Optical Imaging of Coronary Artery Disease

Joseph Schmitt, PhD
VP Research & Development
LightLab, St. Jude Medical
Coronary heart disease is responsible for **1 in 6 deaths** in the U.S.

1.3 million heart attacks per year ➔ **400,000 deaths** (2/3 out-of-hospital)

- About 40% of individuals who experience a coronary attack will eventually die from it (30% within 1 year)

- Over $40 billion spent each year on diagnostic catheterizations, angioplasty, stenting, and bypass surgery.

Most deaths from coronary disease result from rupture of plaque inside the arterial wall.

The Diagnostic Challenge

>> X-ray angiography provides only a silhouette of the artery.

What is the nature of the lesion?  
Is it stable or vulnerable to rupture?  
Should a stent be implanted?  If yes, where and what size?
Intravascular Optical Coherence Tomography

First demonstrated in 1999 by Prof. James Fujimoto and co-workers at MIT, MIT Lincoln Labs, and Mass General Hospital.

A rotating fiber-optic catheter acquires a sequence of images during a spiral pullback scan.
Founding and Evolution of LightLab

Mission: To translate advances in optical imaging into products that improve the diagnosis and treatment of heart disease.

1998: LightLab founded as Coherent Diagnostics, Inc.
2002: Acquired by Goodman Ltd. (Japan) for $32M (10 employees)
2010: Acquired by St. Jude Medical for $90M (~ 80 employees)
Today: Growing subsidiary of St. Jude Medical (180+ employees).

MIT

MGH

Optical Coherence Tomography

GOODMAN

St. Jude Medical
Fiber optics; Semiconductor light sources

PTCA balloon catheters

1st commercial TD-OCT

In vivo OCT macrophage detection

1st human studies

OCT / histo correlation studies

Thin capped lip lesion imaging

Thrombus assessment

Drug-eluting stent coverage

Biodegradable stent assessment

2001

2003

2005

2007

2009

In vivo OCT

MEMS tunable lasers

Contrast flush protocol

Polygon scanners, FDML lasers

1st commercial FD-OCT

Thrombus assessment

Thin capped lip lesion imaging

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C7XR Coronary OCT Imaging System

- Fast flush, spiral pullback acquisition
- 5 cm arterial segment in 2.5 sec
- Rapid delivery imaging catheter

100 frames/s, 500 lines/frame
15 um axial resolution
10 mm scan diameter
Fiber-Optic Imaging Catheter

Fiber lens

125 μm (0.005”)

Imaging core composed of 3 fusion-spliced fiber segments

0.9 mm (0.035”)
Example Image Acquisition: Stent at Follow-Up

ThoraxCentre, the Netherlands
Stent Imaging

Freshly implanted

DES follow-up

BMS follow-up

New Device Evaluation: Bioabsorbable Stents

A Bright Future

- More than 50,000 procedures performed to date
- Emerging gold standard for stent evaluation
- Emerging tool for guidance of thrombus removal
- Key potential role in identification and treatment of rupture-prone plaque