Optical Coherence Tomography

When Black and White TV Just Isn’t Good Enough

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What is OCT?

- **Optical Coherence Tomography (OCT)** is an optical imaging modality that uses near-infrared light to create high-resolution images of tissue microstructure.

- **Key Features:**
  - Micrometer-level resolution
  - Subsurface imaging
  - High tissue contrast
  - Safe, non-ionizing radiation
C7-XR Dragonfly™ Imaging Catheter

Insertable length: 135 cm with hydrophilic coating

2.7 Fr tip diameter (distal 28 cm) with hydrophilic coating

Optical fiber quick-connect

Purge port with 3ml syringe

Minirail tip compatible with .014” guidewire
Intravascular OCT

- Flexible fiberoptic catheter used for light delivery
- Catheter rotates to create image frames
- Catheter pulls back to map vessel segment
- Lesion analysis, stent planning, post-stent assessment, follow-up
Image Generation

- Measure echo time delay of reflected light waves
- One pixel $\rightarrow 5 \times 19 \text{ um}$
- One axial line $\rightarrow 1024$ pixels
- One frame $\rightarrow 500$ axial lines
- Optical resolution $\rightarrow 15$ axial, 20 to 40 um transverse
Pullback Generation

- One pullback $\rightarrow$ 270 frames
Normal Coronary Artery

Intima

Media

Adventitia

Black and White TV
Normal, Mild Intimal Thickening
Calcified Plaque

- Signal poor (darker)
- Low backscatter
- Low attenuation
- Sharp edges

Calcium Nodule

Circumferential Calcium
Calcified Plaque with Rupture
Lipid

Top is bright
Body is dark
High attenuation
Diffuse edge
Fibrous Plaque

Homogeneous
High backscatter, bright
Finely textured
Low attenuation
Metallic stent struts (BMS & DES)
Bright inner surface reflection
Shadows behind
DES compared to BMS in OCT

F/U DES at 1 Mo

F/U BMS
Red Thrombus
Edge Dissection

![Diagram of Stent Dissection](image-url)
Small Intimal Tear
Zoom Feature (Magnify)
Tissue Penetration
61 intermediate stenosis by angiography were assessed by FFR.
- FFR less than 0.80 was considered significant.
- OCT vs IVUS on these vessels for anatomic assessment.
- In vessels less than 3 mm in diameter OCT was superior to IVUS in identifying functionally significant lesions.
- MLA for IVUS was 2.42 mm².
- MLD for IVUS was 1.55 mm².

(J Am Coll Cardiol 2012;59:1080–9) © 2012
Dissection – OCT vs. IVUS
FD-OCT vs IVUS

- Edge dissection during stent implantation
- Neointimal growth on previously implanted stent at follow-up
Stent Underexpansion & Malapposition: OCT vs. IVUS

Stent malapposition: 10 atm
## Technical Comparison

<table>
<thead>
<tr>
<th></th>
<th>OCT</th>
<th>IVUS</th>
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<tbody>
<tr>
<td><strong>Resolution</strong></td>
<td>Axial</td>
<td>15 µm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Transverse</td>
<td>100 - 200 µm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td><strong>Imaging Speed</strong></td>
<td>Rotational</td>
<td>200 - 300 µm</td>
</tr>
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<td></td>
<td></td>
<td>✓</td>
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<tr>
<td></td>
<td>Pullback</td>
<td>20 mm/s</td>
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<tr>
<td></td>
<td></td>
<td>✓</td>
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<tr>
<td><strong>Scan Diameter</strong></td>
<td></td>
<td>15 mm (var)</td>
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<tr>
<td></td>
<td></td>
<td>✓</td>
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<tr>
<td><strong>Tissue Penetration</strong></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6 -10 mm</td>
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1. Clearly see what I am doing
2. Image thrombus
3. Determine thin cap fibroatheroma (TCFA) and hence possible vulnerable plaque
4. Visualize bio-absorbable stents
5. Visualize spontaneous dissection well
6. Determine measurements in small vessels < 3 mm with accuracy
7. Image the vessel in a timely fashion
• “The high resolution OCT images provide a glimpse at structural detail not seen before by other imaging modalities. We believe that OCT has the potential to identify thin-cap fibro-atheromas, clearly highlight intraluminal thrombus, and assess the complete healing of novel drug-eluting stent designs. Volcano is committed to exploring the various clinical benefits of our OCT platform…”

Michael Lussier- President, Volcano Europe 2008
• "Volcano is committed to being the leader in intravascular imaging...Our investment in this OCT product line underscores that commitment, and opens a series of new clinical applications and opportunities...”

• “a breakthrough that is the result of a 10 year development effort and an investment of over $150 million dollars...”

Scott Huennekens, President and Chief Executive Officer of Volcano 2008, 2009
Final Thoughts

- IVUS is used more than OCT right now because OCT is new…
- Physicians don’t know how to interpret the OCT images at the present time
- Financial concerns
- What do I do with what I find?
  - I can’t lie to my staff anymore…
Beer Goggles… OCT vs. IVUS
I’m Not Very Sure I Understand What I’m Seeing
You Win! OCT is BETTER!