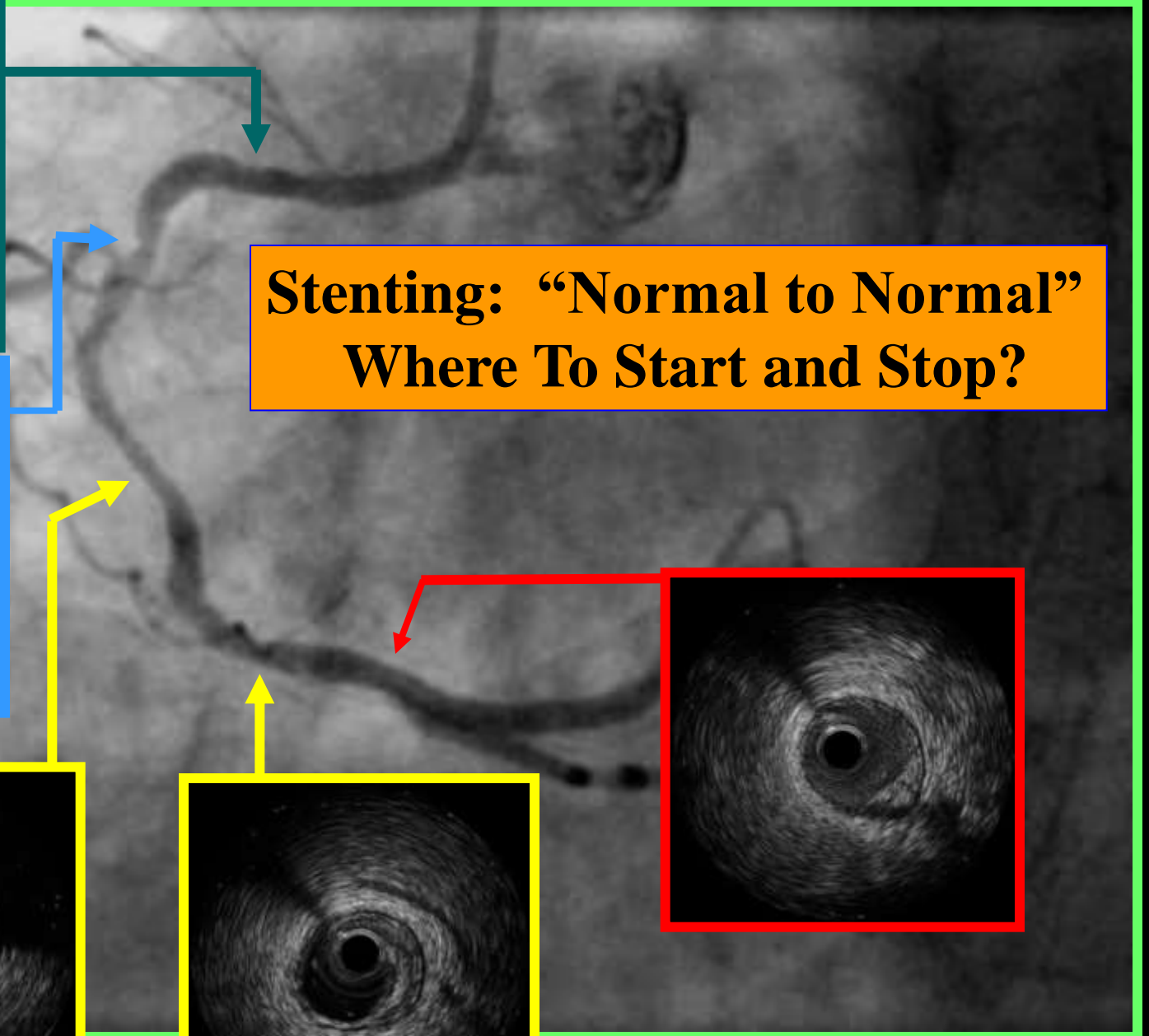
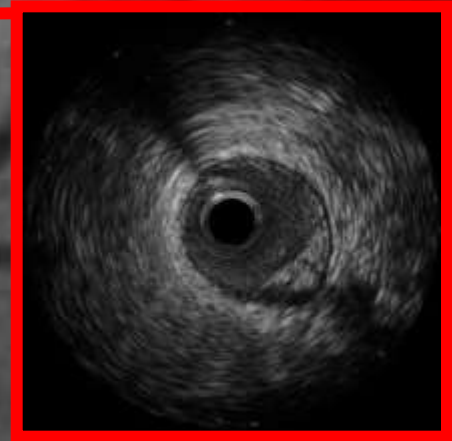
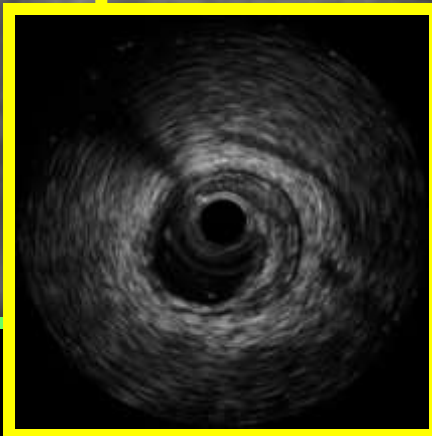
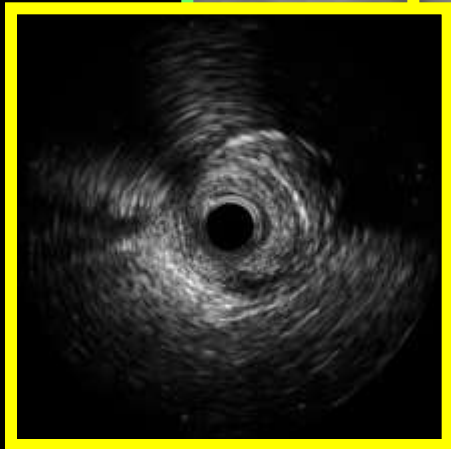
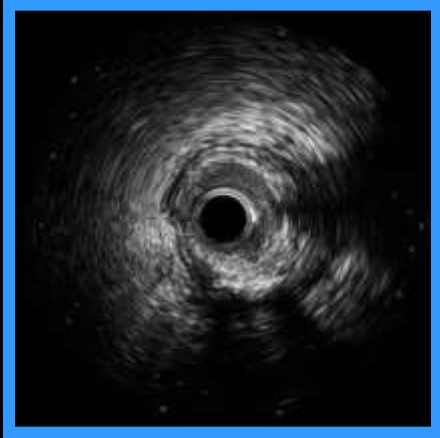


Improving PCI Outcomes
Angiography Alone is Not Enough
Role for NIRS-IVUS

James A. Goldstein MD
Director of Research and Education
Dept of Cardiovascular Medicine
William Beaumont Hospital

**Stenting: “Normal to Normal”
Where To Start and Stop?**



Where We Need to Do Better in the Cath Lab

★ Optimal Stenting Procedures

→ Determine Optimal Vessel Length to Stent

→ Measure Precise Stent Length

→ Optimize Stent Deployment

→ Minimize Subacute Thrombosis and Late Restenosis

★ Characterize Non-Flow Limiting Lesions

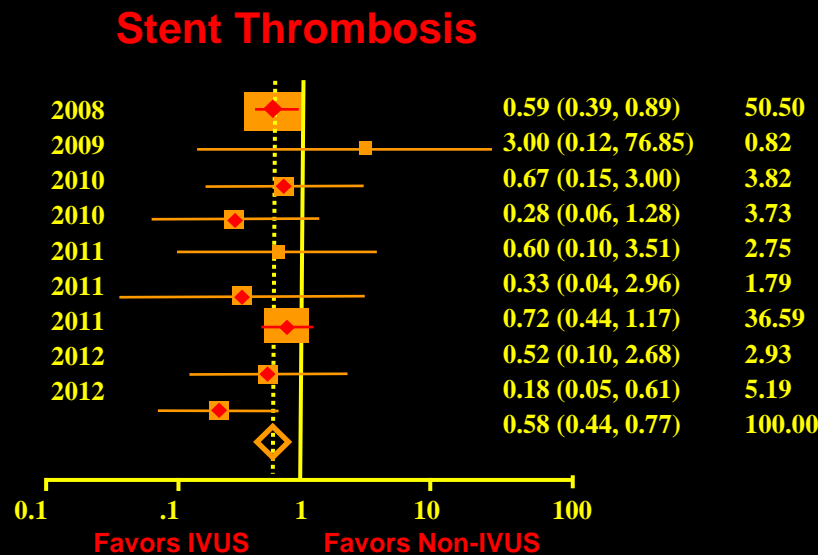
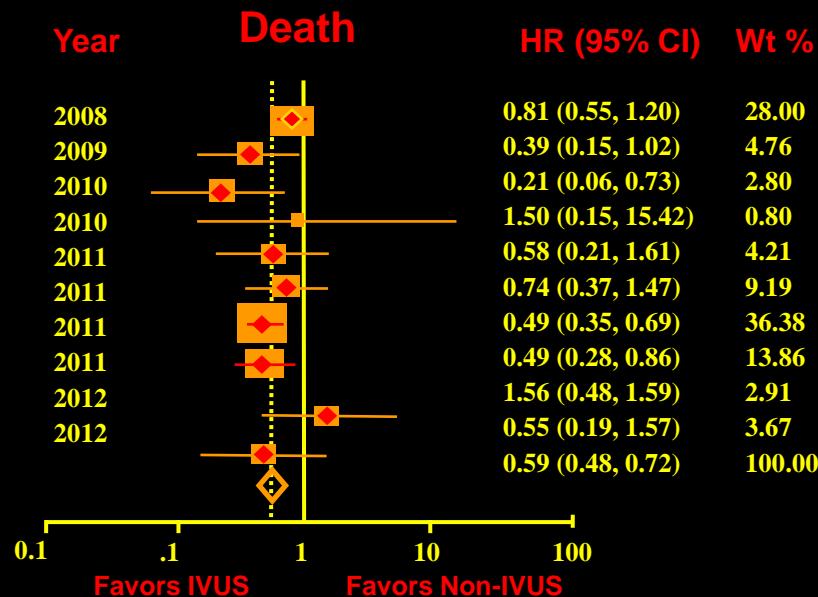
→ Pre-emptive PCI of VP?

Direct Coronary Imaging Facilitates Optimal PCI and Improved Outcomes

Meta-Analysis of 11 Studies (n=19,619 pts)

Compared with angiography-guidance, IVUS-guided DES implantation was associated with a reduced incidence of

- ➔ • Death (HR: 0.59, 95% CI: 0.48-0.73, $p < 0.001$)
- ➔ • Stent thrombosis (HR: 0.58, 95% CI: 0.44-0.77, $p < 0.0001$)
- ➔ • Major adverse cardiac events (HR: 0.87, 95% CI: 0.78-0.96, $p = 0.008$)



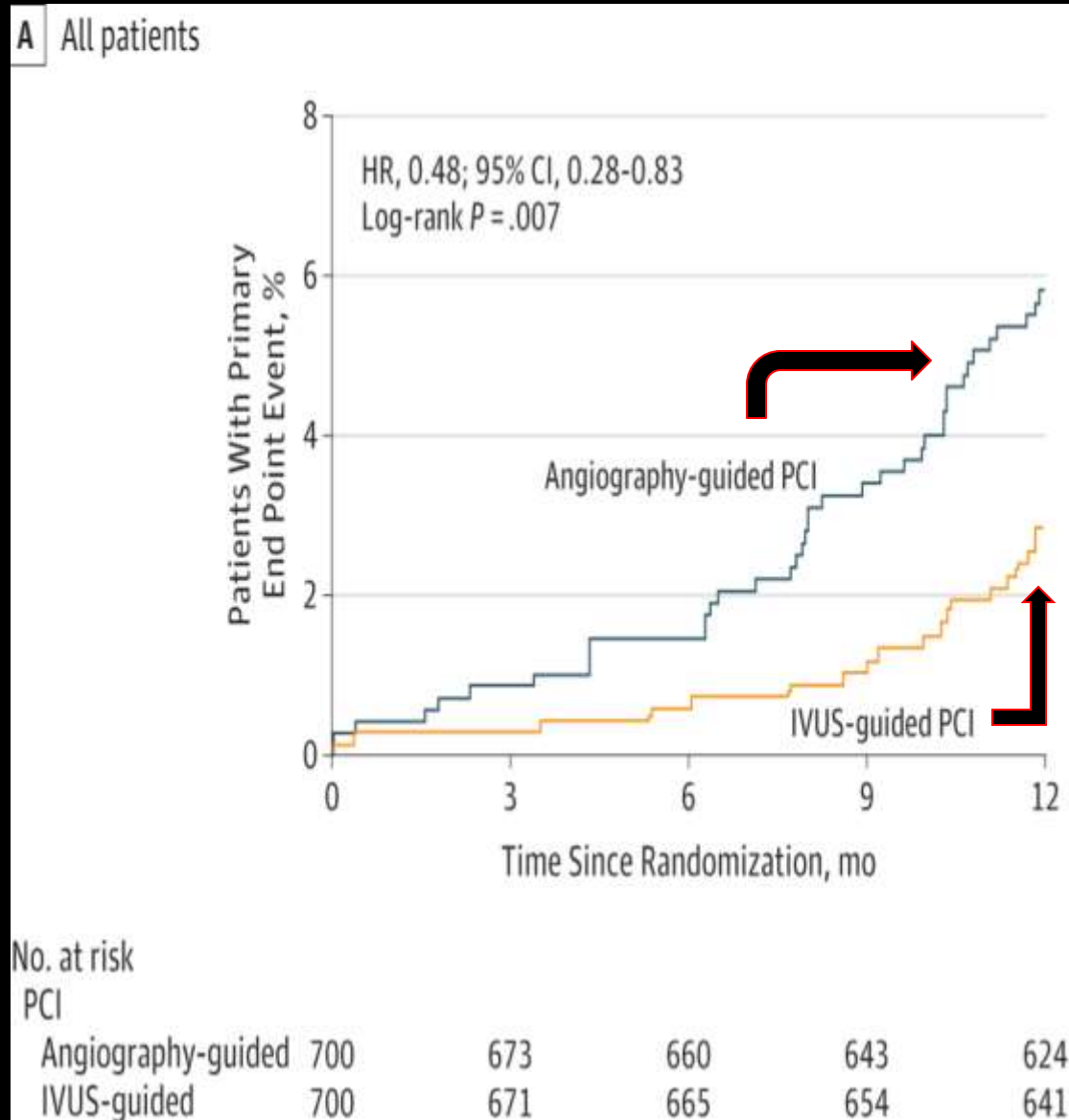
ADAPT-DES

Witzenbichler B et al. *Circulation*. 2014;129:463-470

- ➔ **IVUS Guidance changed procedure >75% cases**
 - ➔ **Longer, appropriately sized stents**
- ➔ **IVUS Guidance Improved Clinical Outcomes**
 - ➔ **33% reduction in MI**
 - ➔ **50% reduction ST**
 - ➔ **38% reduction TVR**

IVUS vs Angiography-Guided DES Implantation

JAMA. 2015;314(20):2155-2163. doi:10.1001/jama.2015.15454



IVUS: 2.9% absolute and 48% relative reduction in MACE

Benefits of IVUS on PCI Outcome

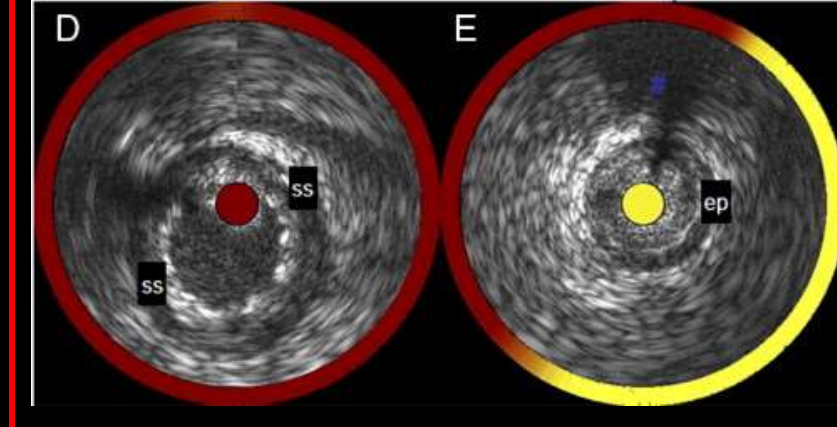
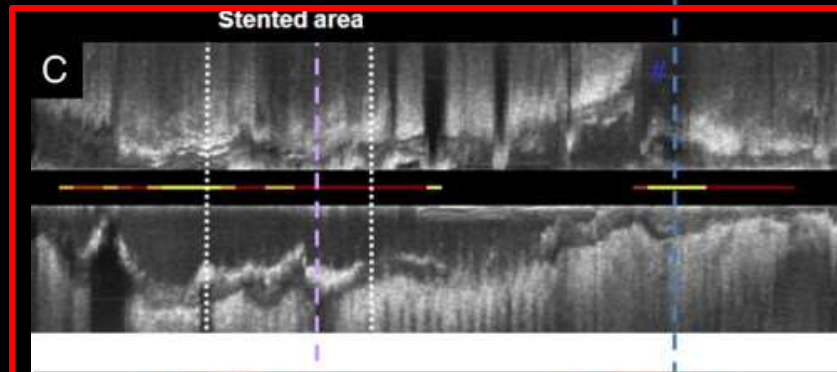
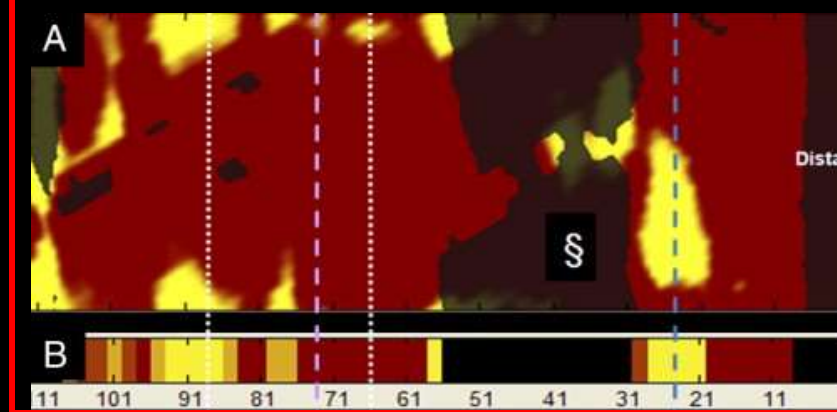
- **Optimal Length of Vessel to Stent**
- **Precise Choice of Stent Length**
- **Optimal Stent Expansion**
- **Detection Stent Edge Complications**

Hypothesis

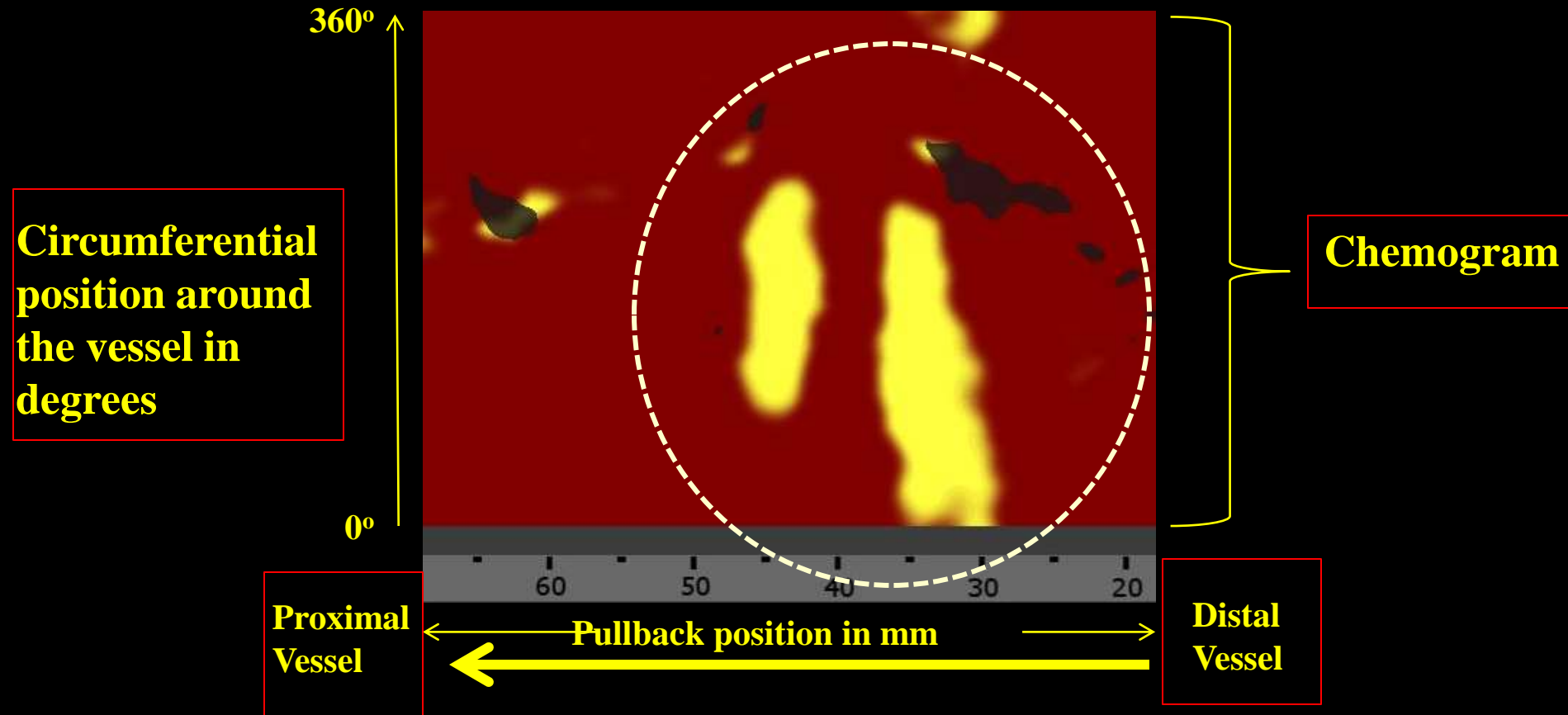
Plaque Composition May Influence Outcome

Data Acquired by a Combined IVUS and NIRS Catheter

Adapted from Bourantas, et al. *JACC* 2013;16(13):1369



Intracoronary Near-Infrared Spectroscopy (NIRS) Has Been Validated to Detect LCP in Patients



$LCBI = \# \text{ pixels in a region of interest indicating lipid} \times 1000$
 $MaxLCBI_{4mm} = \text{maximum LCBI in any 4-mm segment}$

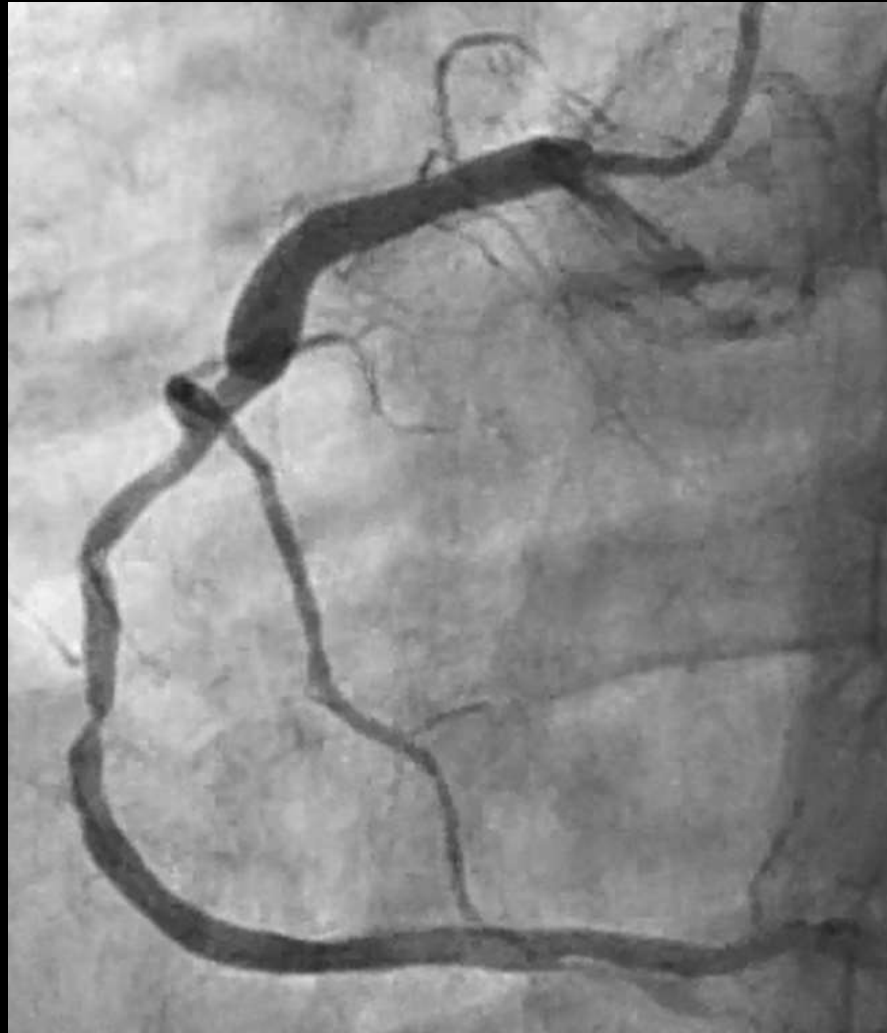
NIRS-IVUS Plaque Characterization

**Proper Length of Vessel to Stent
Optimal Stent Deployment**

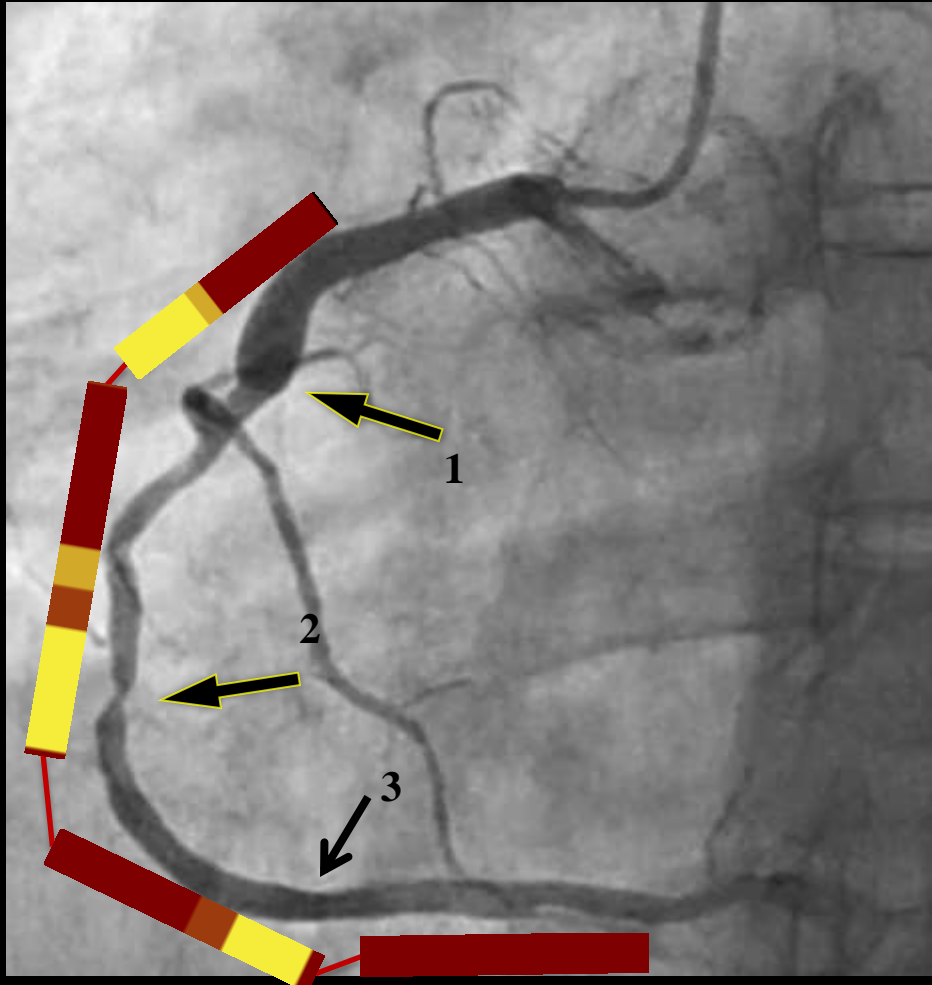
Patient with USA

Stenting: “Full Lesion Coverage”

Where To Start and Stop?



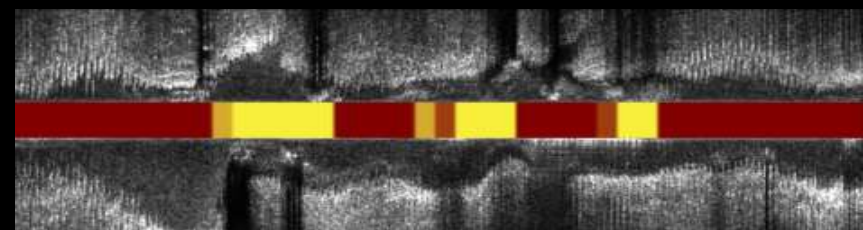
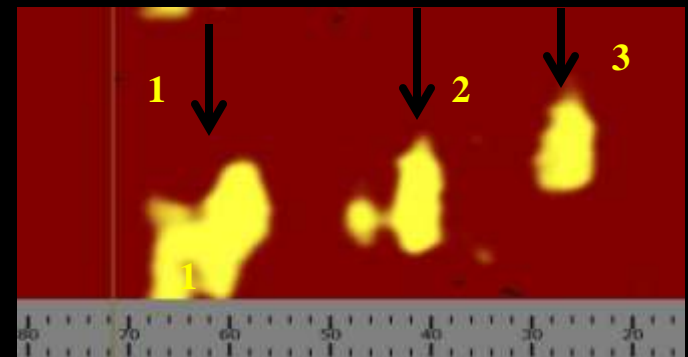
NIRS Reveals Lipid Core at the Stenotic Site, and Lipid Cores at Two Additional Locations



One lipid core is located at the stenotic site (#2)

The $\text{MaxLCBI}_{4\text{mm}}$ at the proximal, non-stenotic site is 428 (#1)

Stenotic Culprit Site



NIRS-IVUS at the Stenotic Site

Lumen Area:

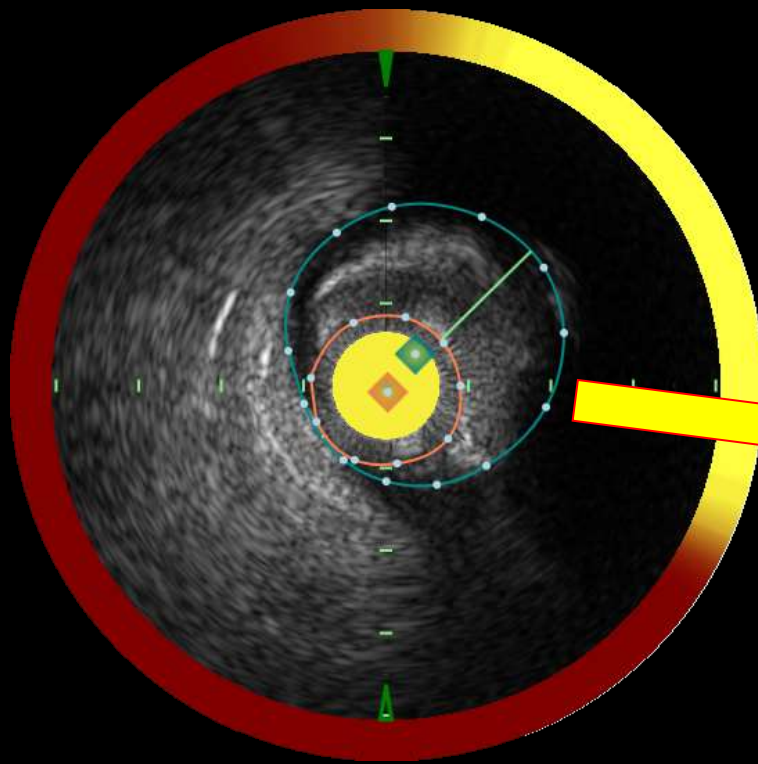
2.63 mm²

Plaque Burden:

71%

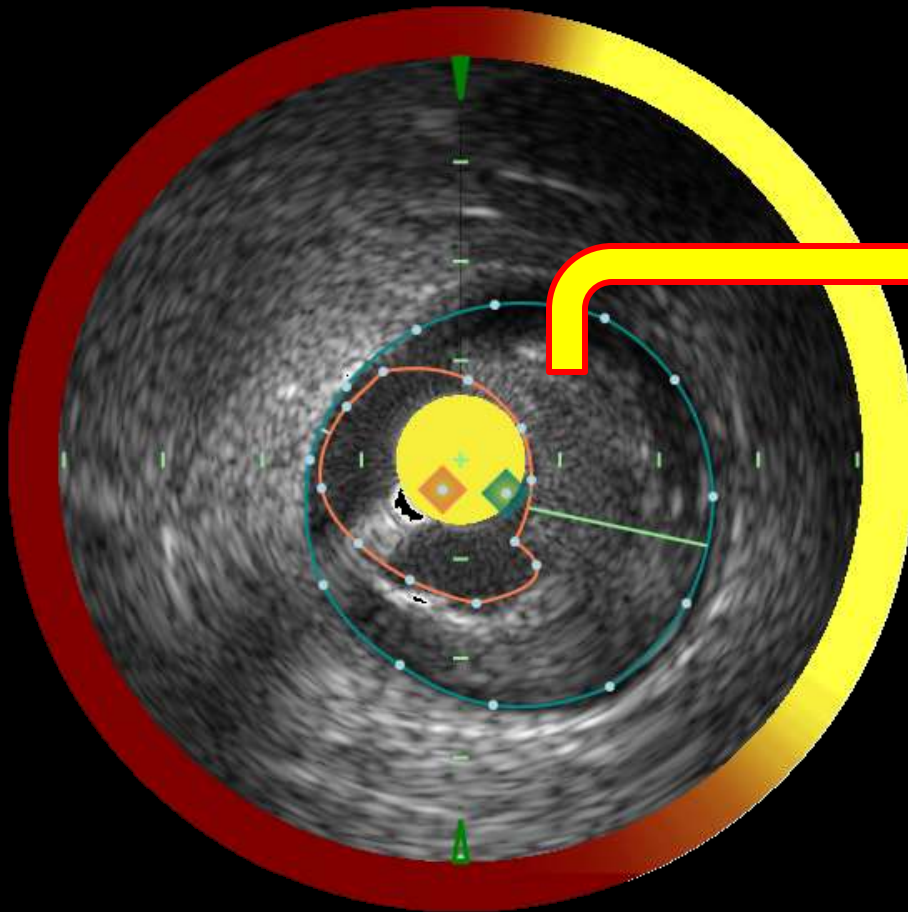
maxLCBI_{4mm}:

374



NIRS-IVUS at Proximal Site

Not Severely Stenotic by Angio,
but IVUS Reveals Bulky LCP with Lumen Area $<4\text{mm}^2$
and $>70\%$ Plaque Burden

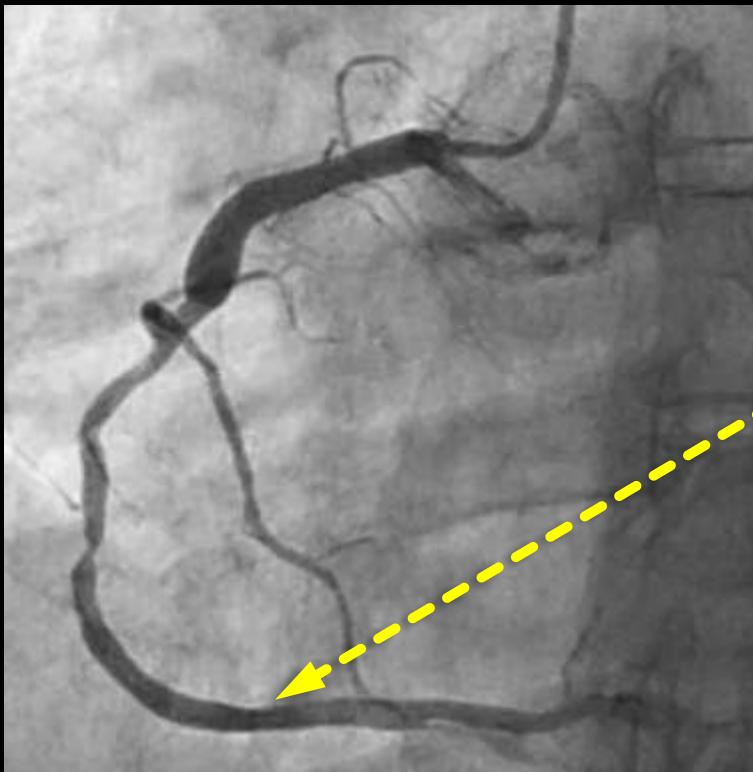


The Distal Lesion Was Found to be Non-Stenotic with MLA $>4\text{mm}^2$

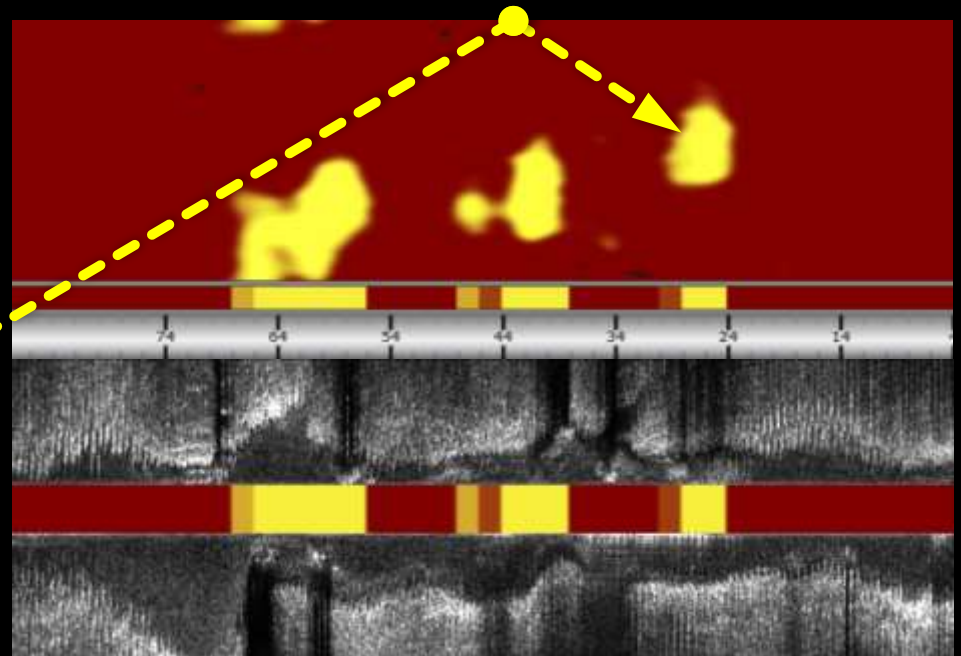
Plaque burden:
40.75%

Min Lumen Area:
4.7mm²

maxLCBI_{4mm}:
334



Non-Stenotic Site



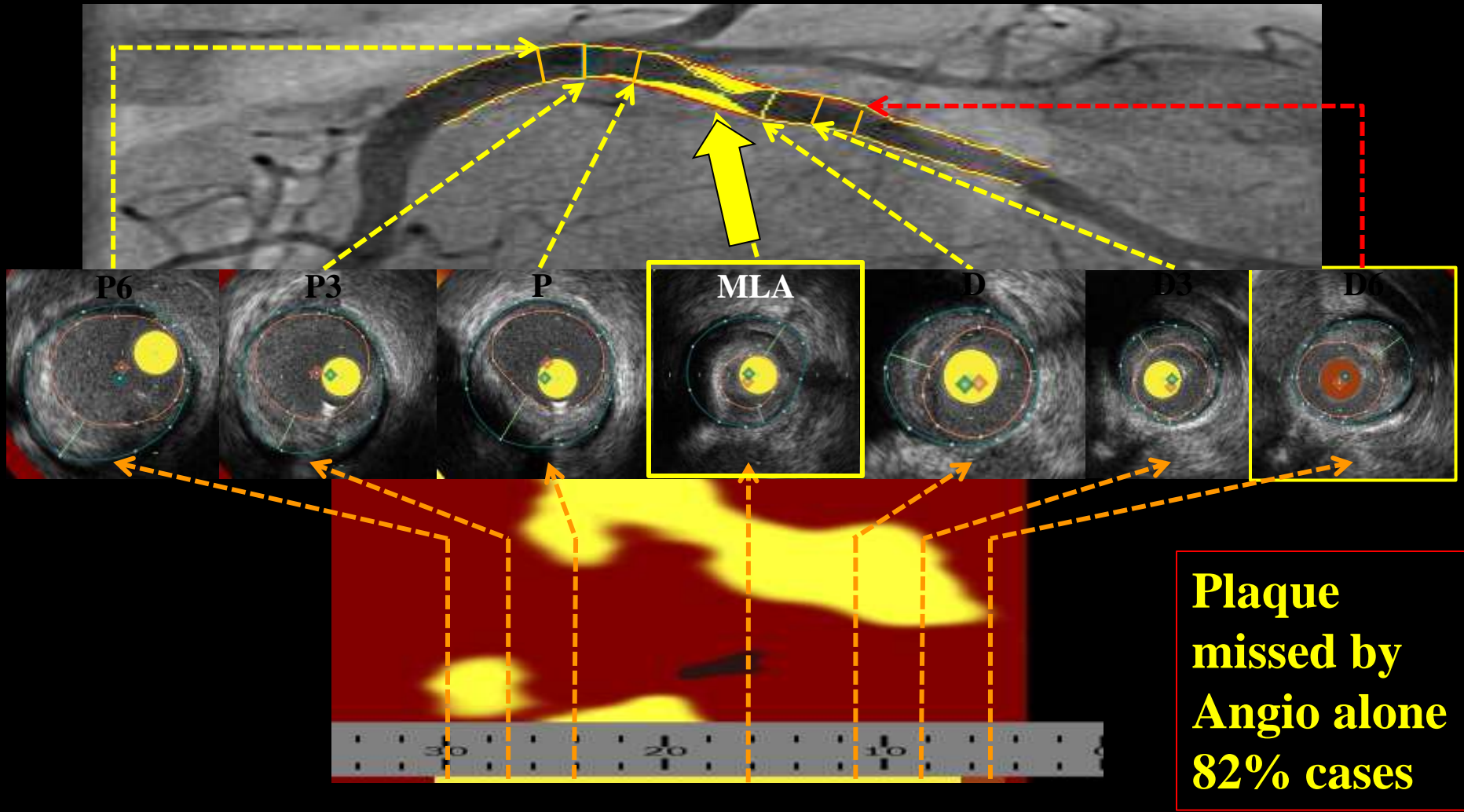
NIRS-IVUS “Proven” Optimal Result



Full Lesion Length Coverage
Optimal stent Expansion & Apposition

Lipid Core Plaque Beyond Angiographic Stenosis

Hanson et al Coronary Artery Disease 2015

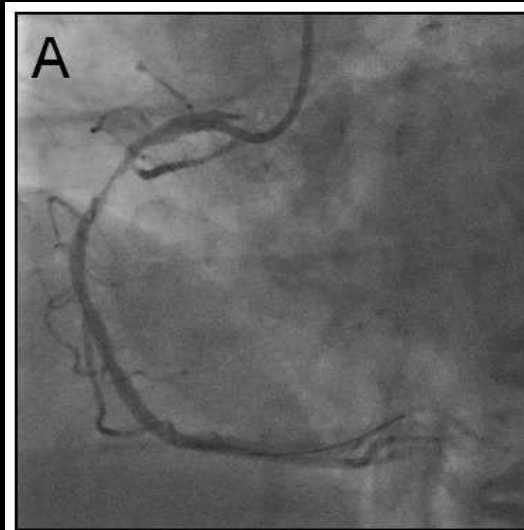


Direct Coronary Imaging Optimizes Lesion Coverage

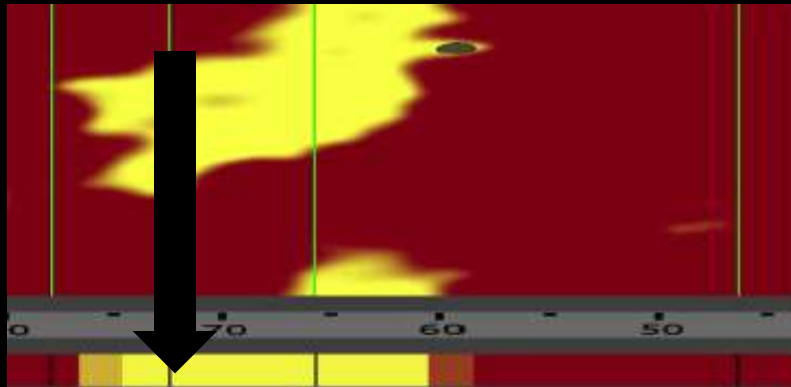
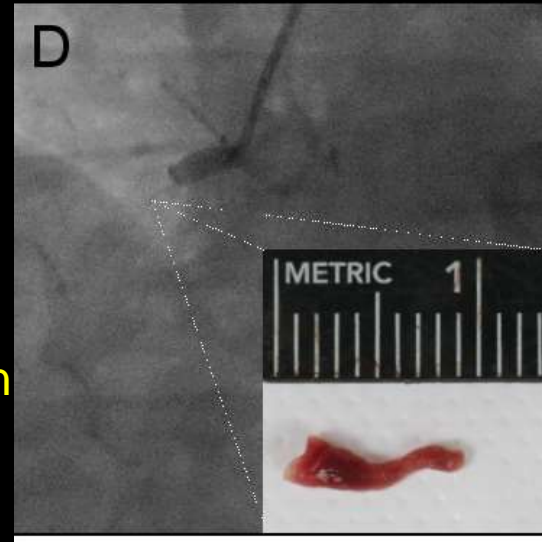
Acute Stent Thrombosis

Uncovered LCP

63 y.o.
male
with MI



Recurrent pain
eight hours
post stenting



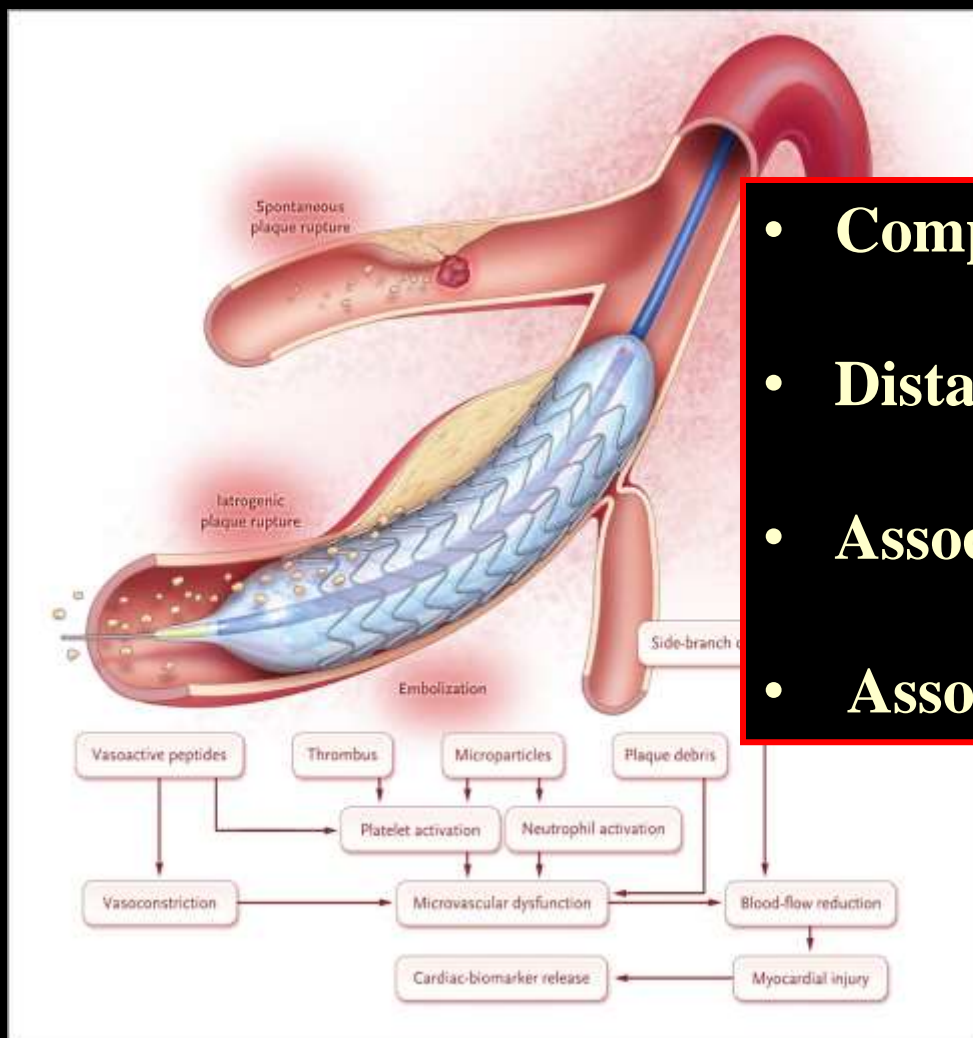
The proximal end of the stent
that thrombosed is located
in a lipid-core plaque.

Proximal



Mechanisms of Peri-procedural MI

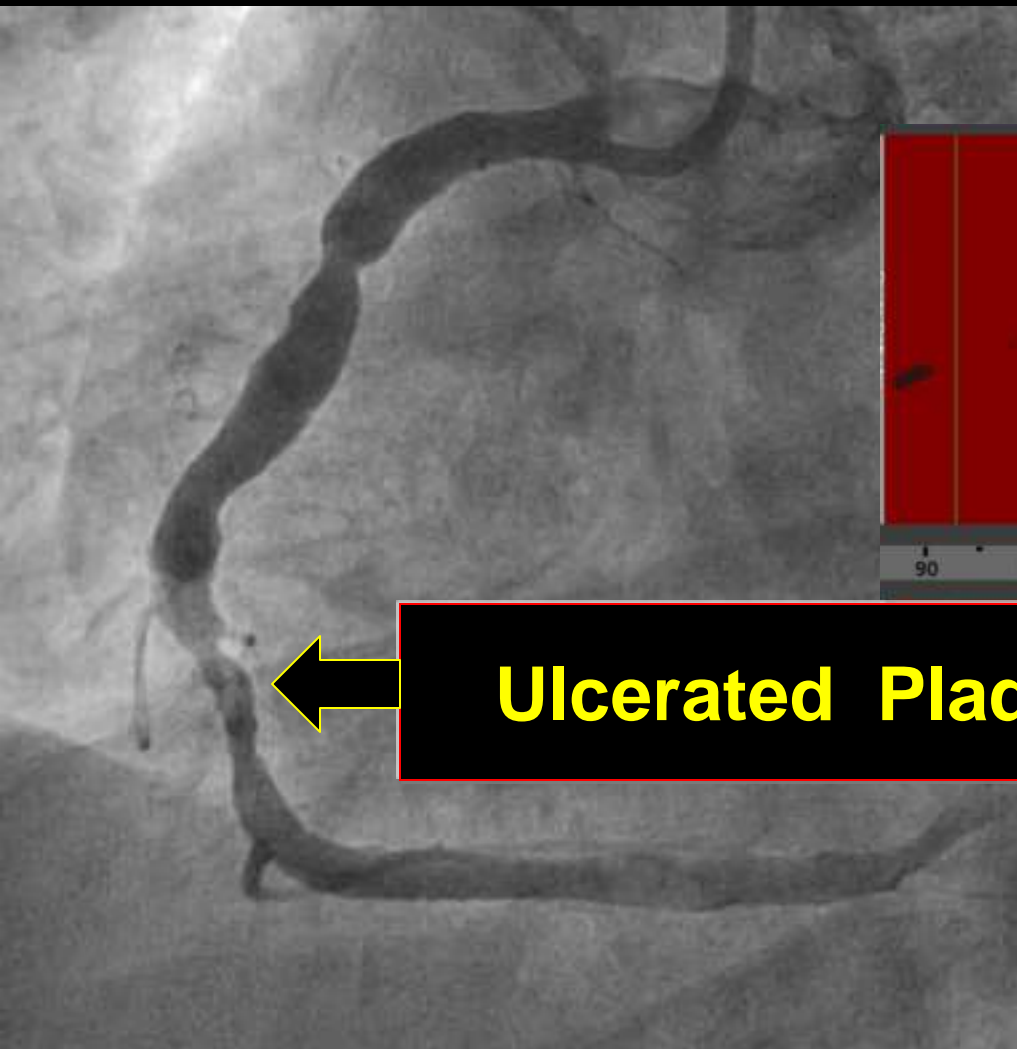
Lipid Core Plaque & Distal Embolization



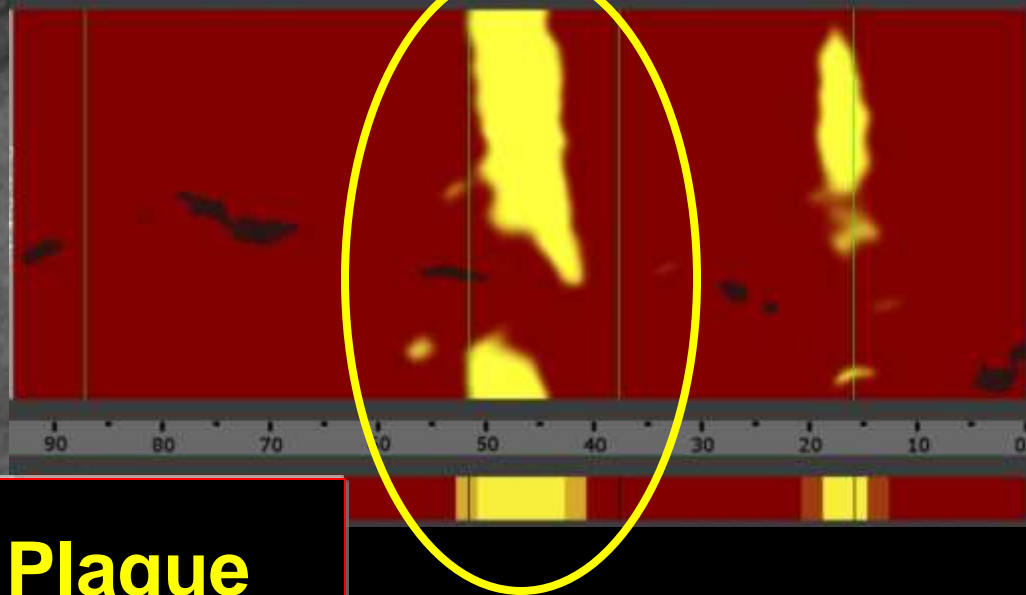
- Complicates 12-15% of PCI's
- Distal Embolization Lipid common
- Associated with Fibrosis by MRI
- Assoc. with Increased Mortality

Lipid Core Plaque & Distal Embolization

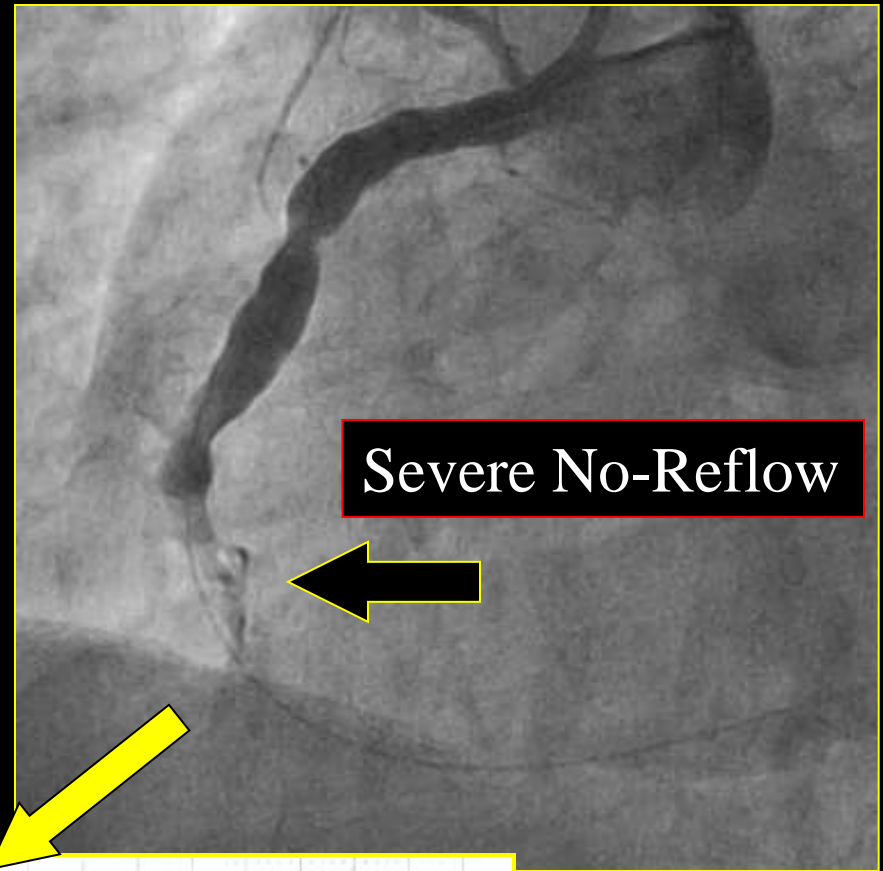
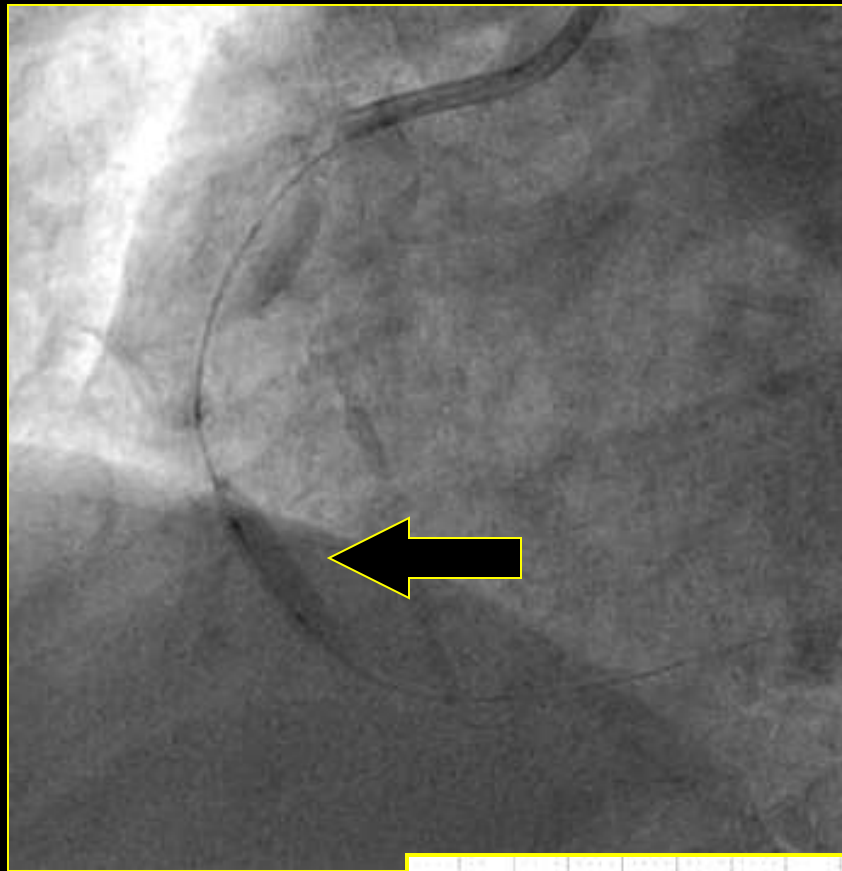
Circumferential LCP



Ulcerated Plaque

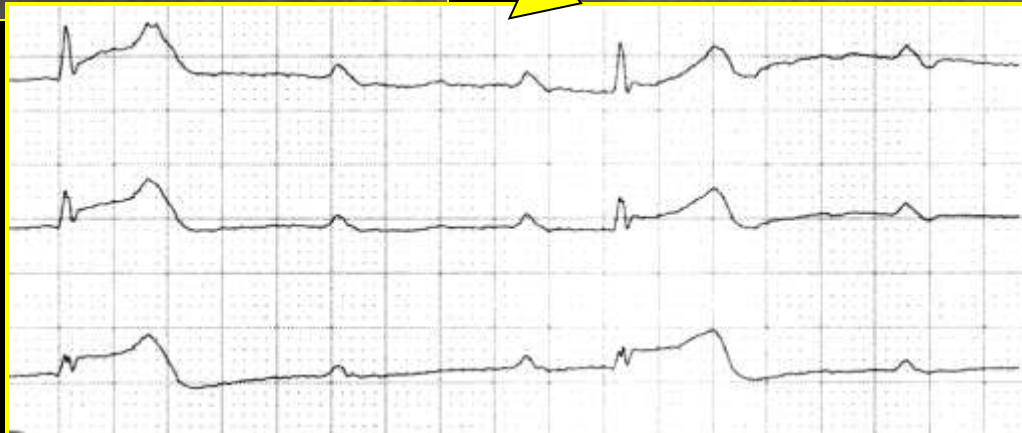


Peri-Procedural No-Reflow & MI



Severe No-Reflow

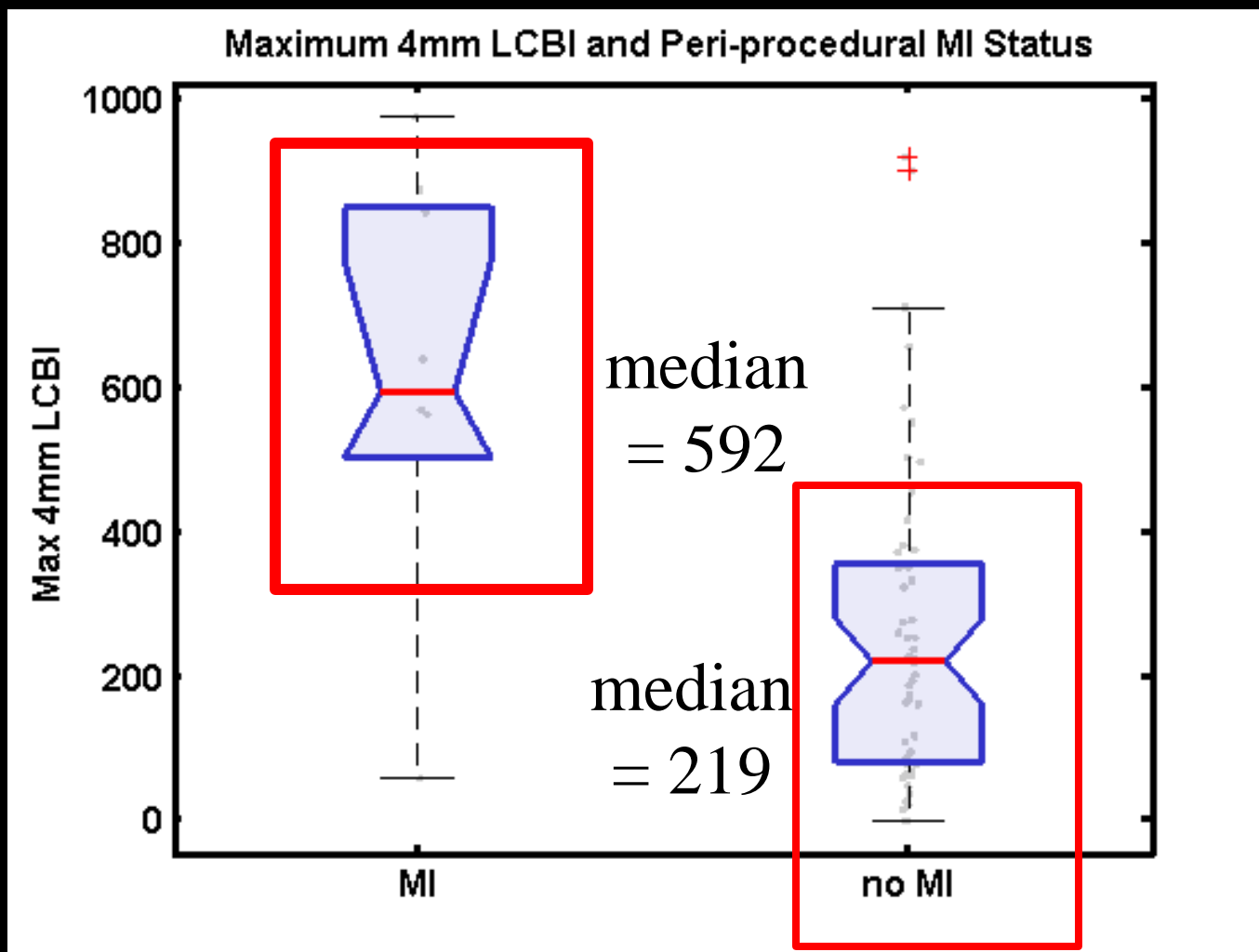
Pround Reflex
Brady-Hypo



Goldstein et al:
JACC Imaging
2009;2: 1420-
1424

MaxLCBI_{4mm} > 500 Predicts 50% risk PPMI

Goldstein et al. Circ Cardiovasc Interv. 2011;4:429-437

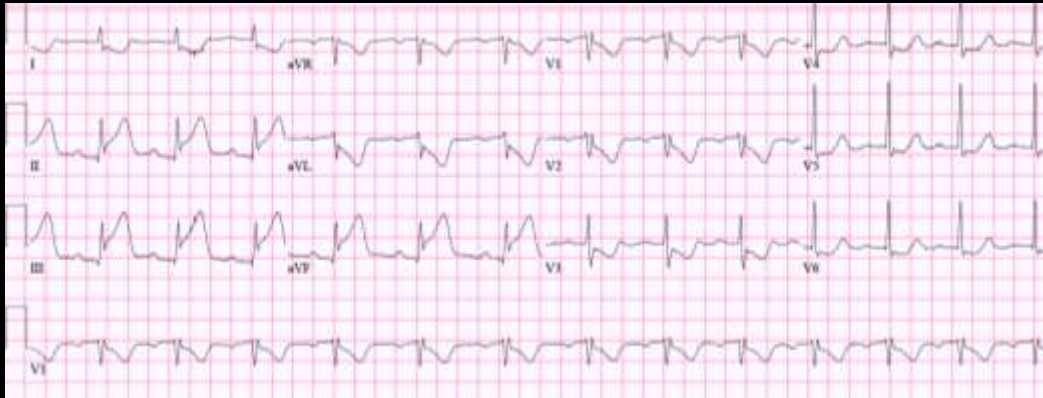


The VP Hypothesis

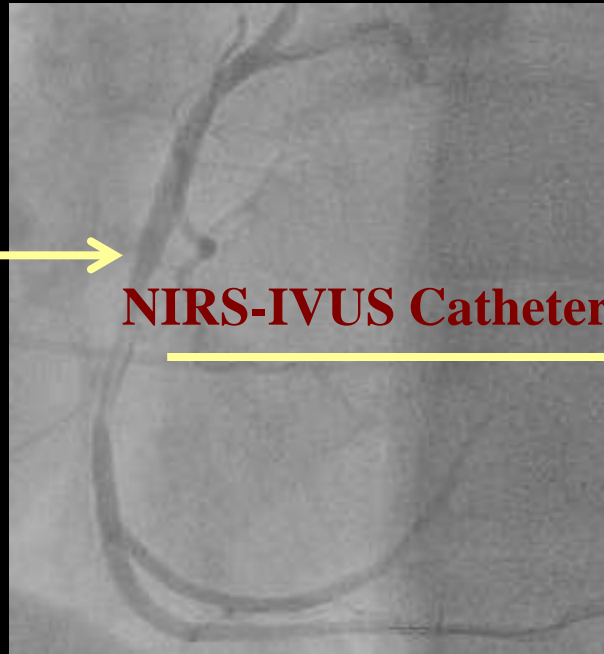
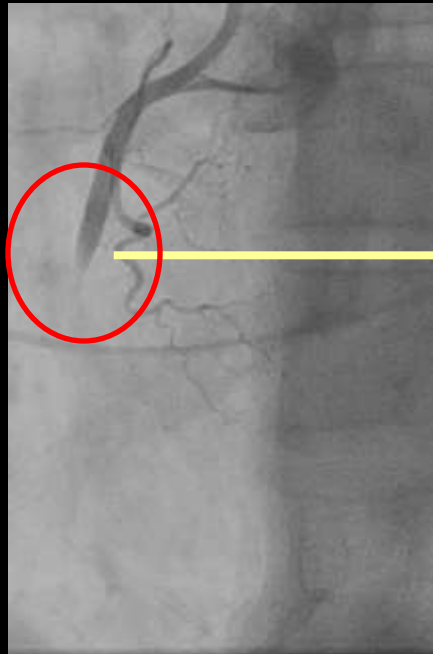
Connecting the Dots

Patterns of LCP in ACS

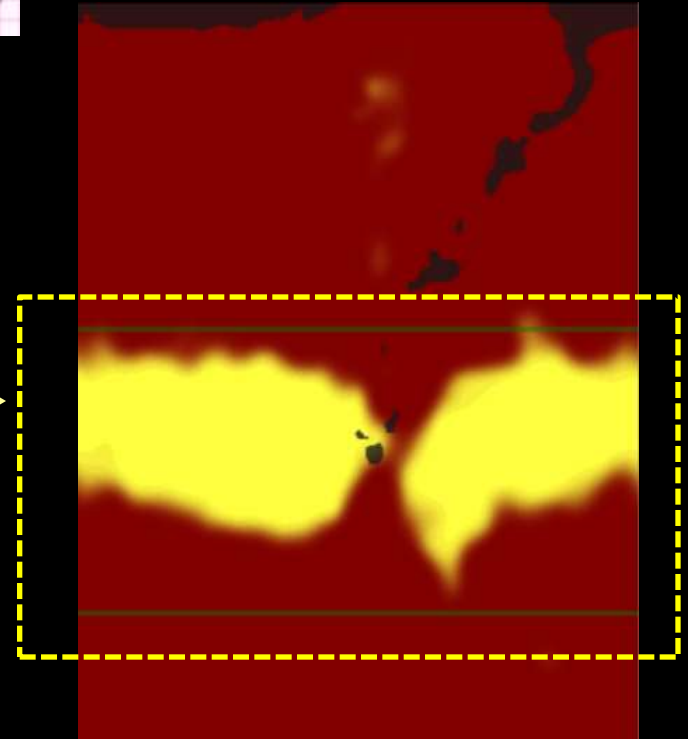
Connecting the Dots: 54 Year Old with Inferior-Posterior MI



These LCP lesions did not develop overnight!



NIRS-IVUS Catheter

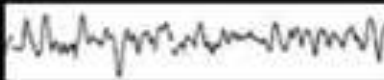


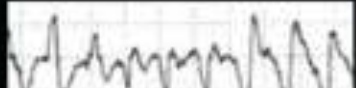




**Angiogram After PTCA with
Small Balloon
Flow Restored**

**Madder, et al
JACC Intervent 2013;6:838-46**




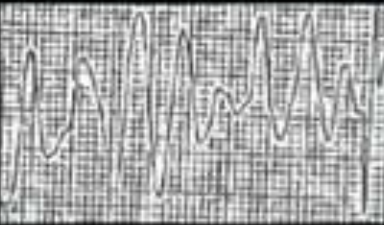

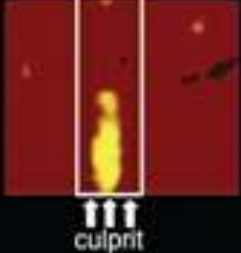
Detection by Intracoronary NIRS of LCP at Culprit Sites in Survivors of Cardiac Arrest

Madder RD et al J Invasive Cardiol 2014;26:78-79

CASE	Age	Cardiac Arrest from Ventricular Arrhythmia	Initial Angiogram after Resuscitation	NIRS Chemogram	Culprit maxLCBI _{4mm}
I	59				449
II	84				883

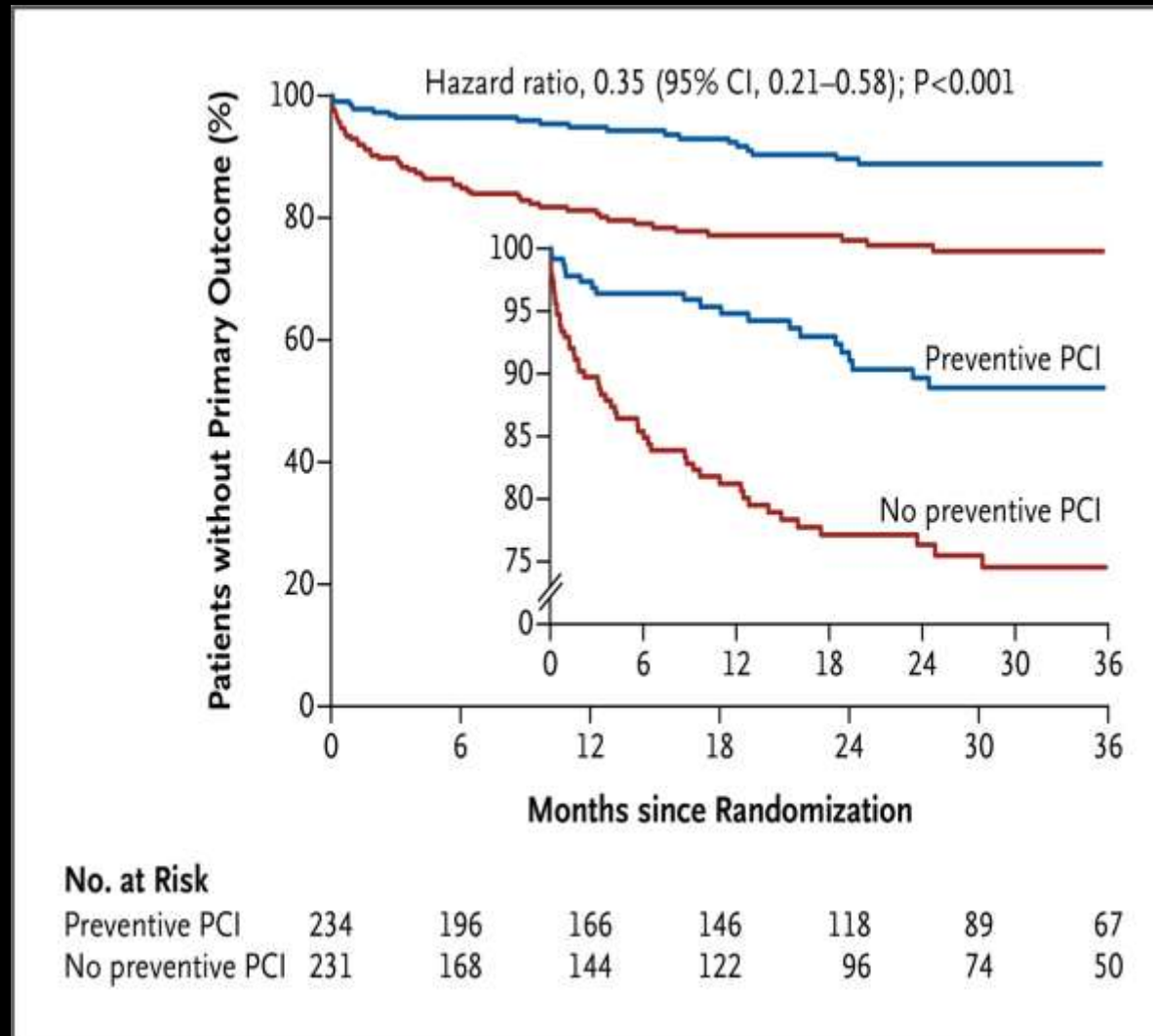
These LCP lesions did not develop overnight!

We Need to Detect Non-Culprit VP in the Cath Lab

IV	53				498
V	52			 ↑↑↑ culprit	533

PRAMI Study

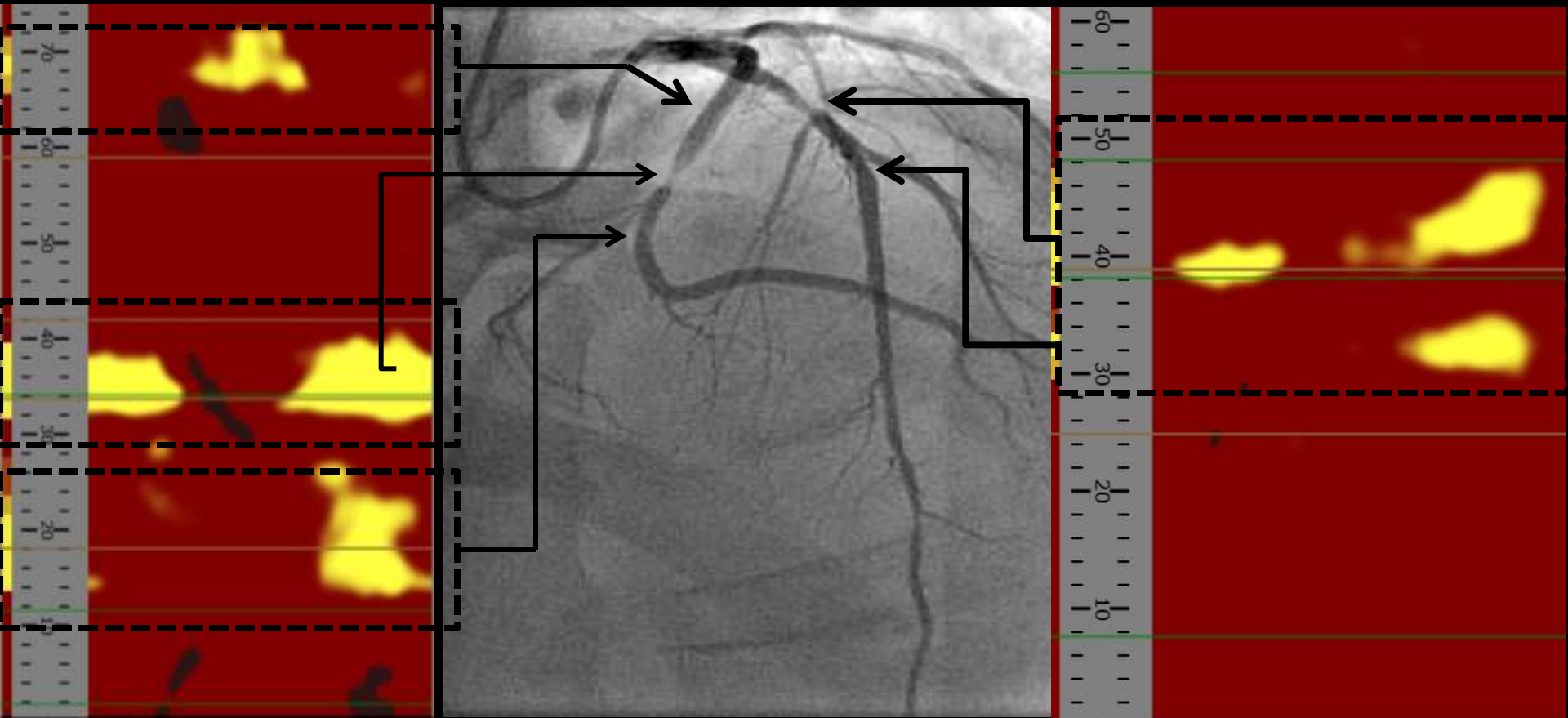
Wald DS et al. N Engl J Med 2013;369:1115-1123



Preventive PCI in non-infarct major stenoses reduced MACE compared with PCI limited to infarct artery

Prevalence of LCP in Target Lesions in ACS v CSA

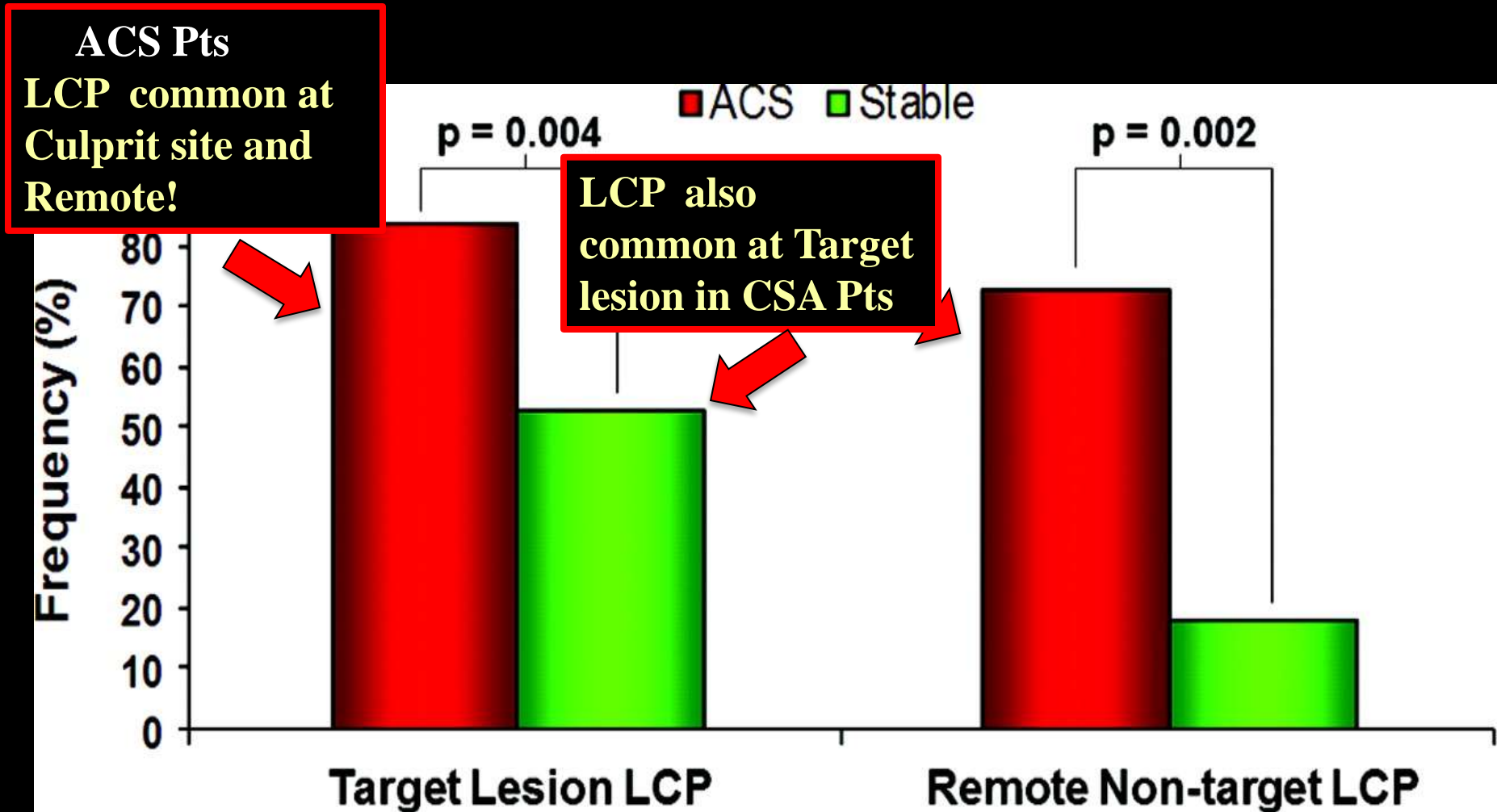
Madder & Goldstein. *Circ Cardiovasc Interv* 2012;5:55-61



Remote LCP in 70% ACS Cases

Prevalence of LCP in Target Lesions in ACS v CSA

Madder & Goldstein. Circ Cardiovasc Interv 2012;5:55-61



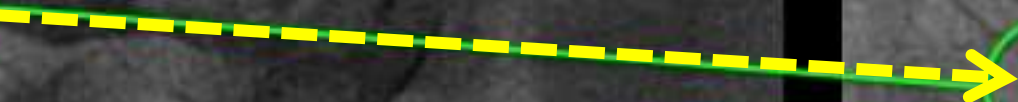
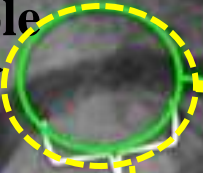
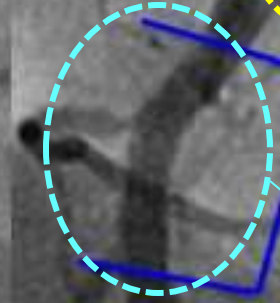
- Most Culprit Lesions in ACS=LCP
- But Many Pts with CSA Harbor LCP

64 year old presents with STEMI in March 2012

Unstable angina October 2012

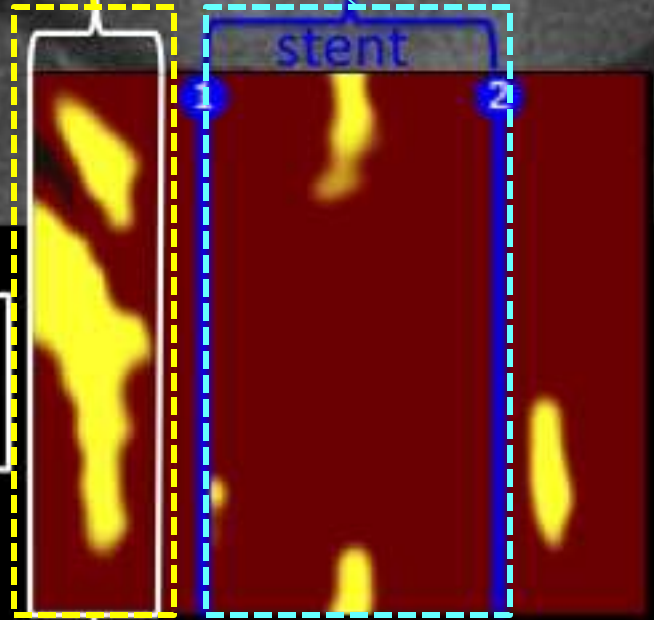


? Vulnerable plaque



New culprit at vulnerable plaque site

Stent placed in STEMI culprit



maxLCBI_{4mm}
694

Madder et al. Eur Heart J
Cardiovasc Imaging 2016;17:393-399

Benefits of NIRS-IVUS imaging (Diagnosis, Guidance and prognosis)

- ➔ **• Pre-procedural Strategy**
 - **Length/Size of Vessel to Stent**
- ➔ **• Early procedural assessment
(Guidance)**
 - **Geographic Miss, Expansion,
Malapposition, Dissection, and Clot**
- ➔ **• Prognosis**
 - **“Vulnerable Plaque”**