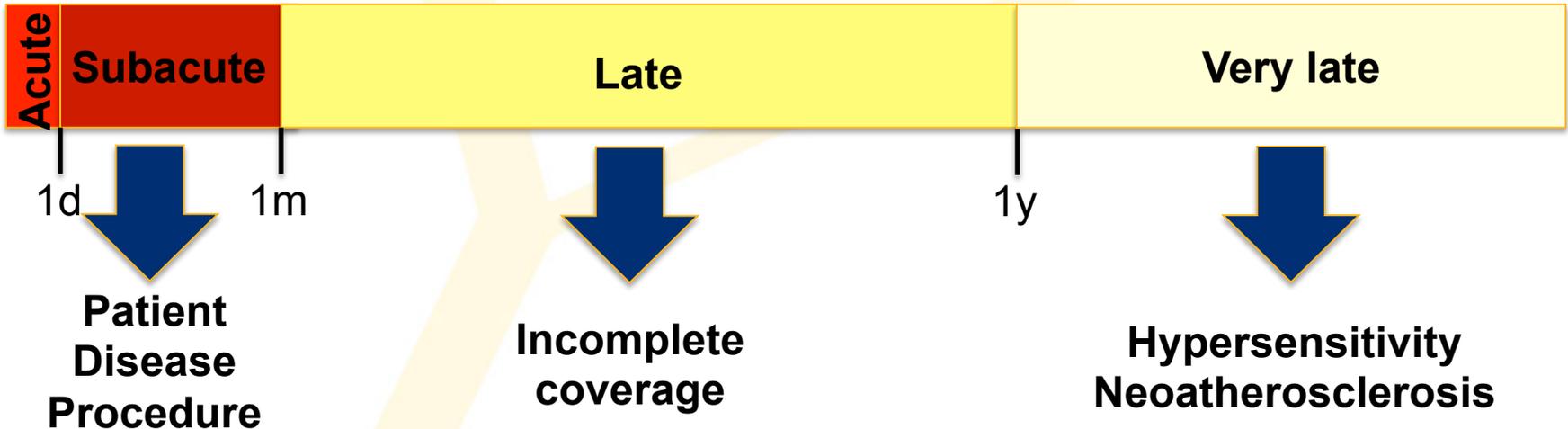
It might predict propensity to stent thrombosis



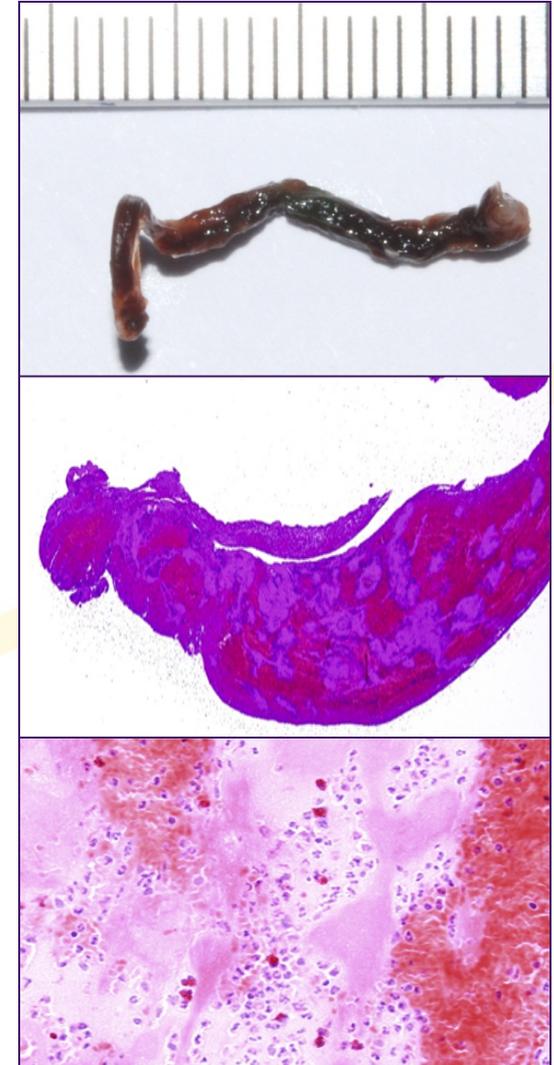
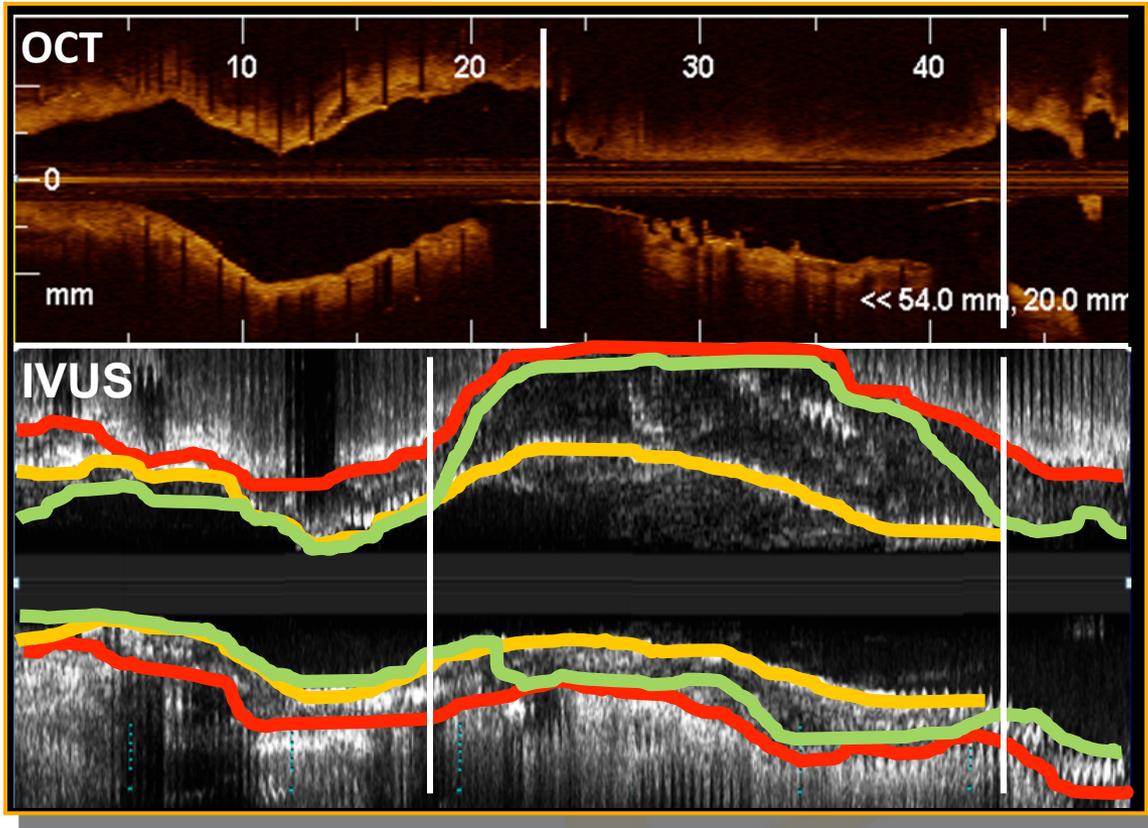
Which kind of stent thrombosis?

→ BMS neointimal healing

→ DES neointimal healing

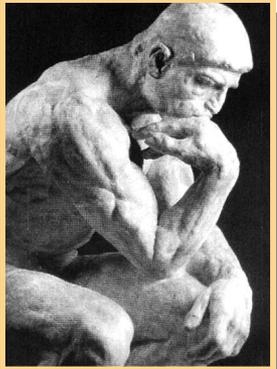


Coverage



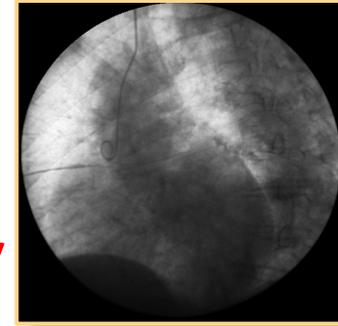
**Very late stent thrombosis over
late-acquired ISA**

Coverage



What is the interest of assessing coverage?

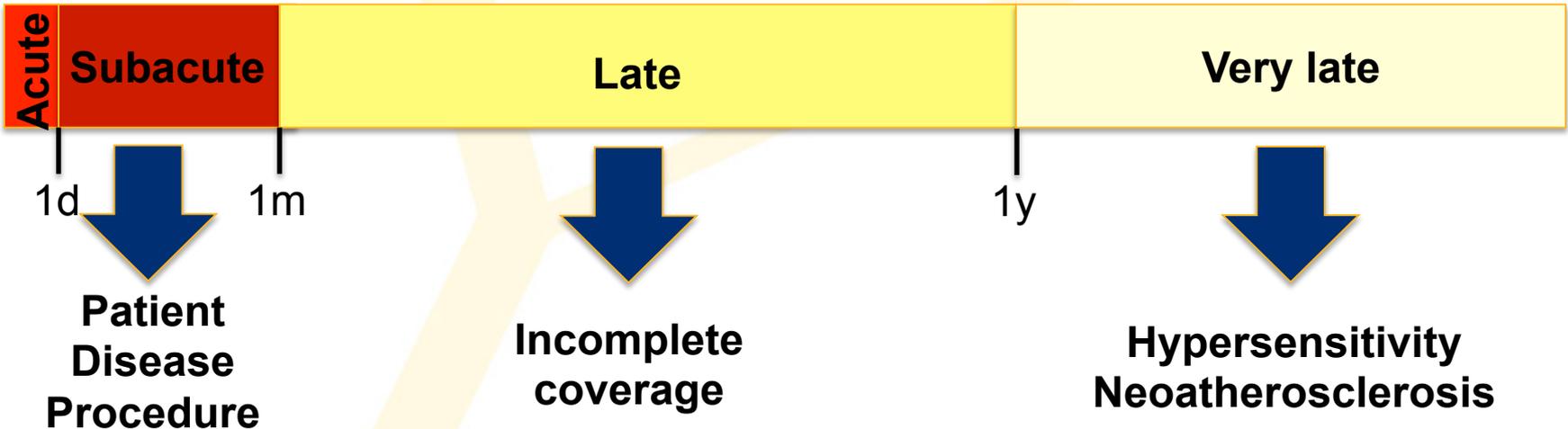
It might predict propensity to LATE stent thrombosis



Which kind of stent thrombosis?

→ BMS neointimal healing

→ DES neointimal healing



- **Coverage as predictor of stent thrombosis**
 - **Discouraging results**

| Clinical trial | LEADERS | HORIZONS -AMI | RESOLUTE -AC | SYRTAX |
|----------------------------------|-------------------------|---------------------------|--------------------------|-------------------------|
| Patients (n) | 1707 | 3006 | 2292 | 1012 |
| Stents | BES vs. SES | PES vs. BMS | R-ZES vs. EES | SES vs. PES |
| Follow-up | 9m | 6m | 13m | 9m |
| Differences in LATE def+prob ST? | 2.6% vs. 2.2% p=0.66 | 3.2% vs. 3.4% p=0.77 | 1.6% vs. 0.7% p=0.05 | 0.2% vs. 0.4% p=0.57 |
| OCT substudy | | | | (5y) |
| Patients (n) | 56 | 118 | 58 | 88 |
| Differences in uncovered struts? | 0.6% vs. 2.1% p=0.04 | 5.7% vs. 1.1% p<0.0001 | 7.4% vs. 5.8% p=0.378 | 1.5% vs. 1.0% P=0.32 |

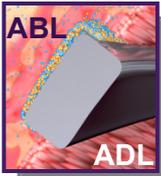
Significant
 Non-significant

We must give it still some thoughts

There are also a few encouraging results

- LEADERS trial (NCT00389220)**

- **Stents compared:**



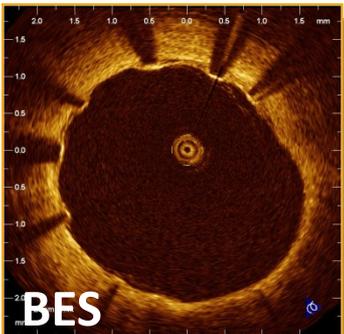
- **Biomatrix (n=857)**
 - BES
 - Biodegradable polymer
 - Abluminal coating
- **Cypher Select (n=850)**
 - SES
 - Durable polymer
 - Conformal coating

- **Non-inferiority of BES at 9m:**

- **Cardiac death + MI + TVR**

- **No differences in late ST rates**
- **OCT substudy**
 - **Better coverage in BES at 9m**

9m

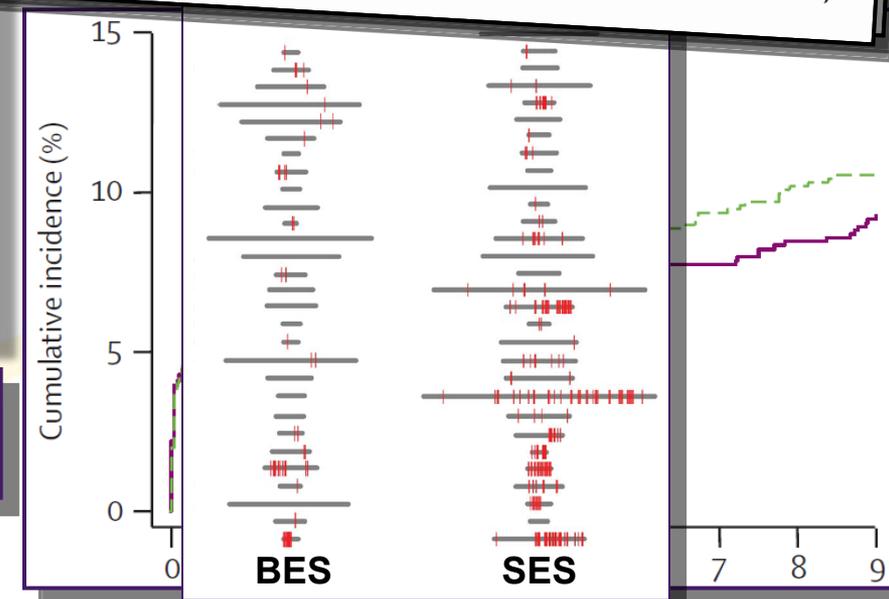


European Heart Journal (2010) 31, 165–176
doi:10.1093/eurheartj/ehp480

CLINICAL RESEARCH
Coronary heart disease

An optical coherence tomography study of a biodegradable vs. durable polymer-coated limus-eluting stent: a LEADERS trial sub-study

Peter Barlis^{1,2}, Evelyn Regar², Patrick W. Serruys², Konstantinos Dimopoulos^{1,3}, Willem J. van der Giessen², Robert-Jan M. van Geuns², Giuseppe Ferrante¹, Simon Wandel⁴, Stephan Windecker^{4,5}, Gerrit-Anne van Es⁶, Pedro Eerdmans⁷, Peter Jüni^{4,8}, and Carlo di Mario^{1,3*}

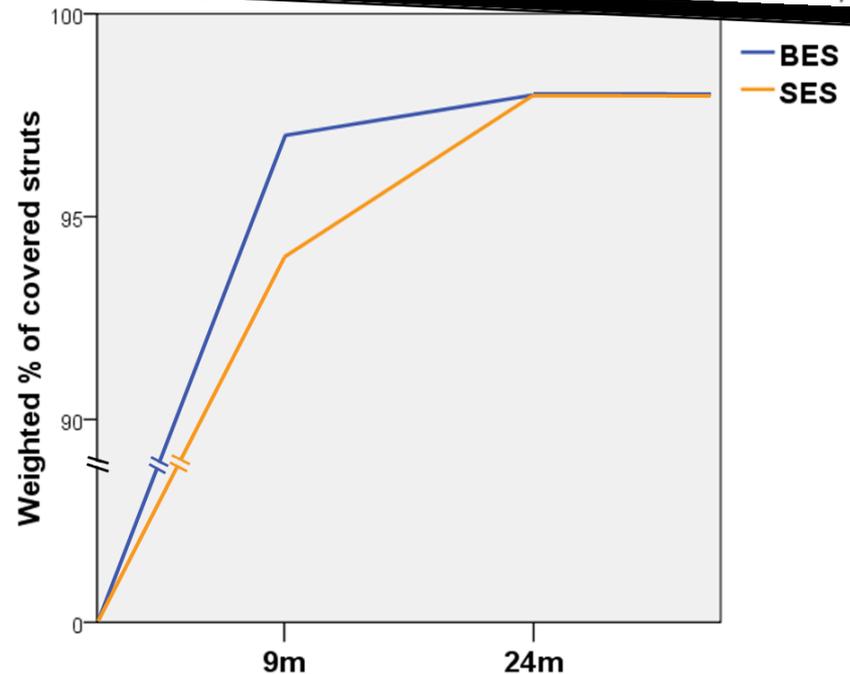
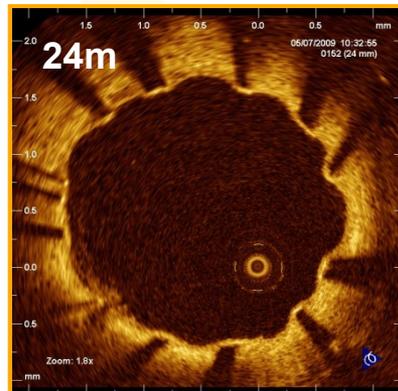
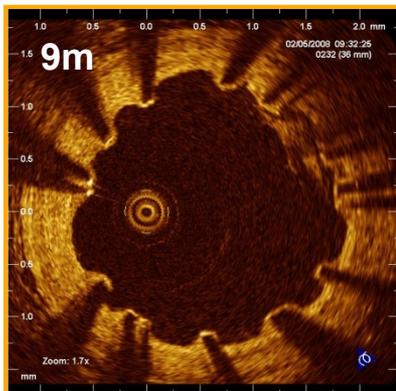


- **LEADERS trial (NCT00389220)**

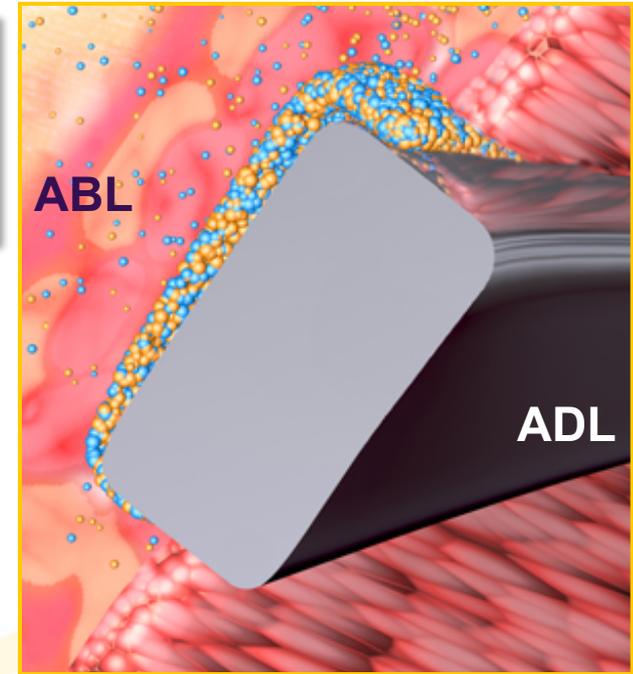
Long-term tissue coverage of a biodegradable polylactide polymer-coated biolimus-eluting stent: Comparative sequential assessment with optical coherence tomography until complete resorption of the polymer

Juan Luis Gutiérrez-Chico, MD, PhD, FESC, FACC,^a Peter Jüni, MD, FESC,^b Héctor M. García-García, MD, PhD,^c Evelyn Regar, MD, PhD, FESC,^a Eveline Nüesch, PhD,^b Francesco Borgia, MD,^d Willem J. van der Giessen, MD, PhD, FESC,^a Simon Davies, MD,^d Robert Jan van Geuns, MD, PhD, FESC,^a Gioel Gabrio Secco, MD,^d Susanne Meis, MD,^c Stephan Windecker, MD, FESC,^f Patrick W. Serruys, MD, PhD, FESC, FACC,^a and Carlo di Mario, MD, PhD, FESC, FACC^d Rotterdam, The Netherlands; Bern, and Morges, Switzerland; and London, United Kingdom (Am Heart J 2011;162:922-31.)

- **Coverage of SES improves between 9-24 months**
- **No difference BES-SES at 24m**



- **Abluminal coating**
- **Poly-lactide biodegradable polymer**
 - **Hydrolysis degradation in 9-12m**



| | Biodegradable polymer BES | Durable polymer SES | Risk ratio (95% CI) | p value |
|--|---------------------------|---------------------|---------------------|---------|
| Definite stent thrombosis | | | | |
| Early | 14/857 (2%) | 14/850 (2%) | 0.99 (0.47-2.08) | 0.98 |
| Late | 3/857 (<1%) | 4/850 (1%) | 0.74 (0.17-3.33) | 0.70 |
| Very late | 3/857 (<1%) | 15/850 (2%) | 0.20 (0.06-0.67) | 0.004 |
| Overall | 20/857 (2%) | 32/850 (4%)* | 0.62 (0.35-1.08) | 0.09 |
| Probable stent thrombosis | | | | |
| Early | 5/857 (1%) | 2/850 (<1%) | 2.48 (0.48-12.78) | 0.26 |
| Late | 2/857 (<1%) | 0/850 (-) | 4.97 (0.24-103.4)† | 0.16‡ |
| Very late | 3/857 (<1%) | 5/850 (1%) | 0.59 (0.14-2.45) | 0.46 |
| Overall | 10/857 (1%) | 7/850 (1%) | 1.41 (0.54-3.69) | 0.49 |
| Possible stent thrombosis | | | | |
| Early | 0/857 (-) | 0/850 (-) | .. | .. |
| Late | 7/857 (1%) | 9/850 (1%) | 0.77 (0.29-2.08) | 0.61 |
| Very late | 26/857 (3%) | 27/850 (3%) | 0.95 (0.55-1.62) | 0.84 |
| Overall | 33/857 (4%) | 36/850 (4%) | 0.90 (0.56-1.45) | 0.67 |
| Definite or probable stent thrombosis | | | | |
| Early | 18/857 (2%) | 16/850 (2%) | 1.12 (0.57-2.19) | 0.75 |
| Late | 5/857 (1%) | 4/850 (1%) | 1.24 (0.33-4.63) | 0.75 |
| Very late | 6/857 (1%) | 20/850 (2%) | 0.29 (0.12-0.73) | 0.005 |
| Overall | 29/857 (3%) | 39/850 (5%)* | 0.73 (0.45-1.19) | 0.20 |

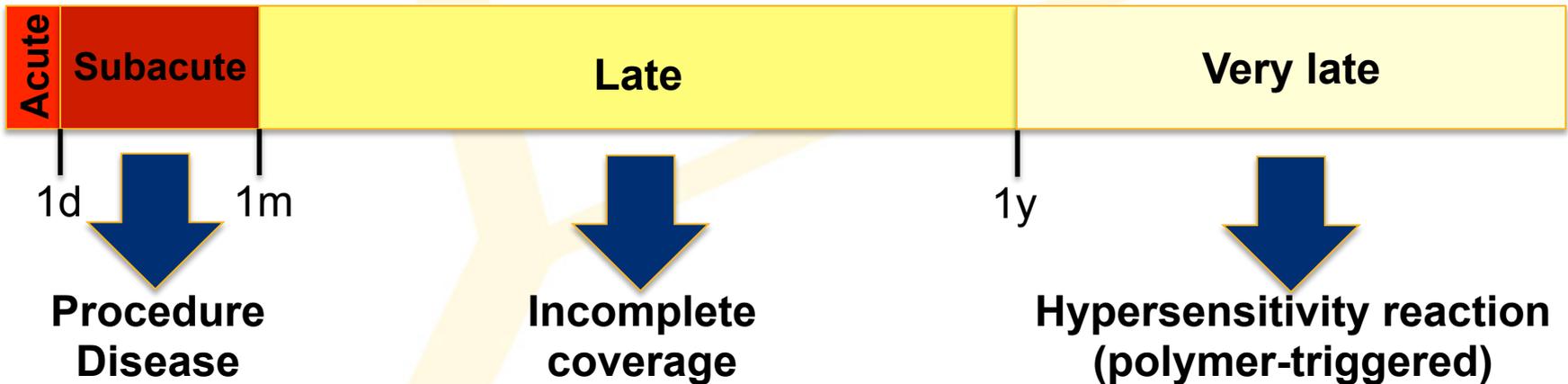
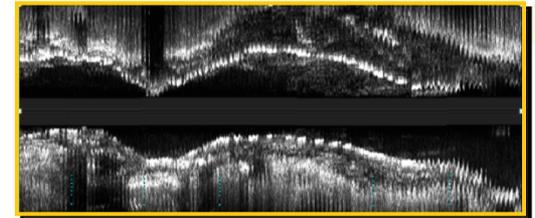
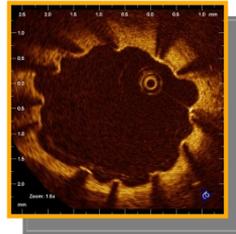
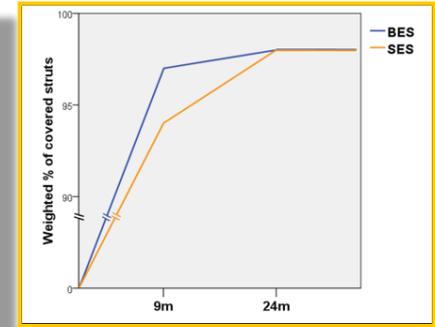
Long-term clinical outcomes of biodegradable polymer biolimus-eluting stents versus durable polymer sirolimus-eluting stents in patients with coronary artery disease (LEADERS): 4 year follow-up of a randomised non-inferiority trial

Giulio G Stefanini*, Bindu Kalesan*, Patrick W Serruys, Dik Heg, Pawel Buszman, Axel Linke, Thomas Ischinger, Volker Klauss, Franz Eberli, William Wijns, Marie-Claude Morice, Carlo Di Mario, Roberto Corti, Diethmar Antoni, Hae Y Sohn, Pedro Eerdmans, Gerrit-Anne van Es, Bernhard Meier, Stephan Windecker, Peter Juni

Lancet 2011; 378: 1940-48

Coverage

- **Findings consistent with the mechanisms of ST**
 - **Similar coverage** - **Similar late ST**
 - **No polymer** - **Lower very late ST**
- **Faster coverage rate in BES**
 - **Duration of DAPT? (Unexplored)**

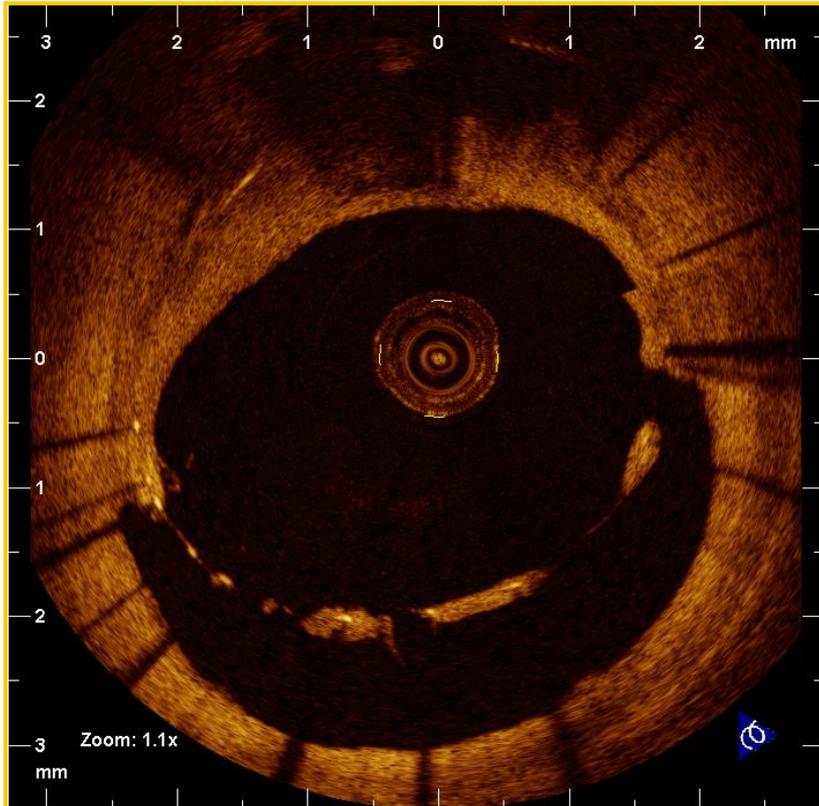


- Coverage
- **Apposition**
- Technique dependent features
 - **Double / triple layers**
 - **NASB struts**
- Specific evidence on bifurcations
(long term results)



Incomplete stent apposition (ISA)

- **Acute ISA associated with:**
 - **Delayed coverage**
 - **Very late stent thrombosis**



Circulation

JOURNAL OF THE AMERICAN HEART ASSOCIATION

American Heart Association
Learn and Live™

Delayed Coverage in Malapposed and Side-Branch Struts With Respect to Well-Apposed Struts in Drug-Eluting Stents : In Vivo Assessment With Optical Coherence Tomography
 Juan Luis Gutiérrez-Chico, Evelyn Regar, Eveline Nüesch, Takayuki Okamura, Joanna Wykrzykowska, Carlo di Mario, Stephan Windecker, Gerrit-Anne van Es, Pierre Gobbens, Peter Jüni and Patrick W. Serruys



European Heart Journal (2012) 33, 1334–1343
 doi:10.1093/eurheartj/ehr484

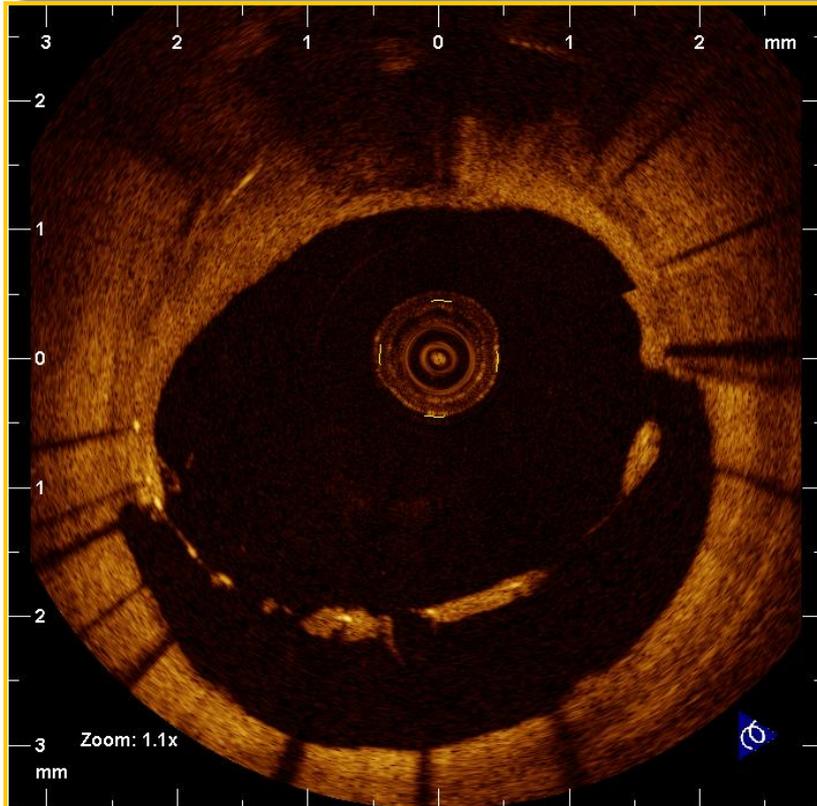
CLINICAL RESEARCH
 Interventional cardiology

Impact of incomplete stent apposition on long-term clinical outcome after drug-eluting stent implantation

Stéphane Cook^{1†}, Parham Eshtehardi^{1†}, Bindu Kalesan^{1,2}, Lorenz Räber¹, Peter Wenaweser¹, Mario Togni¹, Aris Moschovitis¹, Rolf Vogel¹, Christian Seiler¹, Franz R. Eberli³, Thomas Lüscher³, Bernhard Meier¹, Peter Jüni^{2,4}, and Stephan Windecker^{1,4*}

Incomplete stent apposition (ISA)

- **Several studies have reported more ISA:**
 - **In the polygon of confluence**
 - **Ipsilateral to the SB**



Optical coherence tomography assessment of a new dedicated bifurcation stent

Pawel Tyczynski¹, MD, PhD; Giuseppe Ferrante¹, MD; Neville Kukreja¹, MA, MRCP; Cristina Moreno-Ambroj¹, MD; Peter Barlis¹, MD, PhD; Nandakumar Ramasami², MRCP; Ranil De Silva¹, PhD, MRCP; Kevin Beatt², PhD, FRCP; Carlo Di Mario^{*1,3}, MD, PhD, FRCP
EuroIntervention 2009;5:544-551

ORIGINAL ARTICLE

Simple Versus Complex Approaches to Treating Coronary Bifurcation Lesions: Direct Assessment of Stent Strut Apposition by Optical Coherence Tomography

Pawel Tyczynski,^{a,b} Giuseppe Ferrante,^a Cristina Moreno-Ambroj,^a Neville Kukreja,^a Peter Barlis,^a Elio Pieri^a, Ranil de Silva,^{a,c} Kevin Beatt,^d and Carlo Di Mario^{a,c}
Rev Esp Cardiol. 2010;63(8):904-14

Optical coherence tomography (OCT) strut-level analysis of drug-eluting stents (DES) in human coronary bifurcations

Hiroyuki Kyono¹, MD, Giulio Guagliumi², MD, Vasile Sirbu², MD, Noah Rosenthal¹, MD, Satoko Tahara¹, MD, PhD, Giuseppe Musumeci², MD, Antonio Trivisonno², MD, Hiram G. Bezerra¹, MD, PhD, Marco A. Costa^{1*}, MD, PhD, FACC, FSCAI
EuroIntervention 2010;6:69-77

Immediate Results of Bifurcational Stenting Assessed With Optical Coherence Tomography

Catheterization and Cardiovascular Interventions 00:000-000 (2012)
 Nicola Viceconte,^{1,2} MD, Pawel Tyczynski,¹ MD, PhD, Giuseppe Ferrante,¹ MD, PhD, Nicolas Foin,³ PhD, Pak Hei Chan,¹ MD, Eduardo Alegria Barrero,¹ MD, and Carlo Di Mario,^{1*} MD, PhD, FESC

Optical coherence tomography for guidance of distal cell recrossing in bifurcation stenting: choosing the right cell matters

Eduardo Alegria-Barrero¹, MD, PhD; Nicolas Foin², PhD; Pak Hei Chan¹, MD; Dimitrios Syrseloudis¹, MD; Alistair C Lindsay¹, MD, PhD; Konstantinos Dimopoulos¹, MD, PhD; Rafael Alonso-González¹, MD; Nicola Viceconte³, MD; Ranil De Silva¹, MD, PhD; Carlo Di Mario^{*1}, MD, PhD, FESC, FACC, FRCP
EuroIntervention 2012;8:205-213

Incomplete stent apposition (ISA)

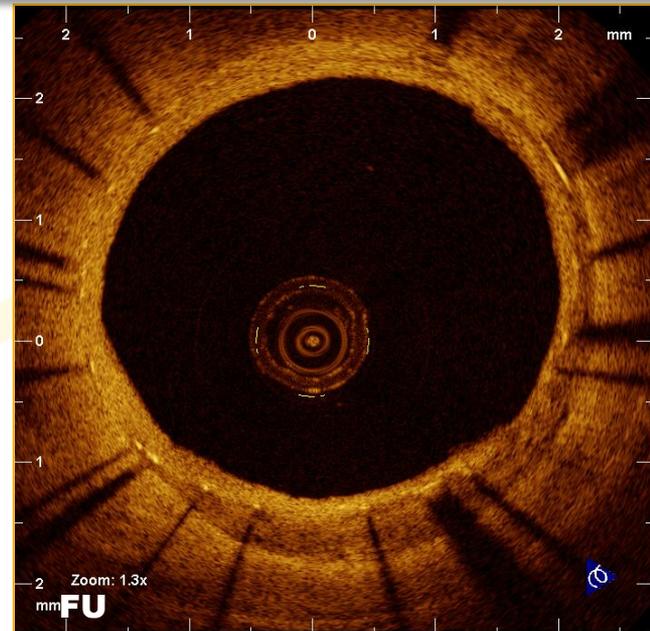
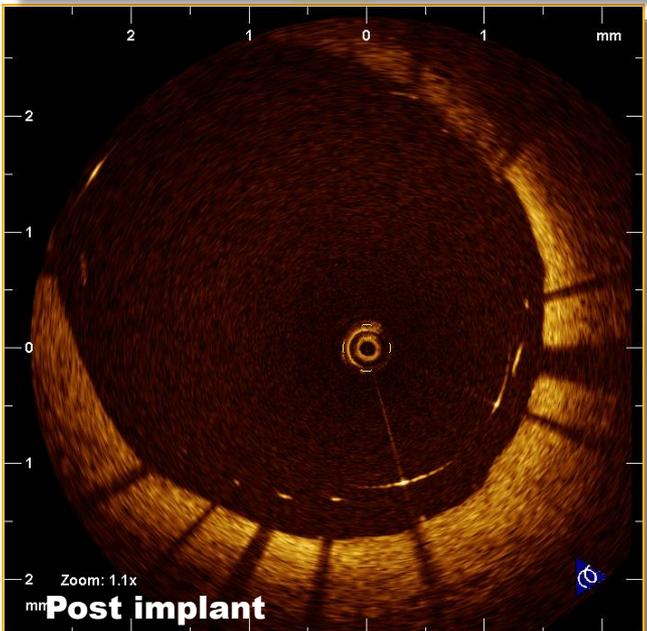
- **Neointimal healing reaction tends to correct ISA:**
 - **71.5% acute ISA regions reapposed at 6-13 months**
 - **Healing patterns of ISA**

Vascular Tissue Reaction to Acute Malapposition in Human Coronary Arteries

Sequential Assessment With Optical Coherence Tomography

Juan Luis Gutiérrez-Chico, MD, PhD; Joanna Wykrzykowska, MD, PhD; Eveline Nüesch, PhD; Robert Jan van Geuns, MD, PhD; Karel T. Koch, MD, PhD; Jacques J. Koolen, MD, PhD; Carlo di Mario, MD, PhD; Stephan Windecker, MD, PhD; Gerrit-Anne van Es, MSc, PhD; Pierre Gobbens, MSc; Peter Jüni, MD; Evelyn Regar, MD, PhD; Patrick W. Serruys, MD, PhD
Circ Cardiovasc Interv 2012;5:2029

Layered pattern



Incomplete stent apposition (ISA)

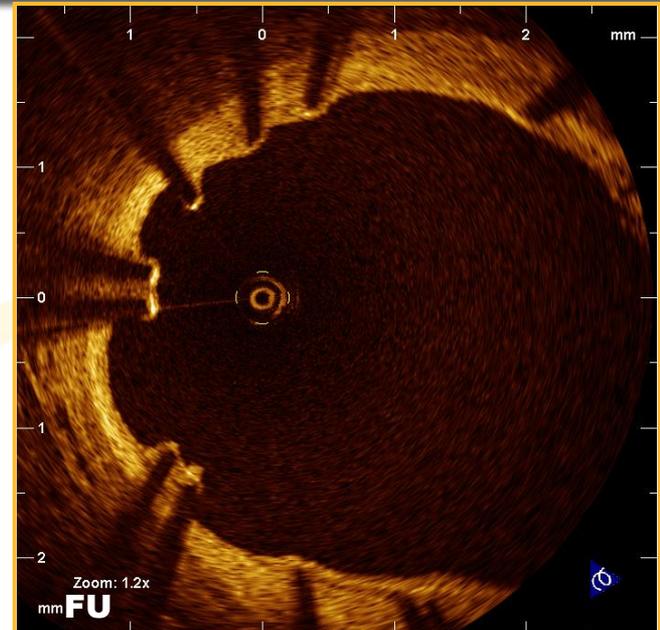
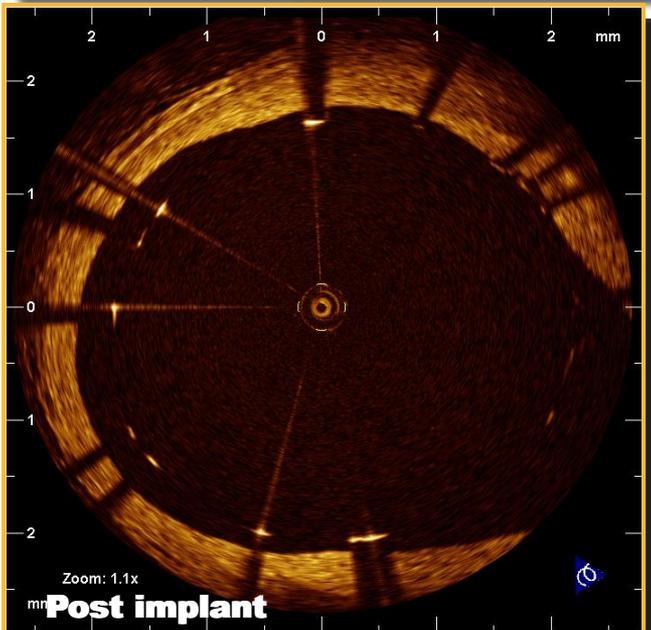
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Circ Cardiovasc Interv 2012;5:2029

Crenellated pattern



Incomplete stent apposition (ISA)

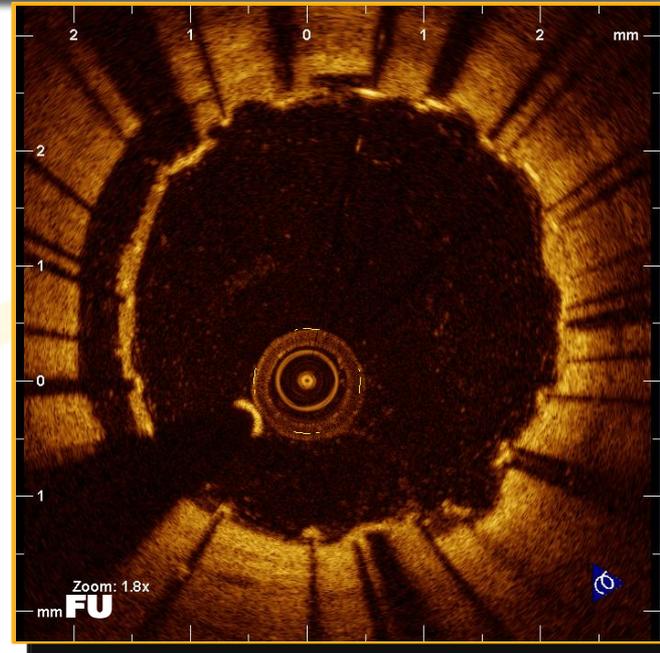
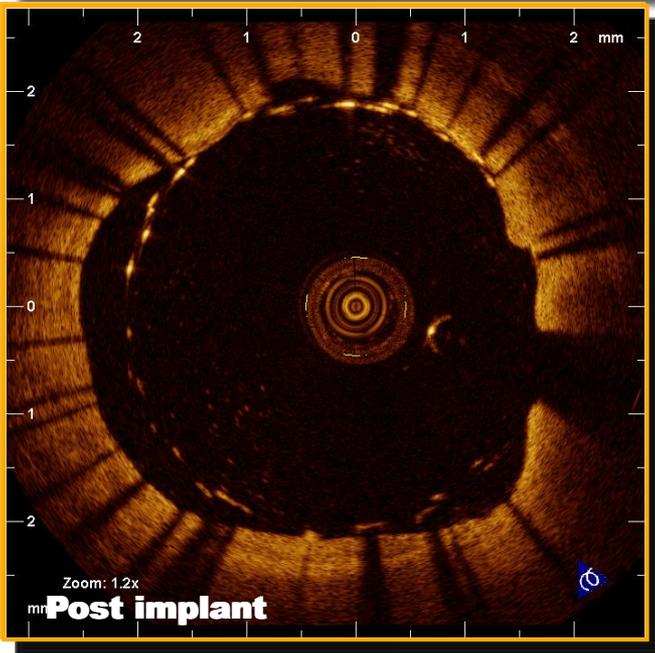
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Vascular Tissue Reaction to Acute Malapposition in Human Coronary Arteries

Sequential Assessment With Optical Coherence Tomography

Juan Luis Gutiérrez-Chico, MD, PhD; Joanna Wykrzykowska, MD, PhD; Eveline Nüesch, PhD; Robert Jan van Geuns, MD, PhD; Karel T. Koch, MD, PhD; Jacques J. Koolen, MD, PhD; Carlo di Mario, MD, PhD; Stephan Windecker, MD, PhD; Gerrit-Anne van Es, MSc, PhD; Pierre Gobbens, MSc; Peter Jüni, MD; Evelyn Regar, MD, PhD; Patrick W. Serruys, MD, PhD
Circ Cardiovasc Interv 2012;5:2029

Bridged pattern



Incomplete stent apposition (ISA)

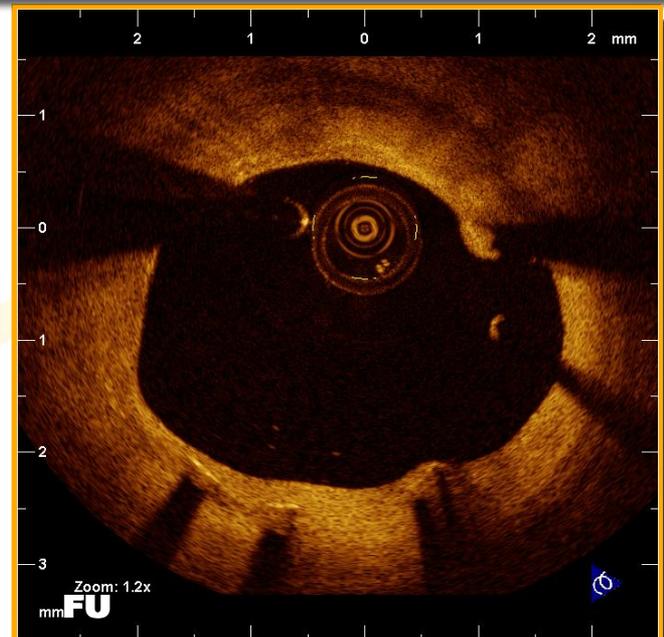
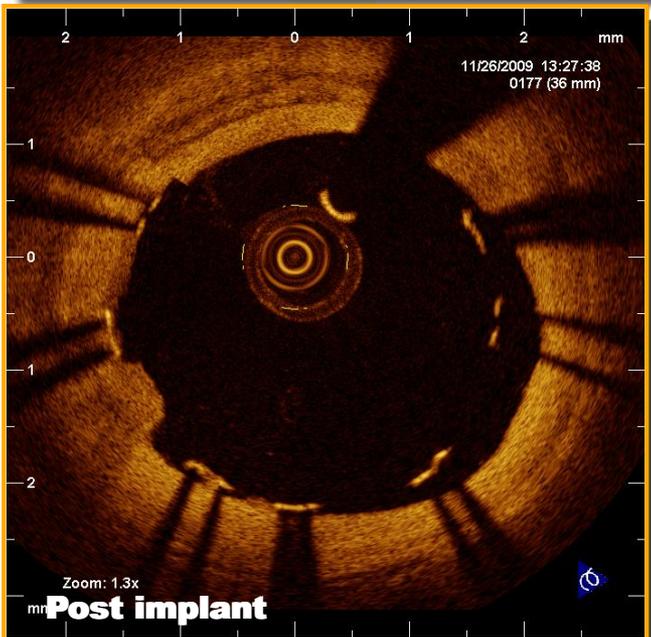
- **Neointimal healing reaction tends to correct ISA:**
 - **71.5% acute ISA regions reapposed at 6-13 months**
 - **Healing patterns of ISA**

Vascular Tissue Reaction to Acute Malapposition in Human Coronary Arteries

Sequential Assessment With Optical Coherence Tomography

Juan Luis Gutiérrez-Chico, MD, PhD; Joanna Wykrzykowska, MD, PhD; Eveline Nüesch, PhD; Robert Jan van Geuns, MD, PhD; Karel T. Koch, MD, PhD; Jacques J. Koolen, MD, PhD; Carlo di Mario, MD, PhD; Stephan Windecker, MD, PhD; Gerrit-Anne van Es, MSc, PhD; Pierre Gobbens, MSc; Peter Jüni, MD; Evelyn Regar, MD, PhD; Patrick W. Serruys, MD, PhD
Circ Cardiovasc Interv 2012;5:2029

Bridged pattern



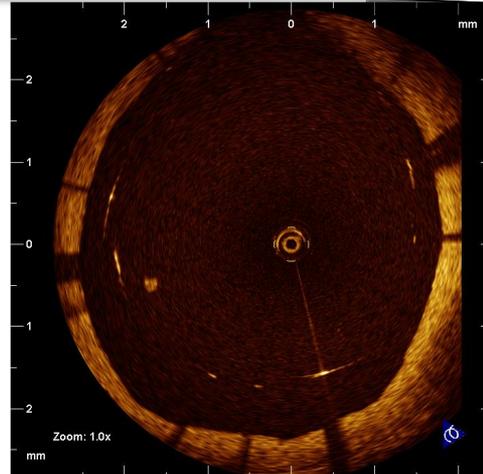
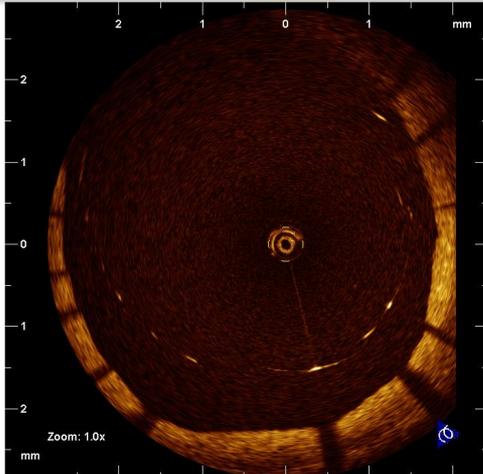
Incomplete stent apposition (ISA)

Partially bridged pattern

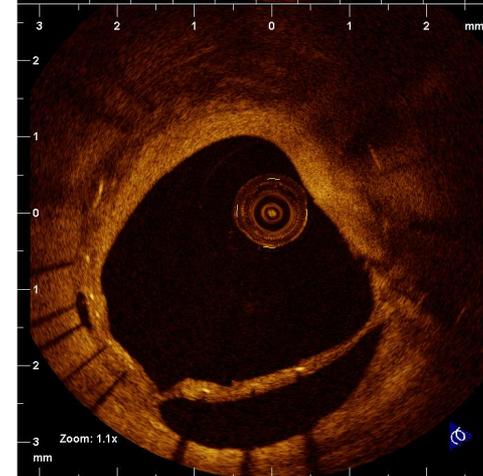
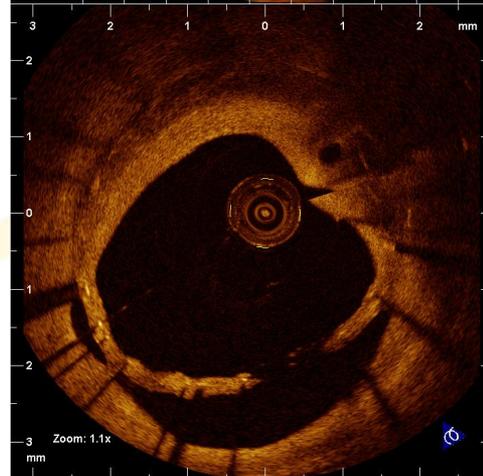
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Post-implant



6m

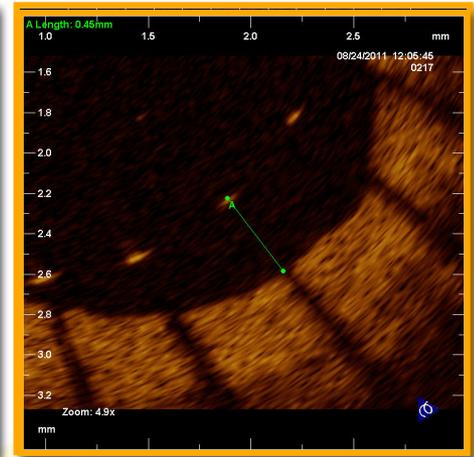
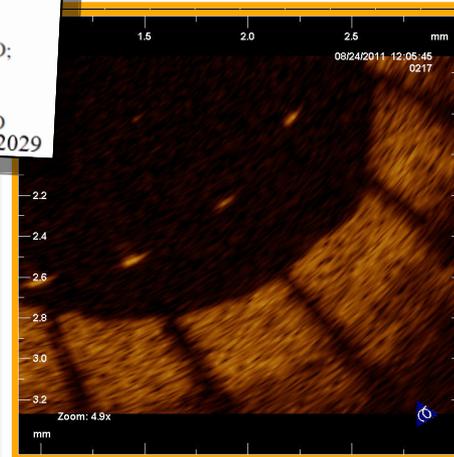


Incomplete stent apposition (ISA)

Vascular Tissue Reaction to Acute Malapposition in Human Coronary Arteries Sequential Assessment With Optical Coherence Tomography

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- Spontaneous resolution and coverage depend on ISA size:
 - ISA volume
 - Maximal ISA distance



Likelihood at follow-up of

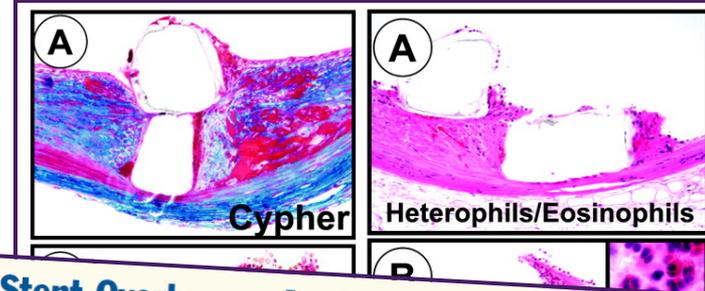
| | | Resolved ISA (%) | Grossly covered (%) | | Persistent ISA (%) | Grossly delayed healing (%) |
|-----------------------|--------|------------------|---------------------|-------|--------------------|-----------------------------|
| Max ISA distance (µm) | < 270 | 100 | 100 | ≥ 270 | 46.15 | 20.5 |
| | < 350 | 94.9 | 100 | ≥ 350 | 57.1 | 26.9 |
| | < 400* | 92.7 | 97.6 | ≥ 400 | 57.7 | 28.6 |
| | < 520 | 83.3 | 92.6 | ≥ 520 | 69.2 | 30.8 |
| | < 850 | 75.4 | 87.9 | ≥ 850 | 100 | 100 |

- Coverage
- Apposition
- **Technique-dependent features**
 - **Double / triple layers**
 - **NASB struts**
- Specific evidence on bifurcations
(long term results)



Technique-dependent issues: double layers

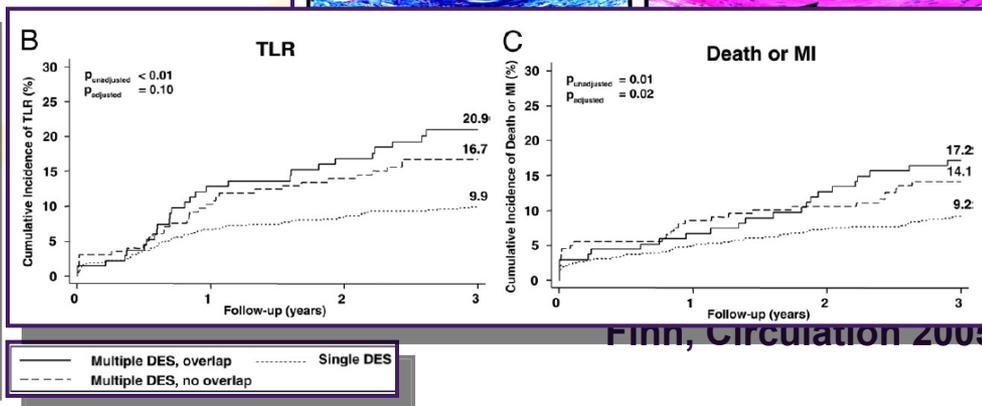
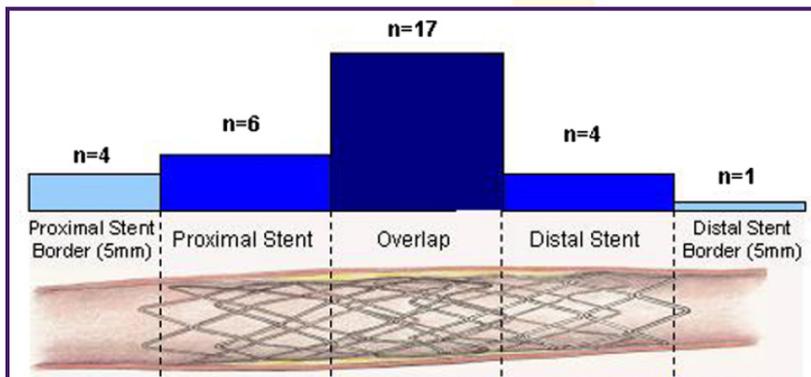
- **Overlaps:**
 - **Double drug dose: Delayed healing**
 - **Double metal-to-artery ratio: Hyperplasia**
- **Histology:**
 - **Delayed healing in DES overlaps**
- **Angiography in pt with overlap:**
 - **Predilect site for restenosis**
 - **Higher:**
 - **Late loss**
 - **TLR**
 - **Death + MI**



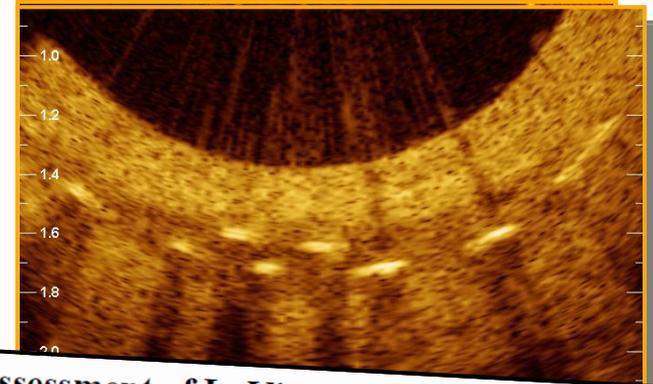
Impact of Stent Overlap on Angiographic and Long-Term Clinical Outcome in Patients Undergoing Drug-Eluting Stent Implantation

Lorenz Räber, MD,* Peter Jüni, MD,†‡ Lukas Löffel, BA,* Simon Wandel, PhD, MSC,‡ Stéphane Cook, MD,* Peter Wenaweser, MD,* Mario Togni, MD,* Rolf Vogel, MD, MSC,* Christian Seiler, MD,* Franz Eberli, MD,§ Thomas Lüscher, MD,|| Bernhard Meier, MD,* Stephan Windecker, MD*†

JACC Vol. 55, No. 12, 2010

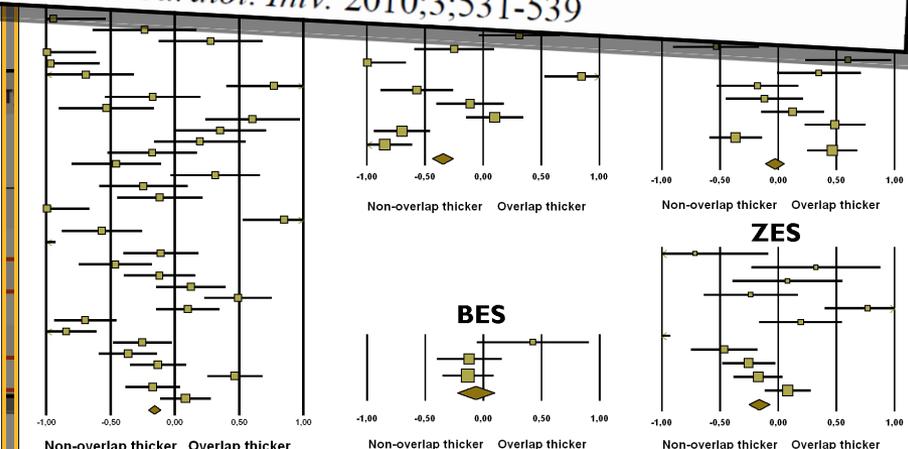
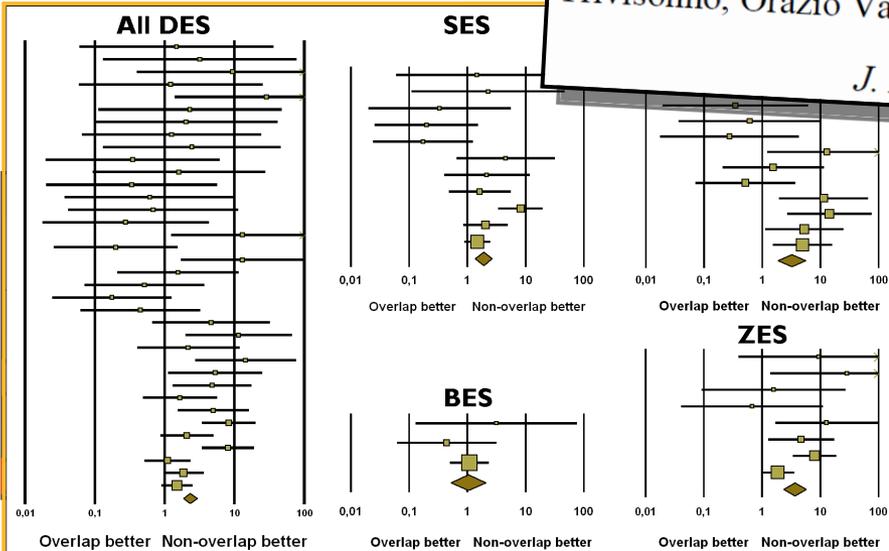


- **OCT:**
 - **ODESSA:**
 - **No differences overlaps / non-overlaps**
 - Coverage
 - NIH
 - **Heterogeneous effect**
 - **Some cases o**
 - **Some cases v**



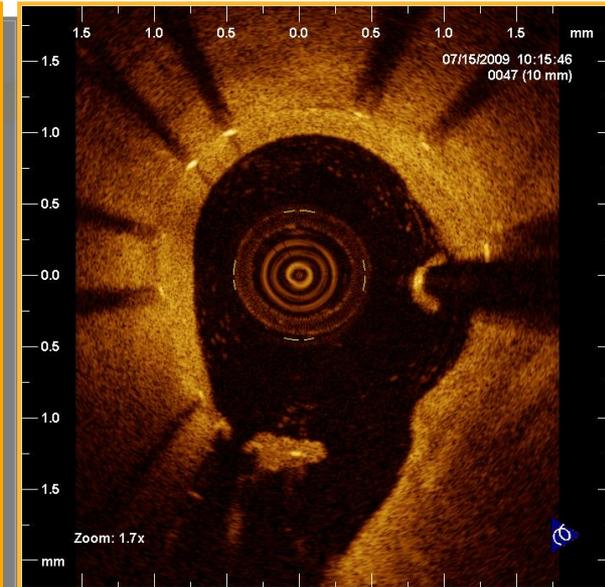
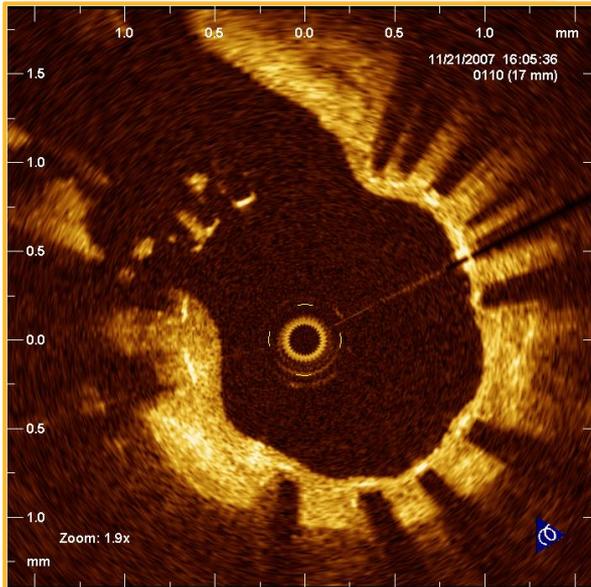
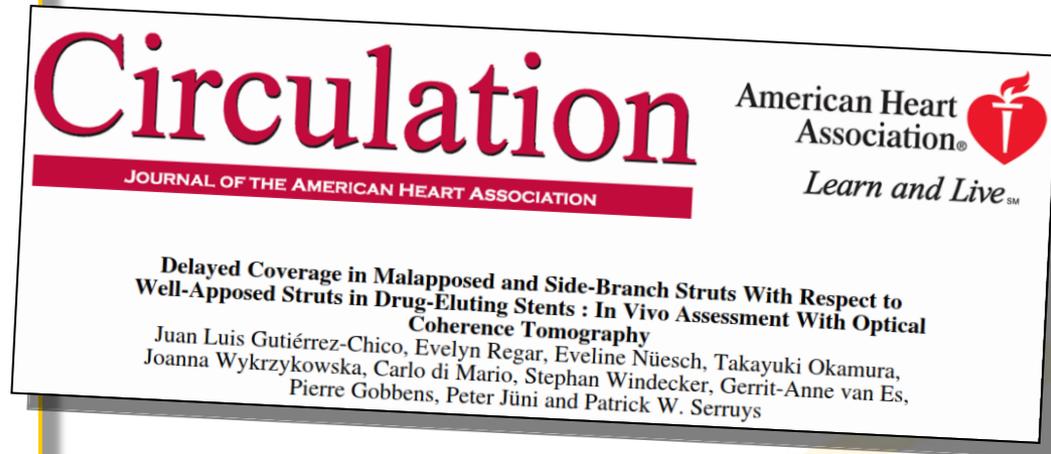
Optical Coherence Tomography Assessment of In Vivo Vascular Response After Implantation of Overlapping Bare-Metal and Drug-Eluting Stents
 Giulio Guagliumi, Giuseppe Musumeci, Vasile Sirbu, Hiram G. Bezerra, Nobuaki Suzuki, Luigi Fiocca, Aleksandre Matiashvili, Nikoloz Lortkipanidze, Antonio Trivisonno, Orazio Valsecchi, Giuseppe Biondi-Zoccai, Marco A. Costa, on behalf of the ODESSA Trial Investigators
J. Am. Coll. Cardiol. Interv. 2010;3;531-539

Uncoverage



Technique-dependent issues: non-opposed side-branch struts (NASB)

- **NASB (jailing) struts**
 - **Delayed coverage with respect to well apposed**
 - **Important : provisional stenting is becoming default technique for bifurcation**
 - **Better coverage than ISA**
 - **Less diseased underlying vessel?**
- **Floating struts (mid-lumen)**
 - **Still no evidence**



- Neointimal healing process
- Coverage
- Apposition
- Technique dependent features
 - Double / triple layers
 - NASB struts
- **Specific evidence on bifurcations
(long term results)**



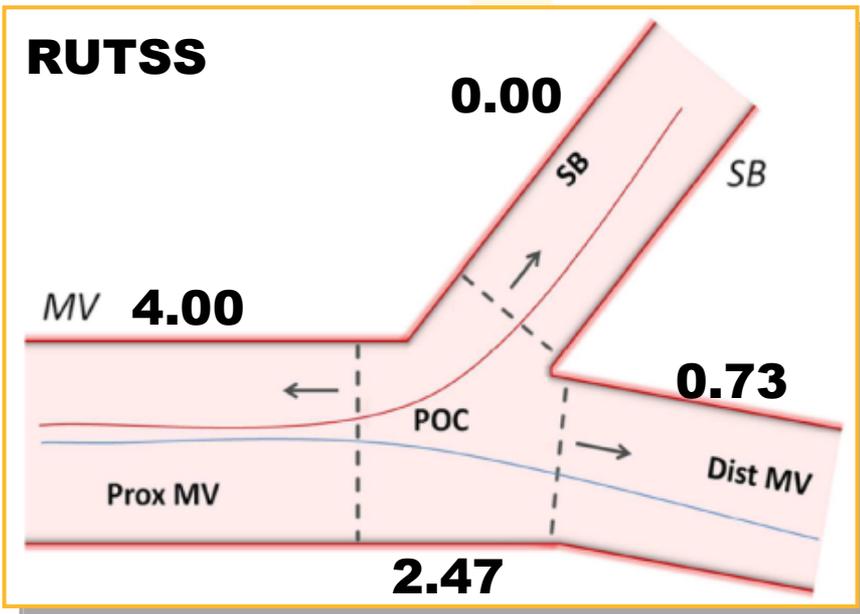
Specific evidence on bifurcations

- **Scarce evidence hitherto**
- **Long term results of Tryton device (dedicated “reverse culotte”)**
 - **N=13**
 - **Good coverage**
 - **Distal > proximal**
 - **High restenosis rates**

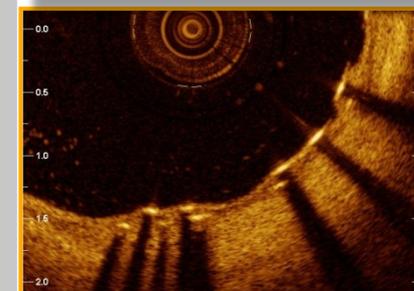
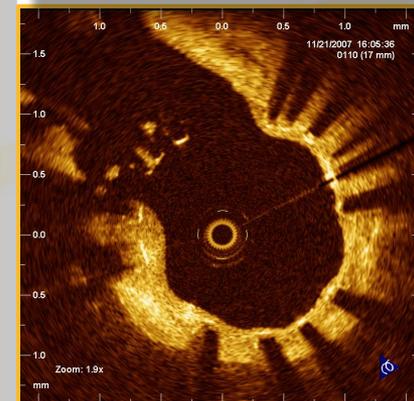
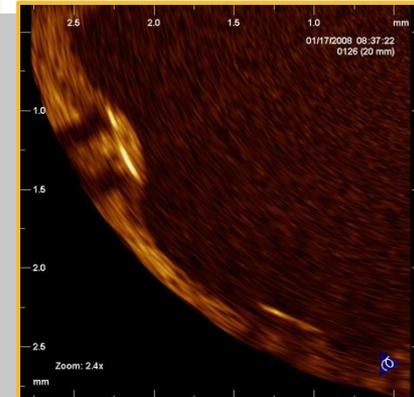
Healing Responses After Bifurcation Stenting with the Dedicated TRYTON Side-Branch Stent™ in Combination with XIENCE-V™ Stents: a Clinical, Angiography, Fractional Flow Reserve and Optical Coherence Tomography Study

The PYTON (Prospective Evaluation of the TRYTON Side-Branch Stent™ with an additional XIENCE-V™ Everolimus-Eluting Stent in Coronary Bifurcation Lesions) Study

C. Dubois*†, MD, PhD, T Adriaenssens*, MD, G. Ughi†, Ir, S. Wiyono*, MD, J. Bennett*, MD, M. Coosemans*, MD, B. Ferdinande*, MD, P. Sinnaeve*†, MD, PhD, J. D’hooghe†, PhD, W. Desmet*†, MD, PhD



- **Coverage by OCT estimates the degree of neointimal healing**
- **Association coverage / risk of thrombosis**
 - **Still not clear at all**
- **Detached struts (ISA, NASB)**
 - **Delayed healing**
 - **Higher risk of stent thrombosis (ISA)**
- **ISA tends to be reduced over time**
 - **Max ISA distance <270 μm : 100% corrected**
 - **Max ISA distance <400 μm : 92% corrected**
- **Double metallic layers: heterogeneous response**
 - **Some cases thicker NIH (than in monolayer)**
 - **Some cases more delayed healing (than in monolayer)**
- **Scarce evidence on bifurcations**
 - **No comparative study**



Dr. Juan Luis Gutiérrez-Chico

OCT and long term bifurcation evolution

European Bifurcation Club



**Thank you very much
for your attention!**

jlgutierrez@medynet.com