Why and How to Apply Imaging Device for Calcified Lesion in PCI

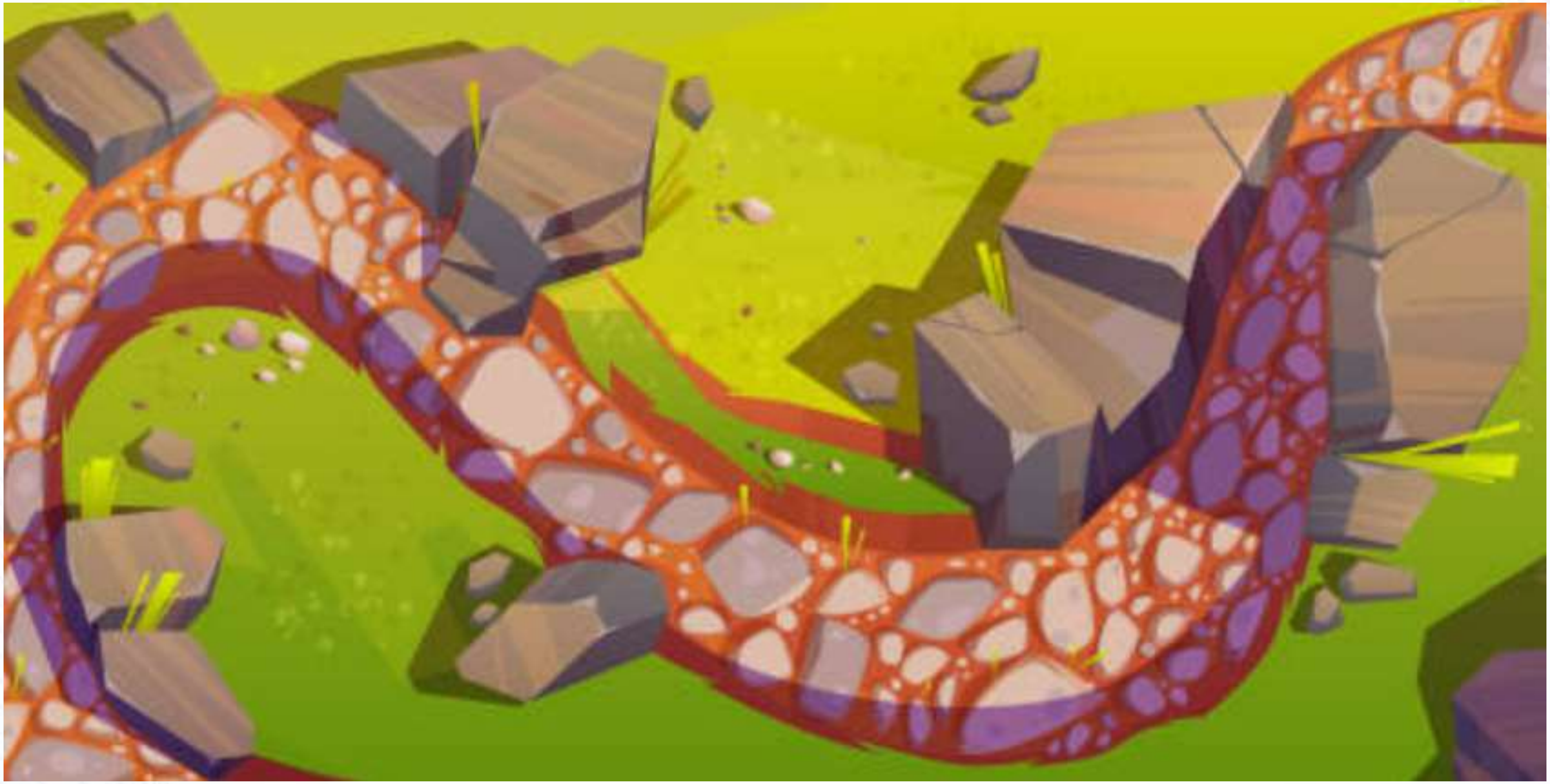
Sunao Nakamura MD PhD

FACC, FESC, FAHA, FSCAI

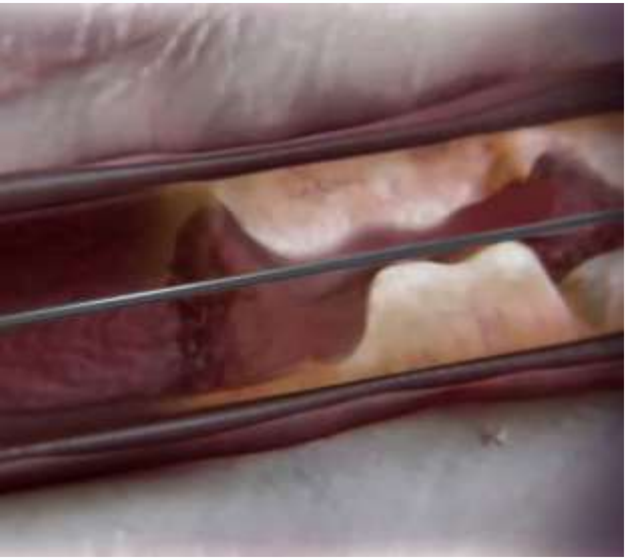
Shotaro Nakamura MD, Naoyuki Kurita MD, Satoko Tahara MD, Masaaki Okutsu MD,
Tomohiko Sato MD, Toru Naganuma MD, Satoru Mitomo M.D.
Hiroyoshi Kawamoto MD, Kentaro Tanaka MD, Satoshi Matsuoka MD,
Hiroaki Nakajima MD, Hirokazu Onishi MD, Yusuke Watanabe MD,
Koji Hozawa M.D., Toru Ohuti M.D., Hiroto Yabushita MD,

The New Tokyo Hospital ; Japan Tokyo

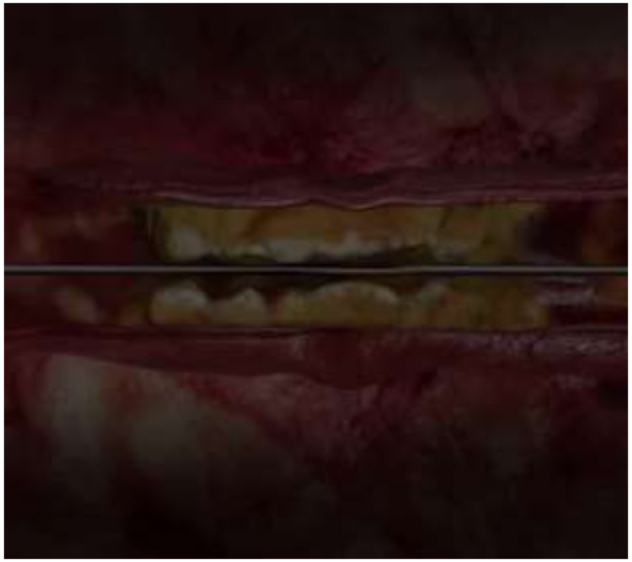
Rocks on the Road



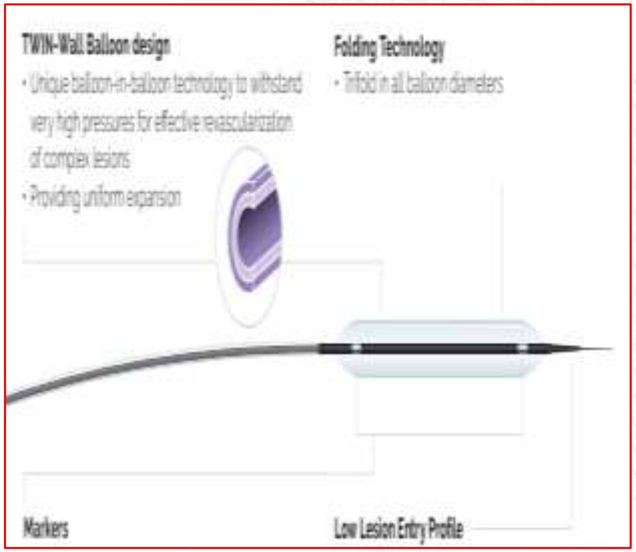
Diamond Back



ROTA



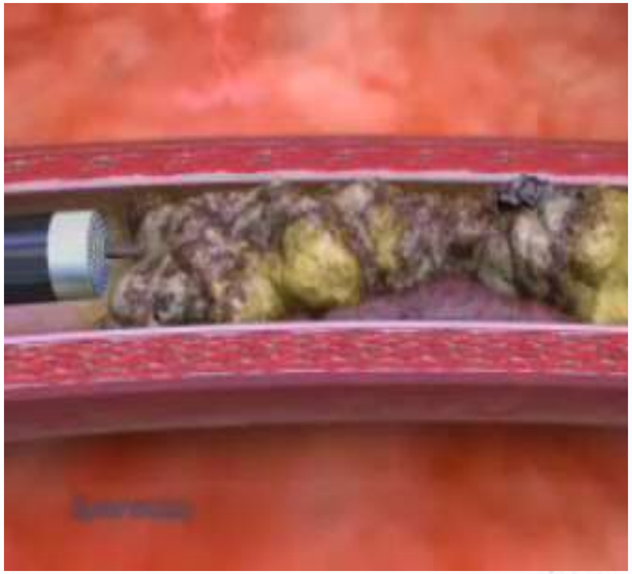
OPN-HP-balloon



Shock Wave

Cutting Balloon

LASER



Choice of Appropriate Devices is a KEY

See a Long Way Ahead

Why imaging device is IMPORTANT ?

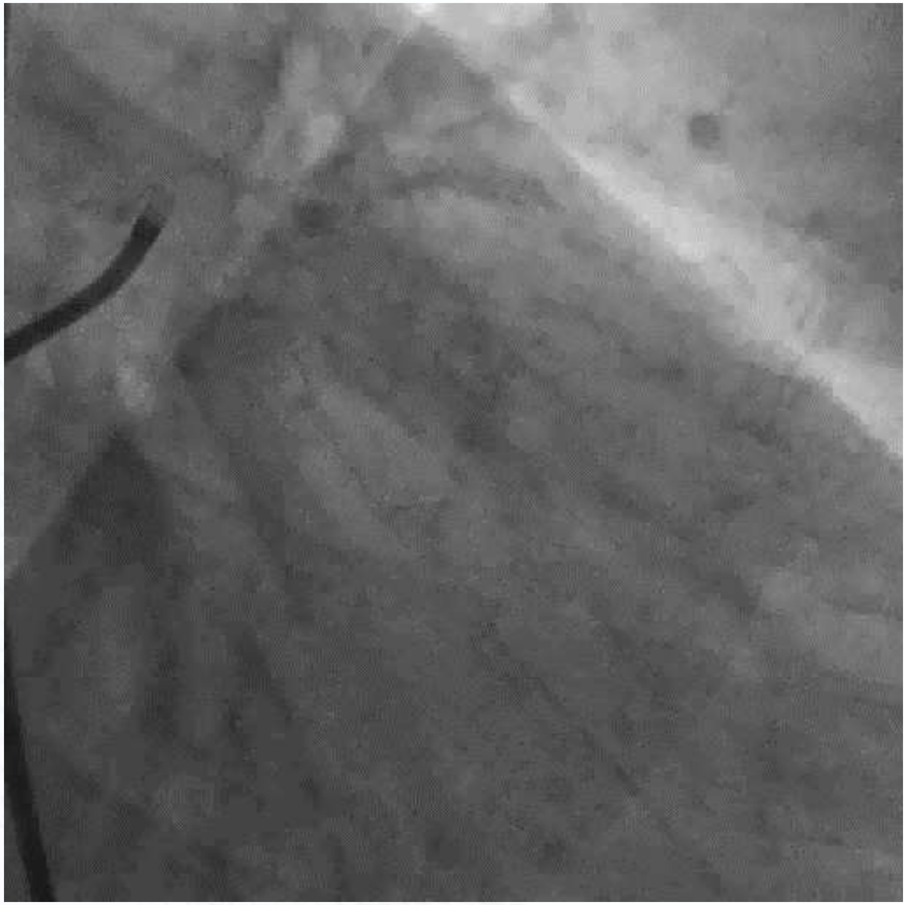
Because…

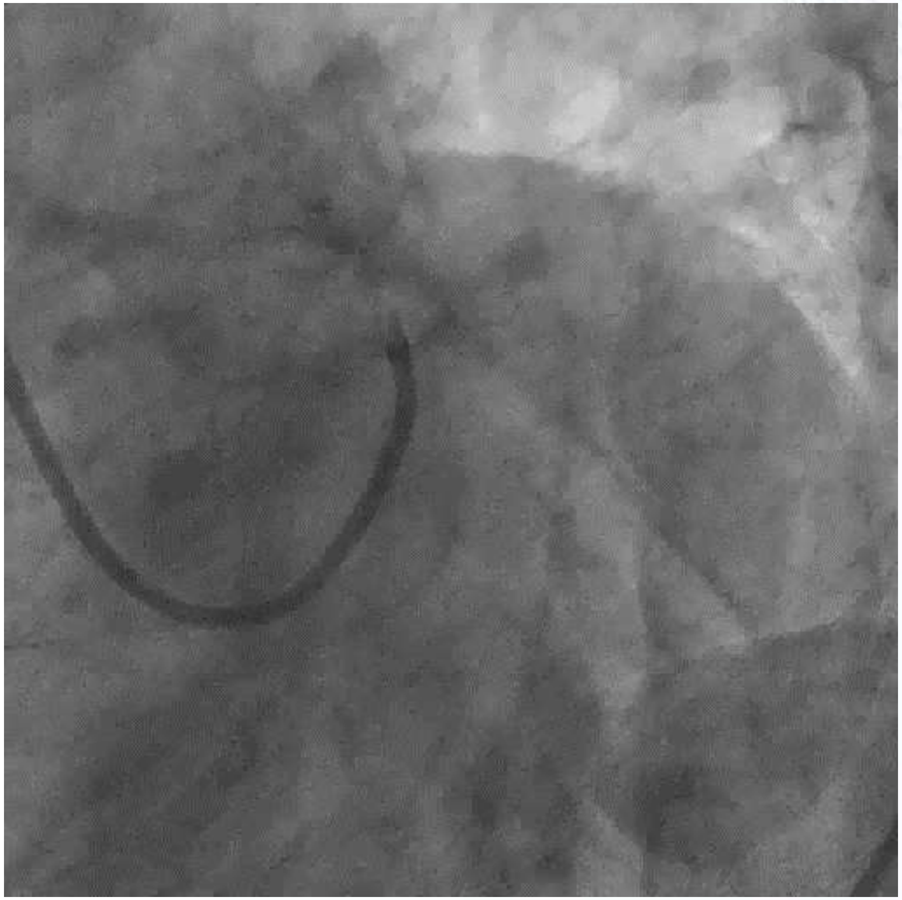
If we use this, we would see

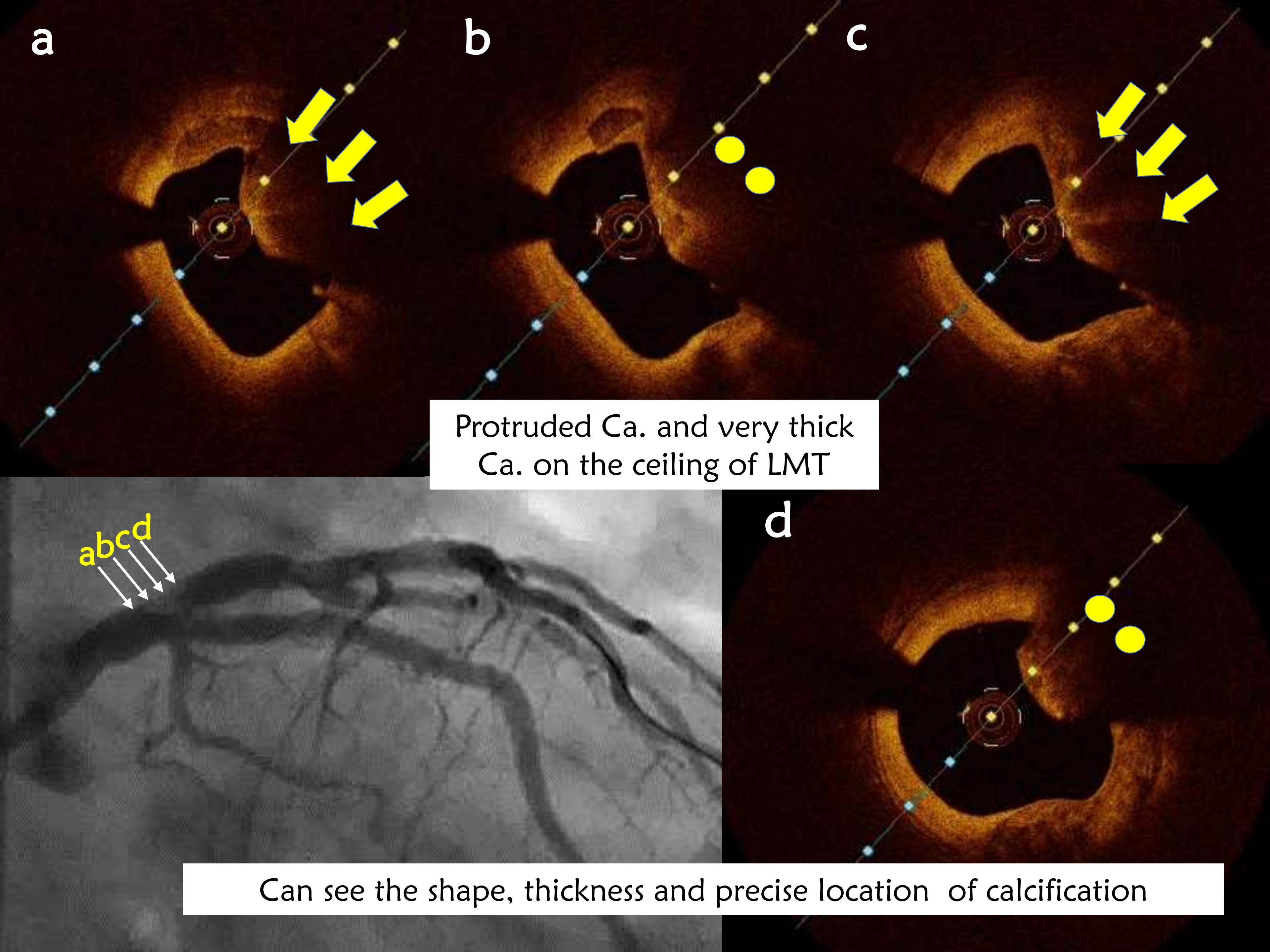
“ Beyond THE SEEN” “Behind the SEEN ”

Case 1 : LMT stenosis with severely calcified lesion

60 y.o. male ESRD on HD patients with severe discomfort on exertion.
LMT bifurcation area stenosis with severely calcified lesion

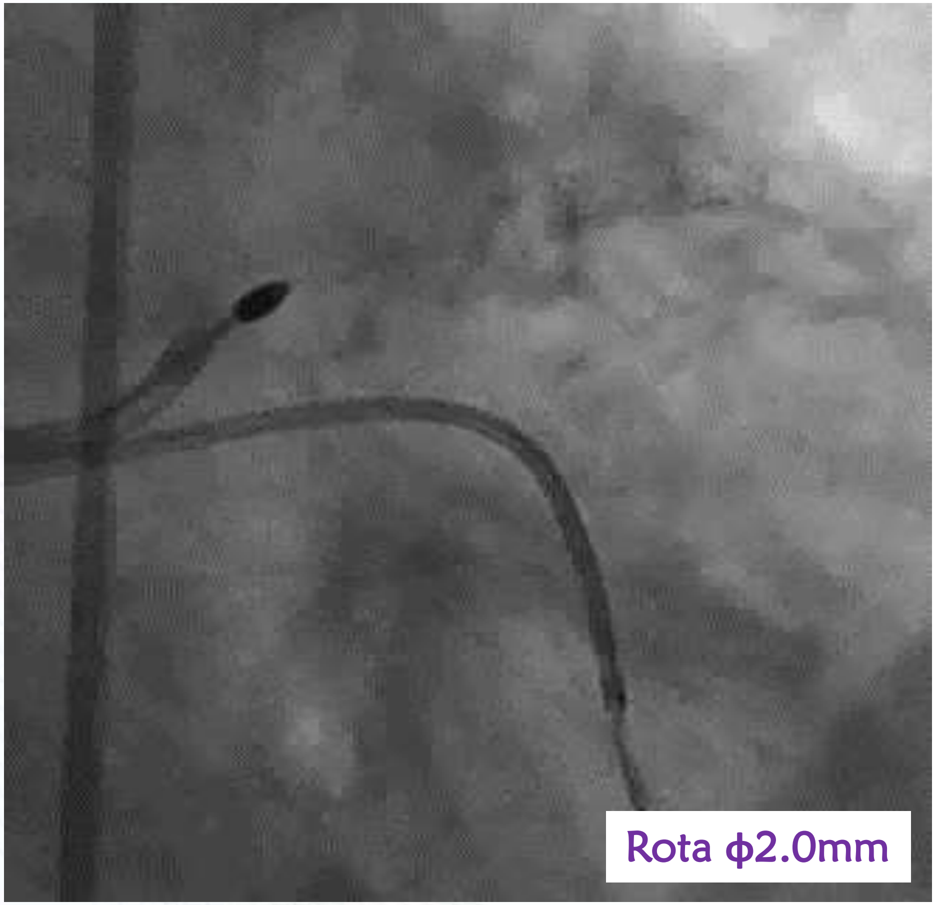


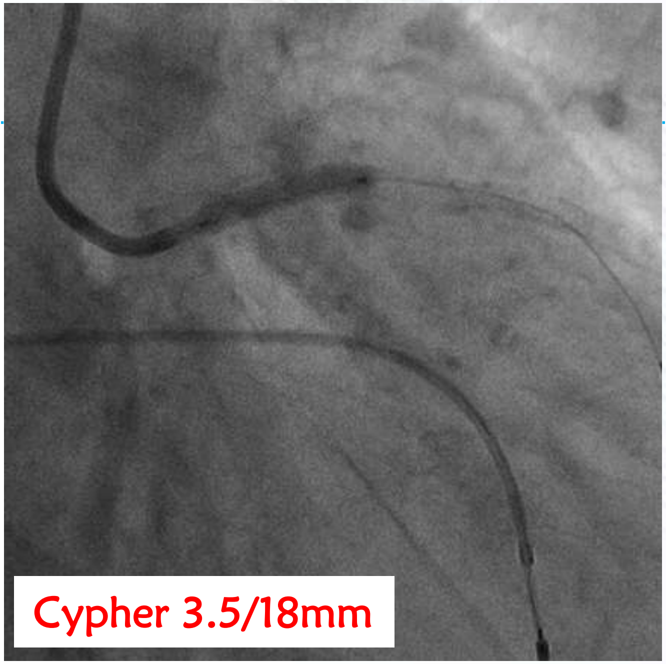


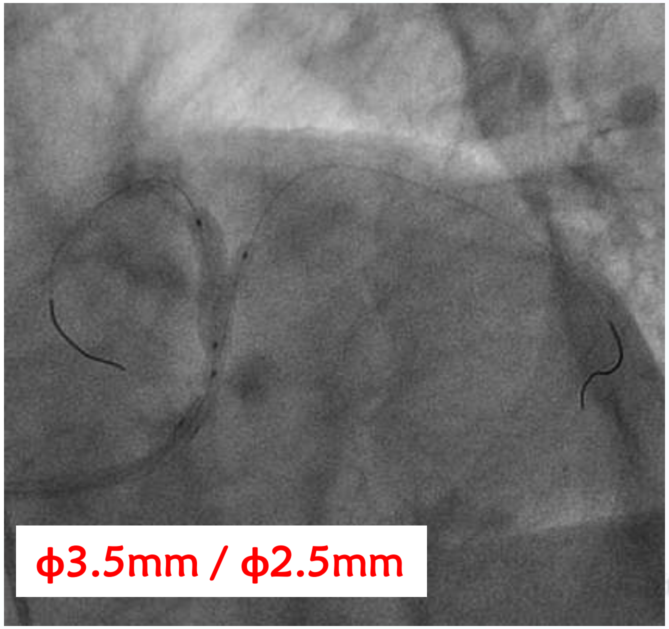

a
b
c
Protruded Ca. and very thick Ca. on the ceiling of LMT
abcd
d
Can see the shape, thickness and precise location of calcification

PCI with Rota. and Cypher

ACCURATE PLANNED INTENTIONAL DIRECTIONAL CUTTING

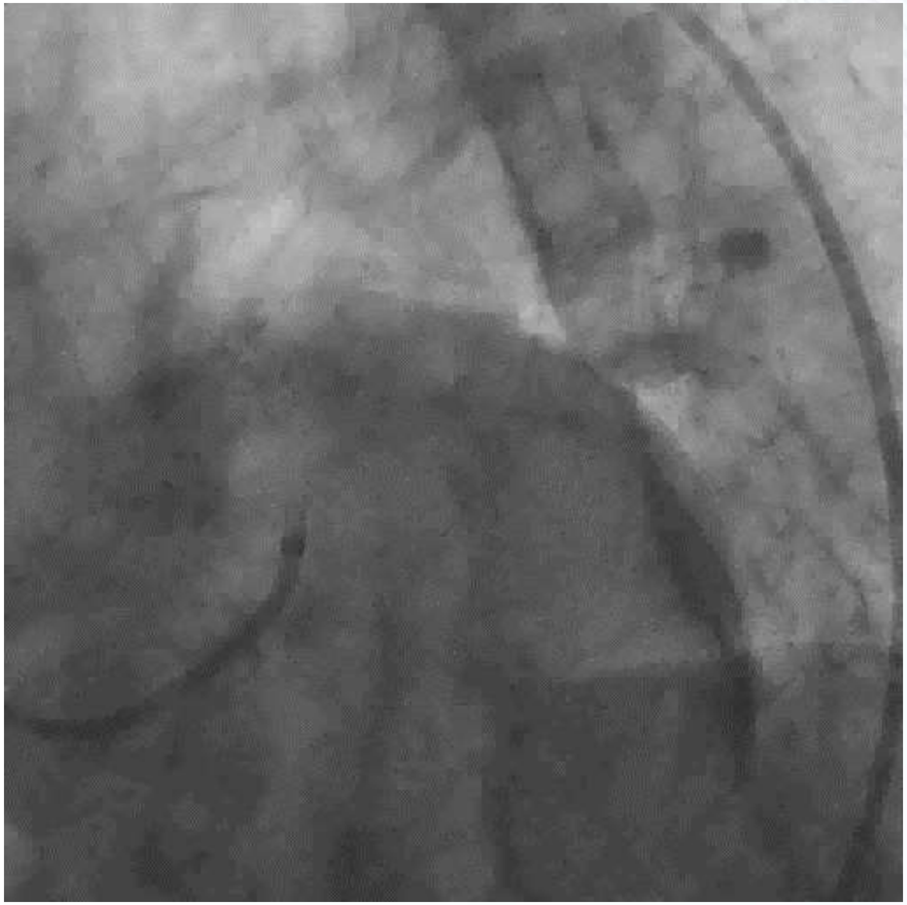


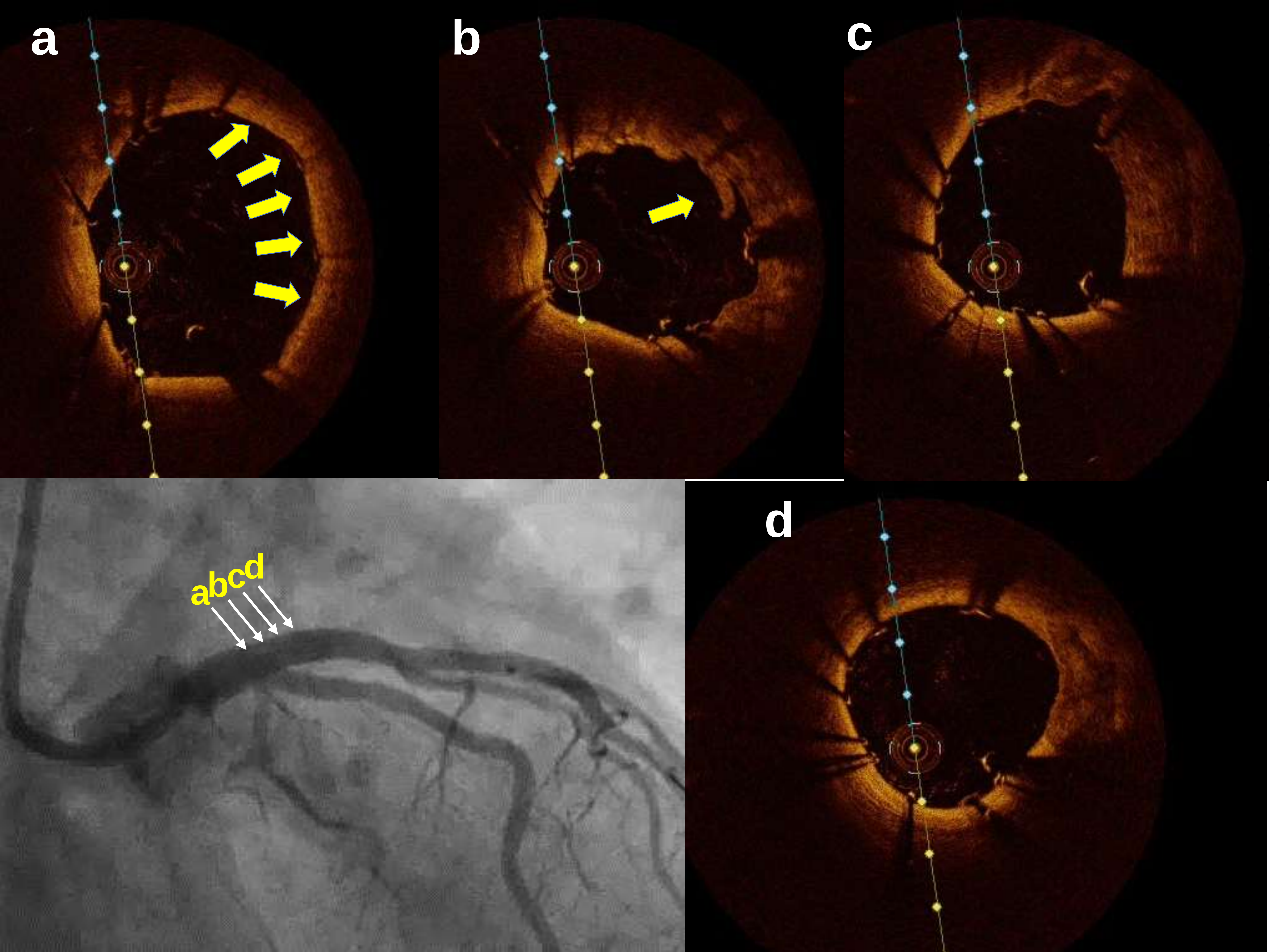




Case 1 : LMT stenosis with severely calcified lesion

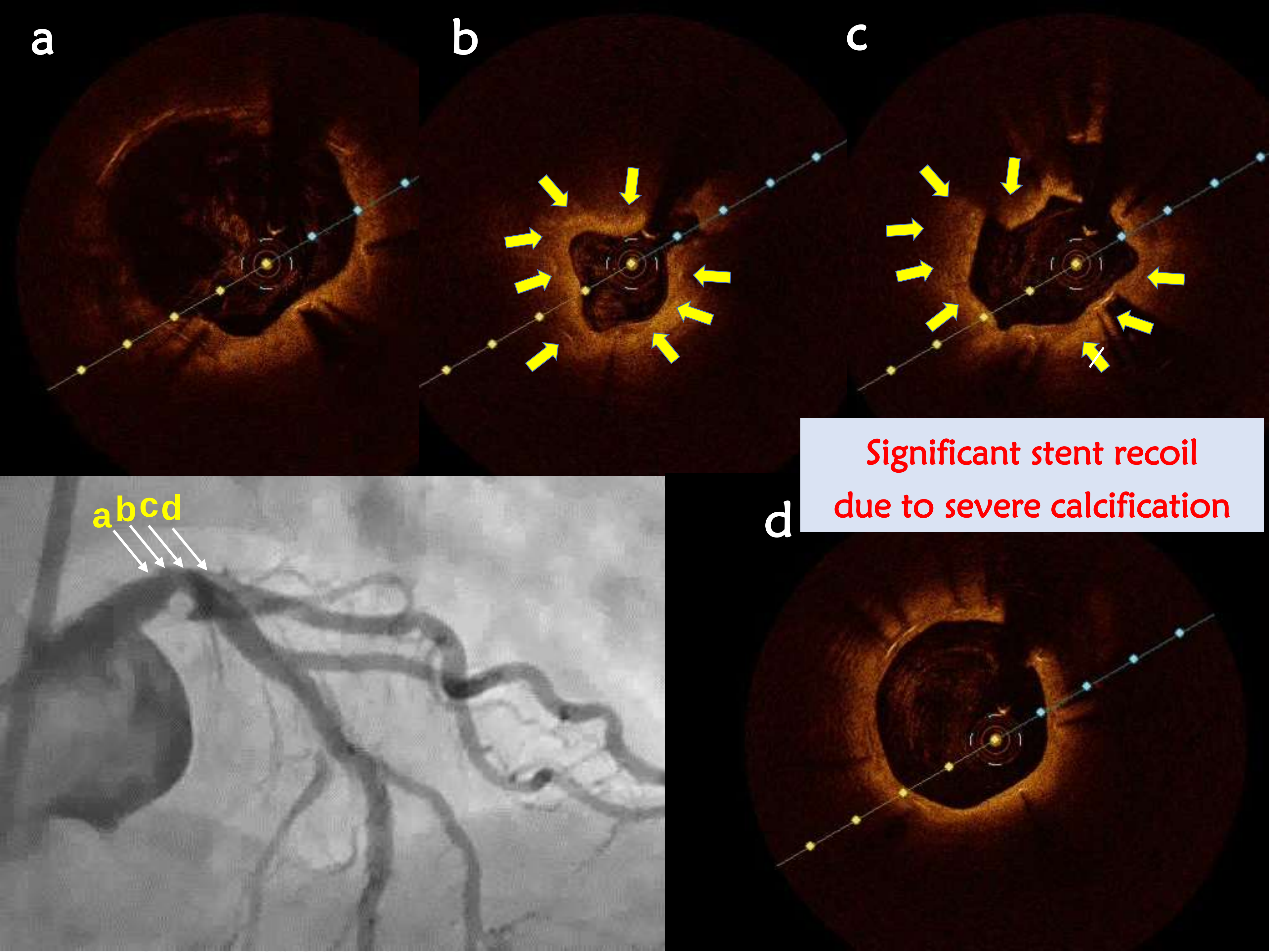
60 y.o. male ESRD on HD patients: Final Angiogram




a
b
c
d
abcd

Story Continued !!

9 month Later after PCI : 61 y.o. male ESRD on HD patients:

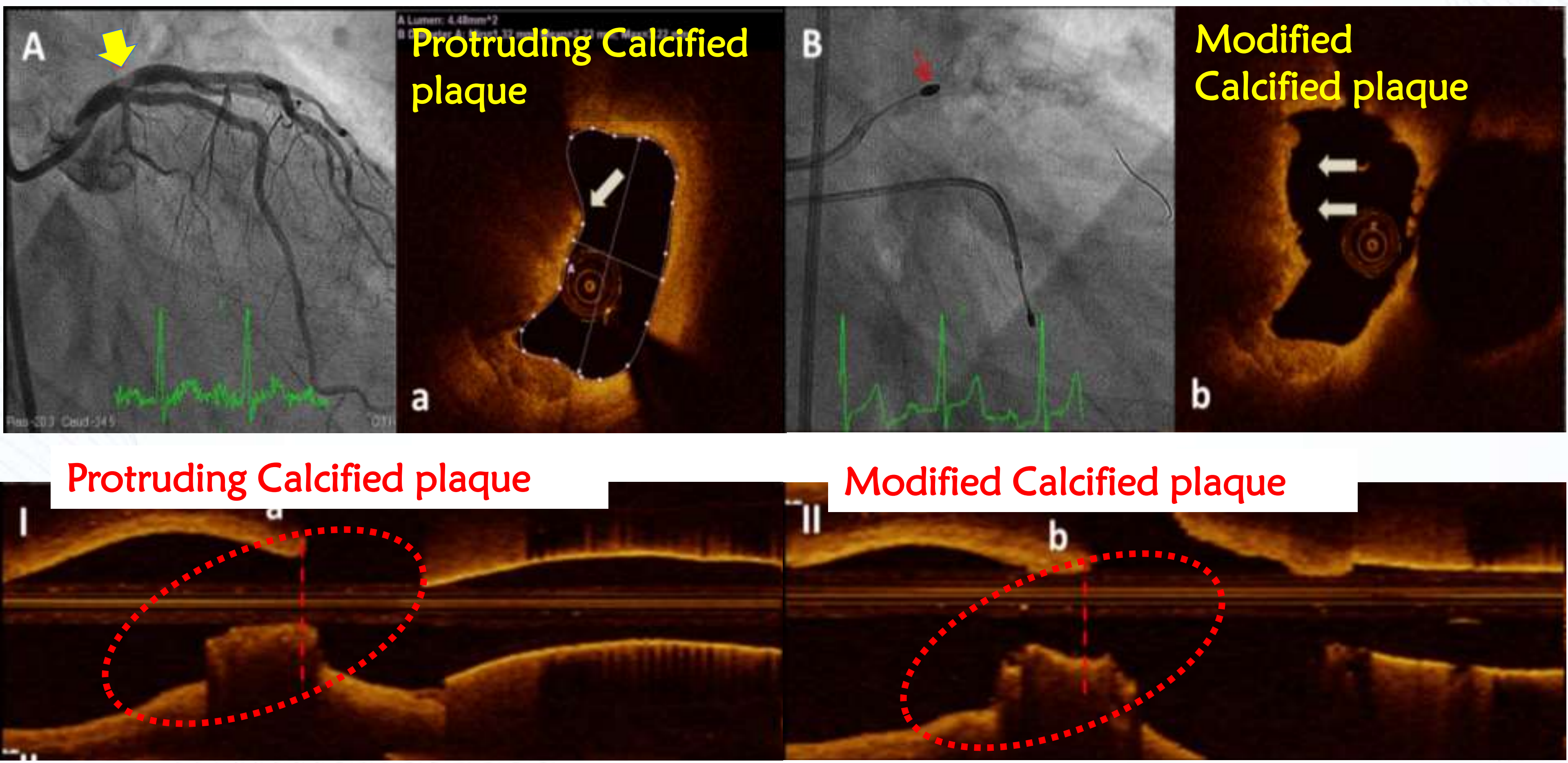

a
b
c
Significant stent recoil
due to severe calcification
abcd
d

FD-OCT Assessment of Stent Constriction 9-M after SES Implantation in Patient With Hemodialysis

Y. Fujino, S. Nakamura, M Costa, et al. JACC Intervention. 2013

Pre Rota

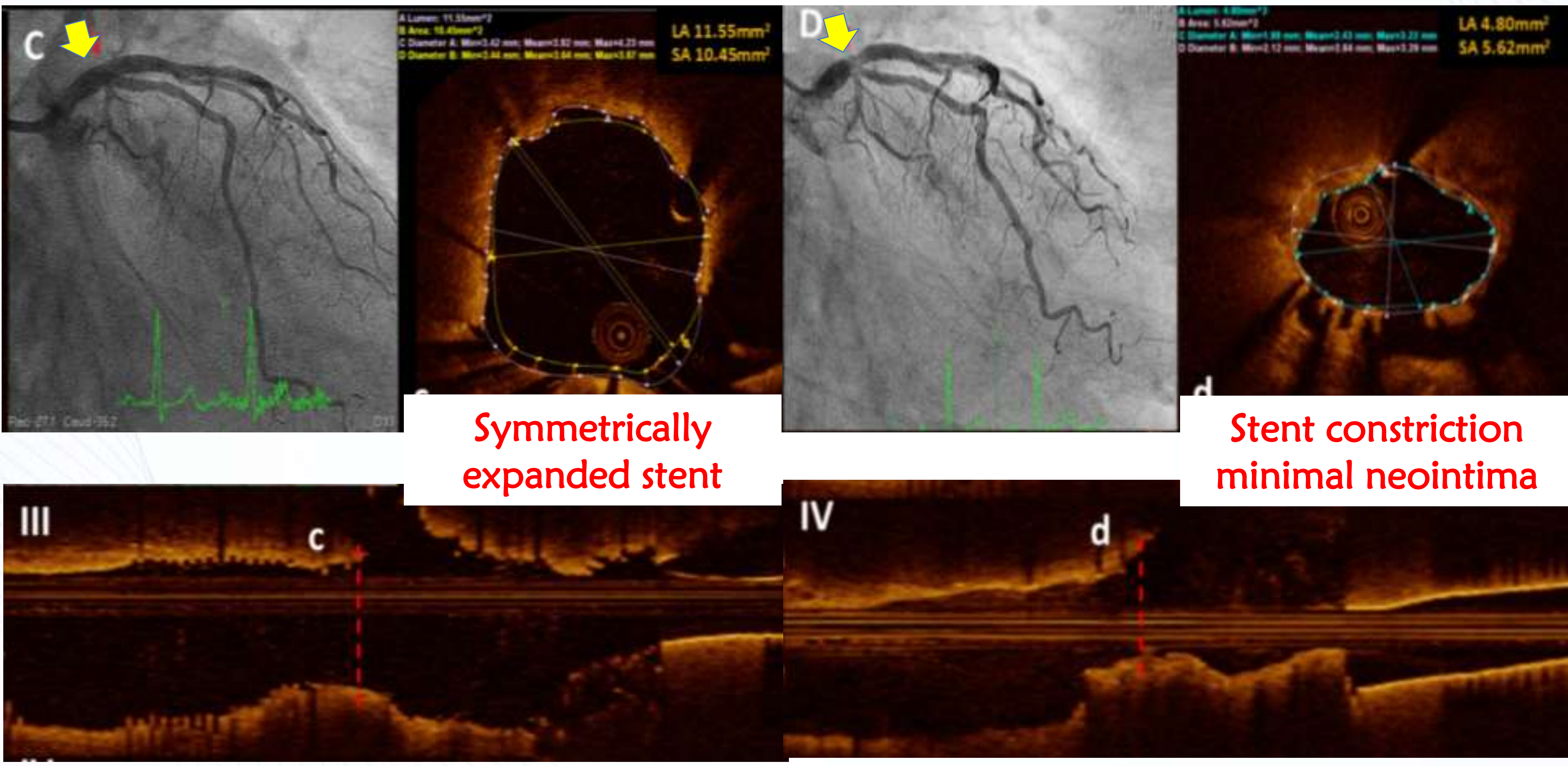
Post Rota



FD-OCT Assessment of Stent Constriction 9-M after SES Implantation in Patient With Hemodialysis

Y. Fujino, S. Nakamura, M Costa, et al. JACC Intervention. 2013

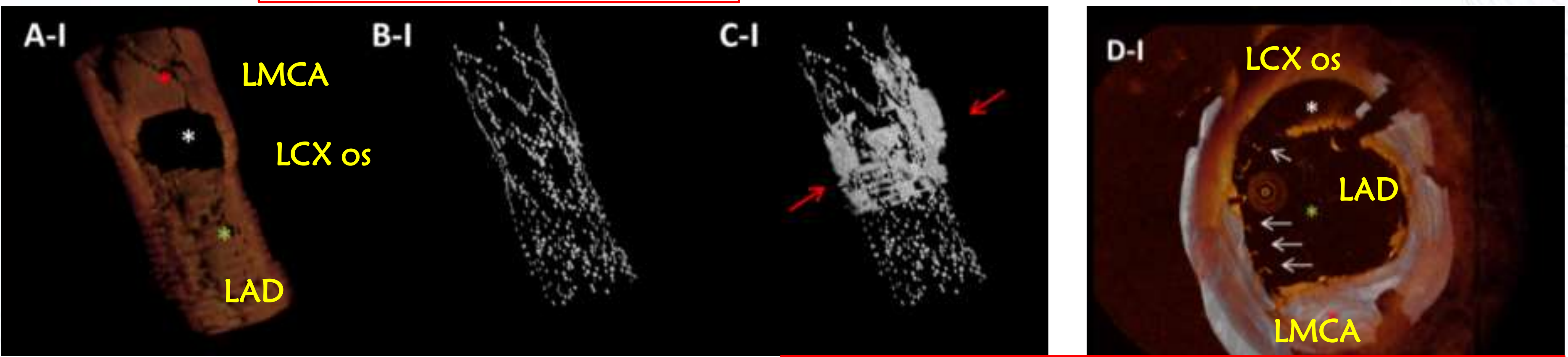
Post-SES | F/U 9 months



FD-OCT Assessment of Stent Constriction 9-M after SES Implantation in Patient With Hemodialysis

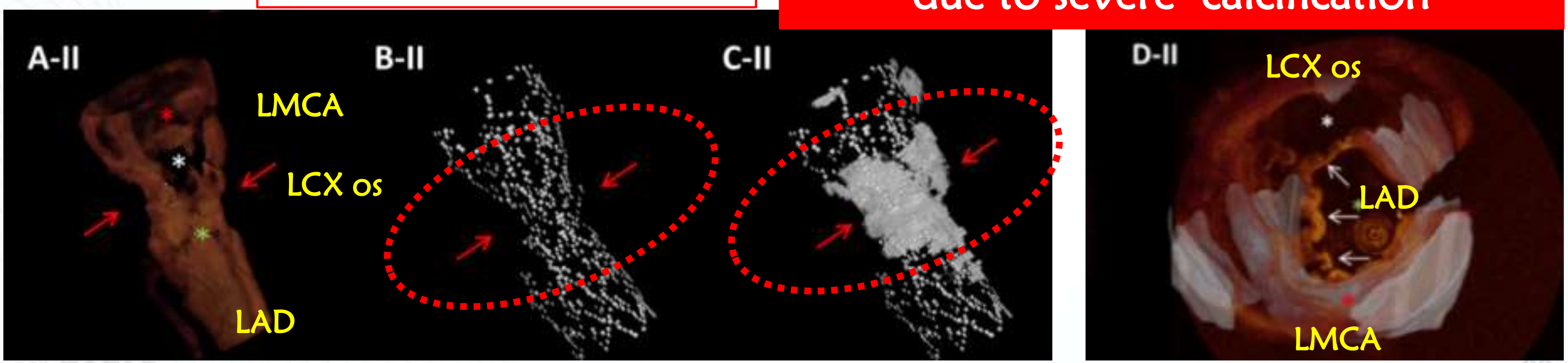
Y. Fujino, S. Nakamura, M Costa, et al. JACC Intervention. 2013

Post-SES



F/U 9 months

Significant stent recoil
due to severe calcification



Impact of Rotational Atherectomy for Heavily Calcificated Unprotected Left Main Disease: The New Tokyo Registry.

H.Yabushita, S.Nakamura et.al Ciculation Jounal 2013

TLR-MB	7 (10.9)
TLR-MB in non-HD	1 (2.1)
TLR-MB in HD	6 (46.2)

TLR	12 (18.8)
TLR-MB	7 (10.9)
TLR-MB in non-HD patients (n=51)	1 (2.1)
TLR-MB in HD patients (n=13)	6 (46.2)
MI	3 (4.7)
Definite/Probable ST	2 (6.1)

Calcification in LMT !!!

In case of hemodialysis patients, it is highly probable to cause stent recoil at chronic phase despite of ablation of calcified lesion using rotational atherectomy.

Therefore they are prone to restenosis.

Yusuke Fujino

M.D. PhD FACC

JACC Intervention. 2013

Hiroto Yabushita

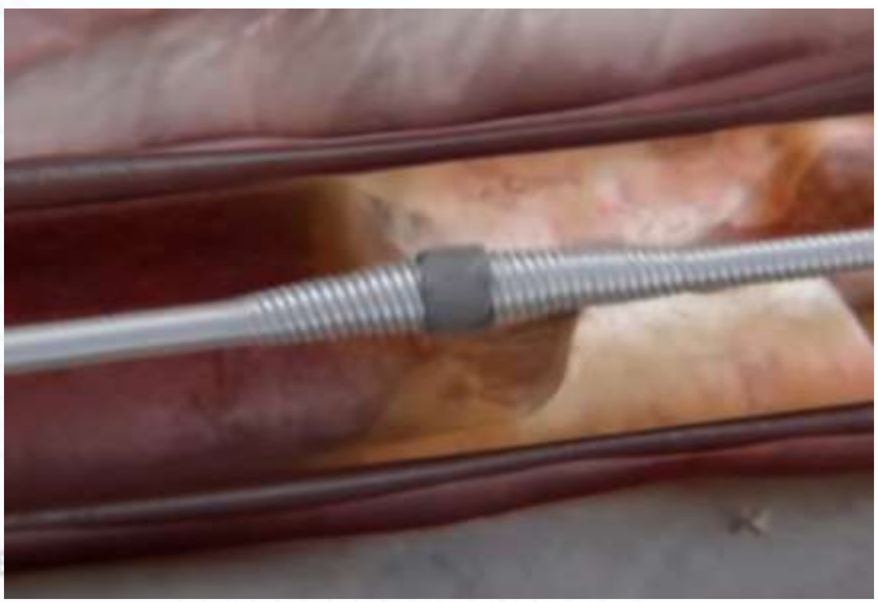
M.D. PhD

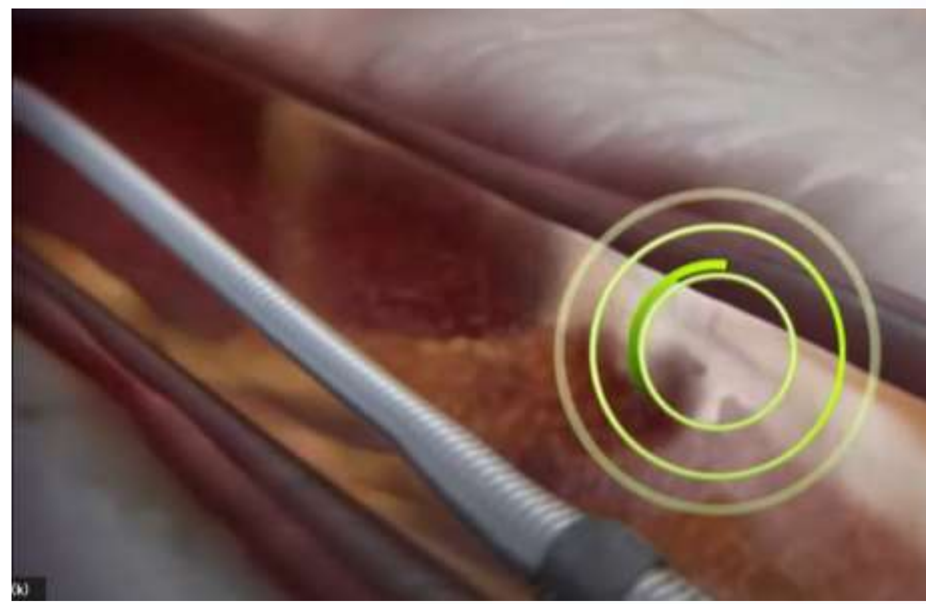
Ciculation Jounal 2013

Diamondback

The Diamondback uses a differential sanding mechanism of action to reduce plaque while potentially minimizing damage to the medial layer of the vessel. Softer tissue flexes away from the crown while fibrotic tissue or arterial calcium is engaged and treated facilitating stent deployment. A drive shaft with an eccentrically mounted diamond-coated crown provides proximal and distal sanding to reduce occlusive material and restore luminal

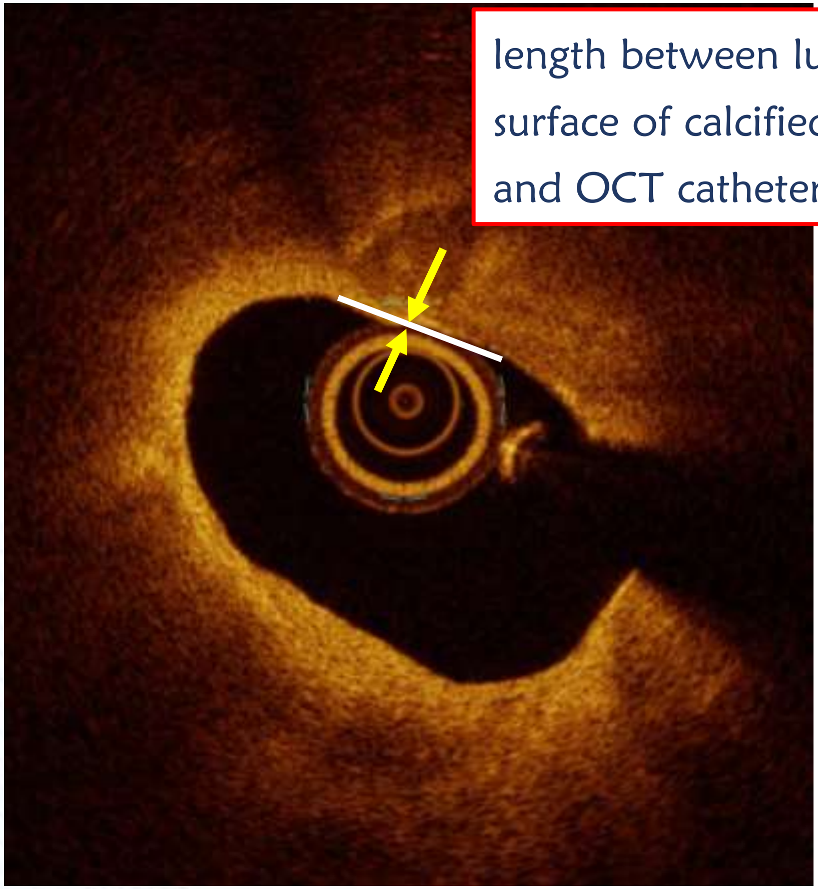
"Diamndback" :Very fine diamond-coated crown provides proximal and distal sanding to reduce occlusive material and restore luminal patency.





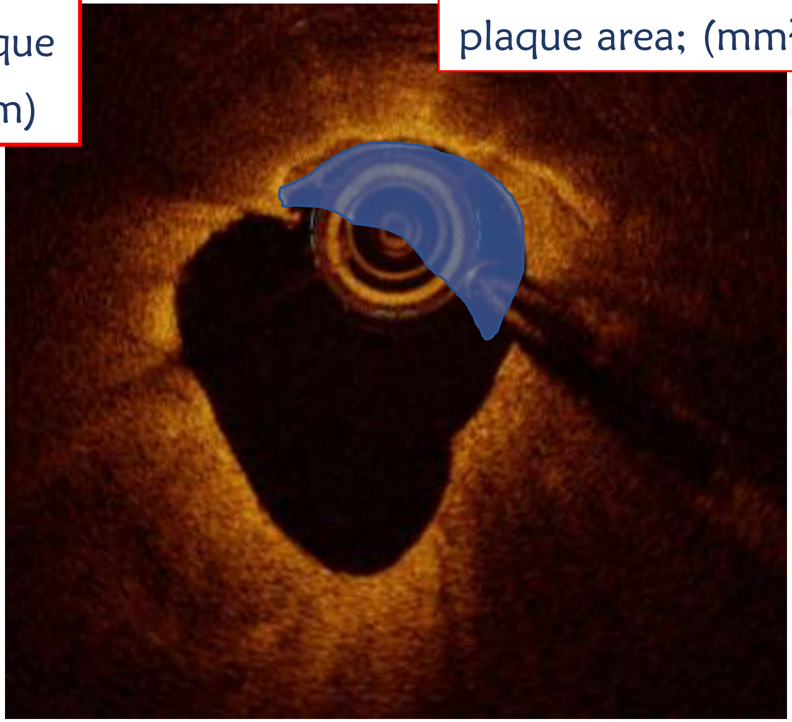
Corresponding OCT cross-sectional frames : Diamond Back

Pre ablation



length between luminal surface of calcified plaque and OCT catheter; (mm)

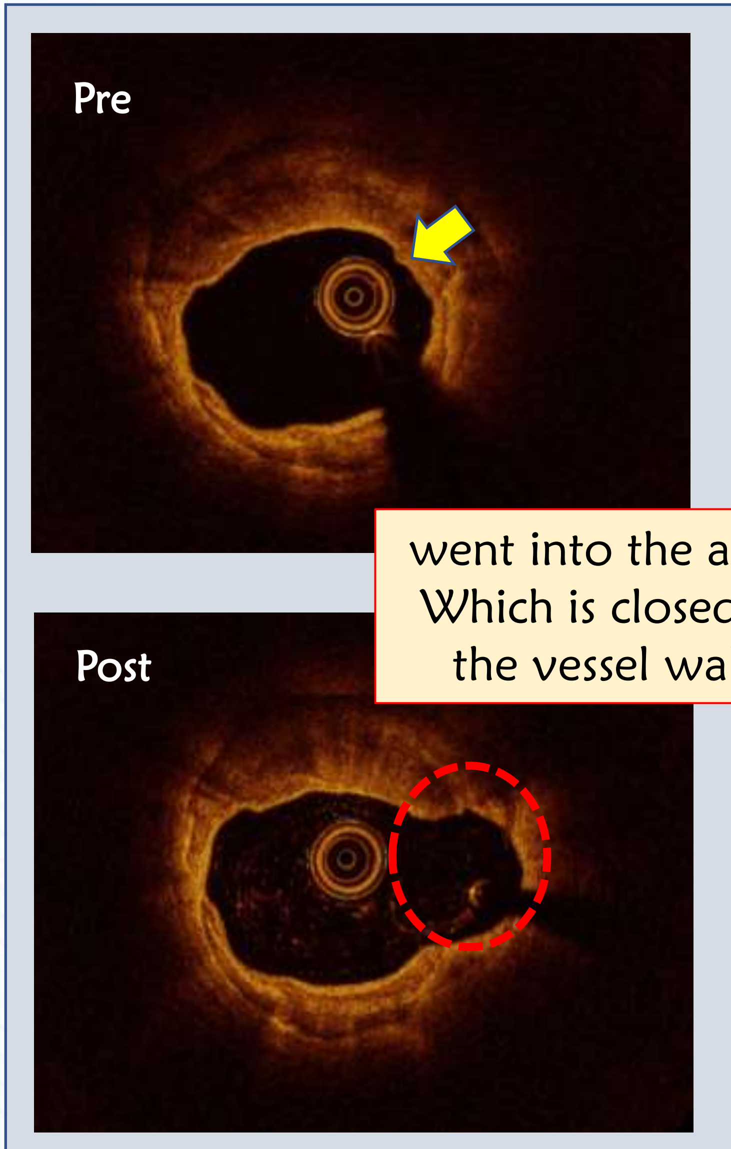
Post ablation



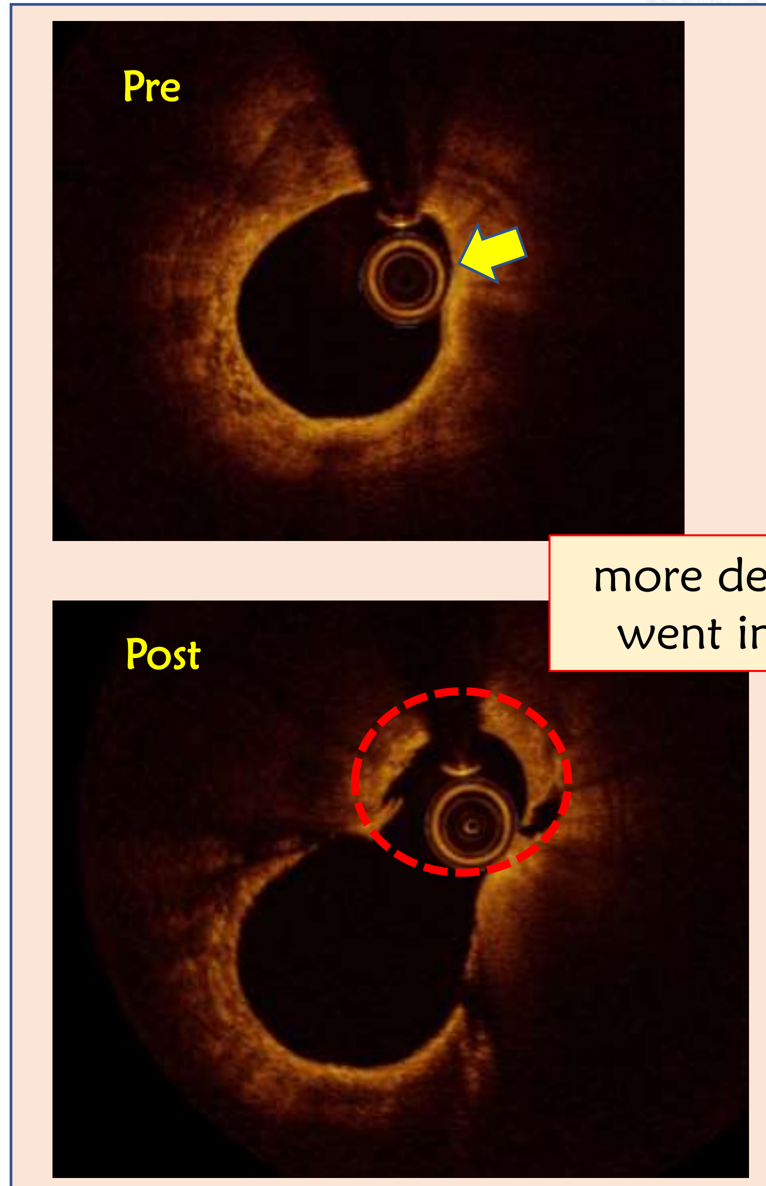
Ablated calcified plaque area; (mm^2)

Unpublish DATA in NTH

Diamond Backs : Funny movement but follows the rule of GW bias



went into the area,
Which is closed to
the vessel wall.

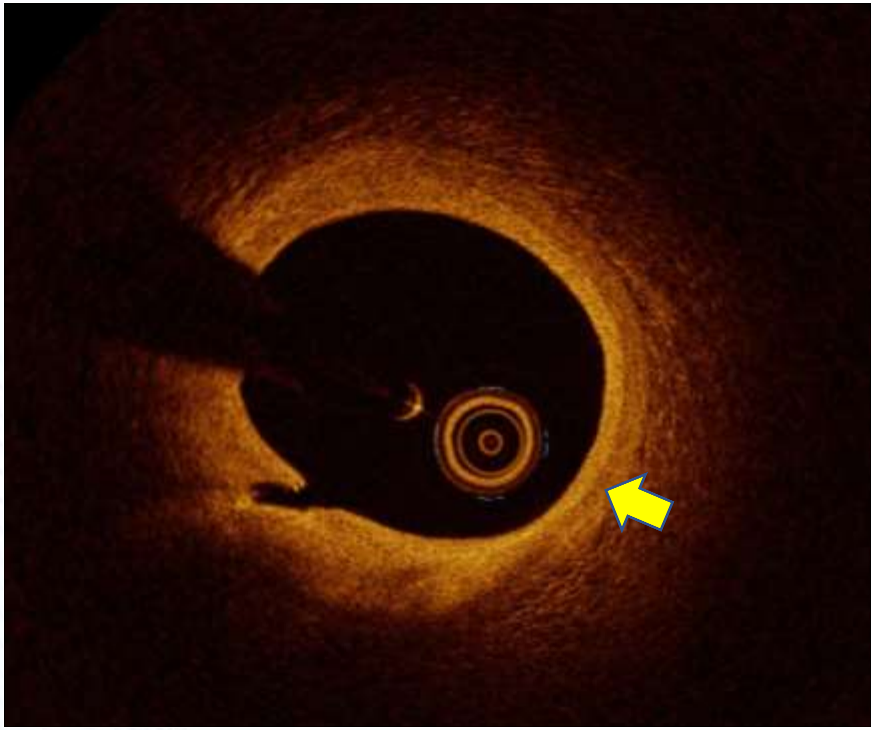


more deeply
went into.

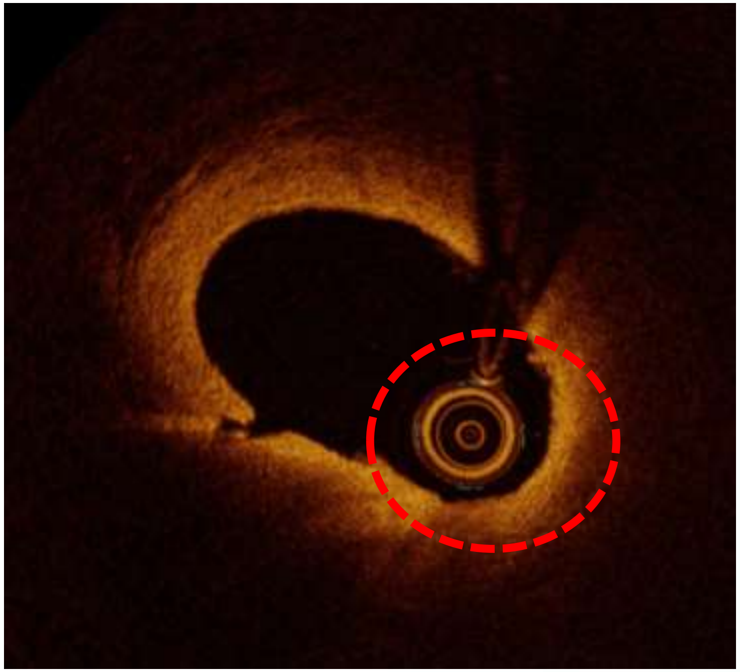
Diamond Backs follows the rule of GW bias !!

Sometimes go to …Even in the area of soft plaque

Pre



Post

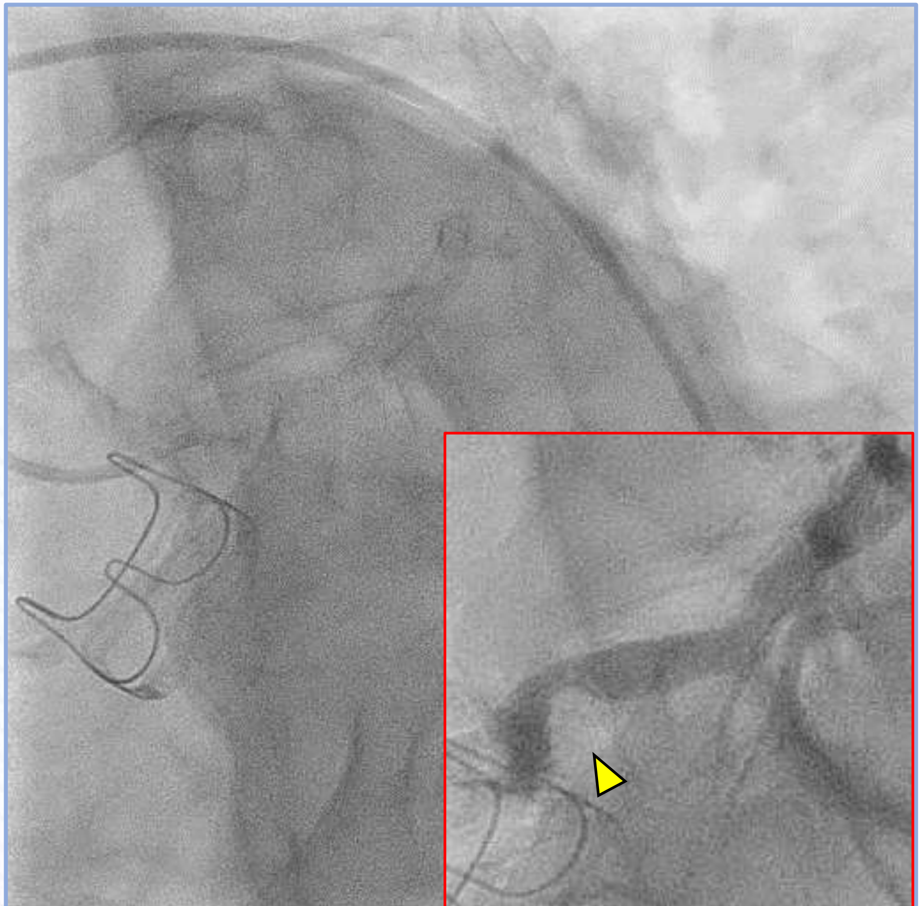


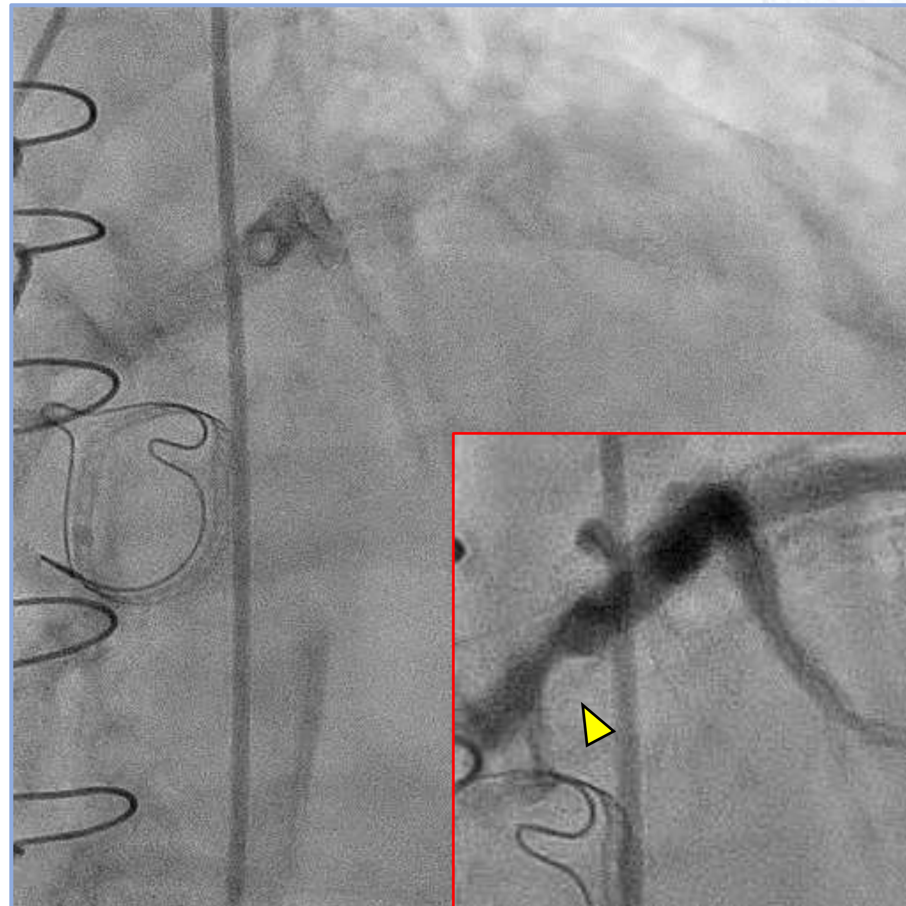
"hollowed out area"

definitely in the normal area

Case 2 : LMT Ost. ISR with eccentric NIH : and some Ca.

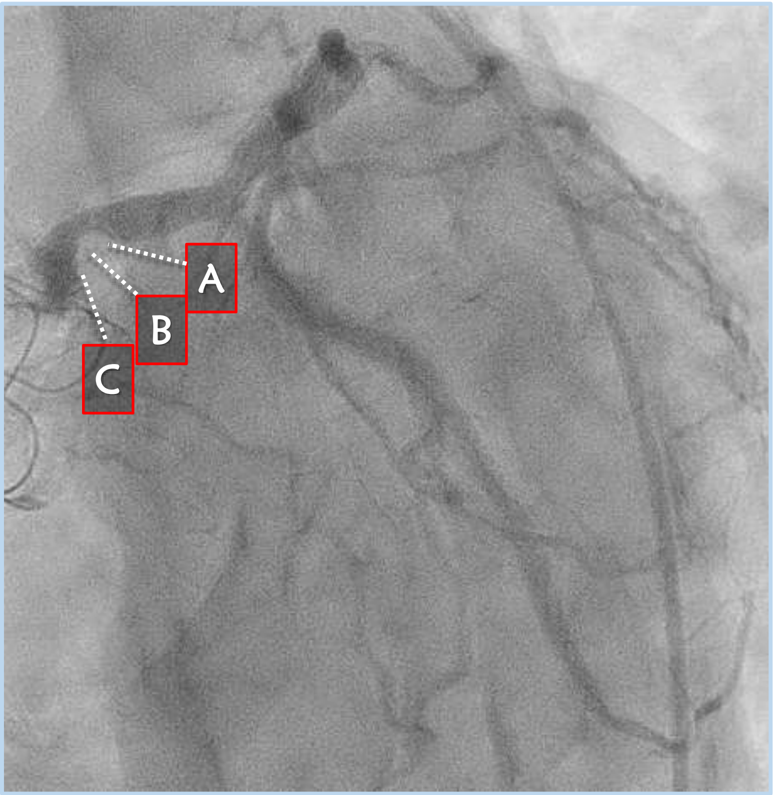
73 yo Male, EF 55.4% (antero-septal moderate hypo) Cre 0.78mg/dl (eGFR 68)



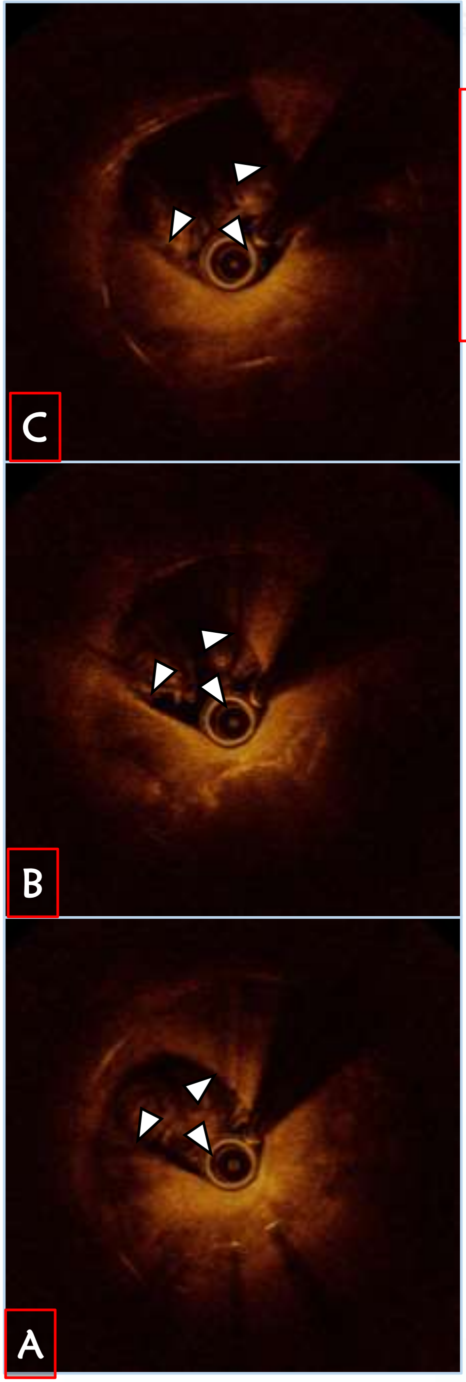


Significant ISR in **Proximal, BOTTOM** of LMT : Not Good Target of Rota

Pre OCT



Eccentric NIH with neoatheroscrelosis



Neoatherosclerotic change

➡ Fibrotic plaque

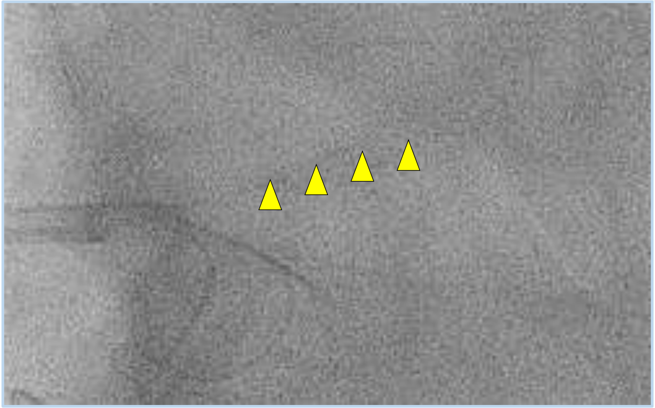
Neoatherosclerotic change

➡ Deep calcification Lipid plaque

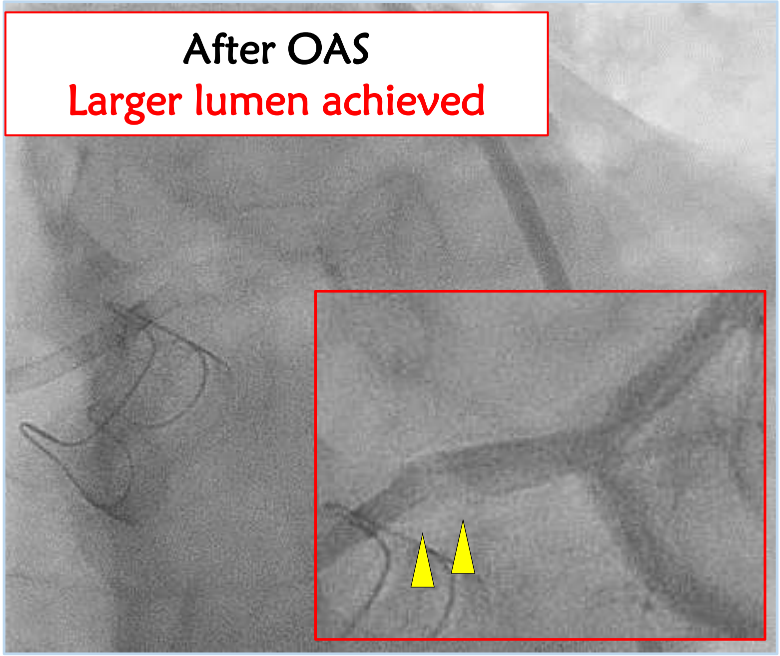
Neoatherosclerotic change

➡ Lipid plaque

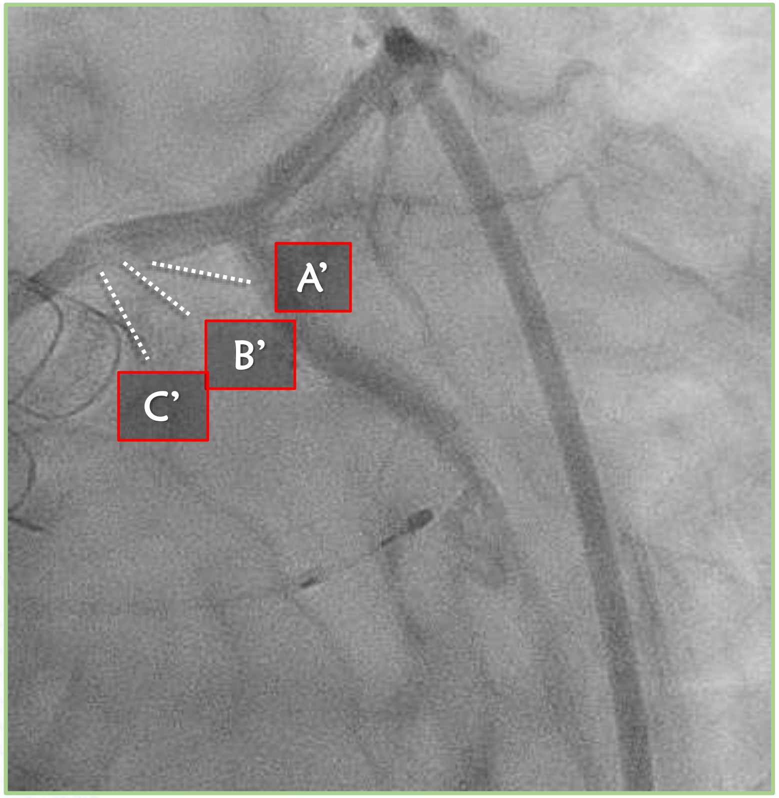
Lesion preparation with orbital atherectomy: Diamondback



Diamondback (1.25mm): 120,000 rpm

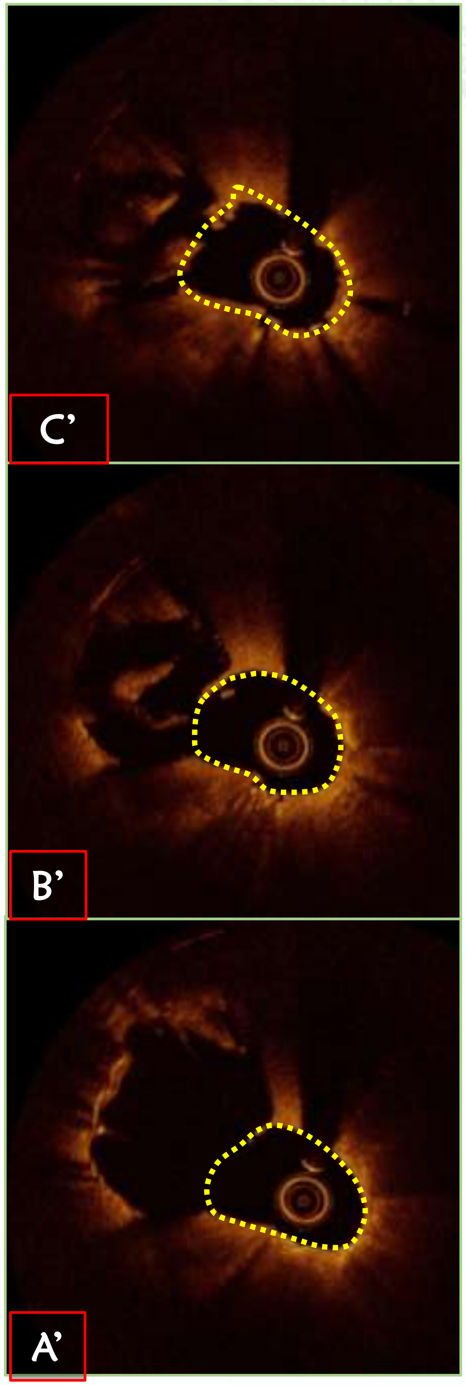


OCT after OAS

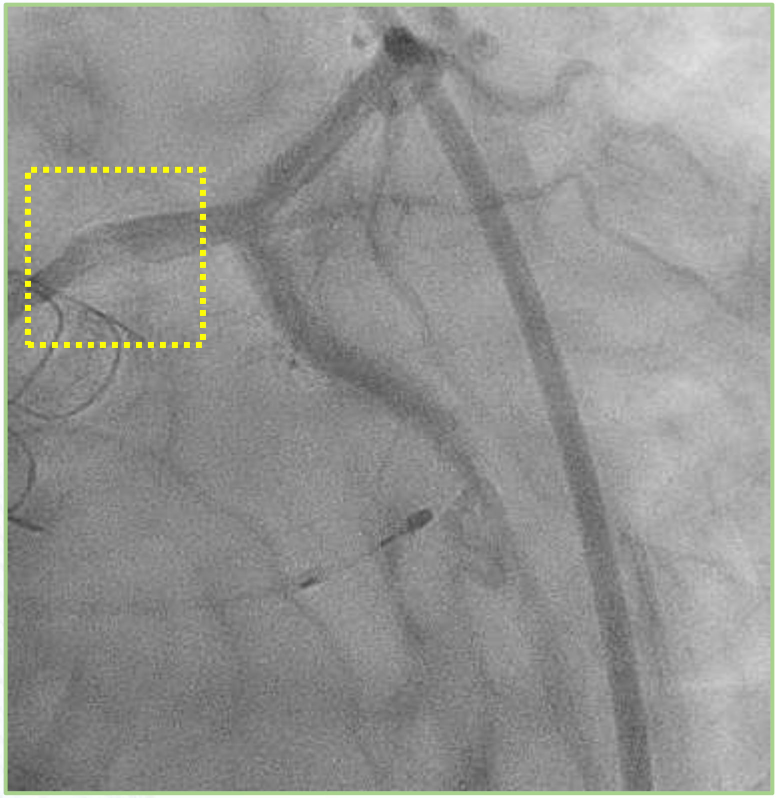


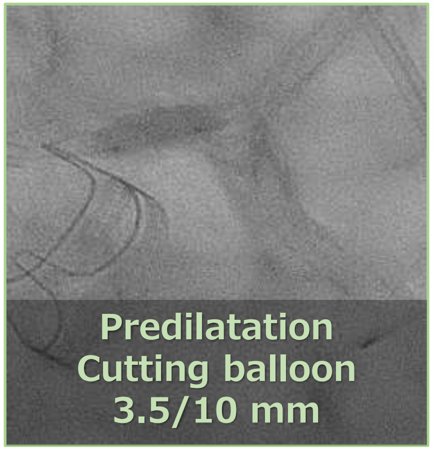
According to the wire bias,

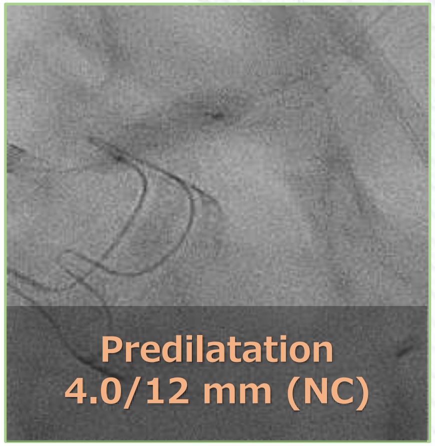
Nicely debulked eccentric NIH

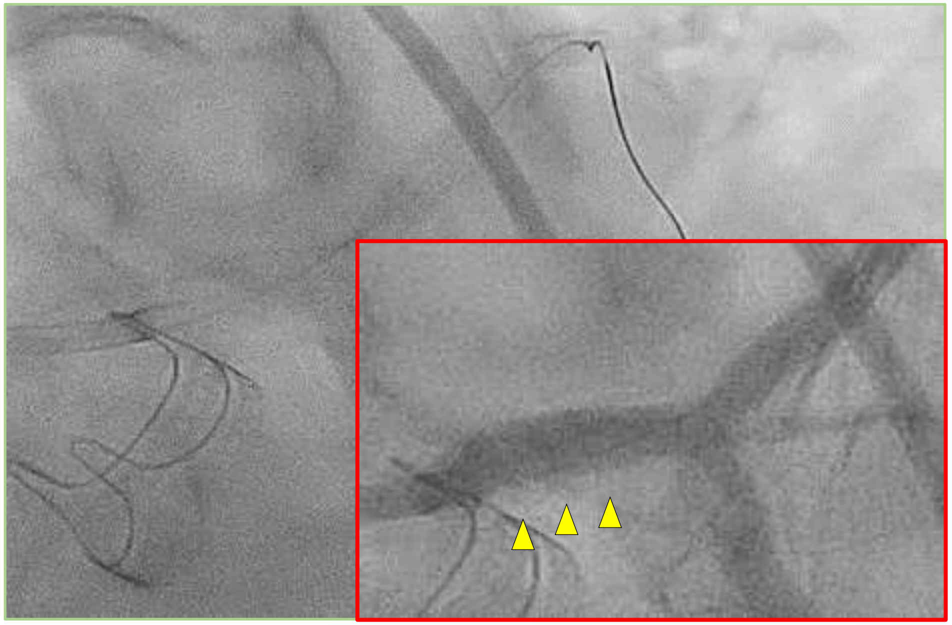


Additional lesion preparation with cutting and non-compliant balloons





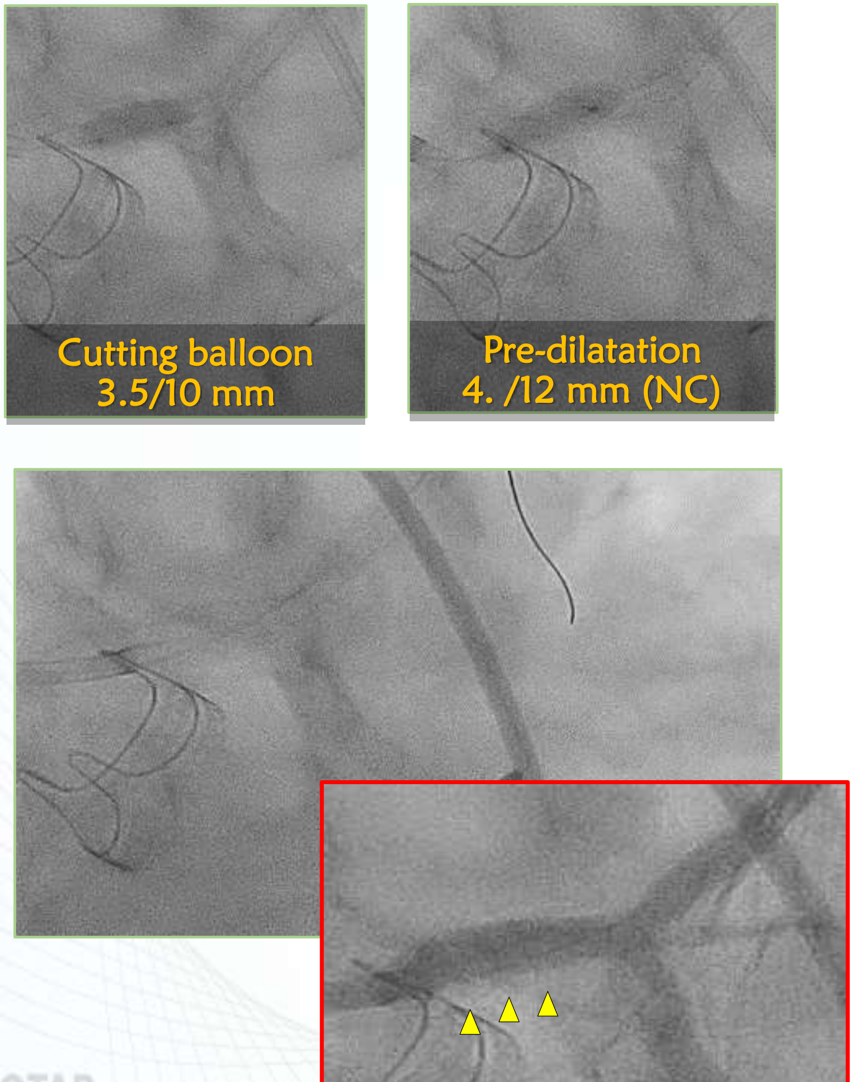




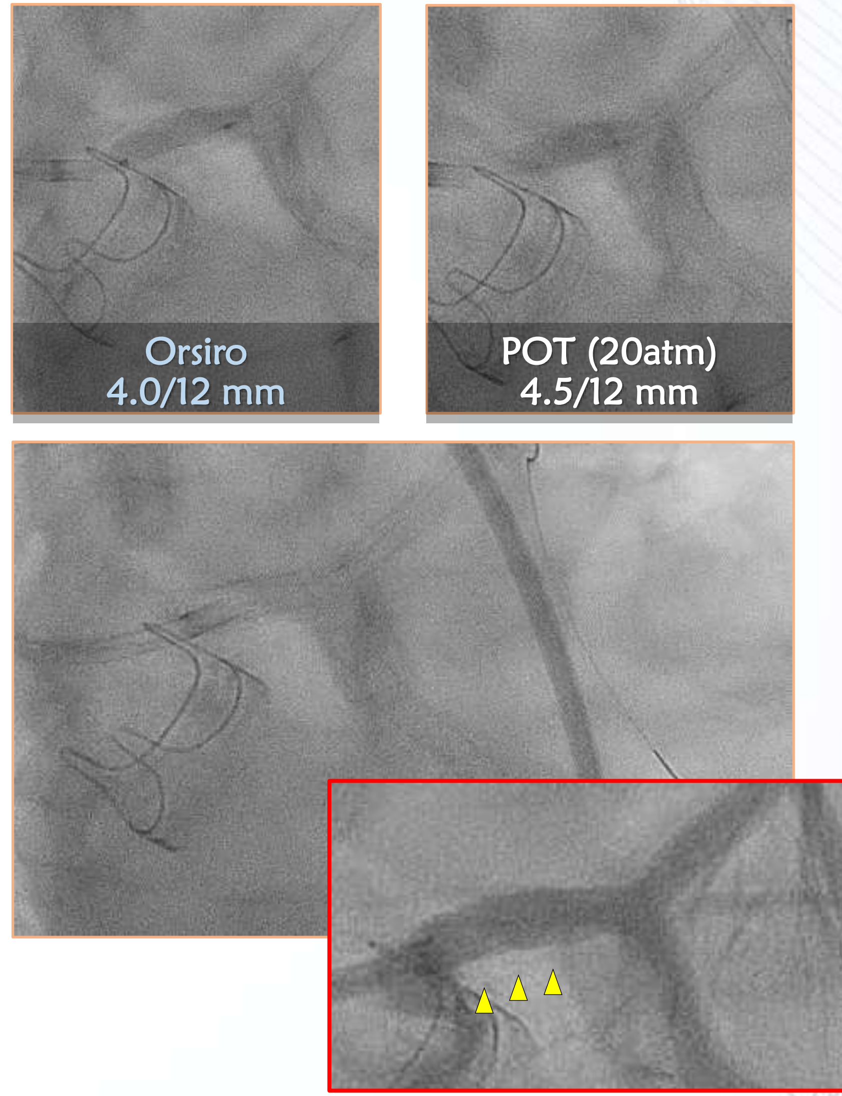
After additional lesion preparation:
More larger lumen achieved

Stent implantation after the effective plaque volume reduction

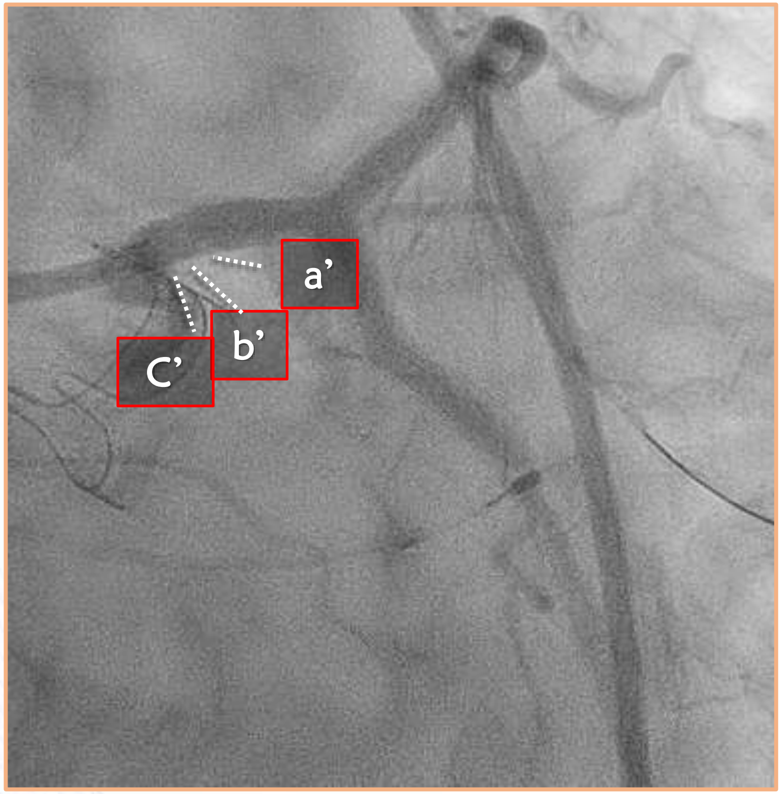
CB and NC pre-Dila.

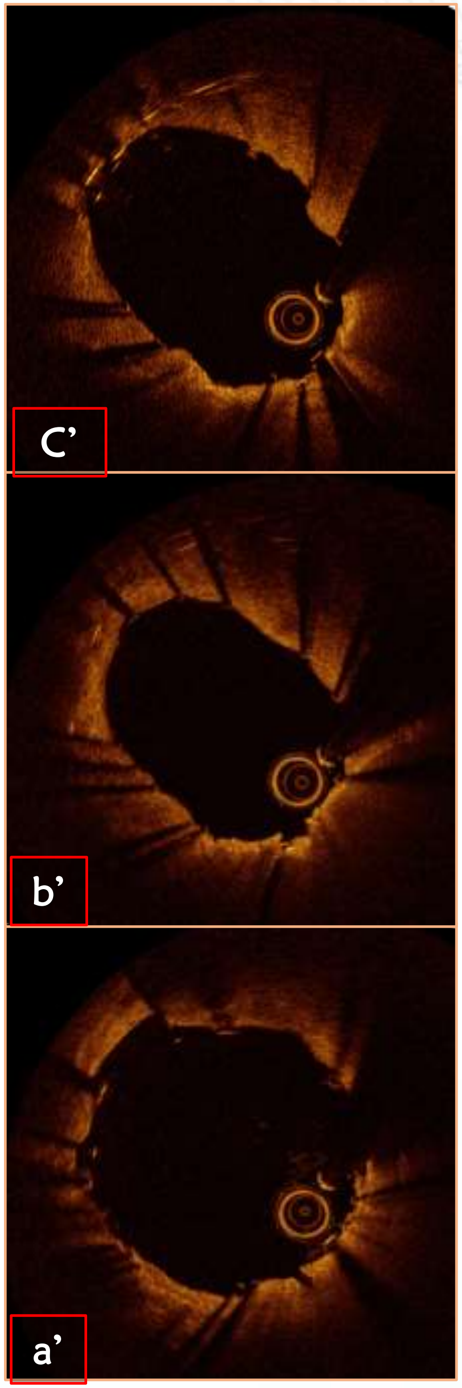


After Stent



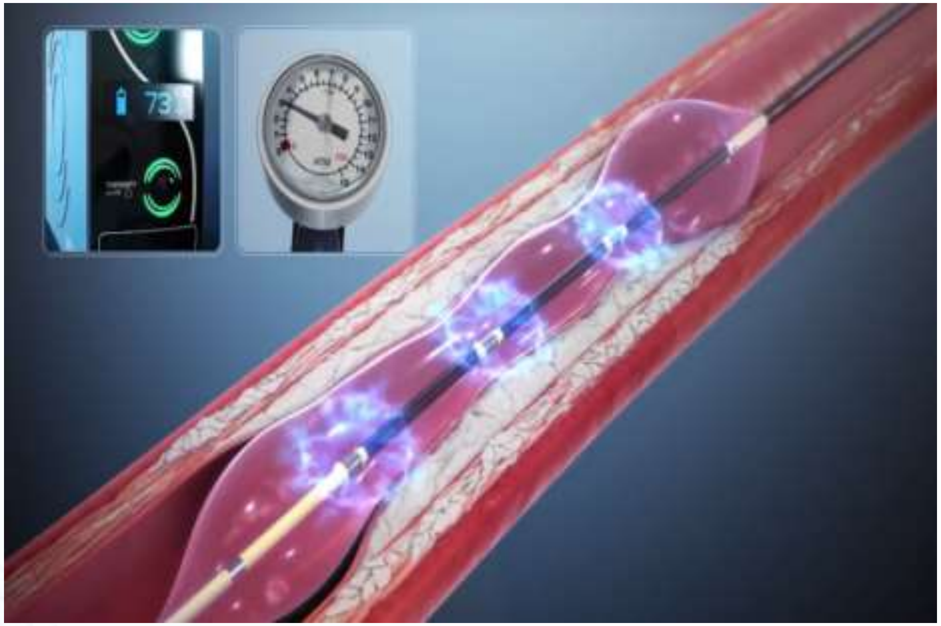
OCT after Stent





Because of the effective plaque reduction,
larger lumen could be achieved,
even after multiple layered stenting.

Shock Wave



Mechanism

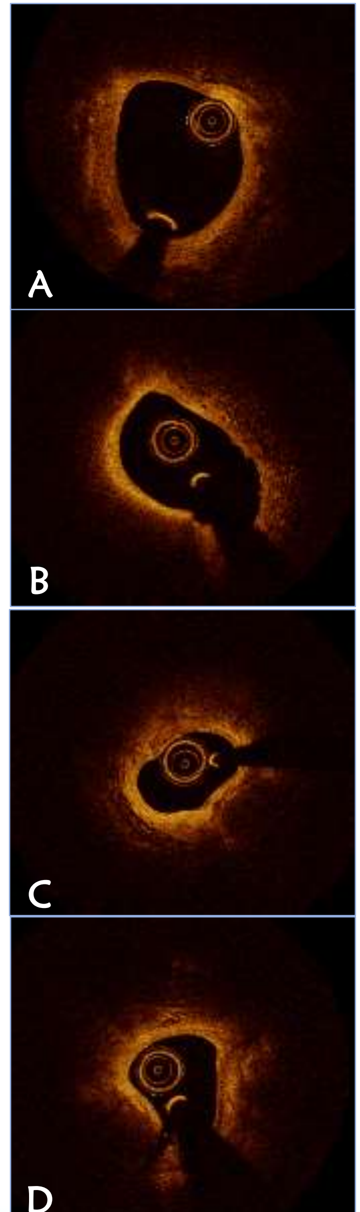
High-speed sonic pressure wave ➡ similar to urologic extracorporeal lithotripsy.
(soft tissue: pass through, calcification: disrupt)

1. Balloon inflation (4atm, 10 sec): Contacting vessel wall, delivering optimal energy.
2. Balloon inflation up to 6atm (breaking calcium)
3. Repeat the cycle (maximum 8 cycles / catheter)

Case 3 : Shock wave in Diffused calcified LAD

Proximal to mid LAD: diffusely and severely calcified lesion

OCT image before Shock wave



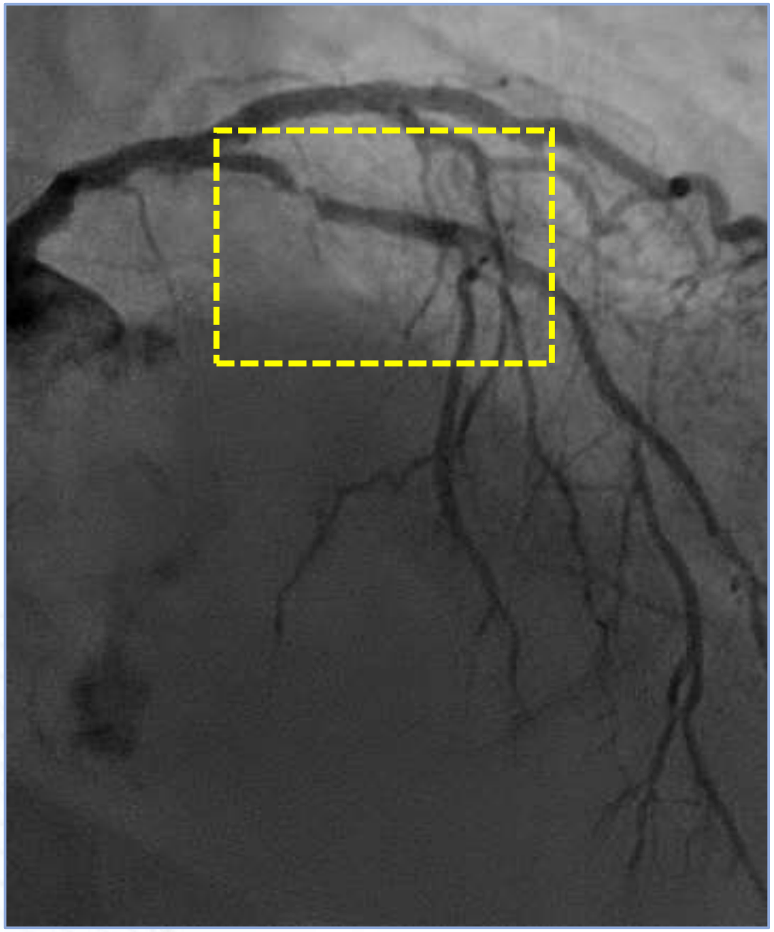
Proximal LAD

Thick calcification +
Lotus root appearance
(recanalized total occlusion)

Diffusely and severely calcified LAD

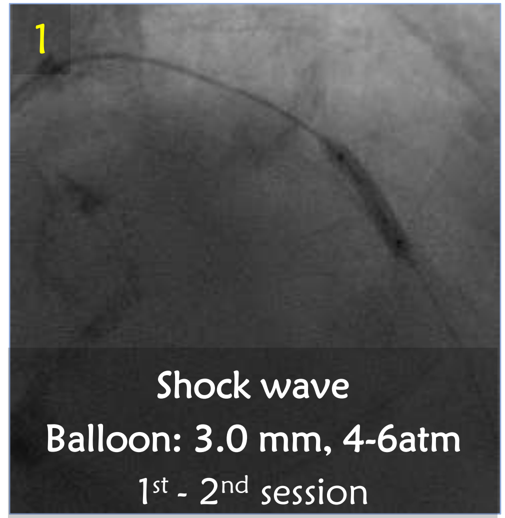
Large arc (>180°)
Thick calcification

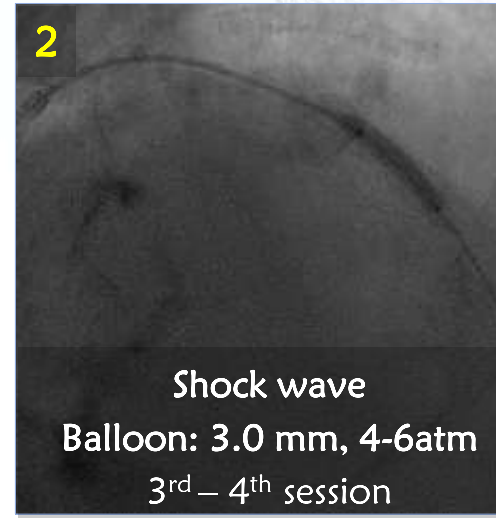
Shock wave in calcified LAD



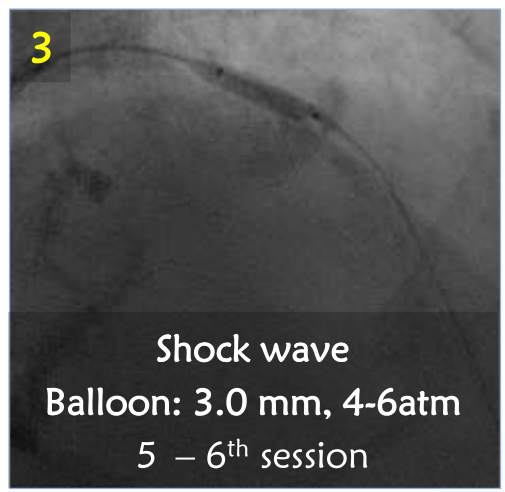
Lesion preparation with shock wave

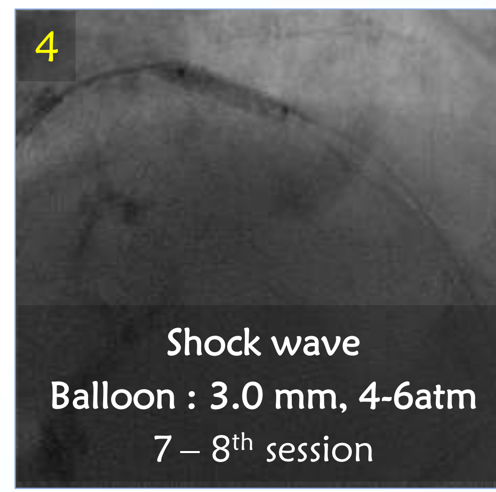
Balloon inflation: 4atm (10sec shock wave)
➡ 6atm ➡ deflation
(Maximum: 8 sessions/ catheter)





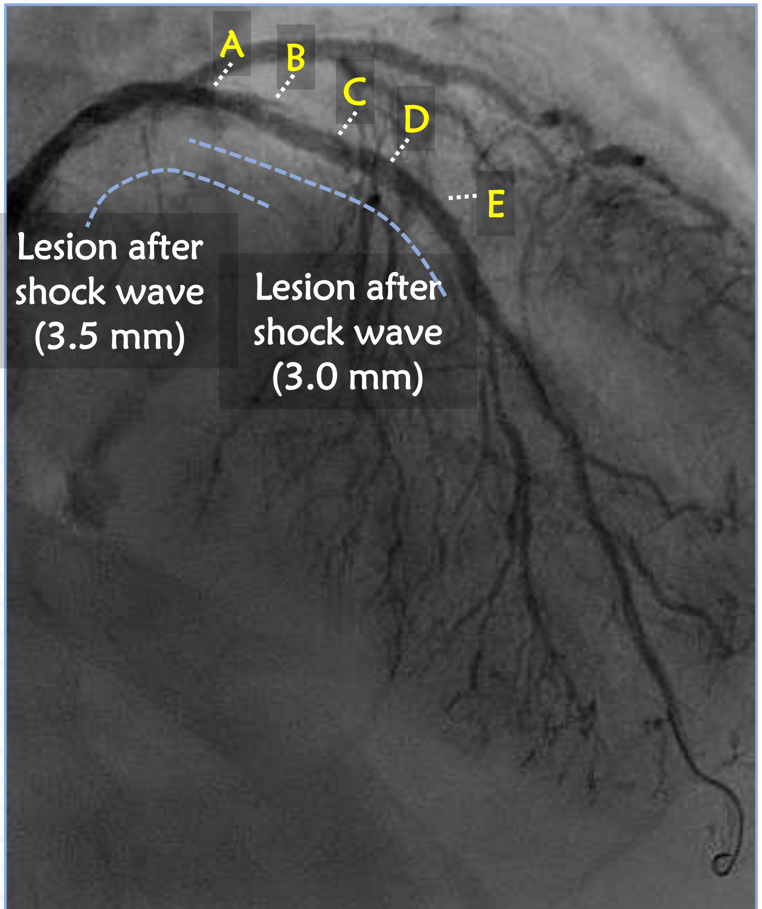
Mid lesion

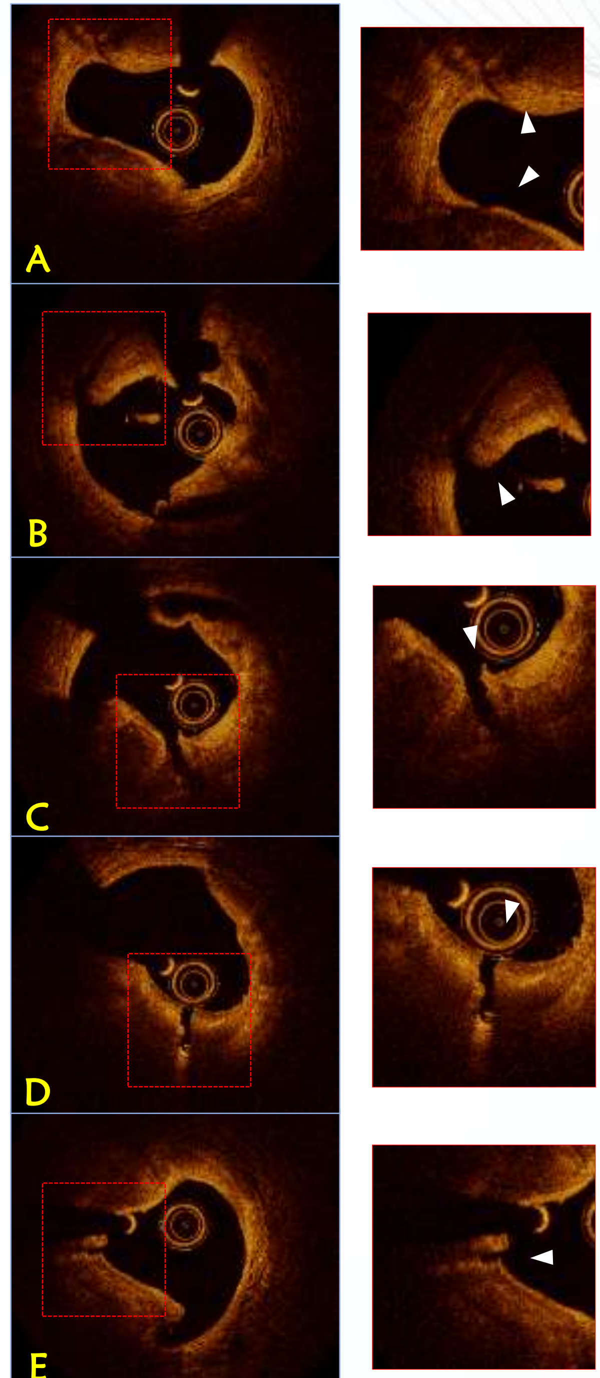




Proximal lesion

OCT after lesion preparation
with shock wave





Cracks of thick calcification

Lesion with lotus root appearance

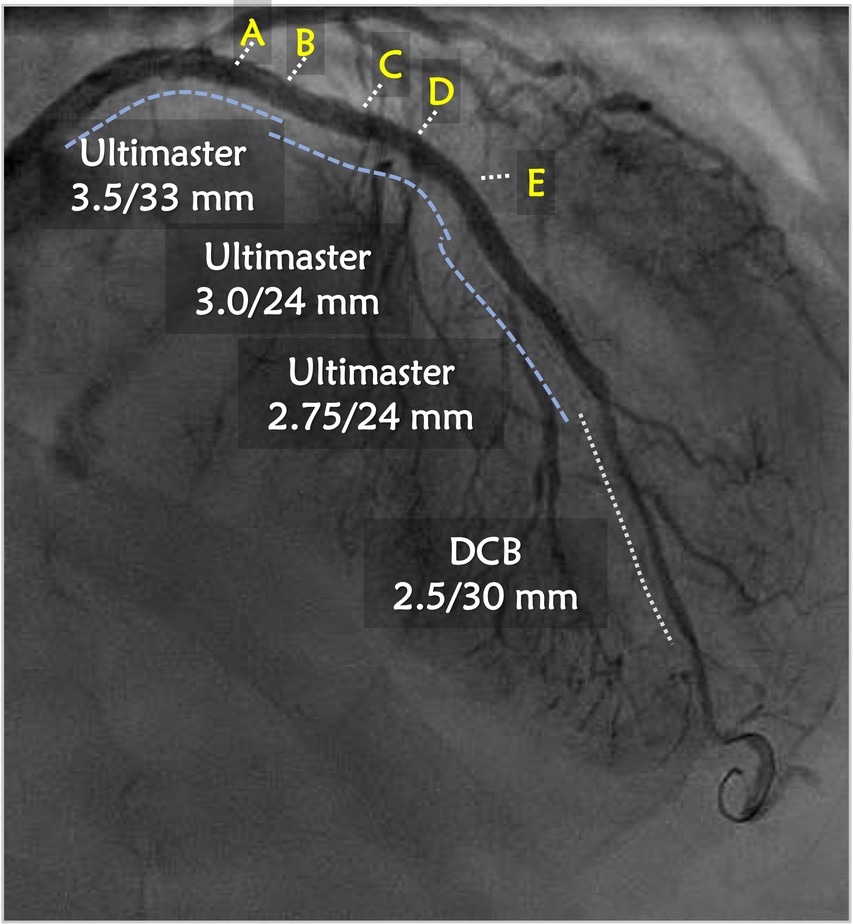
➡ Dissection and lumen expansion

Crack of thick calcification

Crack of thick calcification

Crack of thick calcification

OCT after DES implantation



Diffusely and severely calcified LAD

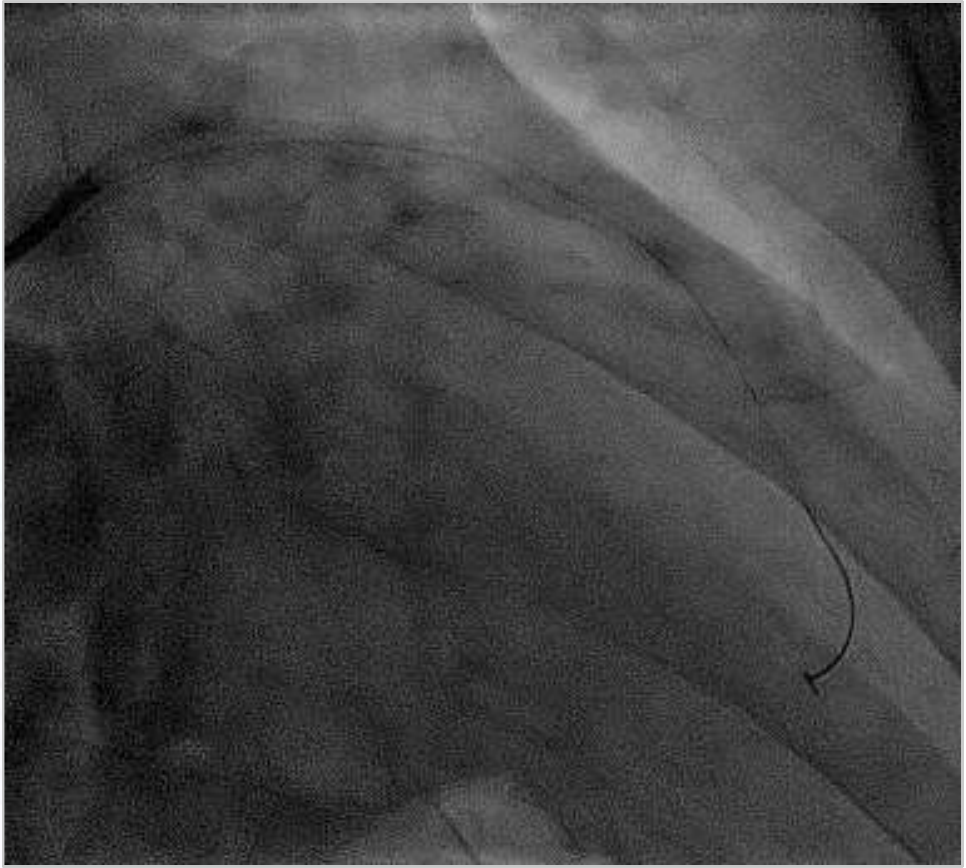
Very Optimal stent Expansion & Optimal stent apposition

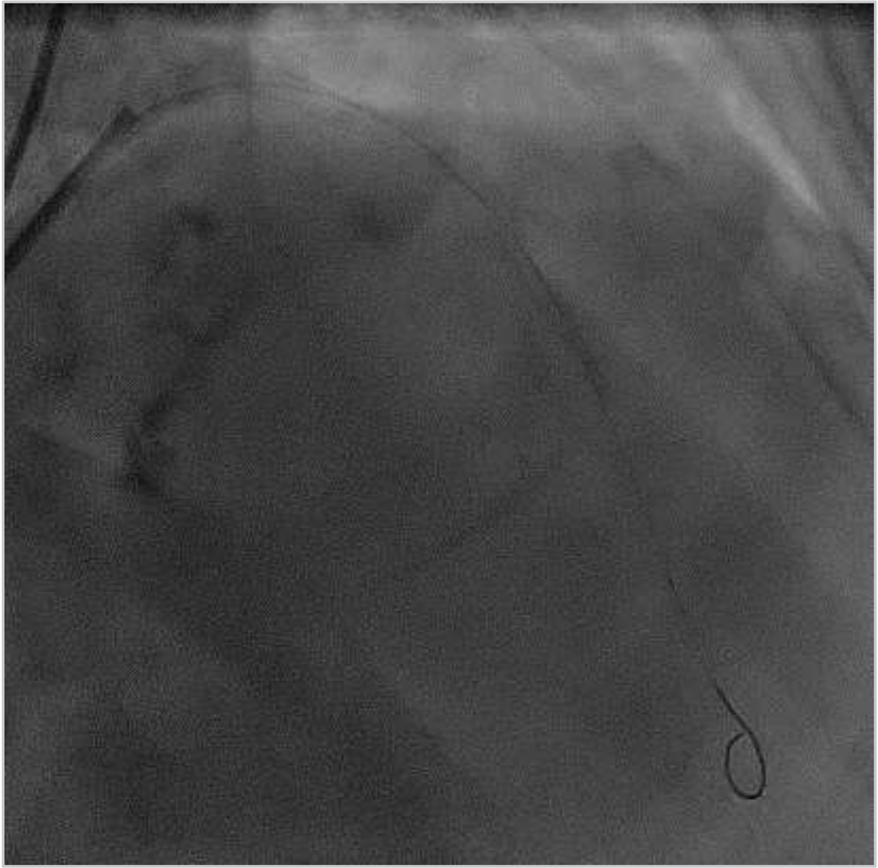
MSA: 5.08 mm^2

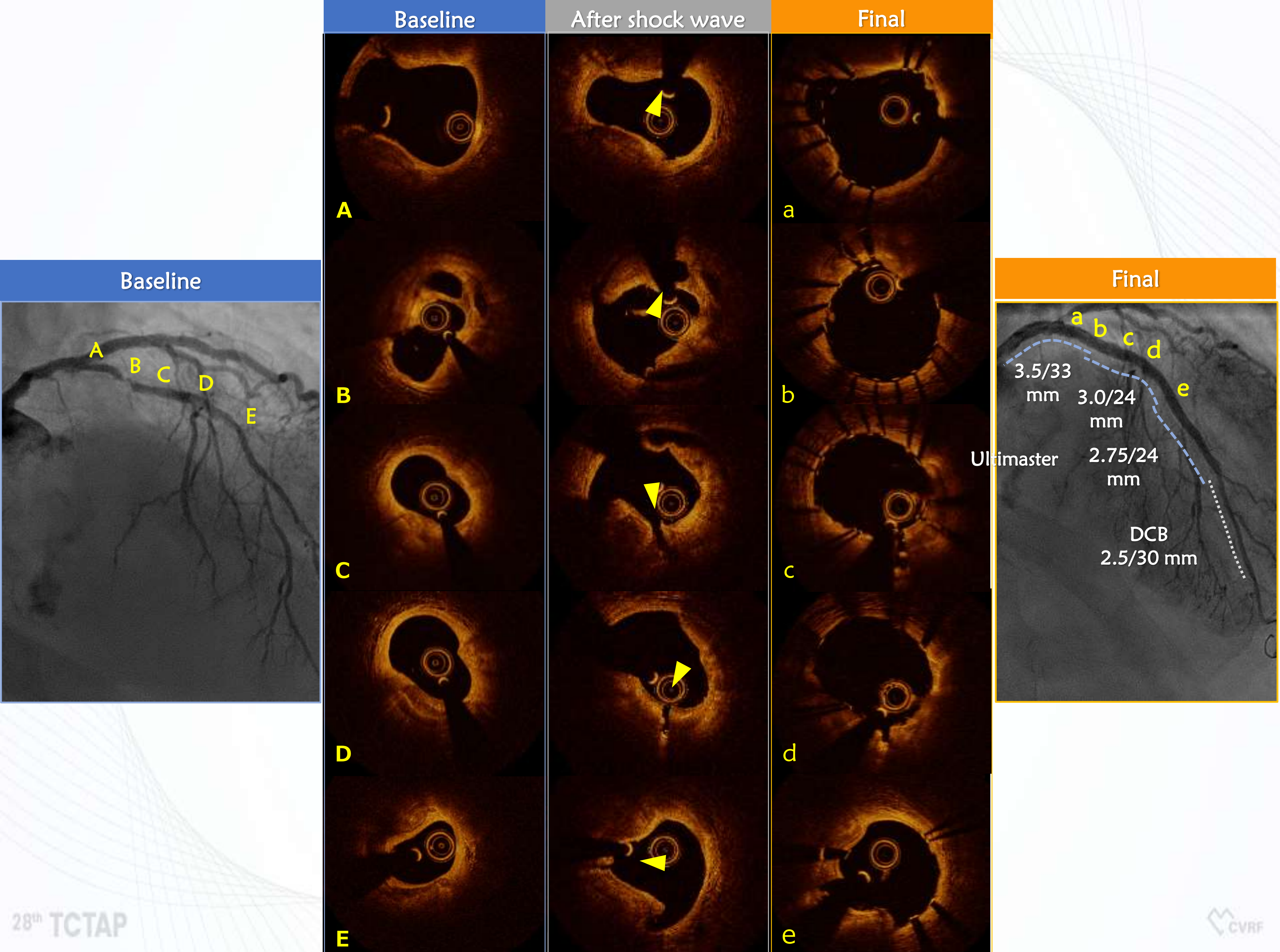
(Segment treated with 2.75mm DES)

DES implantation for the severely calcified lesion after lesion preparation with shock wave

Final angiography



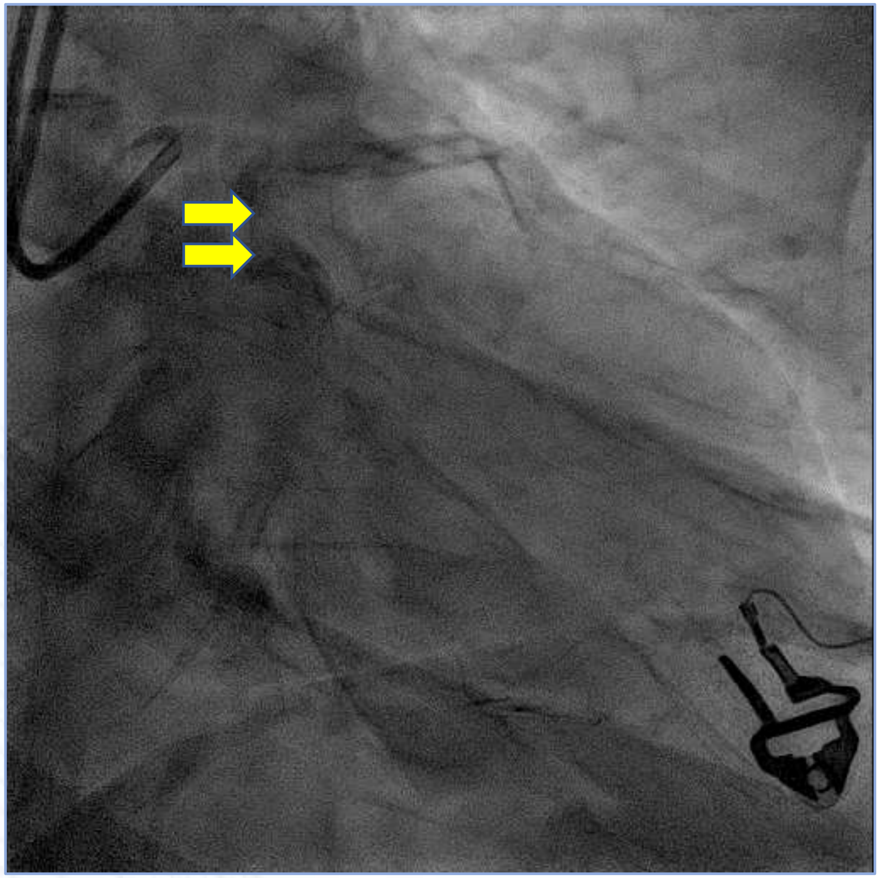




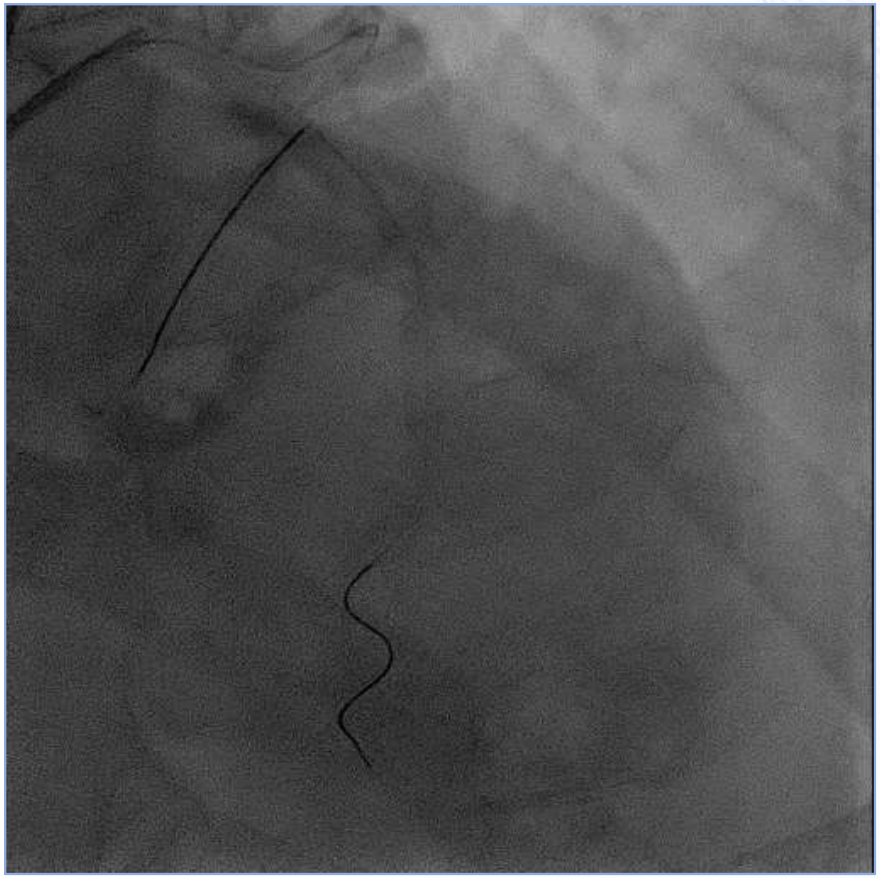
Baseline
After shock wave
Final
A
B
C
D
E
a
b
c
d
e
Baseline
A
B
C
D
E
Final
a
b
c
d
e
3.5/33 mm
3.0/24 mm
Ultimaster
2.75/24 mm
DCB
2.5/30 mm

Case 4. Severely calcified LMT, LAD and LCx lesions

77 year-old, male Stable angina, Coronary risk factors: hypertension, dyslipidemia

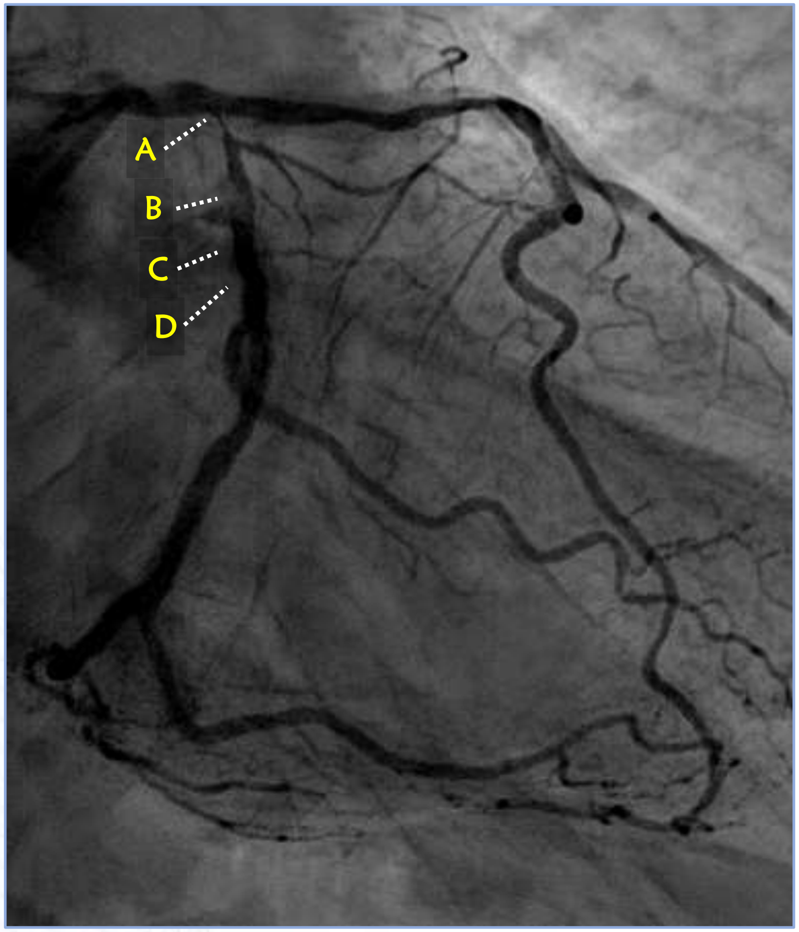


Proximal to mid LCx:
diffusely and severely calcified lesions



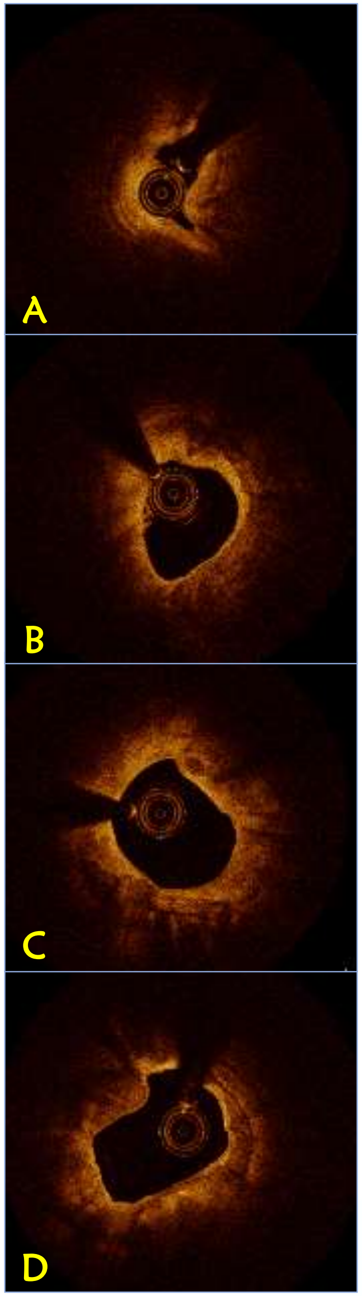
Proximal to mid LAD:
diffusely and severely calcified lesions

Baseline OCT findings LCX



After pre-dilatation with 2.0 NC balloon

➡ baseline OCT

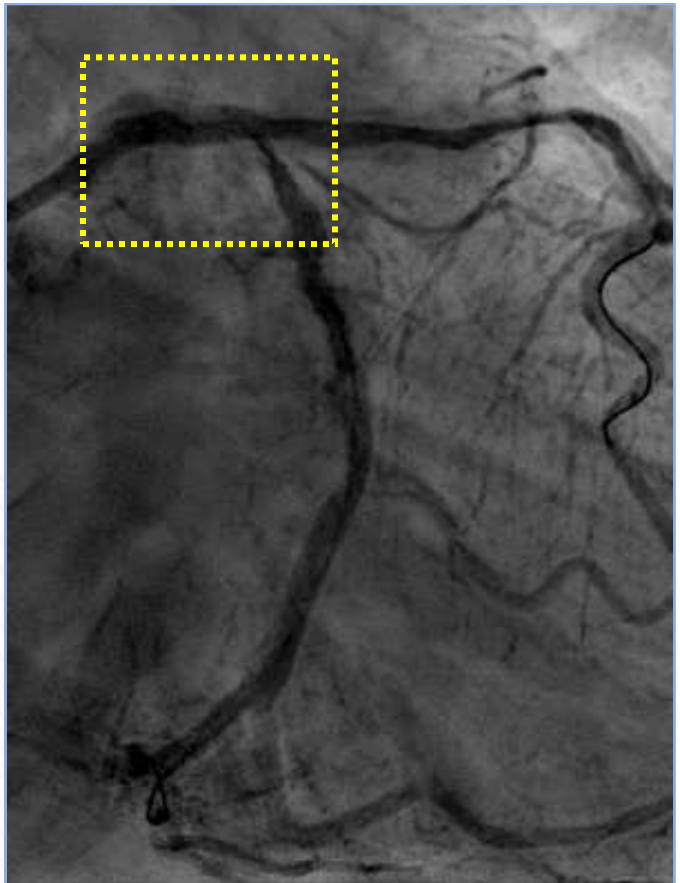


Diffusely and severely calcified LCx

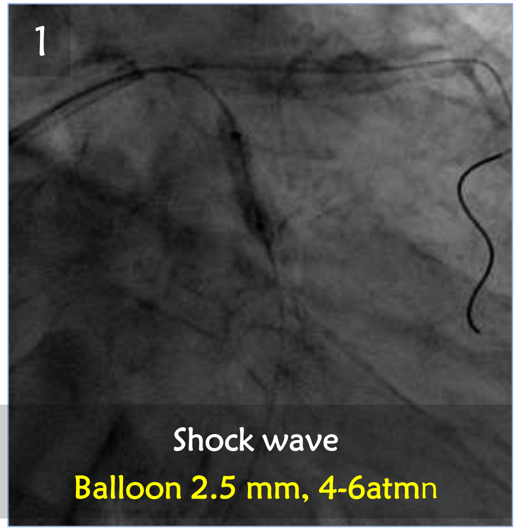
Large arc (>270° degrees)

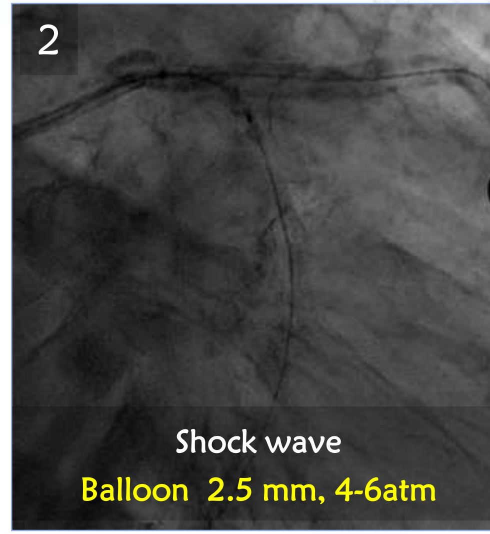
Thick calcification

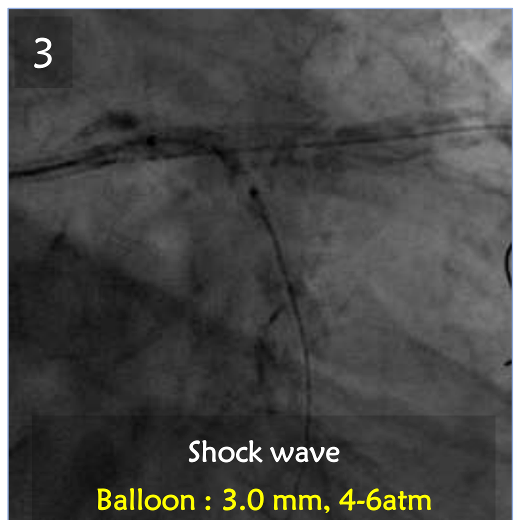
Shock wave for the LCX mid to LMT

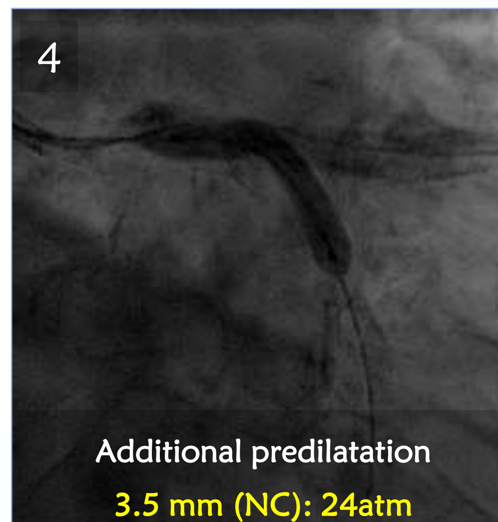


Additional shock wave
for the proximal LCx to LMT
Balloon size up: 2.5 ➡ 3.0 mm

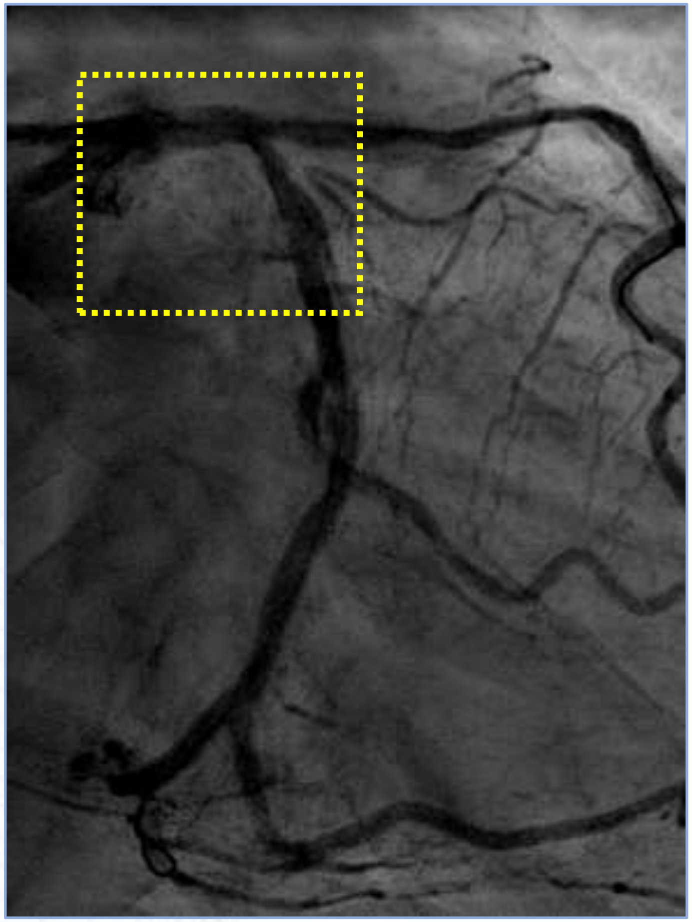




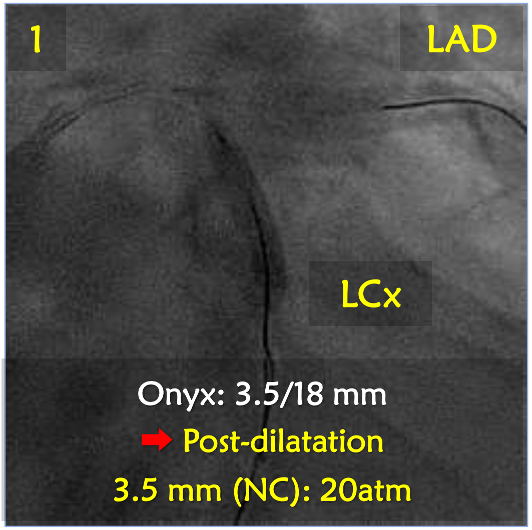




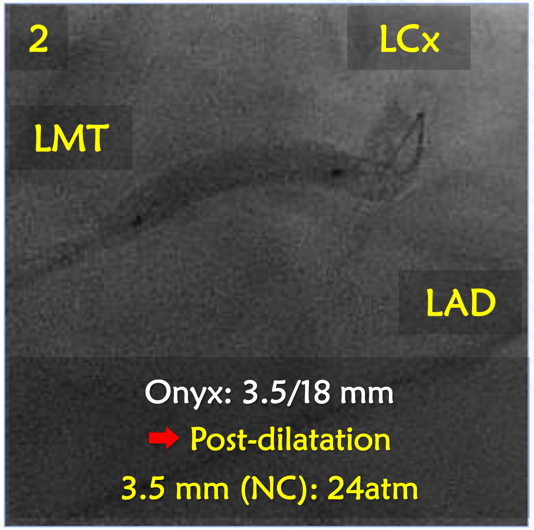
DES implantation for the LMT to the proximal LCx



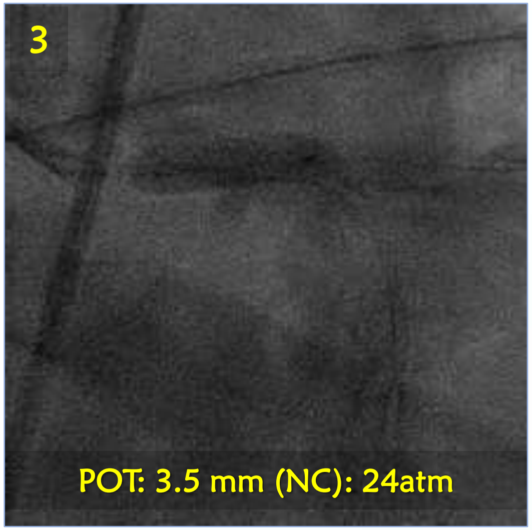
LMT true bifurcation lesion (1.1.1)
➡ Systemic double stenting



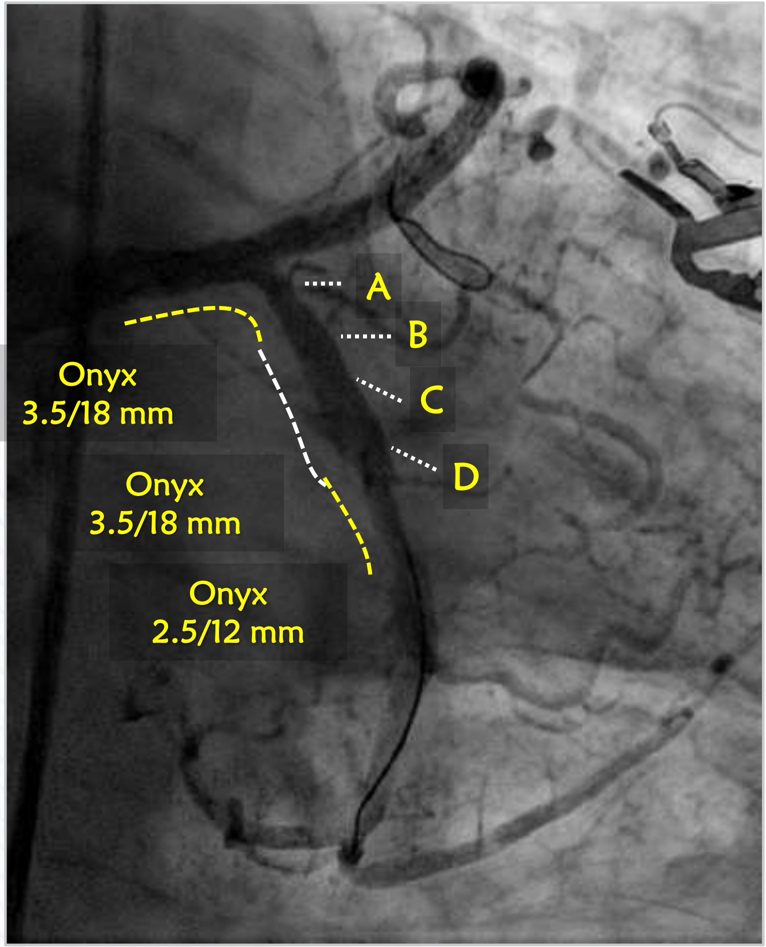
Proximal LCx

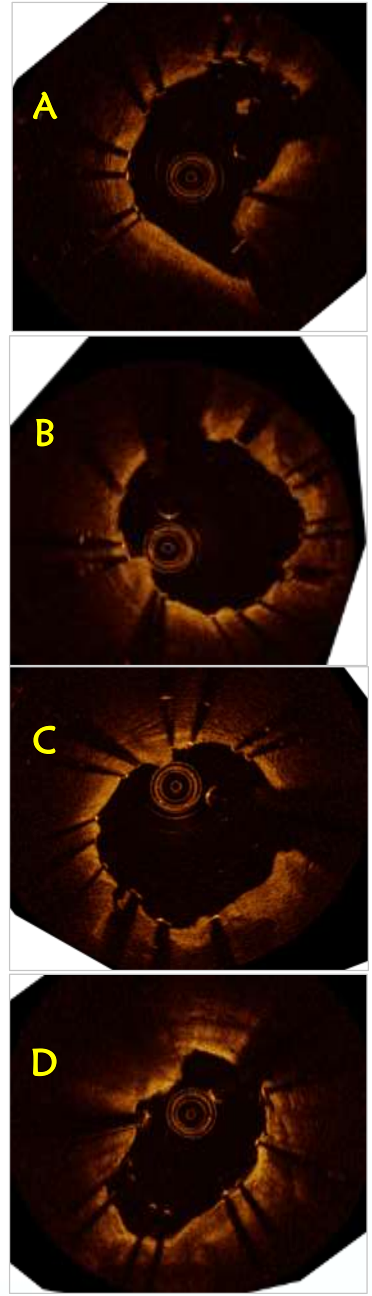


Proximal LCx to LMT



OCT findings:
mid LCx to LMT





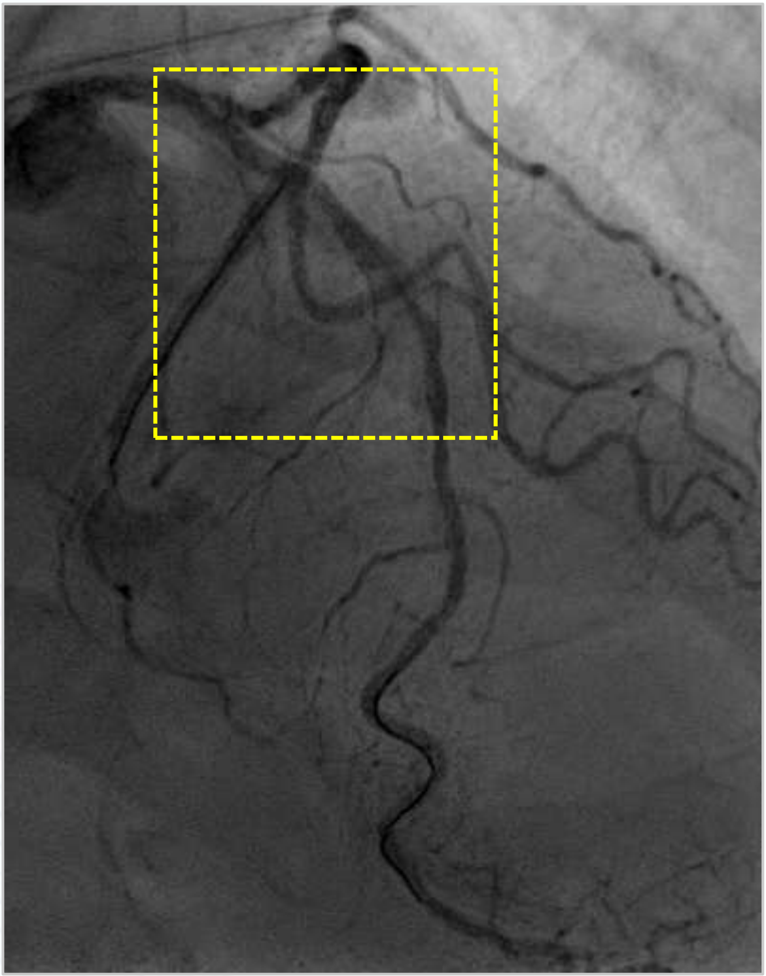
Diffusely and severely calcified LCx

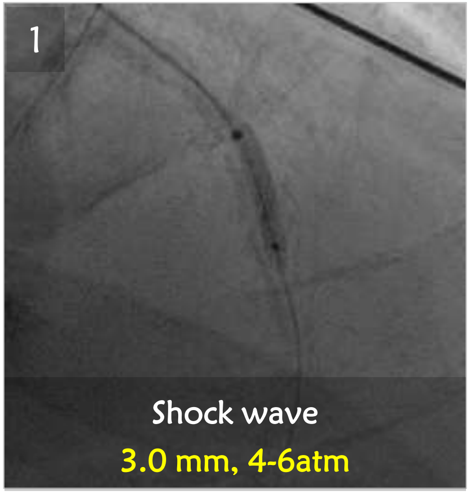
Optimal stent expansion
Optimal stent apposition

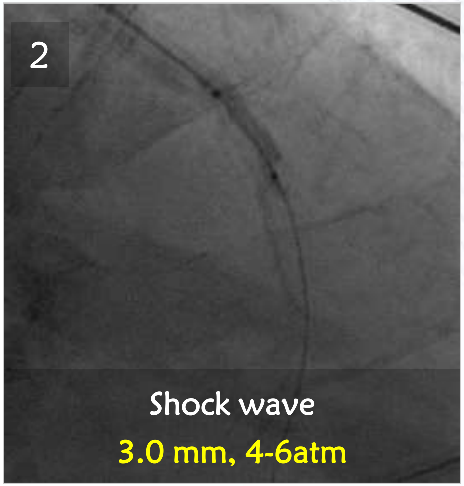
MSA: 4.26 mm^2
(Segment treated with 2.5mm DES)

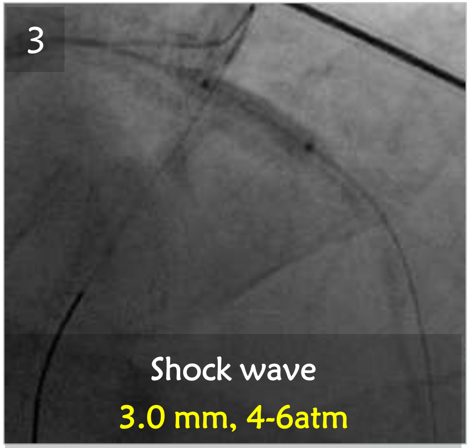
After bailout stenting
➡ No residual dissection extended distally

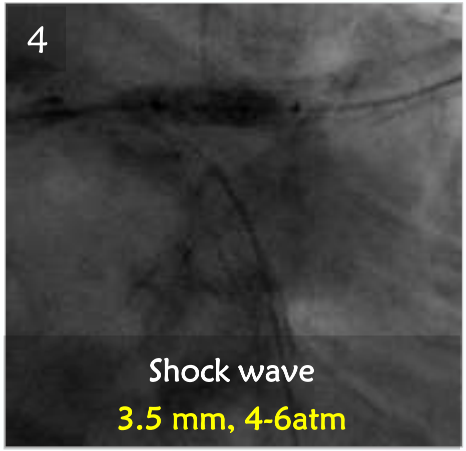
Lesion preparation with shock wave: LAD





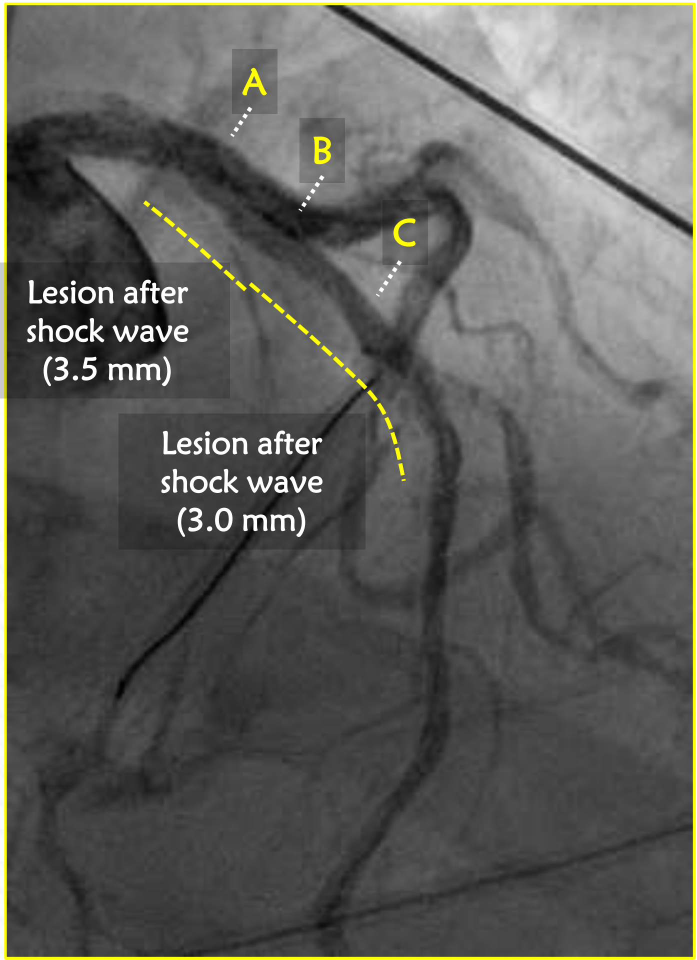




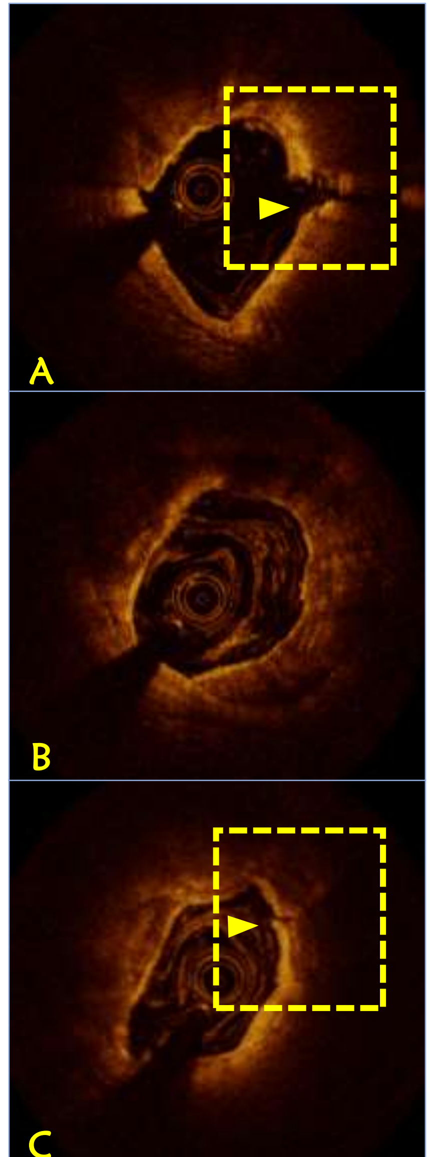


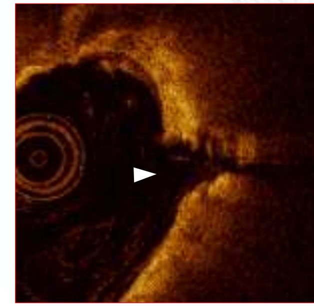
Lesion preparation with shock wave

OCT findings after lesion preparation with shock wave



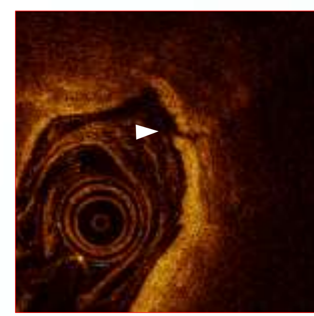
Some part ; unusual expanded lesion without cracks.





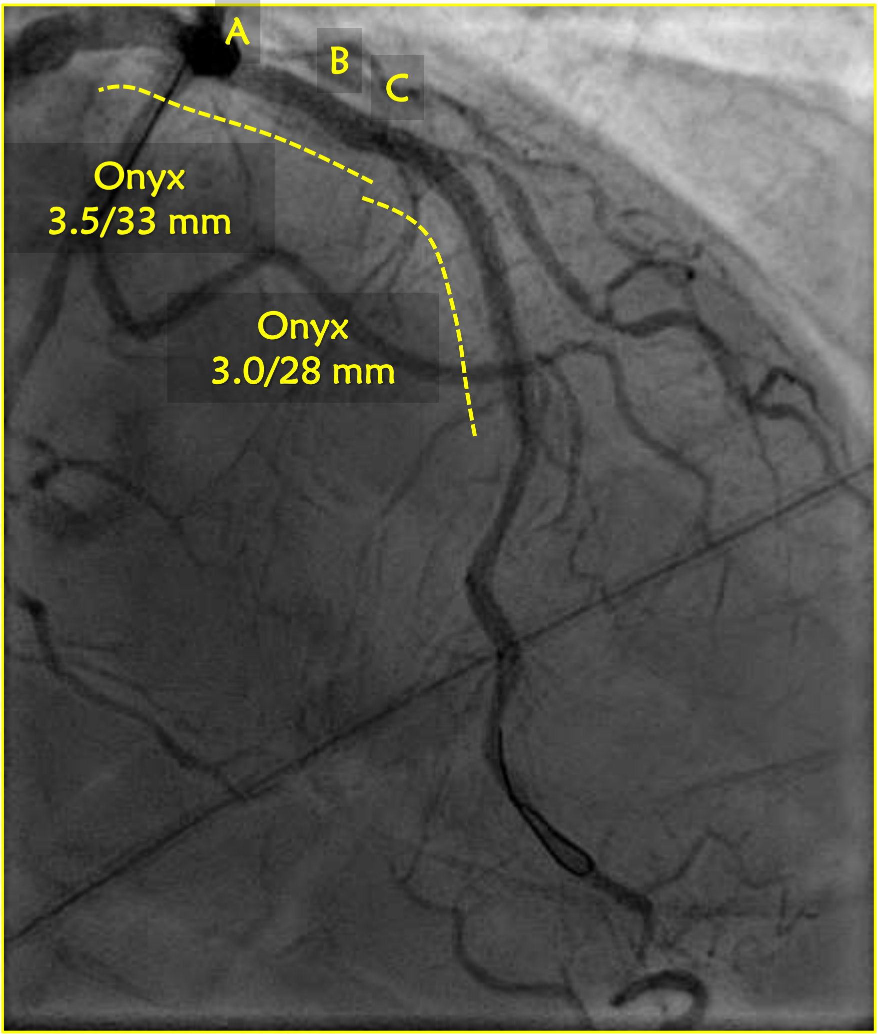
Crack of thick calcification

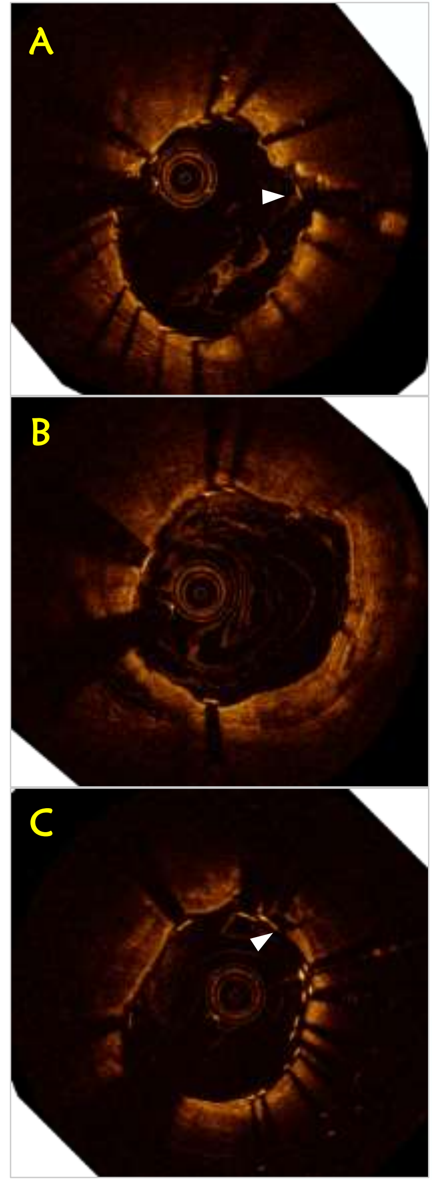
Lesion was expanded; however cracks of calcification were not obviously observed.



Crack of thick calcification

OCT findings: mid to proximal LAD





Diffusely and severely calcified LAD

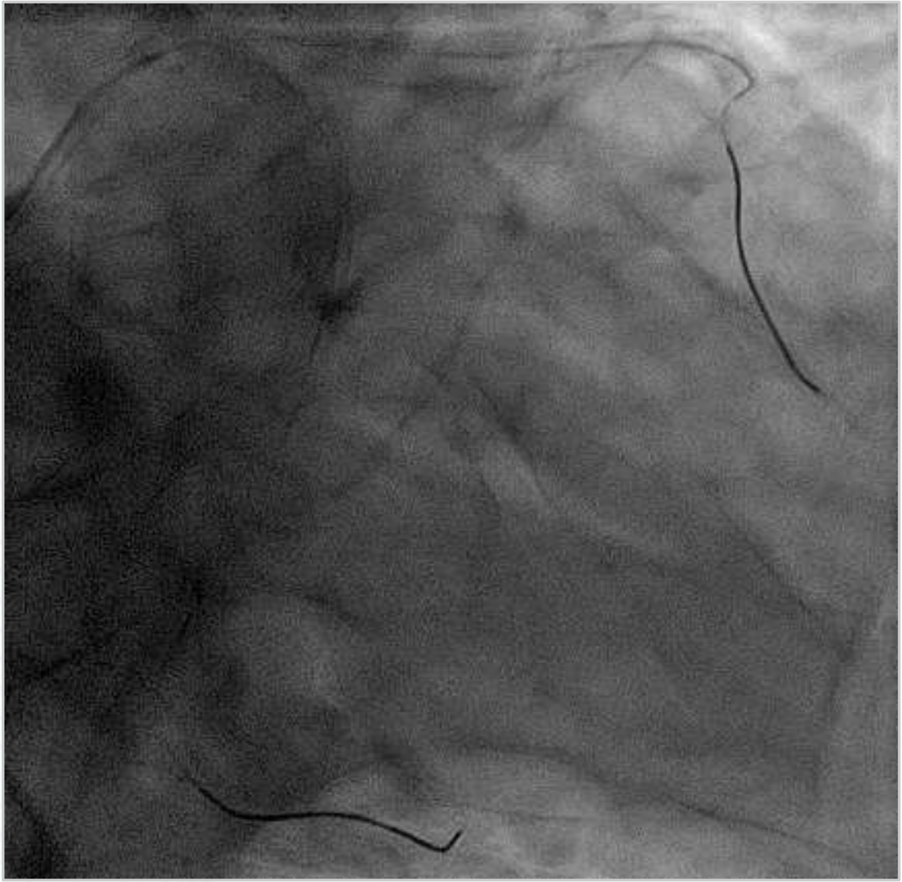
Optimal stent expansion
Optimal stent apposition

MSA: 5.39 mm^2
(Segment treated with 3.0mm DES)

No dissection extended distally

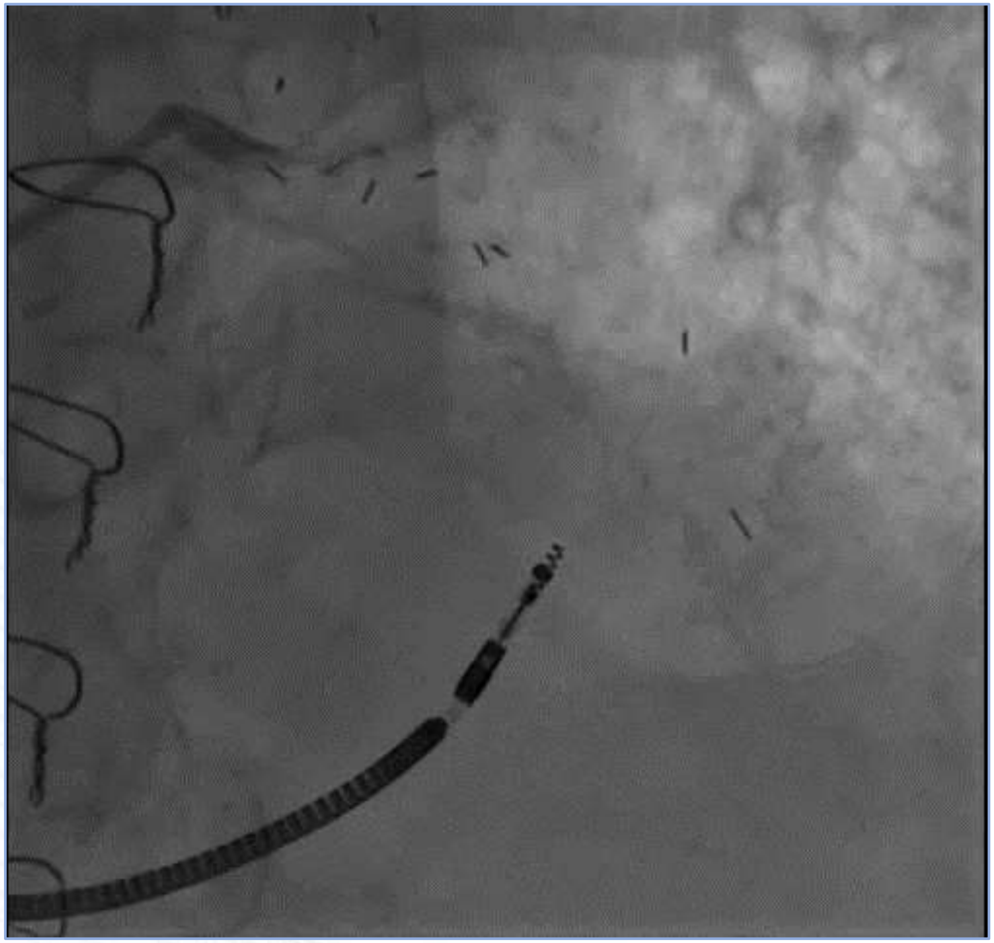
DES implantation for the severely calcified lesion

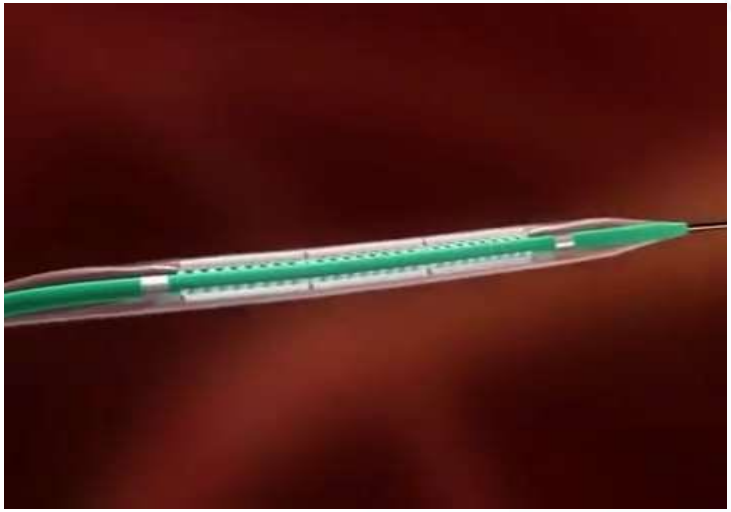
after lesion preparation with shock wave



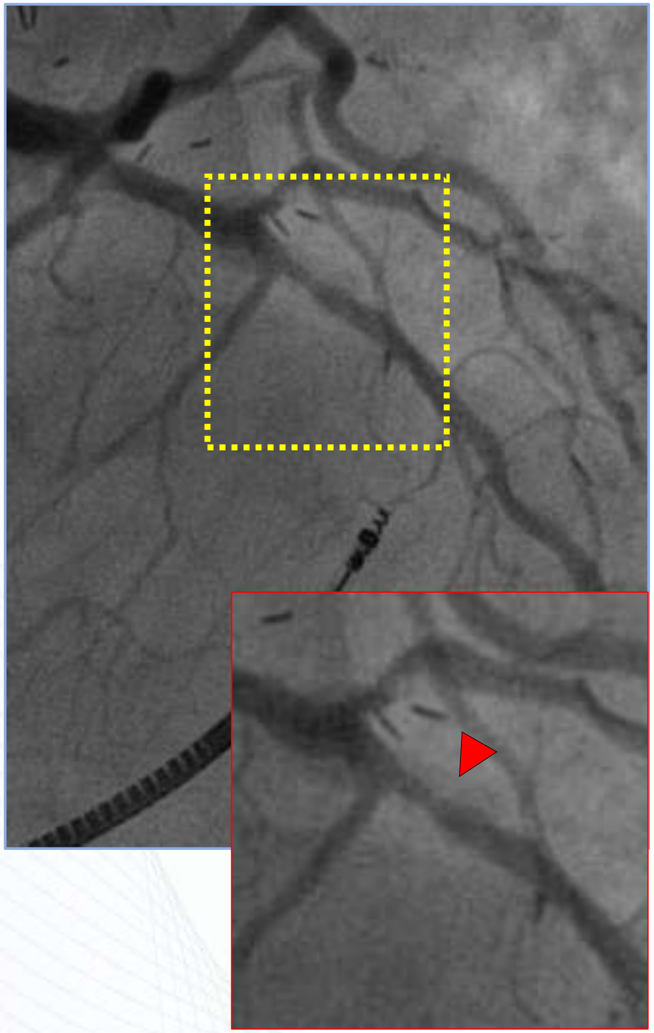
Final angiography

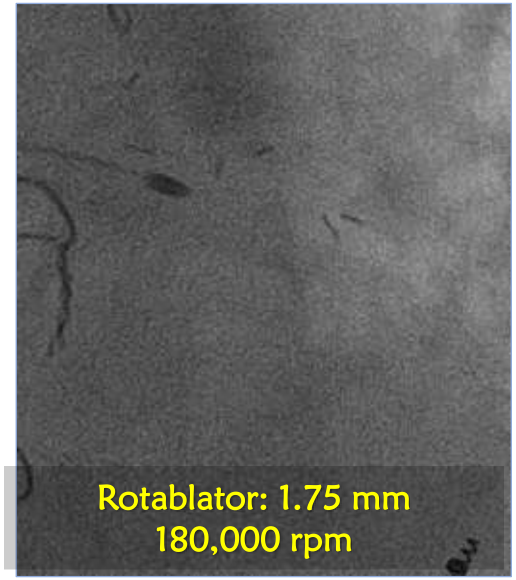
Case 5 : High pressure Cutting Balloon



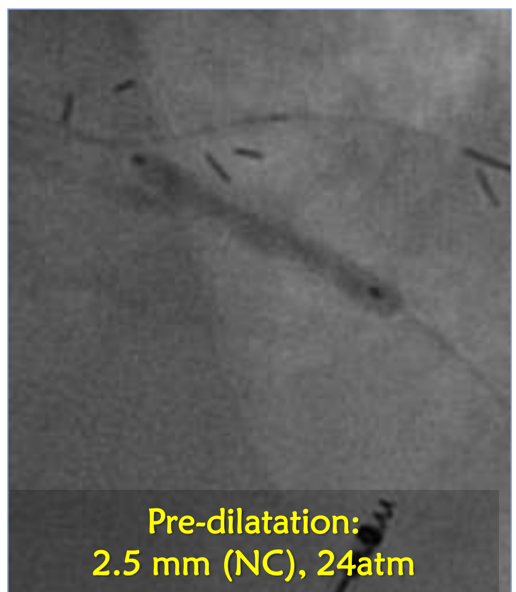


Case 5 : Very Calcified LAD Stenosis





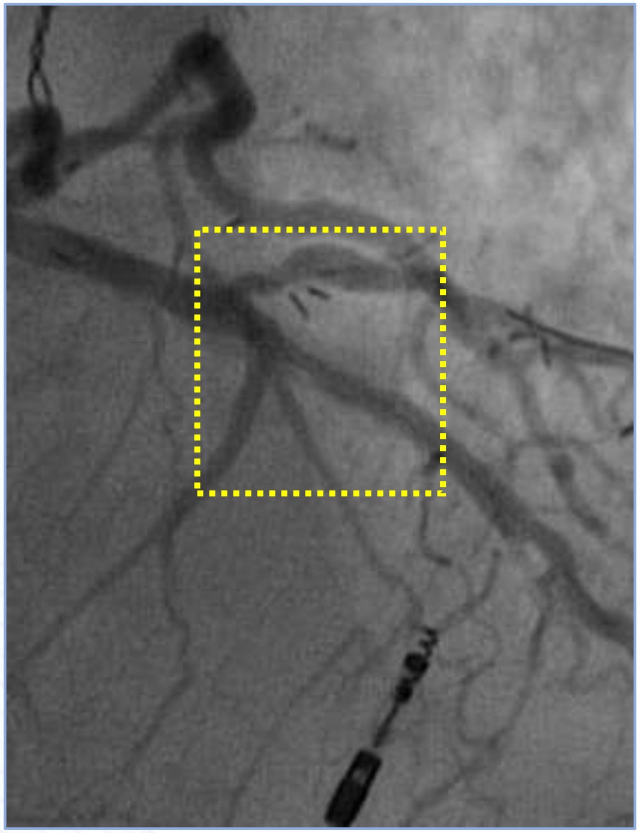
Rota burr (1.75 mm) crossed the lesion.

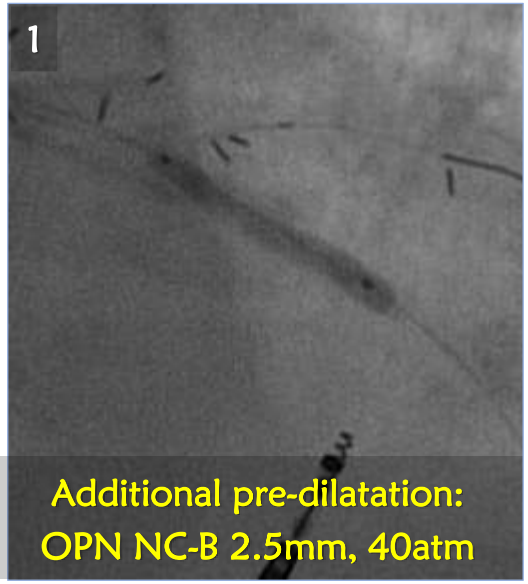


Subsequent pre-dilatation with 2.5 mm NC balloon at high pressure (24atm)

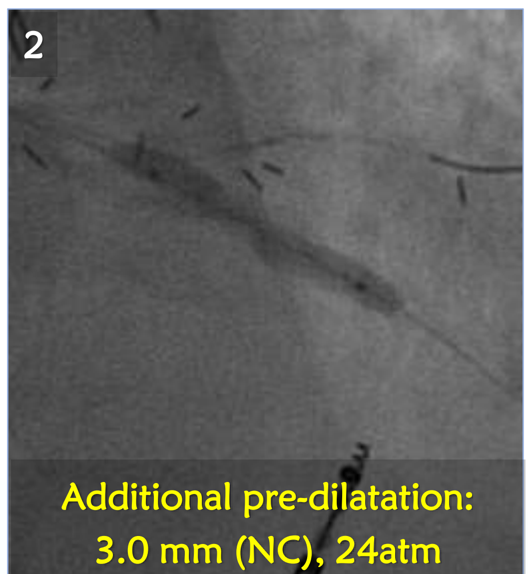
➡ The lesion could not be expanded sufficiently.

Additional lesion preparation: OPN NC balloon





Additional pre-dilatation:
OPN NC-B 2.5mm, 40atm



Additional pre-dilatation:
3.0 mm (NC), 24atm

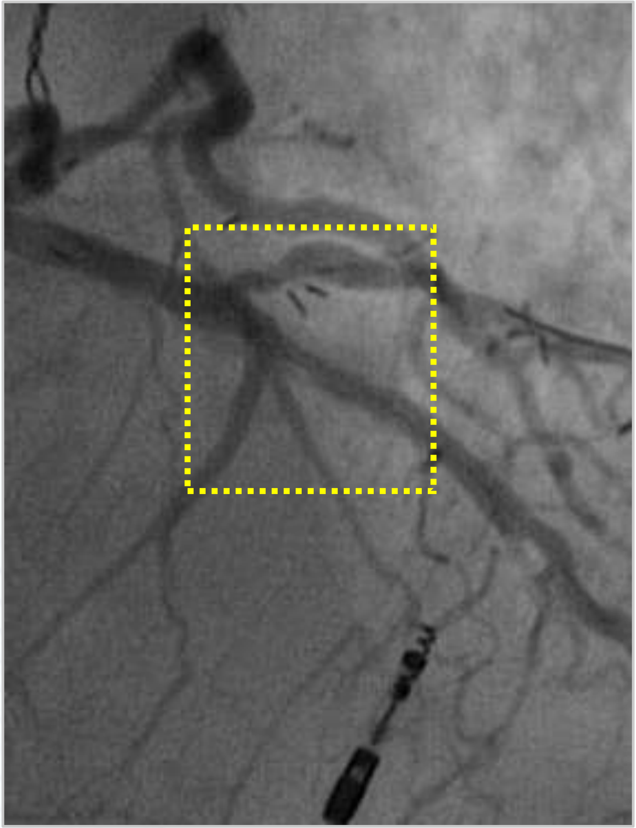
Additional pre-dilatations

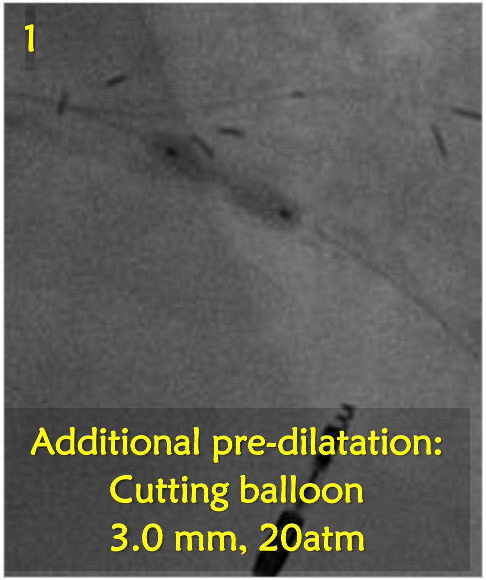
OPN NC balloon:
2.5 mm, **40atm**

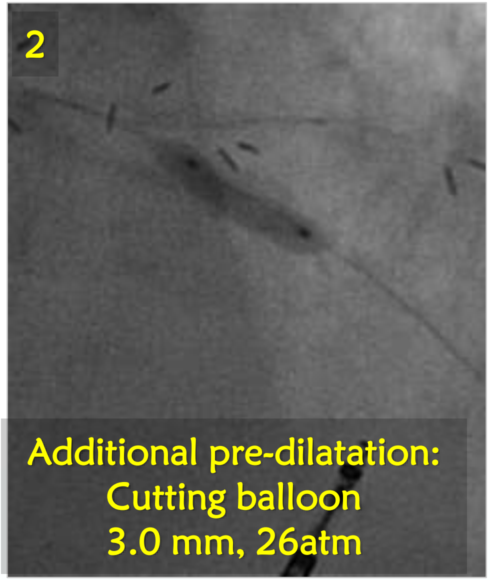
NC balloon:
3.0 mm, **24atm**

➡ Even multiple high pressure pre-dilatations, the lesion could not be expanded sufficiently.

Additional lesion preparation : With HP cutting balloon





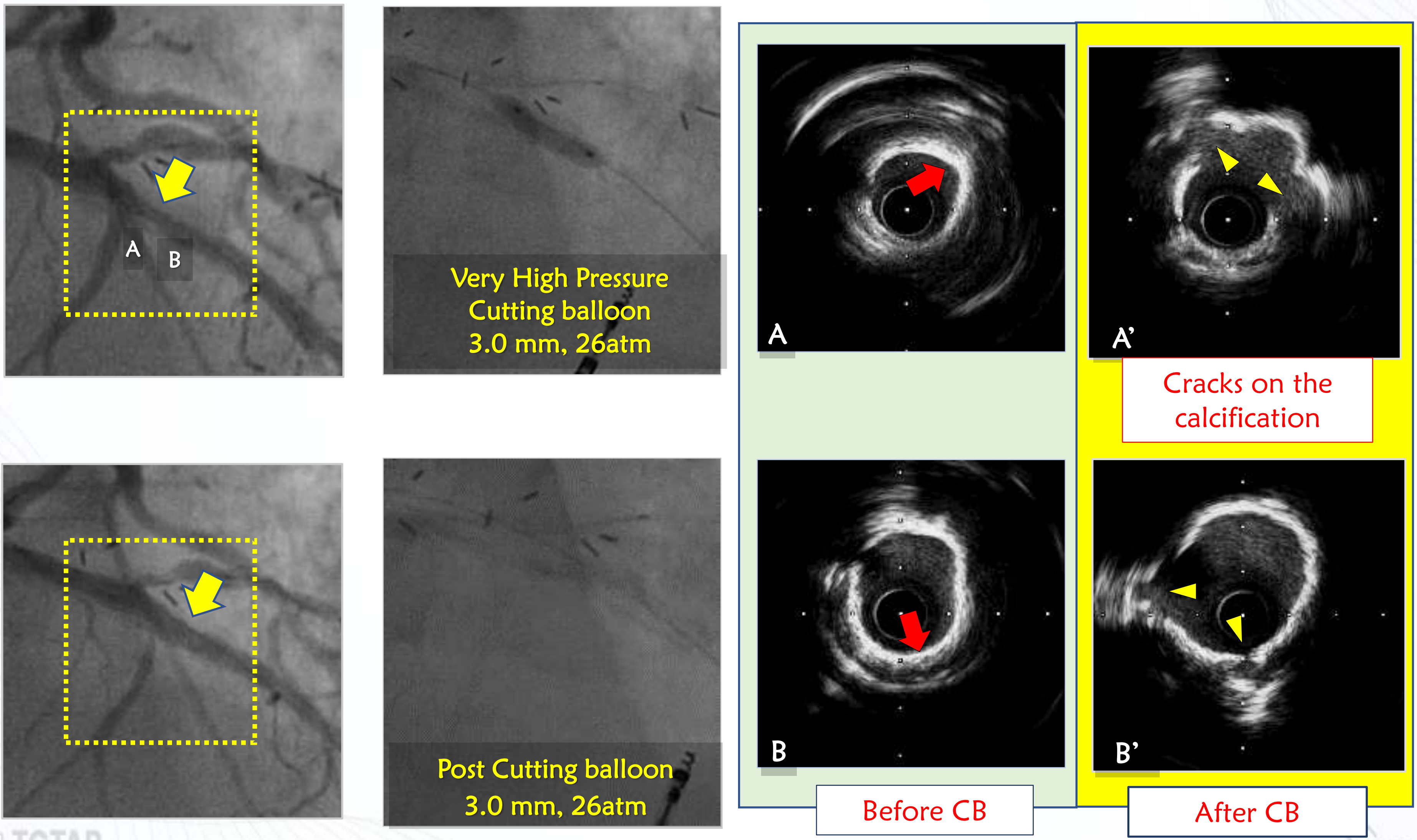


Considering severely calcified lesions, pre-dilatation with cutting balloon at high pressure was additionally attempted.

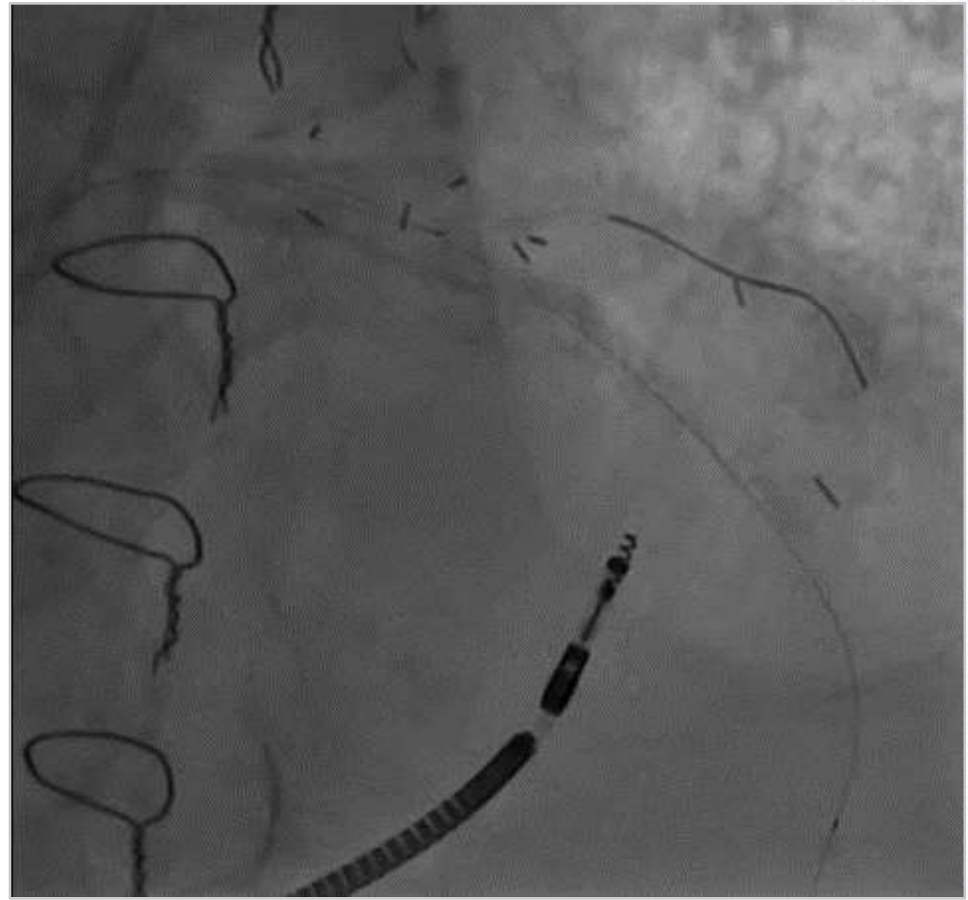
Very High Pressure Cutting Balloon

➡ The lesion could be expanded.

Very High Pressure Cutting Balloon for Calcified Lesion



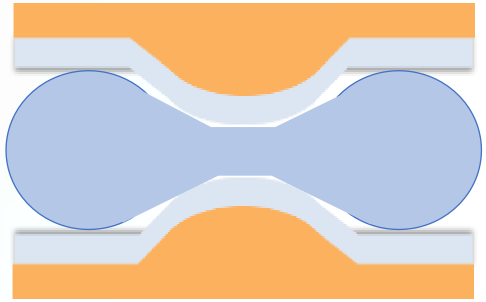
Finally , DCB ballooning : after cutting and NC



According to the IVUS findings showing optimal lesion preparation, the lesion was treated with DCB

Expansion force: NC balloon vs. Cutting balloon

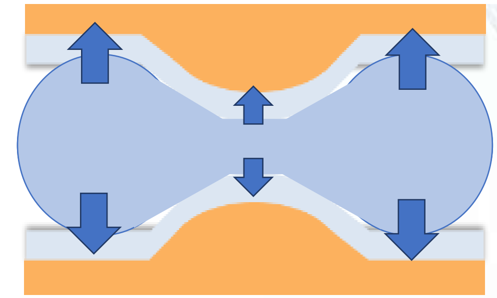
NC balloon



Suboptimal expansion at the severely calcified stenosis

High pressure

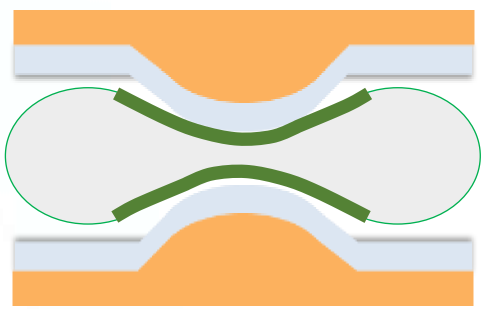
Non-uninform expansion



Expanding force tends to be distributed more to the segments with less resistance.

➡ Insufficient expansion at the tight lesion.

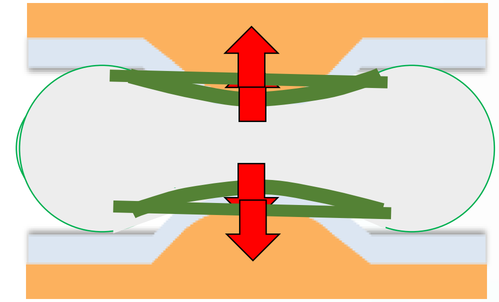
Cutting balloon



Suboptimal expansion at the severely calcified stenosis

High pressure

Uninform expansion



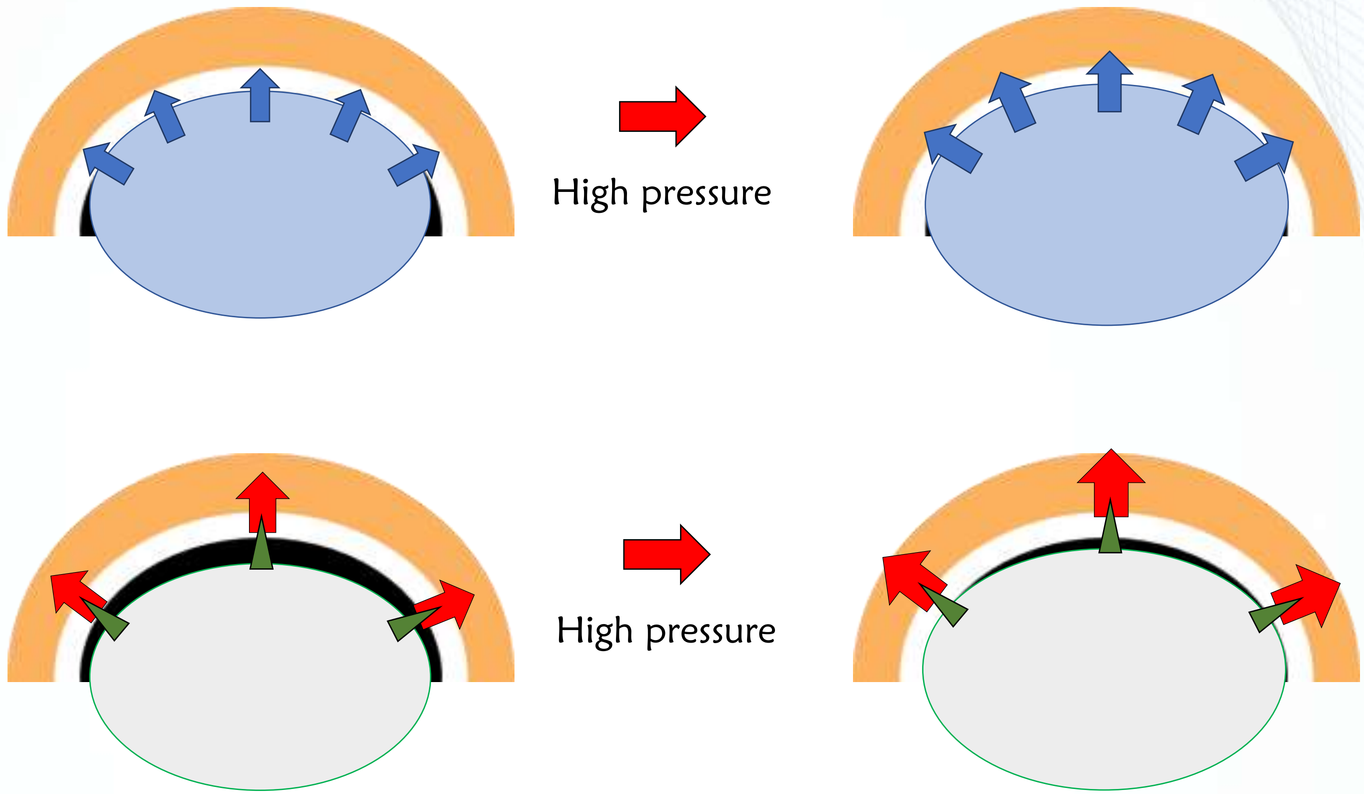
By the blade of cutting balloon, expanding force can be uniformly transmitted to the lesion.

➡ Sufficient expansion at the tight lesion.

Expansion force: NC balloon vs. Cutting balloon

NC balloon

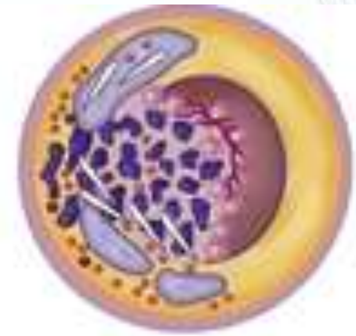
Cutting balloon

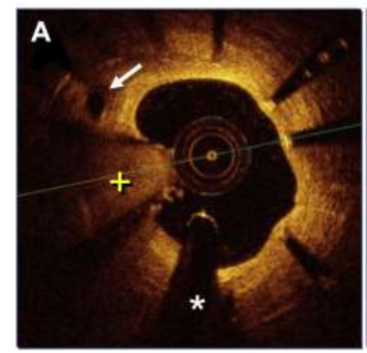


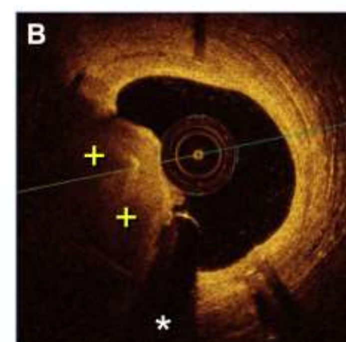
Expansion force is divided by balloon surface area contacting the lesion.

Cutting balloon can contact the lesion at the point of the blades, resulting in stronger expansion force creating cracks on the calcifications

Calcified Nodule

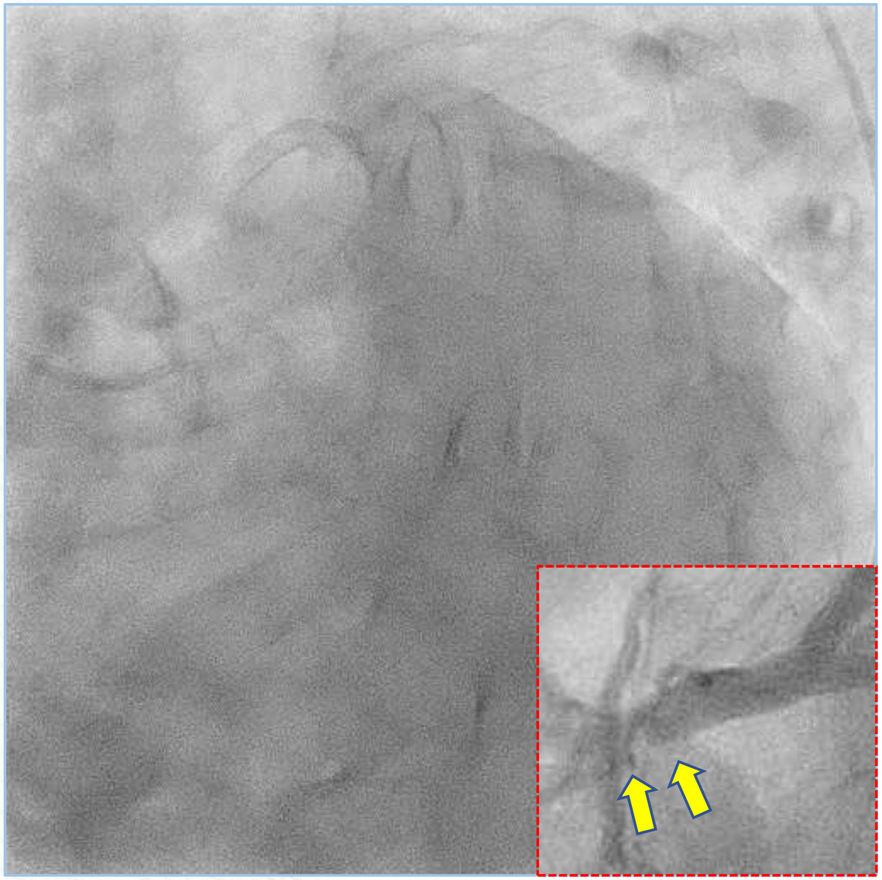


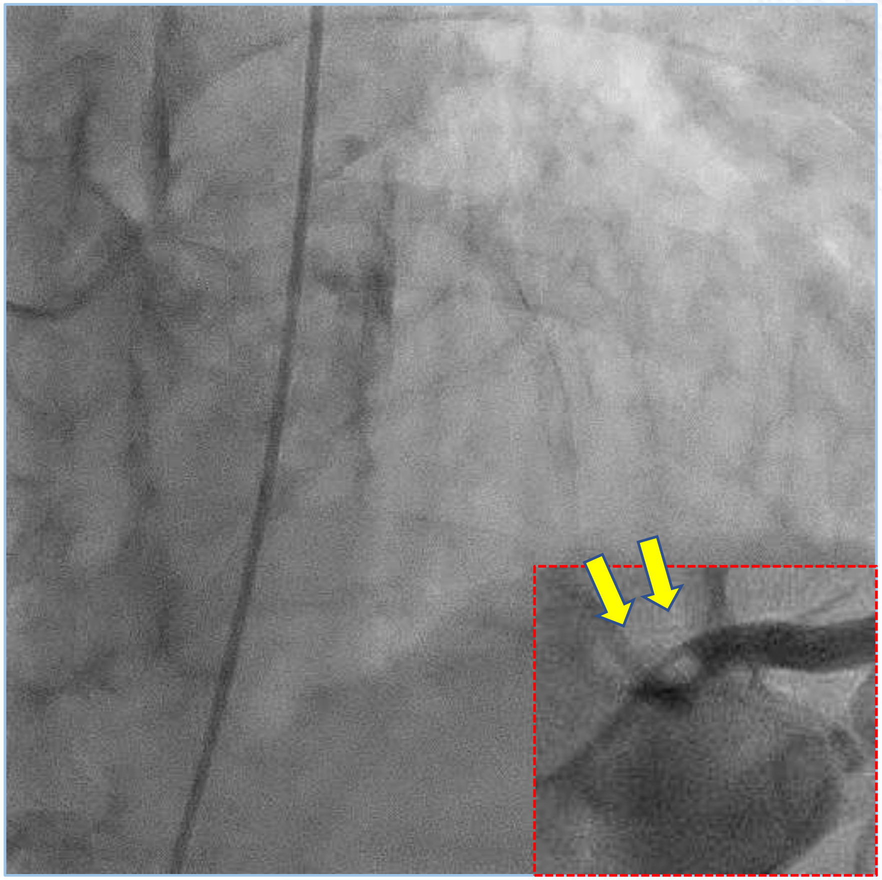




Case 6 : 60's Male HD ; SAP, LMT ISR with calcified nodule

HD patients, Coronary risk factors: HTN, DL, IDDM, EF 55.4% (antero-septal Cre 5.63mg/dl (eGFR 9), BNP 1374.0pg/ml LDL-chol 87mg/dl, HDL-chol 32mg/dl, A1c 6.6% EF 48%(modified Simpson),

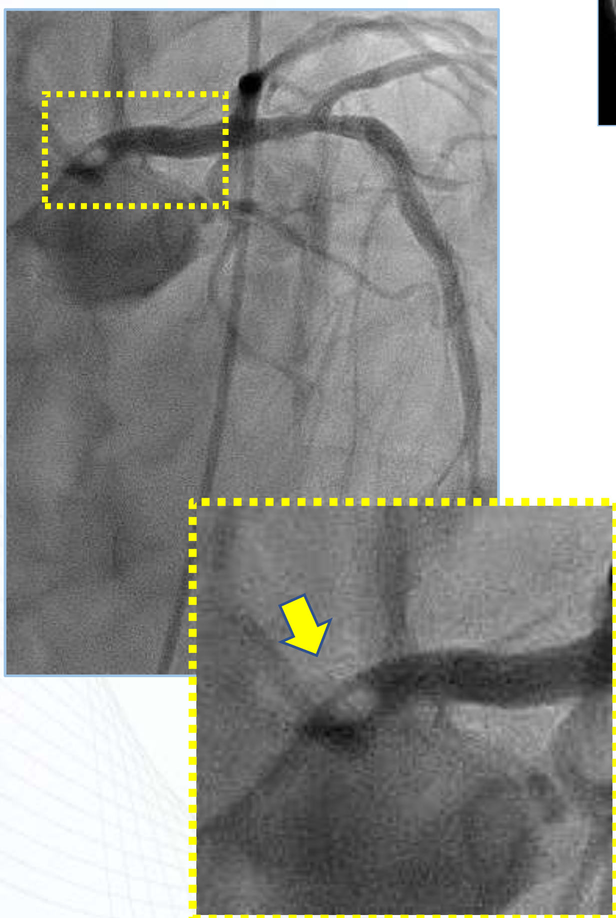


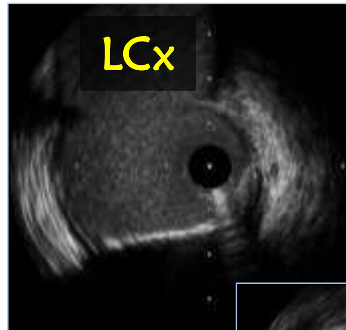


Significant ISR in proximal LMT

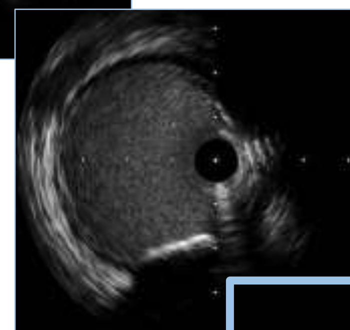
IVUS images : Baseline !!

Pre IVUS evaluation

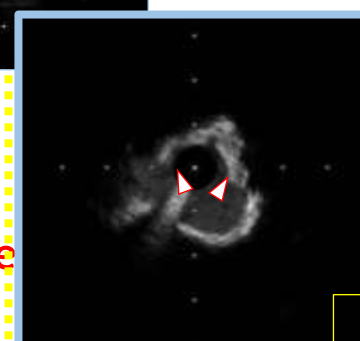




LMT distal bifur.

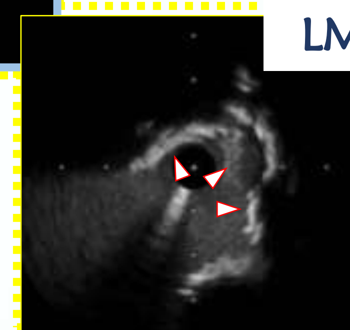


LMT body



LMT lesion

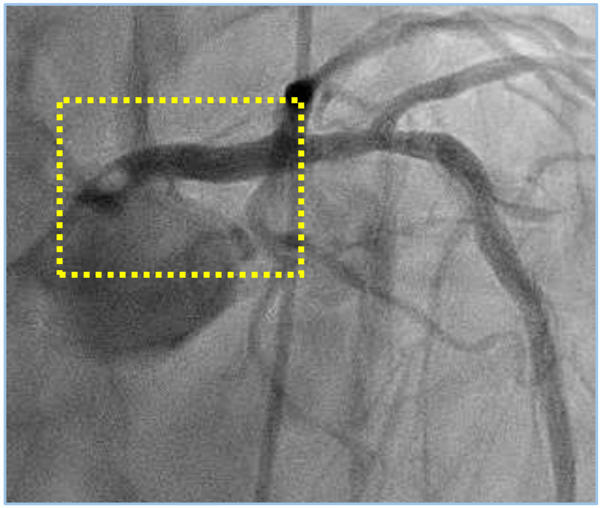
Severe stenosis
with calcified nodule

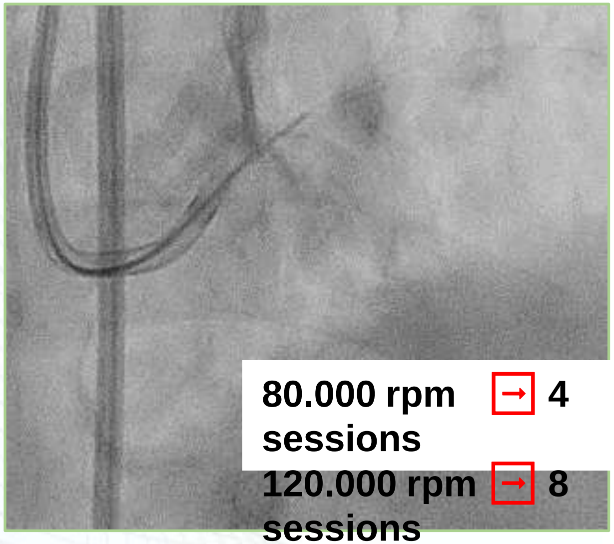


LMT os

Severe stenosis
with calcified nodule

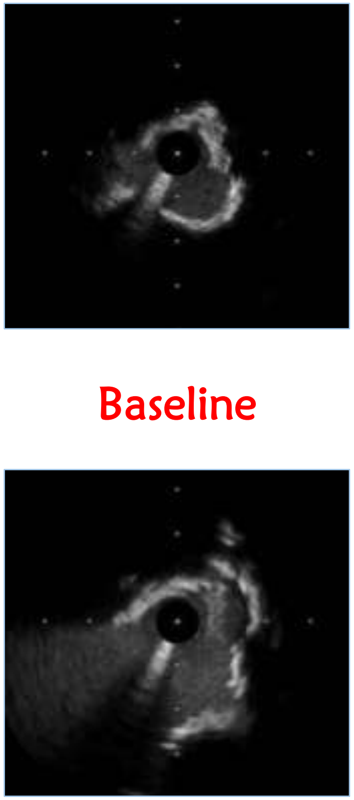
IVUS images before and after OAS



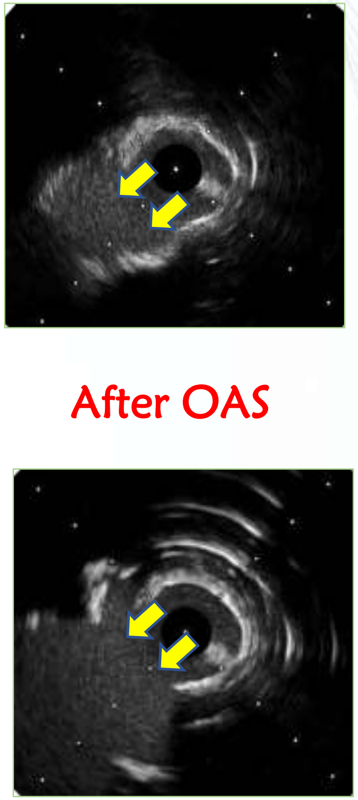


80.000 rpm → 4 sessions
120.000 rpm → 8 sessions

Diamondback for calcified nodule in LMT



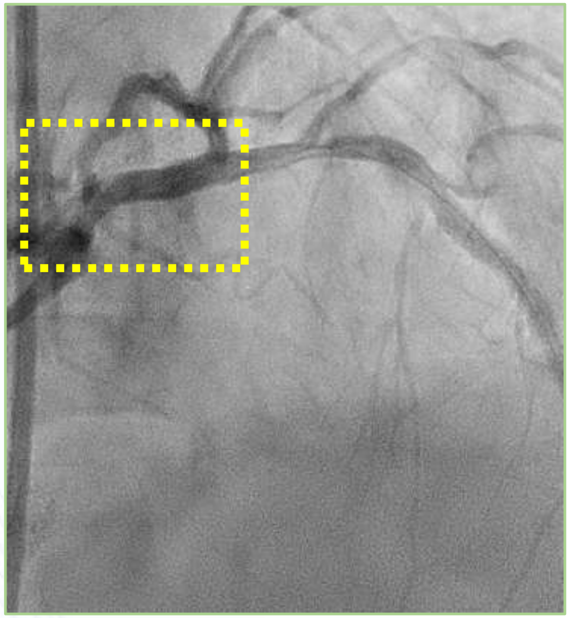
Baseline



After OAS

lesion modification with Diamondback

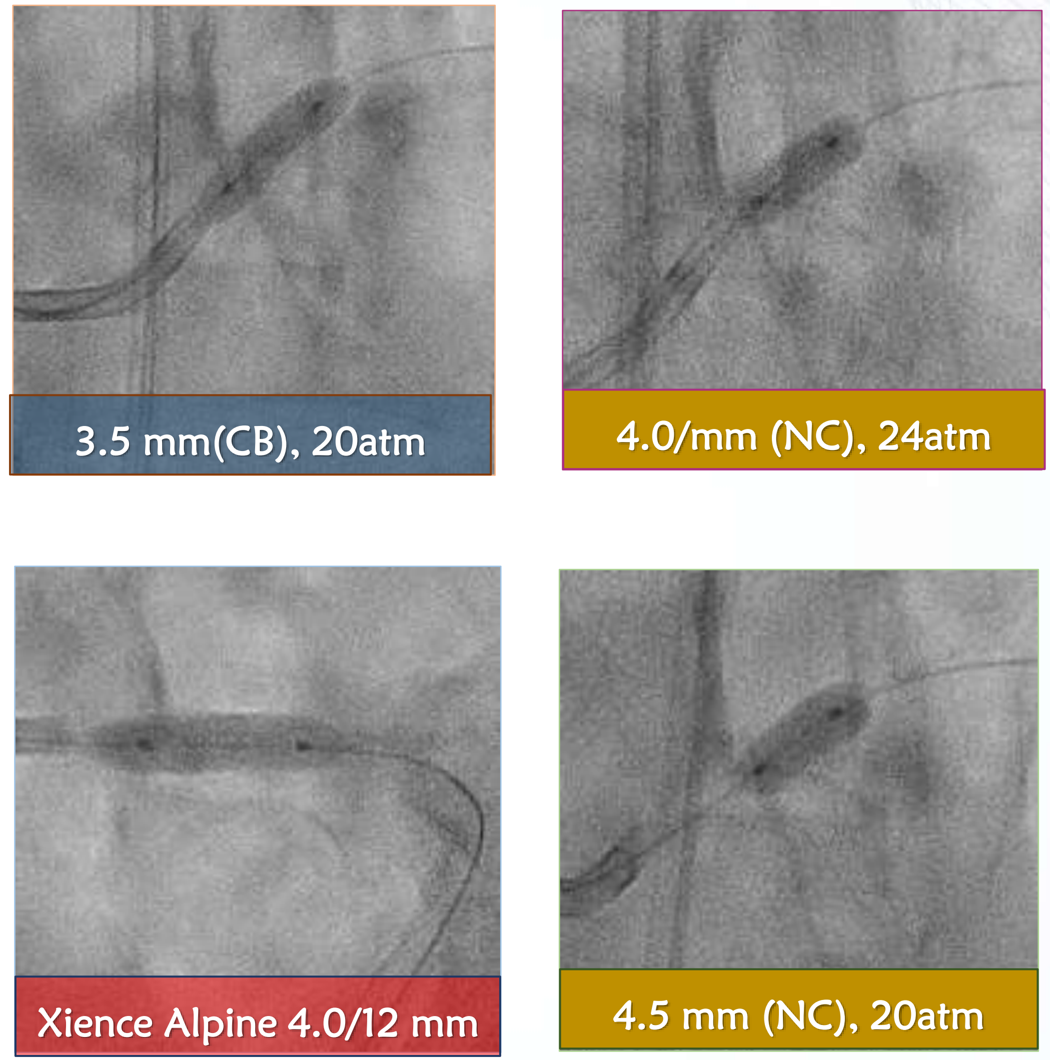
Case 6 : 60's Male HD ; SAP, LMT ISR with calcified nodule



Additional

lesion preparation

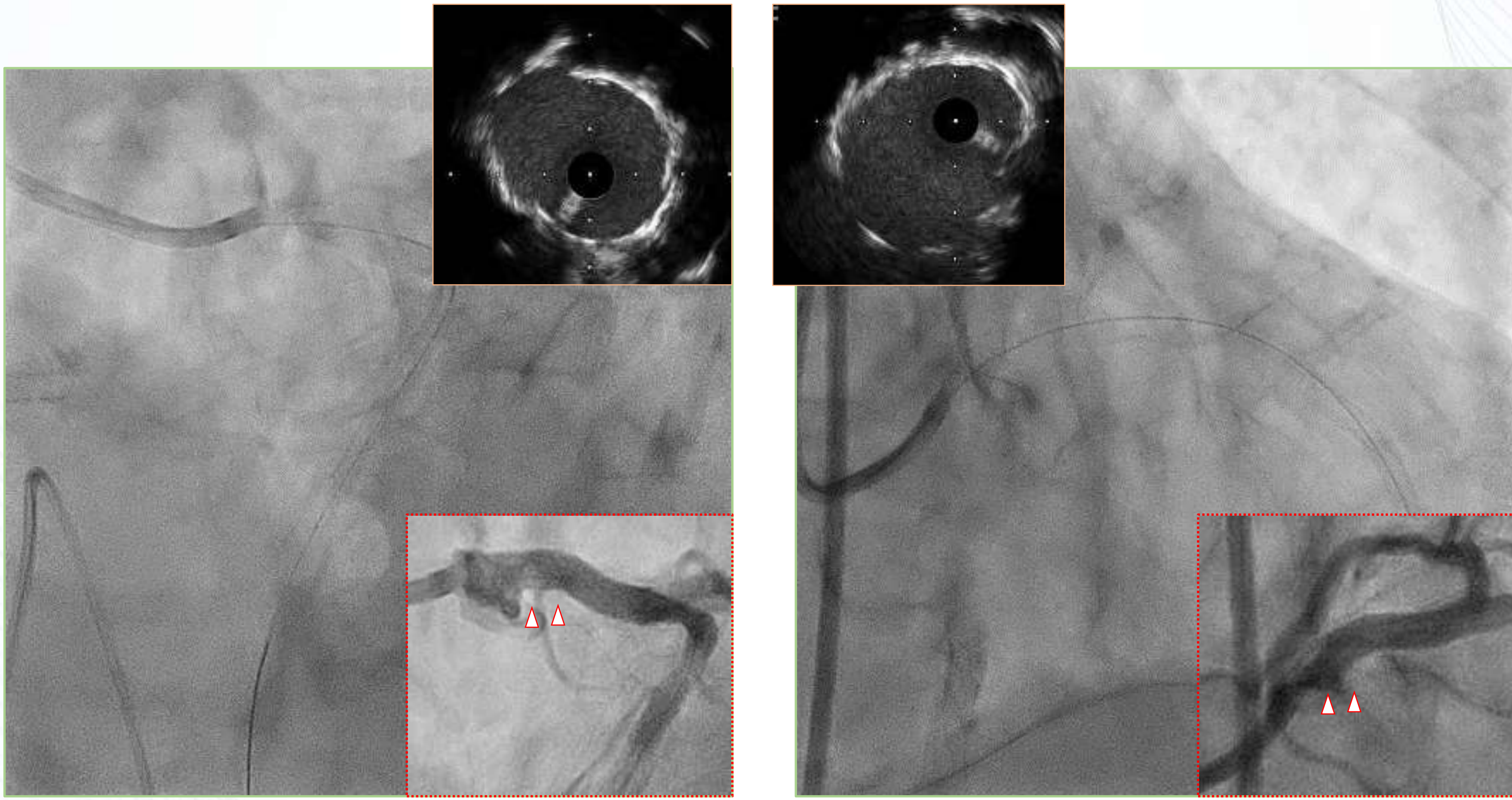
And Stenting



Stent implantation and optimization

Case 6 : 60's Male HD ; SAP, LMT ISR with calcified nodule

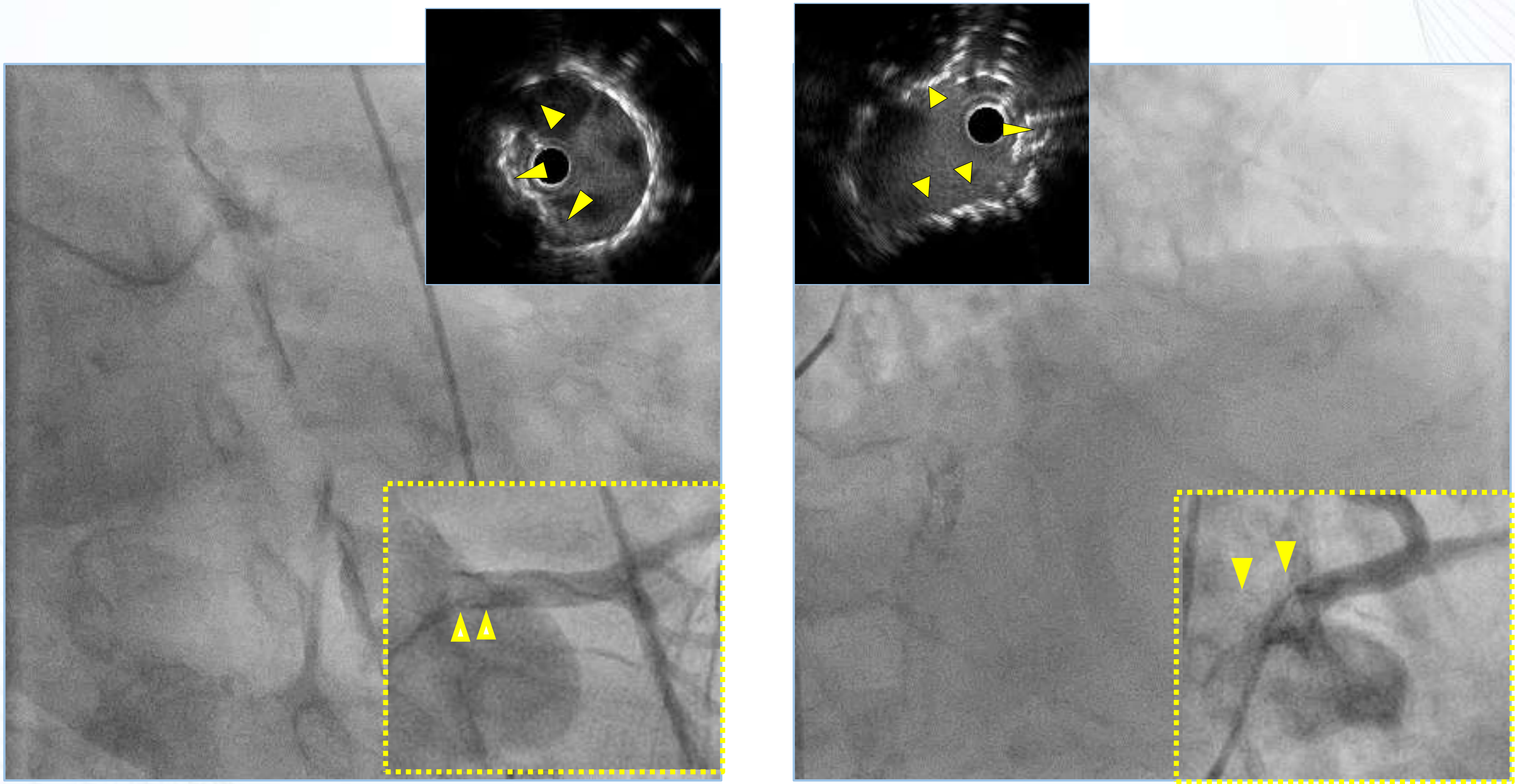
Final angio. → Excellent: results with Optimal stent expansion and apposition MSA: 10.35mm^2



Final

Case 6 : 60's Male HD ; SAP, LMT ISR with calcified nodule

Unfortunately…1 Year later, Pt. symptom recurrence !! RESTENOSIS !!



The patient was sent to CABG

Making light of foundation works,

Buildings are destined to collapse.

Pre PCI…Pre Stenting !!

Niccolò Machiavelli

1469-1527

『Il Principe: 군주론』