Angioplasty
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TCT Asia Pacific

Seoul, April 26-28, 2006
Convention Center of
Sheraton Grande Walkerhill Seoul Hotel,
Seoul, Korea

Meet The Experts: Mini-Lectures and Case Discussions
Friday, April 28, 7:00 AM-8:10 AM
#8: Non-Invasive Imaging Is Changing the Diagnostic Paradigm for CAD: IVUS, CT, FFR

FFR- and IVUS-Guided DES PCI

Erick Schampaert, MD, FSCAI
Hopital Sacre-Cœur de Montreal,
Montreal, Canada

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Introduction

Why

FFR- and IVUS-Guided DES PCI?

Why FFR and IVUS-Guided PCI ?

Angiography has limitations

Pre-Intervention:

FFR (and IVUS) are Adjunctive Dx Tools to

Identify the ischemia-producing lesions

Per-Post-Intervention:

IVUS (and FFR) are Adjunctive Tools to

Minimize Risks of Stent Thrombosis and Restenosis,

despite increasing PCI complexity,

by optimizing DES deployment

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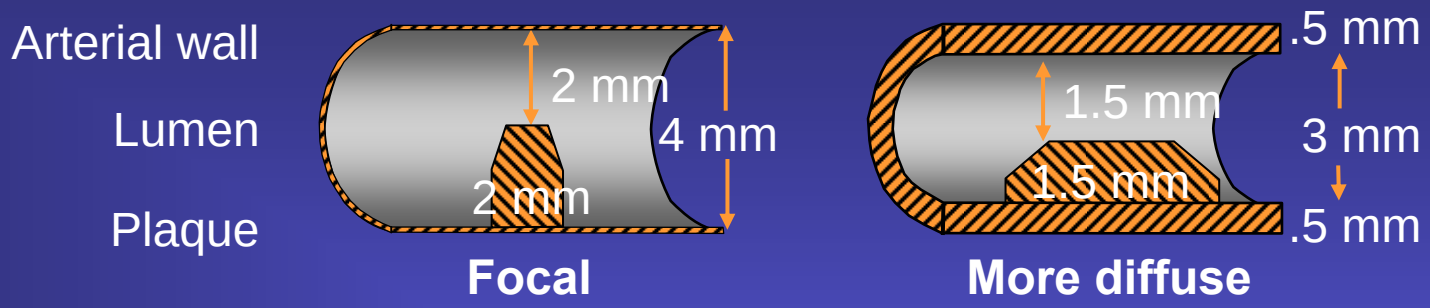
Diffuse Disease: Effect on Angiographic Measurements



Measurements		
MLD (mm)	2.0	1.5
Plaque area (mm)	2.0	1.5
% Diameter stenosis	50	50

Adapted from de Feyter *Circ* 1991;84:412

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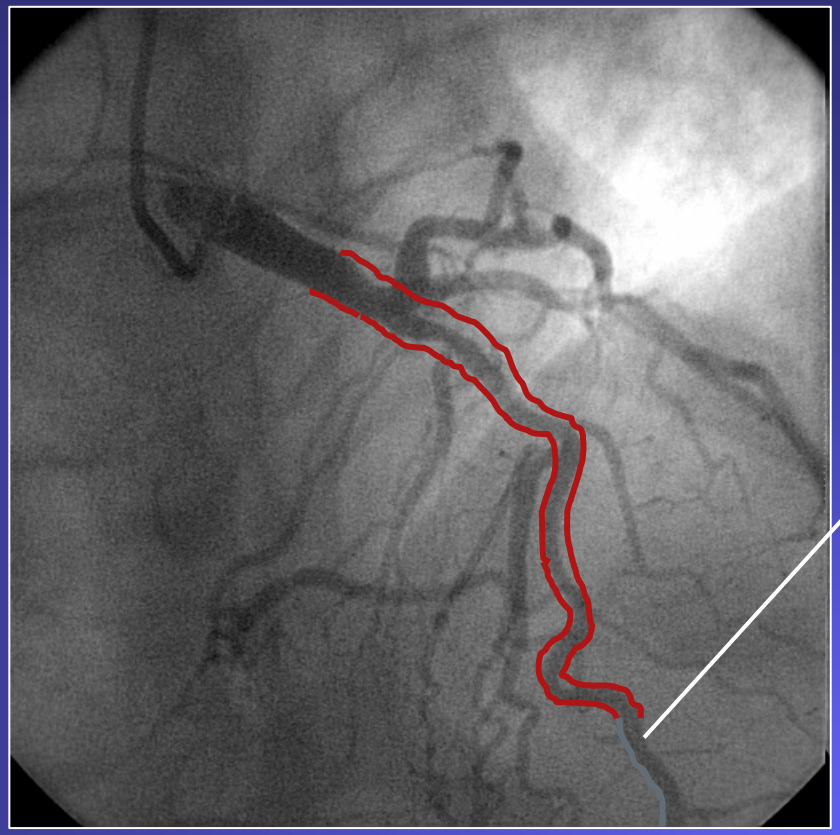
FFR Pre-PCI: No PCI



FFR: 0.76

Gradual Recovery of Pd on pull-back: No focal spot to PCI

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CABG

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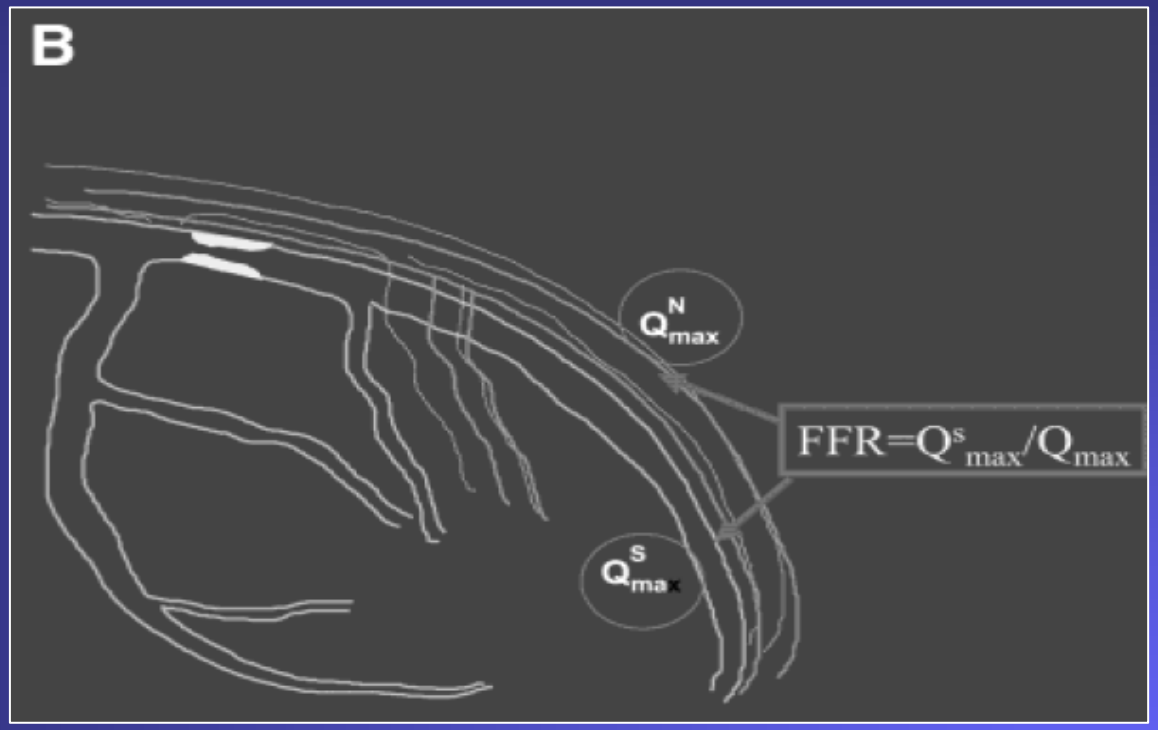
FFR: Fractional Flow Reserve

Physiological assessment of epicardial artery



Normal FFR = 1.0

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Kern CCI 2001; 54: 378

FFR: Fractional Flow Reserve

Poisseuil: $Q = \text{Flow} = \frac{P2 - P1}{R}$

FFR: $\frac{Q^s \text{ max with stenosis}}{Q^N \text{ max w/o stenosis}} = \frac{(Pd-Pv)/R}{(Pa-Pv)/R} = \frac{(Pd-Pv)}{(Pa-Pv)} = \frac{Pd}{Pa}$

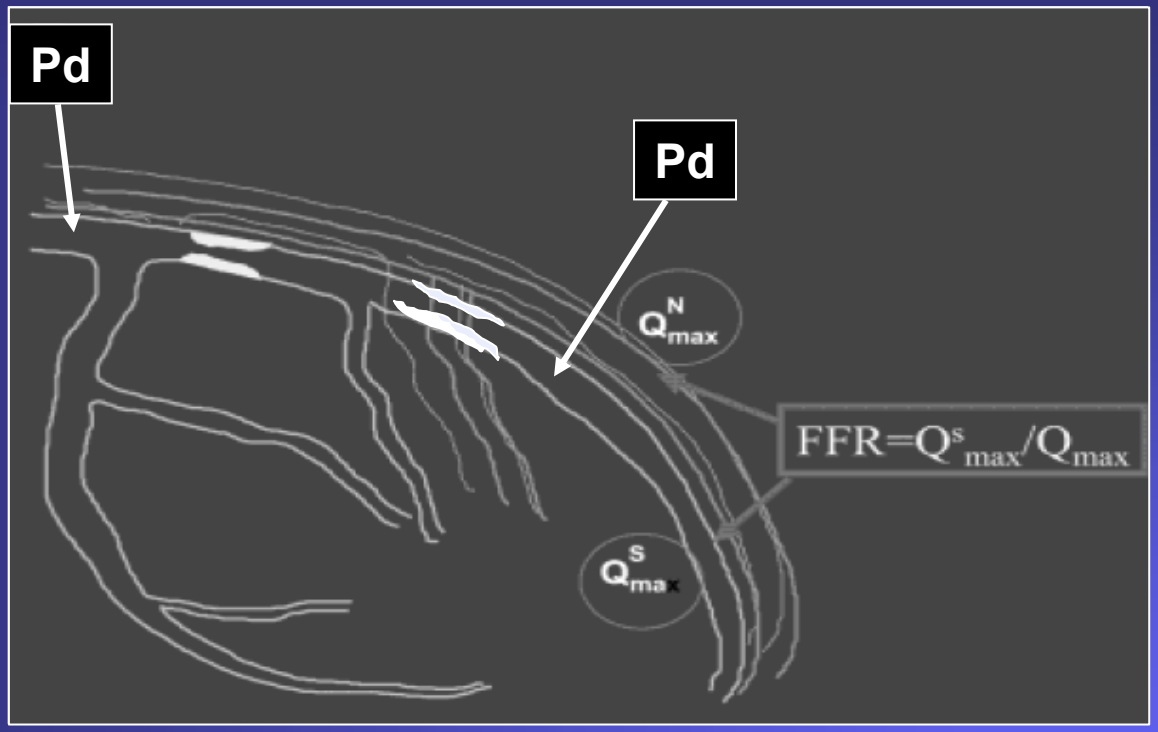
(Adenosine: R is minimal (Hyperemia) and Pv minimal and same)

Pressure-derived FFR: $\frac{Pd}{Pa}$ (via pressure wire) (Hyperemia) (via guiding catheter)

Kern CCI 2001; 54: 378

FFR: Fractional Flow Reserve

Physiological assessment of epicardial "conduit"



Kern CCI 2001; 54: 378

FFR-Guided DES PCI

Pre-Decision to PCI

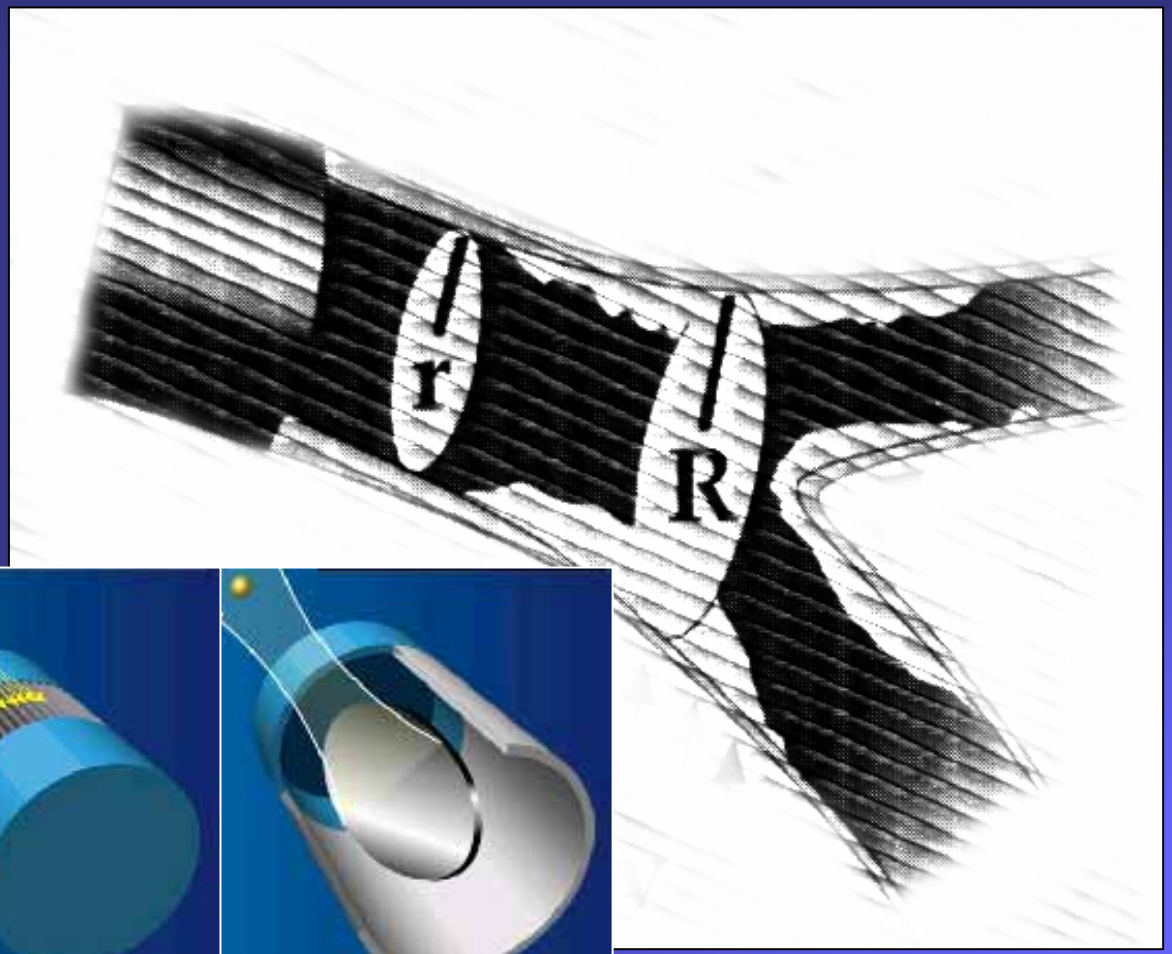
- Intermediate lesions: Hemodynamically significant with a FFR < 0.75-0.80
- Precise localization of the contributing lesions (Pull-back gradient changes)

Per-Post PCI:

- Post-Stent > 0.90-0.94
- Very long lesions, in small vessels

Intravascular Ultrasound

Morphological assessment of wall structure, its lumen and DES



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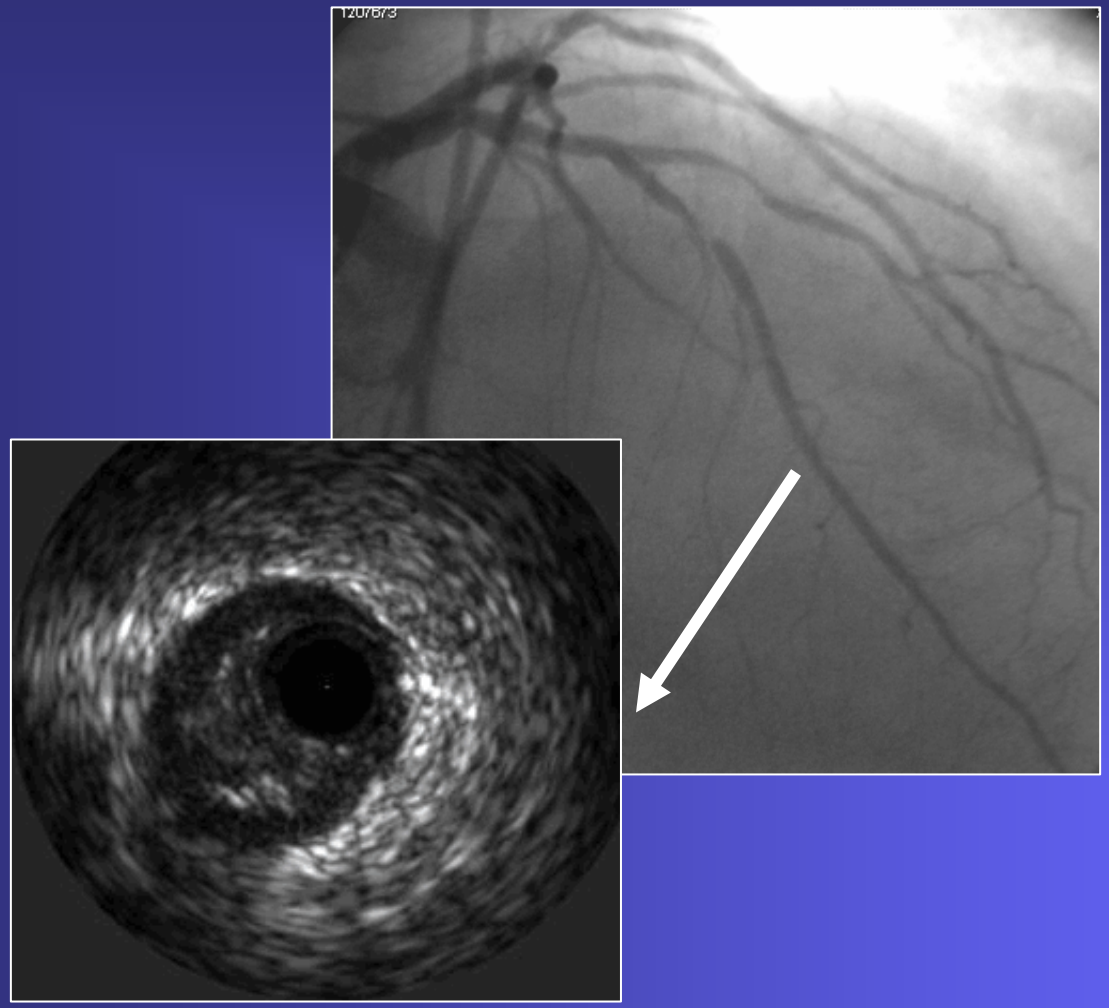
Limitations of Angiography



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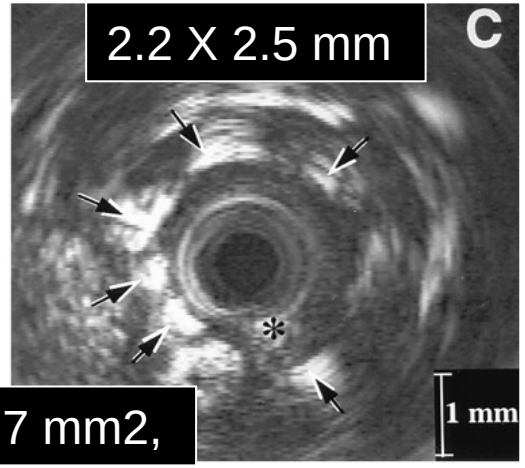
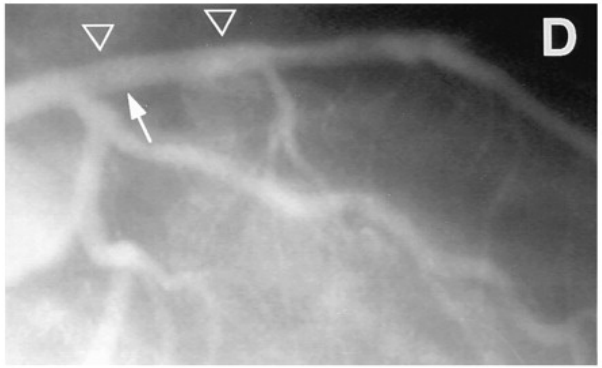
Limitations of Angiography

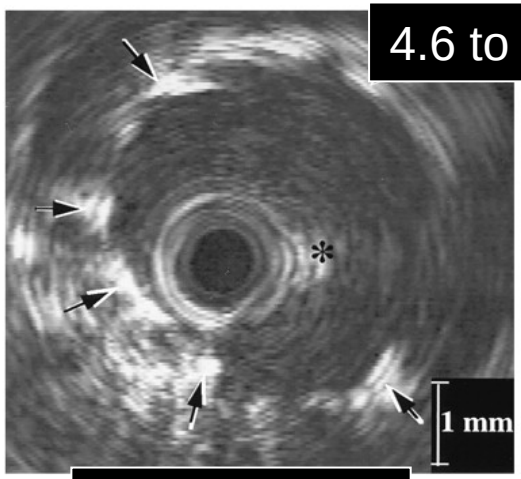
Mean pressure of 14.9 ±3.0 atm and a balloon-to-vessel ratio of 1.17±0.19.

40% of stents with an acceptable angiographic result still required additional dilatation with higher pressures or, less commonly, a dilatation with a larger balloon.

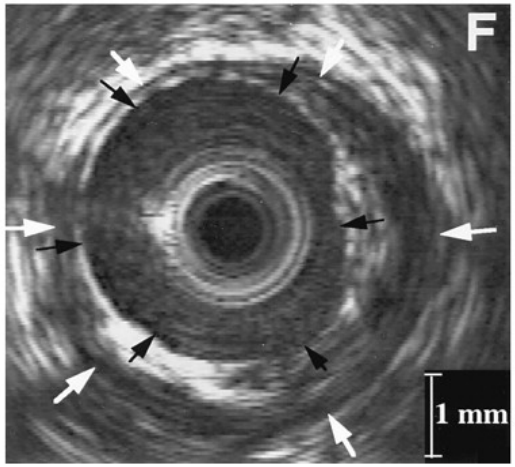




4.6 to 11.7 mm2,



4.2 X 4.5 mm



Colombo, *Circ* 1995;91:1676

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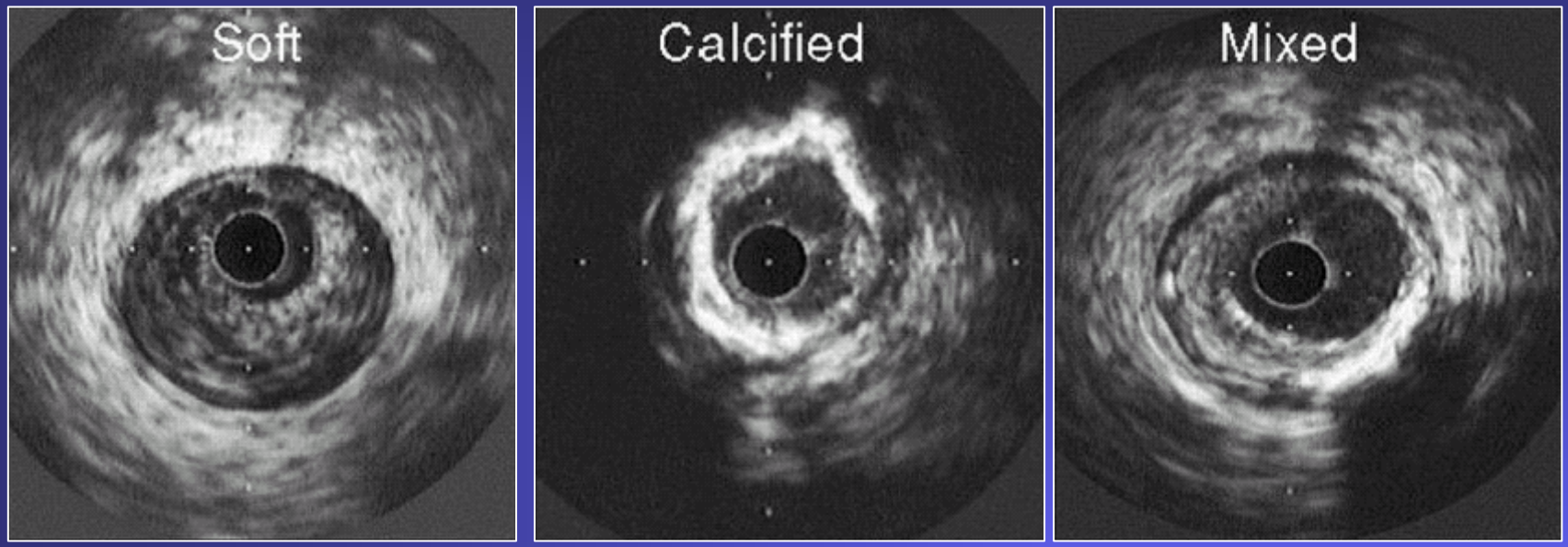
Plaque Composition by IVUS



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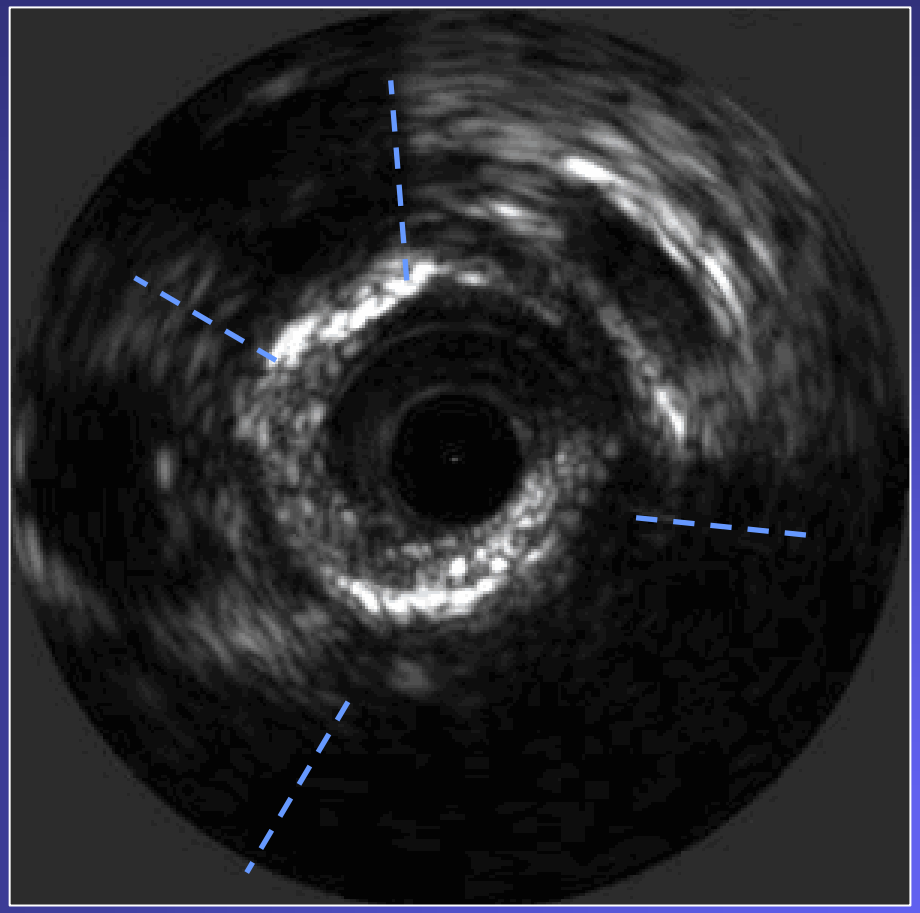
Calcifications by IVUS



Superficial and Deep Plaque Calcifications with “shadowing”

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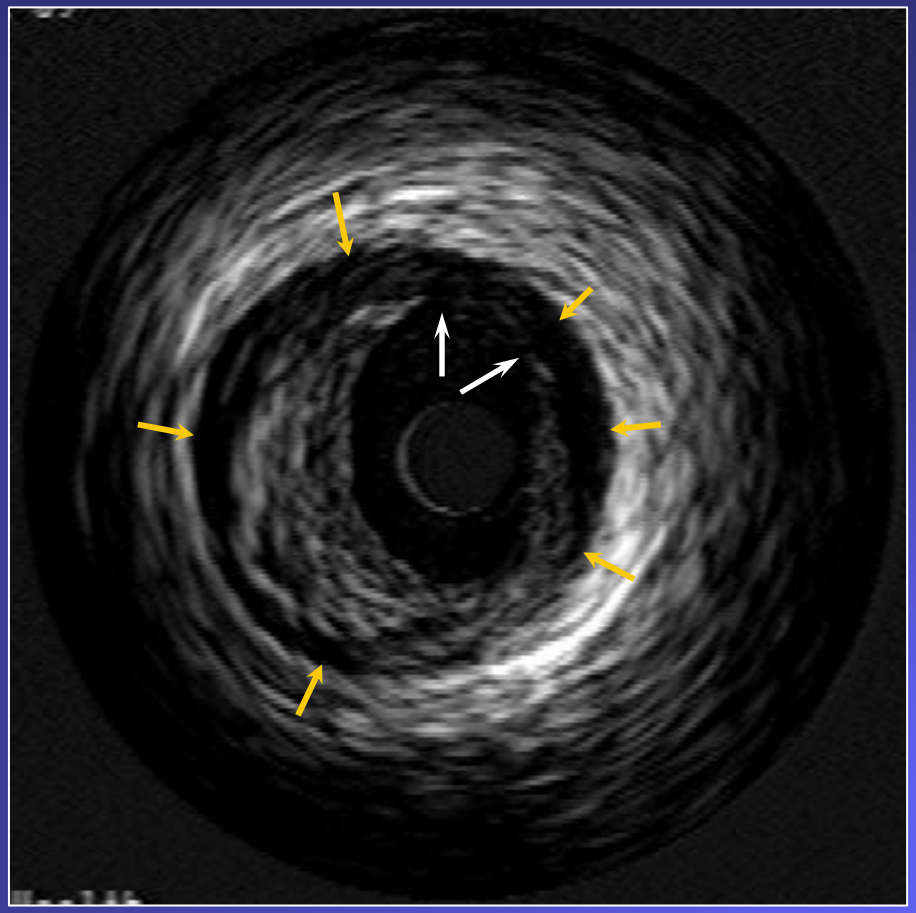
Coronary Dissection by IVUS

Dissection Entry Sites



Dissection Planes

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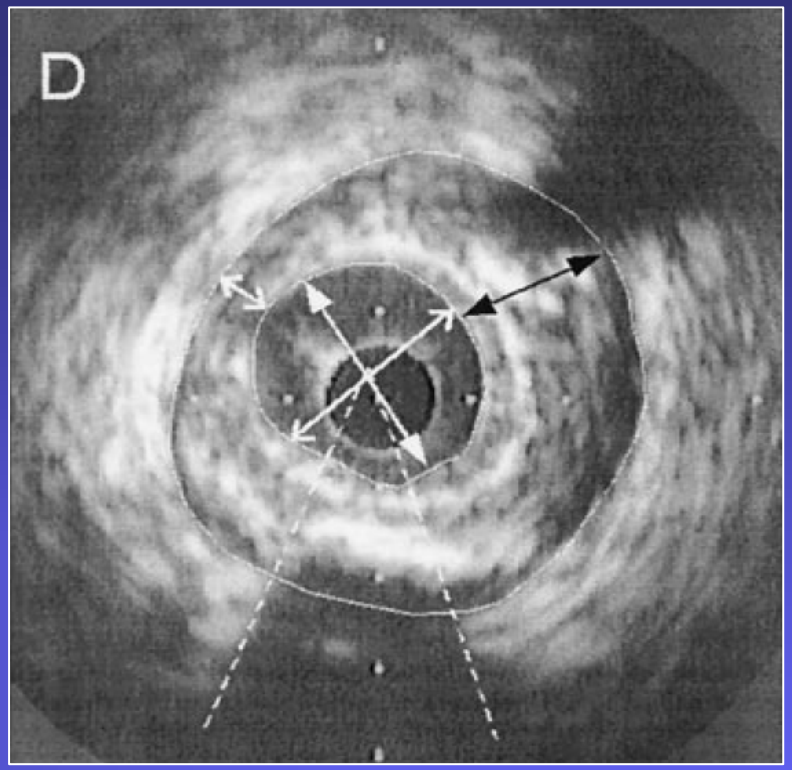
Arterial Wall Morphology by IVUS: QCU

Direct Measurements

- MLA: Minimal Lumen Area, mm^2
- RLA: Ref Lumen Area, mm^2,

  Prox-Dist, Mean (interpolated)
- VA: Vessel or EEL Area, mm^2
- PA: Plaque + Media Area : VA – LA
- MLD: Minimal Lumen Diameter, mm
- MxLD: Maximum Lumen Diameter, mm



Derived Measurments

- %PS: Plaque Stenosis or Plaque Burden: VA-LA/VA x100
- %AS: Area Stenosis = (RLA-MLA) / RLA x 100
- Symetry Index: MLD/MxLD

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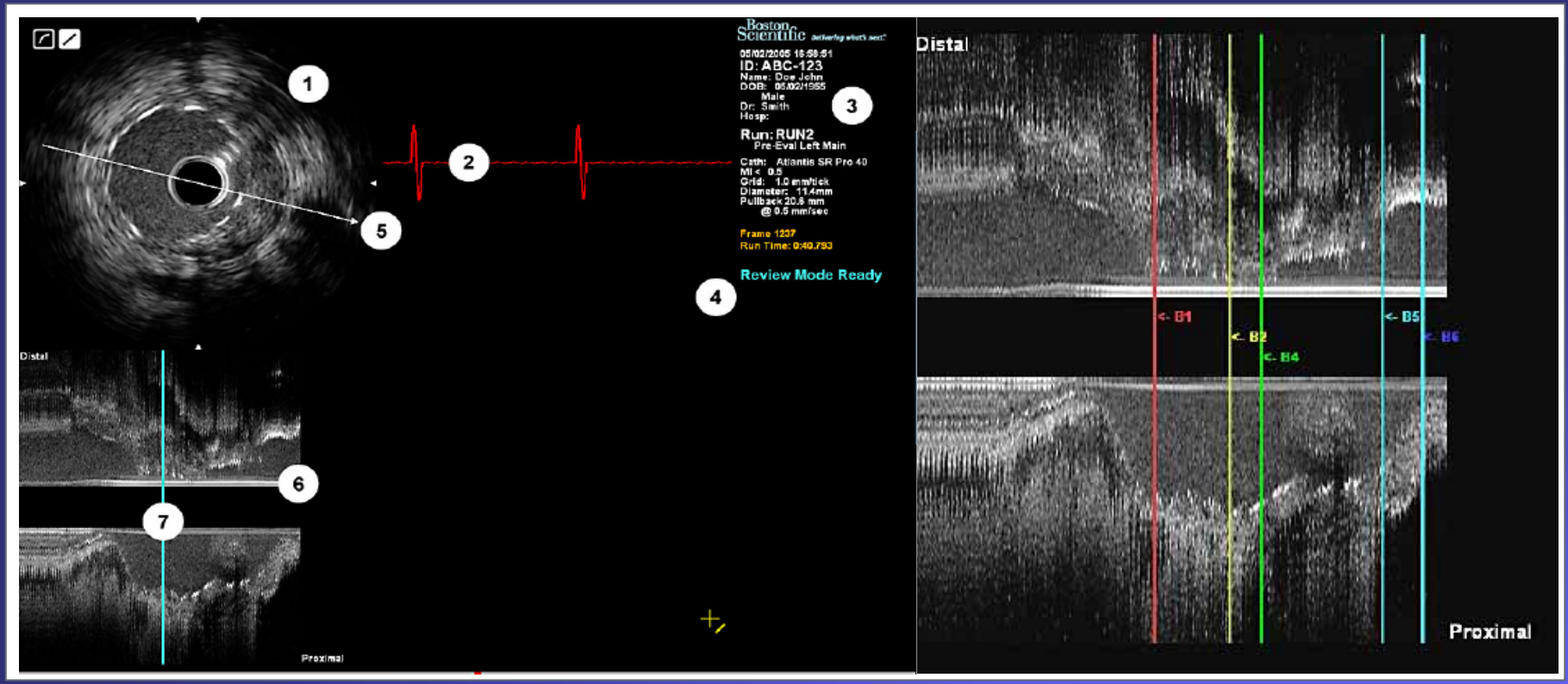
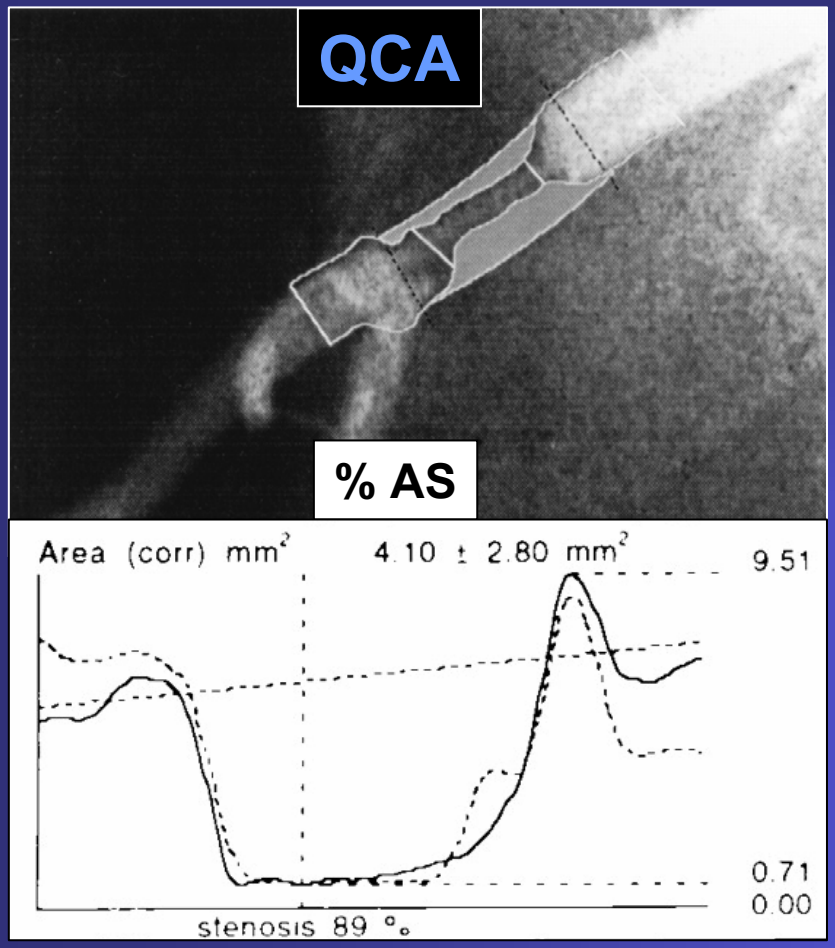
Longitudinal Reconstruction by IVUS



Lesion length: mechanical pull-back at 0.5 mm/sec X duration (sec): mm

Plaque Volume: interpolated via multiple PA (mm^2) x length (mm): mm^3

QCA Measures Lumen
QCU Measures Atherosclerotic Plaque and Lumen



Keane Circ 1995;91:2174

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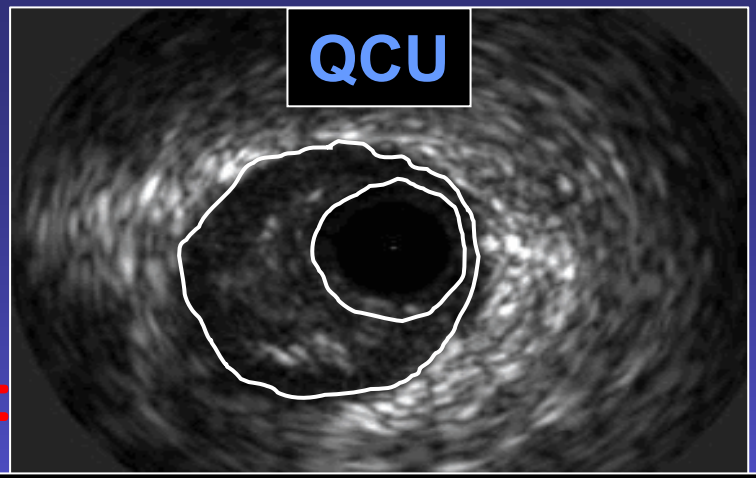

% CSA Stenosis or Plaque Burden

IVUS as Surrogate to Physiology

LAD: 2/4/6:
- Lumen > 2 mm diameter
- Lumen > 4 mm ^{2}
- 60% CSA plaque burden

LM: Lumen > 6.0-9.0 mm ^{2}

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IVUS-Guided BMS PCI Deployment Criteria

Adequate stent expansion and no flow-limiting lesion

1. Complete apposition of entire stent against vessel wall.
2. Optimal stent expansion :
   In-stent MLA ≥ 60% of average of proximal and distal vessel area or ≥ to distal reference lumen area
   Or
   In-stent MLA ≥ 90% of average of proximal and distal lumen area or ≥ to lowest reference lumen area.
3. No significant peri-stent lesion (CSA stenosis >60%)
4. No Fractured plaque or dissection
5. Symmetrical stent expansion: MLD / MxLD ≥ 0·7

Objective was to Decrease Stent Thrombosis

Colombo Circ 1995; 91: 1676
De Jaegere EHJ 1998; 19: 1214

IVUS-Guided BMS PCI Studies

- **2 Case-control studies:**
  - **Albiero et al.**: Reduced restenosis: 22.3 to 9.2%
  - **CRUISE**: Reduced TVR: 15.3% to 8.5%
- **4 RCT:**
  - **RESIST** and **OPTICUS**: No benefit
  - **AVID**: Reduced TLR in Vessels < 3.25 mm: 14.6 to 7.9%

    in SVG: 20.4 to 5.7%
  - **TULIP**: Lower MACE in lesions > 20 mm, vessels > 3.0 mm

No RCT for IVUS-Guided DES PCI

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Orford JACC 2004; 43: 1335

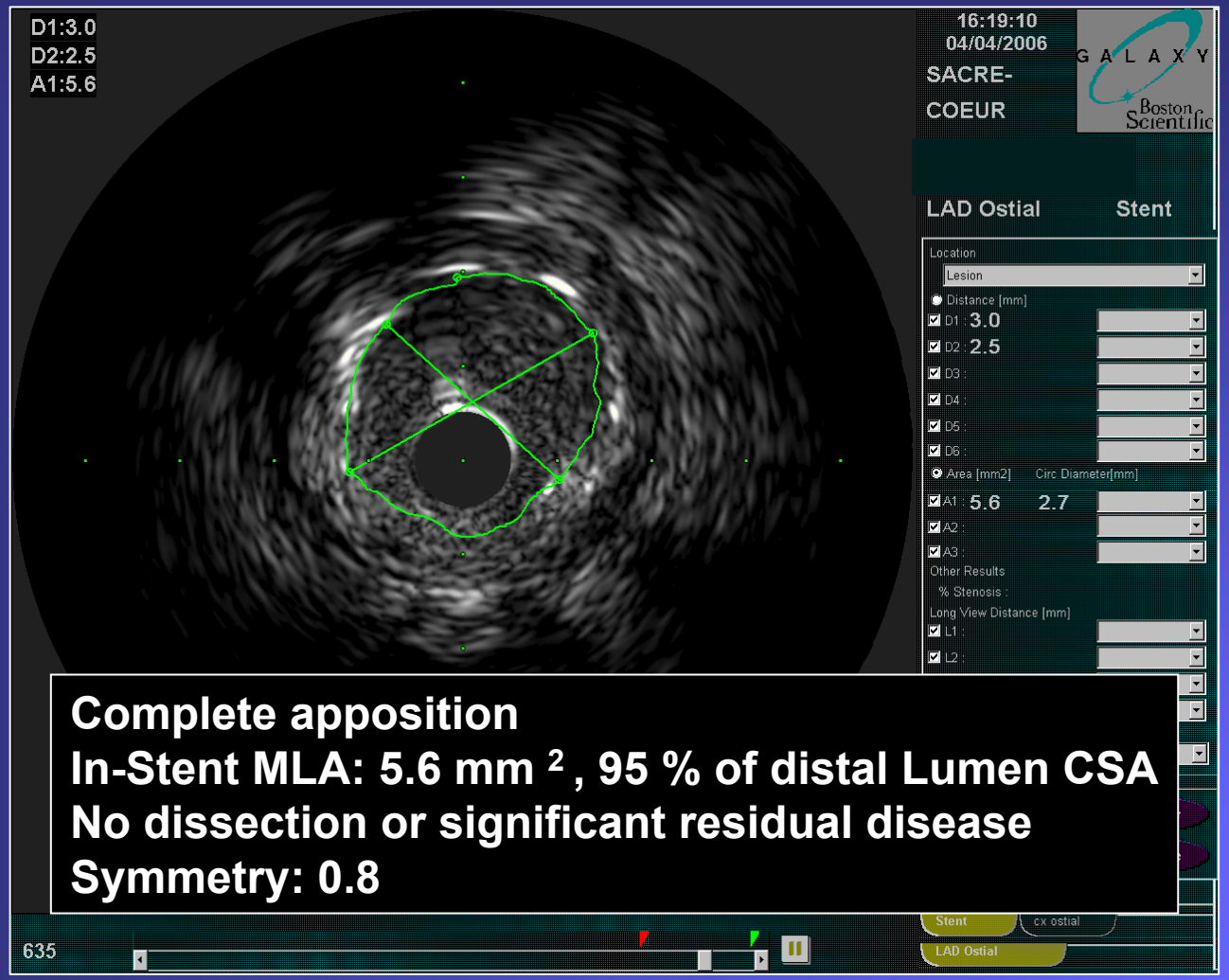
IVUS Example (LA)

72 y.o. ♂

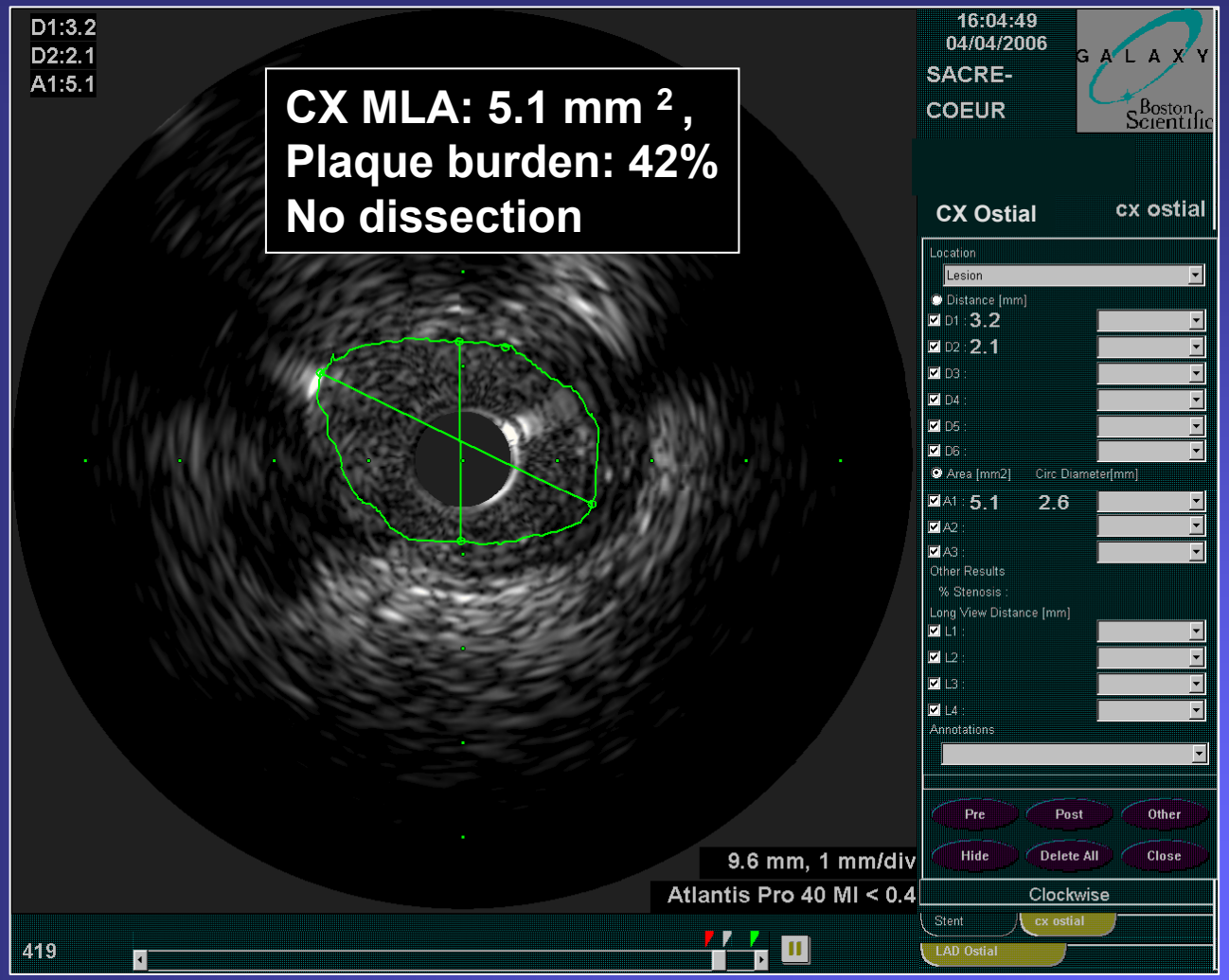
HTN, HLP

Ant STEMI: TNK at 11:30

IVUS of Cypher 3.0/13 to 20 Atm. in ostial LAD



IVUS of the CX



IVUS-Guided DES PCI

Pre-Decision to PCI:

- **Each time IVUS is perform:**
  - Plaque composition and extent (plaque burden, %CSA)
  - Calcifications: extent, distribution (radial, circumferential)
  - Vascular remodeling (positive and negative)
- Ambiguous LM or bifurcation lesion: plaque presence and extent
- Calcified +++ lesion: radial and circumferential distribution and extent
- Dissection / False lumen

IVUS-Guided DES PCI

Pre- and Per-PCI:

1. **LM** (Decreased MACE with IVUS)
2. **Long lesions** (Strong predictor of Stent Thrombosis, JACC 2005; 45: 954)
3. **Bifurcation** (Increased Stent thrombosis in AMI, JACC 2005 45: 947) , High Restenosis rate)
4. **DES Thrombosis**: (Mechanisms: Stent under-expansion + residual stenosis, JACC 2005; 45: 995)
5. **Ostial** (Geographic miss and subsequent restenosis)
6. ISR (Mechanisms of restenosis)
7. **AMI/ DCA / RCA / CTO** (Increased risk of LSM, Circ 2006; 113: 414, JACC 2005; 46: 1002)

IVUS-Guided DES PCI

Post-PCI:

- **Each time IVUS is perform:**
  - Opportunity to confirm optimal stent deployment
- Angiographically ambiguous result post-PCI
- Post-dilatation balloon incomplete expansion
- Dissection / False lumen

Conclusion

Recommendation

↑ Complexity / ↑ Risk → ↑ FFR (Dx)
↑ IVUS (PCI)

Objective (RCT?)

Angio-Guided DES PCI: MACE: 10% (Death: 1%, ST: 2%, TLR: 7%)
vs.
IVUS-Guided DES PCI: MACE: 5.0% (Death: 1% ST: 1%, TLR: 3%)

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