



The 44<sup>th</sup> Annual International Congress of the  
EGYPTIAN SOCIETY OF  
**CARDIOLOGY**  
CardioEgypt2017



# Vulnerable plaque is a hidden enemy

**Hesham Refaat**

Zagazig University  
Egypt

## Clinical history :

- 55 years old male patient.
- History of diabetes mellitus and systemic hypertension on medical therapy.
- Current smoker.
- This patient gave a history of precordial chest pain, precipitated by exertion and relieved by rest and SL nitroglycerin, and radiated to back and left shoulder ..... typical ischemic chest pain.



The 44<sup>th</sup> Annual International Congress of the  
EGYPTIAN SOCIETY OF  
**CARDIOLOGY**  
CardioEgypt2017



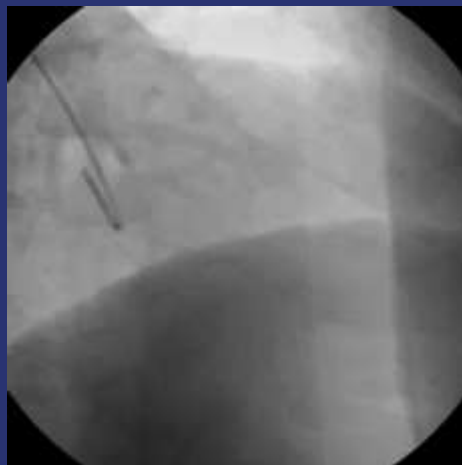
- **ECG** : within normal limits.
- **Cardiac troponin and other biomarkers of myonecrosis** : within normal limits.
- **ECHO** : LVDD and AV sclerosis
- **Exercise ECG** : was incomplete and inconclusive for exercise induced myocardial ischemia.
- The patient was **still symptomatic**, despite optimal anti-ischemic drug therapy.
- **Coronary angiography** was then performed .....



the 44<sup>th</sup> Annual International Congress of the  
**EGYPTIAN SOCIETY OF  
CARDIOLOGY**  
CardioEgypt2017



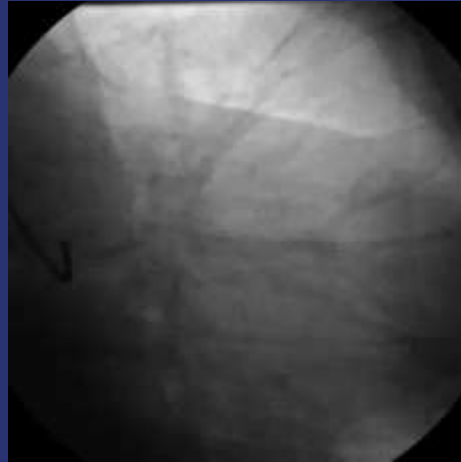
## Coronary angiography :



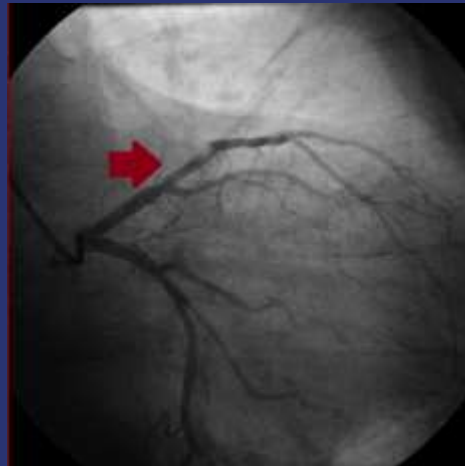
the 44<sup>th</sup> Annual International Congress of the  
**EGYPTIAN SOCIETY OF  
CARDIOLOGY**  
CardioEgypt2017



## Coronary angiography :



## Coronary angiography :



## Coronary angiography :

- intermediate lesion (60%) involving middle LAD segment  
(**Culprit Lesion**)
- Proximal to it .... another non-significant lesion.

## What is the next step ?!!! ESC 2014 Guidelines



The 44<sup>th</sup> Annual International Congress of the  
**EGYPTIAN SOCIETY OF  
CARDIOLOGY**  
CardioEgypt2017



## ESC 2014 Guidelines :

### Recommendations for the clinical value of intracoronary diagnostic techniques

Re-commendations	Class <sup>a</sup>	Level <sup>b</sup>	Ref. <sup>c</sup>
<b>FFR</b> to identify haemodynamically relevant coronary lesion(s) in stable patients when evidence of ischaemia is not available.	I	A	50,51,713
<b>FFR-guided PCI</b> in patients with multivessel disease.	IIa	B	54
<b>IVUS</b> in selected patients to optimize stent implantation.	IIa	B	702,703,706
<b>IVUS</b> to assess severity and optimize treatment of unprotected left main lesions.	IIa	B	705
<b>IVUS or OCT</b> to assess mechanisms of stent failure.	IIa	C	
<b>OCT</b> in selected patients to optimize stent implantation.	IIb	C	

# FFR

< 0.8 = functionally significant



The 44<sup>th</sup> Annual International Congress of the  
**EGYPTIAN SOCIETY OF  
CARDIOLOGY**  
CardioEgypt2017

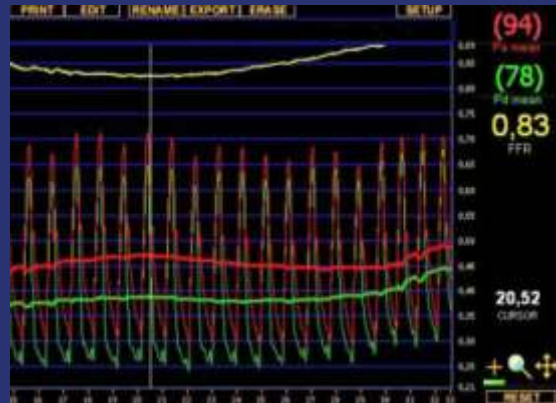


## FFR assessment :



$$\text{FFR} = 0.83$$

Non-significant stenosis  
Functional



## According to FFR data :

- Revascularization was deferred.
- Optimal anti-ischemic measures were given.

## One month later,

The patient was still symptomatic.

So ...

- further anatomical assessment.
- revascularization to be considered.



## ESC 2014 Guidelines :

### Recommendations for the clinical value of intracoronary diagnostic techniques

Recommendations	Class <sup>a</sup>	Level <sup>b</sup>	Ref. <sup>c</sup>
FFR to identify haemodynamically relevant coronary lesion(s) in stable patients when evidence of ischaemia is not available.	I	A	50,51,713
FFR-guided PCI in patients with multivessel disease.	IIa	B	54
IVUS in selected patients to optimize stent implantation.	IIa	B	702,703,706
IVUS to assess severity and optimize treatment of unprotected left main lesions.	IIa	B	705
IVUS or OCT to assess mechanisms of stent failure.	IIa	C	
OCT in selected patients to optimize stent implantation.	IIb	C	

**The patient was still symptomatic**

So ....

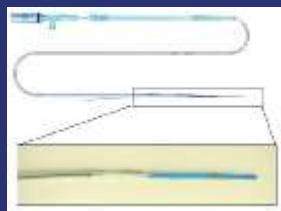
Anatomical assessment :

- IVUS
- OCT
- IVUS - NIRS

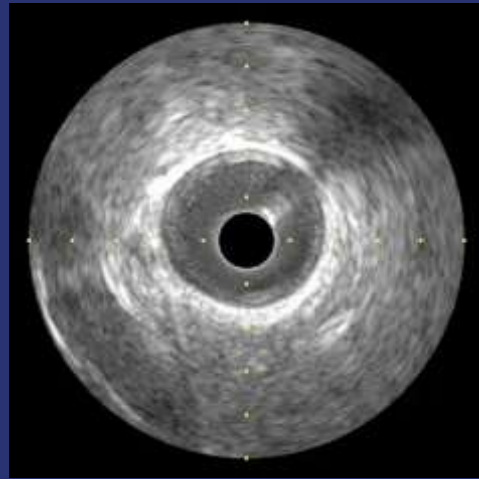
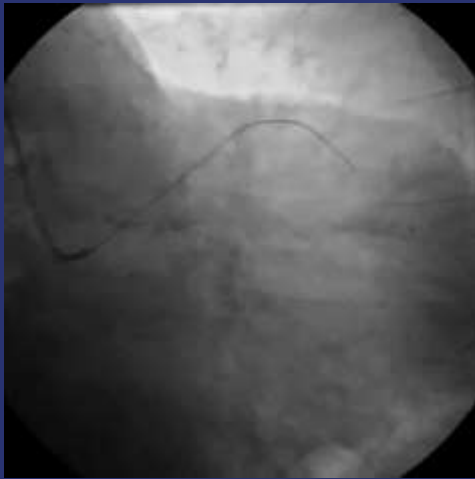


## The IVUS equipment :

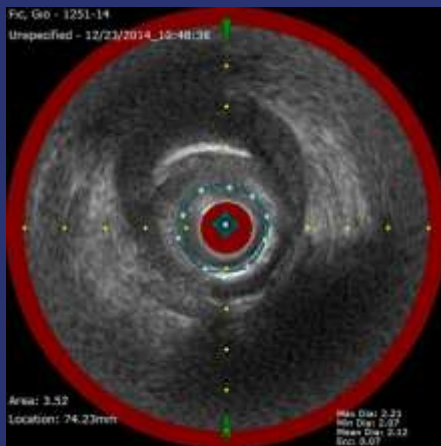
- Catheter with a miniaturized probe at the tip.
- Pullback device.
- Console to reconstruct real-time images.



**IVUS :**



**IVUS :**



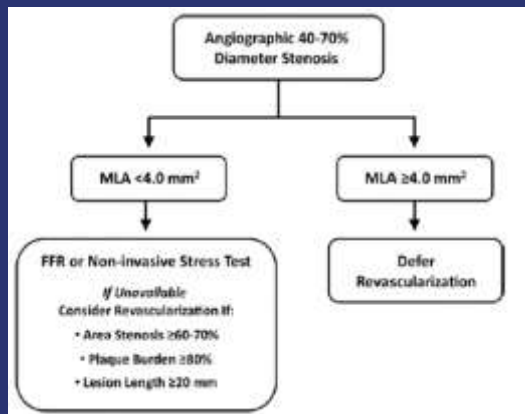
**MLA = 3.48 mm<sup>2</sup>**



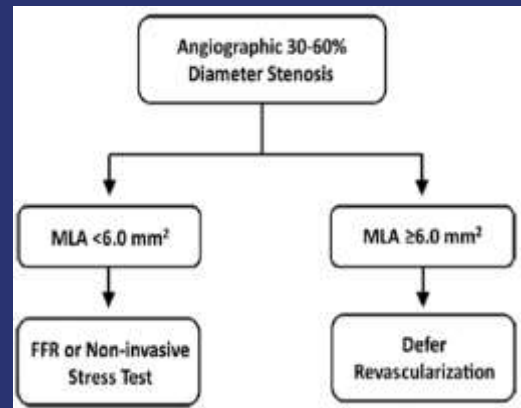
**Plaque burden = 65.66 %**



## IVUS criteria for assessment of intermediate lesions :



Non-LMCA lesions ( 40 – 70% )

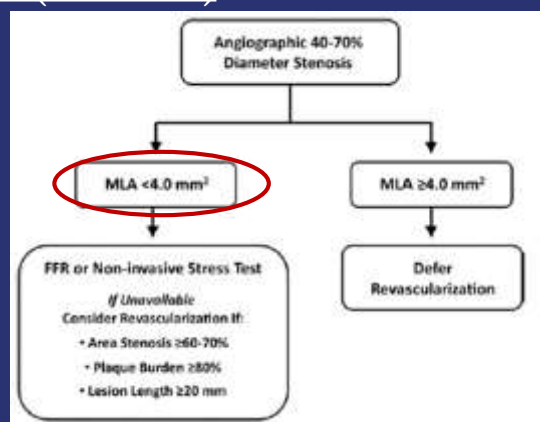


LMCA lesions ( 30 – 60% )



## IVUS criteria for assessment of intermediate lesions :

Non-LMCA lesions ( 40 – 70% )





- Coronary angiography :  
intermediate lesion (60%) involving middle LAD segment

- FFR : 0.83

Non-significant lesion

- IVUS : MLA = 3.48 mm<sup>2</sup>

Significant lesion

?????



## Physiological & anatomical mismatch

Further assessment :

- OCT
- IVUS-NIRS



## The OCT equipment :

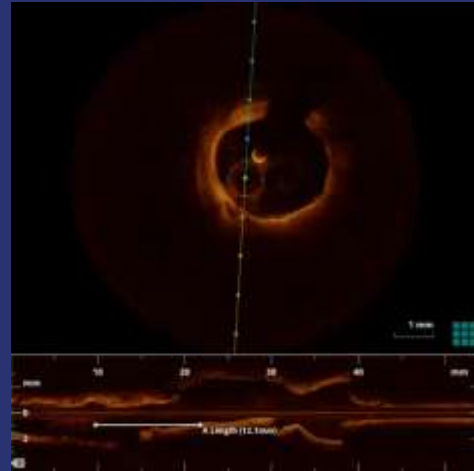
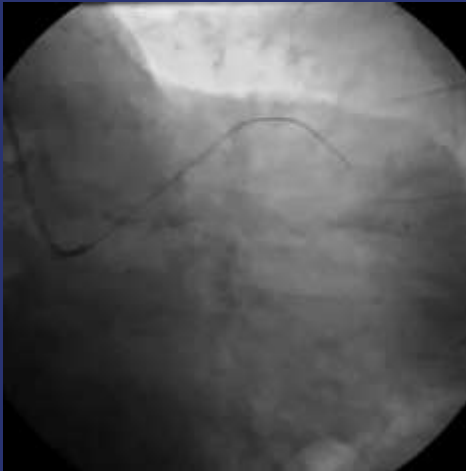
- OCT catheter ( Dragonfly Imaging catheter ).
- Pullback device ( DOC ).
- Console to reconstruct real-time images.



44th Annual International Congress of the  
EGYPTIAN SOCIETY OF  
**CARDIOLOGY**  
CardioEgypt2017



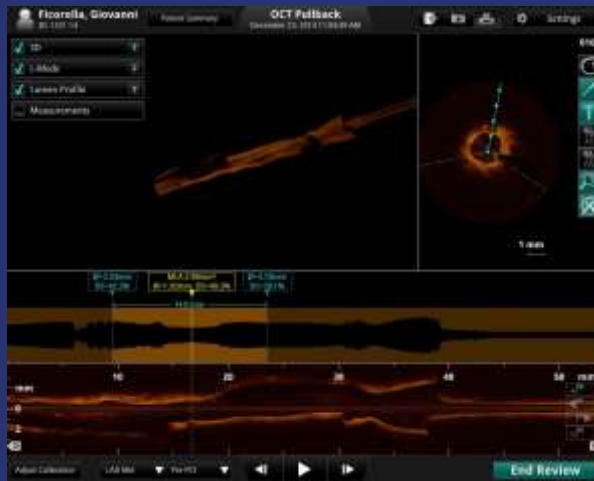
## OCT :



44th Annual International Congress of the  
EGYPTIAN SOCIETY OF  
**CARDIOLOGY**  
CardioEgypt2017



## OCT :



### 3D-OCT

### L-Mode OCT

### Lumen profile OCT

### Cross sectional OCT

Lesion length = 14 mm

MLA = 2.9 mm<sup>2</sup>

Proximal reference = 3.1 mm<sup>2</sup>

Distal reference = 3.3 mm<sup>2</sup>



## OCT :



### Cross sectional OCT :

- Culprit lesion.
- Plaque rupture with a large cavity formation.
- Plaque type ???!



## OCT:



### Proximal to culprit lesion :

- MLA = 3.6 mm<sup>2</sup>
- Large cavity inside the plaque
- Plaque rupture ?!!
- Plaque type ?!!

Lipid Vs. Calcific



## OCT:



### More proximally :

- Calcific plaque.
- Thin fibrous cap.

TCFA



## OCT:

### Thin-Cap Fibroatheroma as High-Risk Plaque for Microvascular Obstruction in Patients With Acute Coronary Syndrome

Yaichi Ozaki, MD, Atsushi Tanaka, MD, Takashi Tanimoto, MD, Hiromori Kitabata, MD, Maruho Kashiwagi, MD, Takashi Kubo, MD, Shigeho Takamada, MD, Kohsei Ishibashi, MD, Kenichi Komukai, MD, Yasushi Ino, MD, Kunitaka Hirata, MD, Masato Mizukoshi, MD, Toshio Inamishi, MD, Takashi Akasaka, MD

**Background**—Plaque contents can cause microvascular impairment, which is an important determinant of clinical outcomes in patients with acute coronary syndrome (ACS). We hypothesized that percutaneous coronary intervention (PCI) for thin-cap fibroatheroma (TCFA) could easily disrupt the fibrous cap and expose the contents of plaque to coronary flow, possibly resulting in microvascular obstruction (MVO). The purpose of this study was to investigate whether TCFA was associated with MVO after PCI in patients with ACS.

**Methods and Results**—We enrolled 115 patients with ACS who were successfully revascularized with PCI. The patients were divided into a ruptured plaque group (n=56), a nonrupture with TCFA group (n=21), and a nonrupture and non-TCFA group (n=35), according to optical coherence tomography findings of the culprit lesion. Using contrast-enhanced MRI, we assessed MVO. There were no statistically significant differences in patient characteristics. The nonrupture with TCFA group more frequently presented MVO (ruptured plaque, 27%; versus nonrupture with TCFA, 43%; versus non-TCFA and nonrupture, 9%;  $P=0.012$ ). The prevalence of MVO increases as cap thickness decreases.

**Conclusions**—TCFA is more frequently associated with MVO after PCI. TCFA is a high-risk plaque for MVO after PCI in patients with ACS. (Circ Cardiovasc Imaging. 2011;4:420-427.)

**Key Words** acute coronary syndrome ■ MRI ■ microvascular obstruction ■ optical coherence tomography

## TCFA:

- Thin fibrous cap = 50  $\mu$ m
- Calcific plaque.

## Vulnerable feature

# Hidden enemy



## OCT data:

### Culprit lesion :

- $MLA = 2.9 \text{ mm}^2$ .
- Plaque rupture.
- Large cavity inside the plaque.
- Plaque type ?!!

### Proximal to culprit lesion :

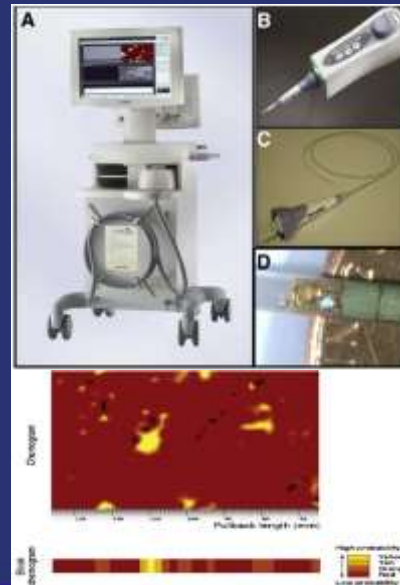
- Calcific plaque.
- Thin fibrous cap = 50  $\mu$ m .... TCFA
- Vulnerable feature.



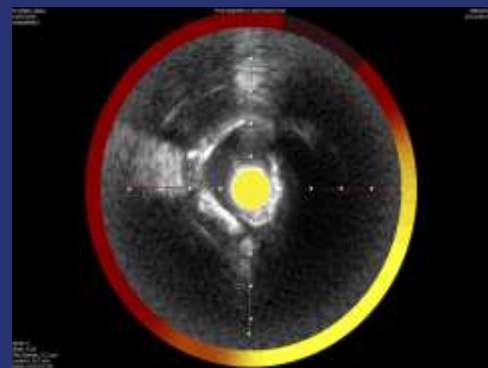
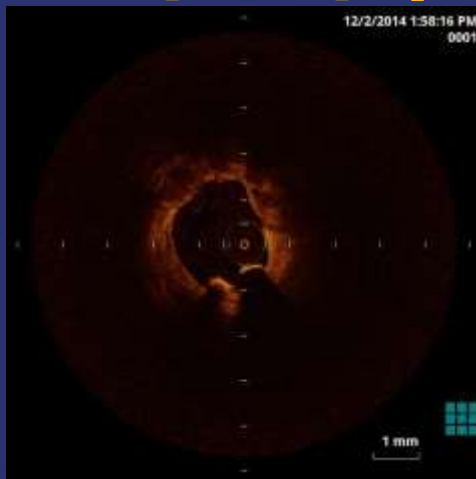
**NIRS :**

Detects lipid-rich plaques.  
Provides "chemogram" of the  
coronary artery wall (LCBI).

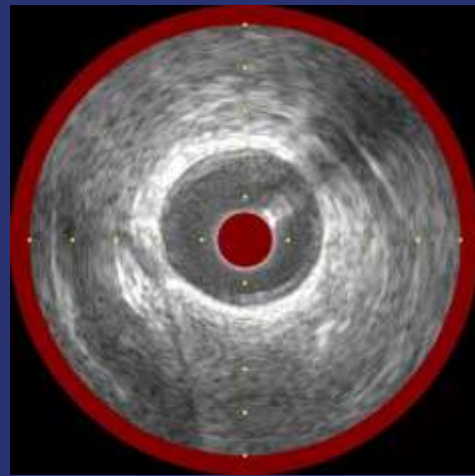
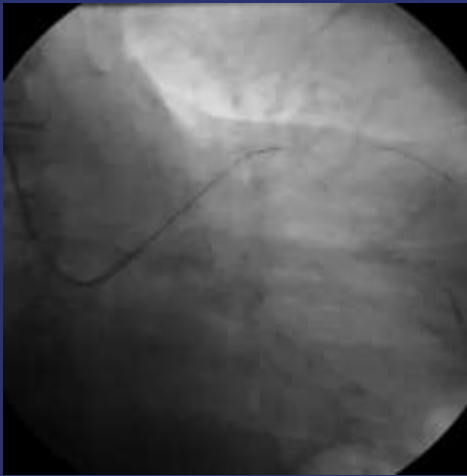
The next step is **NIRS**



**NIRS ... Lipid rich plaque ( LCBI = 540 )**



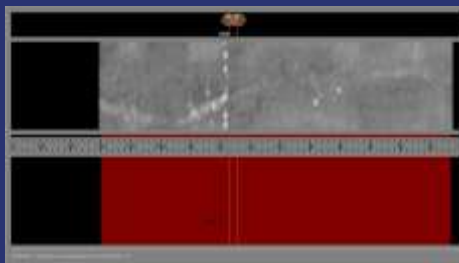
## NIRS :



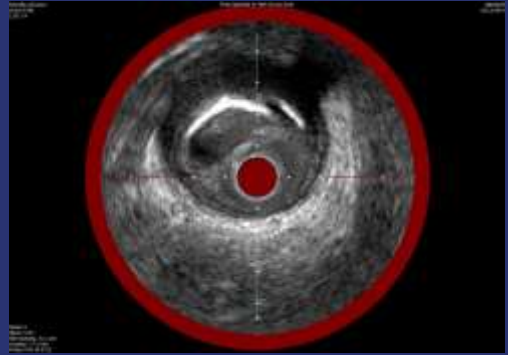
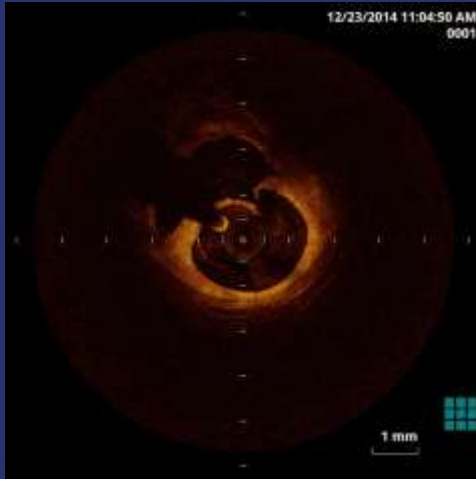
## NIRS :

LCBI = 0

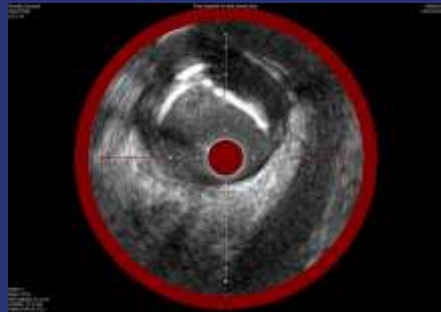
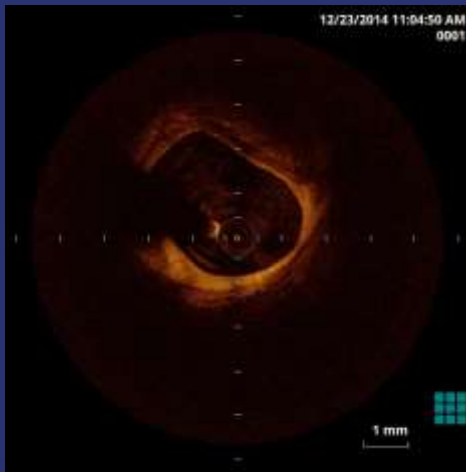
Plaque type: fibrocalcific



# OCT Vs. NIRS :

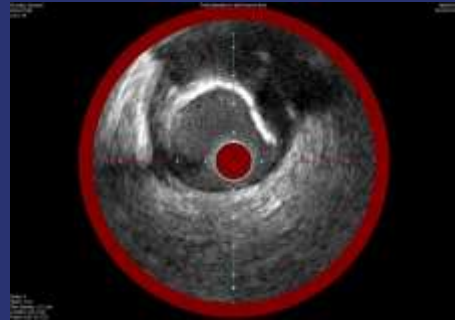
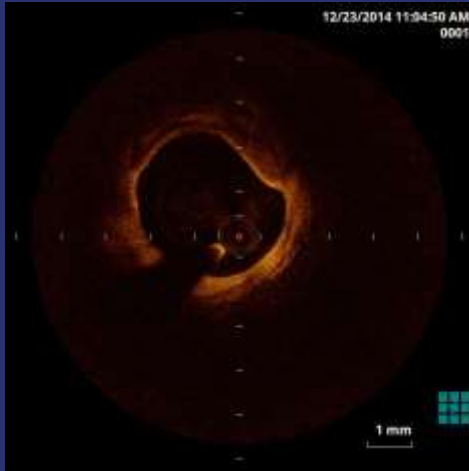


# OCT Vs. NIRS :

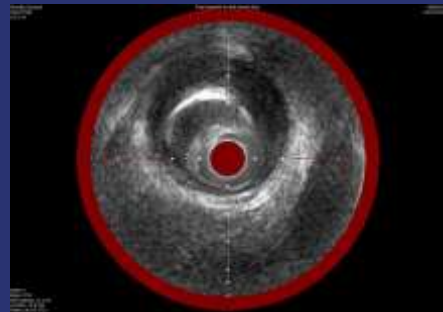
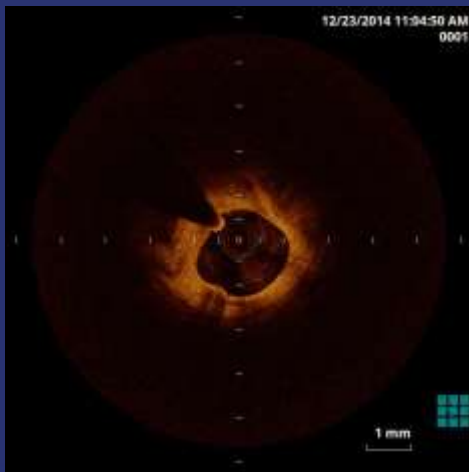




# OCT Vs. NIRS :



# OCT Vs. NIRS :



### NIRS data :

Culprit lesion.

LCBI = 0 ... No evidence of lipid rich plaque.

Fibrocalcific plaque.

MLA= 3.48mm<sup>2</sup> & Plaque burden= 65.66%

**Culprit lesion = ruptured protruding calcified nodule  
It isn't always lipid  
Hidden enemy**

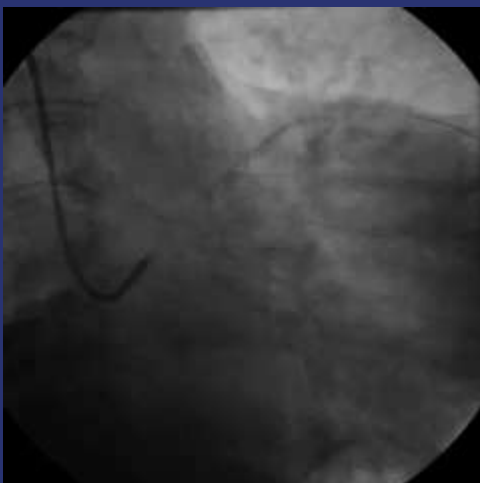


### PCI :

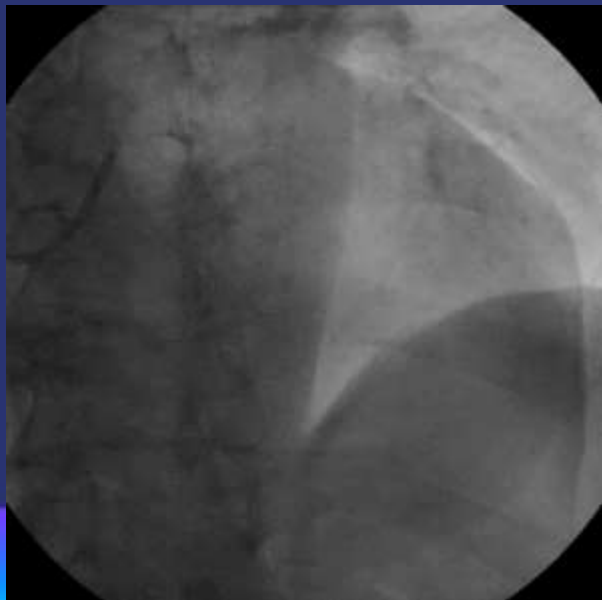
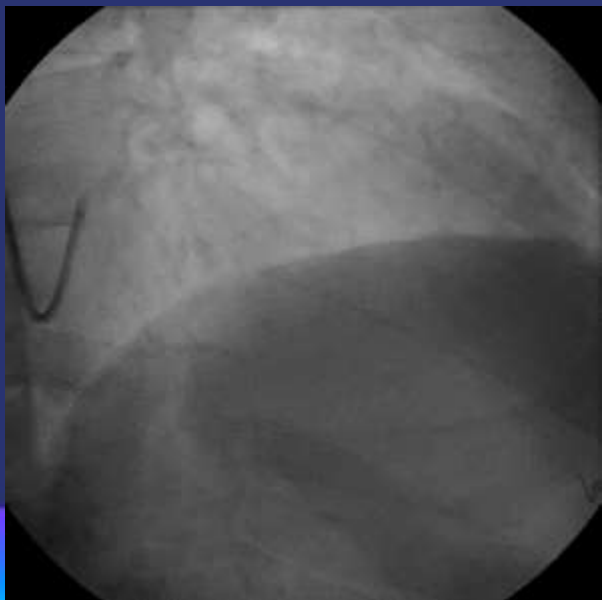
- Radial approach.
- 2 BMW guiding wires involving culprit lesion (mid LAD) and side branch.
- DES 3.5 x 14 mm deployed at 14 atm.
- Optimal final angiographic results.



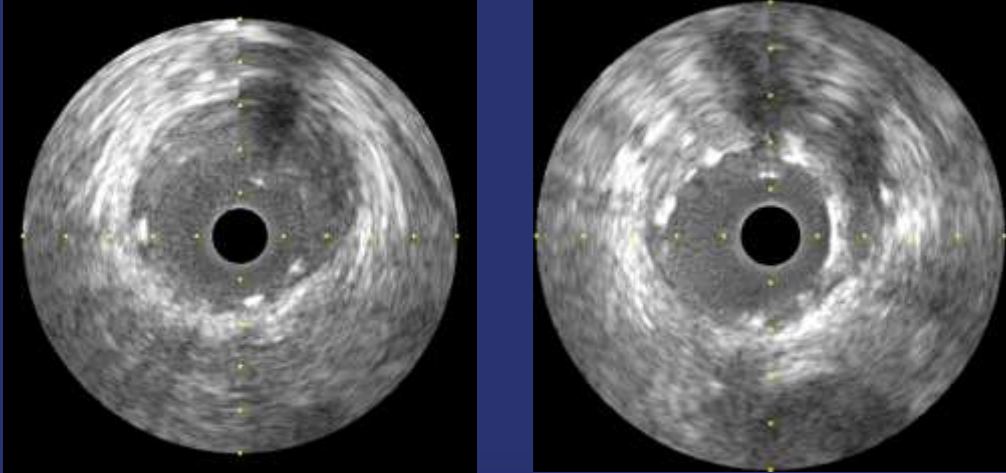
PCI:



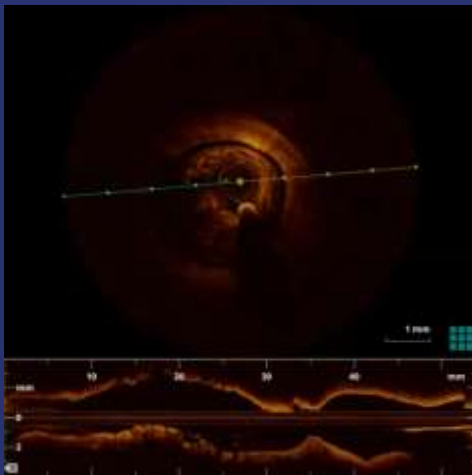
PCI: Optimal final angiographic results.



## Post PCI-IVUS : Optimal stent expansion & No acute complication



## Post PCI-OCT :

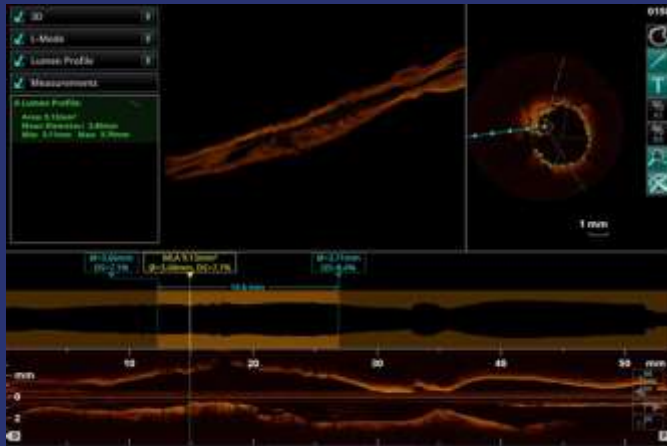


- Optimal stent expansion, except for
- intrastent dissection.
  - proximal stent edge dissection.
  - minimal stent malapposition.

These acute complications weren't significant, and so no further interventions were carried out.



## Post PCI-OCT :

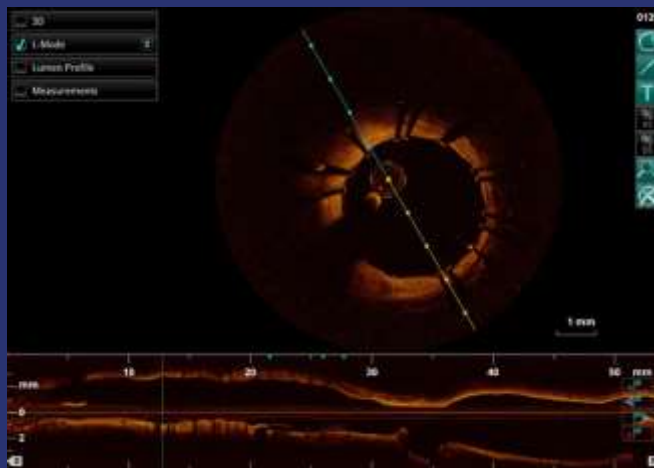


3D OCT  
longitudinal OCT  
cross-sectional OCT

Good stent expansion



## Post PCI-OCT :



Cross-sectional OCT  
evidence of optimal  
stent expansion :

metallic struts are well  
opposed against intimal  
surface.



## Post PCI-OCT :



OCT evidence of stent malapposition :

malapposition distance  
6 mm



## Post PCI-OCT :

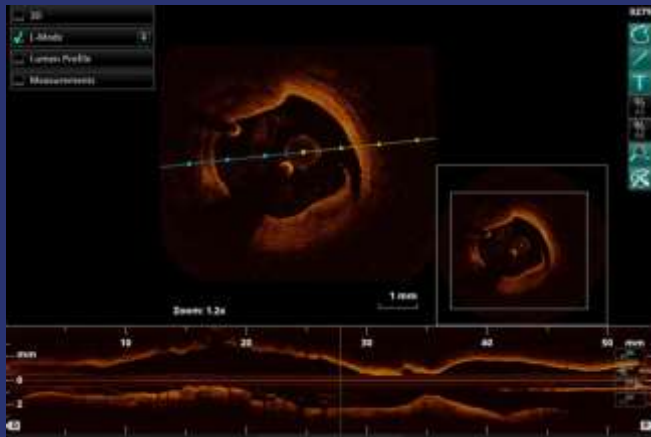


OCT evidence of small intrastent dissection :

dissection distance  
6 mm



## Post PCI-OCT :



OCT evidence of small proximal stent edge dissection



## Take Home Message

- Coronary angiography is the workhorse invasive imaging technique for diagnostic and interventional procedures. However, there are some scenarios in which an experienced interventional cardiologist requires complementary information to that provided by angiography.
- The term "Vulnerable Plaque" was initially coined in reference to coronary stenosis that did not appear to be significant by angiography but subsequently caused adverse cardiac events. It is a hidden enemy.



## Take Home Message

- Novel intracoronary imaging modalities (IVUS, OCT, IVUS-NIRS) are very valuable in identifying the characteristic features of these vulnerable plaques, especially in angiographically intermediate lesions.
- Rupture of protruding calcified nodules may be the underlying substrate responsible for ischemic events in selected patients. The "vulnerable plaque" isn't always lipid.
- OCT and NIRS have an important role in assessing intermediate lesions, and evaluating the process of coronary intervention.



## The choice of imaging modality

Imaging Modality	Resolution (µm)	Penetration	Fibrous cap	Lipid core	Inflammation	Calcium	Thrombus	Current Status
Grayscale IVUS	150-250	Good	+	+	-	+++	+	CS/CA
VH-IVUS	200-250	Good	+	++	-	+++	+	CS/CA
IB-IVUS	150	Good	+	++	-	+++	+	CS
Angioscopy	10-50	None	+	++	-	-	+++	CS/CA
OCT	10-15	Poor	+++	+++	+	++	++	CS/CA





*Thank You*



the 44<sup>th</sup> Annual International Congress of the  
**EGYPTIAN SOCIETY OF  
CARDIOLOGY**  
Cardio Egypt 2017

