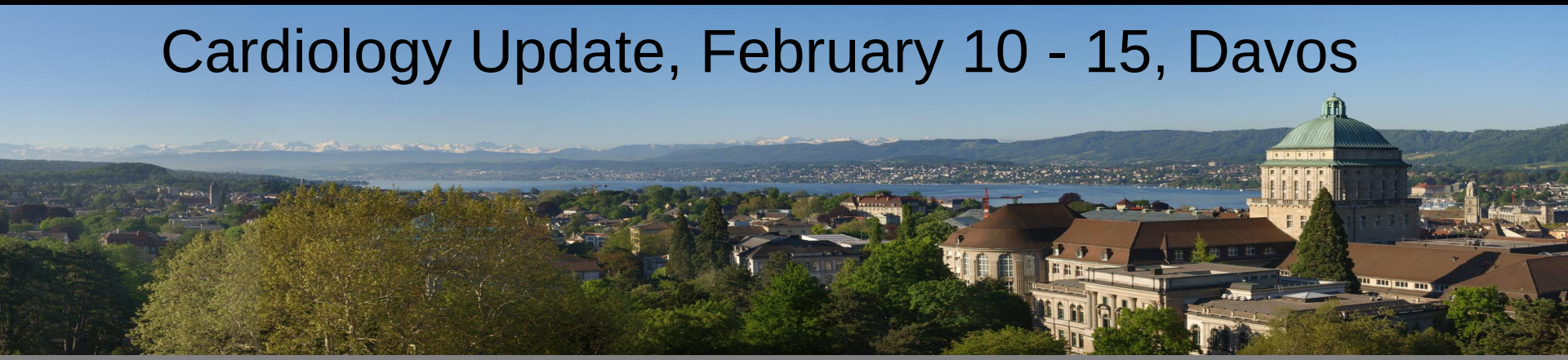
Cardiology Update, February 10 - 15, Davos



OCT – how it works

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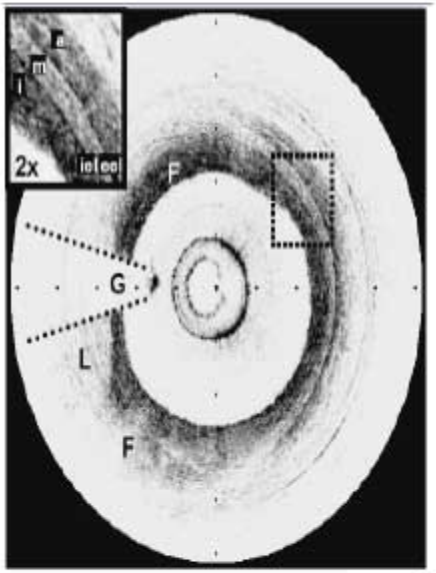
The history of intravascular OCT

- 1990-91: **Invention of OCT**
  - -Fujimoto (USA); Tanno (Japan)
- 1996-1999 **Exploratory ex-vivo studies** **Mass. General Hospital**
  - - (Brezinski, Tearney, Boppart, Bouma, Fujimoto et al)
- 2000-2002 **First published clinical studies**
  - - ***Stent imaging*** *(Grube et al, 2001; Bouma et al, 2002)*
  - - ***Plaque characterization*** *(Yabushita et al, 2002)*
  - - ***Macrophage detection*** *(Tearney et al, 2002)*
- 2002 **Commercialization phase**
  - **-LightLab** M2-M3
- 2008 **New technology systems**
  - **Lightlab M4**
  - **MGH OFDI**
  - **Terumo OFDI**
  - **Volcano**



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OCT – comparison to other intracoronary imaging modalities

Technology	Resolution	Fibrous cap	Lipid core	Inflammation	Calcium	Thrombus	Detection
IVUS	>100 µm	+	+	-	+++	+	Gross plaque morphology and dimensions. Remodelling
Angioscopy	100 µm	+	++	-	-	+++	Plaque surface visualisation
OCT	10 µm	+++	+++	++	+++	+	Detailed morphology, including fibrous cap, macrophages
Thermography	500 µm	-	-	+++	-	-	Surface temperature
Spectroscopy	-	+	++	++	++	-	Chemical and tissue characteristics
Intravascular MRI	160 µm	+	++	+	++	+	Gross plaque morphology and structure

MacNeill BD. Arterioscler Thromb Vasc Biol 2003

OCT – „First-in-man“

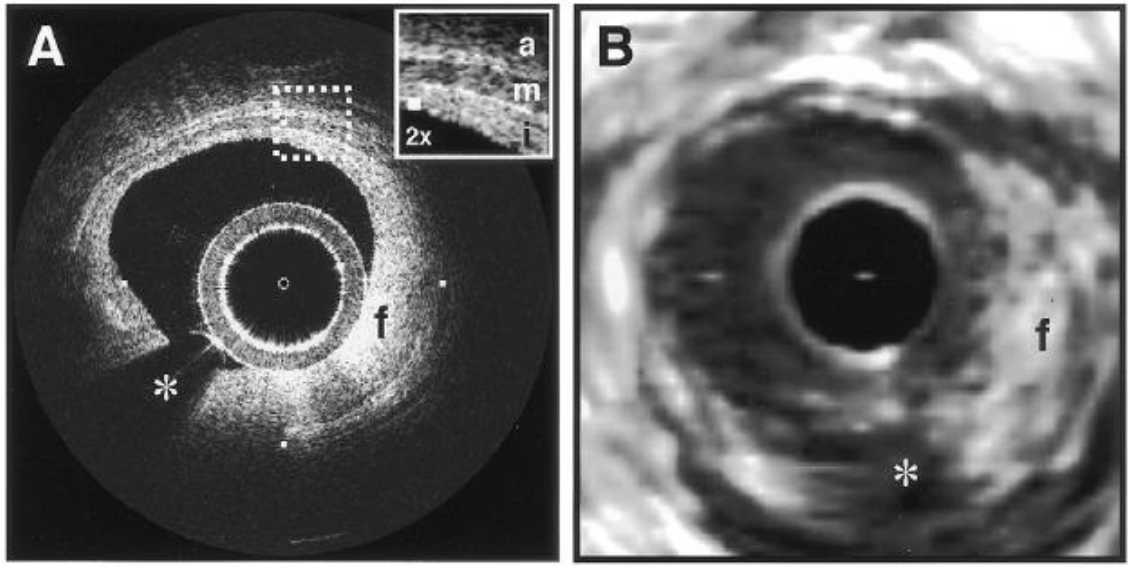

Figure 2. Fibrous coronary plaque imaged in vivo by optical coherence tomography (OCT) **(A)** and intravascular ultrasound (IVUS) **(B)**. **(A)** From 9 o'clock to 2 o'clock, this OCT image demonstrates visualization of the intima (with intimal hyperplasia [i]), media (m) and adventitia (a). The internal and external elastic laminae are visible as signal-rich lines bordering the media (inset). A plaque extending from 2 o'clock to 9 o'clock contains a homogeneous, signal-rich region consistent with a fibrous plaque (f) that is partially obscured by a guidewire shadow artifact (*). **(B)** In the corresponding IVUS image, the fibrous plaque (f) is also visualized. Tick marks, 1 mm.

Jang IK. J Am Coll Cardiol 2002

OCT technology

- OCT is an intravascular imaging modality that utilizes near-infrared light to generate cross-sectional blood vessel images
- Up to 10 to 15 μm of spatial resolution compared with the 100- to 200-μm resoluti
- OCT imaging depths range from 1 to 3 mm into the vessel wall, whereas IVUS imaging depths range from 4 to 10 mm
- OCT imaging requires transient blood clearing during image acquisition (since near-infrared light is scattered by red blood cells)

OCT – time domain vs. frequence domaine imaging

- First generation – **time delay OCT** (TD-OCT) systems
  - Utilized a moving reference mirror to calibrate reflected light waves for image acquisition (mirror mechanics were relatively slow)
    - Acquisition time: 1-2 mm/s

- Second-generation technology - **frequency domain (also called Fourier domain) OCT** (FD-OCT).
  - Compared with TD-OCT, FD-OCT has a better spatial resolution and 10 times faster image acquisition (because it utilizes an ultrafast frequency swept light source rather than a mechanical reference mirror)
    - Acquisition time: 20-40 mm/s

OCT intracoronary imaging

The ILUMIEN OCT system uses a
2.7F monorail C7 Dragonfly Intravascular Imaging Catheter.
Delivered through a 6F guide over standard 0.014-inch intracoronary guidewire

- 1. Advance the catheter distal to the segment of interest and position according to the vessel segment of interest.
- 2. Start scanning by activation from the image console (flushing the OCT catheter at this moment might damage the catheter which should be avoided).
- 3. Start contrast injection.
- 4. **Start OCT pullback when an optimal blood clearance** is achieved as seen on the monitor of the image console.
- 5. Acquire the fluoroscopic images simultaneously.
- 6. Monitor ECG, heart rate and arterial pressure during pullback to rule out ischaemia.
- 7. **Withdraw the OCT imaging catheter into the guiding catheter once the pullback is completed.**
- 8. Re-insert the OCT catheter for image acquisition in another segment of interest if needed.

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Tools & Techniques: Intravascular ultrasound and optical coherence tomography

C7 OCT Vascular System

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Consensus Standards for Acquisition, Measurement, and Reporting of Intravascular Optical Coherence Tomography Studies

A Report From the International Working Group for Intravascular Optical Coherence Tomography Standardization and Validation

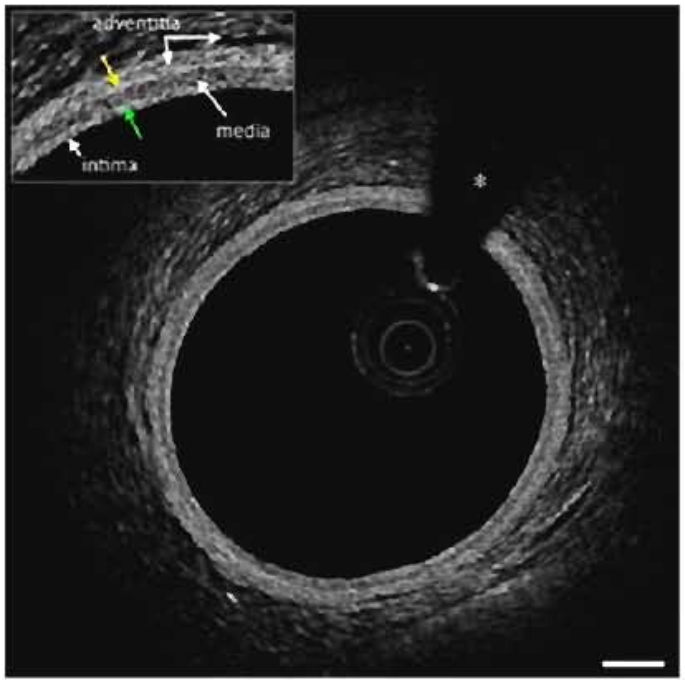
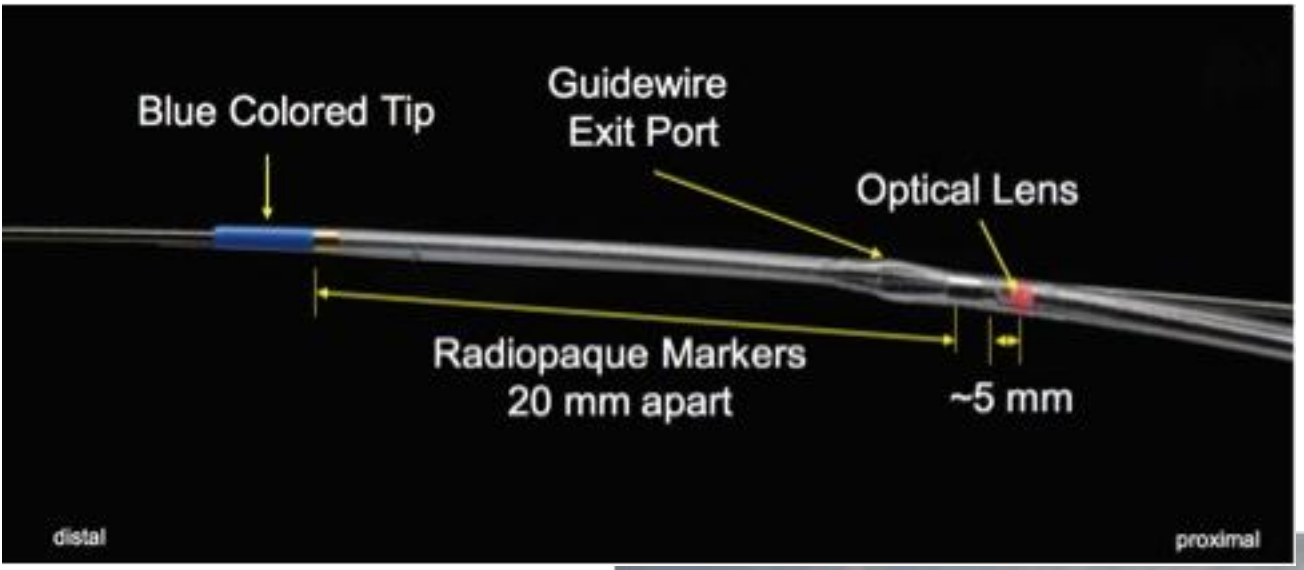
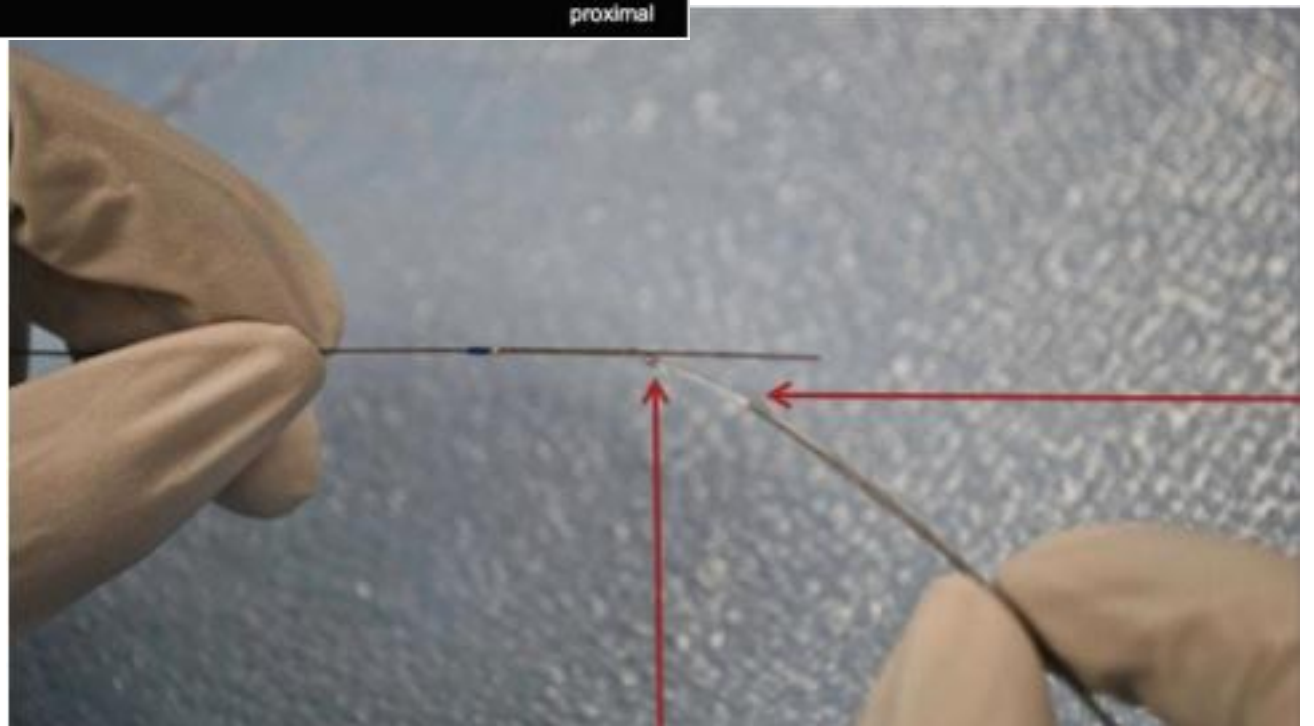


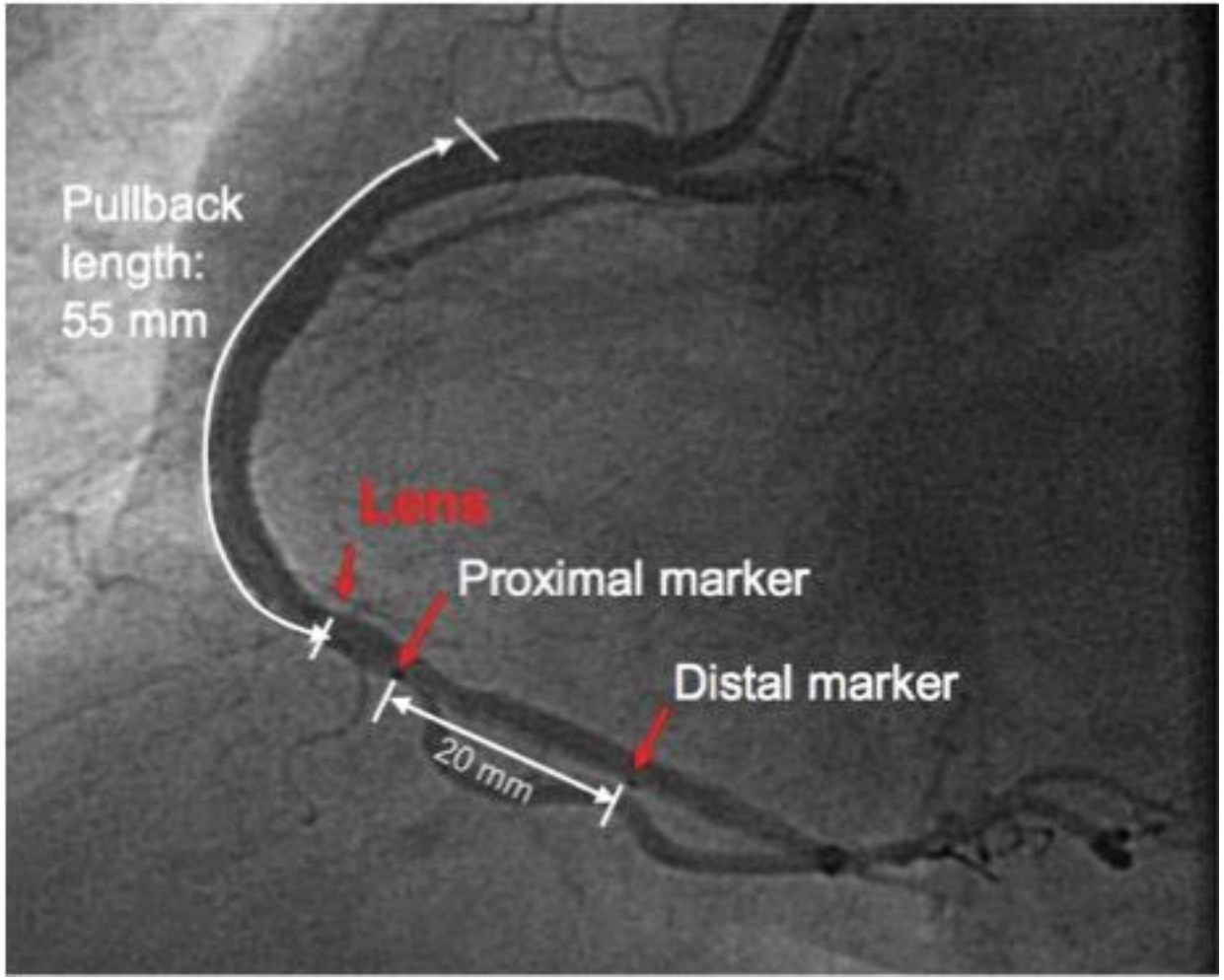
Figure 1 Normal Artery Wall

OCT imaging catheter

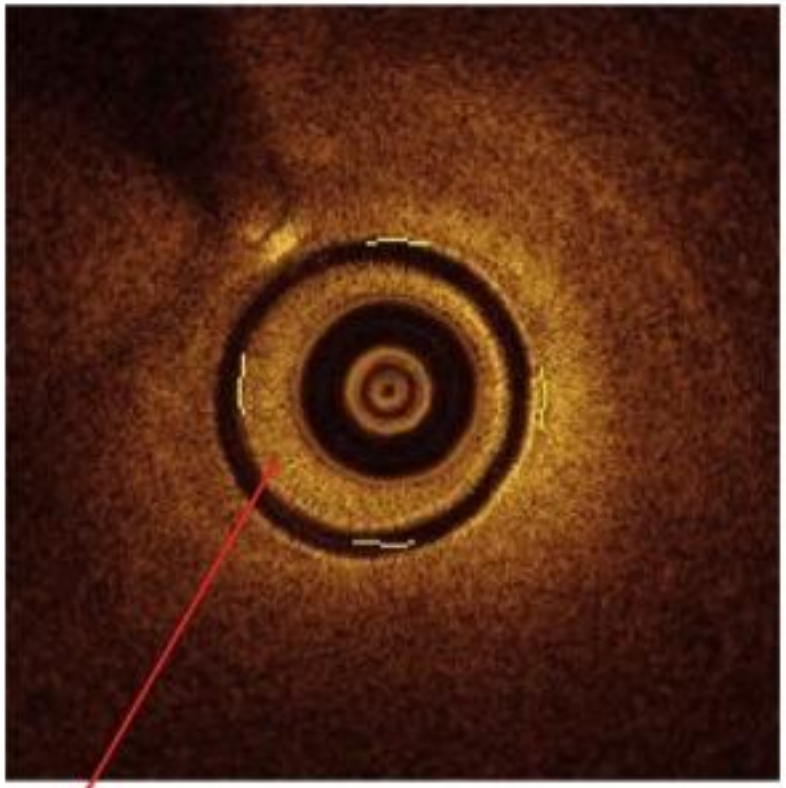




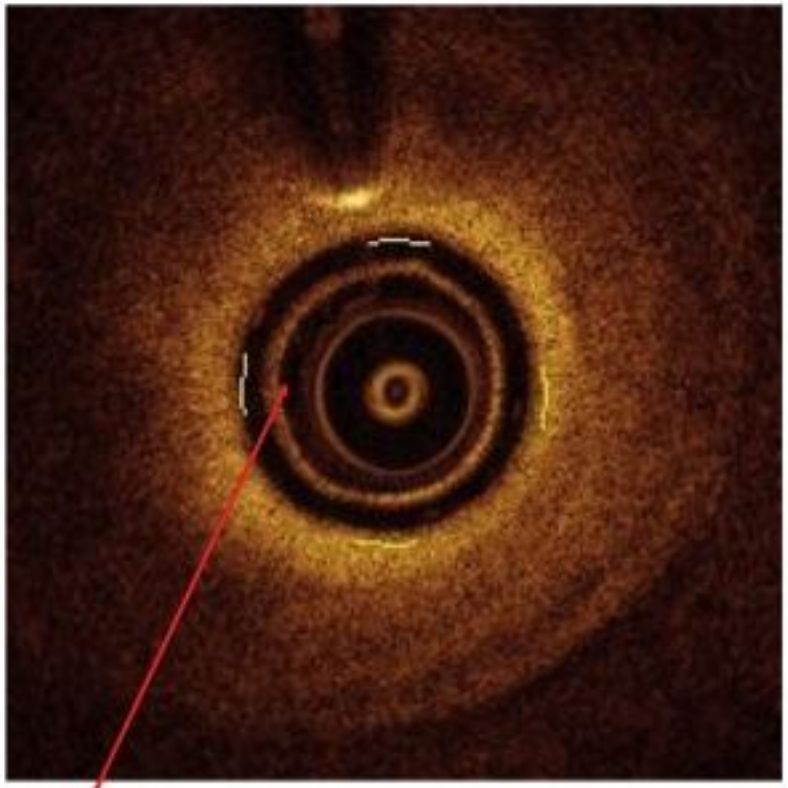
OCT imaging


Pullback
length:
55 mm
Lens
Proximal marker
Distal marker
20 mm

OCT imaging



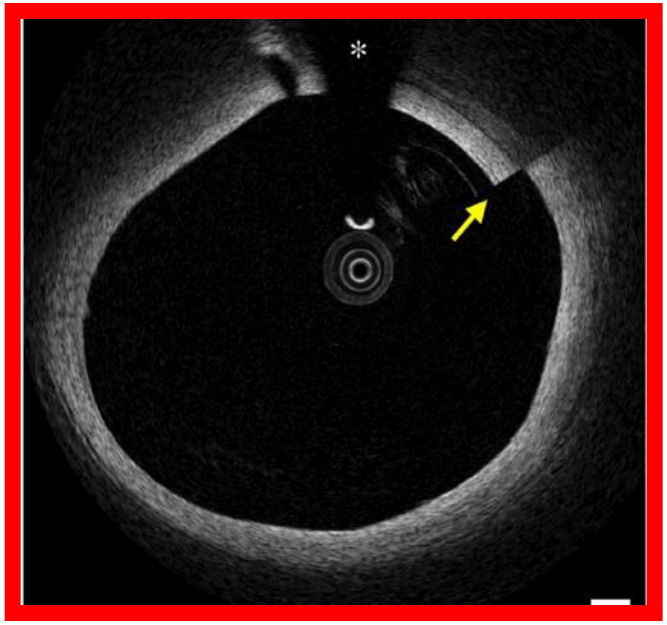
TM *

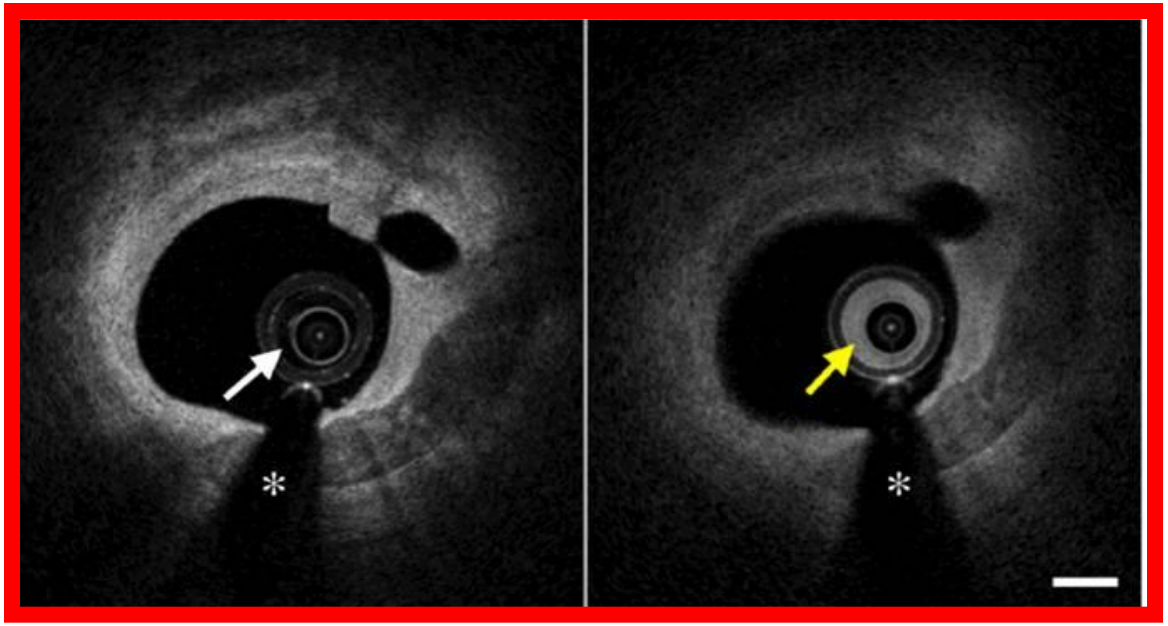


Blood in catheter lumen

Purged catheter lumen

Cave: OCT artifacts





J Am Coll Cardiol. 2012 Mar 20;59(12):1058-72.

OCT image: plaque rupture and plaque erosion

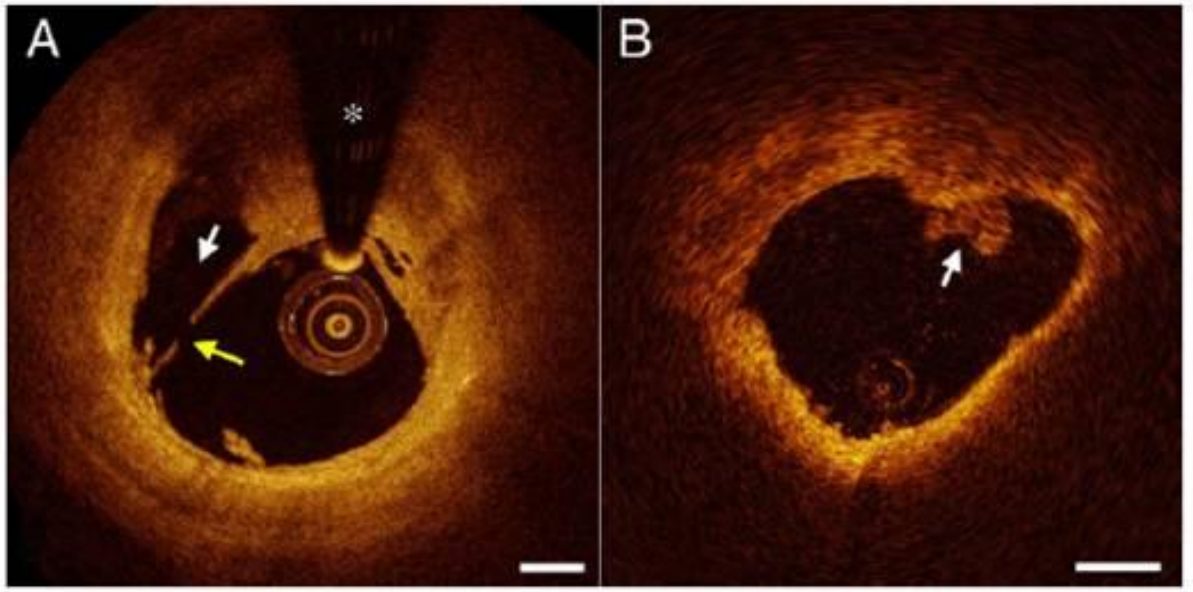


Figure 7 Plaque Rupture and Erosion

J Am Coll Cardiol. 2012 Mar 20;59(12):1058-72.

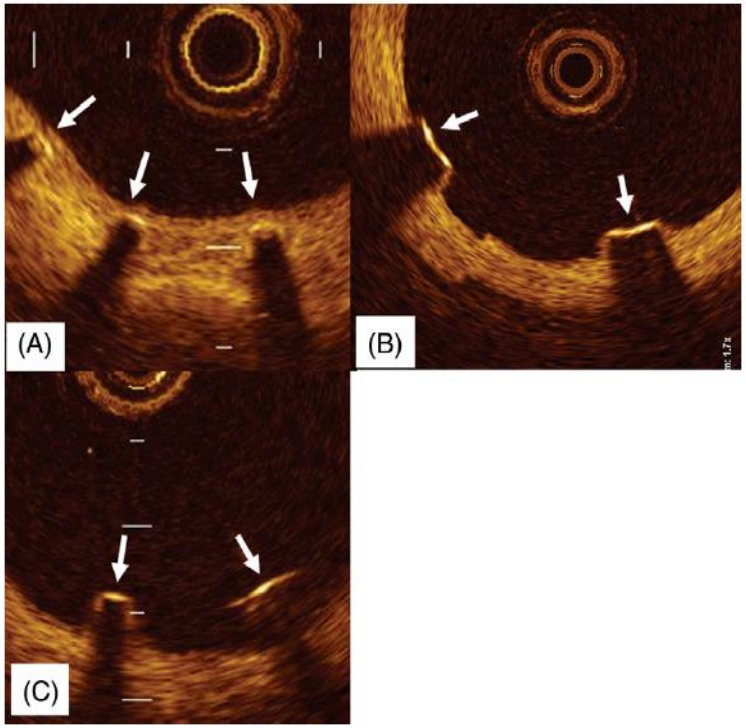
OCT for evaluation of stent healing

European Heart Journal (2007) **28**, 961–967

Neointimal coverage of sirolimus-eluting stents at 6-month follow-up: evaluated by optical coherence tomography

Daisuke Matsumoto, Junya Shite*, Toshiro Shinke, Hiromasa Otake, Yusuke Tanino, Daisuke Ogasawara, Takahiro Sawada, Oscar Luis Paredes, Ken-ichi Hirata, and Mitsuhiro Yokoyama

Department of Internal Medicine, Division of Cardiovascular and Respiratory Medicine, Kobe University Graduate School of Medicine, 7-5-1 Kusunoki-cho, Chuo-ku, Kobe, Hyogo 650-0017, Japan



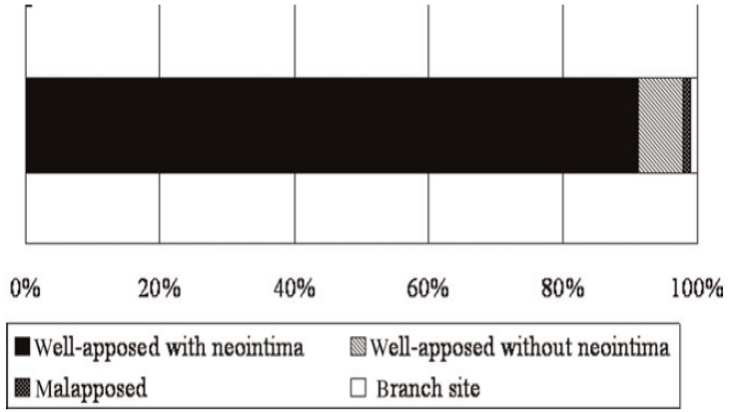


Figure 5 Distribution of SES strut condition. Of the 6840 stent struts in 57 SES, 6236 (91%) were classified as well-apposed with neointima, 455 (7%) as well-apposed without neointima, 79 (1%) as malapposed without neointima, and 70 (1%) were at the site of a major side branch.

Figure 1 Classification of SES strut conditions by OCT. (*A*) Well-apposed with neointimal coverage. (*B*) Well-apposed without neointimal coverage. (*C*) Malapposed without neointimal coverage.

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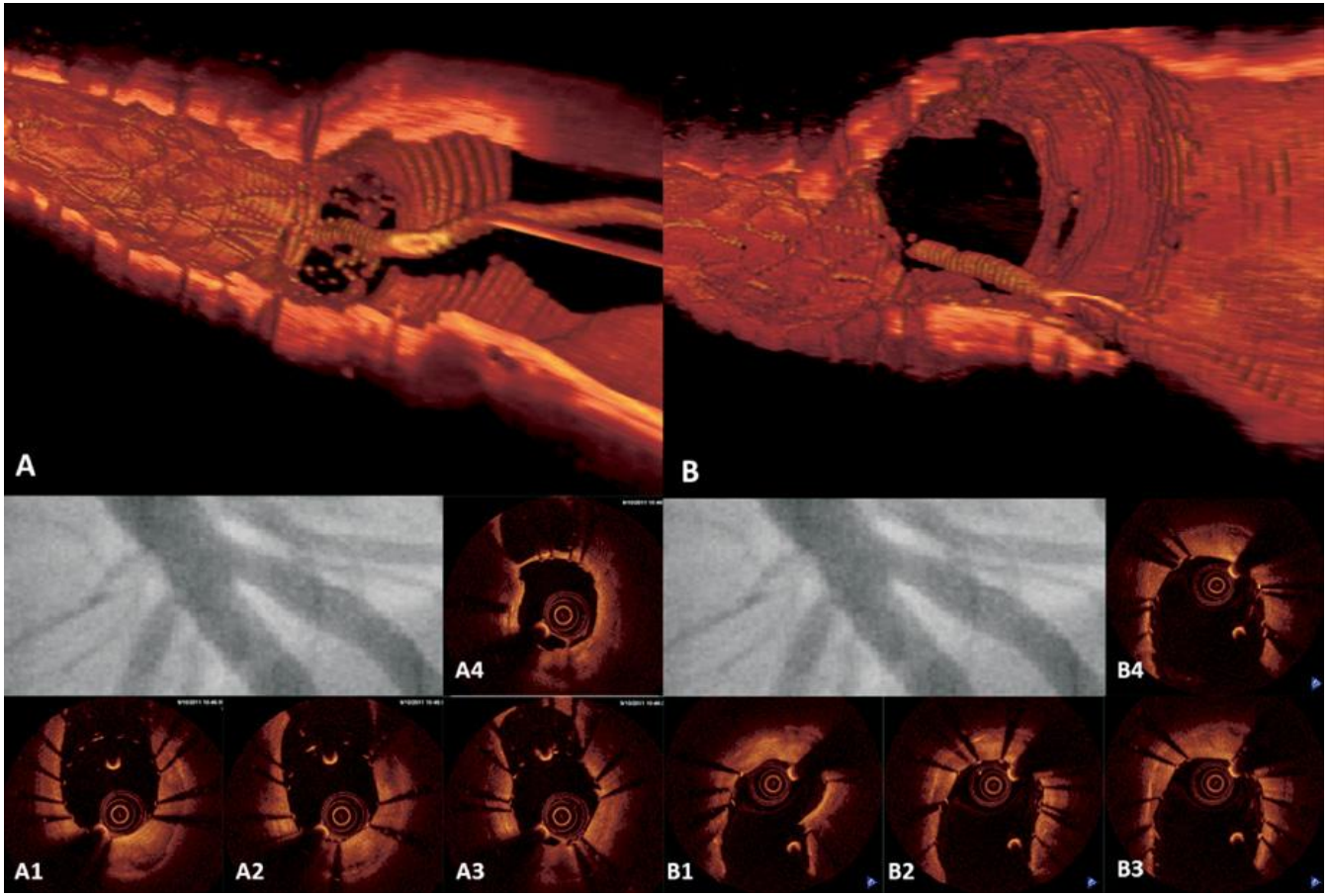
OCT – 3 dimensional reconstruction



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Thank you

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