NIRS vs. IVUS: Lessons from

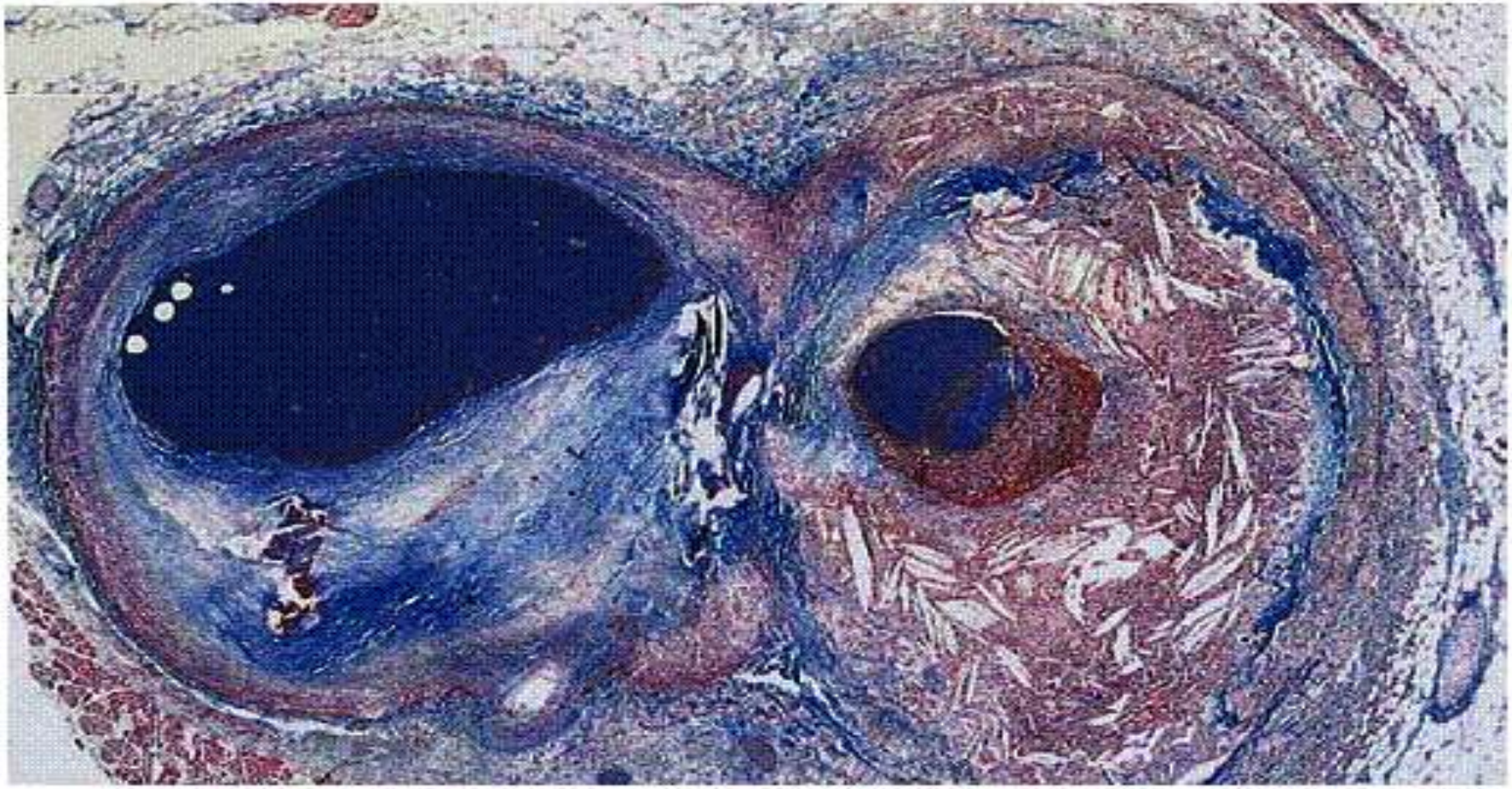
in Vivo ACS Patients & in Vitro SCD Cases

Shanghai Ren Ji Hospital

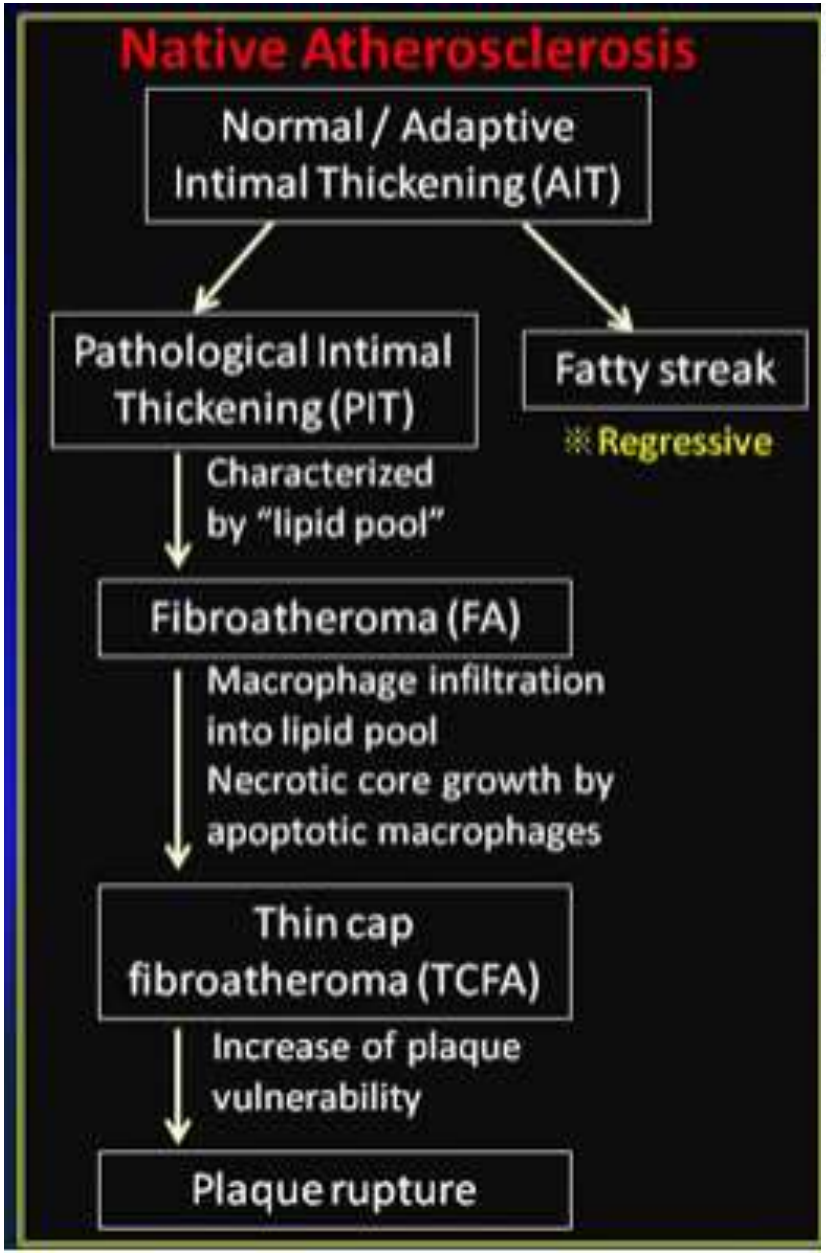
Pu Jun, MD, FESC

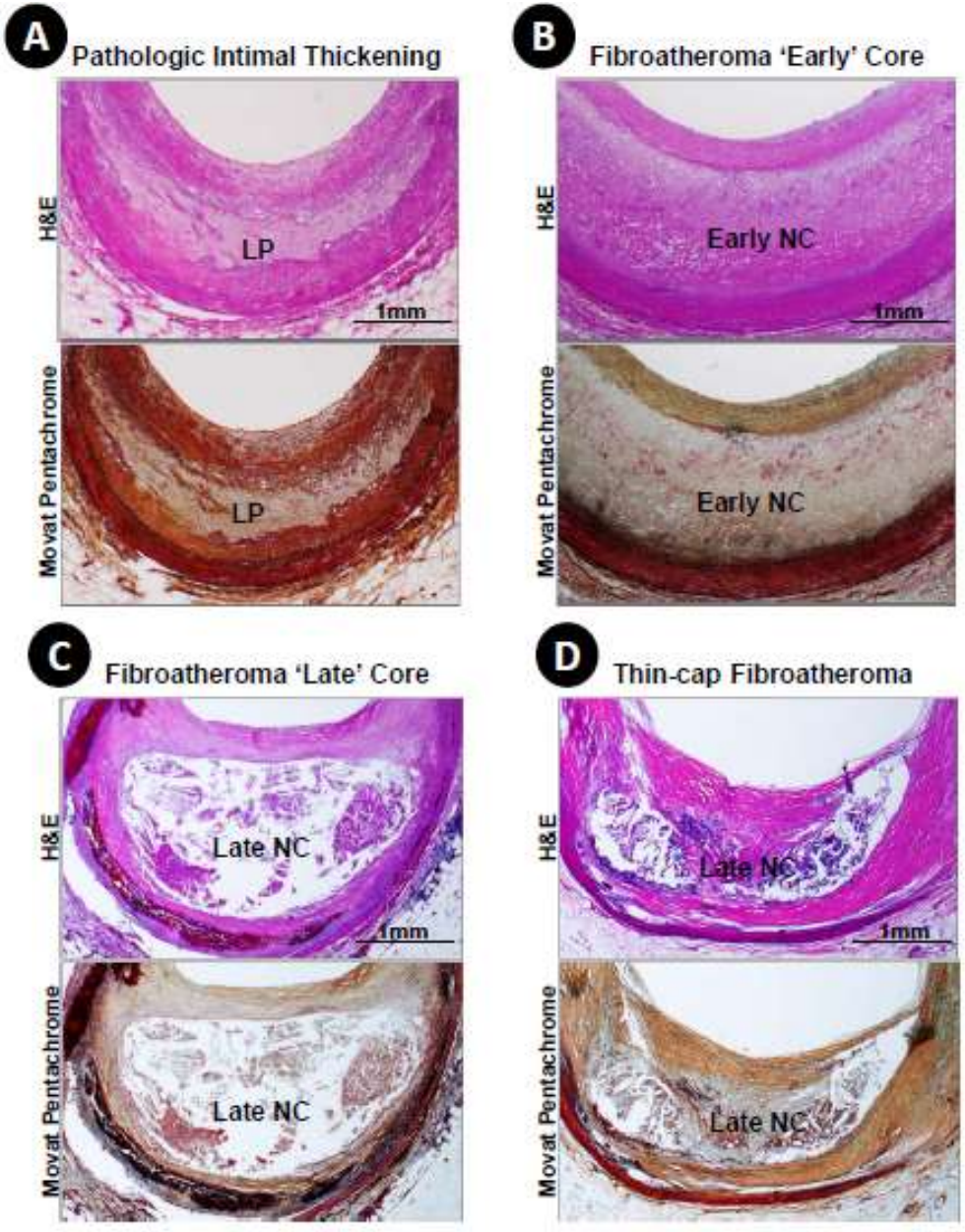
Volcano ≈ Vulnerable Plaque

A patient died from Anterior STEMI

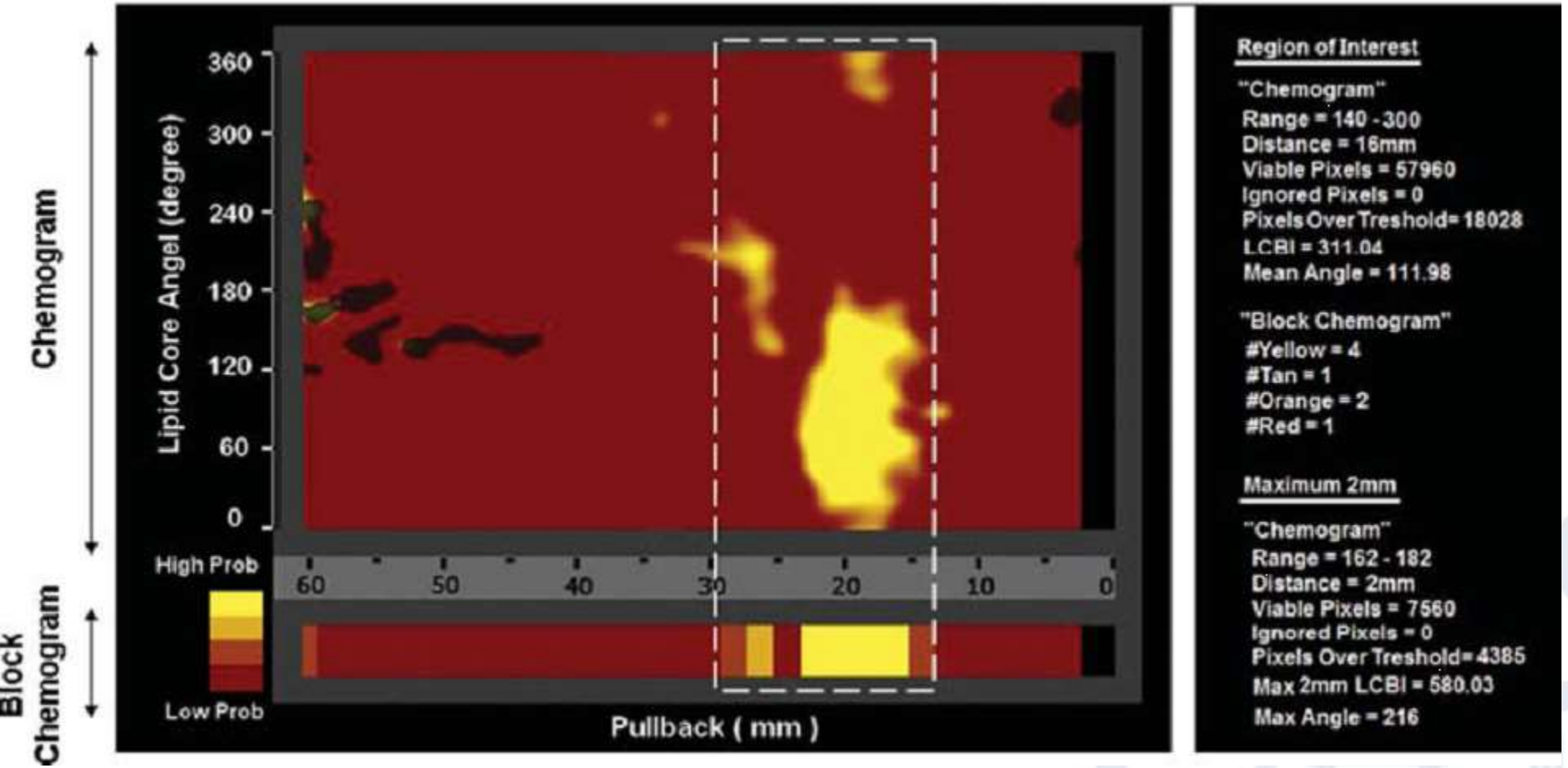


Human plaques with lipid pool & necrotic core



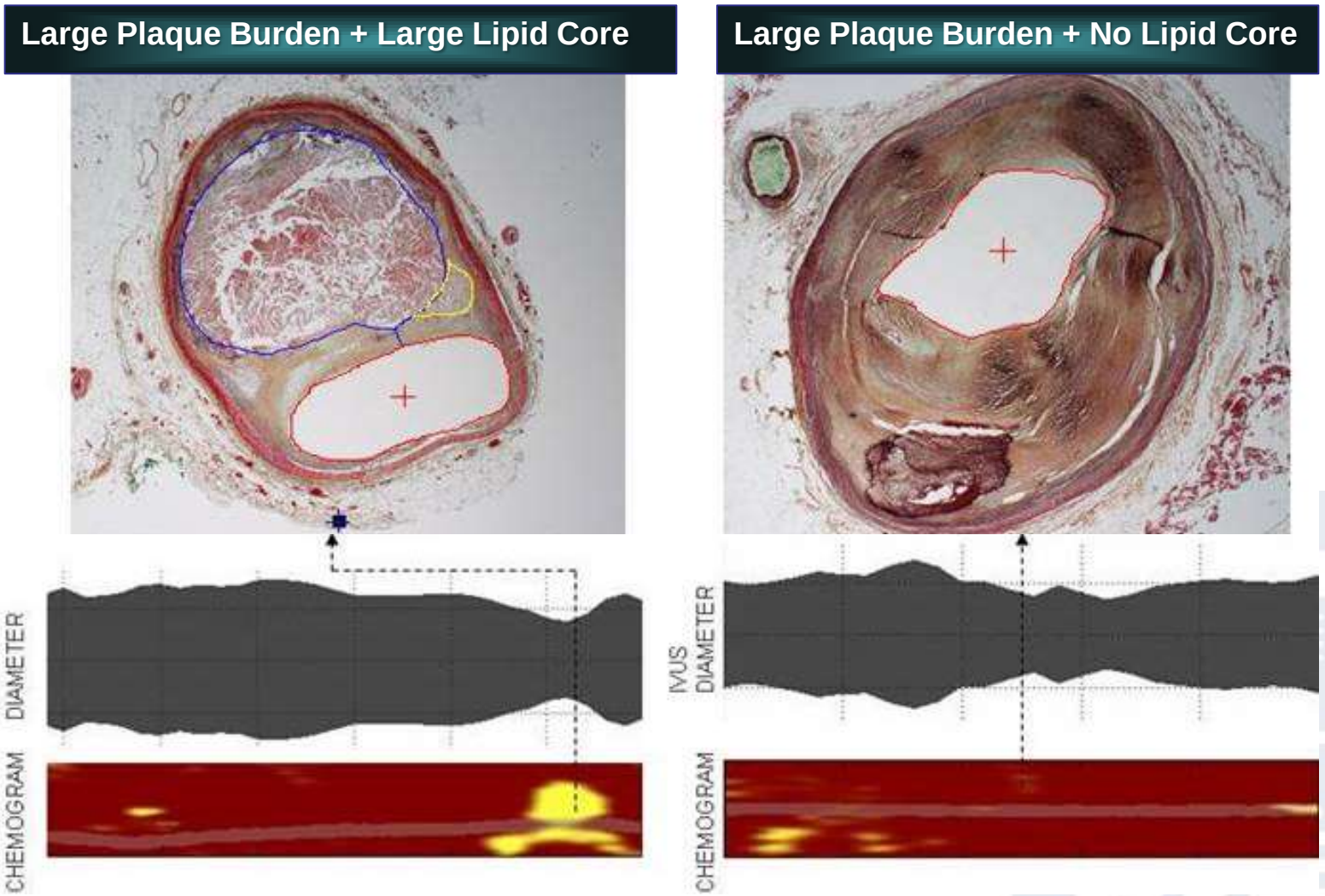


NIRS has been developed to detect lipid core plaque (LCP)

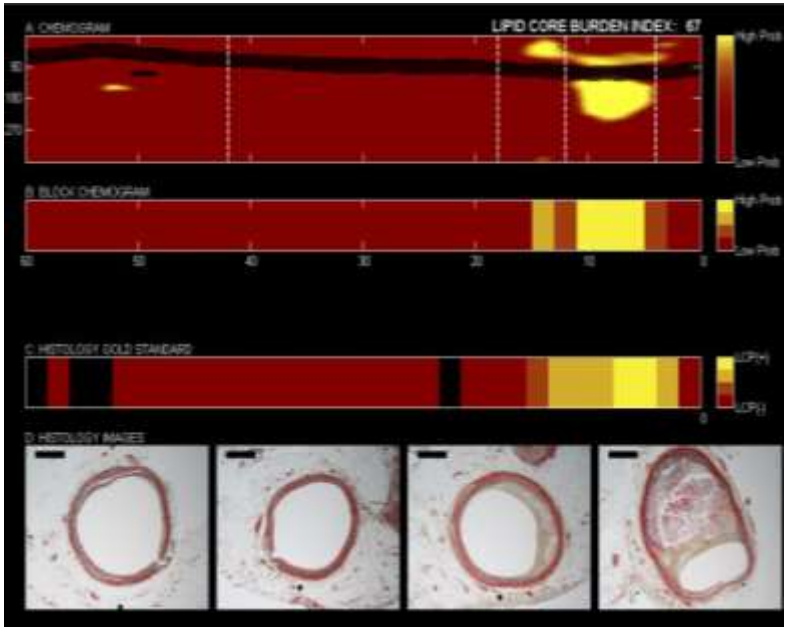


A digital colour-coded map of the artery wall indicating the location and intensity of lipid core

NIRS Can Differentiate Lesions with Large Plaque Burden

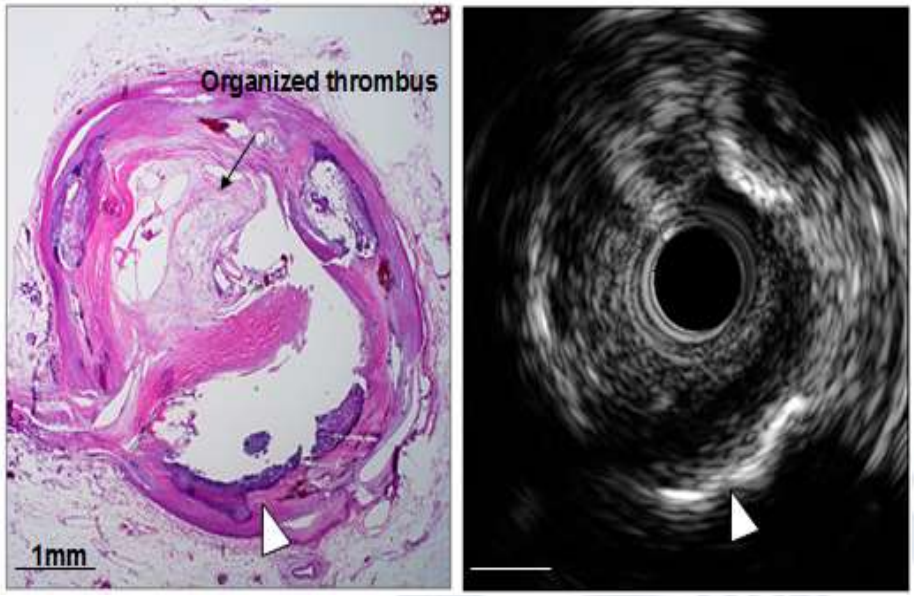


NIRS Vs. IVUS



Lipid core plaque

Limitation: No structure information



Plaque Rupture

Limitation: lipid rich plaque before rupture

上海交通大學
SHANGHAI JIAO TONG UNIVERSITY

European Heart Journal (1998) **19**, 207–229

Clinical application and image interpretation in intracoronary ultrasound

C. Di Mario, G. Görge, R. Peters, P. Kearney, F. Pinto, D. Hausmann, C. von Birgelen, A. Colombo, H. Mudra, J. Roelandt and R. Erbel on behalf of the Study Group on Intracoronary Imaging of the Working Group of Coronary Circulation and of the Subgroup on Intravascular Ultrasound of the Working Group of Echocardiography of the European Society of Cardiology

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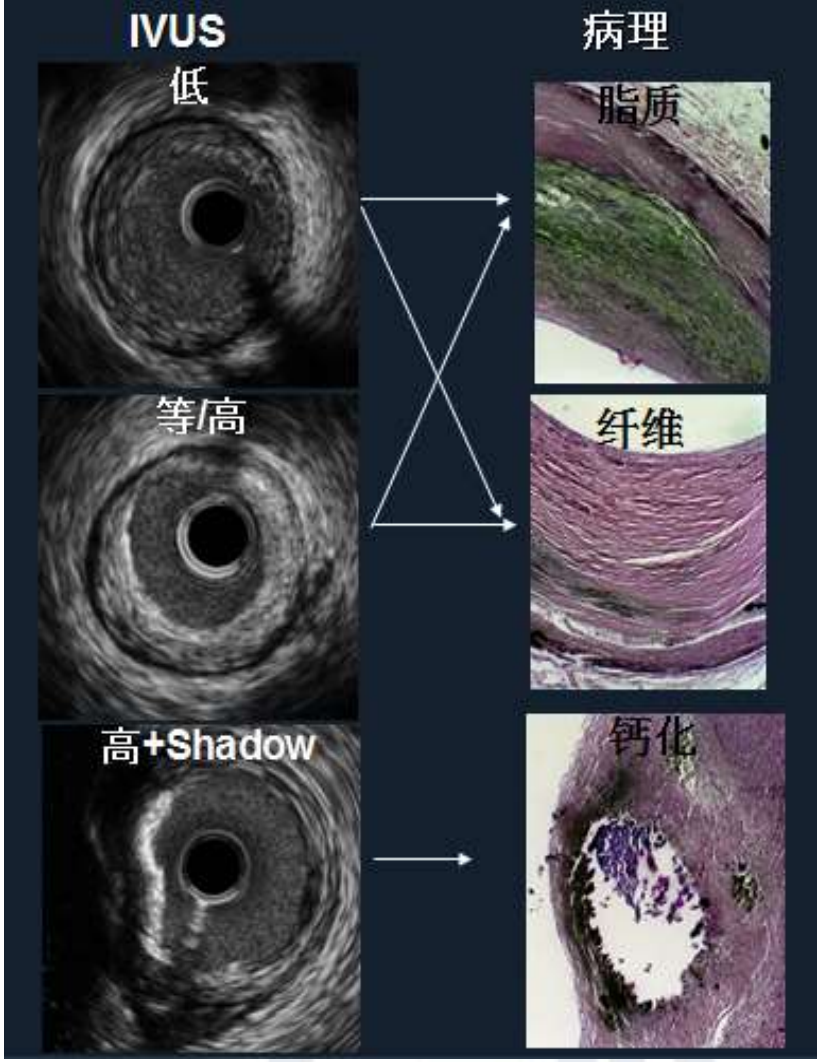
PII S0735-1097(01)01175-5

ACC CLINICAL EXPERT CONSENSUS DOCUMENT

American College of Cardiology Clinical Expert Consensus Document on Standards for Acquisition, Measurement and Reporting of Intravascular Ultrasound Studies (IVUS)

A Report of the American College of Cardiology
Task Force on Clinical Expert Consensus Documents
Developed in Collaboration with the European Society of Cardiology
Endorsed by the Society of Cardiac Angiography and Interventions



It is generally accepted :

-Grayscale IVUS is limited to the detection of NC lesions;

-There is no specific ultrasonic textural patterns associated with NC.

Histological validation study of 2294 human coronary autopsy specimens from cardiovascular death victims

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Insights Into Echo-Attenuated Plaques, Echolucent Plaques, and Plaques With Spotty Calcification

Novel Findings From Comparisons Among Intravascular Ultrasound, Near-Infrared Spectroscopy, and Pathological Histology in 2,294 Human Coronary Artery Segments

Can Grayscale IVUS Detect Necrotic Core–Rich Plaque?

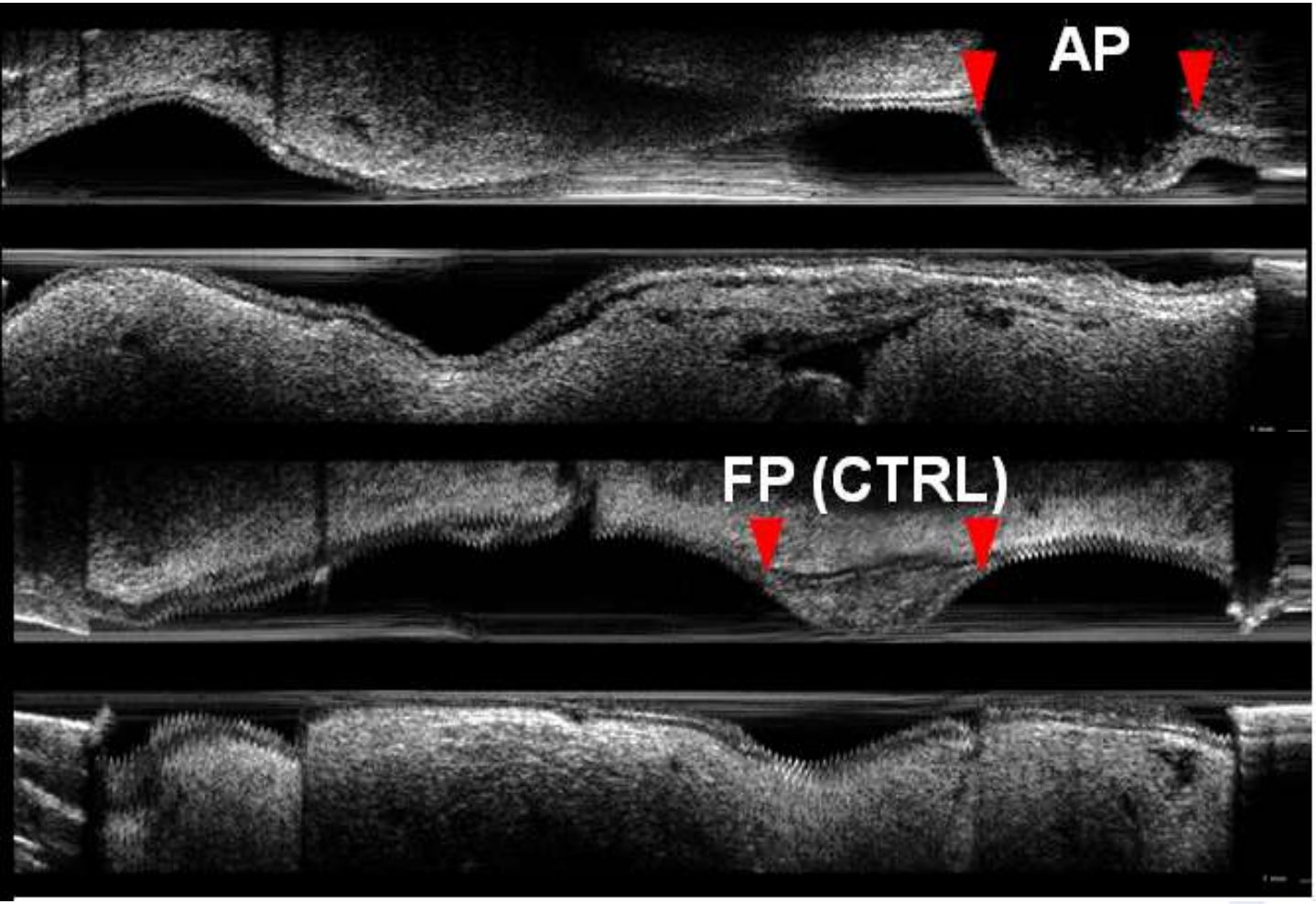
I read with great interest the paper by Pu et al. (1) in the *Journal* and congratulate the investigators on an excellent study, which contributes greatly to our current knowledge of intravascular ultrasound (IVUS). It is generally accepted that grayscale IVUS is limited to the detection of lipid-rich necrotic core lesions, and there is no specific grayscale ultrasonic signature associated with necrotic core. However, Pu et al.'s (1) IVUS histological validation study of 2,294 classification scheme by IVUS grayscale image characteristics should be updated on the basis of the novel findings by Pu et al. (1) on echo-attenuated plaque.

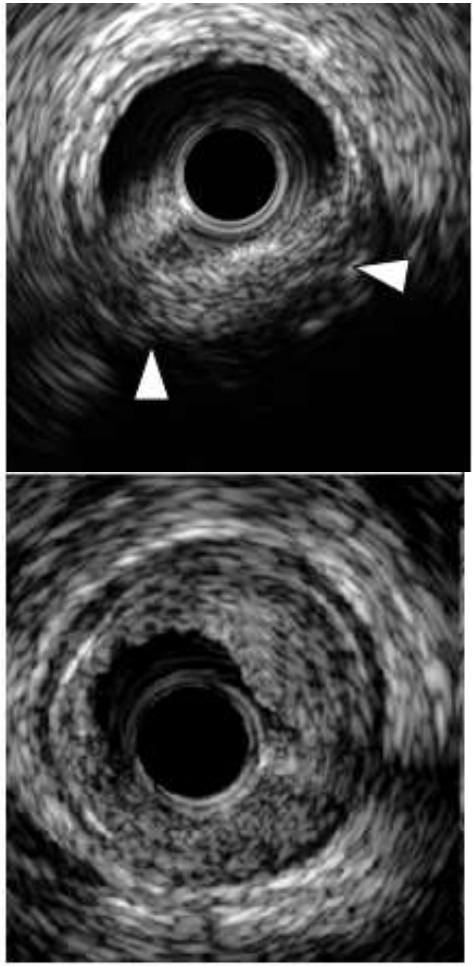
*Erling Falk, MD
*University of Copenhagen
Niels Andersensvej 65
DK-2900 Hellerup
Copenhagen
Denmark
E-mail: erlingfalk478@gmail.com

http://dx.doi.org/10.1016/j.jacc.2014.08.044

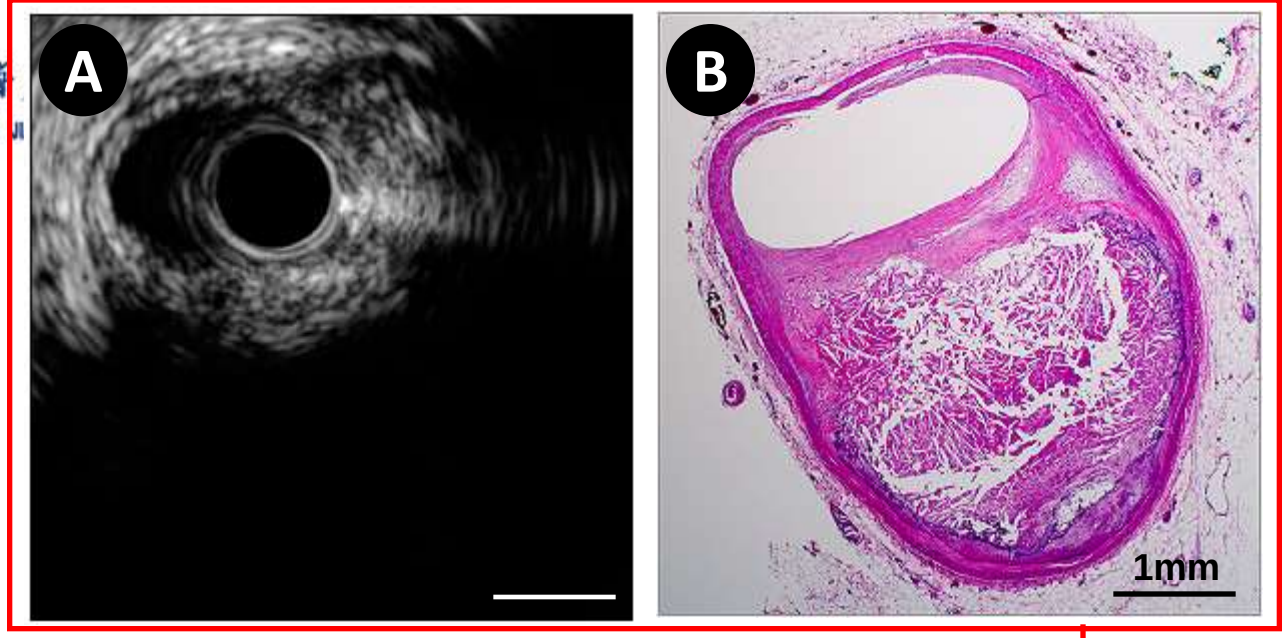
REFERENCES

Echo-attenuated plaque a unique IVUS signature

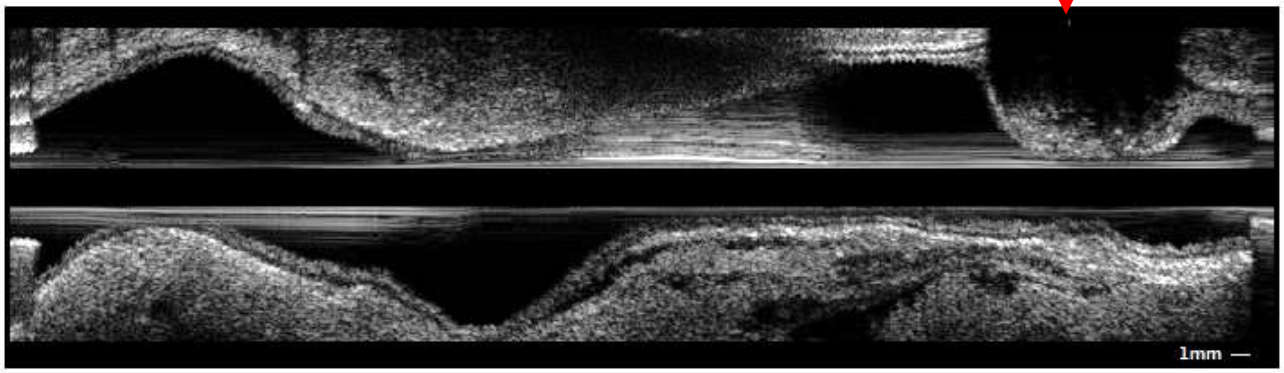




Echo-attenuated signature - defined as the absence of ultrasound signal behind plaque that was either hypoechoic or isoechoic to reference adventitia, but without bright calcium


A
B
1mm

C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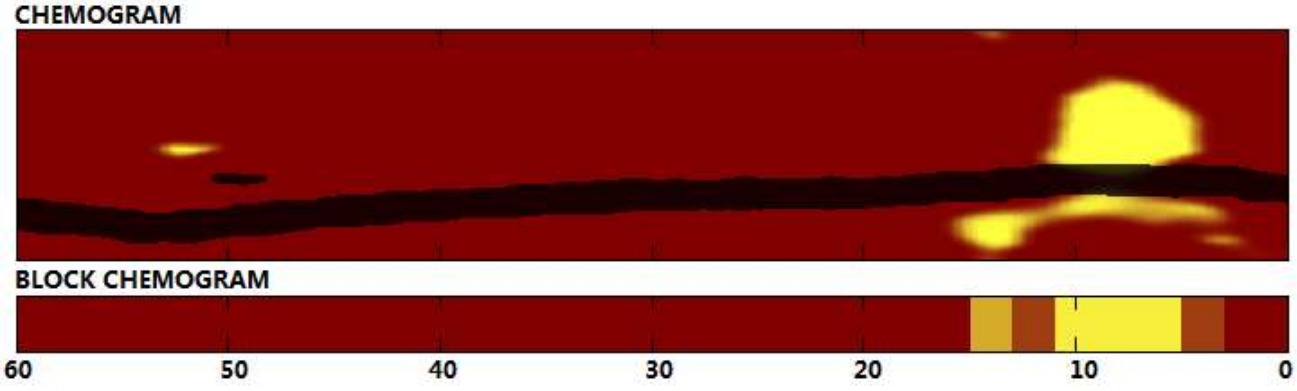
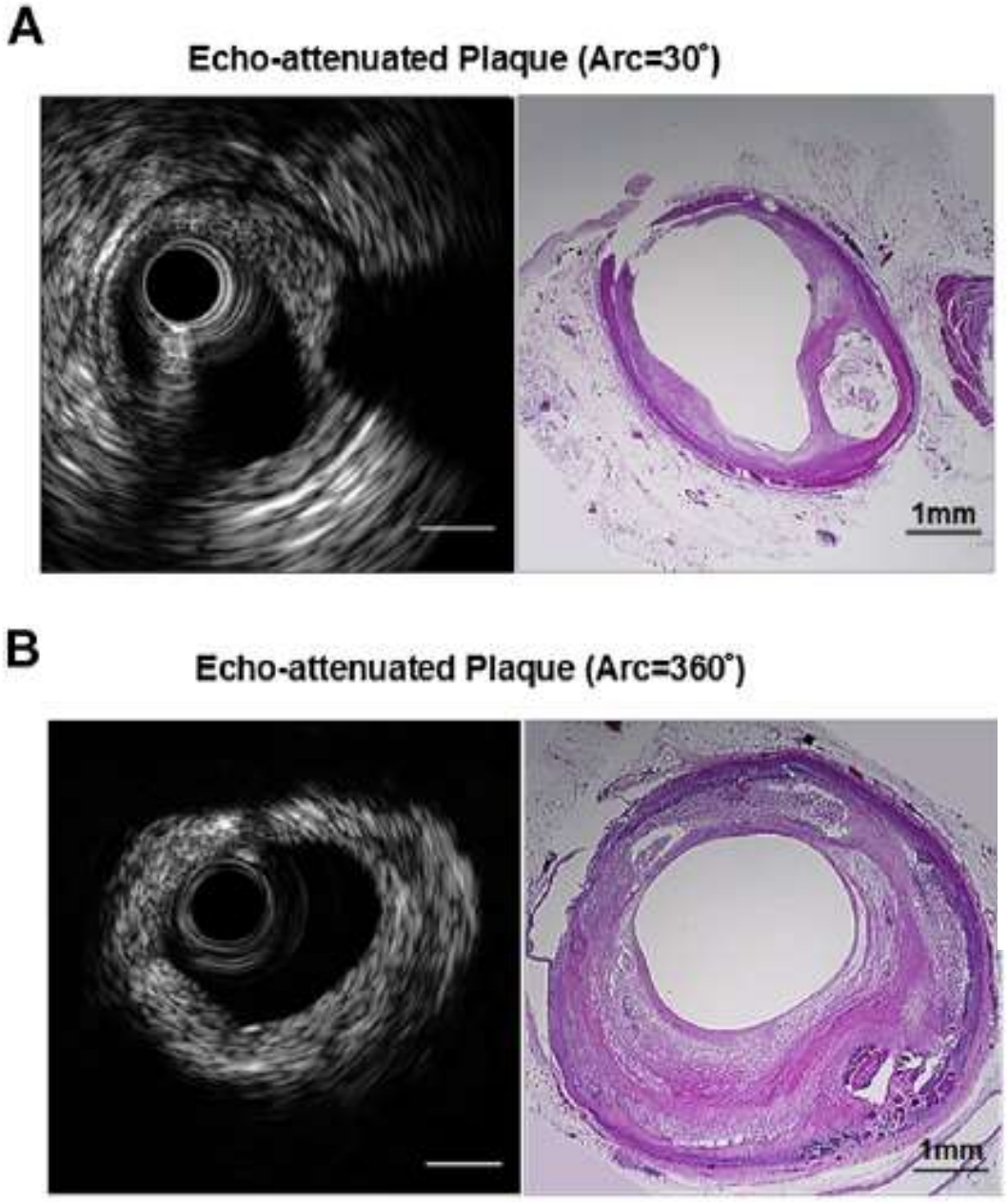
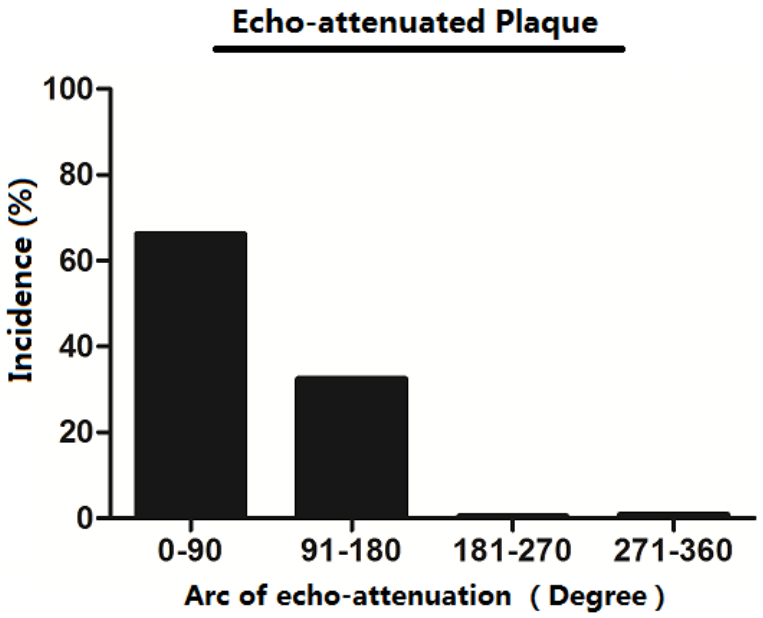
D

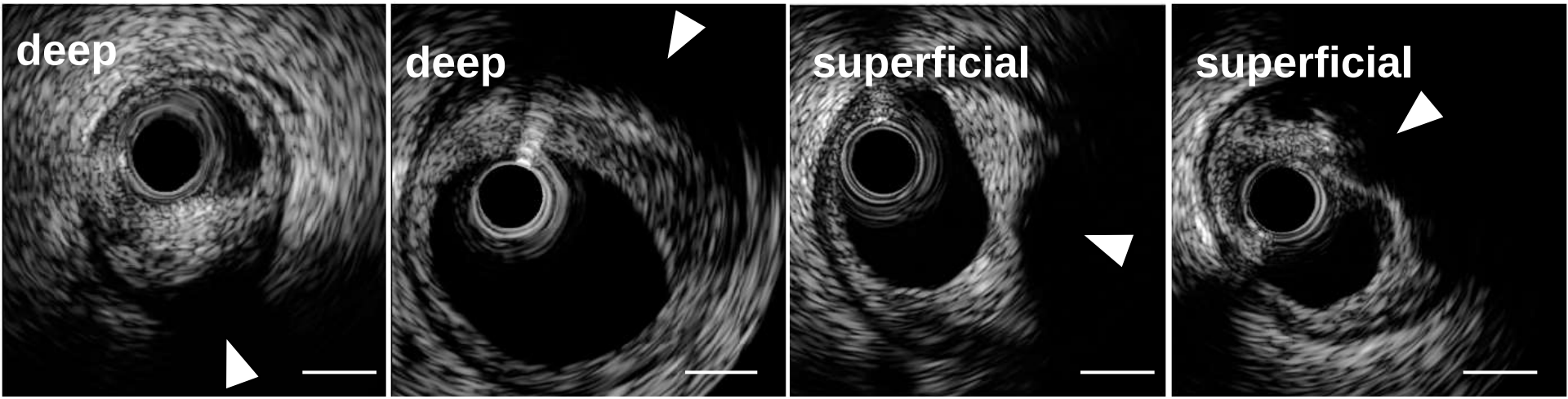

CHEMOGRAM
BLOCK CHEMOGRAM
60
50
40
30
20
10
0
Pullback [mm]

Arc of Echo-attenuated plaque

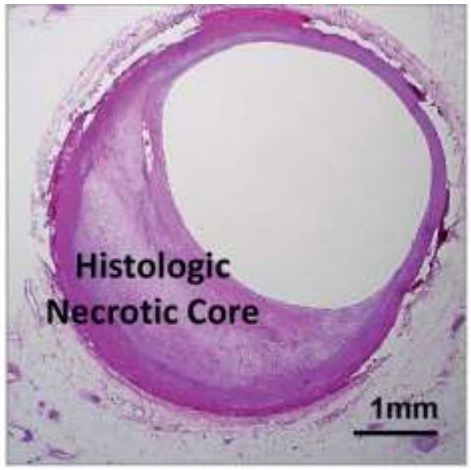


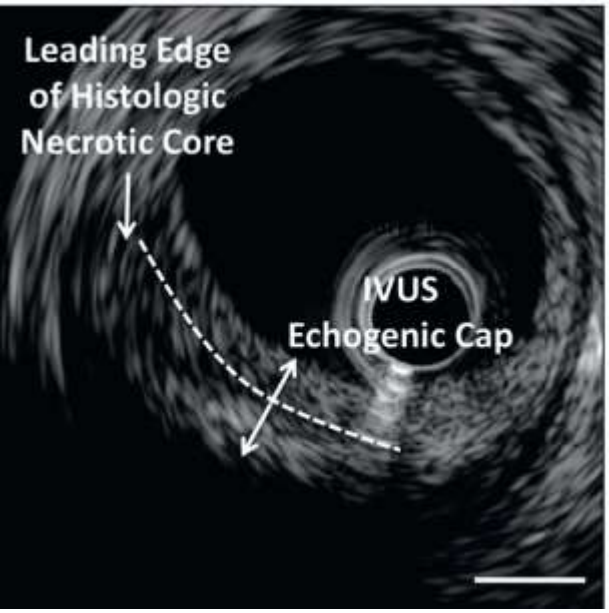


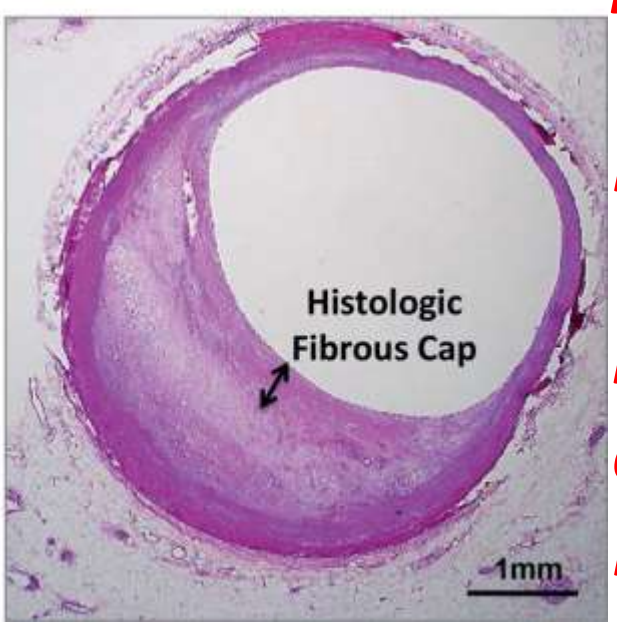
Echo-attenuation with superficial location is a reliable IVUS signature for high-risk plaque containing a large necrotic core



The Location of Histologic NC in Echo-Attenuated Plaque





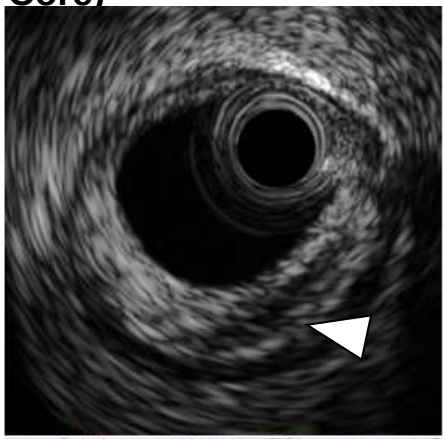


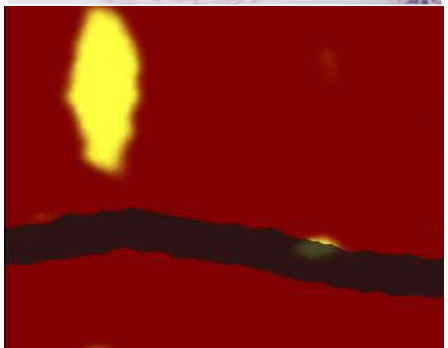
IVUS:
Thickness of "echogenic cap" of echo-attenuated plaque

Pathology:
Thickness of the histologic fibrous cap covering the NC

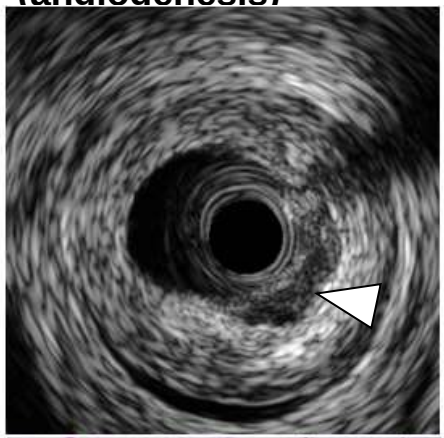
Echo-lucent plaques

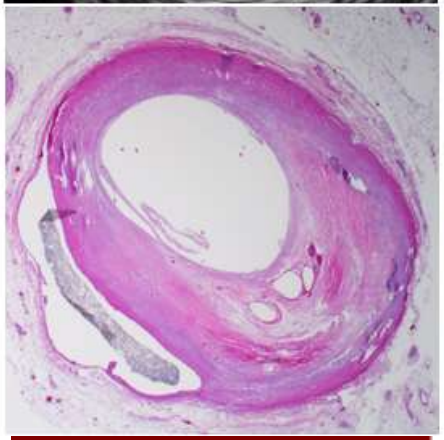
IVUS:EP (superficial)
Path: Late FA (Necrotic Core)





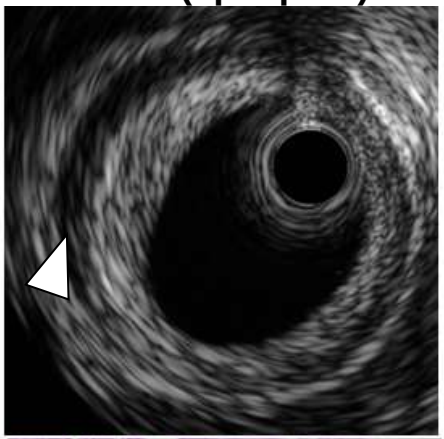
IVUS:EP (superficial)
Path: Bland fibrous (angiogenesis)

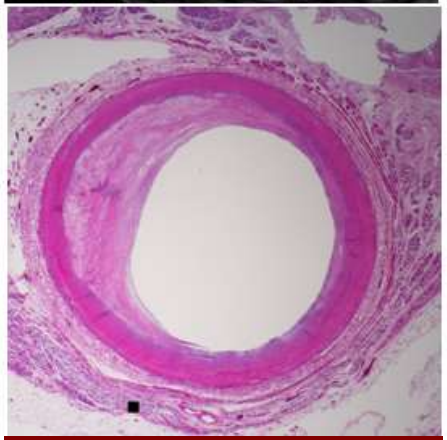




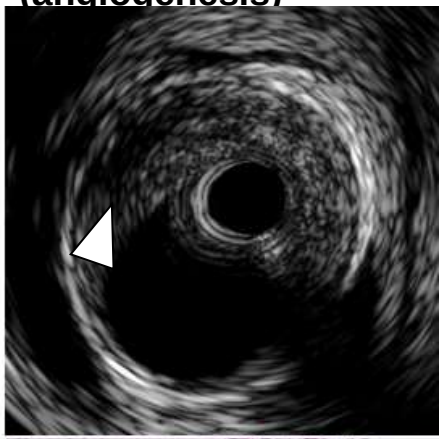
IVUS:EP (deep)

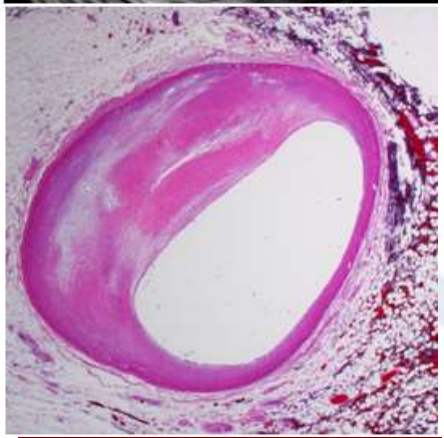
Path: PIT (lipid pool)



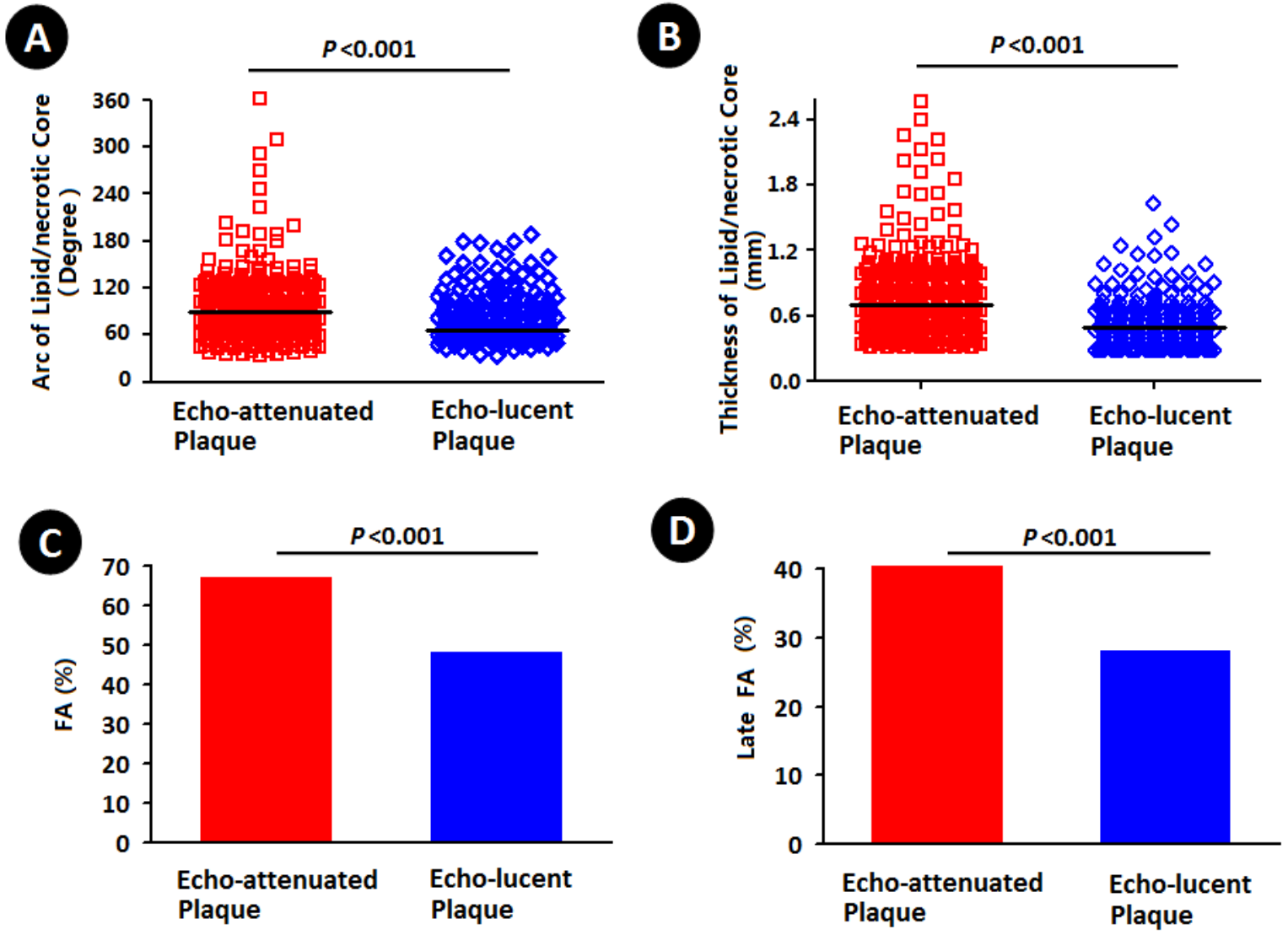


IVUS:EP (deep)
Path: Bland fibrous (angiogenesis)

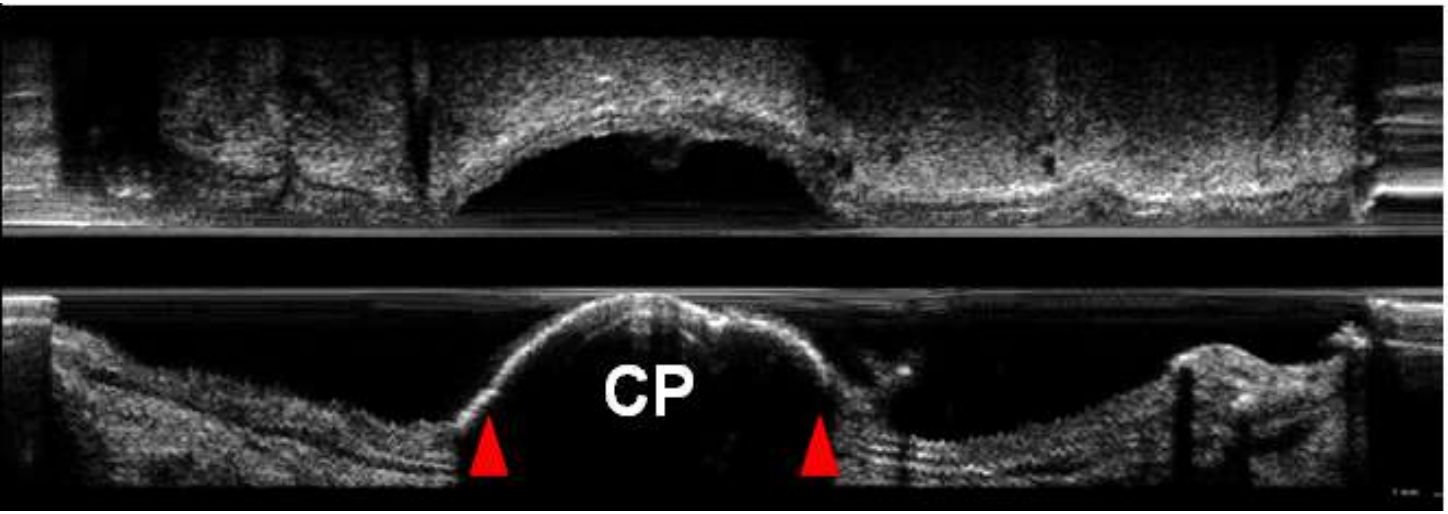


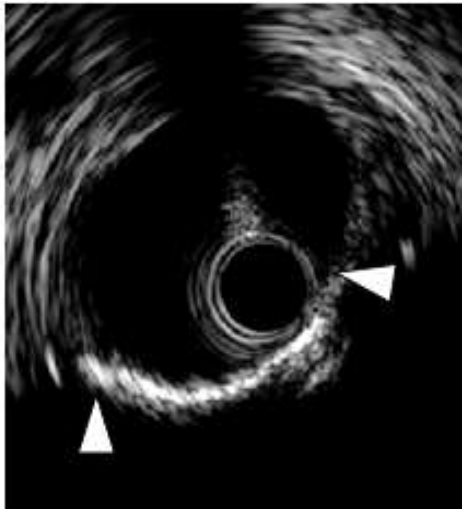


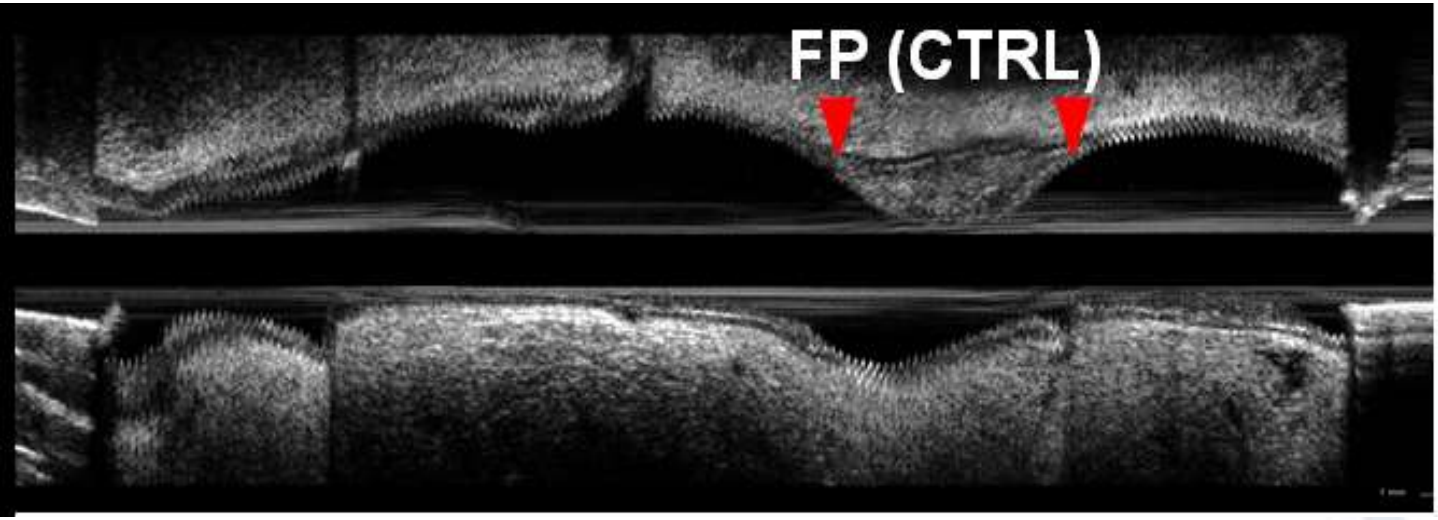
Compared with echo-attenuated plaques, echolucent plaques associated with smaller NIRS- LCP

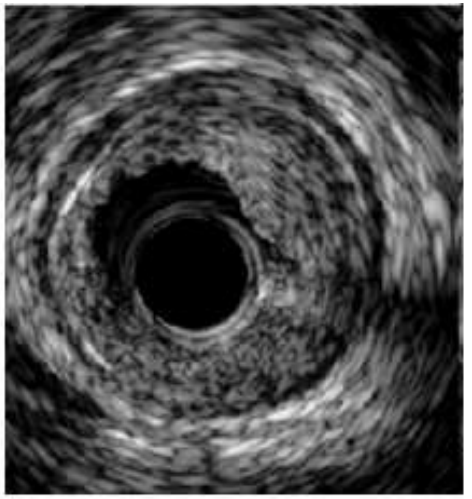


What is behind the Calcium?
Limitation of the IVUS: can not penetrate into Calcium



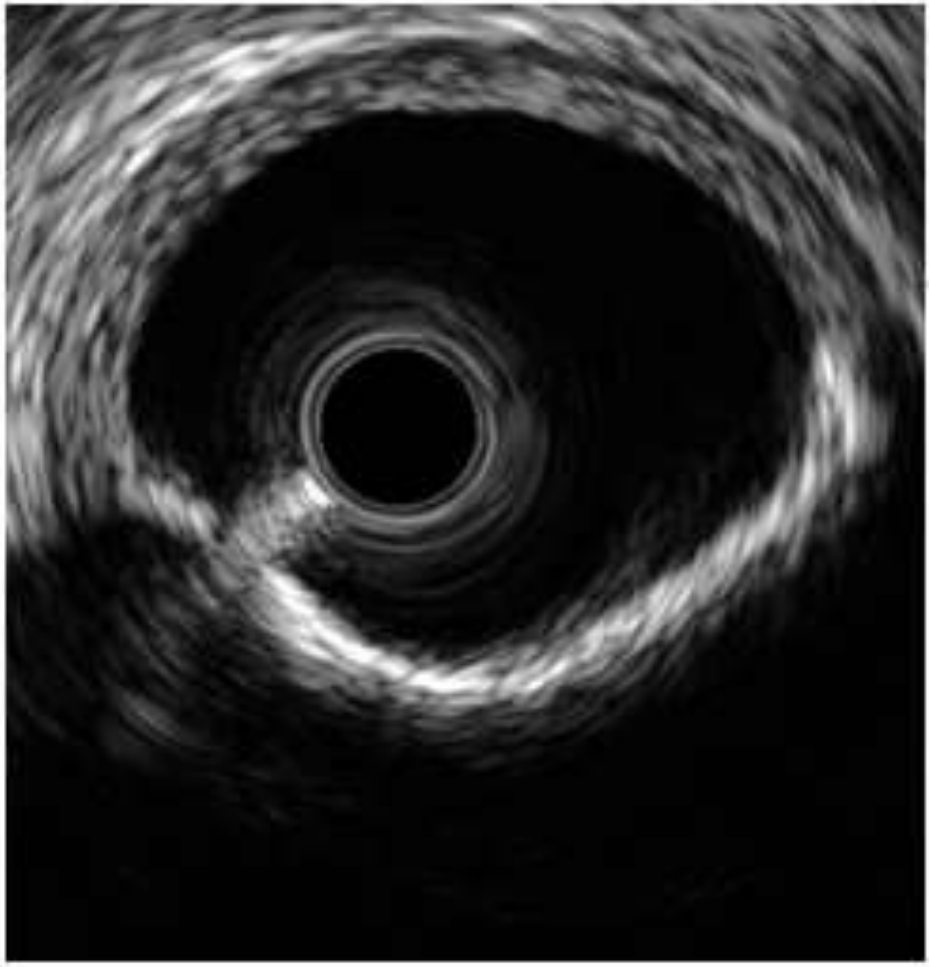


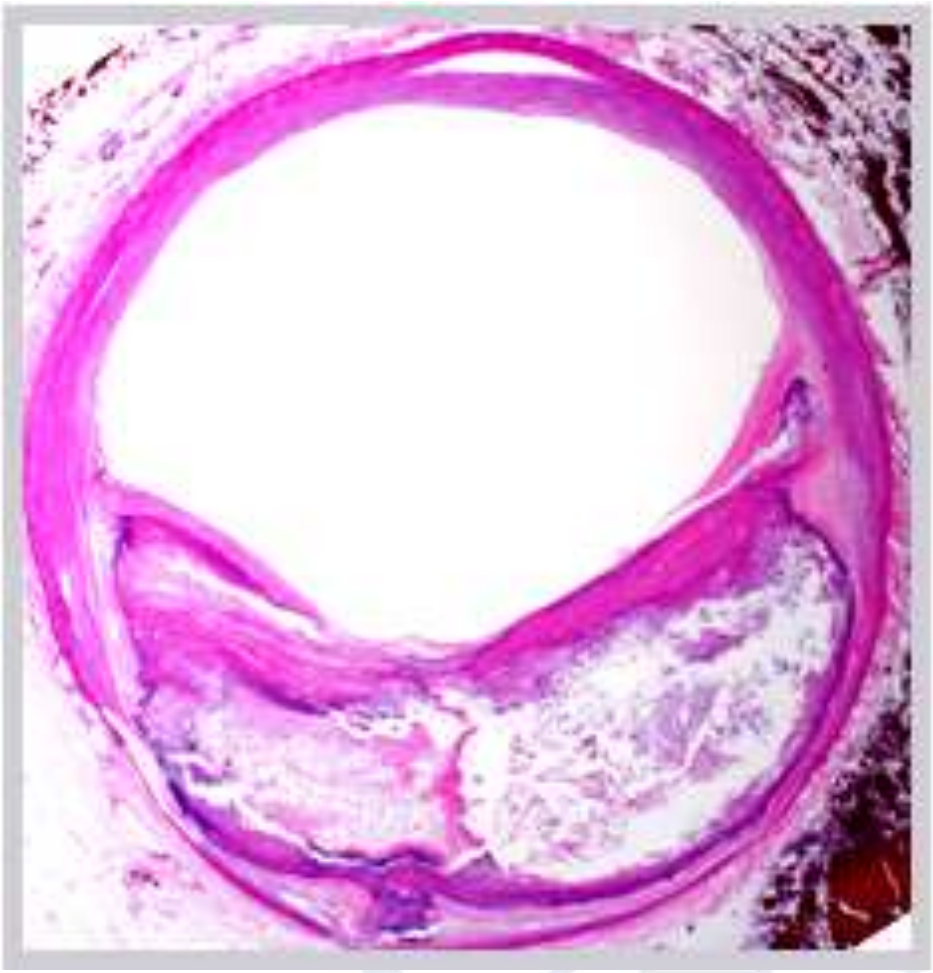




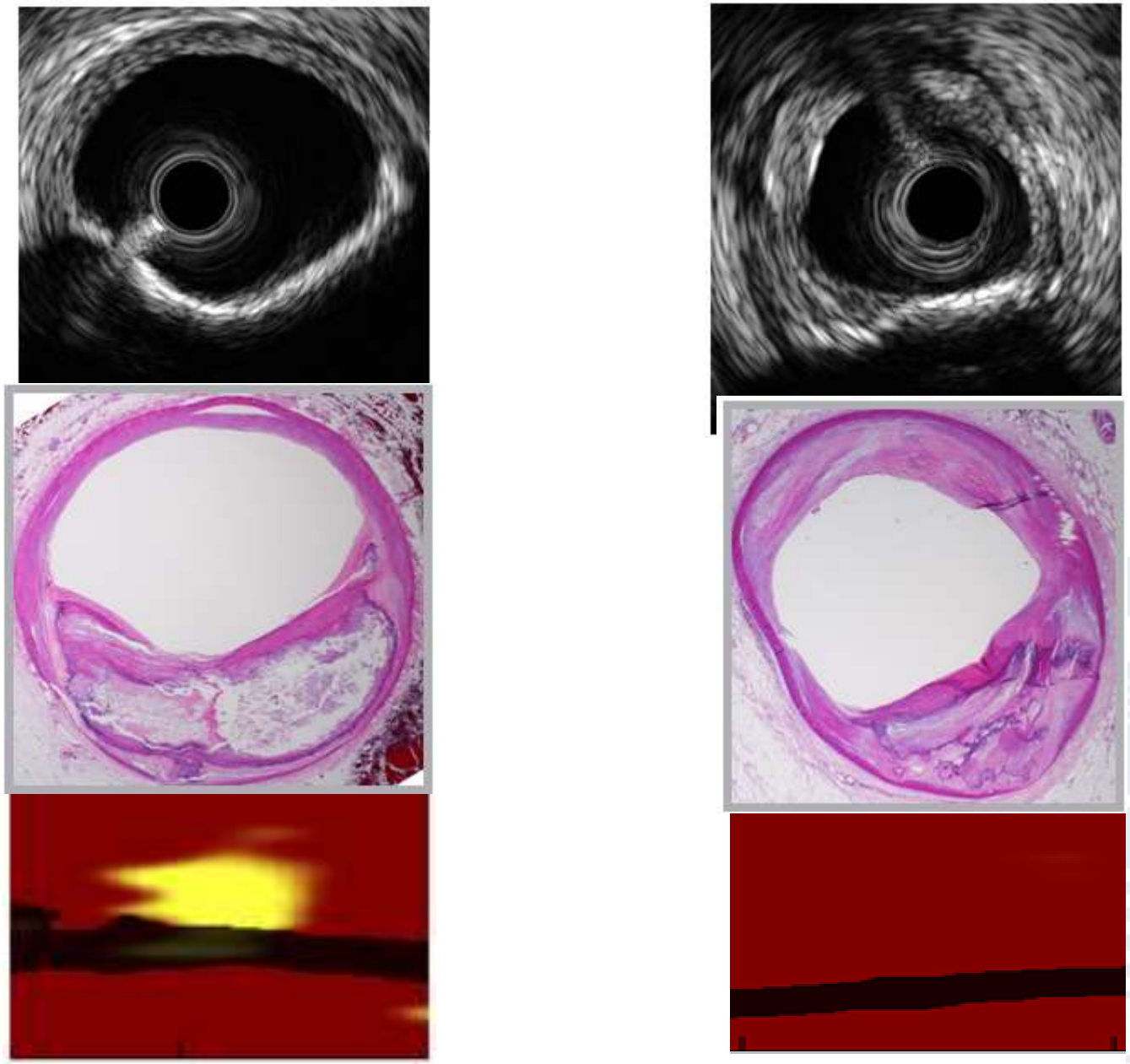
Behind Calcium, could be a very big NC

Rotation for Calcified stenosis : No reflow

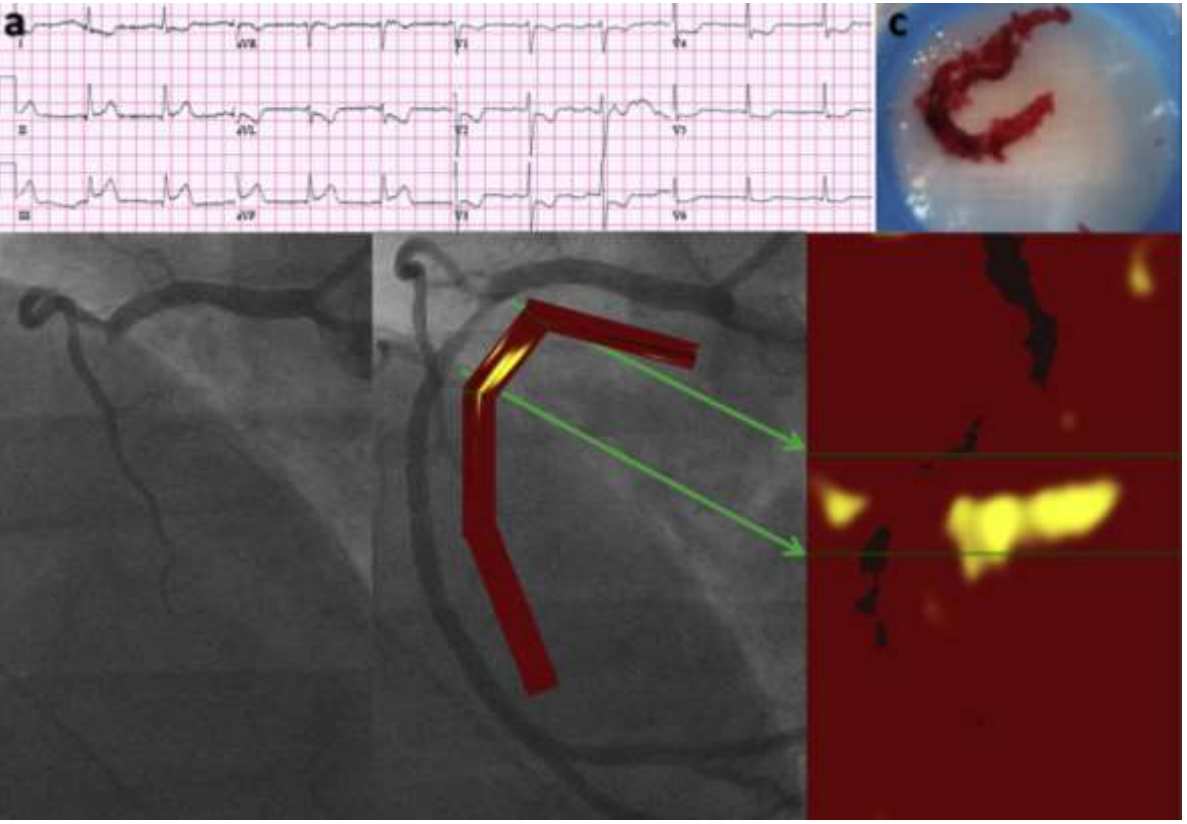


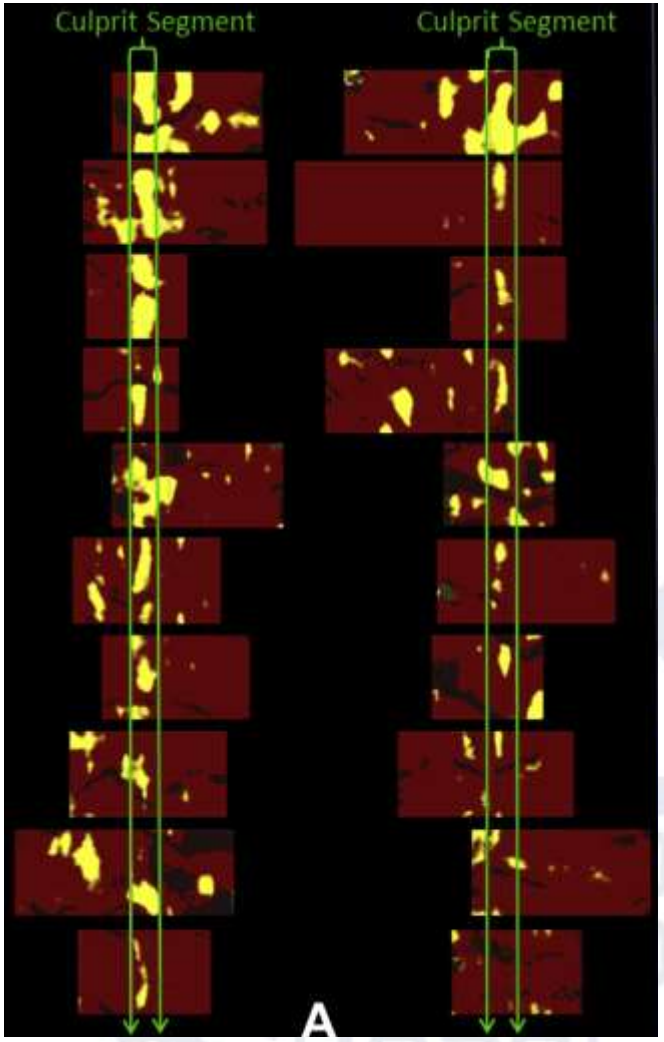


NIRS could “see”calcified plaque with/without NC



Culprit Lesions in STEMI: Insights from Near-infrared Spectroscopy



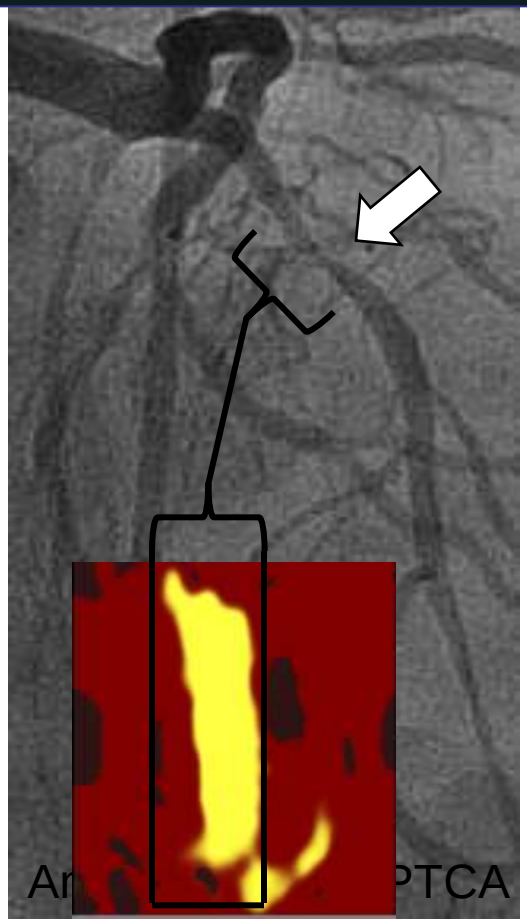


J Am Coll Cardiol Intv. 2013;6(8):838-846

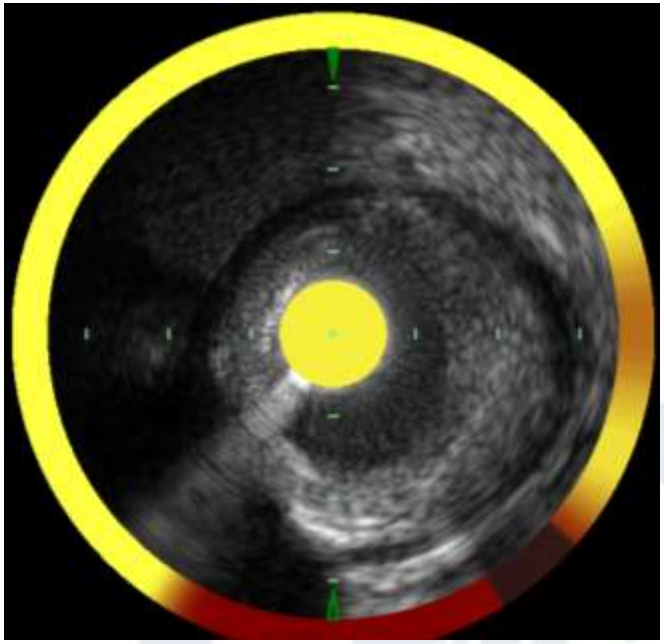
Why might a large lipid burden be important?

35 year old male with sudden cardiac arrest while mowing his lawn.

Initial angiogram



Ar PTCA



maxLCBI$_{4mm}$ = 813

Plaque burden = 67%

Baseline

Male，71 year old

Risk factors

DM

HBP

Symptoms

Repeated chest pain 3d

Diagnostic examination

ECG：V1-5 ST suppression

TNI:（+）

GU ZHEN DI
71岁 7月,M,P0004540
切片:1
检查#: 20110614002?
Patient Pos: HFS
Study Desc: CARD 3040
Series Desc: Coro 3040
< 3 - 1 @ >
Shanghai East Renji Hospital
Siemens AXIOM-Artis
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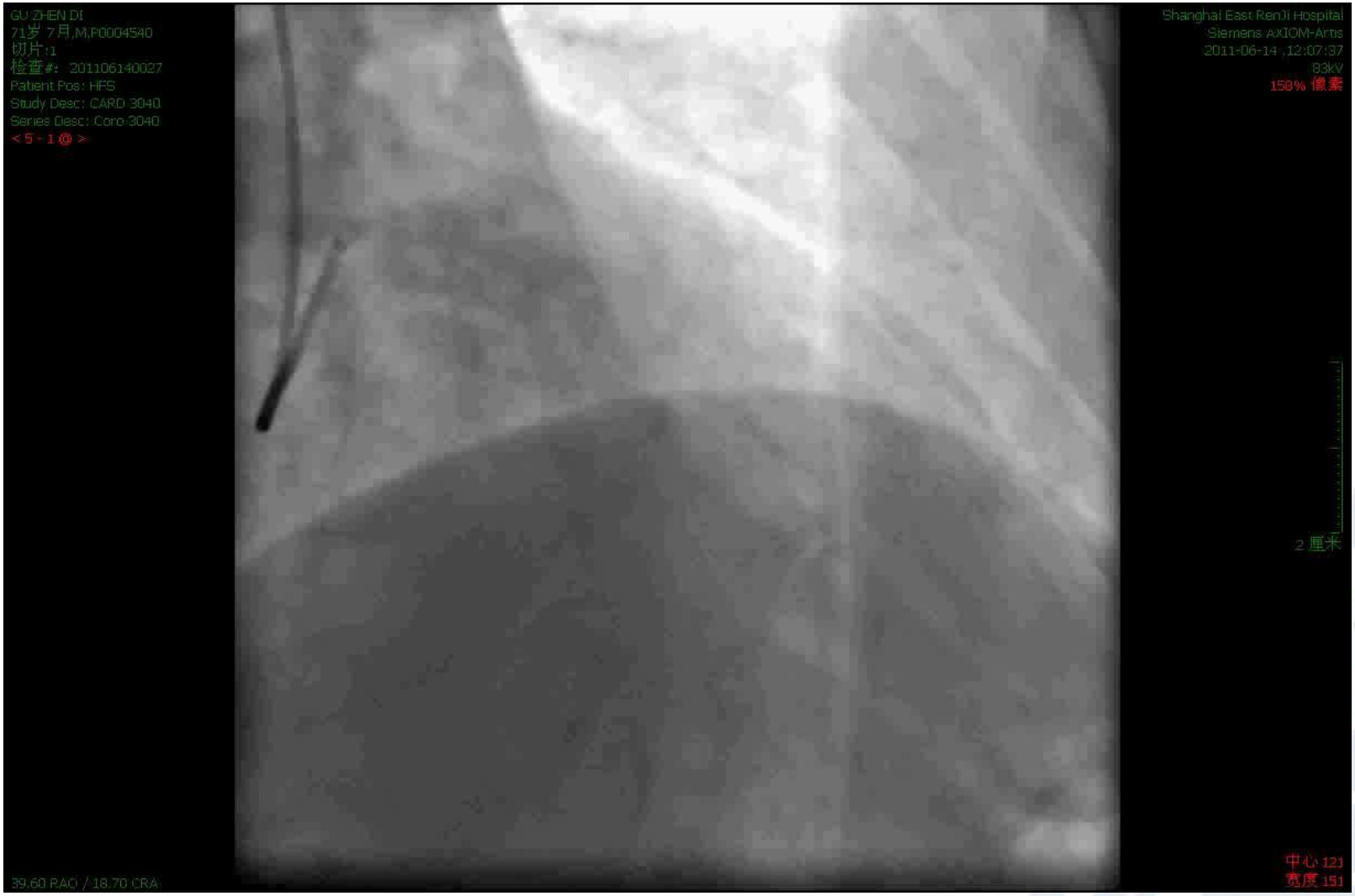
2 厘米
51.30 LAO / 23.40 CAU
中心 121
宽度 131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Study Desc: CARD 3040
Series Desc: Coro 3040
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Shanghai East Renji Hospital
Siemens AXIOM-Artis
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2 厘米
39.60 RAO / 18.70 CRA
中心 121
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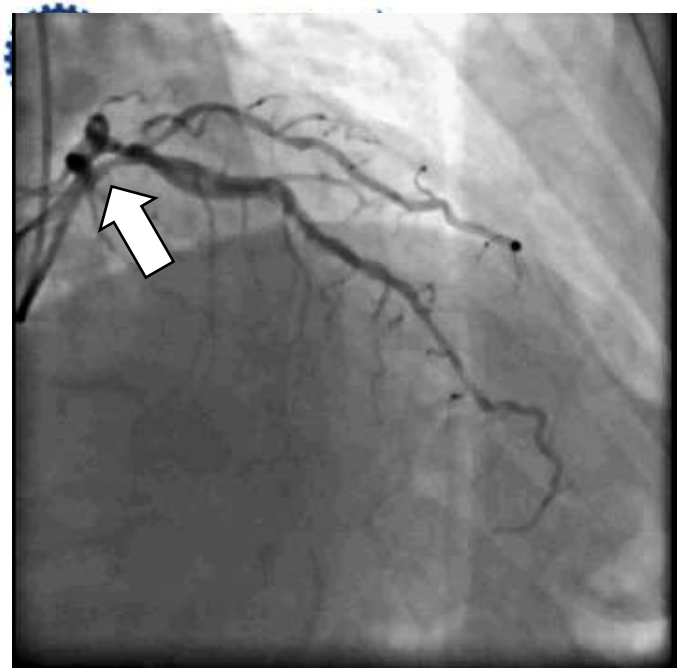
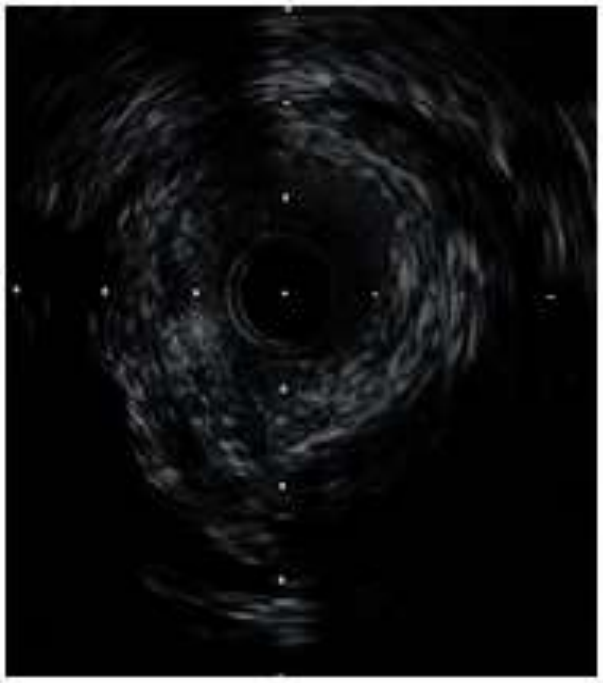
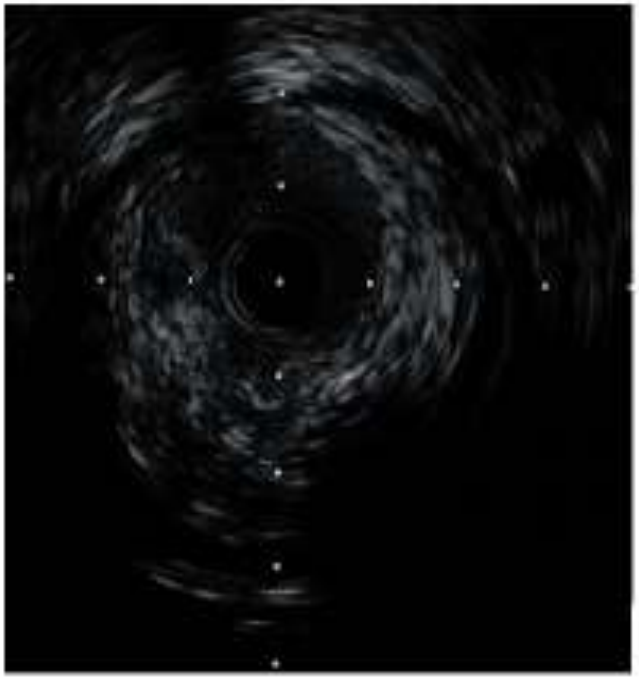
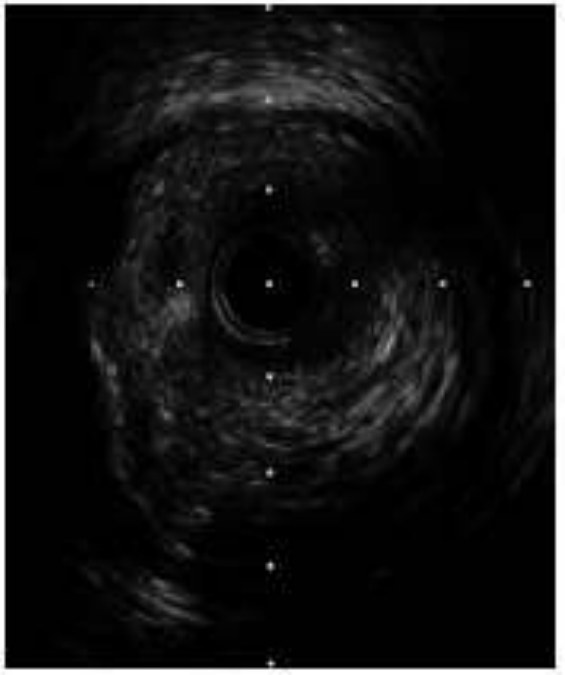
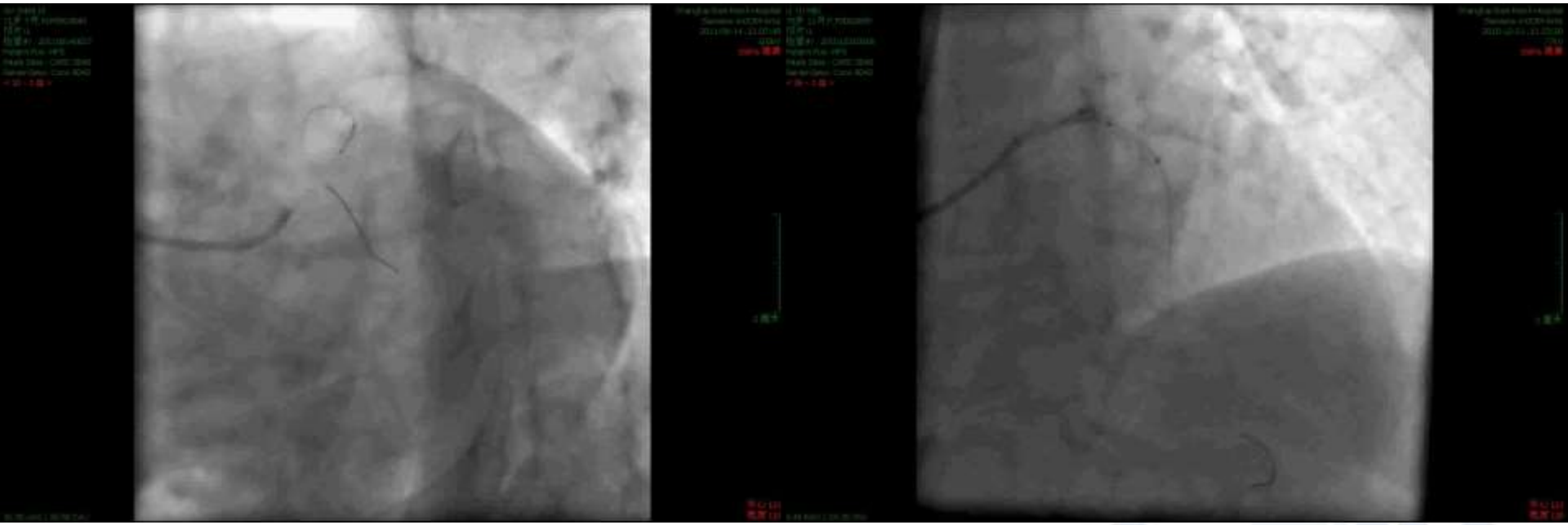


Echo-attenuated plaque !



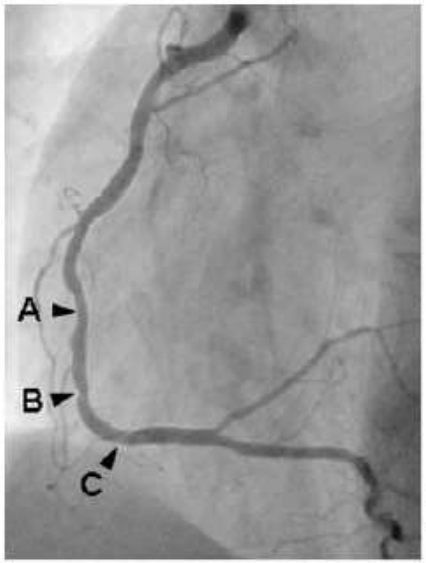


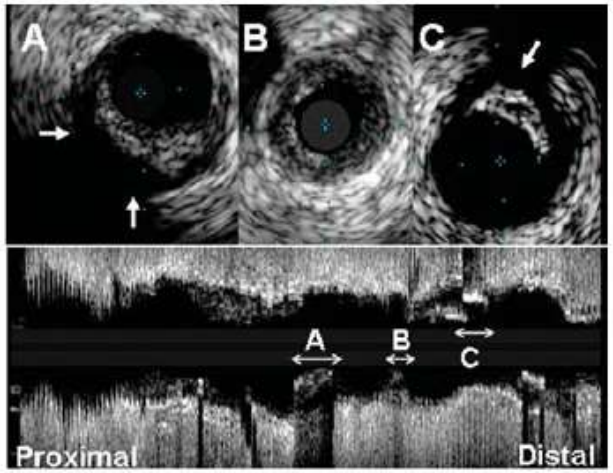


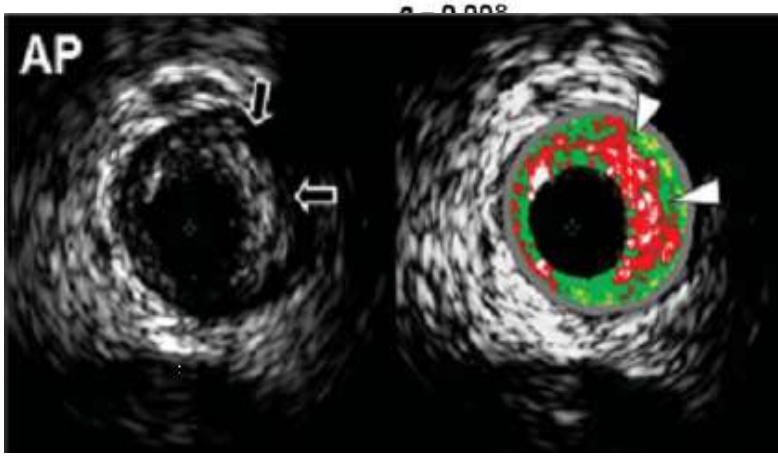


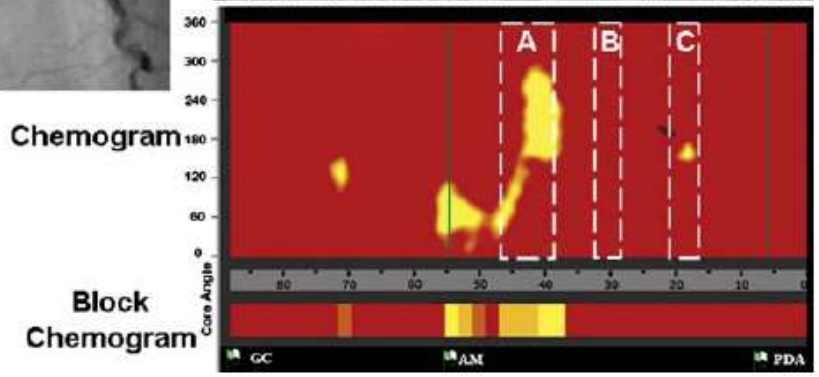
Attenuated plaques

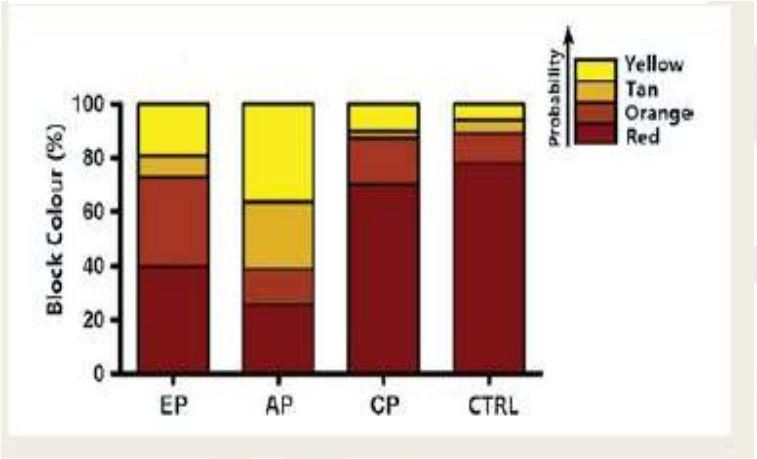
Grayscale-IVUS-detected attenuated plaques indicated the presence of NIRS-detected LCP





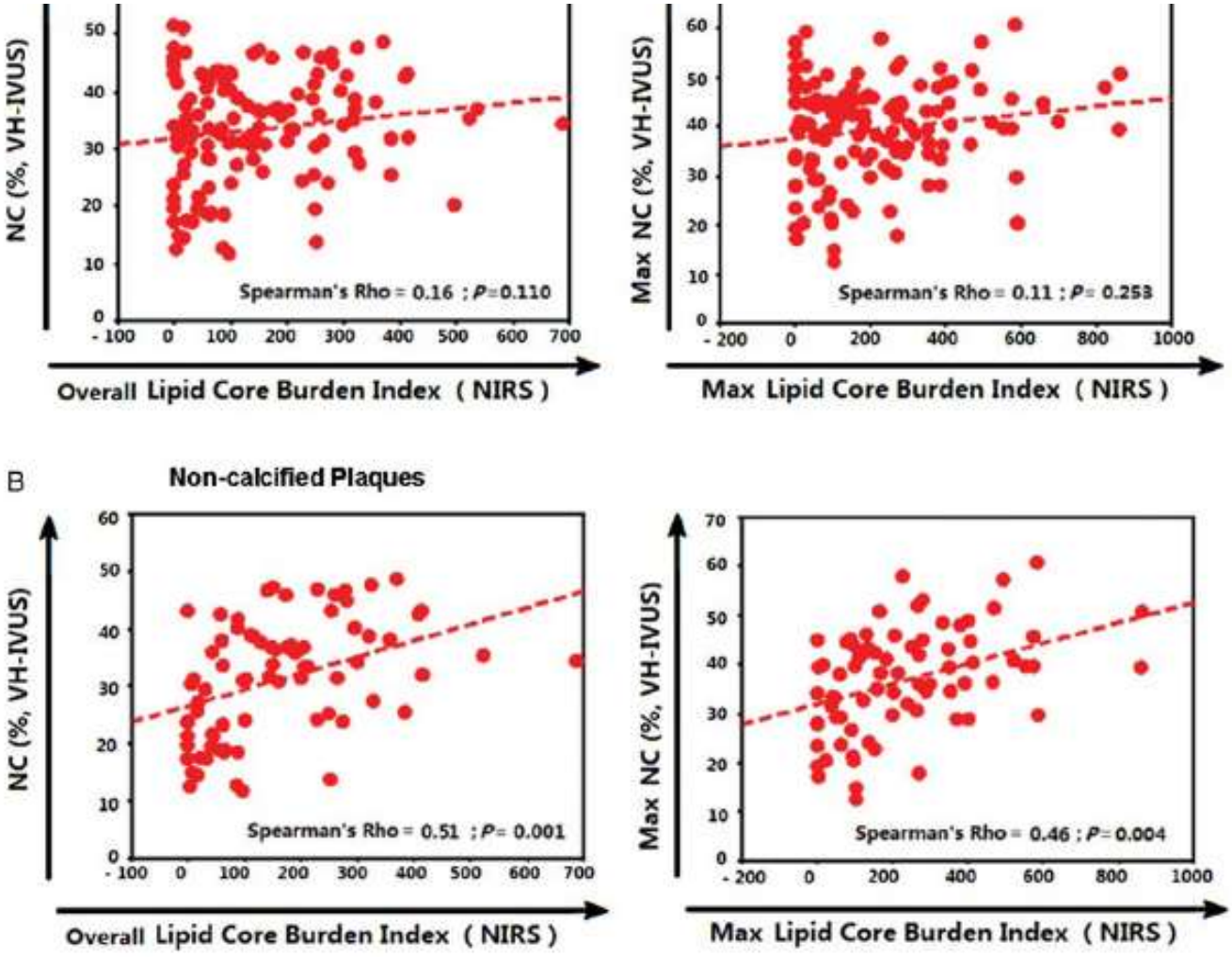




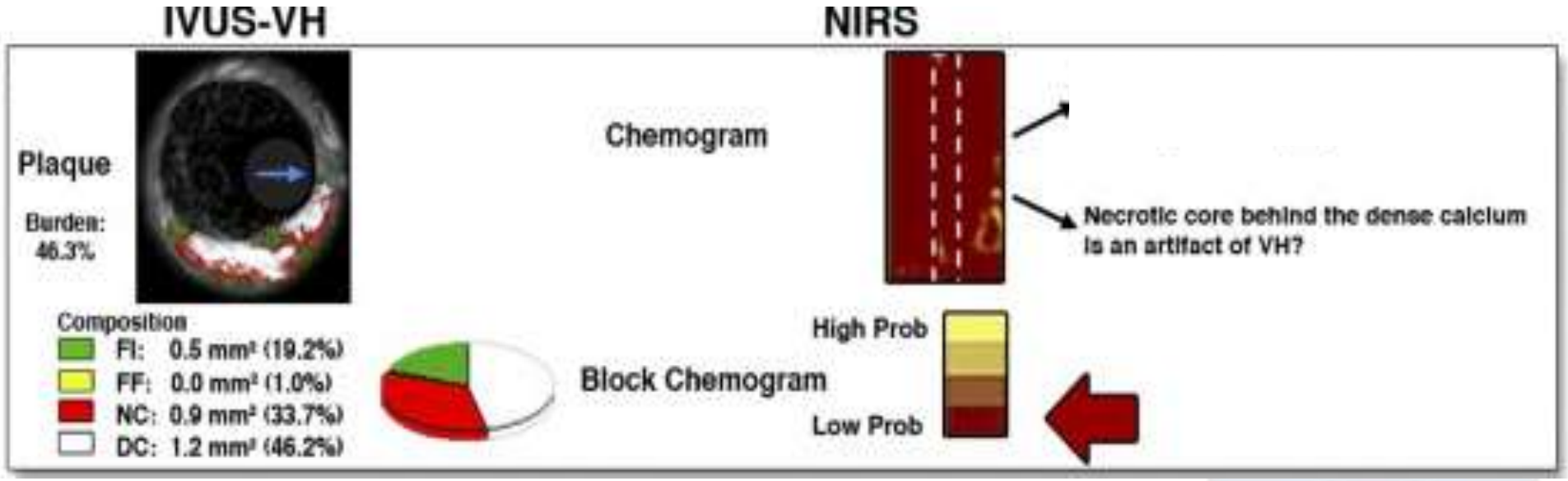


For Calcified Plaques, an interesting finding -

A positive relationship between VH-detected NC and NIRS-detected LCP in non-calcified plaques but not in calcified plaques - Why?



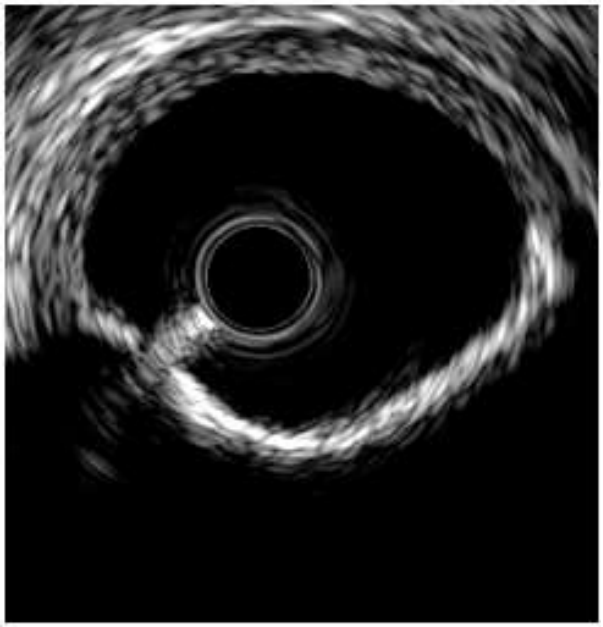
VH-IVUS overestimation of NC content in the presence of calcification

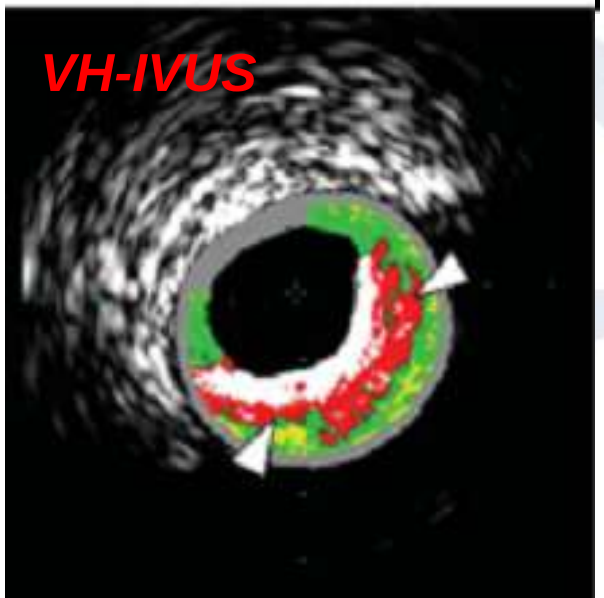


NIRS could "see"calcified plaque with/without NC

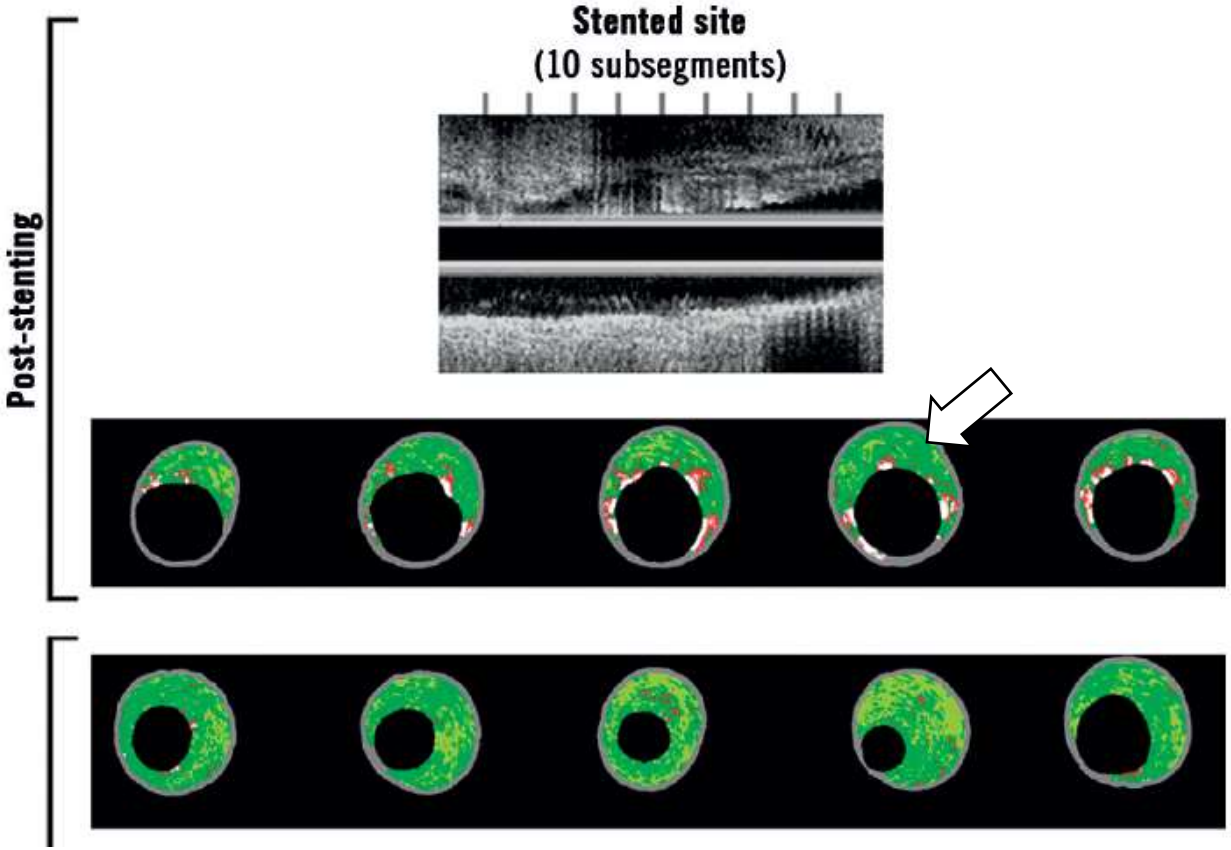
VH-IVUS could not "see" calcified plaque with/without NC

VH-IVUS always put red "necrotic core" behind the calcium





Caution should be taken in the VH-IVUS assessment of NC in vessels with heavy calcification



Artificial addition of calcium-like elements to the atherosclerotic plaque led to an increase in necrotic tissue in virtual histology that is probably artefactual

Take Tome Massage

- Echo-attenuated signature, in particular that with superficial location, indicated a high-risk plaque containing a large NC.
- VH-IVUS overestimation of NC content in vessels with heavy calcification. Caution should be taken.
- NIRS can differentiate calcified plaques with/without NC, and differentiate “True” or “false” AP/EP, thus might improve the tissue characterization of coronary plaques.