慢性完全閉塞病変に対するPCI治療

-Imaging deviceを最大限に活用する-

Hokkaido Social Insurance Hospital　Yasumi Igarashi

Clinical significance of recanalized CTO

Acute phase

1. Relief of symptom
2. Safety margin in PCI of other vessel
3. Escape from bypass surgery

Chronic phase

4. Improvement of LV function
5. Collateral for the future diseased vessel
6. Improvement of long-term prognosis

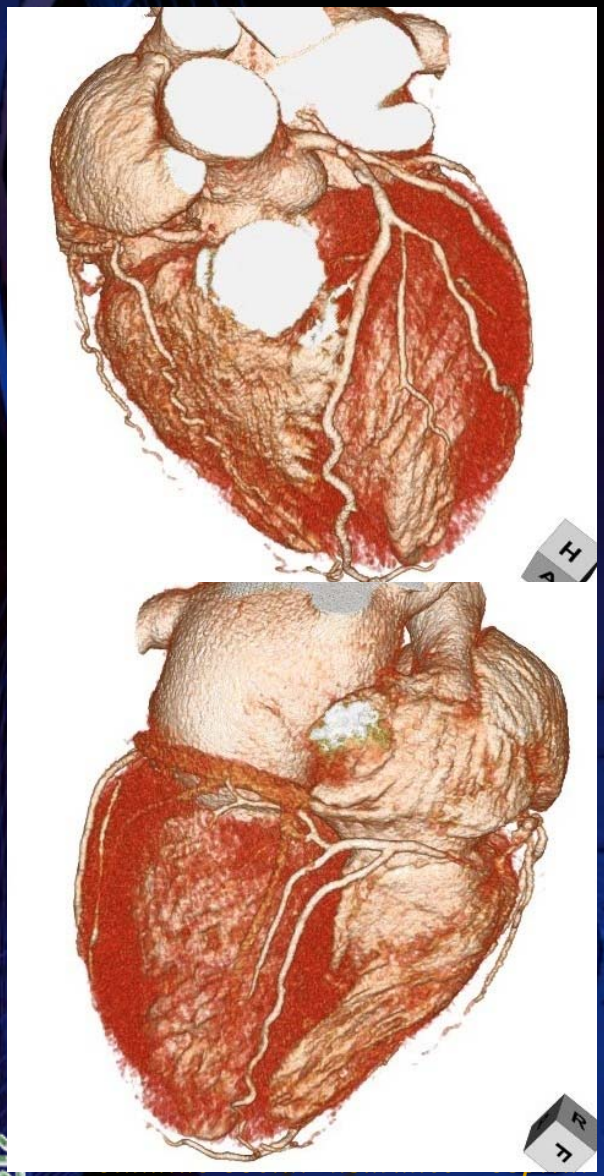
Imaging Modalities for CTO PCI

- Catheter angiogram
- CT angiogram
- IVUS

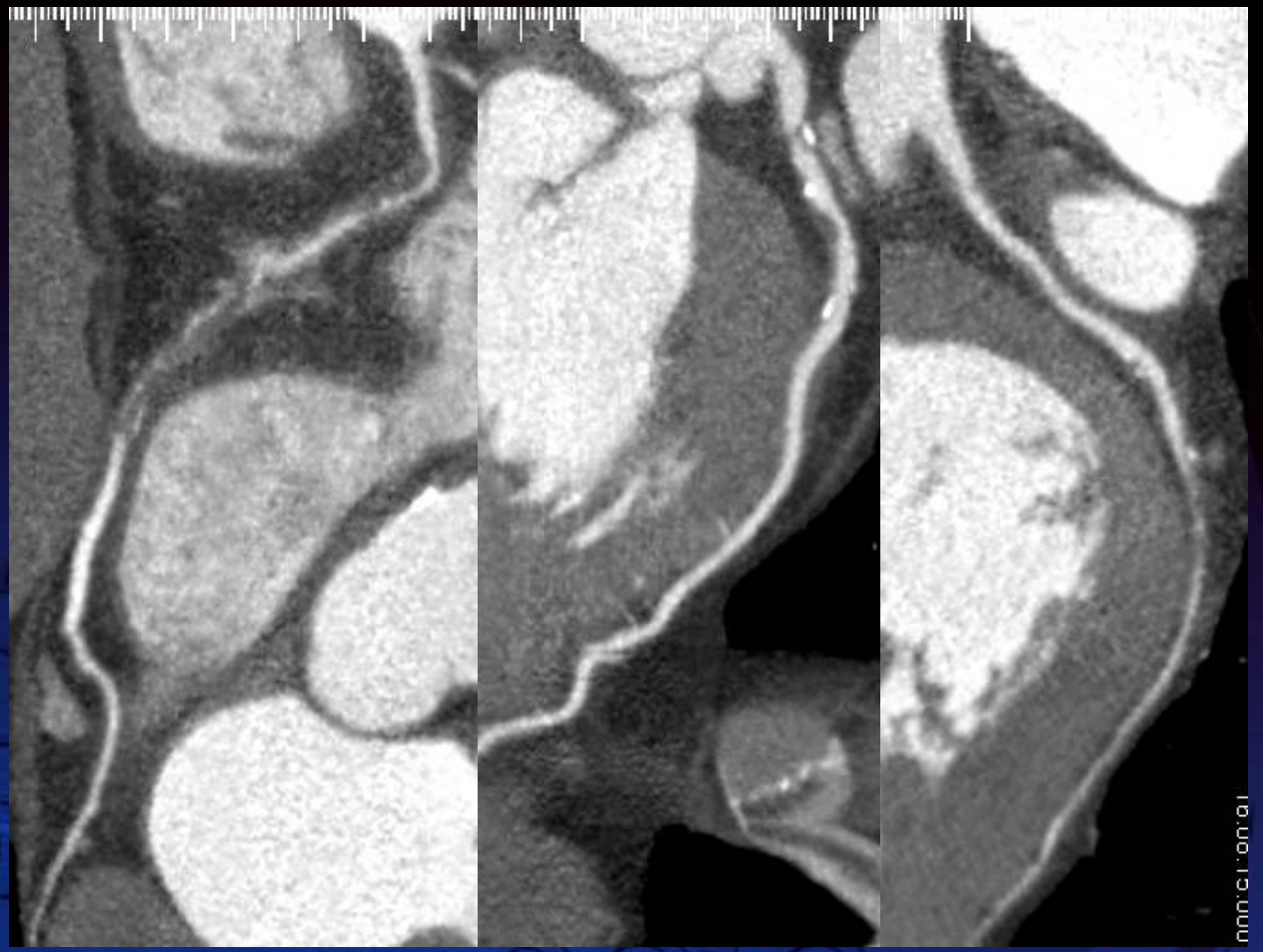
Imaging Modalities for CTO PCI

- Catheter angiogram
- CT angiogram
- IVUS

Screening CCTA



RCA LAD LCX



Conventional CAG vs Coronary CTA

Extractive information

< Catheter angiogram >	< CT angiogram >
· Shape of open vessels	· Shape of open vessels
· Distribution of calcium	· Distribution of calcium
· Collateral circulation	· Collateral circulation
	· Distribution of soft plaque
	· Shape of closed vessels

CCTA predictors of success/failure for CTO PCI

TABLE 3 Angiographic and MSCT Coronary Angiographic Multivariate Predictors of Procedural Failure for Chronic Total Occlusion

Variable	Coefficient	Wald's Chi-square	DF	p Value	OR (95% CI)	−2 Log Likelihood	Hosmer-Lemeshow Test DF	Hosmer-Lemeshow Test p Value	C Index
Clinical/angiographic predictors						50.0	2	0.66	0.80
Occlusion duration >9 mo	1.27	3.30	1	0.07	3.56 (0.90–14.02)				
Tapered stump	−1.93	7.46	1	<0.01	0.15 (0.04–0.58)				
Constant	0.24	0.13	1	0.7					
MSCT coronary angiography predictors						44.2	6	0.99	0.84
Occlusion length >15 mm	1.86	5.21	1	0.02	6.39 (1.30–31.41)				
Severe calcification	2.49	6.51	1	0.01	12.01 (1.78–81.1)				
Stump morphology	—	5.63	2	0.06	—				
Blunt	1 (reference)	—	—	—	—				
Tapered	−2.19	5.23	1	0.02	0.11 (0.02–0.73)				
Not determinable	−2.65	3.46	1	0.06	0.07 (0.00–1.15)				
Constant	−0.45	0.26	1	0.6	—				
Clinical/angiographic + MSCT coronary angiographic predictors						41.0	5	0.60	0.85
Tapered stump*	−2.43	7.98	1	<0.01	0.09 (0.02–0.48)				
Occlusion length >15 mm	2.17	6.16	1	0.01	8.77 (1.58–48.76)				
Severe calcification	2.03	5.18	1	0.02	7.62 (1.33–43.74)				
Constant	−0.67	0.74	1	0.4	—				

*A −2 log-likelihood change in the global model if 1 variable is removed: tapered stump −10.7 (p <0.01 for change), occlusion length −8.2 (p <0.01), and calcification −6.6 (p = 0.01 for change).
DF = degrees of freedom; other abbreviations as in Table 2.

Mollet NR et al, Value of Preprocedure Multislice Computed Tomographic Coronary Angiography to Predict the Outcome of Percutaneous Recanalization of Chronic Total Occlusions. Am J Cardiol 2005;95:240-243

Multivariate predictors of procedure failure in PCI for CTO

	Odds Ratio	*p*-Value	95% CI	Likelihood Ratio Test *p*-Value
Vessel bending, *n*	20.62	< 0.0001	4.72–90.09	< 0.0001
Vessel shrinkage, *n*	10.76	0.0078	1.87–62.05	0.0057
Severe calcification, *n*	4.54	0.0342	1.12–18.38	0.0307

CI = confidence interval. The likelihood ratio test for the whole model was < 0.0001.

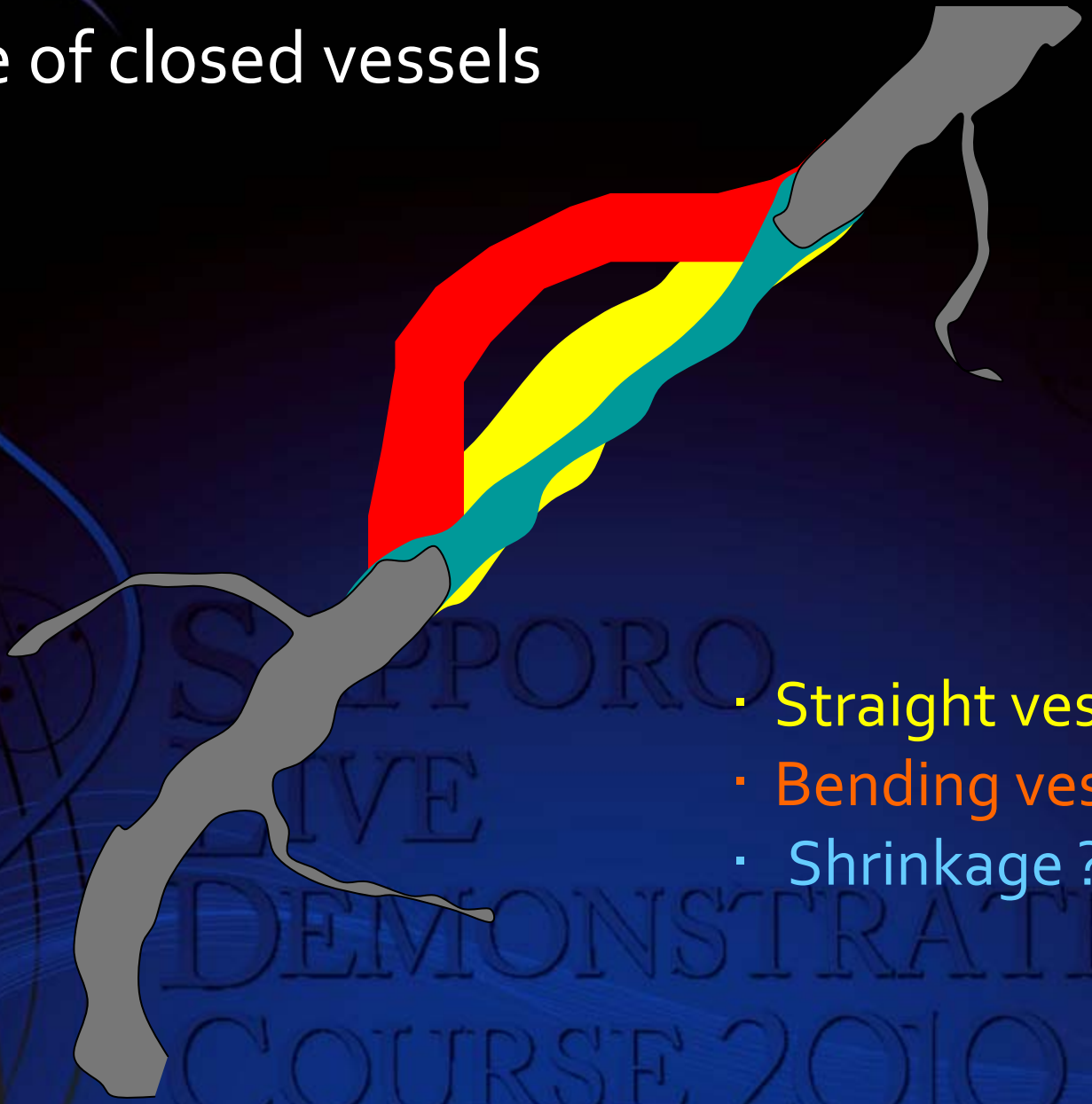
Mariko Ehara, Osamu Katoh, Takahiko Suzuki et al. Impact of Multislice Computed Tomography to Estimate Difficulty in Wire Crossing in Percutaneous Coronary Intervention for Chronic Total Occlusion. J Invasive Cardiol. 2009 Nov;21(11):575-82.

Table 4. Impact of morphological features on wiring success as observed by CTCA.

Findings on CTCA	Detected Group		Nondetected Group		*p*-Value
	Total	No. of Successes	Total	No. of Successes	
Vessel bending	30	17 (57%)	80	76 (95%)	< 0.0001
Vessel shrinkage, *n*	9	4 (44%)	101	89 (88%)	0.0005
Severe calcification, *n*	24	17 (71%)	86	76 (88%)	0.0356
Tapered stump, *n*	56	46 (82%)	54	47 (87%)	0.5542
Significant side branch, *n*	62	50 (81%)	48	43 (90%)	0.1984
In-stent occlusion, *n*	18	16 (89%)	92	77 (84%)	0.5772
Occlusion length ≥ 20 mm, *n*	51	41 (80%)	59	52 (88%)	0.2625
Occlusion length ≥ 30 mm, *n*	25	19 (76%)	85	74 (87%)	0.1787

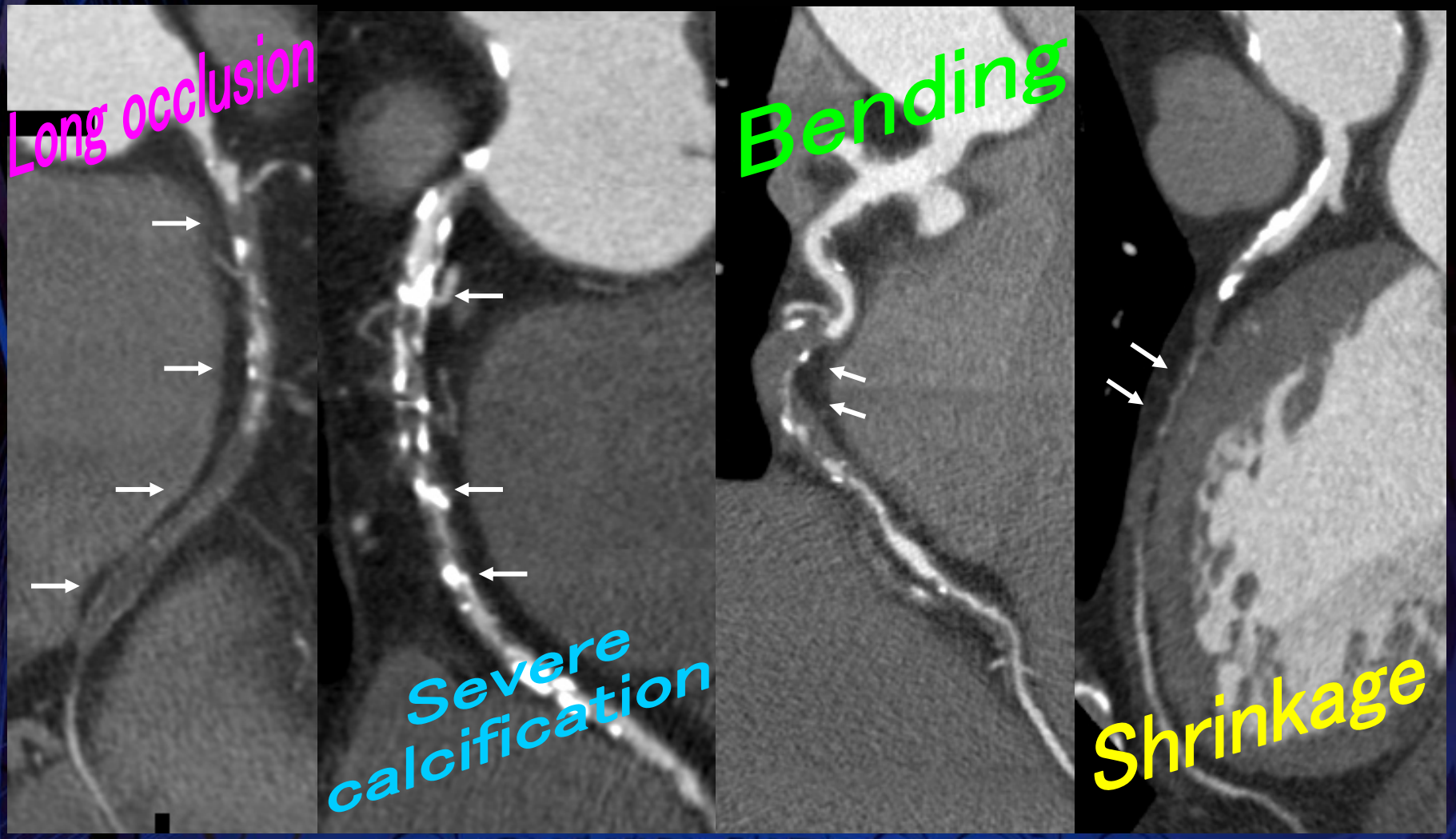
CTCA = *multislice computed tomographic coronary angiography*

Shape of closed vessels



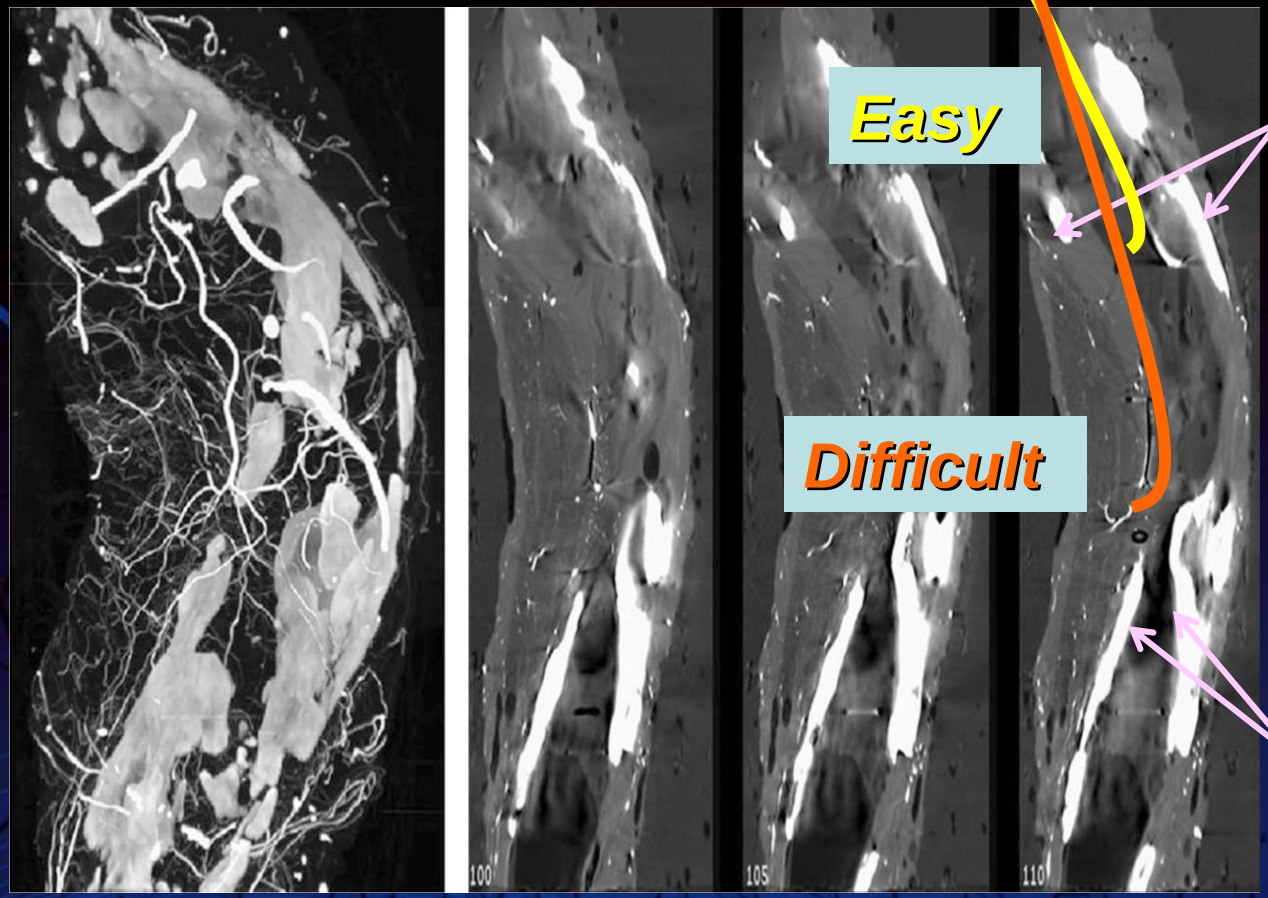
- Straight vessel ?
- Bending vessel ?
- Shrinkage ?

CCTA predictors of procedural failure for CTO



Distribution of calcium

Microscopic CT images of CTO



3D MIP　　MPR

Gregg W. Stone, David E. Kandzari, Roxana M, et al : Percutaneous recanalization of chronically occluded coronary arteries : A consensus document : Part 1 , Circulation. 2005; 112: 2364-2372

Stump morphology

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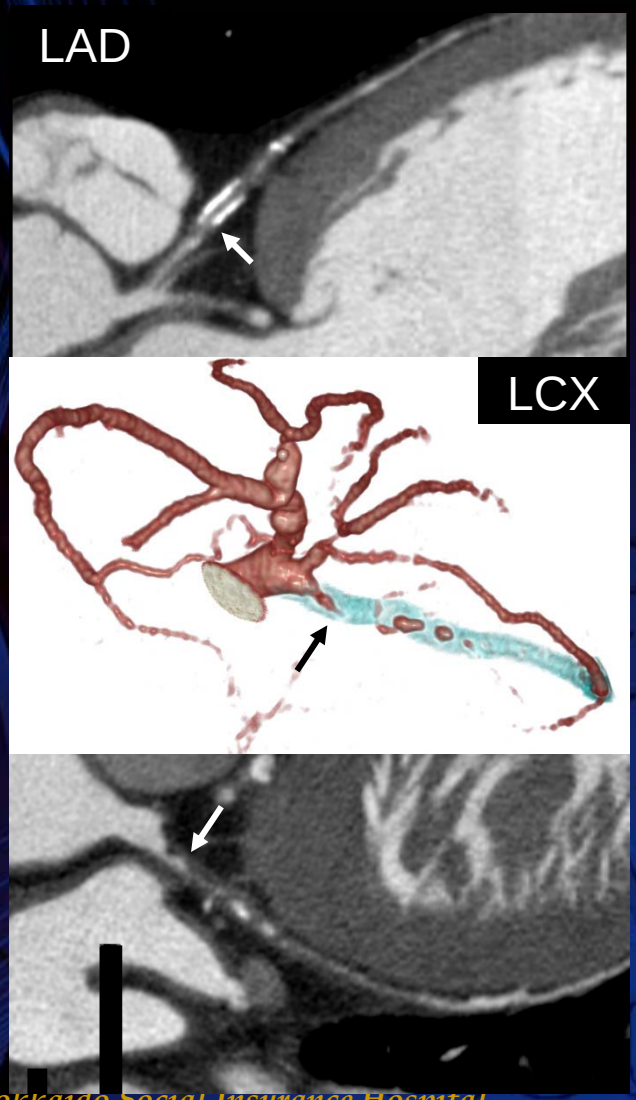
“Easy” CTO

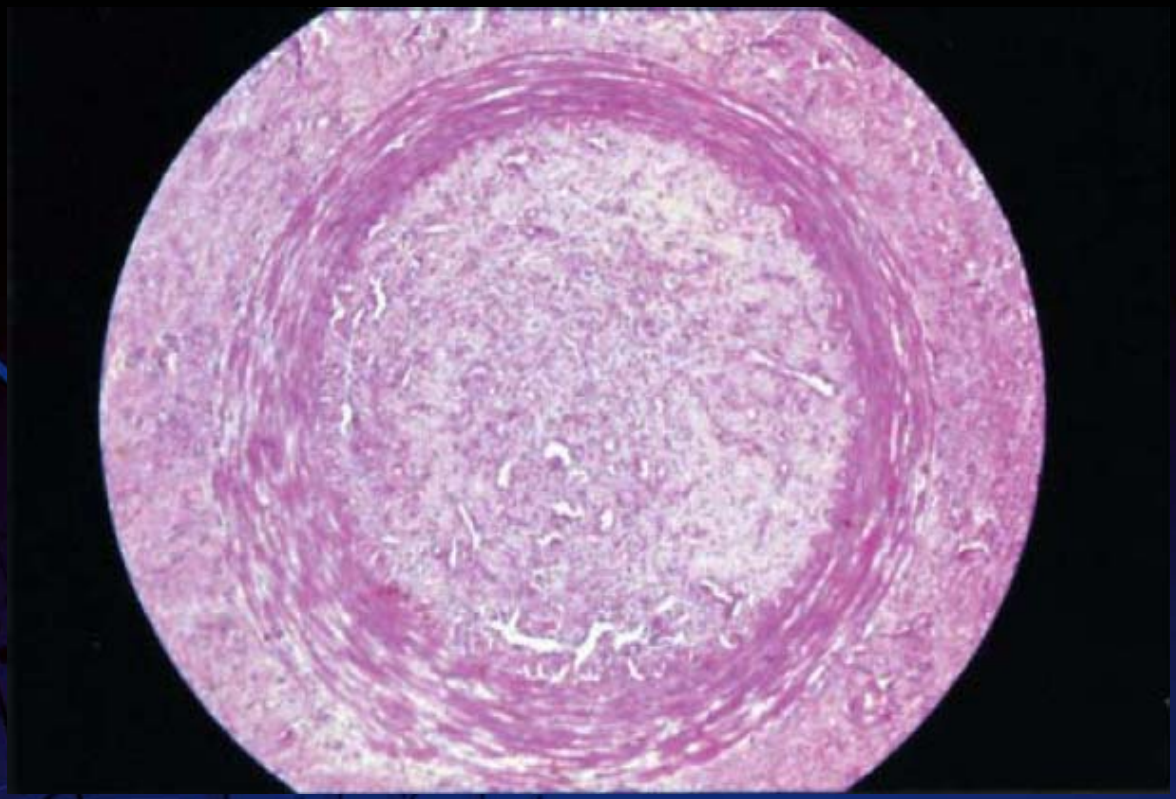
Stump without side branch



“Tough” CTO

No stump with side branch

Micro channels

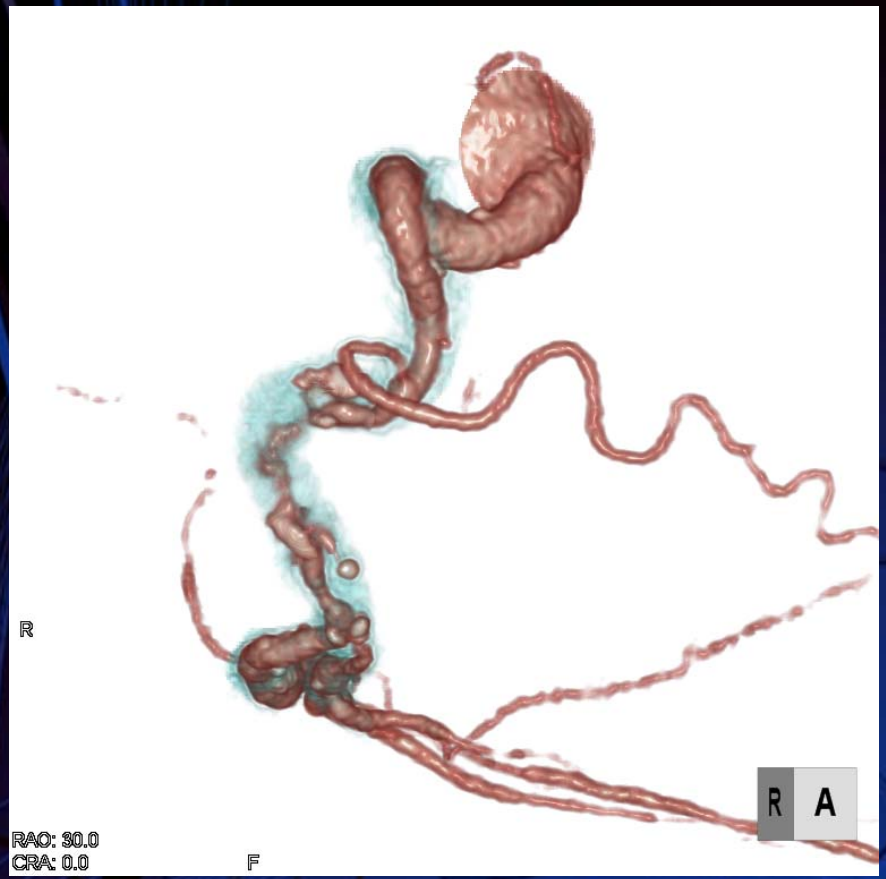


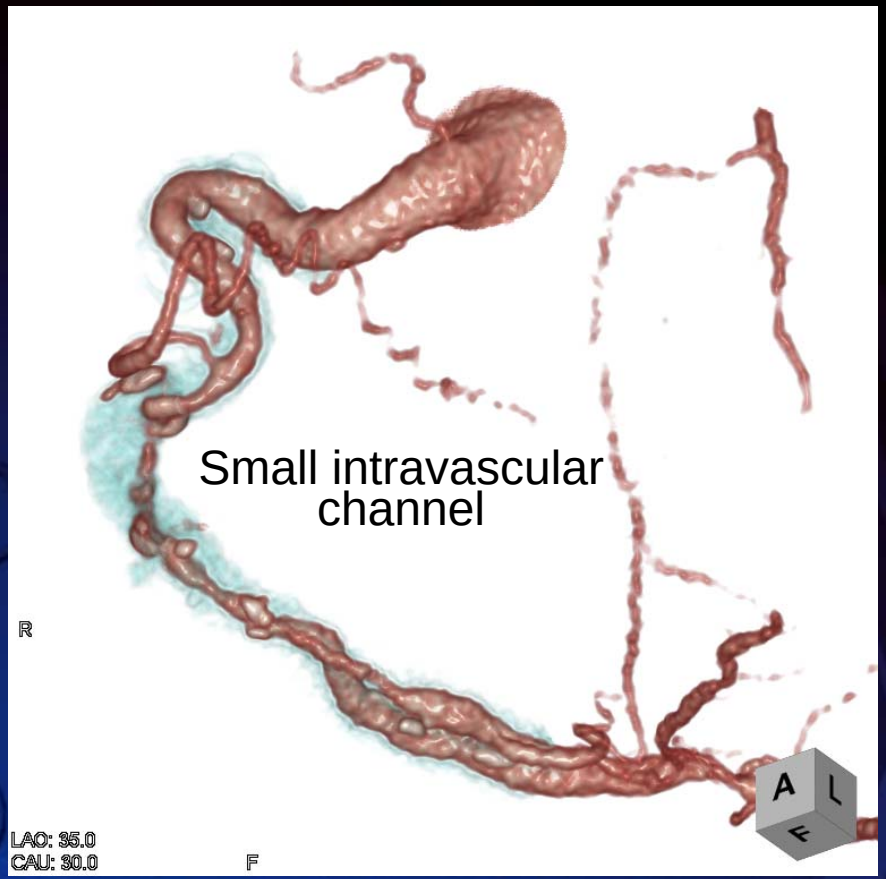
Microscopic section through a chronic total occlusion (CTO)
with visible tiny micro channels.

S Aziz, D R Ramsdale, Chronic total occlusions—a stiff challenge requiring a major breakthrough: is there light at the end of the tunnel? Heart 2005;91(Suppl III):iii42–iii48.

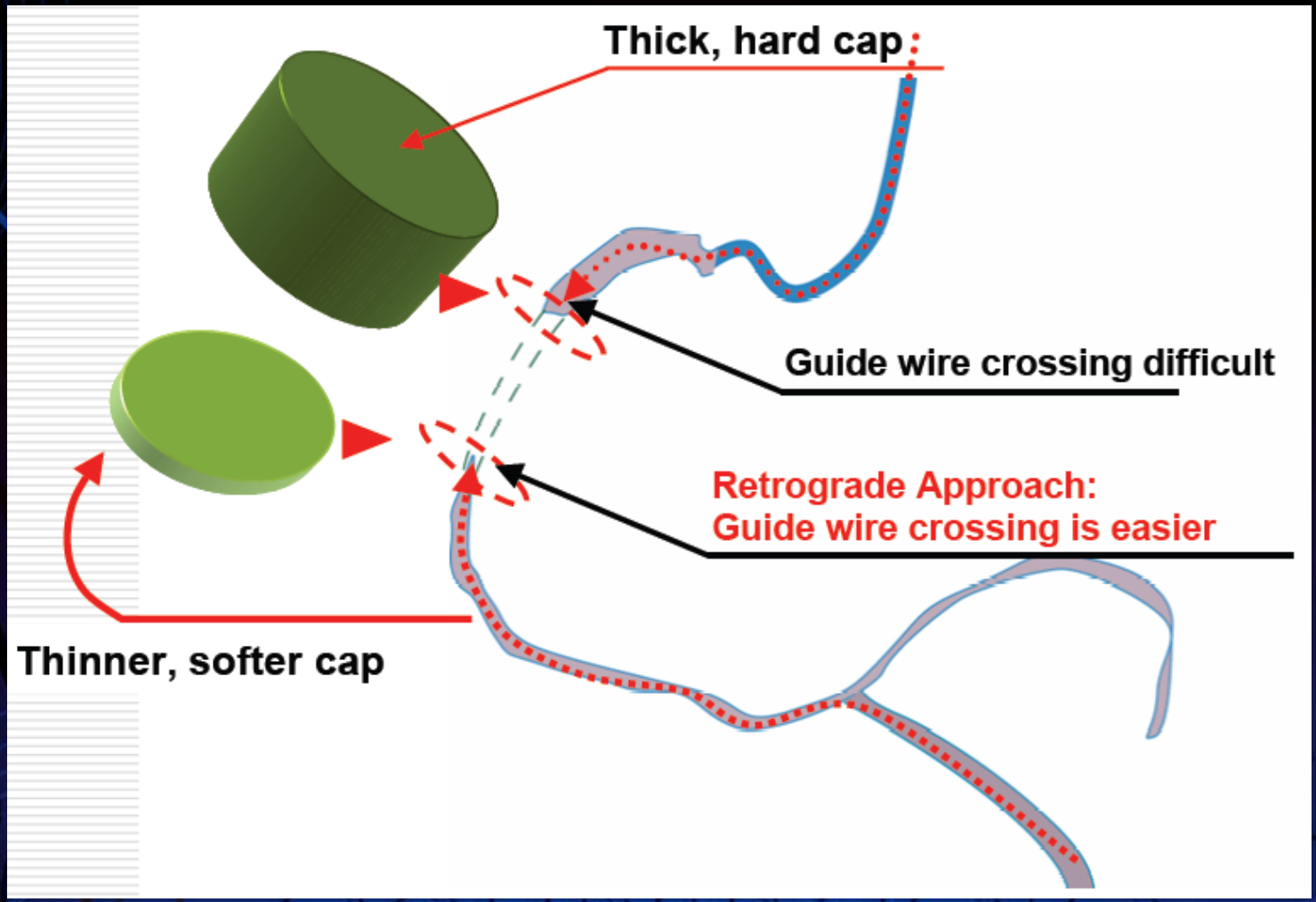
Small Channels

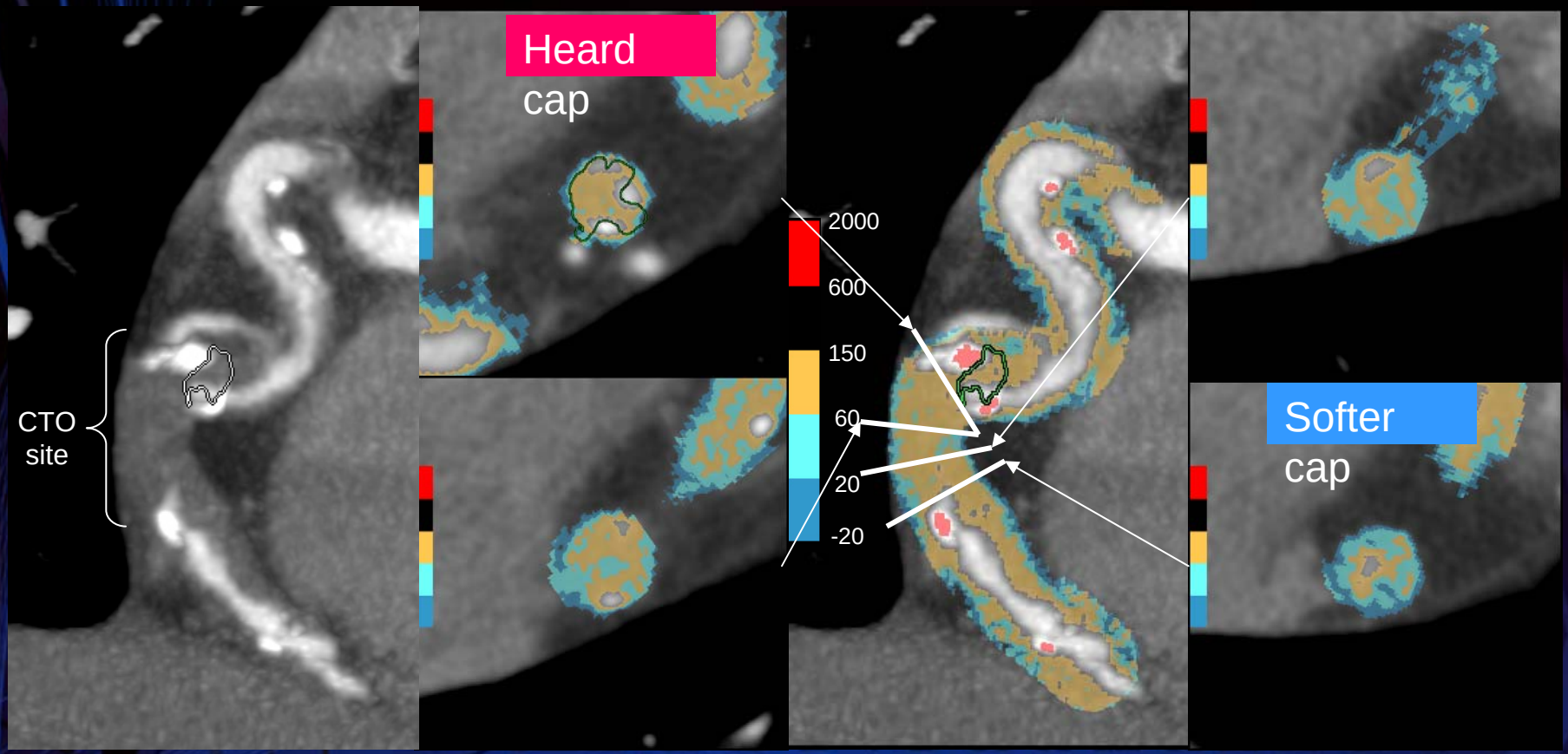
With 3D MAP





Antegrade approach or Retrograde approach




Heard
cap
2000
600
150
60
20
-20
CTO
site
Softer
cap

CASE 2　his 60's　Male
RCA mid CTO retry case

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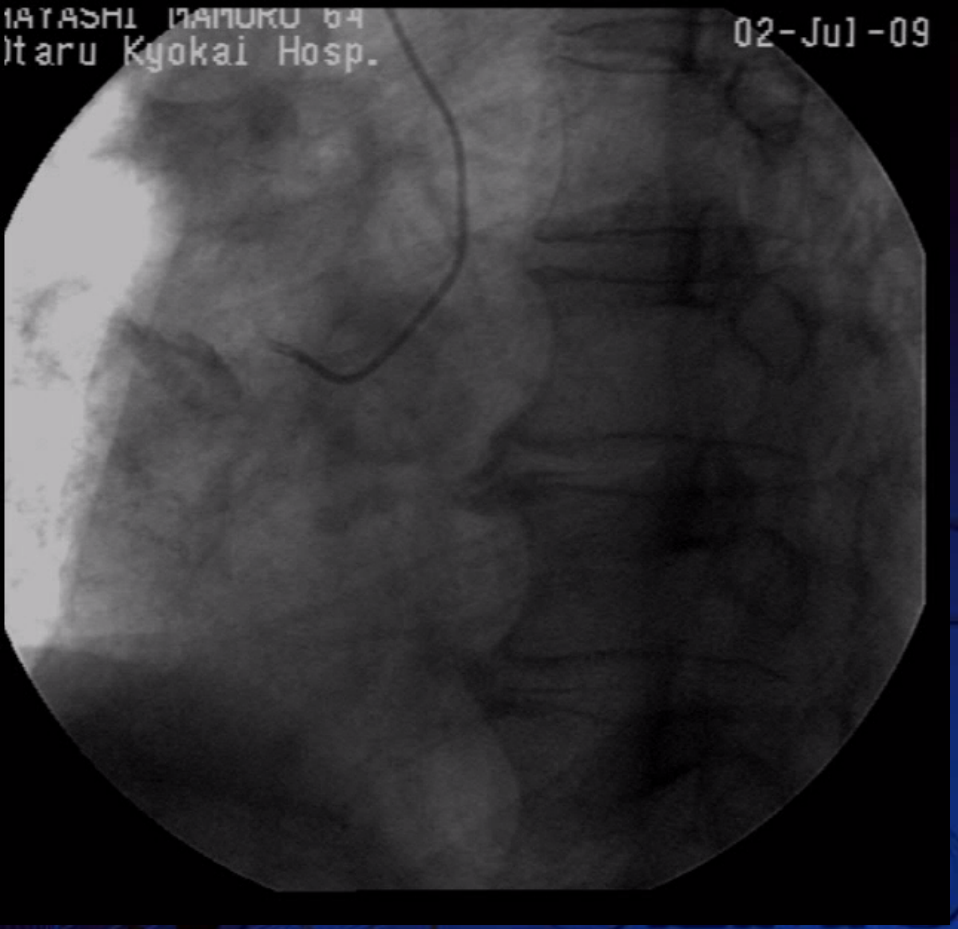
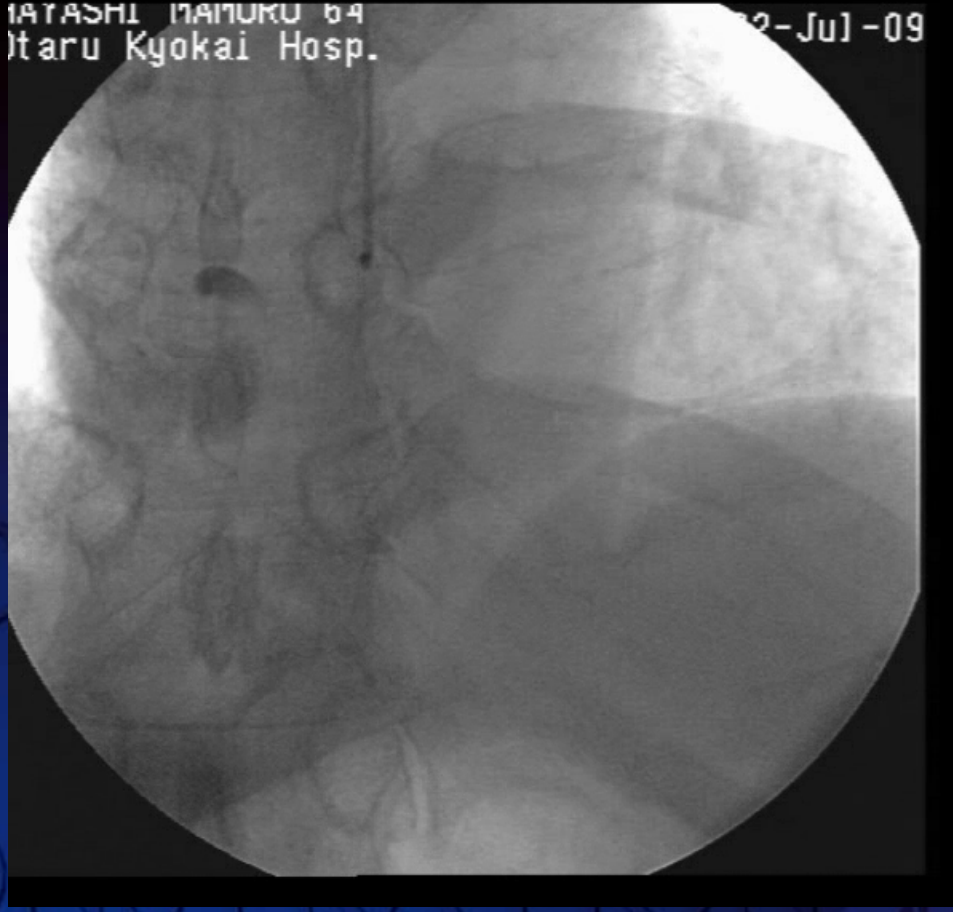
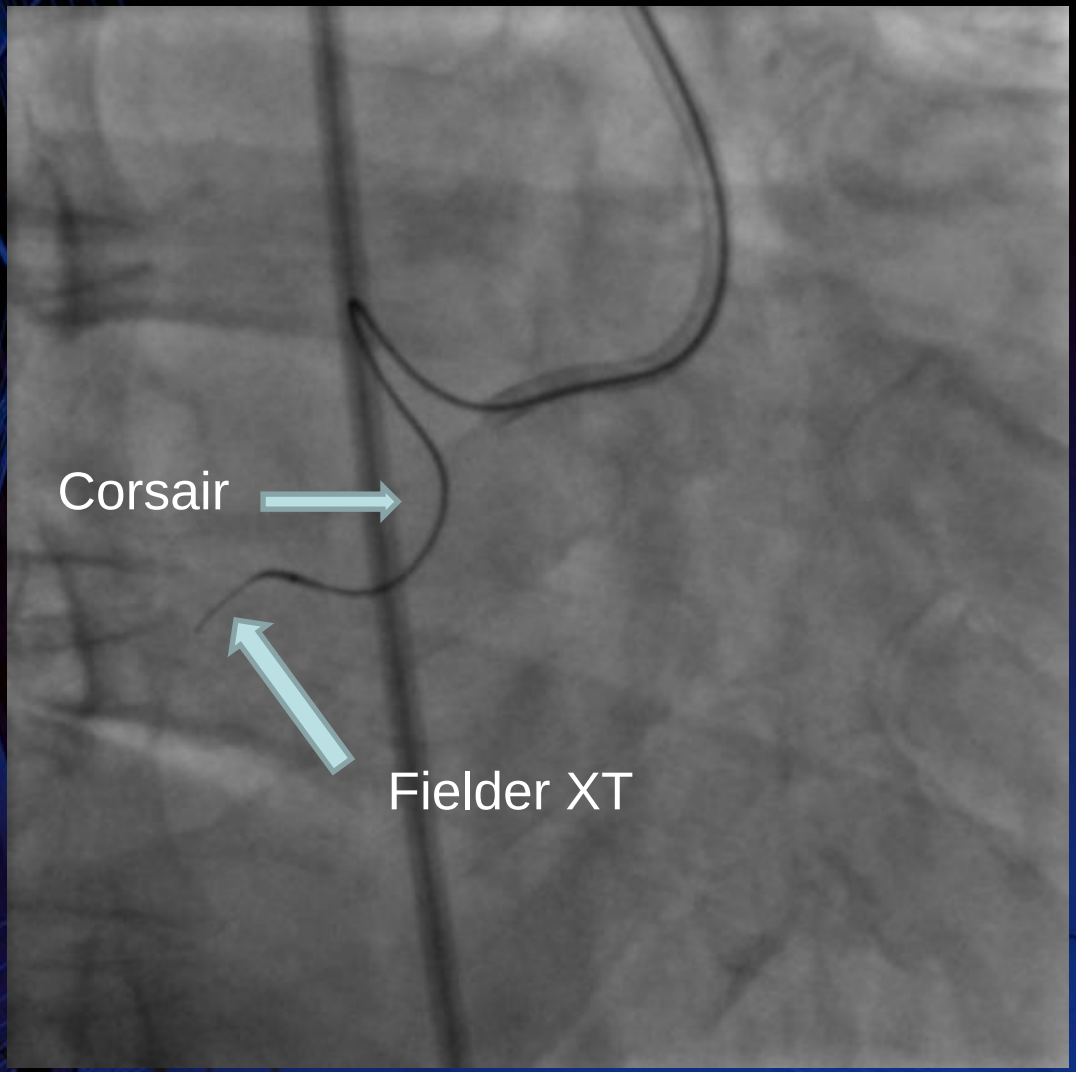
LAO



RAO



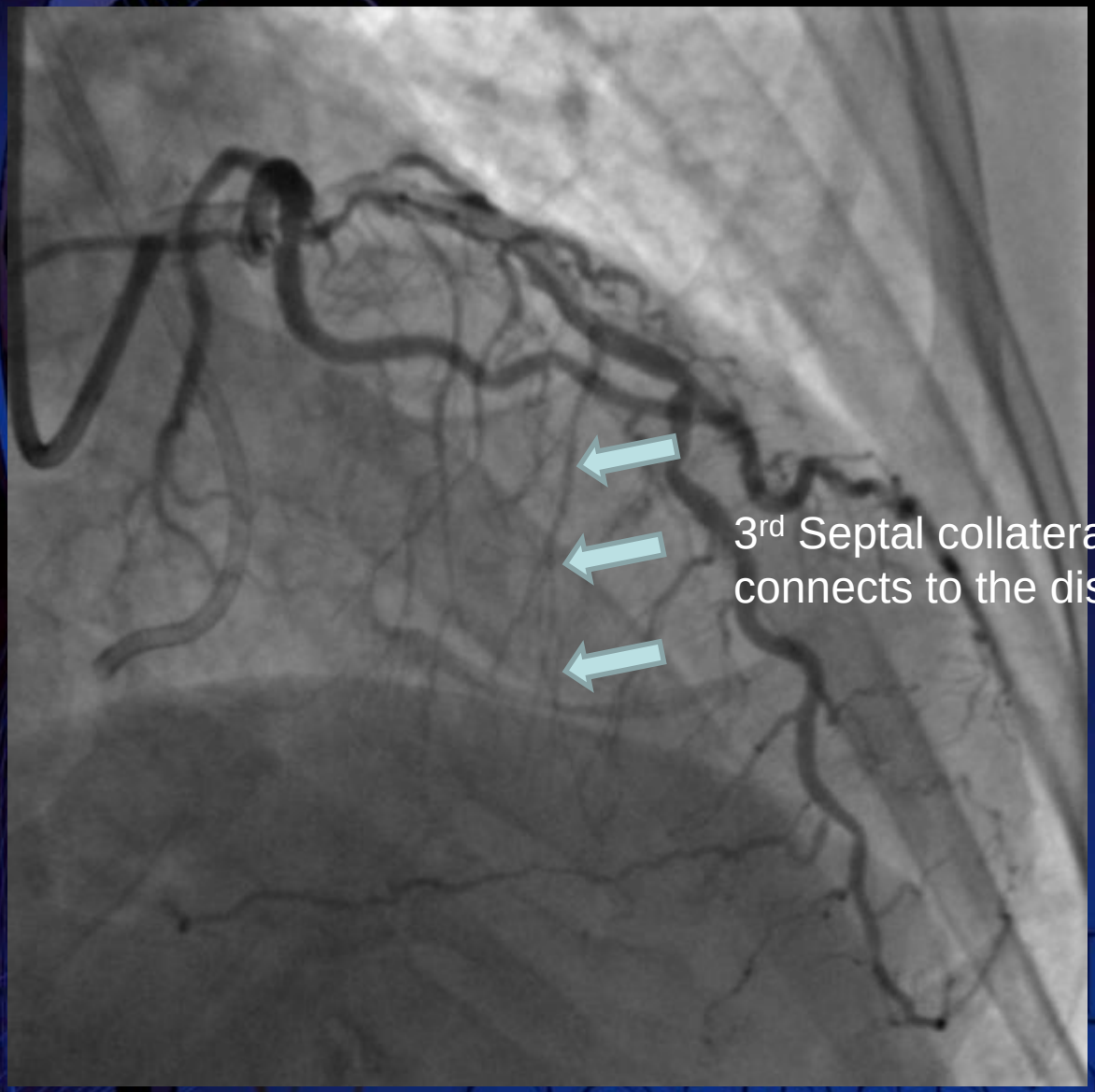


Microcatheter

Finecross
↓
Corsair

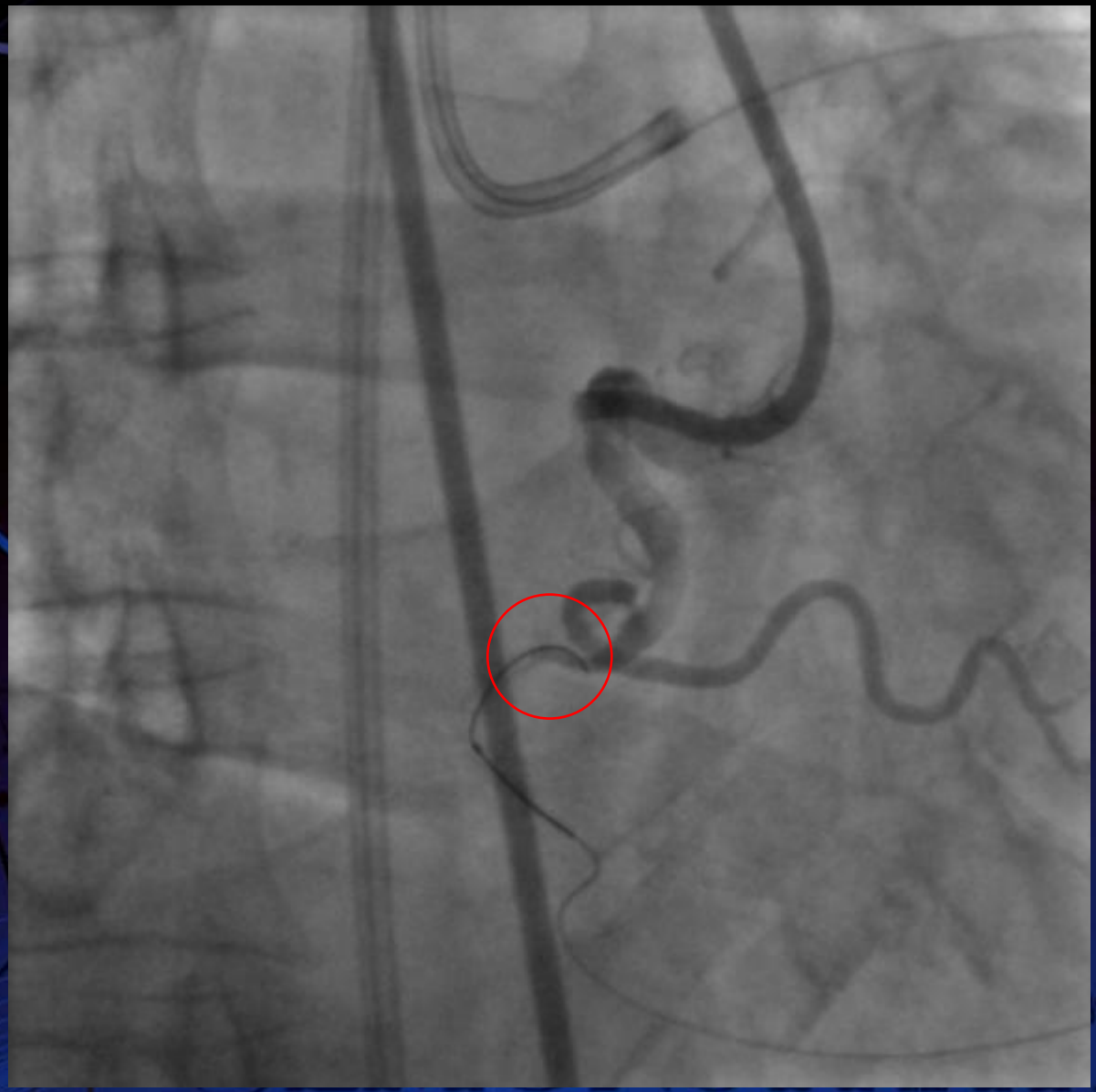
Guidewire

Fielder XT
↓
Fielder FC
↓
Miracle 3g
↓
Fielder XT

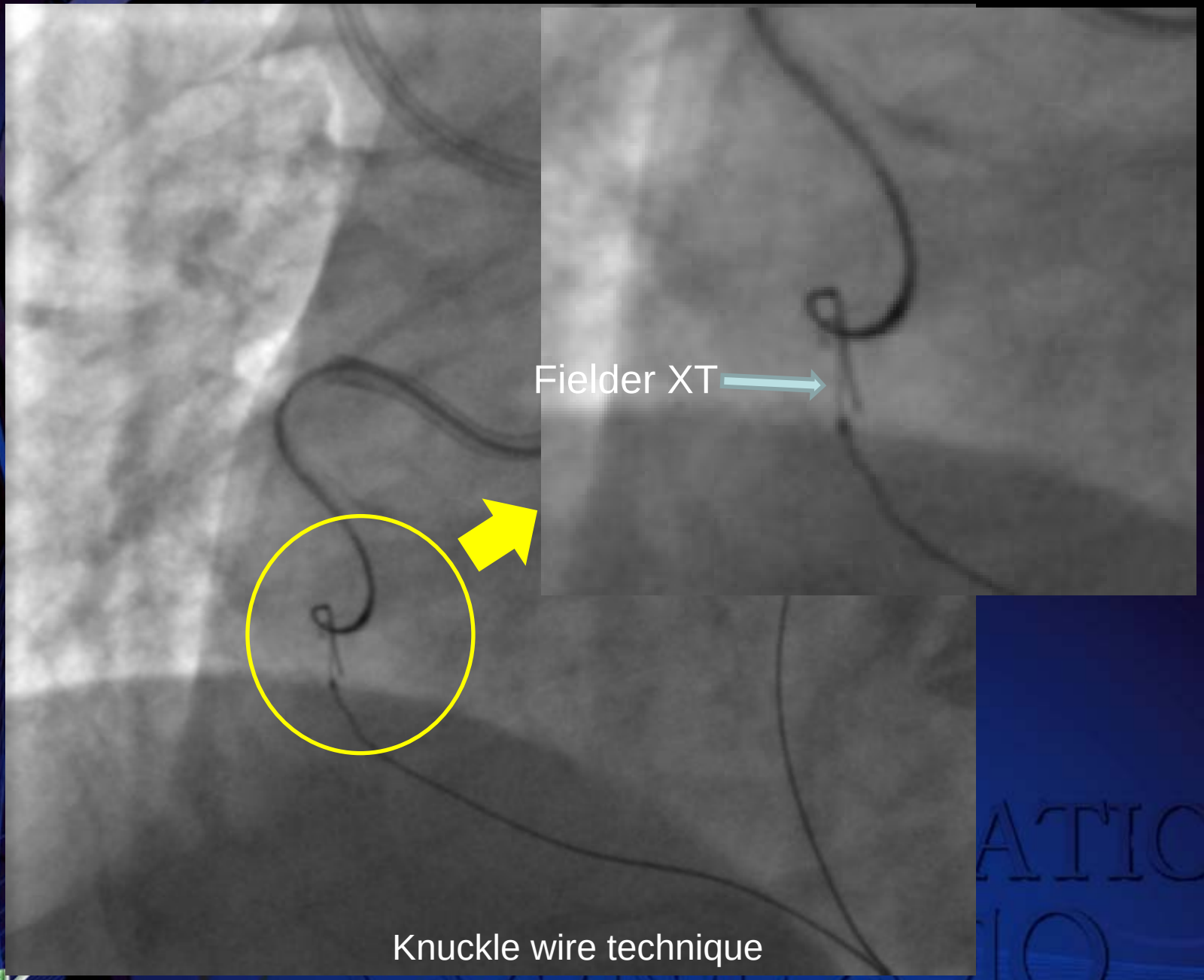


G.C; VL 3.5 8Fr SH mach1

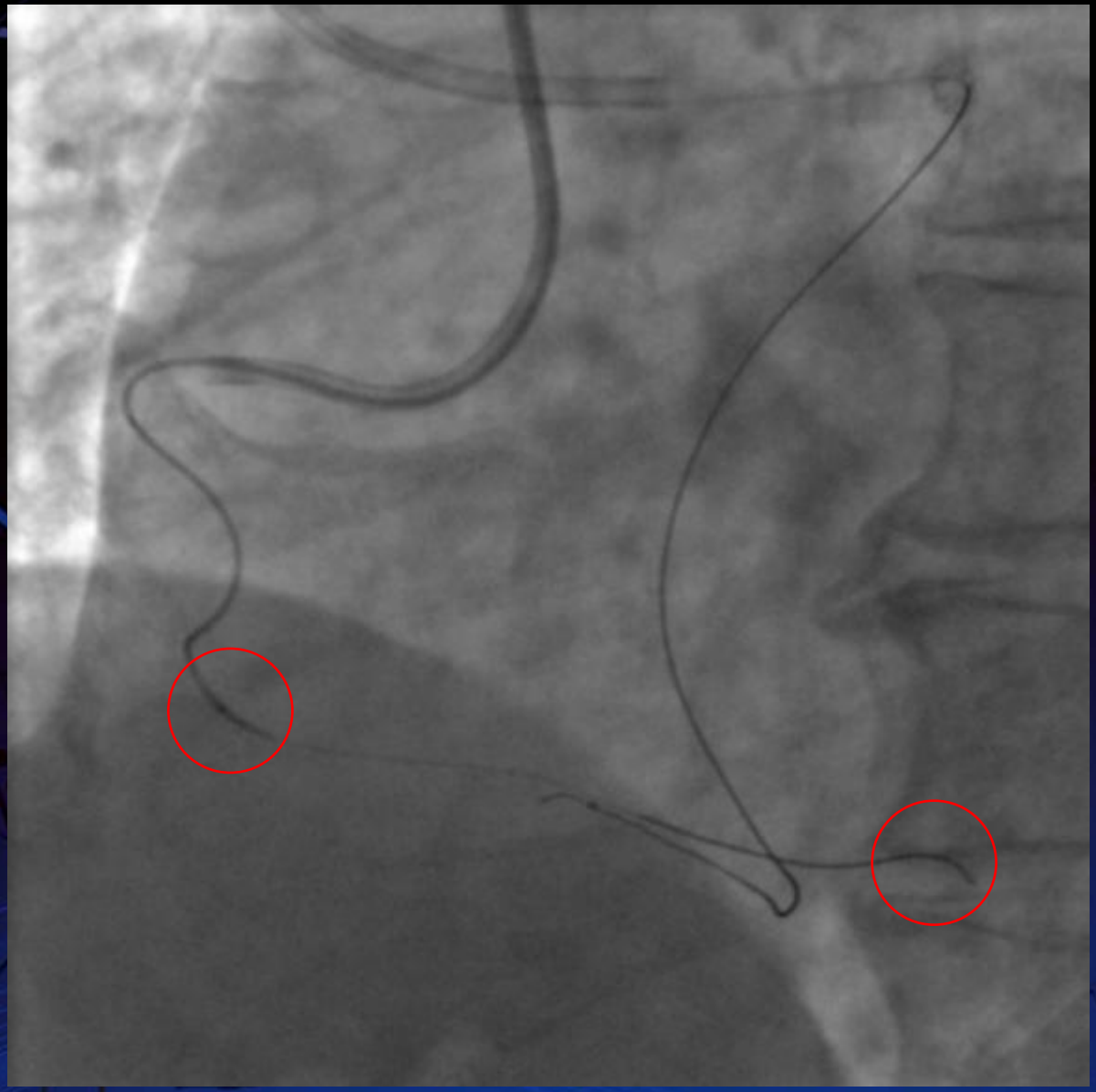
3rd Septal collateral channel connects to the distal RCA

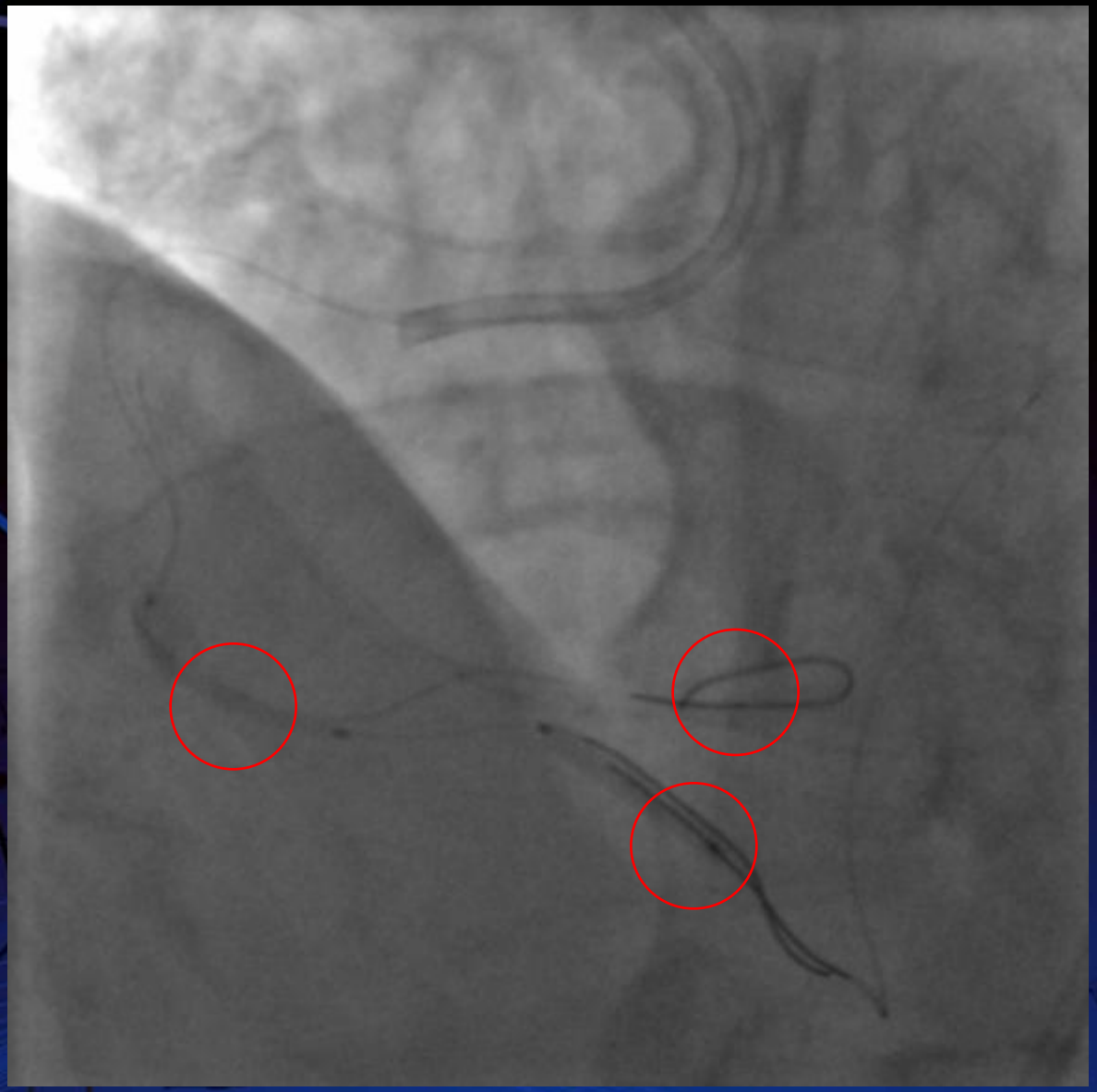


Retrograde wire advance into the subintimal spaces at the proximal end of the lesion.



Knuckle wire technique

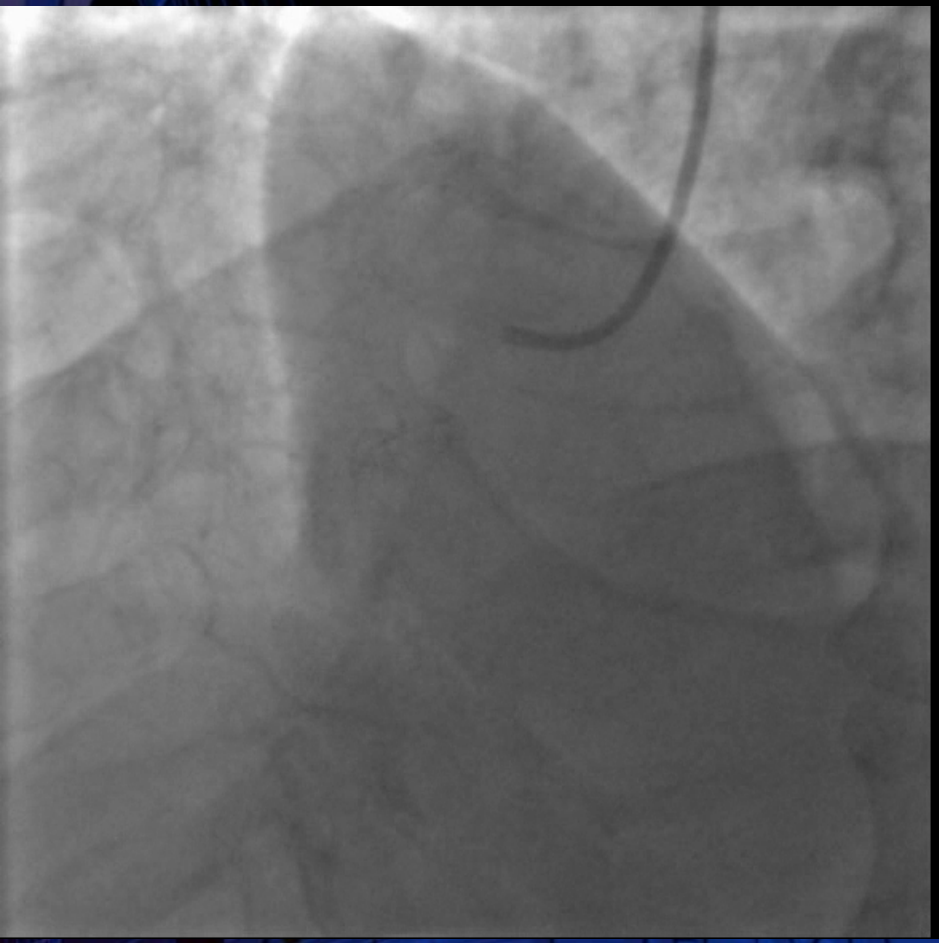


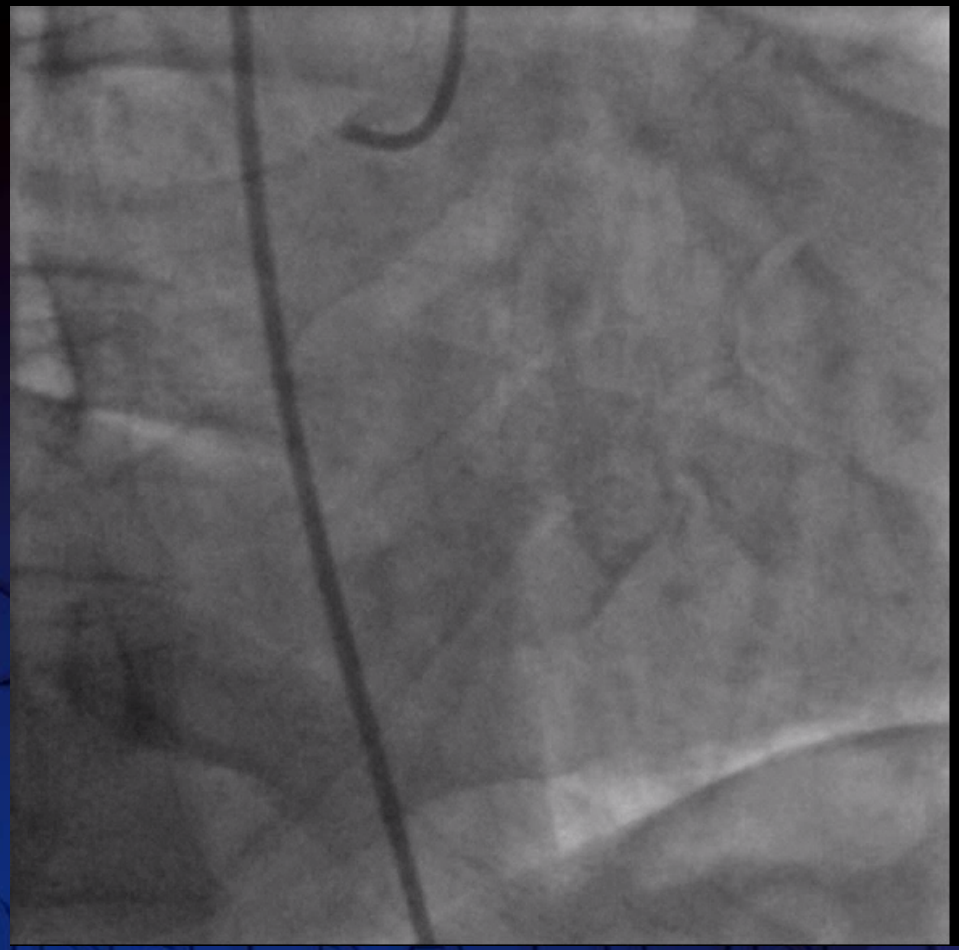


Combination with distal anchor and buddy wire technique

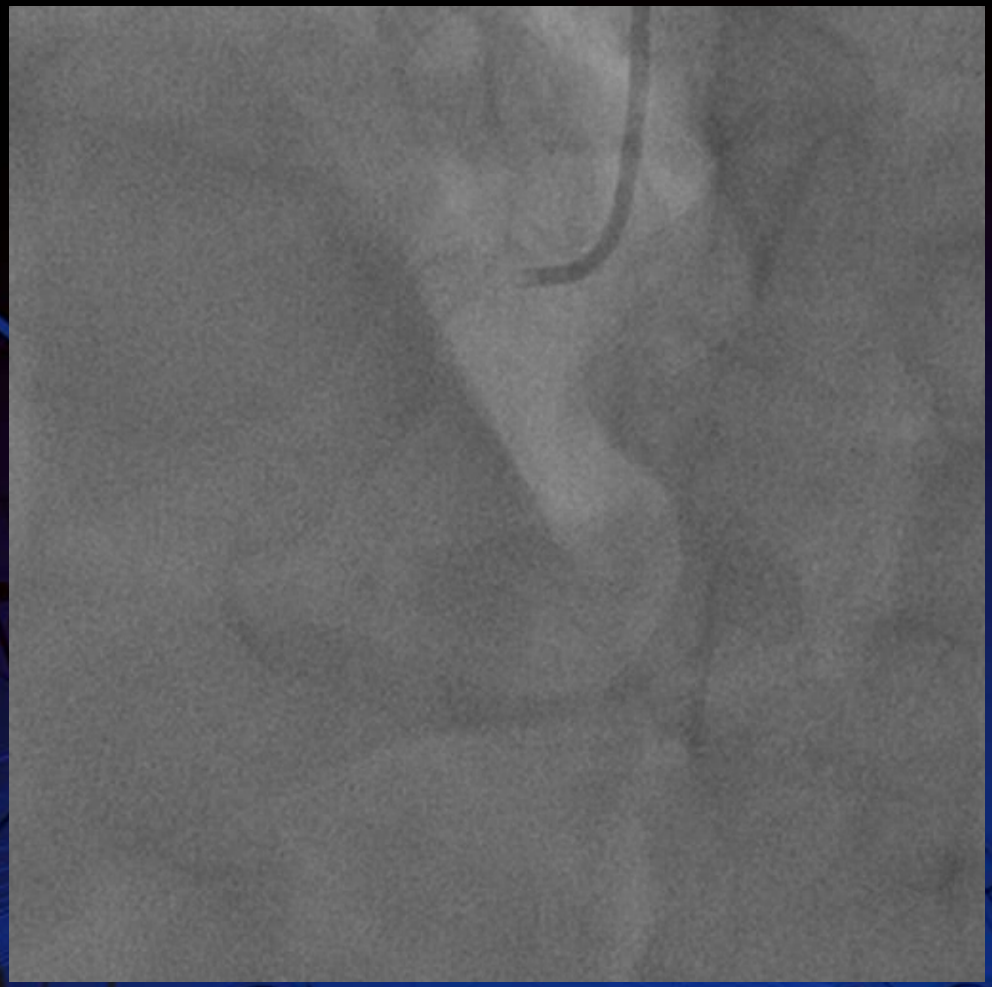
3.5x24mm Flexible DES stent was deployed at 16atm.

Final CAG





RCA mid CTO with diffuse severe calcium



LAO 45

Conventional catheter angiogram vs Coronary CT angiogram

Extractive information

< Catheter angiogram >

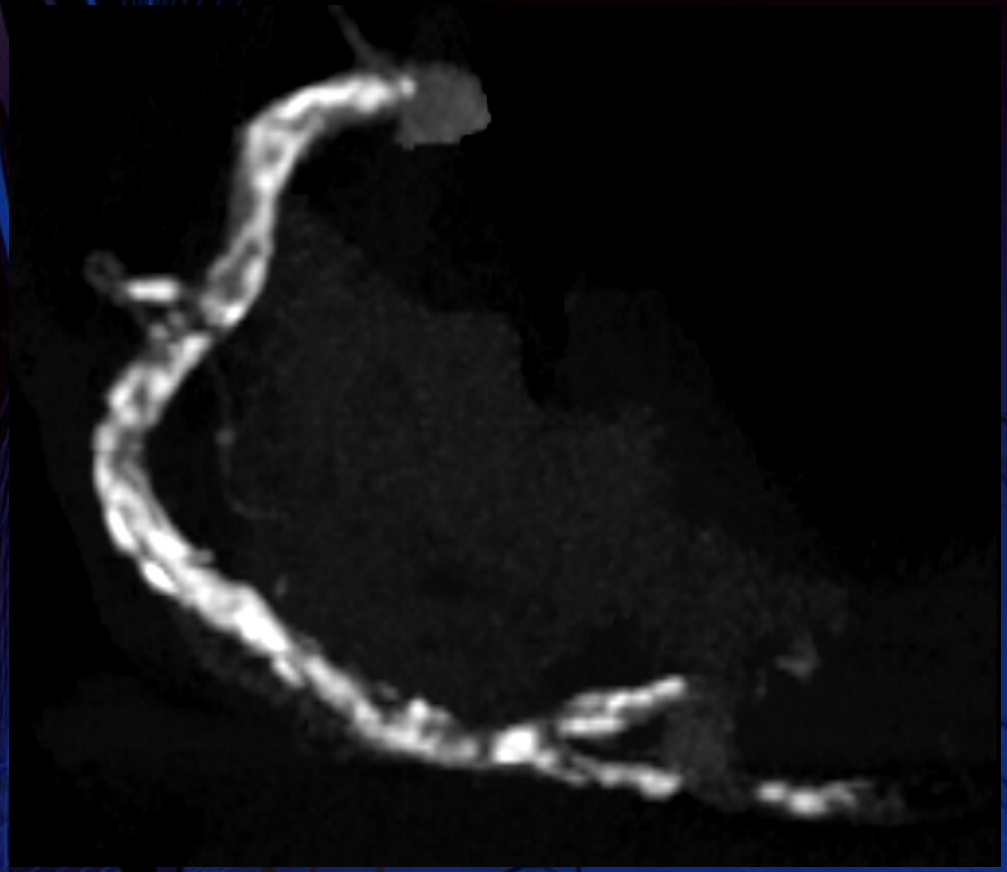
- Shape of open vessels
- Distribution of calcium
- Collateral circulation

< CT angiogram >

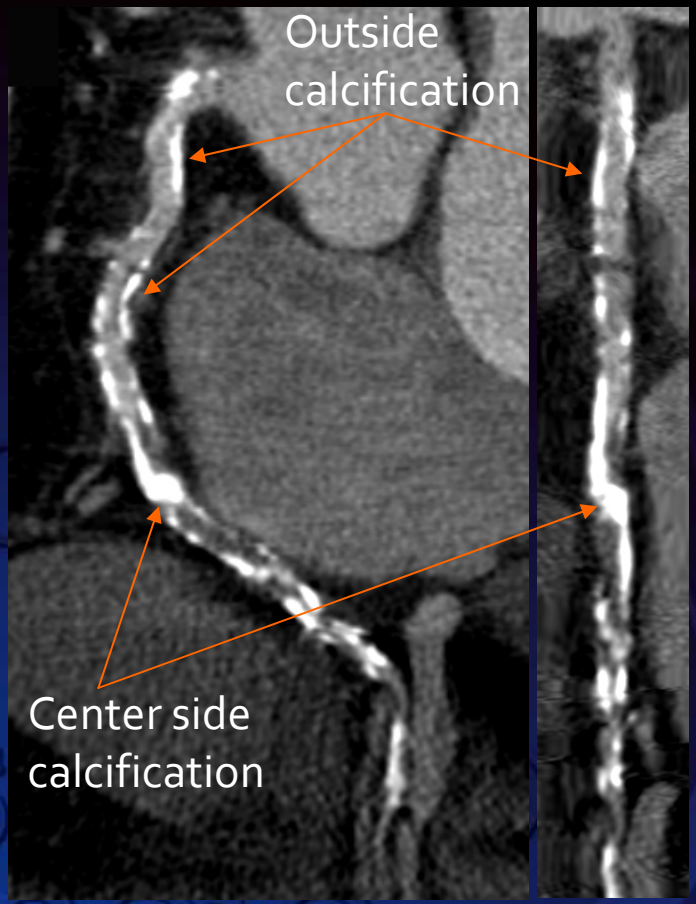
- Shape of open vessels
- Distribution of calcium
- Collateral circulation
- Distribution of soft plaque
- Shape of closed vessels

Distribution of calcium

3D MIP (LAO 45°)

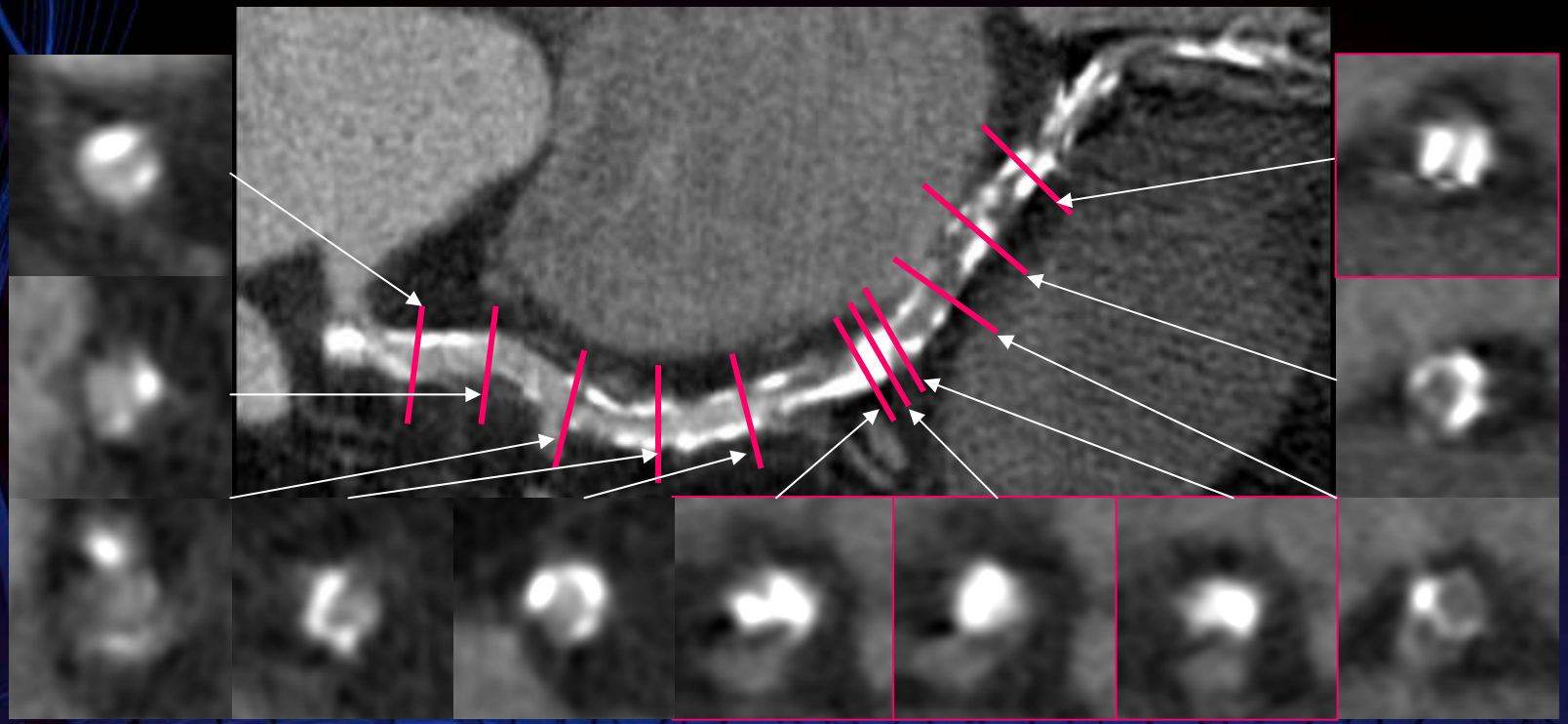


Curved MPR



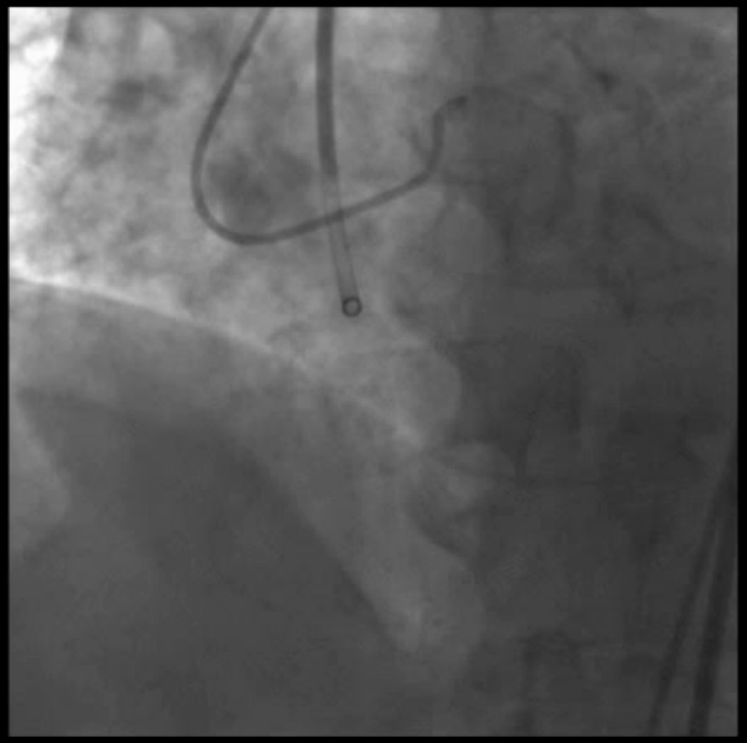
Distribution of calcium

Curved MPR



Cross sectional view

Bi-lateral injection

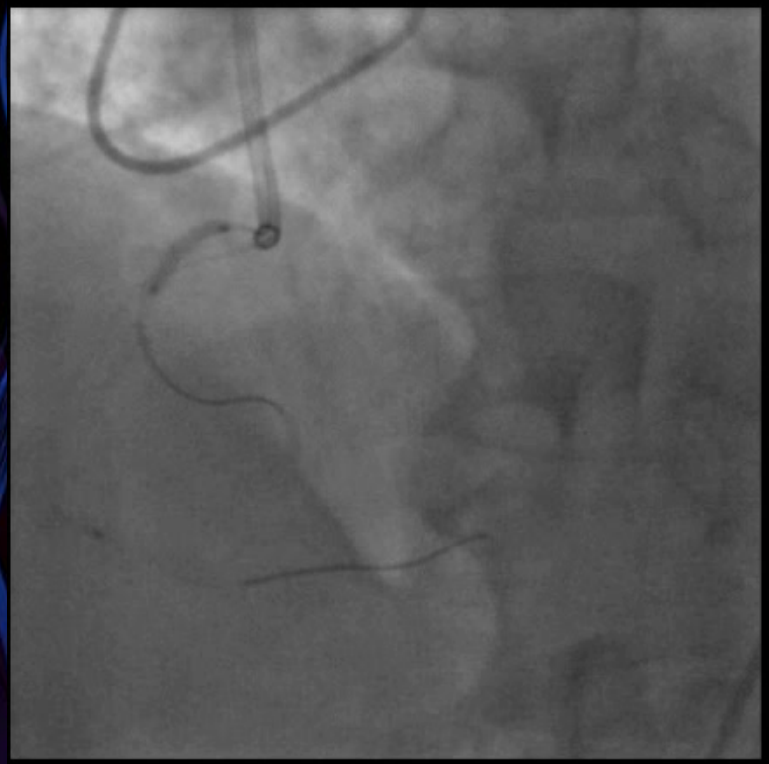


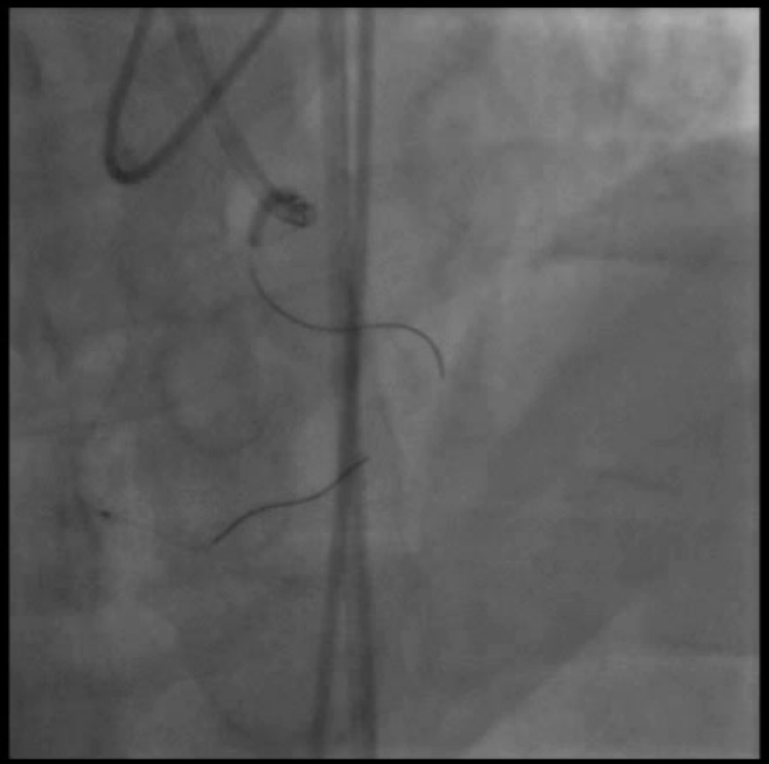
Rt femoral A 8Fr sheath

Lt femoral A 8Fr sheath

G/C : mach 1 FR 4.0 SH 8Fr

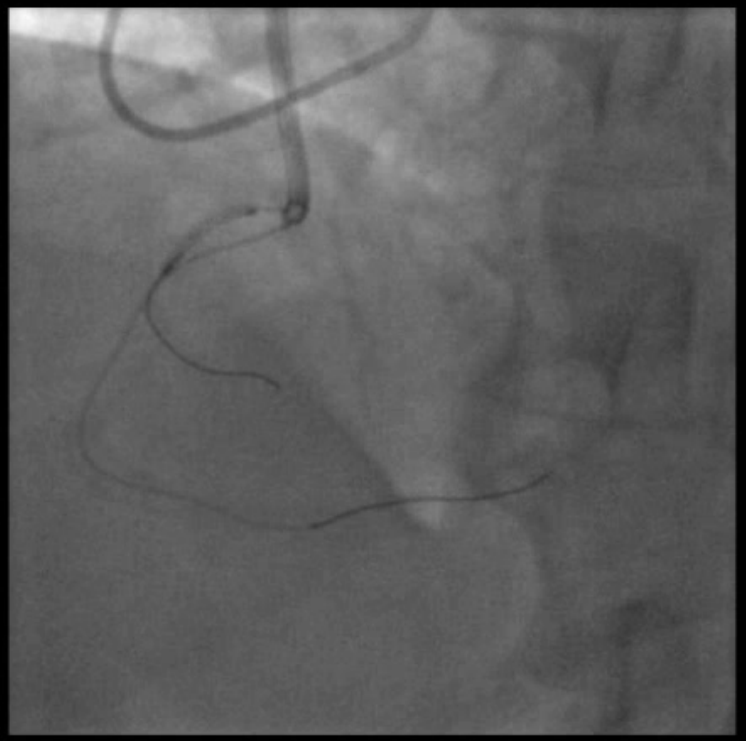
Antegrade wiring





Anchor balloon: ϕ 2.0x15 Voyager
OTW: ϕ 1.25x10 Ryujin G/W: Fielder FC

Trapping TORNUS

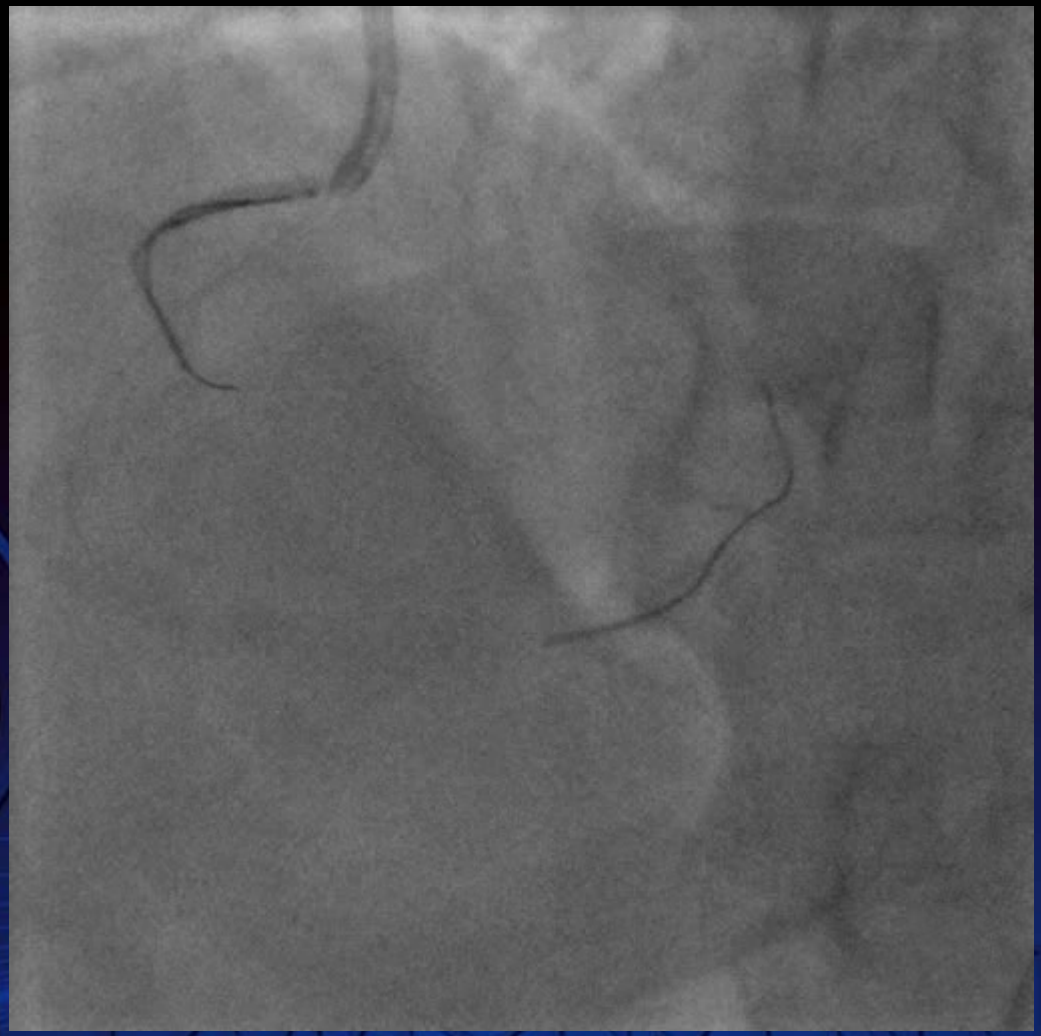


OTW exchange to TORNUS G/W: Fielder FC

Predilatation-2

BC: φ2.5x15Voyager

Antegrade CAG

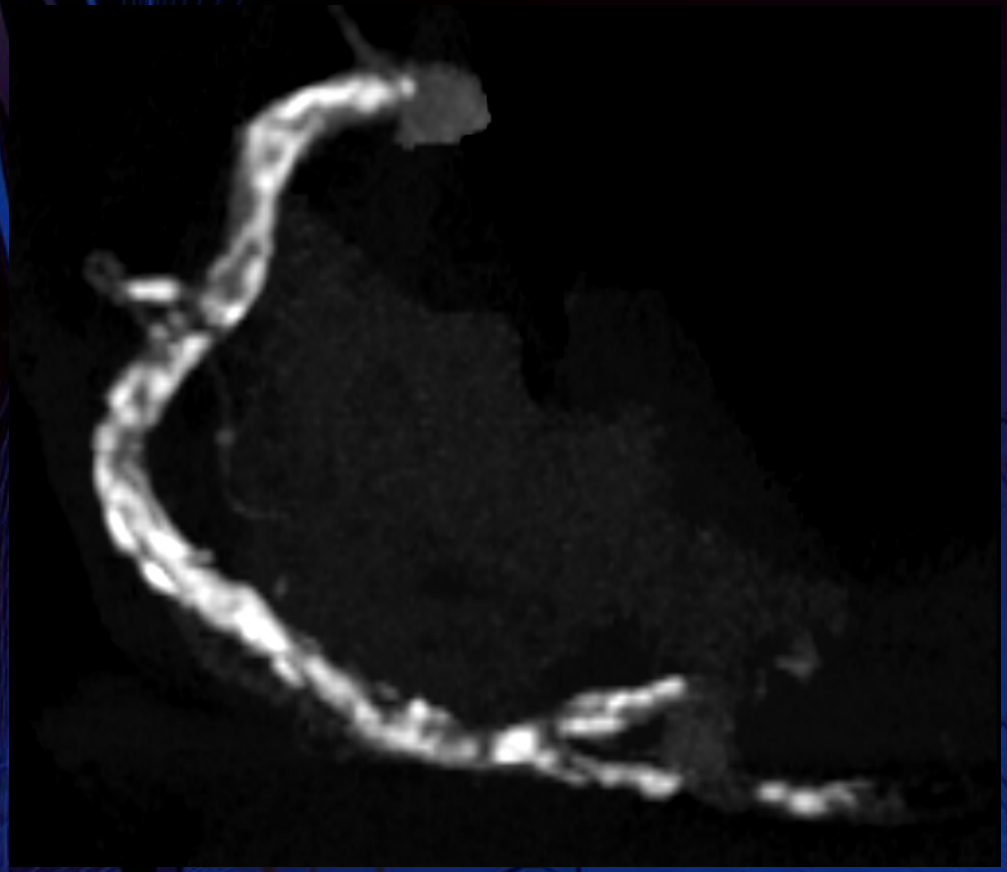


#4PD antegrade wiring

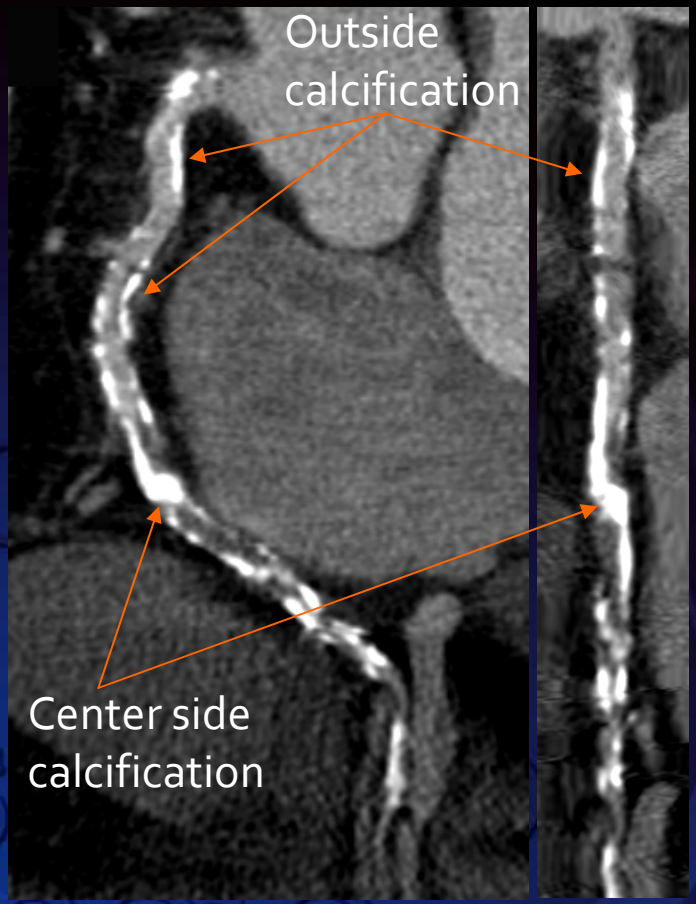
M/C: Crusade G/W: Miracle 3g→Miracle12g→Conquest pro 12g

Distribution of calcium

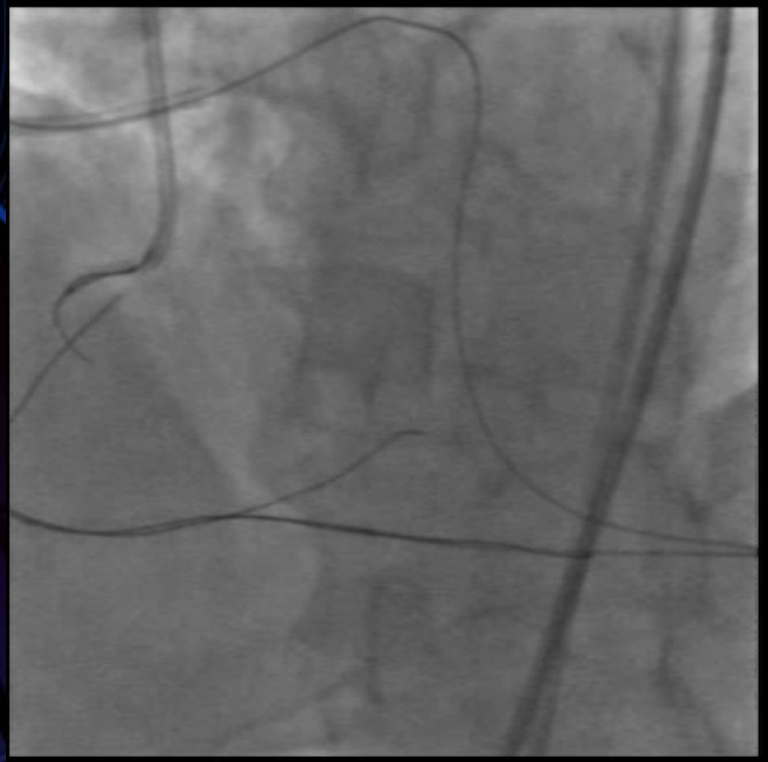
3D MIP (LAO 45°)

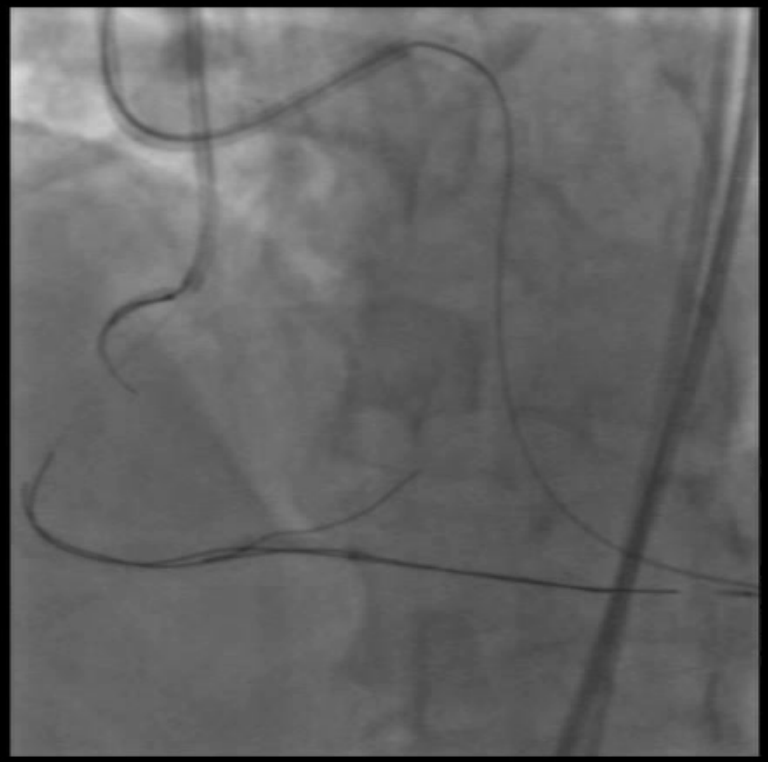


Curved MPR



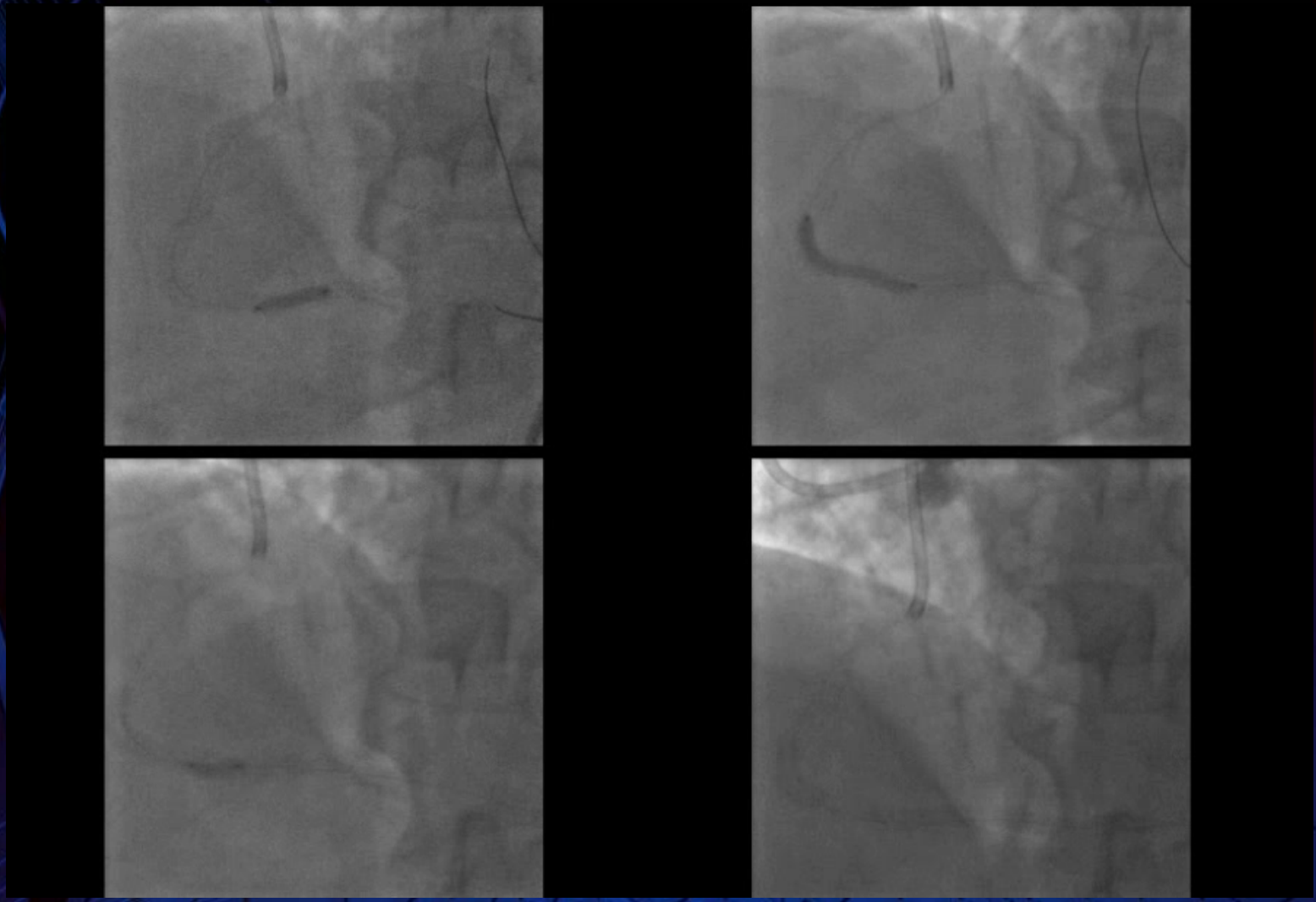
Antegrade wire crossing





Ante. G/W: Miracle 12g　　Ante. BC: φ2.5x15 Voyager

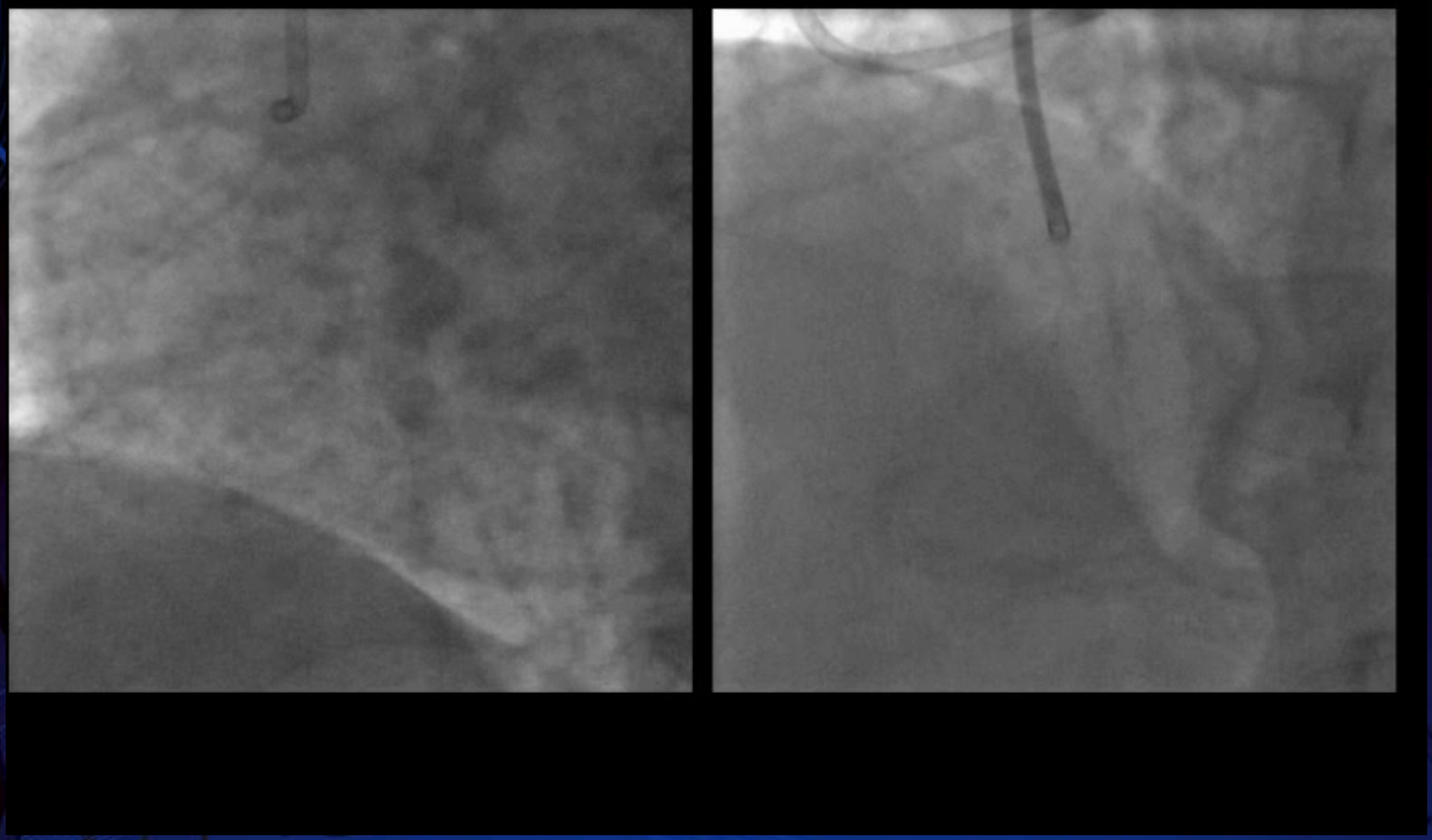
Stenting



#3 dis : φ2.5x16 TAXUS Express ^{2}　　#2 dis ～#3 prox : φ2.75x32 TAXUS Express ^{2}

#3 prox : φ3.0x8 TAXUS Express ^{2}

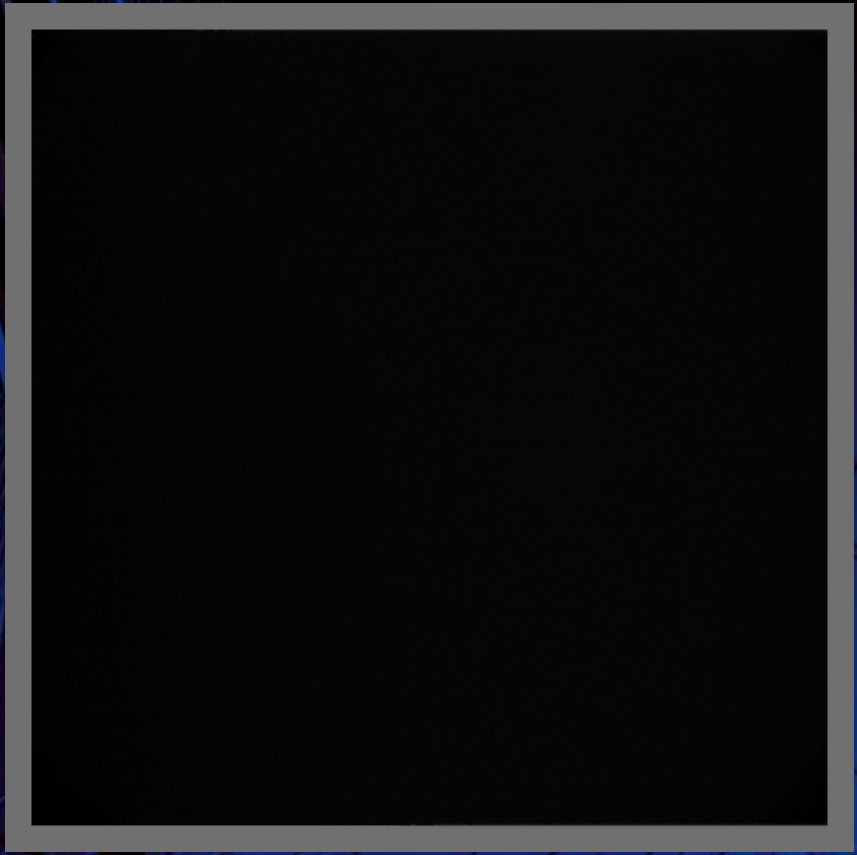
Final CAG

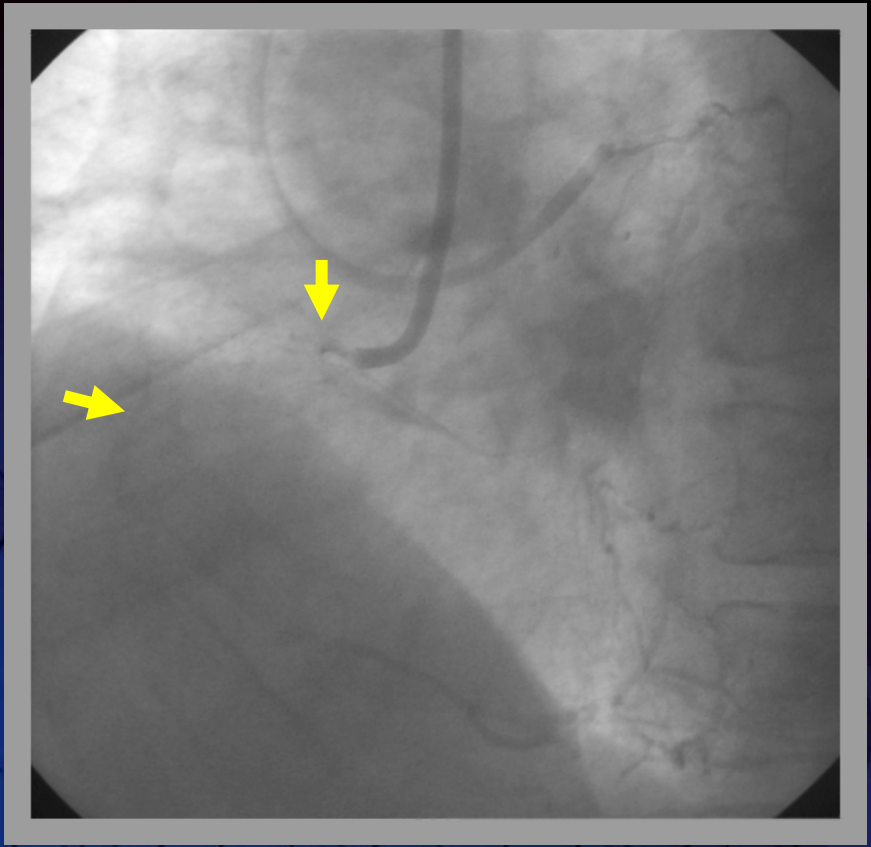


LAO 45

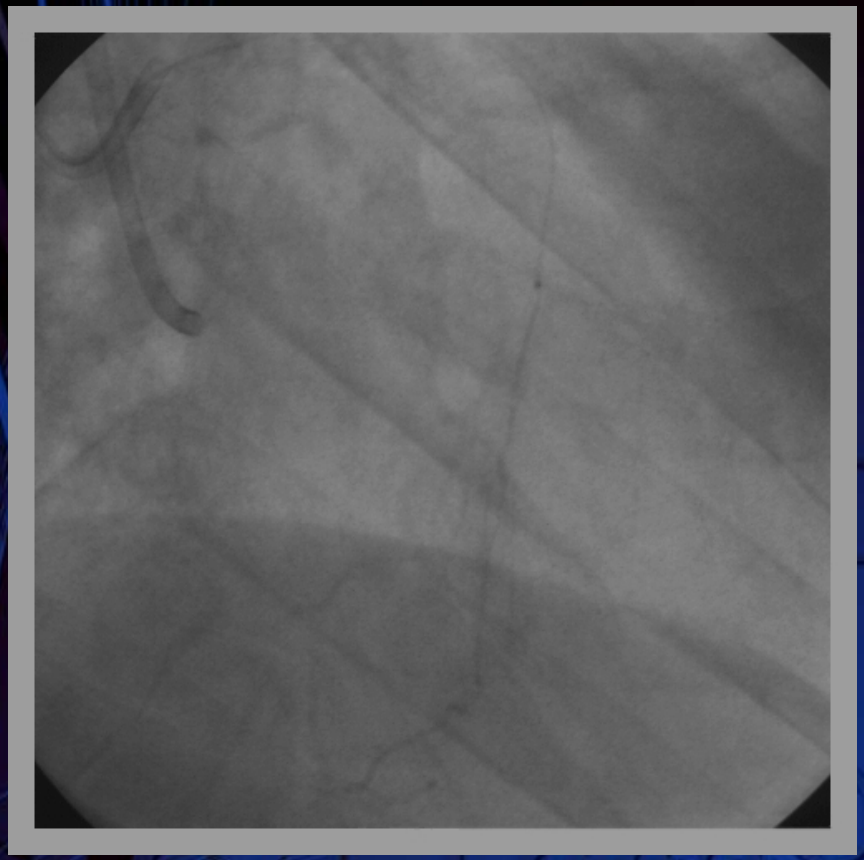
RAO Cranial

CASE 2 (OCT/06)
his 70's Male
RCA ostial CTO case

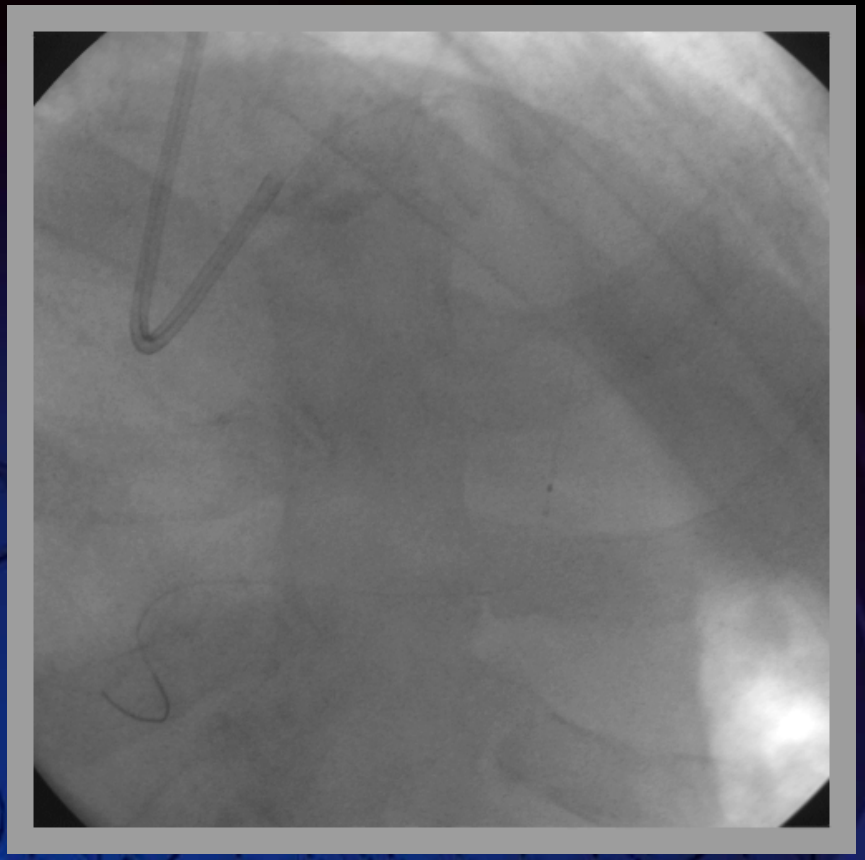




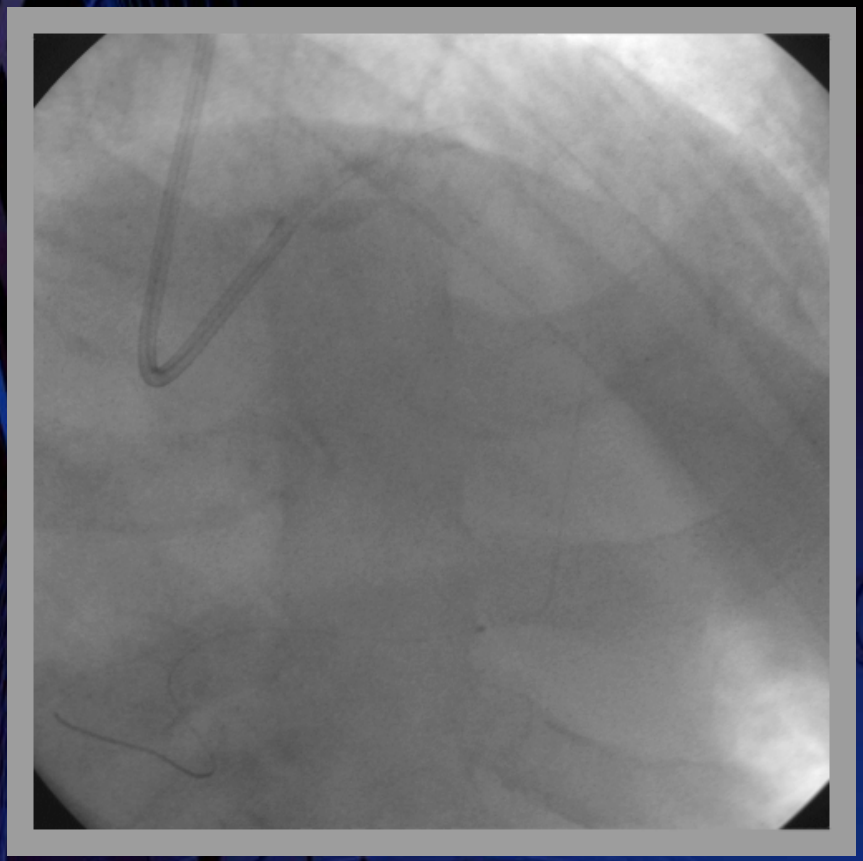
angiogram

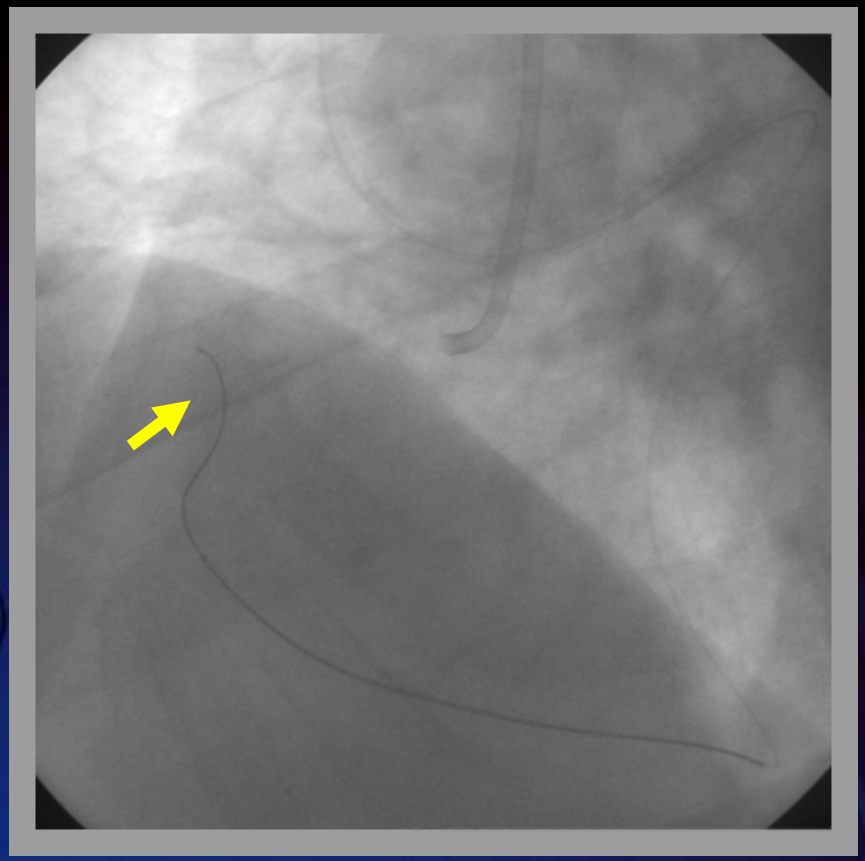


super selective tip injection
septal branch angiography

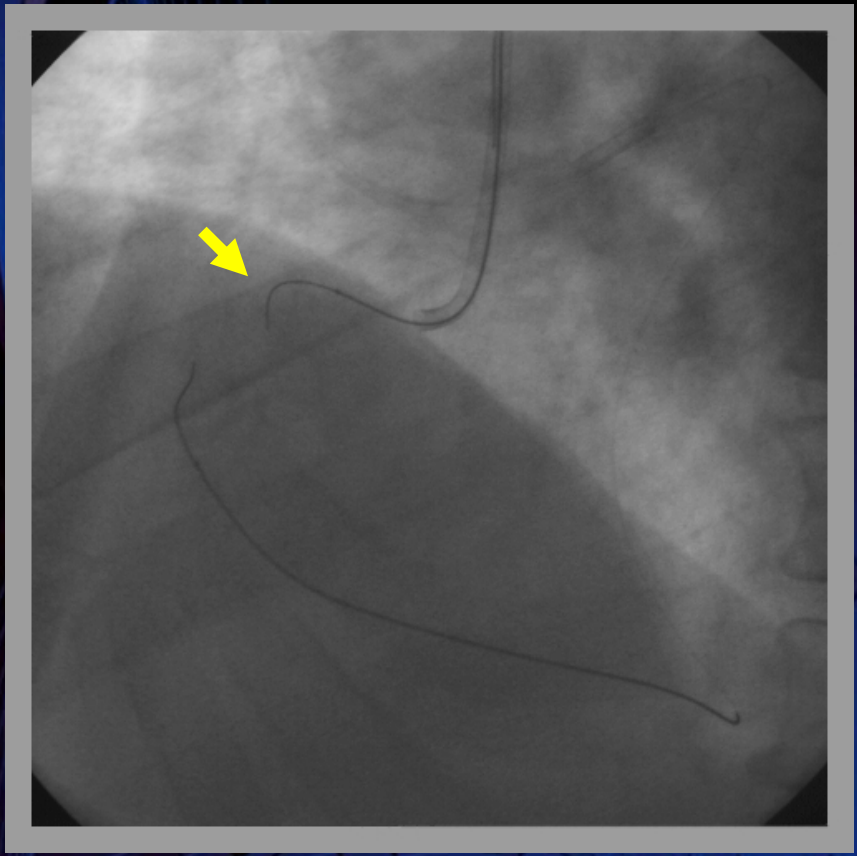


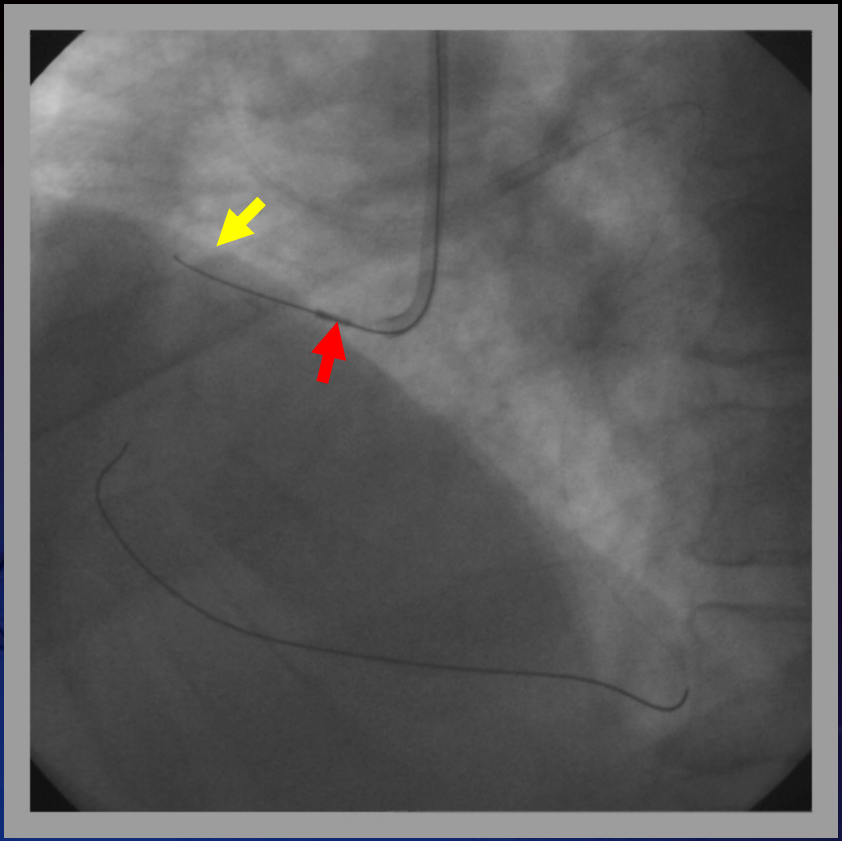
wire passed septal junction



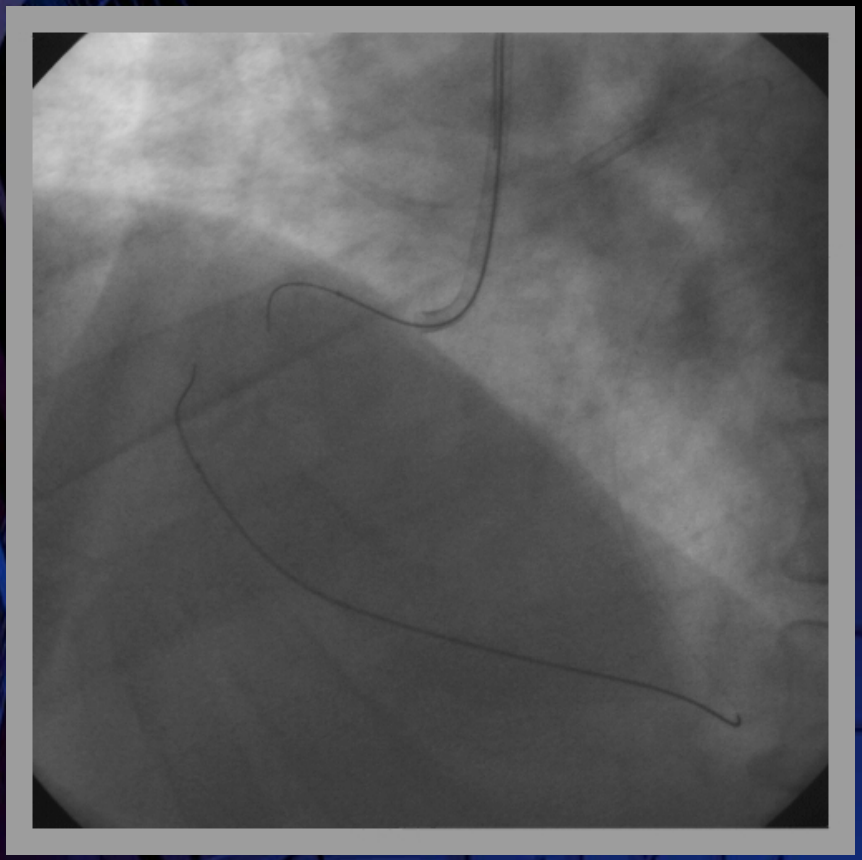


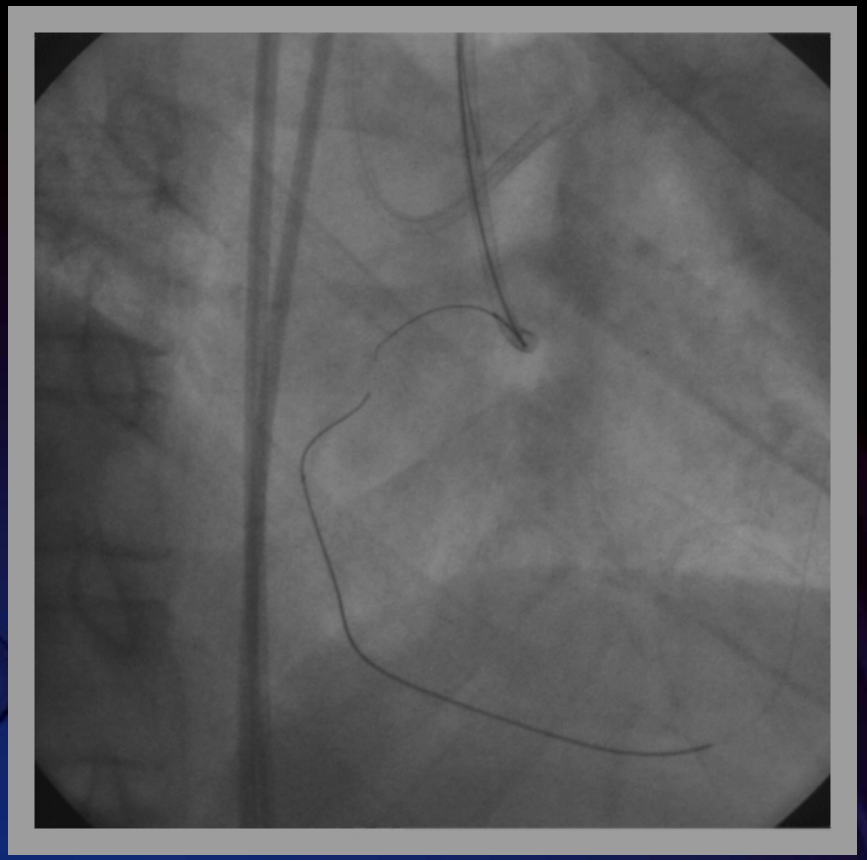
1.25mm OTW balloon dilatation





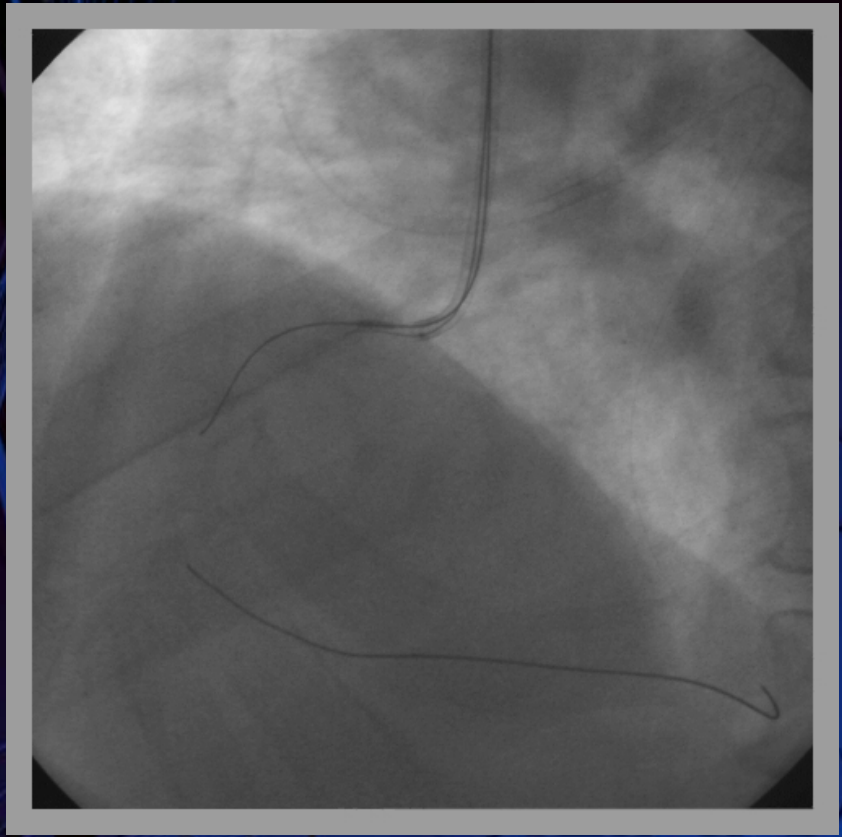
antegrade approach with Tornus backup

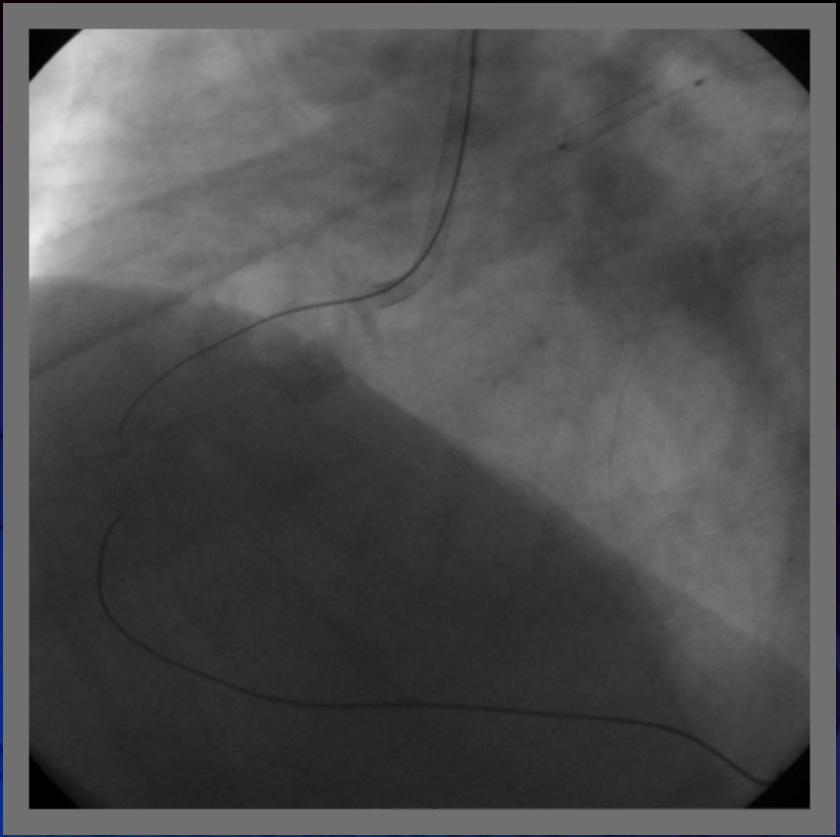


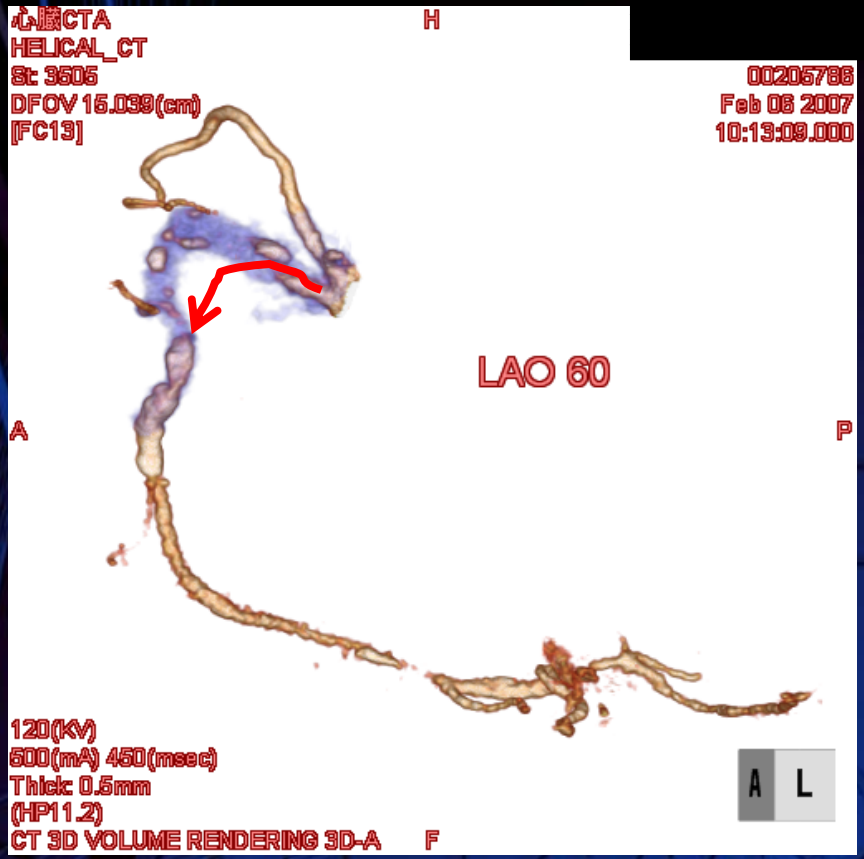


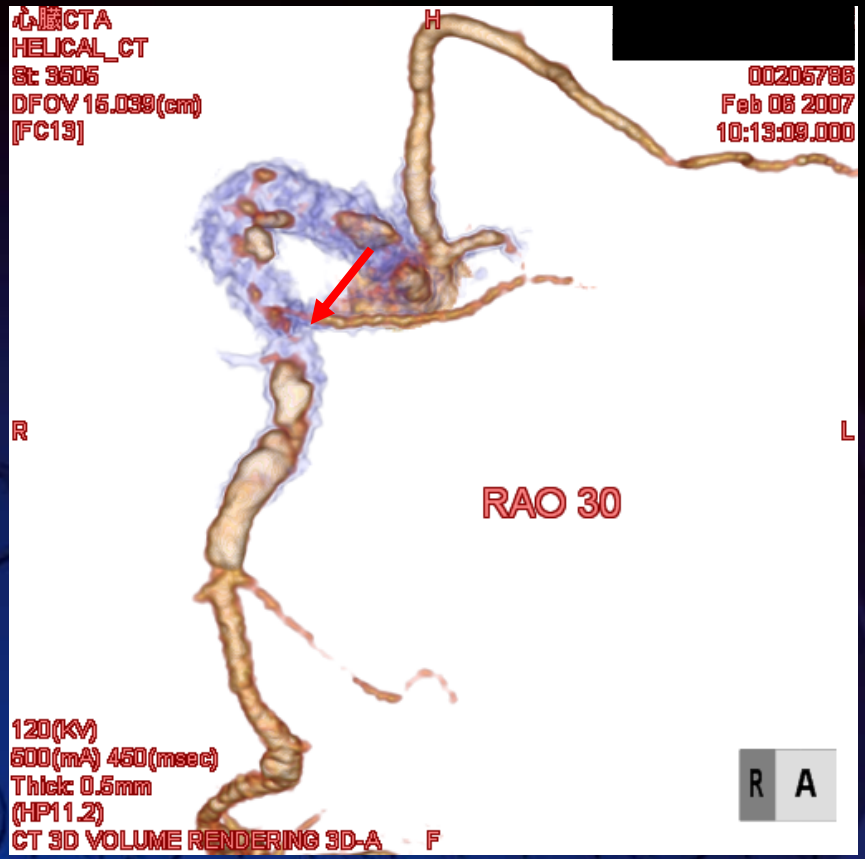
LAO RAO

antegrade approach with Tornus backup






心臓CTA
HELICAL_CT
St: 3505
DFOV 15.039(cm)
[FC13]
00205786
Feb 08 2007
10:13:09.000
H
LAO 60
A
P
120(KV)
500(mA) 450(msec)
Thick: 0.5mm
(HP11.2)
CT 3D VOLUME RENDERING 3D-A
F
A L


心臓CTA
HELICAL_CT
St: 3505
DFOV 15.039(cm)
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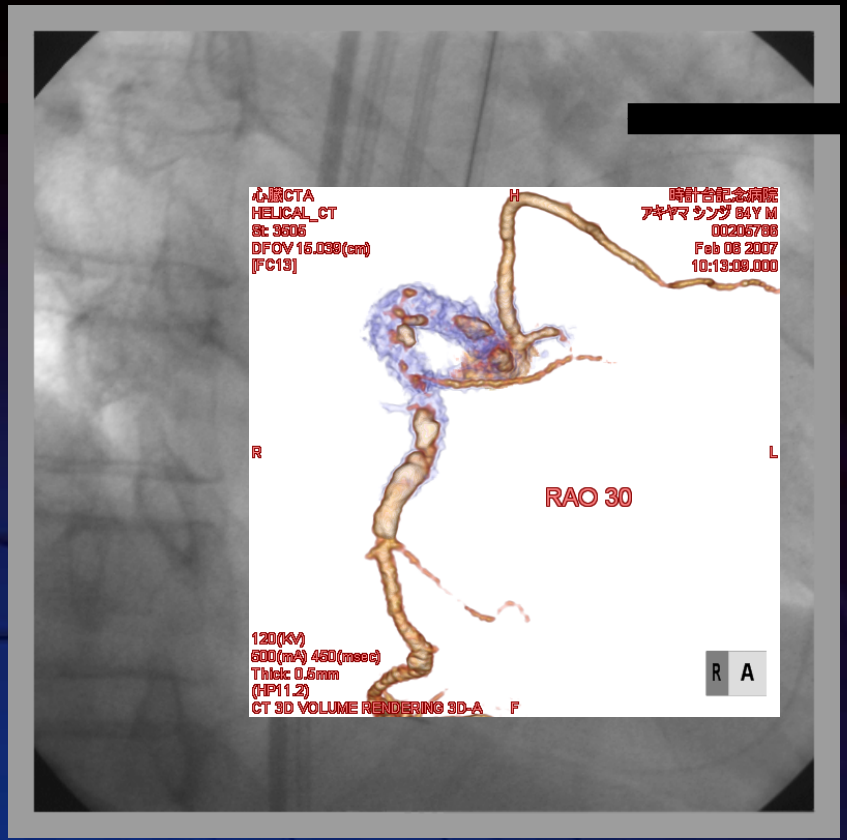
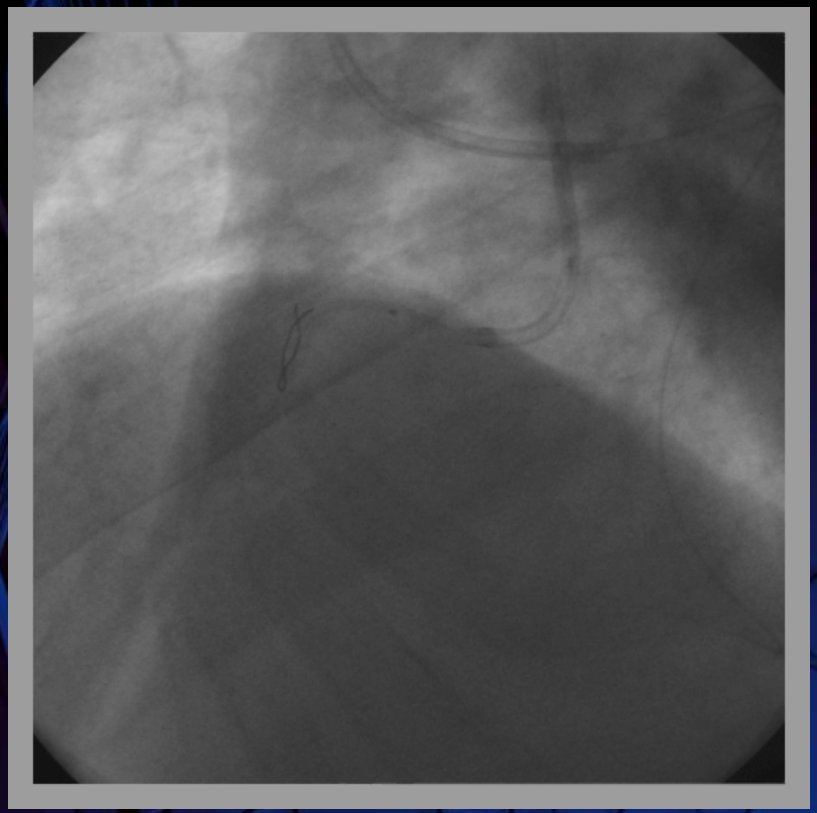
00205786
Feb 08 2007
10:13:09.000
H
RAO 30
R
L
120(KV)
500(mA) 450(msec)
Thick: 0.5mm
(HP11.2)
CT 3D VOLUME RENDERING 3D-A
F
R A

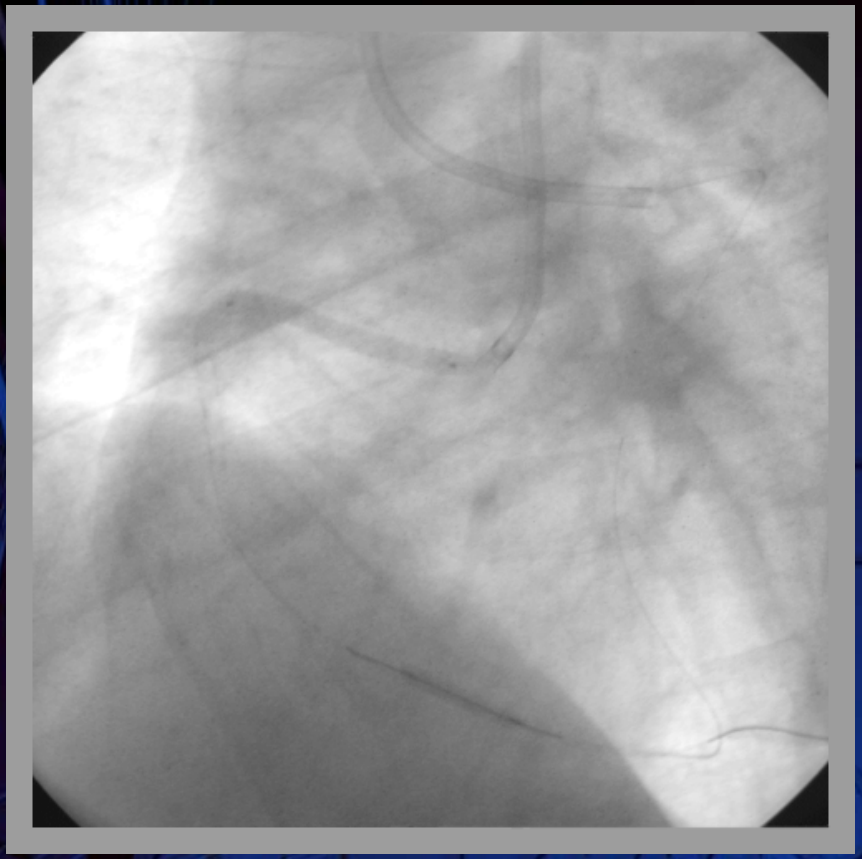
2nd PCI


心臓CTA
HELICAL_CT
St: 3505
DFOV 15.039(cm)
[FC13]
H
時計台記念病院
アキヤマ シンジ 64Y M
00205788
Feb 08 2007
10:13:09.000
LAO 60
A
P
120(KV)
500(mA) 450(msec)
Thick: 0.5mm
(HP11.2)
CT 3D VOLUME RENDERING 3D-A
F
A L


心臓CTA
HELICAL_CT
St: 3505
DFOV 16.039(cm)
[FC13]
H
時計台記念病院
アキヤマ シンジ 64Y M
00205788
Feb 08 2007
10:13:09.000
R
L
RAO 30
120(KV)
500(mA) 450(msec)
Thick: 0.5mm
(HP11.2)
CT 3D VOLUME RENDERING 3D-A
F
R A

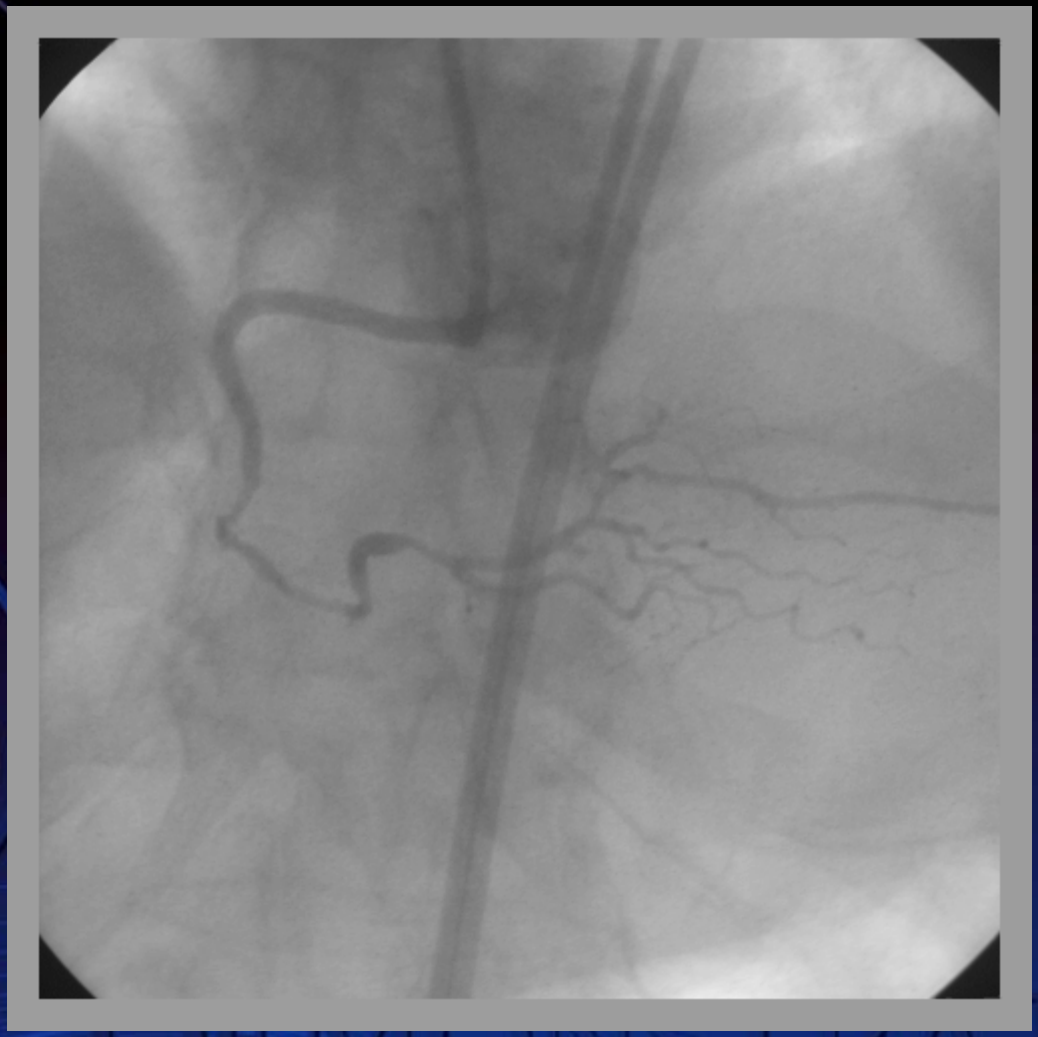


Reverse CART technique



DES to RCA#1

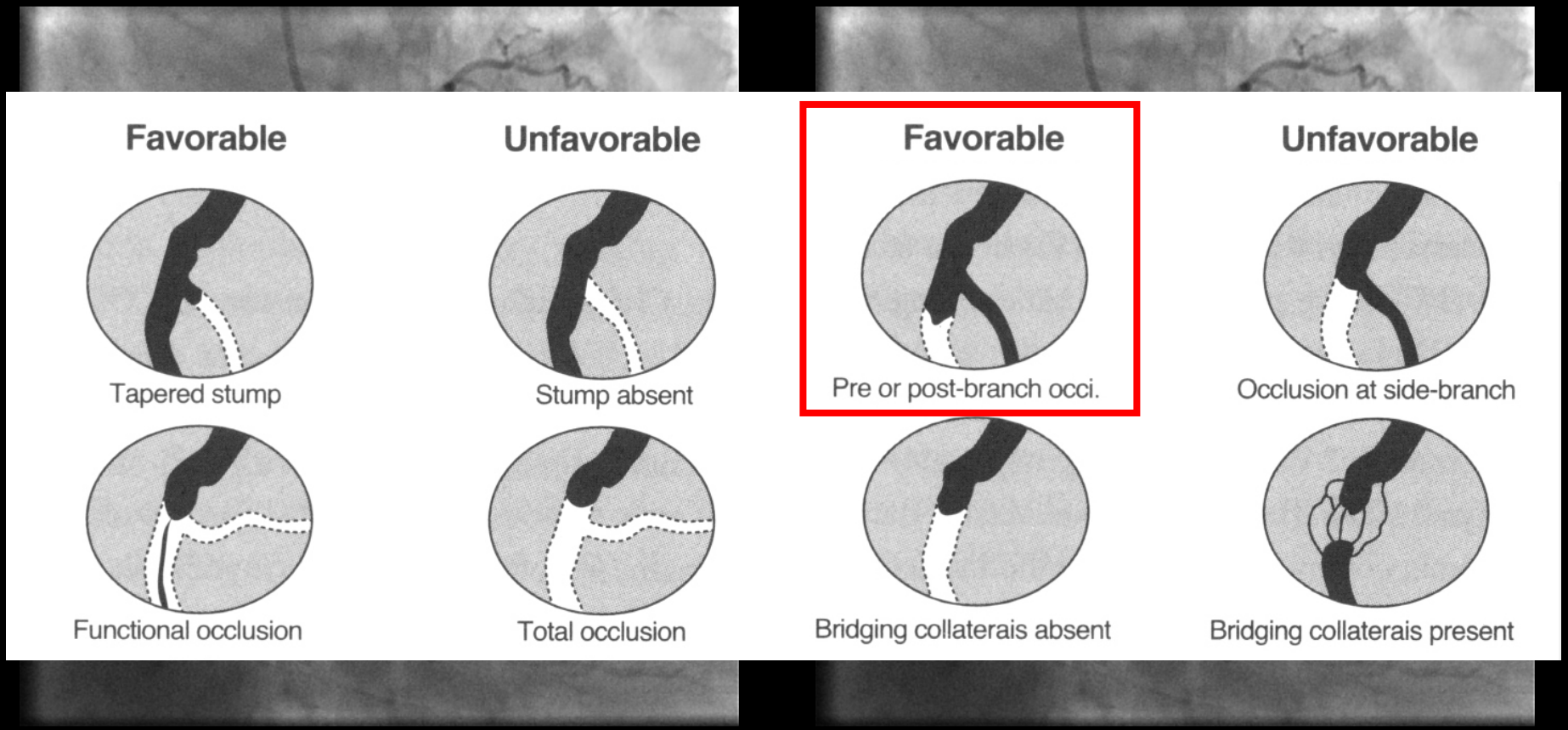
DES to #2



Final angiogram

RCA CTO

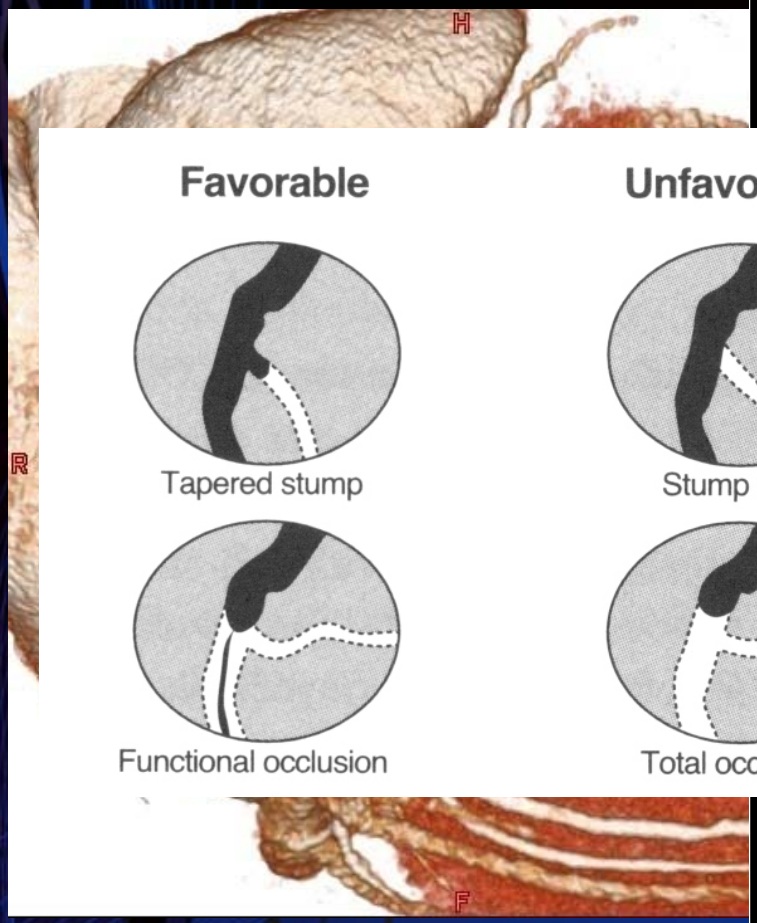
Case 1

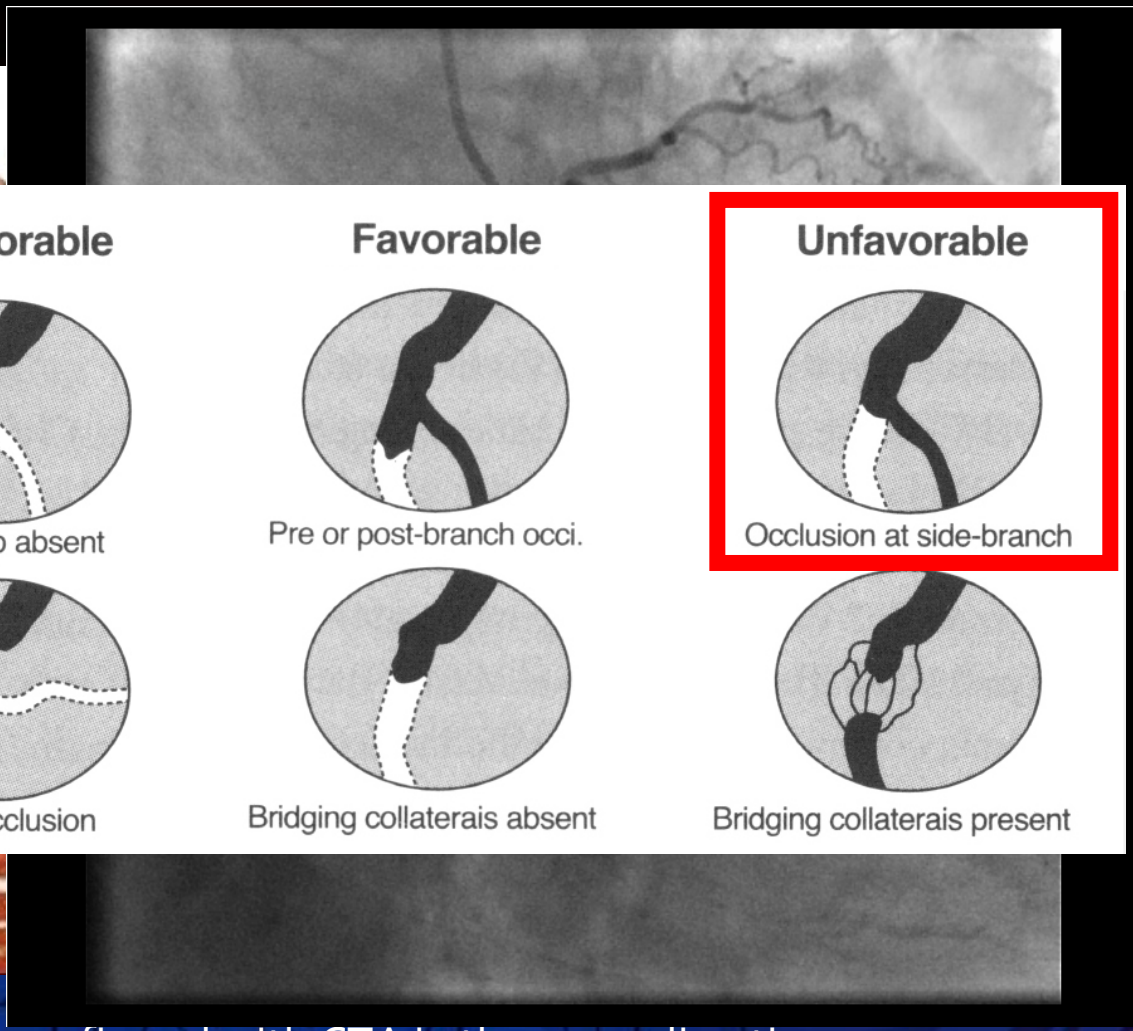


RAO 30° Cd 30°

The form of the vessel is guessed.

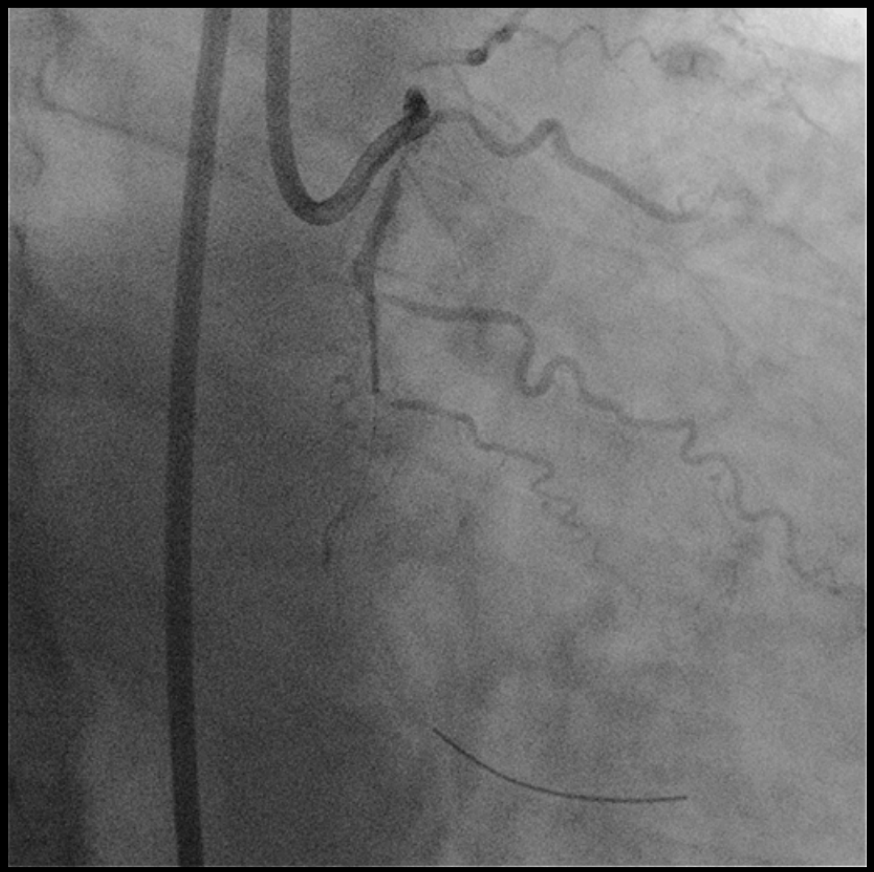
3DMAP assists PCI

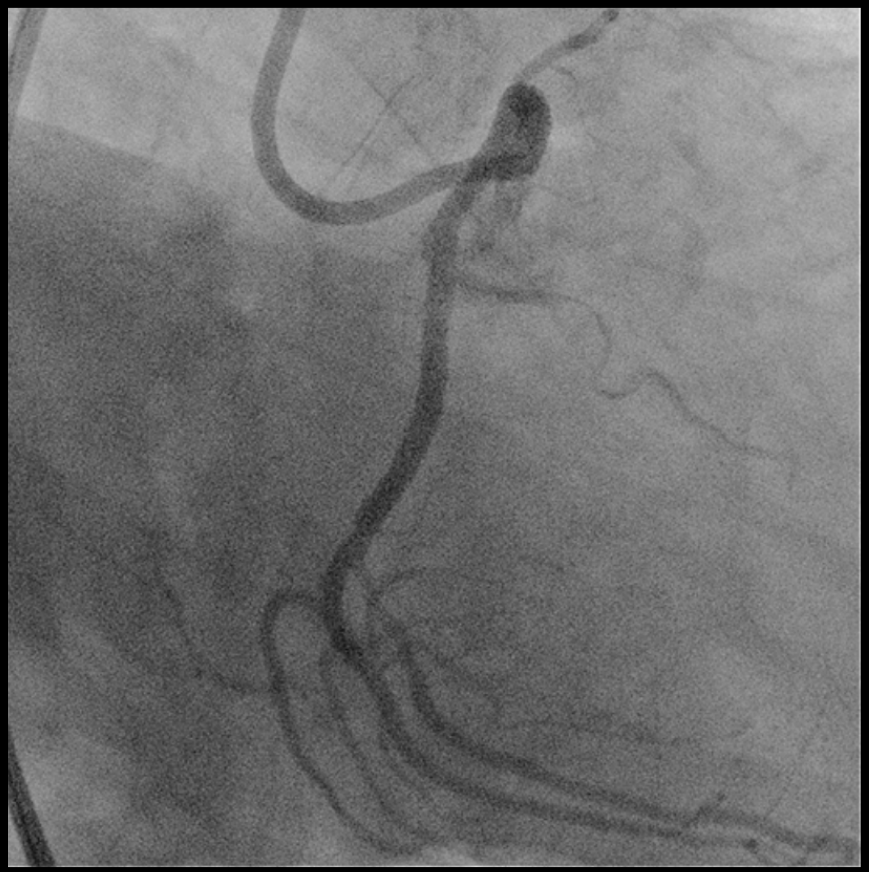




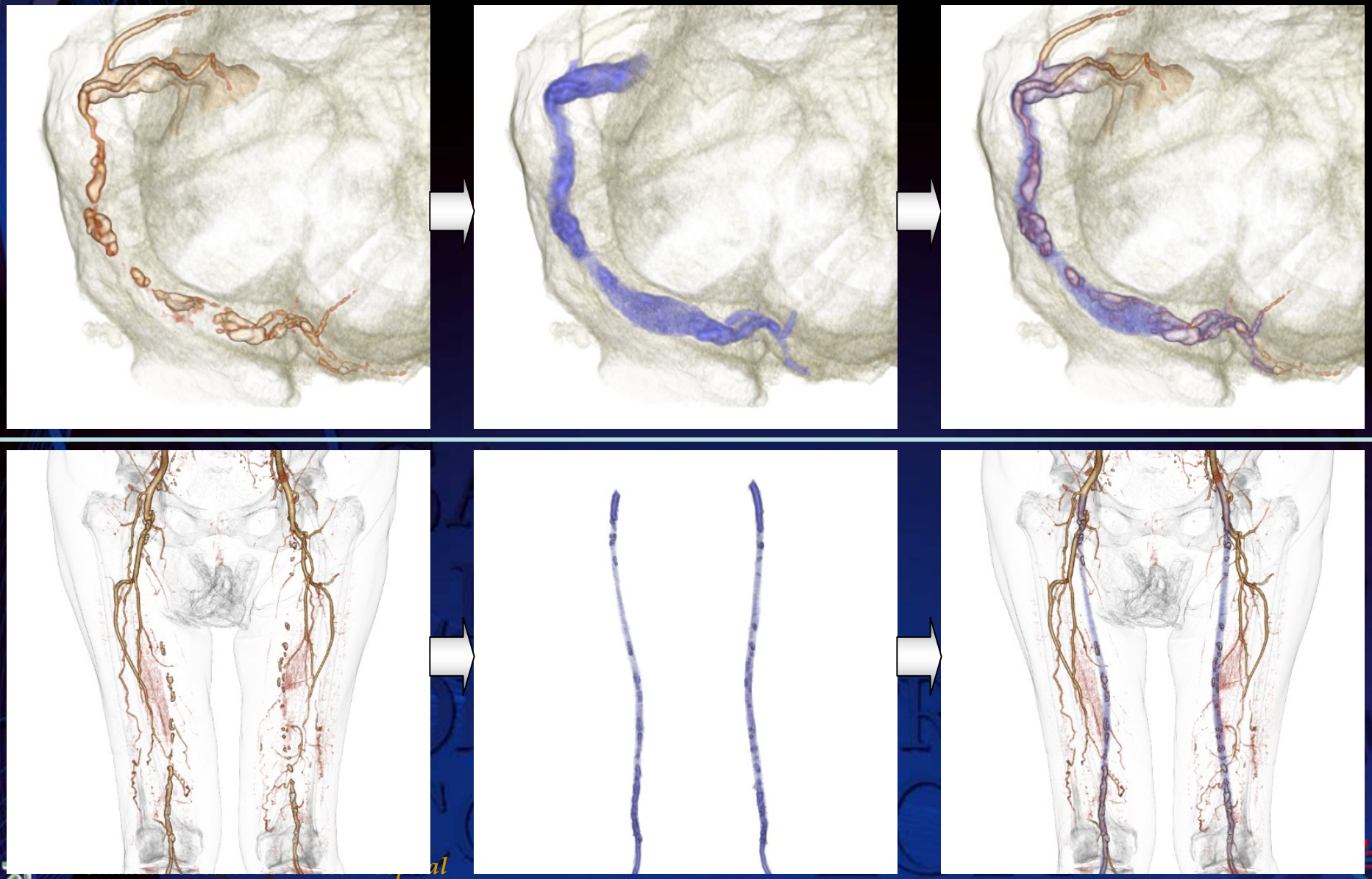
The form of the vessel is confirmed with CTA in the same direction.

3DMAP assists PCI





Construction of 3DMAP



Feature of 3DMAP

- 閉塞部の血管走行を立体的に把握可能。
- 閉塞血管像を半透明にする事で、開存している腔と実際の血管領域との位置関係を把握し易い。
- インターベンション時にメルクマールとなりうる石灰化や分枝の位置関係が分かりやすい。
- 下肢領域においては、皮膚と骨を半透明にFusionする事で、Angio画像との比較が容易になる。
- アンギオ装置のビューアングルに合わせた画像を簡単に表示可能。

MSCT for CTOs

- Volume-rendered MSCT image provides a 3-demensional overview of the coronary segment, and a collateral filling on MSCT can be more clearly visible than on coronary angiography.

- Maximum intensity projection (MIP) allows evaluation of the morphology of the CTO lesion.

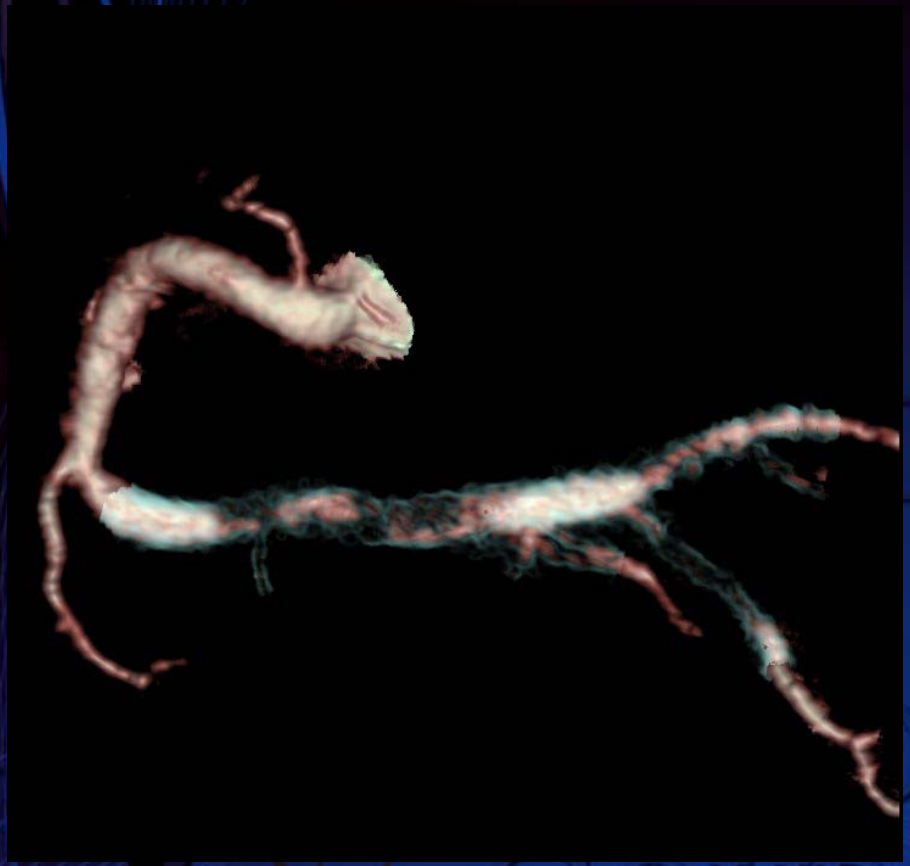
<u>We can know in advance</u>

- the tortuosity of the occluded artery.
- the relation between side branch and target lesion.
- the reliable length measurement of occluded segment.
- the localization of calcification within occluded artery.
- the adequate fluoroscopic angle for PCI procedure.

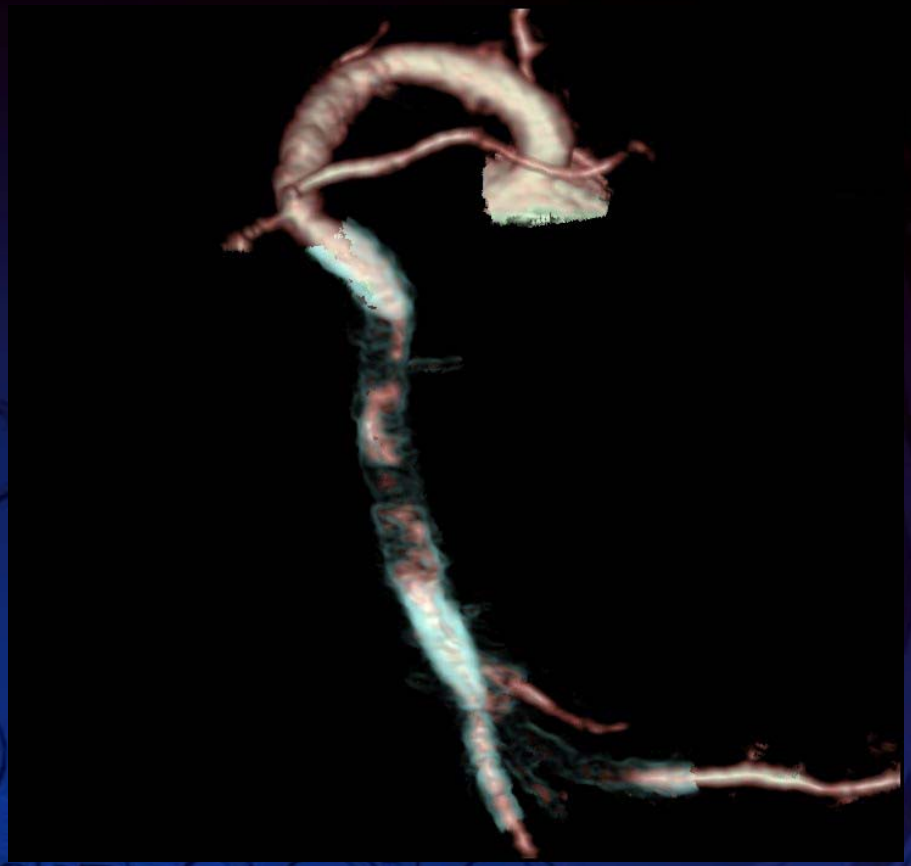
3DMAP Coronary artery

3D MAP-CT can present the adequate fluoroscopic angle for PCI .

LAO 35° Cr 35°

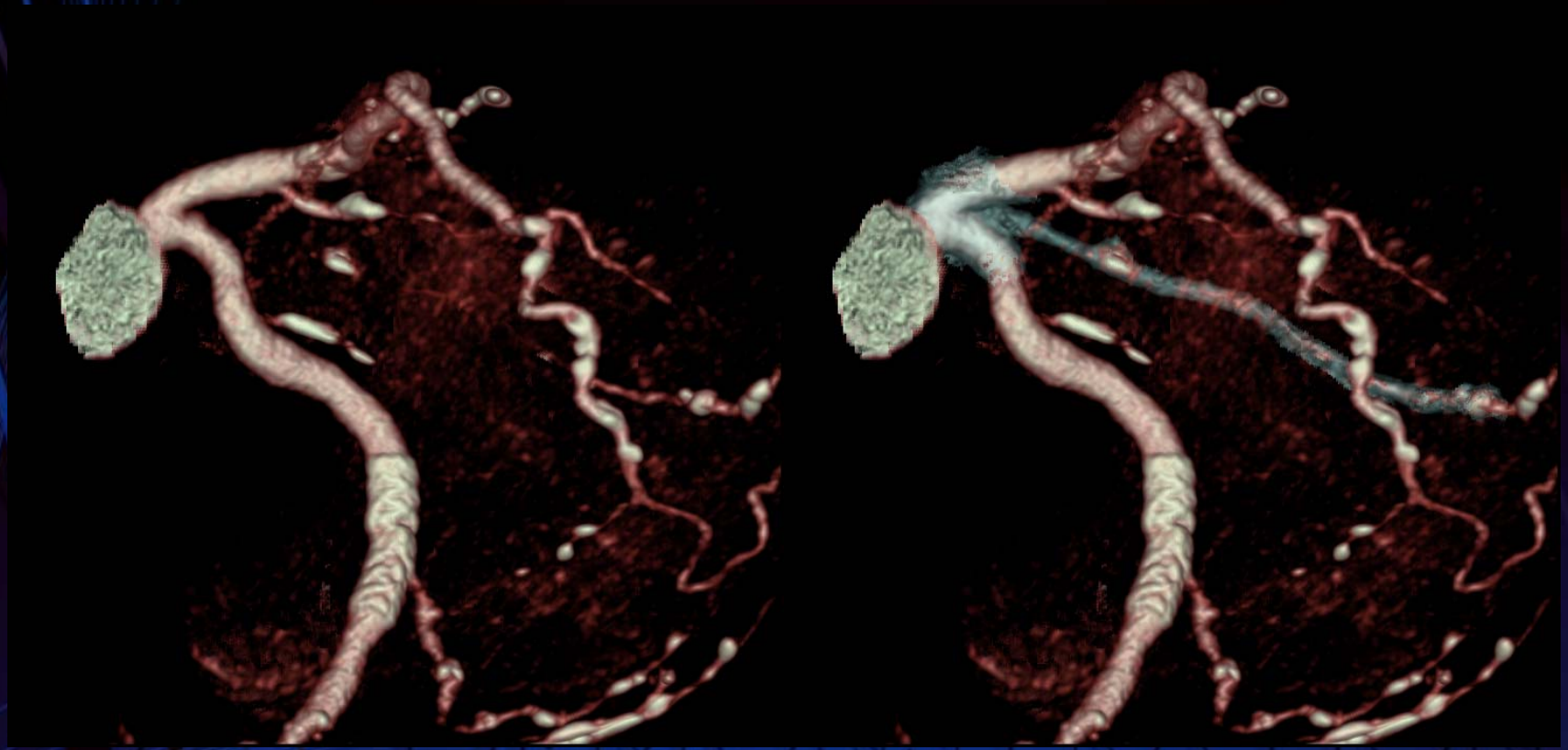


RAO 30° Cd 45°

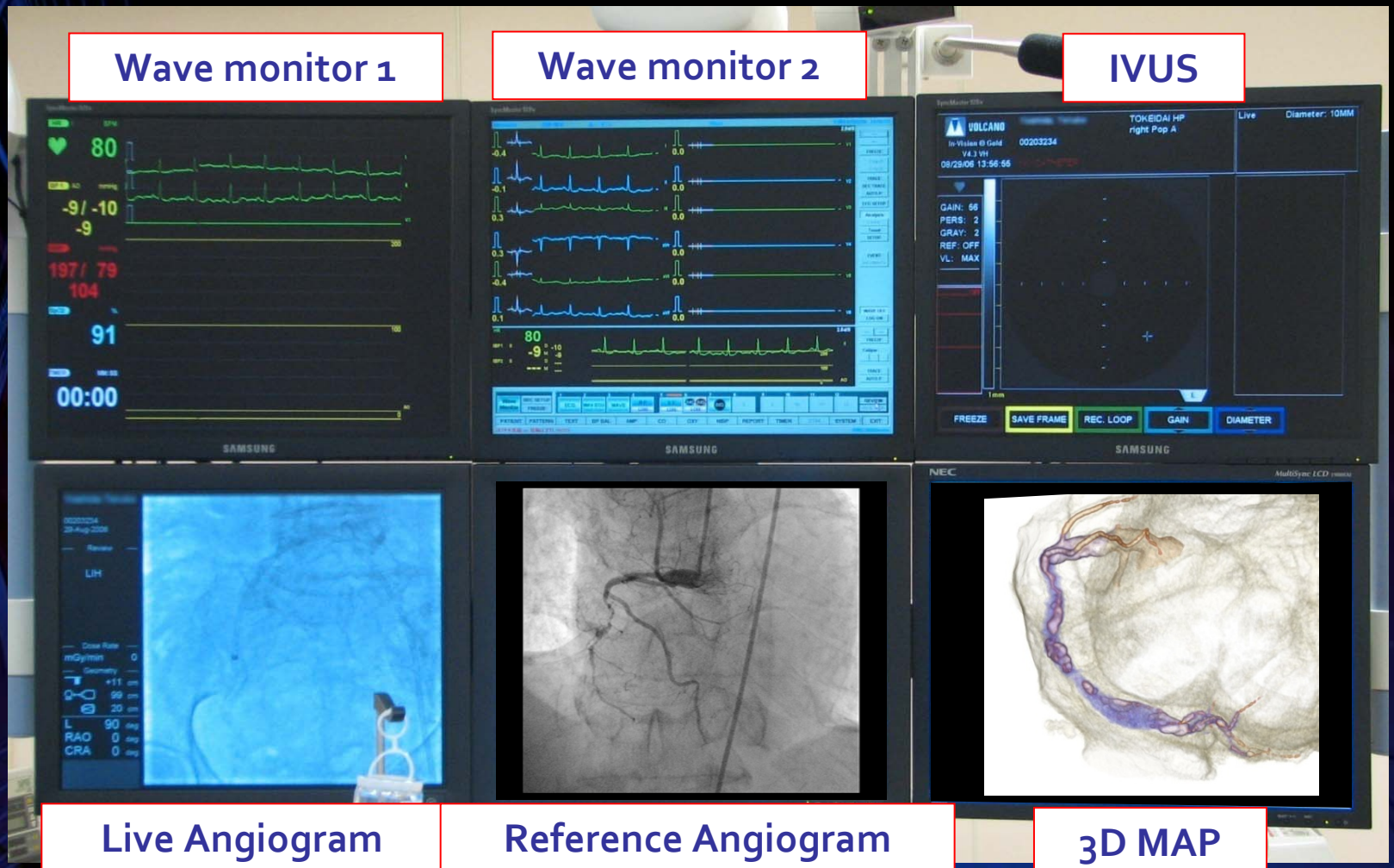


Work Station : Advantage Windows XT

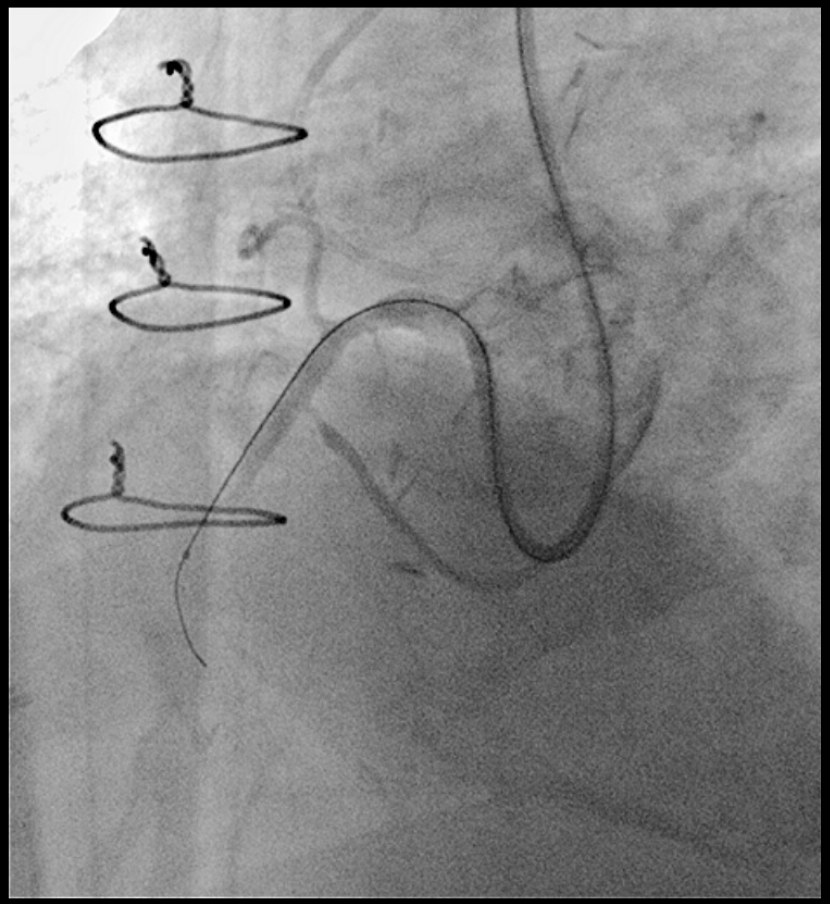
CTO : 3D MAP



Display of 3D MAP in Catheterization laboratory



Display of 3D MAP in Catheterization laboratory at the future




Now transistors replace tubes for a whole new standard of reliability in color television.
This is America's most advanced Color TV—with solid state devices replacing all tubes but one, and innovations for tuning ease and color reproduction not available on the other color sets today.
It was engineered to make the TV repair man a stranger at your house. Separate circuits that work without tubes are contained in 10 solid state modules like the one shown above. This construction principle, using solid state electronics, is designed for maximum operating reliability. It eliminates hundreds of chances for human error in manufacture, and is specified in most space electronics and computer systems.
Fine-tuning is virtually foolproof—so easy, you don't even have to look at the picture. The Motorola Vni-Trak tuning system electronically senses if your picture needs fine-tuning, and turns on a signal light to tell you so. You just turn a knob until the light goes out. That's it.
Added advantages: The all-transistor design gives you instant sound and an automatically color-purified picture in about five seconds. You get faithful color reproduction of the broadcast signal. It's the color set of the future, available right now at your Motorola dealer's. See it soon.
23" picture, measured diagonally; 295 sq. in.
This Color TV is easier to fine-tune right than black and white
MOTOROLA
Leading through Creativity in Electronics

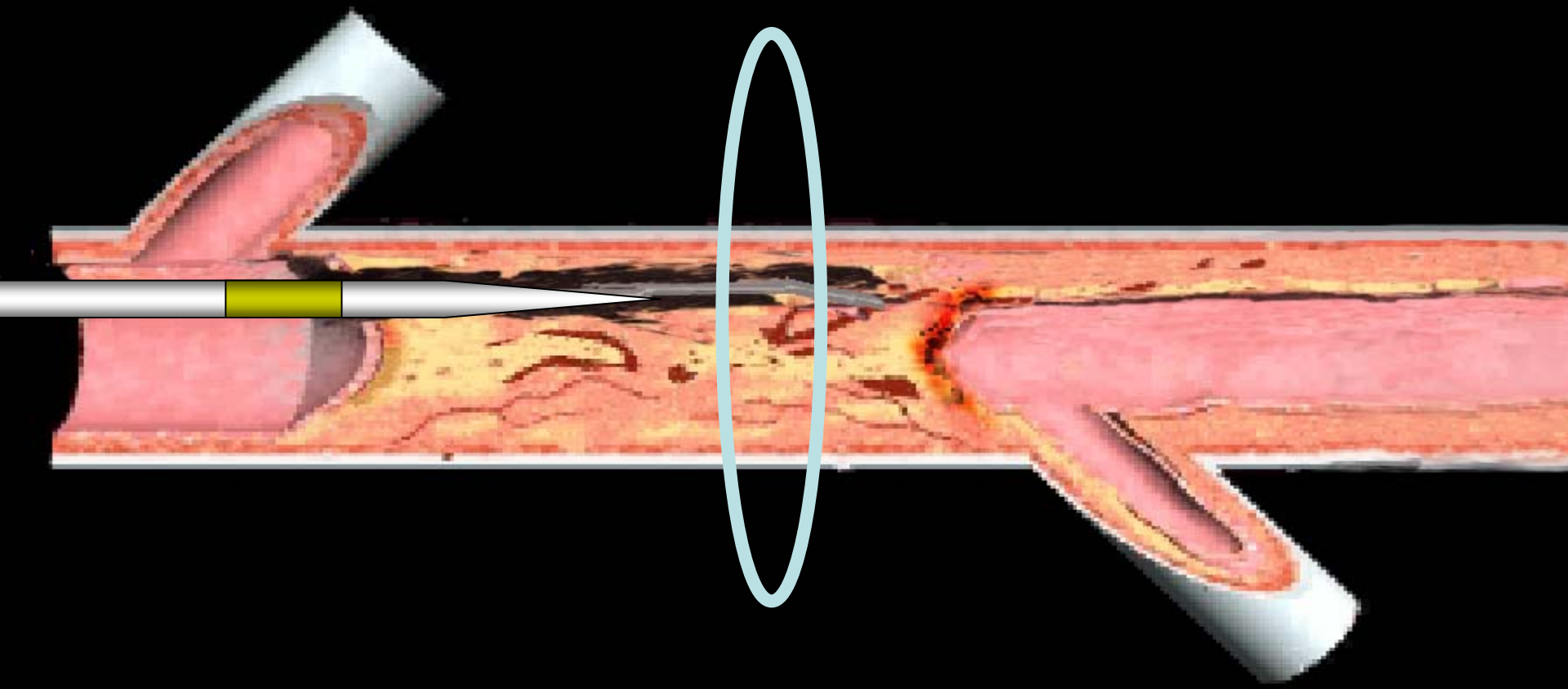

3D


3D

Imaging Modalities for CTO PCI

- Catheter angiogram
- CT angiogram
- IVUS

Major and fundamental limitation of IVUS for CTO recanalization

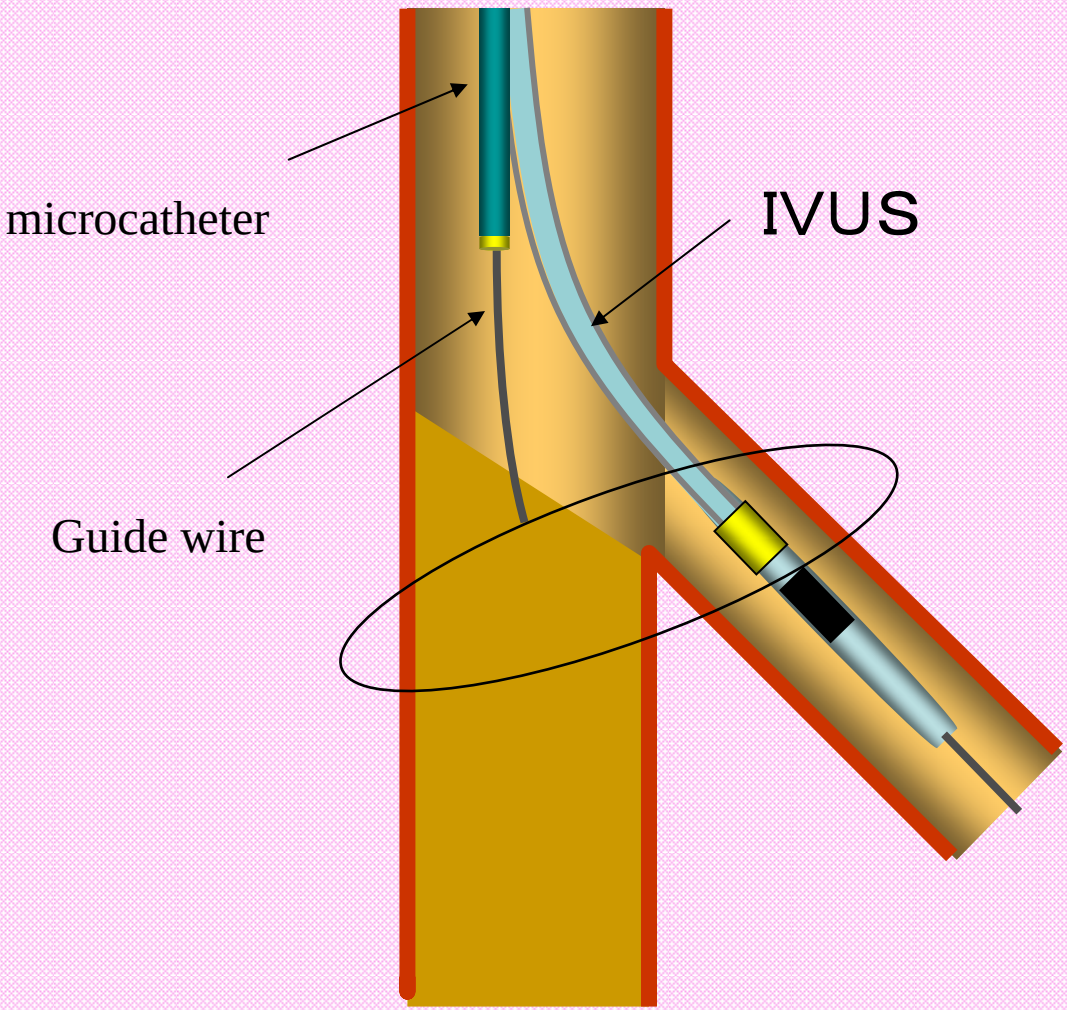


Application of IVUS for CTO PCI

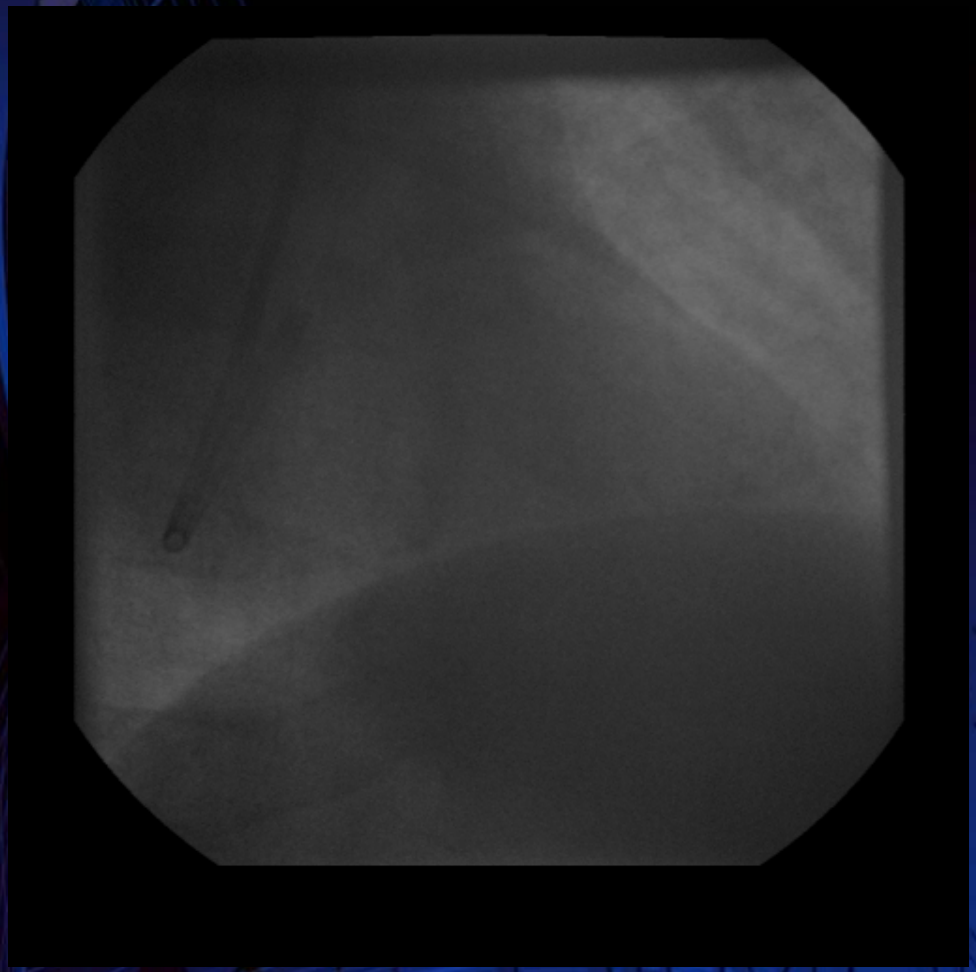
- To detect entry point of bifurcated CTO lesions
- IVUS guided wiring

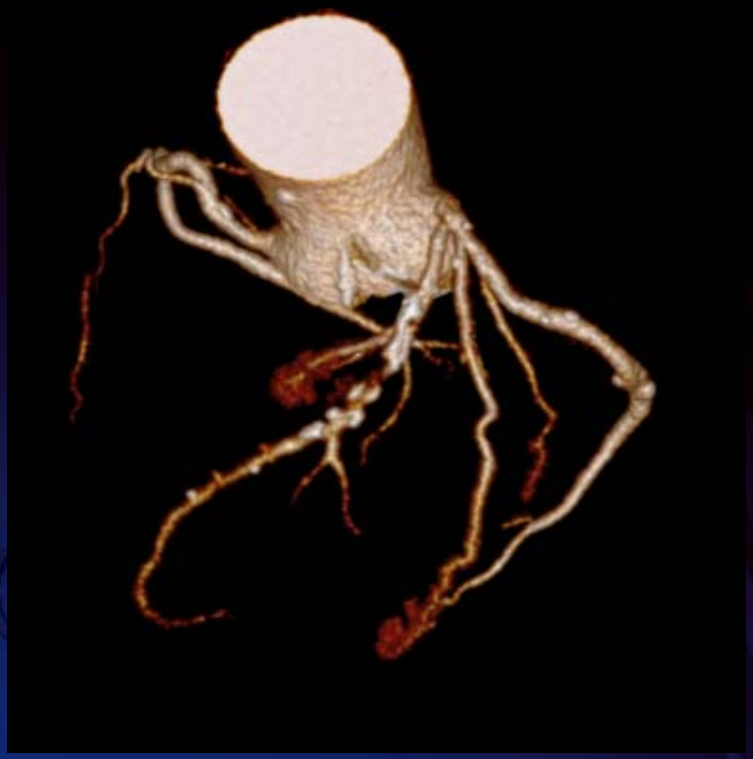
  1)followed after failed parallel wire technique

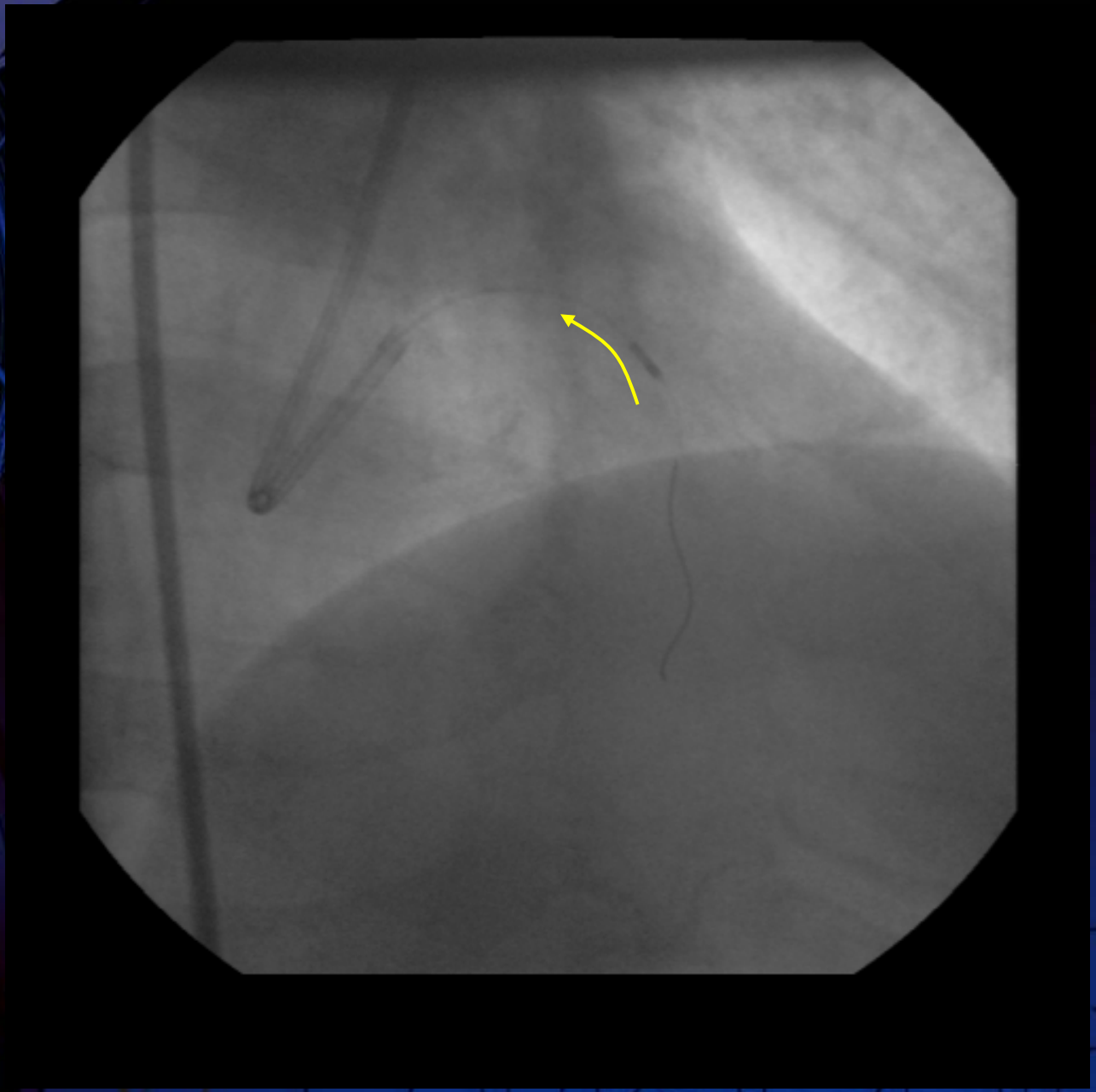
To detect entry point of bifurcated CTO lesions

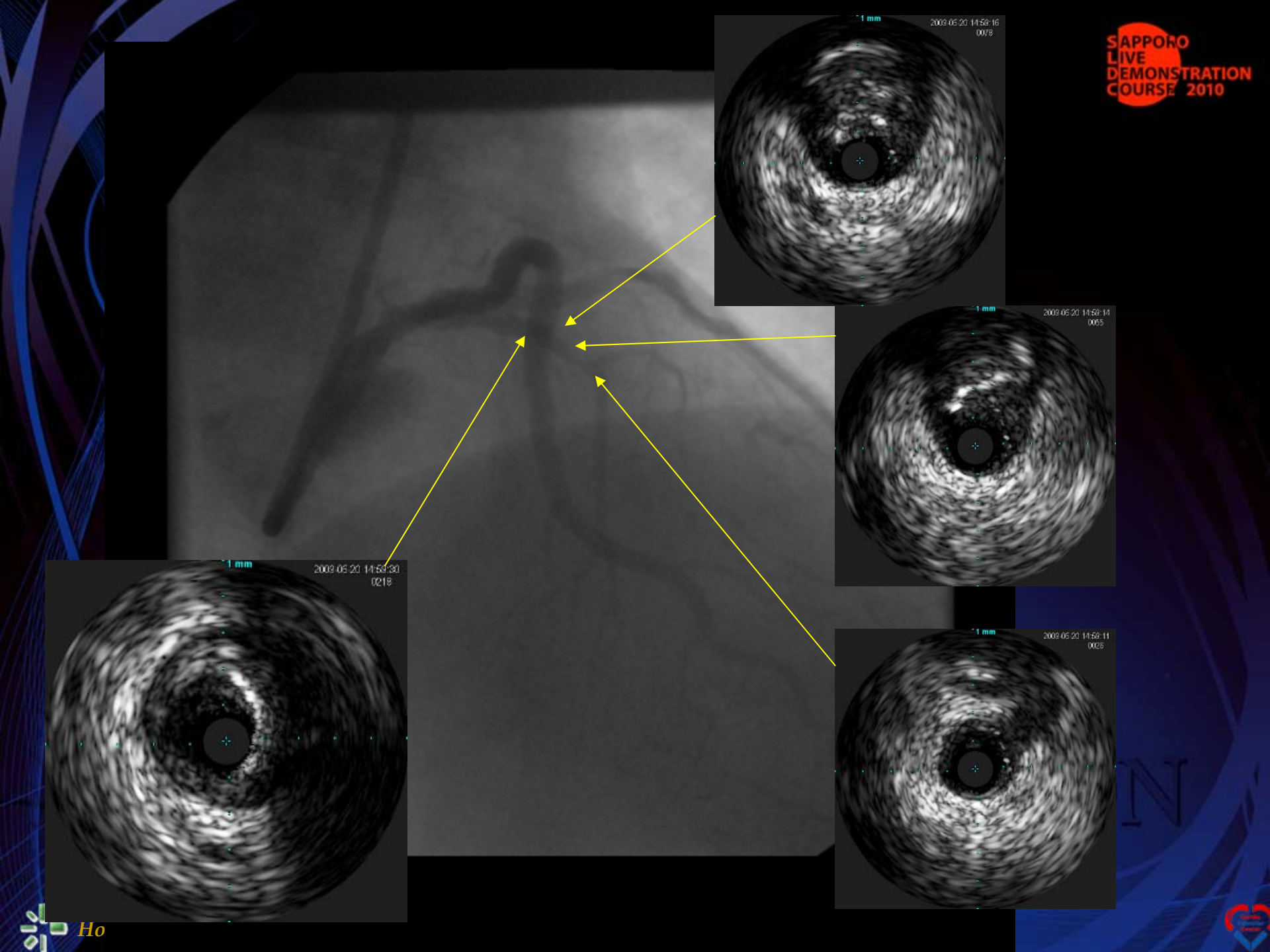


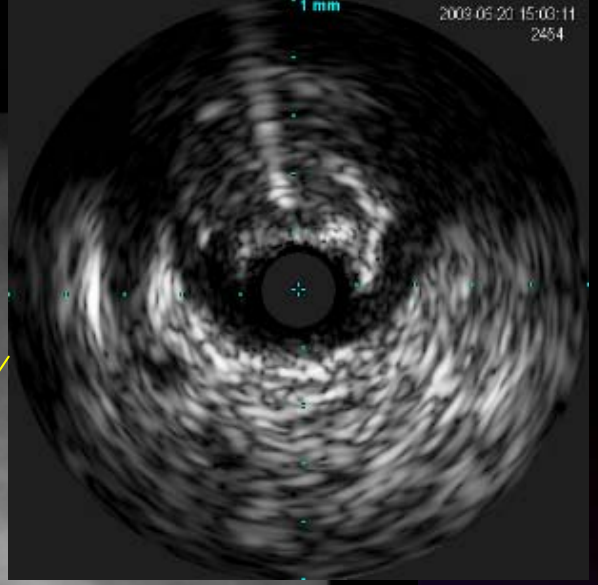
60s y/o male LAD mid CTO(retry) case

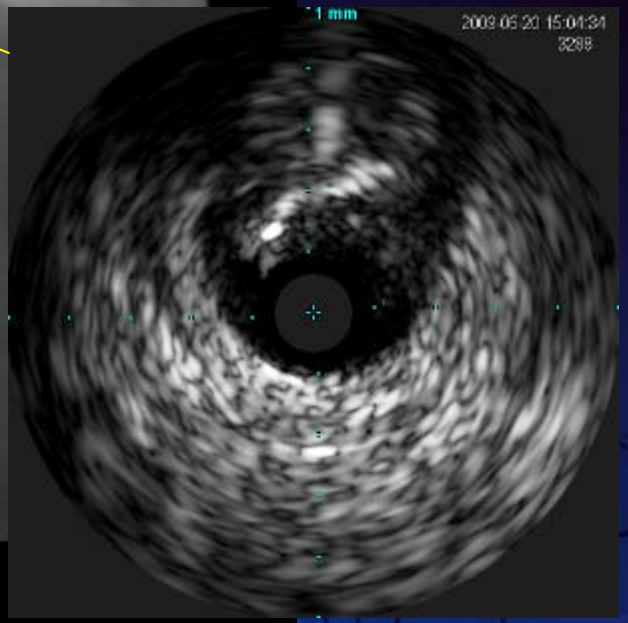




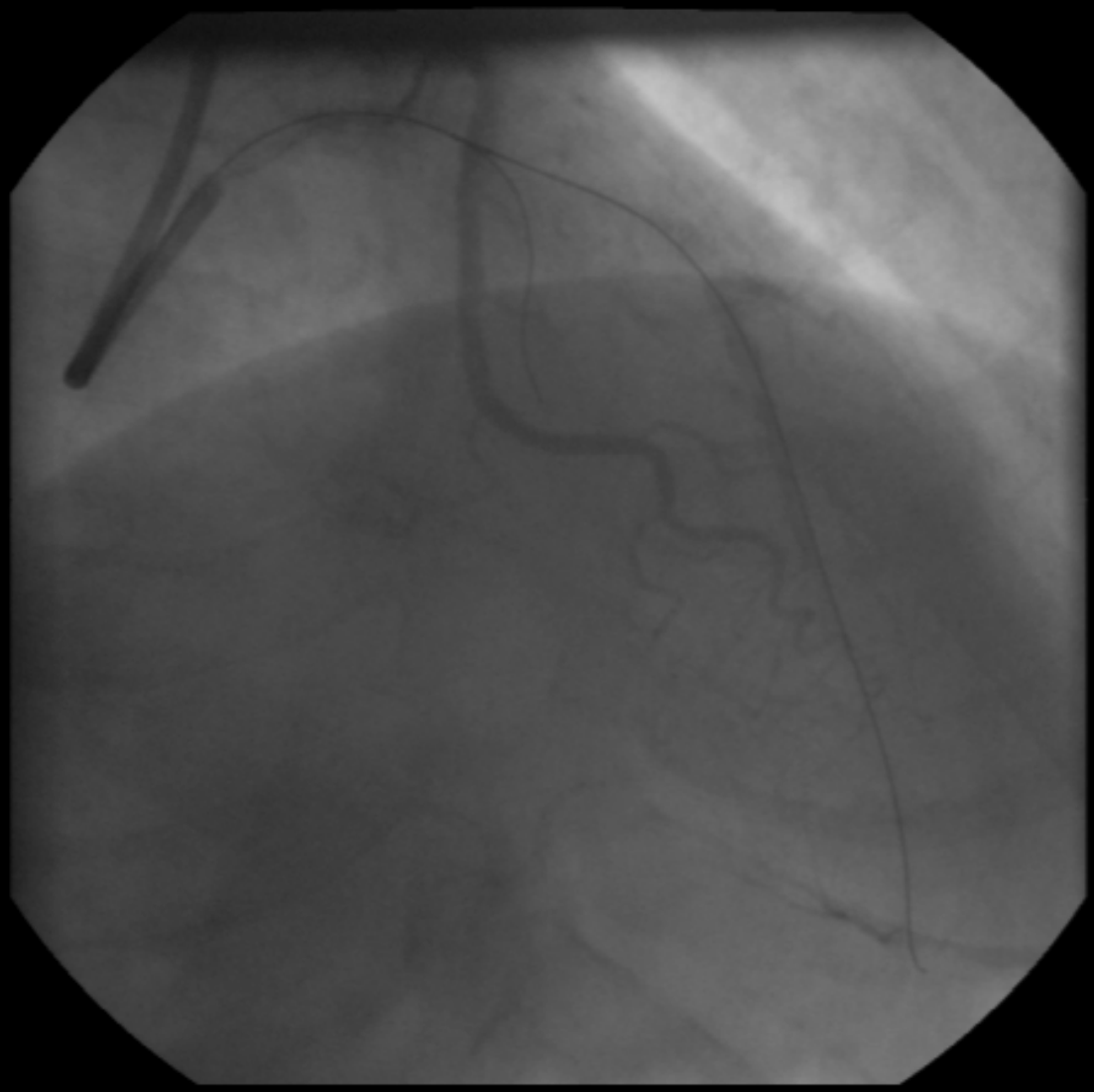


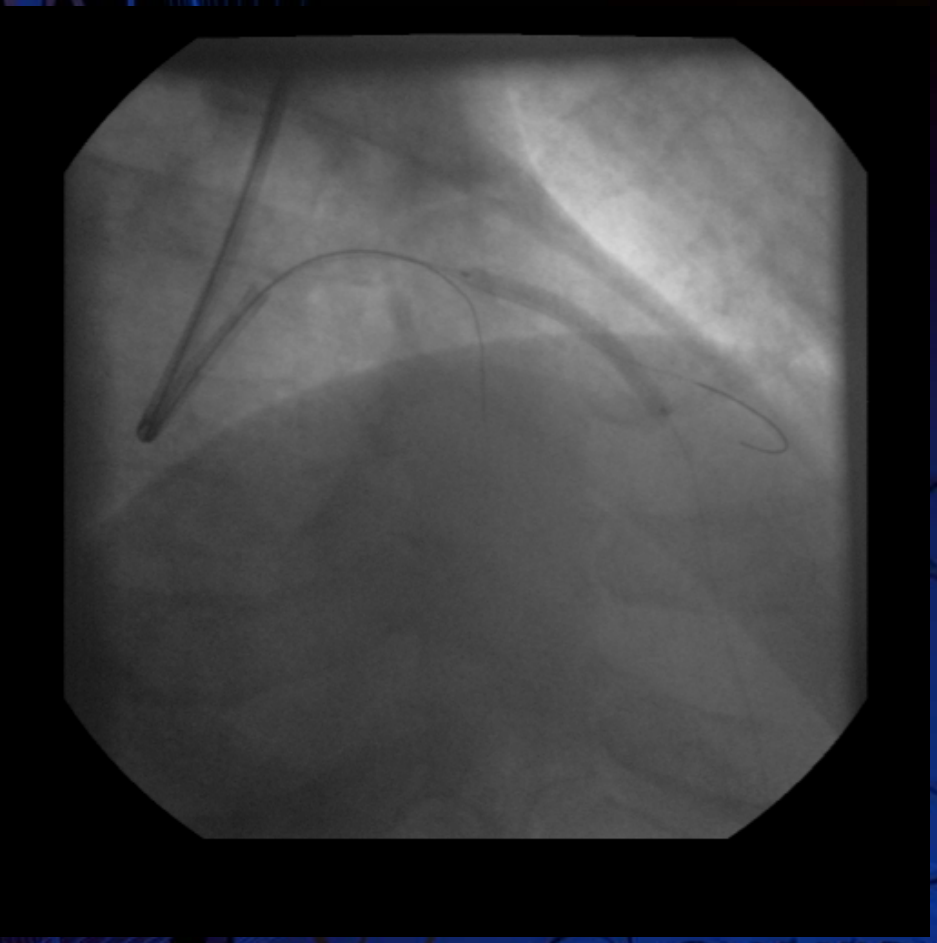

SAPPORO
LIVE
DEMONSTRATION
COURSE 2010
1 mm
2009.05.20 14:59:16
0078
1 mm
2009.05.20 14:59:14
0055
1 mm
2009.05.20 14:59:30
0218
1 mm
2009.05.20 14:59:11
0026
Ho

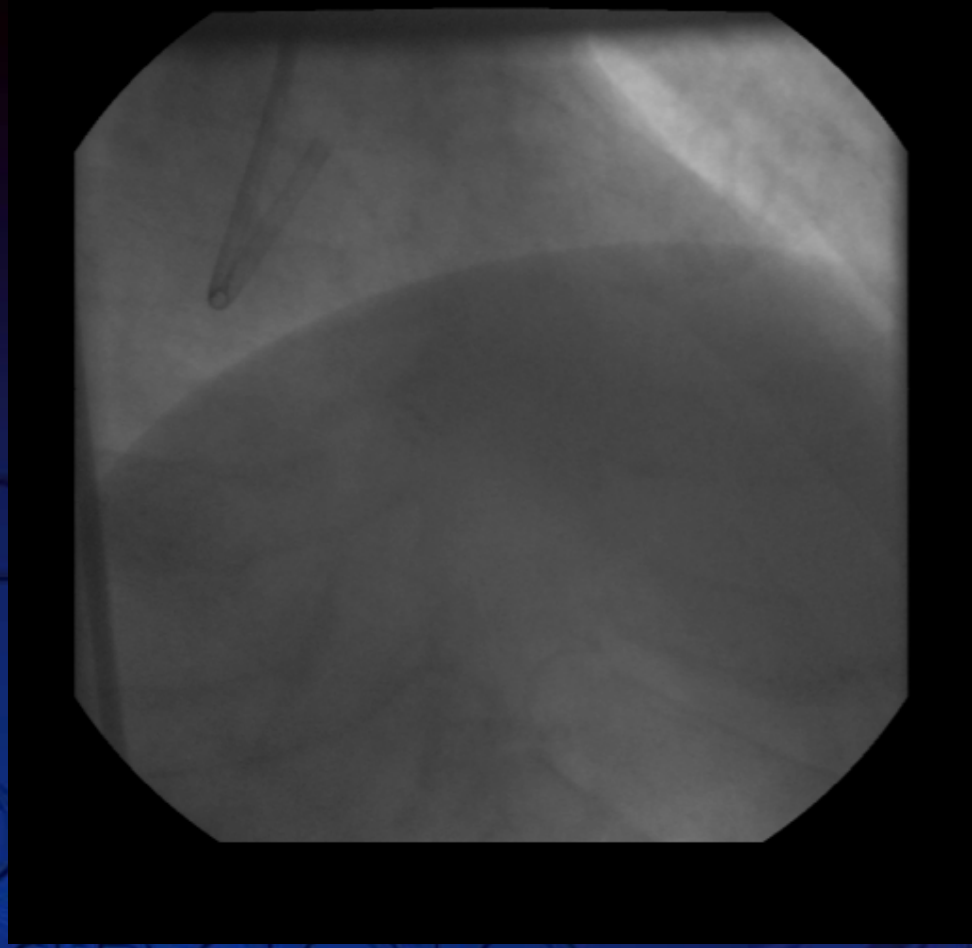




SAPPORO LIVE DEMONSTRATION COURSE 2010





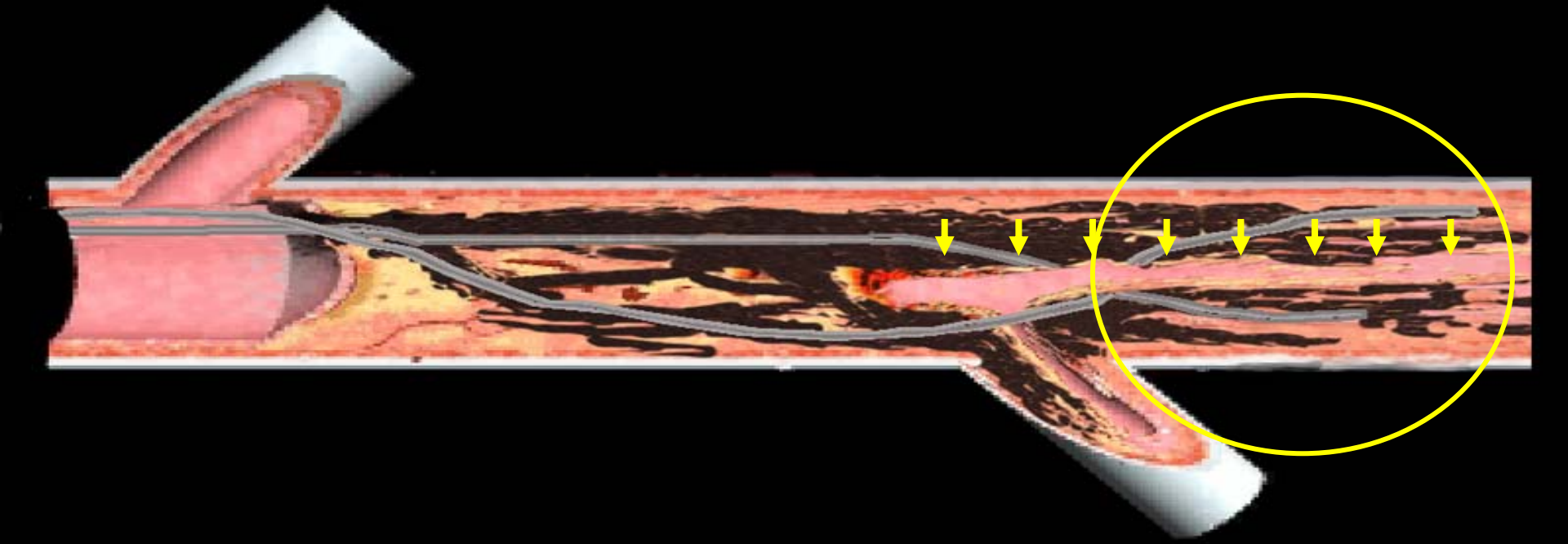


Application of IVUS for CTO PCI

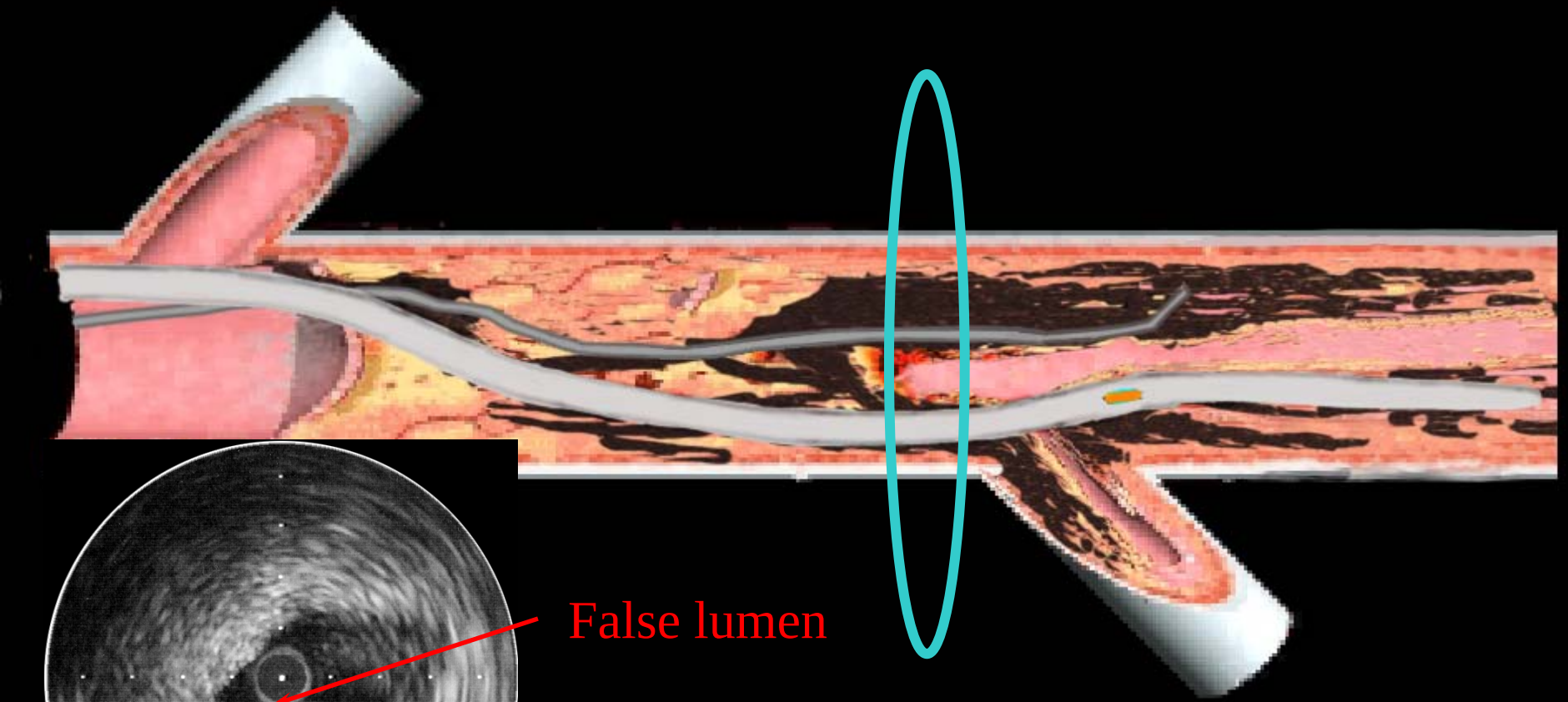
- To detect entry point of bifurcated CTO lesions
- IVUS guided wiring

  1)followed after failed parallel wire technique

Failed parallel wiring technique



IVUS guided wiring technique

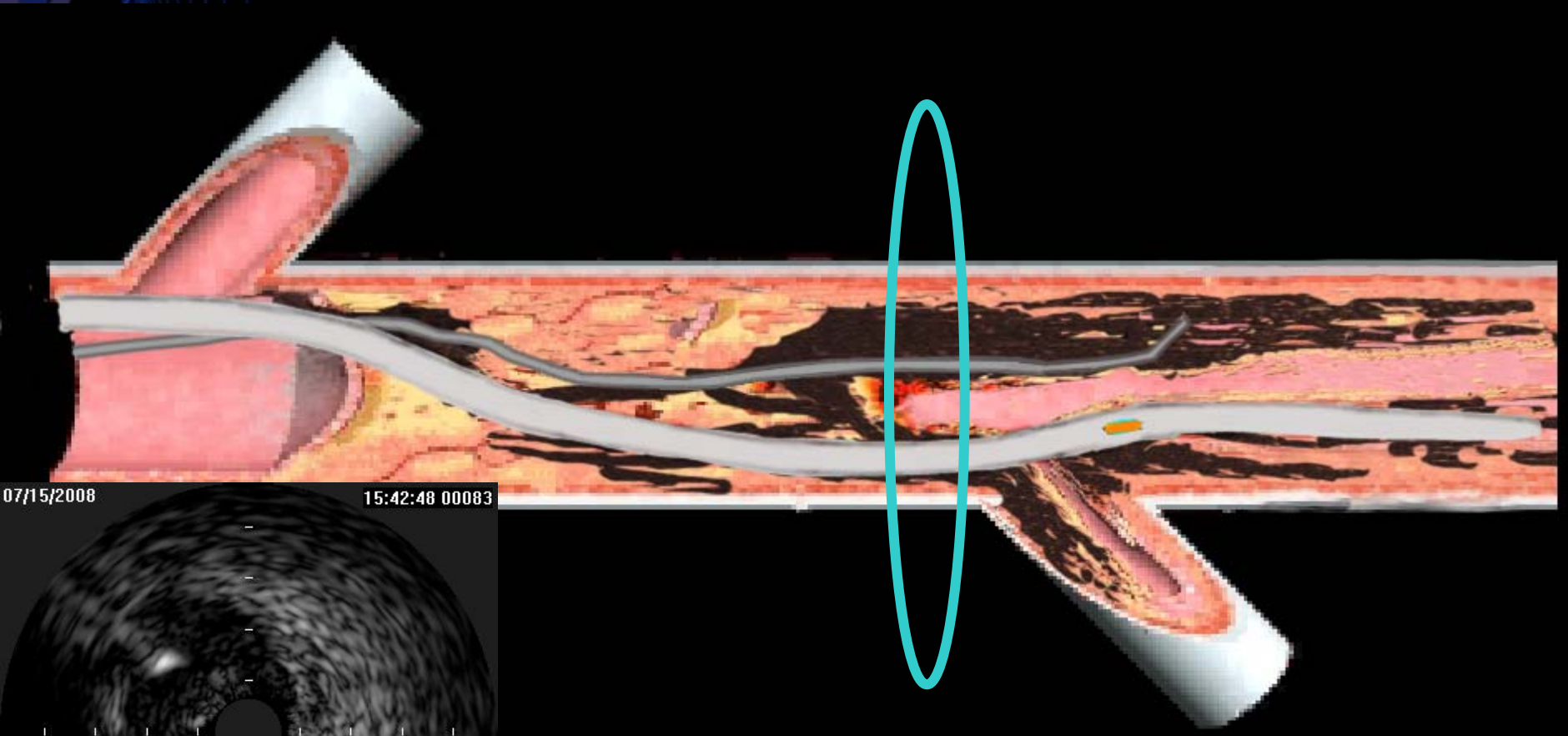


False lumen

True lumen

Guide wire

IVUS guided wiring technique



Technical pitfall and drawback of IVUS guided penetration

1)Dilatation of subintimal space is required to deliver an IVUS catheter when necessary.

2)Large lumen GC(>7F) is required for simultaneous wiring with IVUS.

3) Heavy Calcium frequently disturbs IVUS guided penetration of the entry of CTOs or from subintimal space to true lumen.

Recent consecutive 100 CTO PCI cases

↓

Attempted IVUS guided penetration 6 cases

↓

Successful guide-wire passage 3 cases

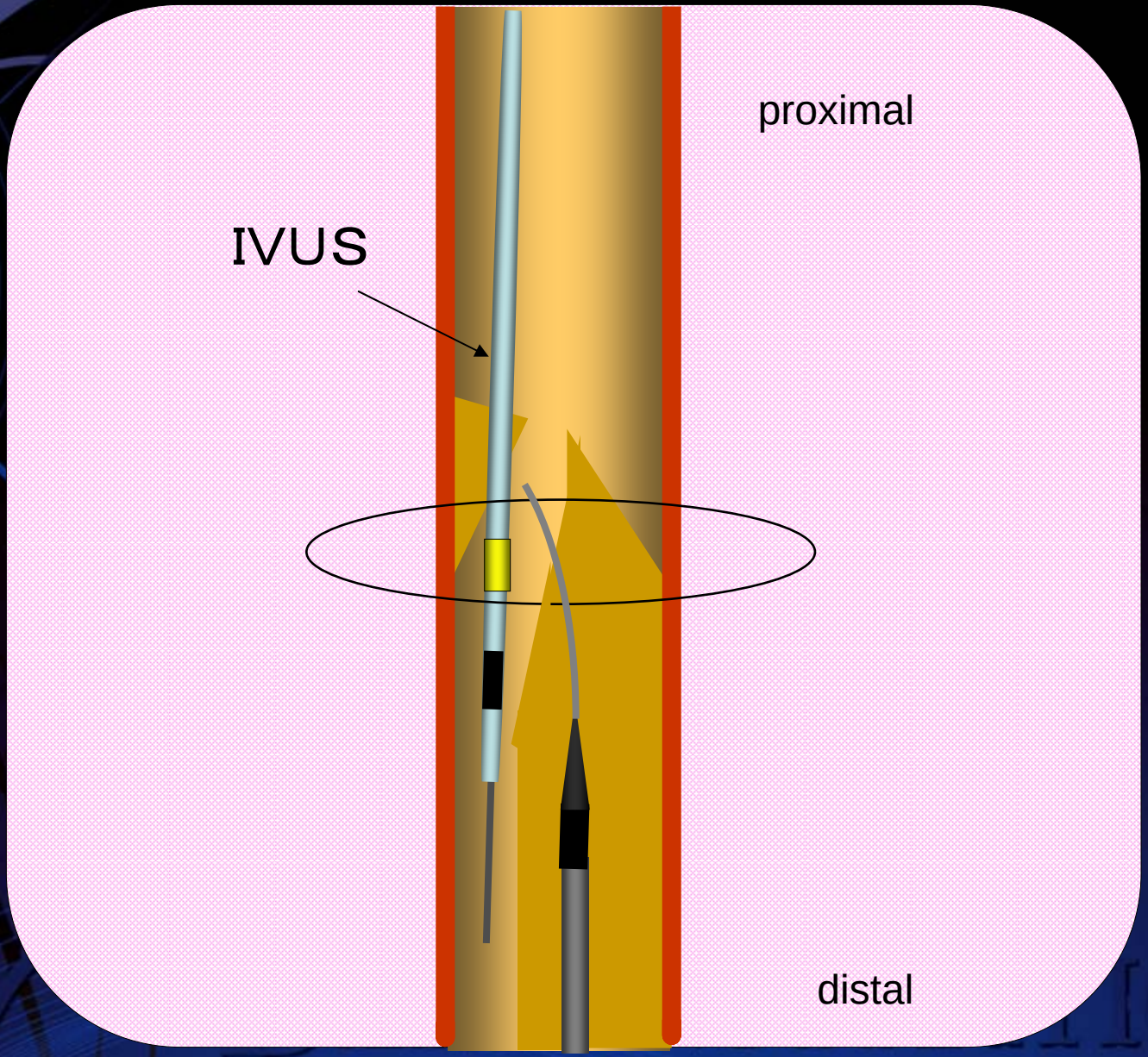
Application of IVUS for CTO PCI

- To detect entry point of bifurcated CTO lesions
- IVUS guided wiring

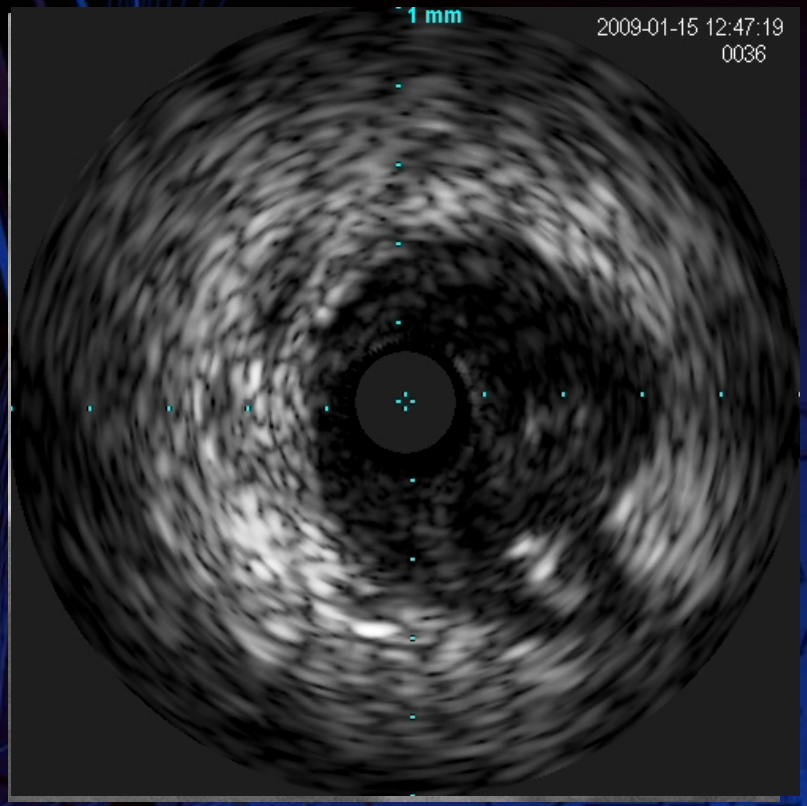
  1)followed after failed parallel wire technique

  2)in reverse CART procedure

Concept of Reverse CART technique

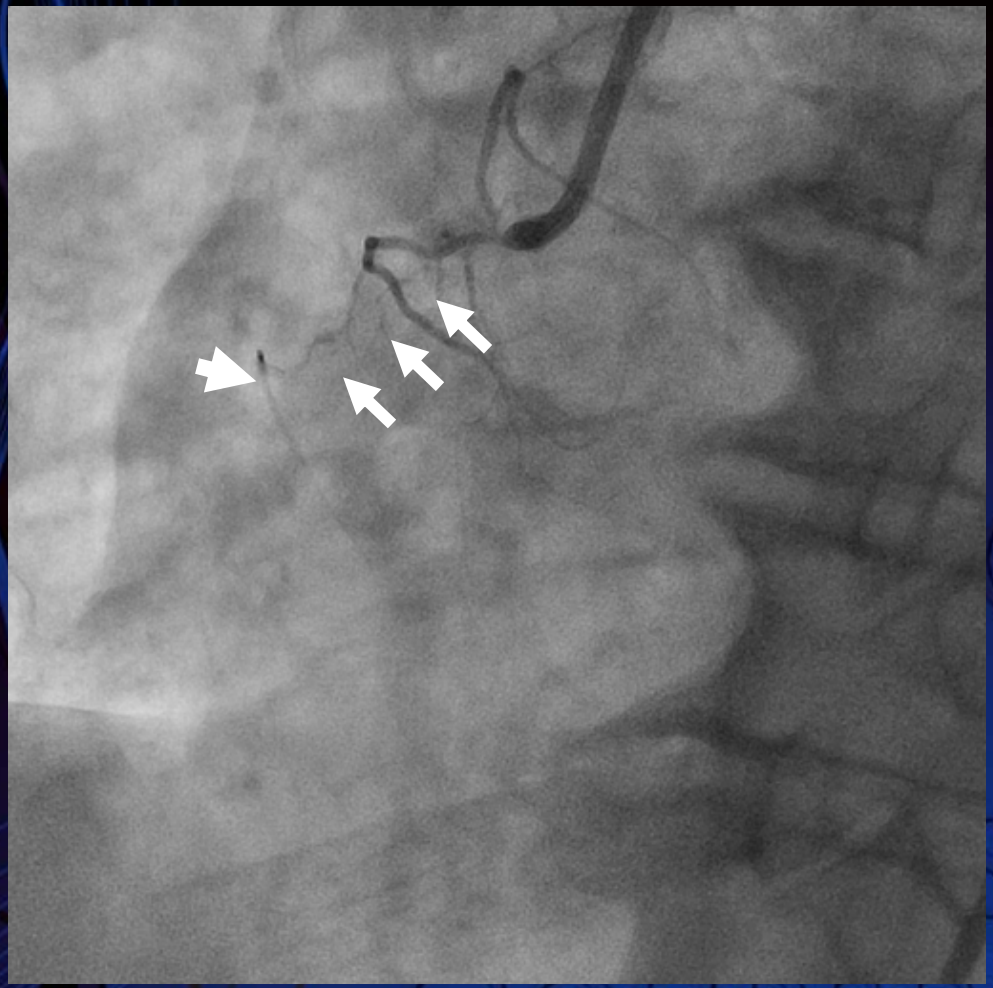

proximal
IVUS
distal

IVUS guided wiring in reverse CART technique



Estimation of IVUS finding

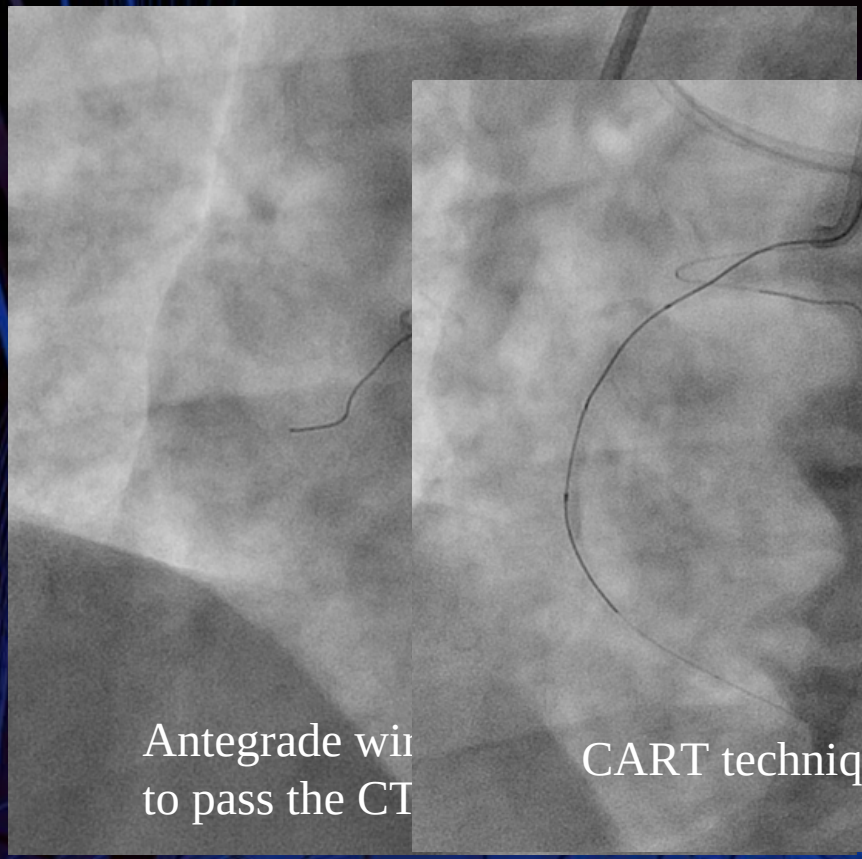
- Position of IVUS probe
- Vessel size
- Position of retrograde guide-wire
- Assessment of dissection



CASE 1

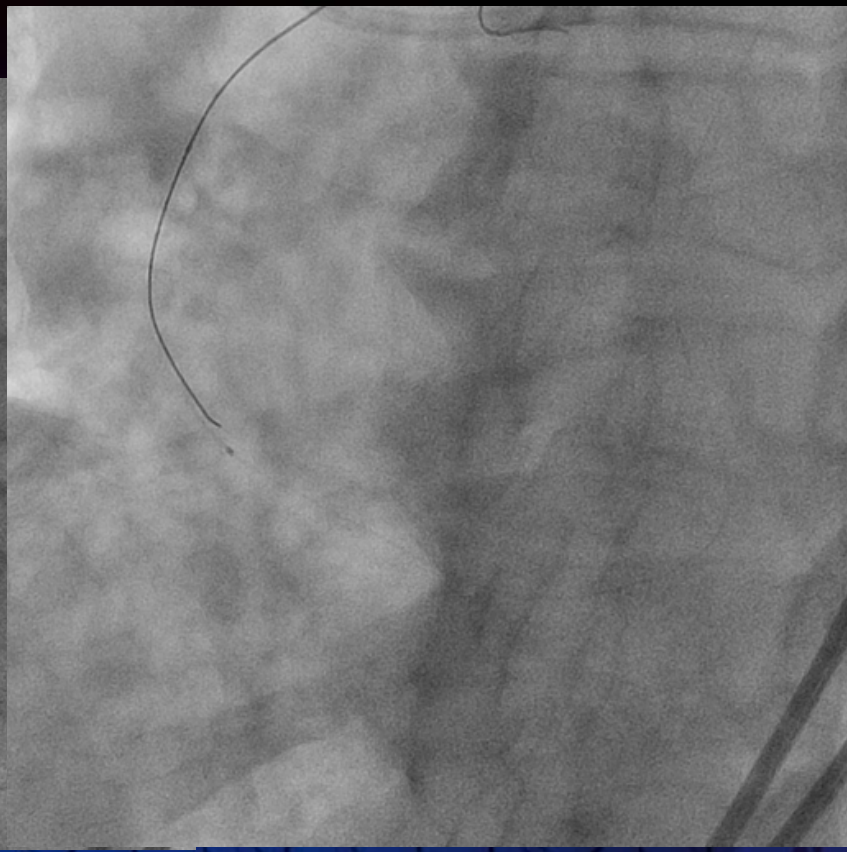
- Male 61y/o
- effort Angina
- Previous revasc.
  08/NOV
  DES in LCX
- Target lesion
  RCA proximal CTO
  denovo PCI

CTO procedure（1）



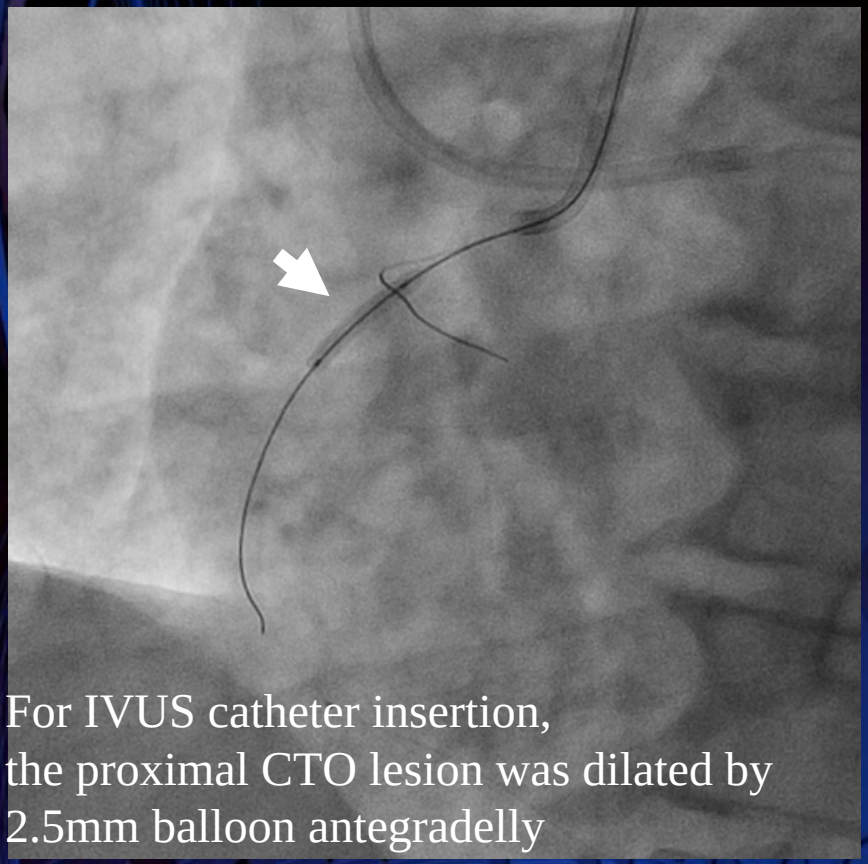
Antegrade wi
to pass the CT

CART technique

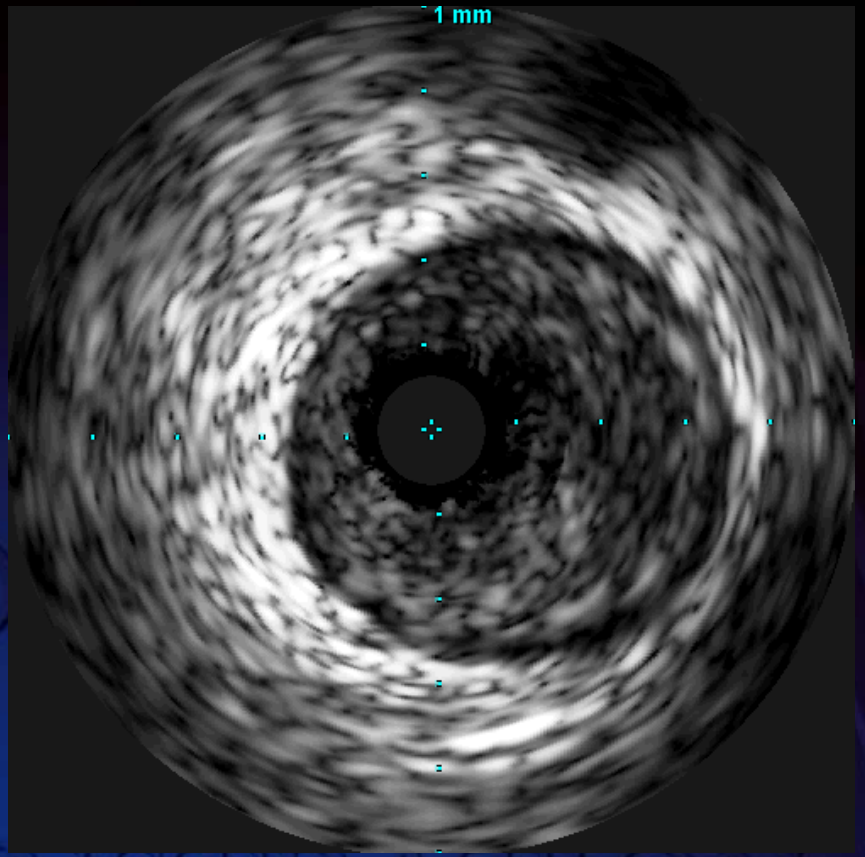


Antegrade guidewire advanced to faulse lumen

CTO procedure（2）



For IVUS catheter insertion,
the proximal CTO lesion was dilated by
2.5mm balloon antegradelly



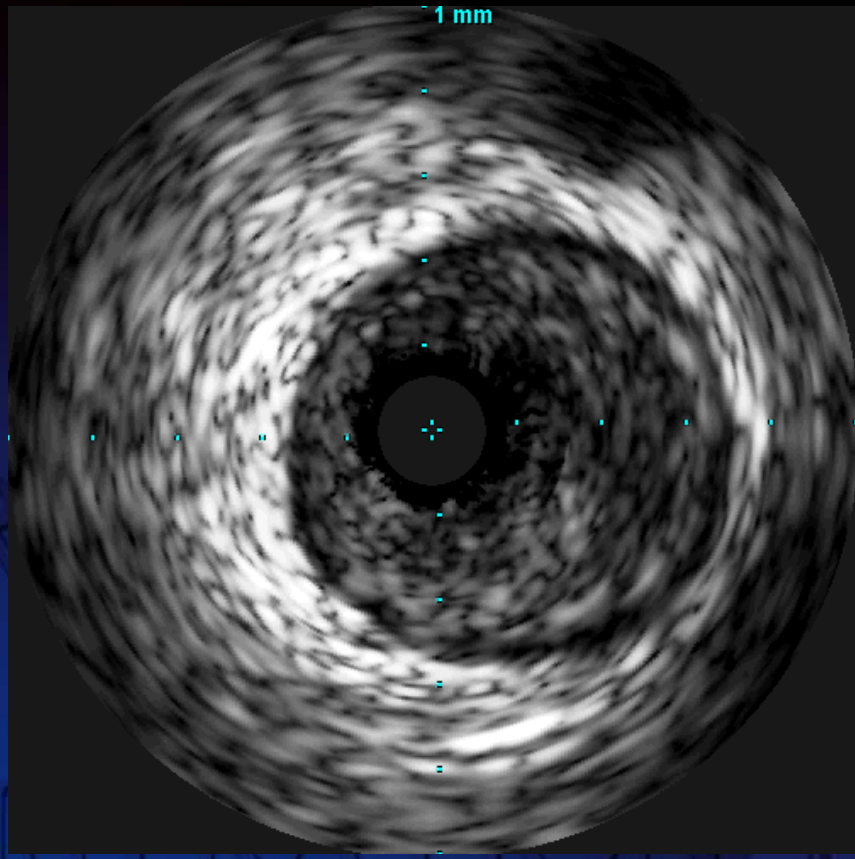
CTO procedure（2）

IVUS catheter position is within the true lumen of vessel.

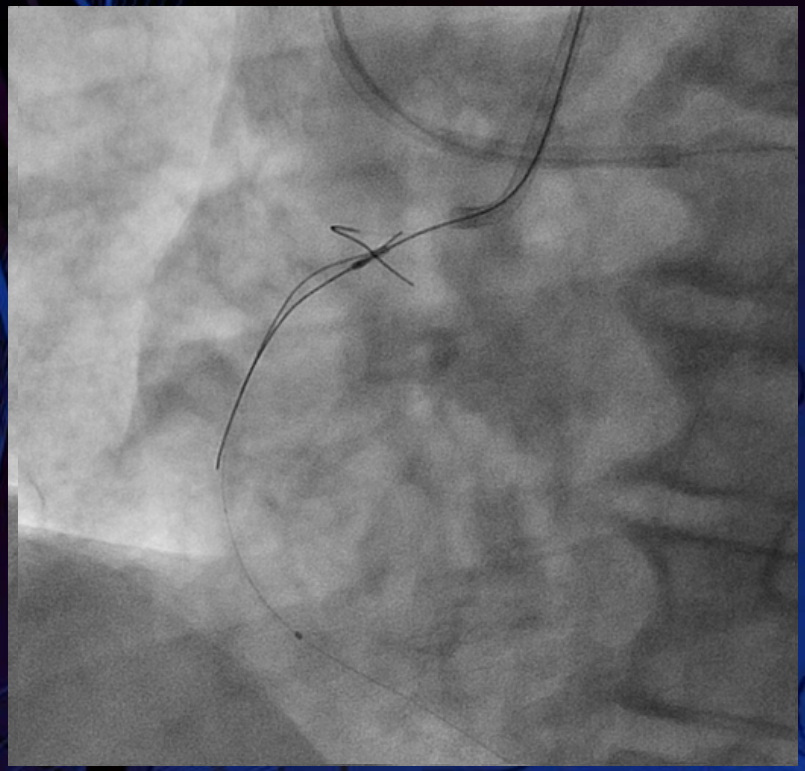
Subintimal dissection is detected from 8 to 12 o’clock direction.

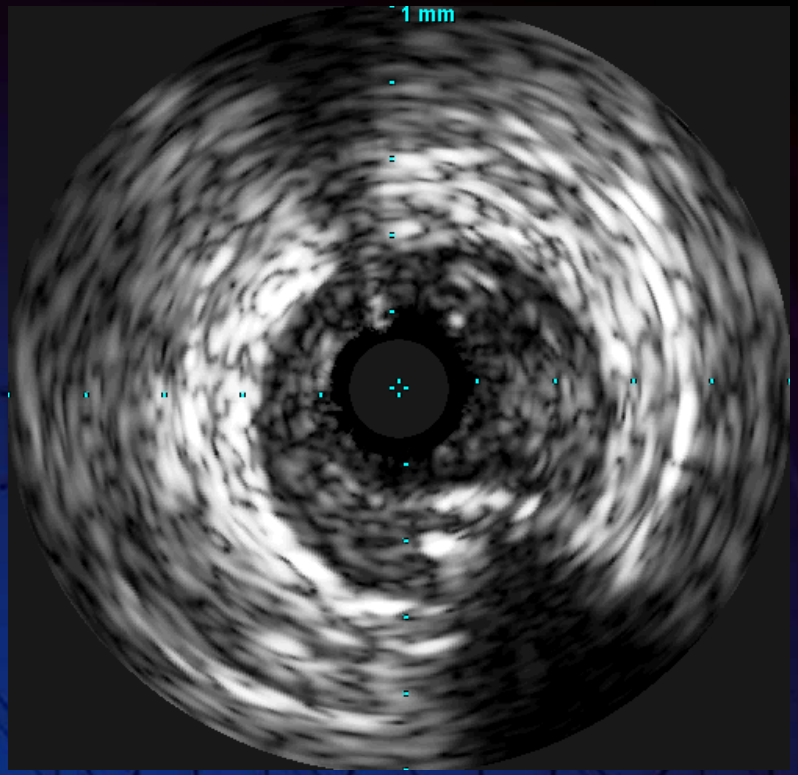
Connection between true lumen and dissected lumen is clearly detected .

IVUS probe position is shifted to 10 o’clock direction that is usually pericardial side of the vessel in RCA.

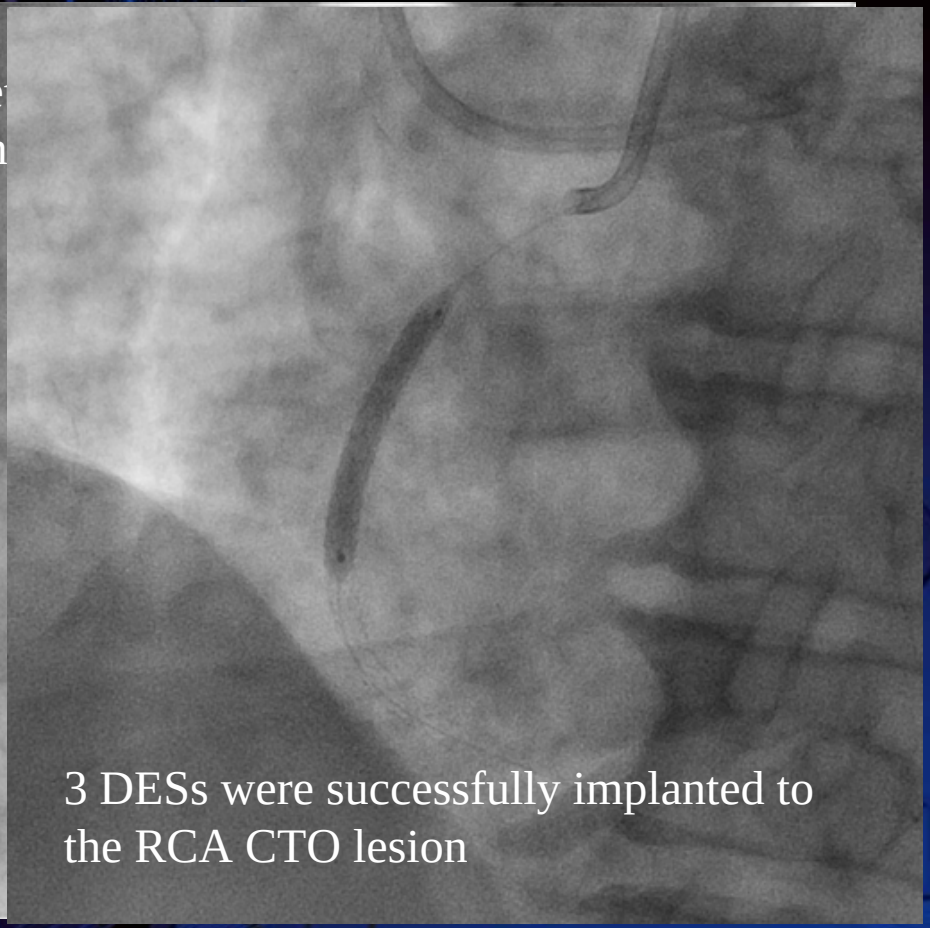


CTO procedure（3）

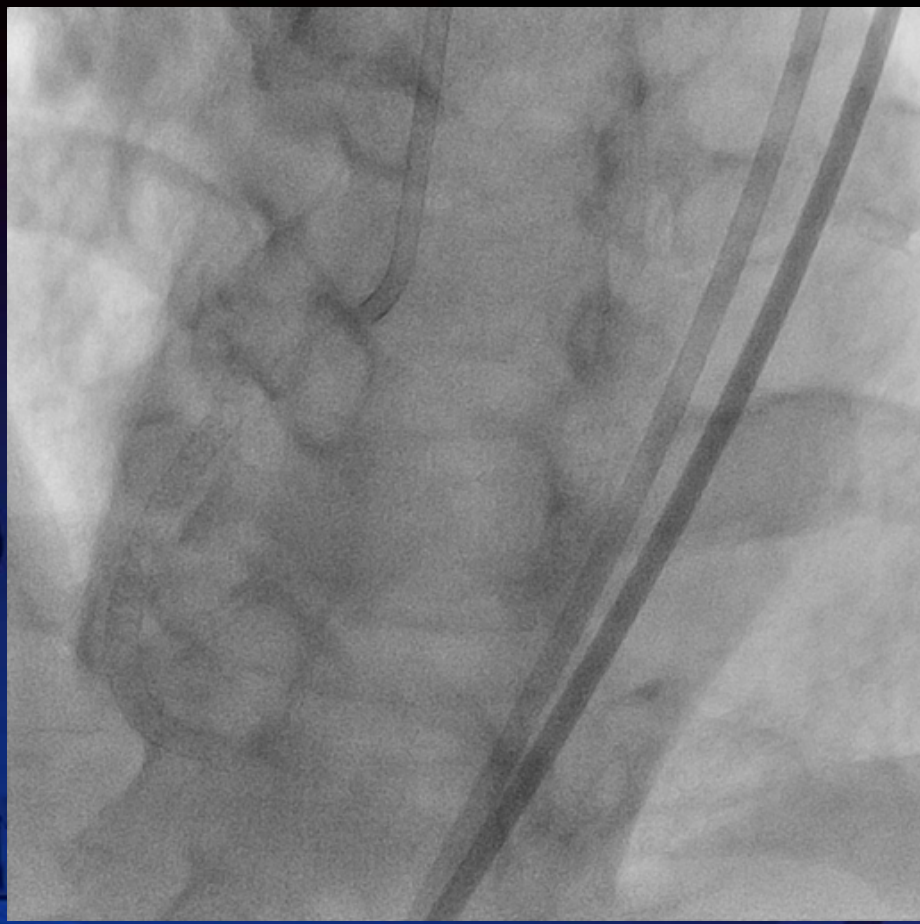


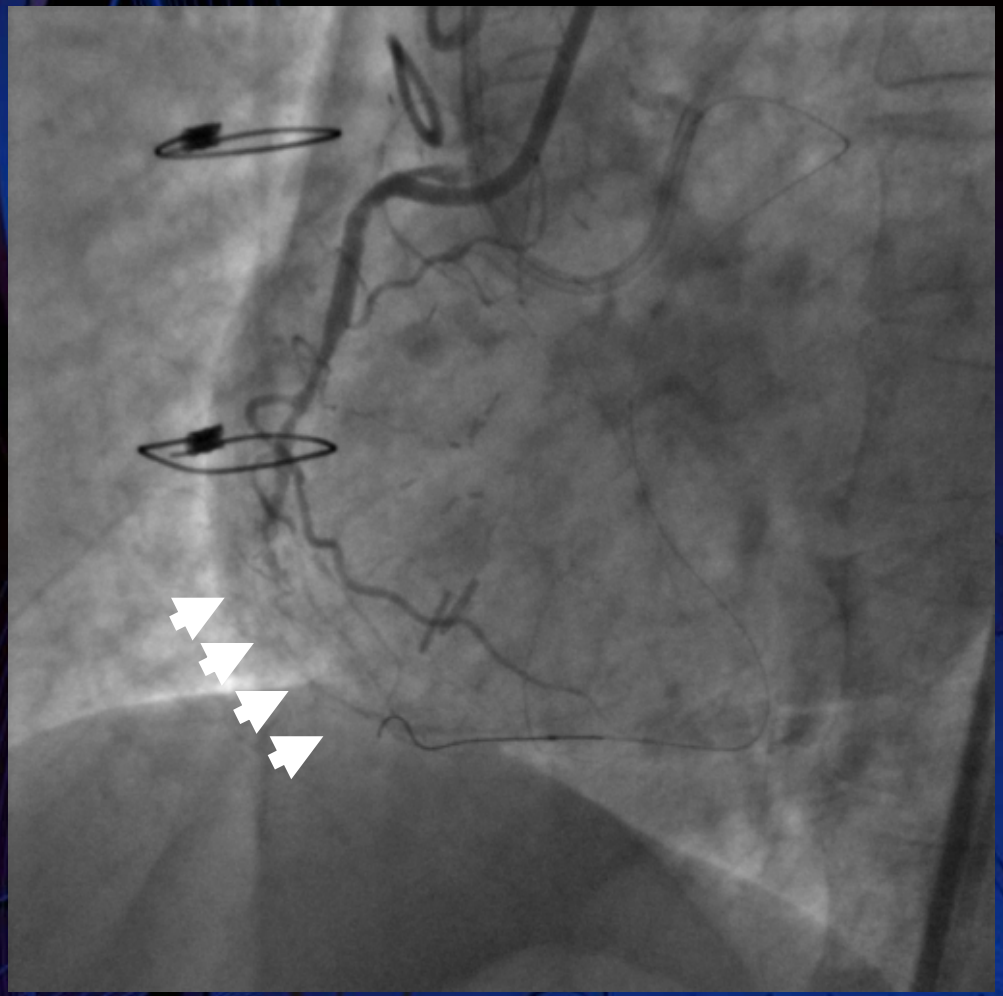


CTO procedure (4)



3 DESs were successfully implanted to the RCA CTO lesion

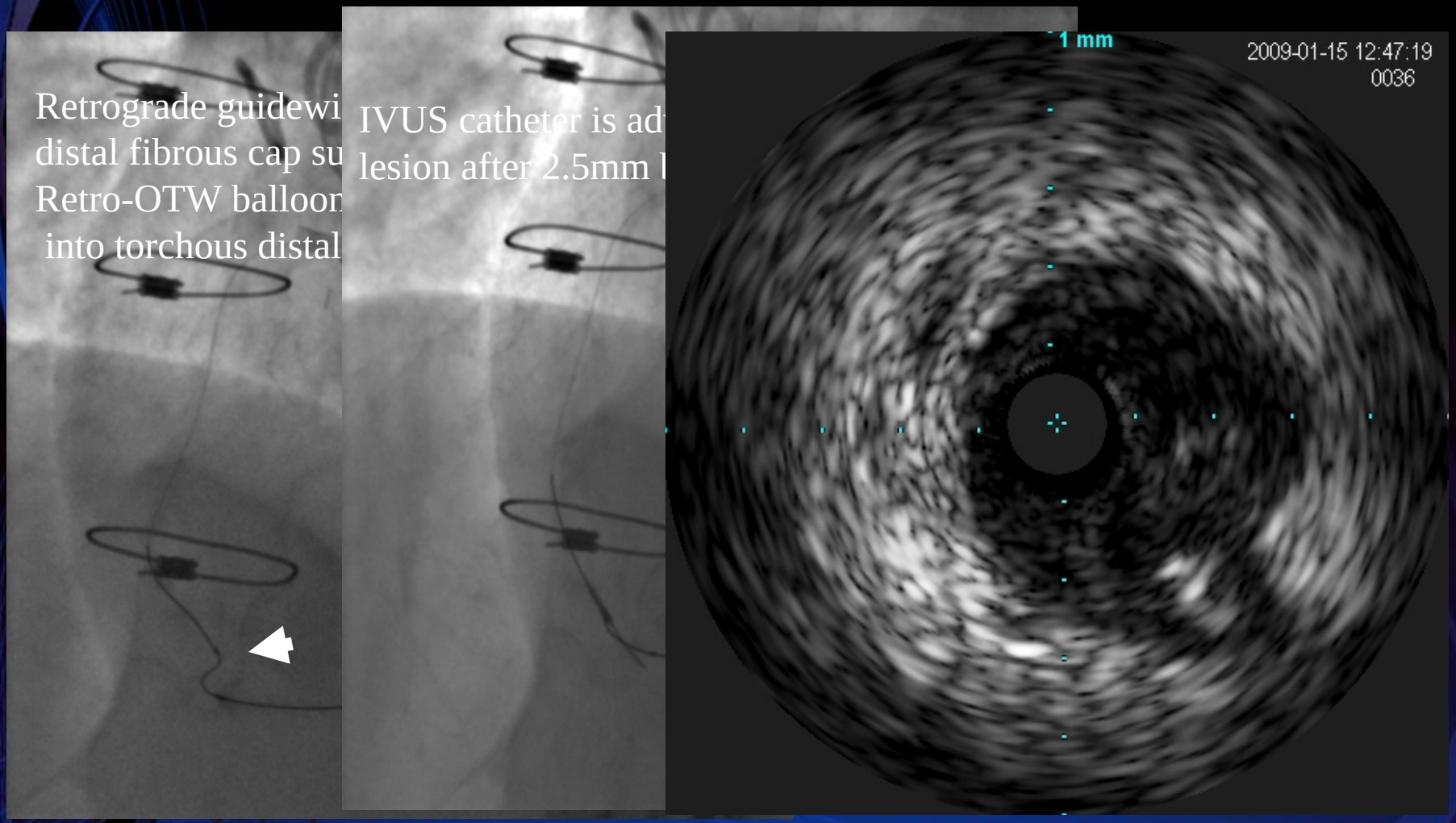




CASE 2

- Male 60s y/o
- effort Angina
- 3VD
- 02/SEP
  CABG/LITA-LAD/
  SVG-LCX/SVG-RCA
  SVG-RCA occluded
- Target lesion
  native RCA CTO
  retry case

CTO procedure（1）

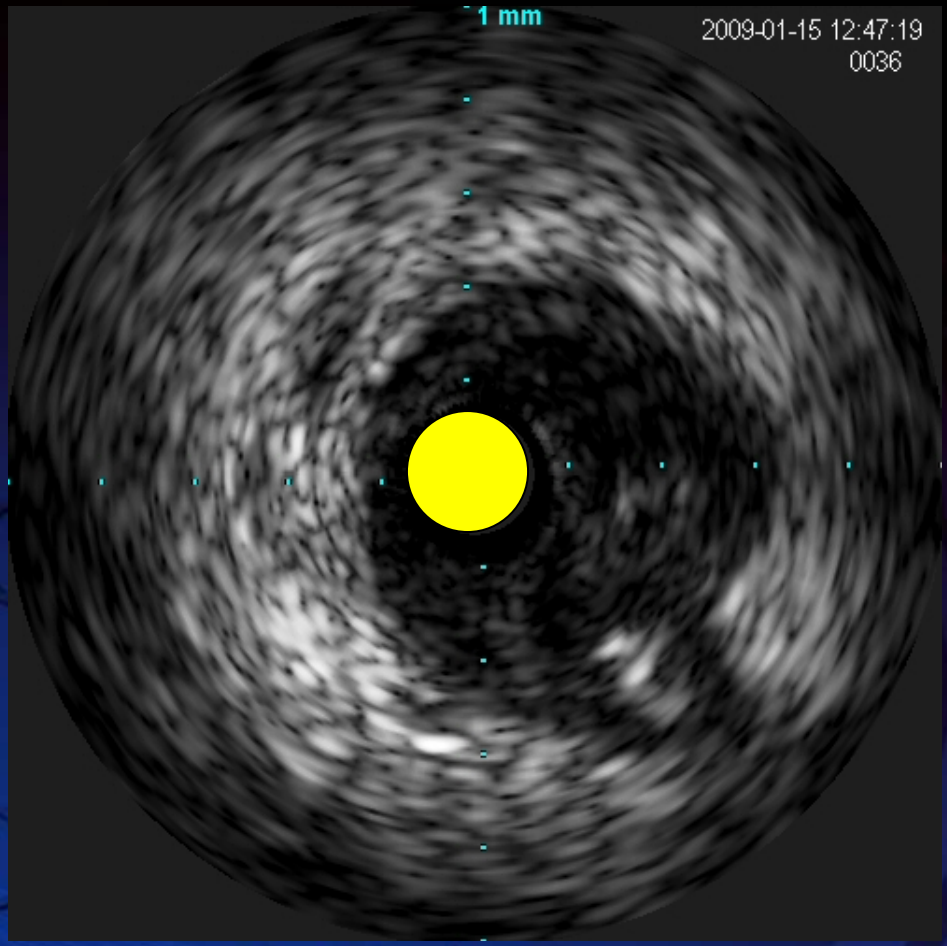


CTO procedure（2）

IVUS catheter position is within the vessel.

Vessel diameter is about 4mm

Retrograde guidewire is detected at subintimal space of 5 o’clock direction but compartmental from the true lumen.

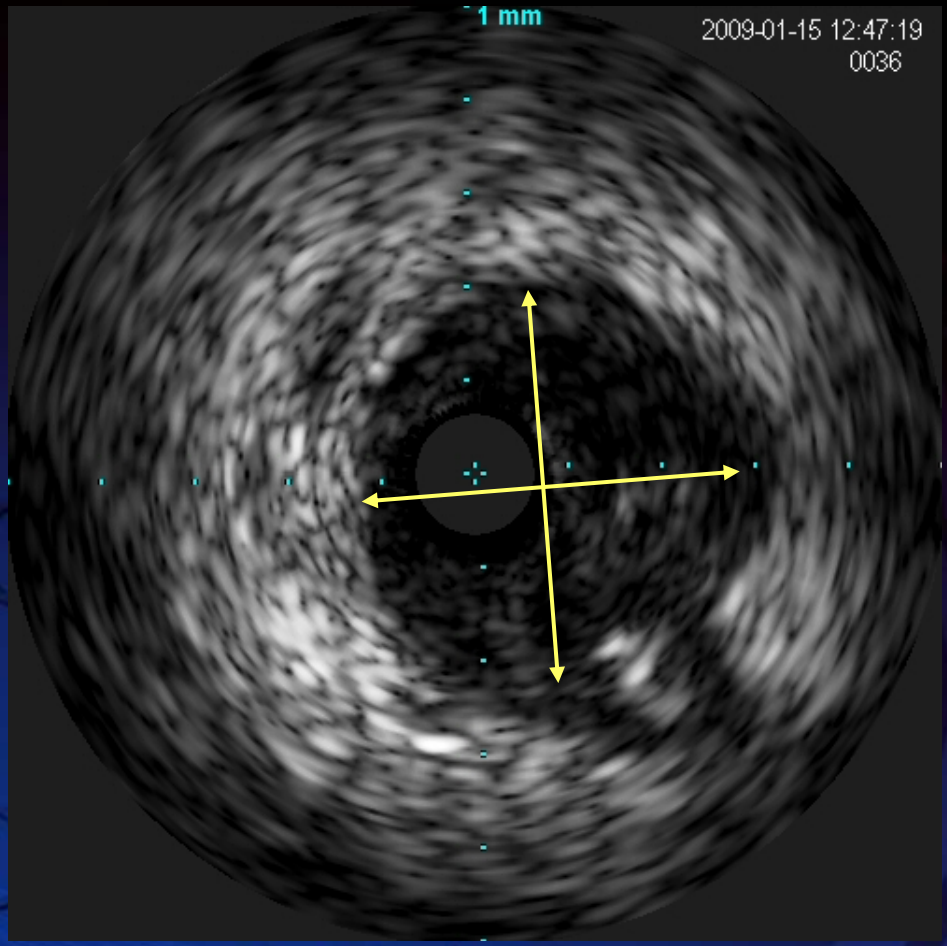


CTO procedure（2）

IVUS catheter position is within the vessel.

Vessel diameter is about 4mm

Retrograde guidewire is detected at subintimal space of 5 o’clock direction but compartmental from the true lumen.

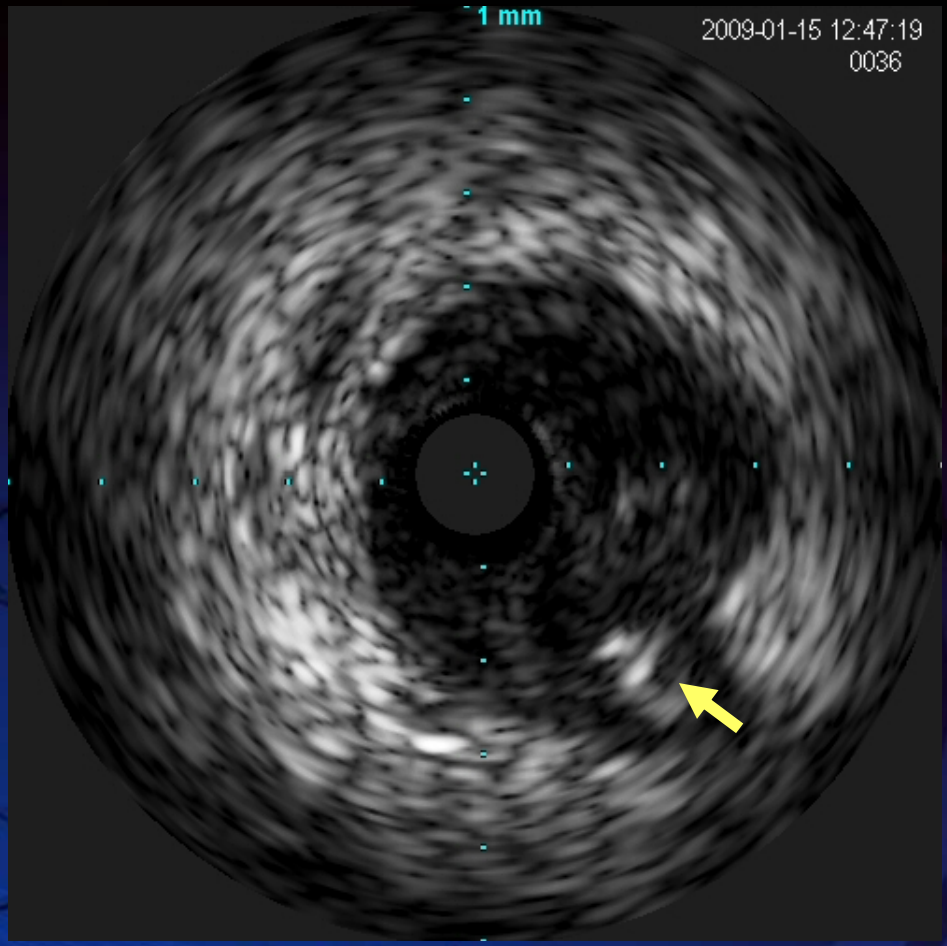


CTO procedure（2）

IVUS catheter position is within the vessel.

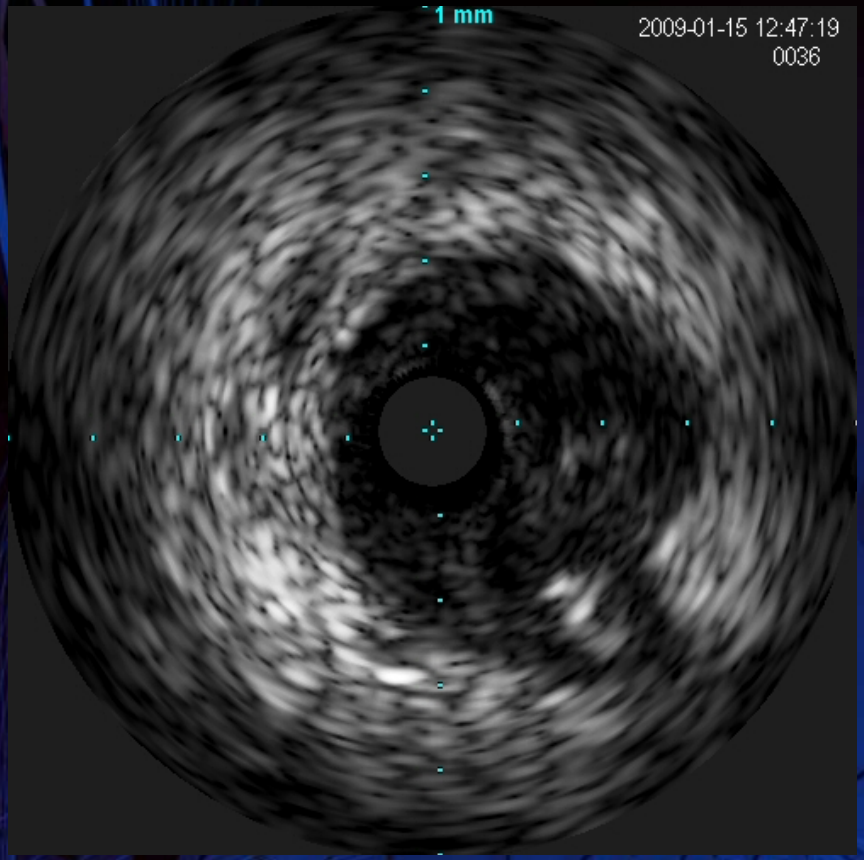
Vessel diameter is about 4mm

Retrograde guidewire is detected at subintimal space of 5 o’clock direction but compartmental from the true lumen.

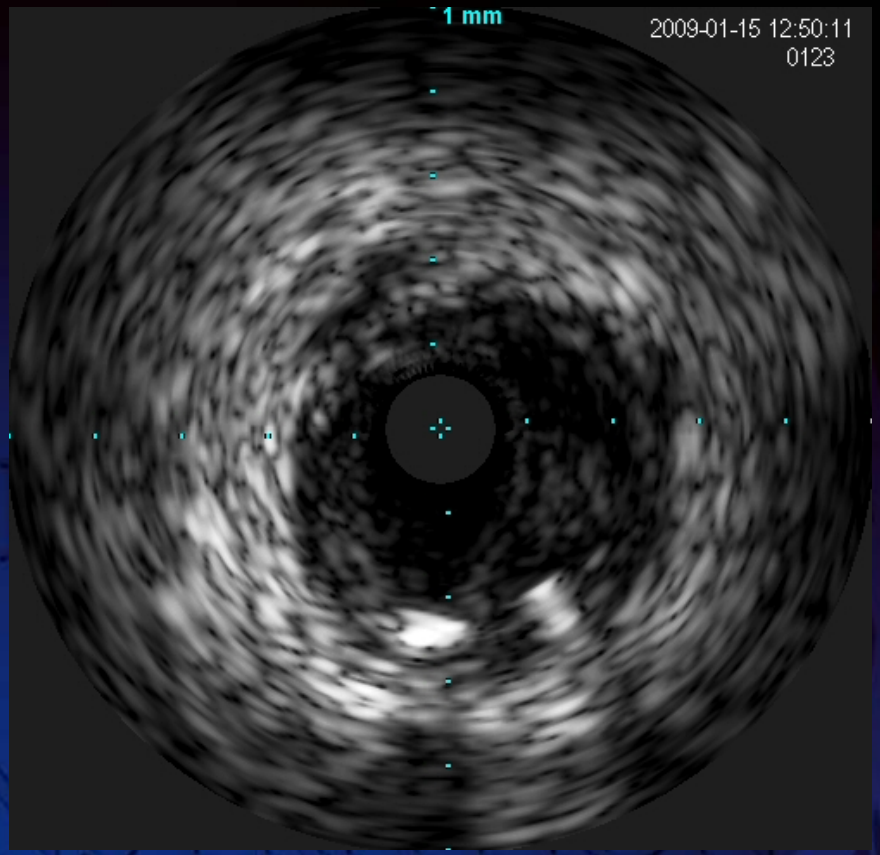


CTO procedure（3）

IVUS finding post antegrade balloon dilatation

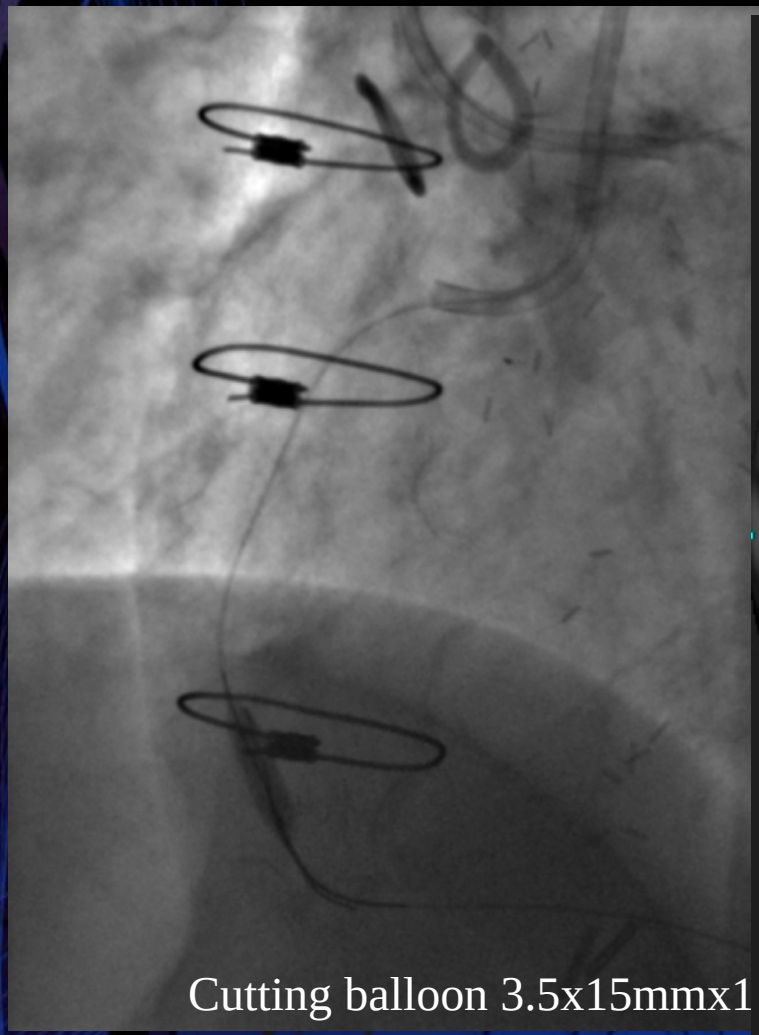


IVUS finding after 2.5mm balloon dilatation

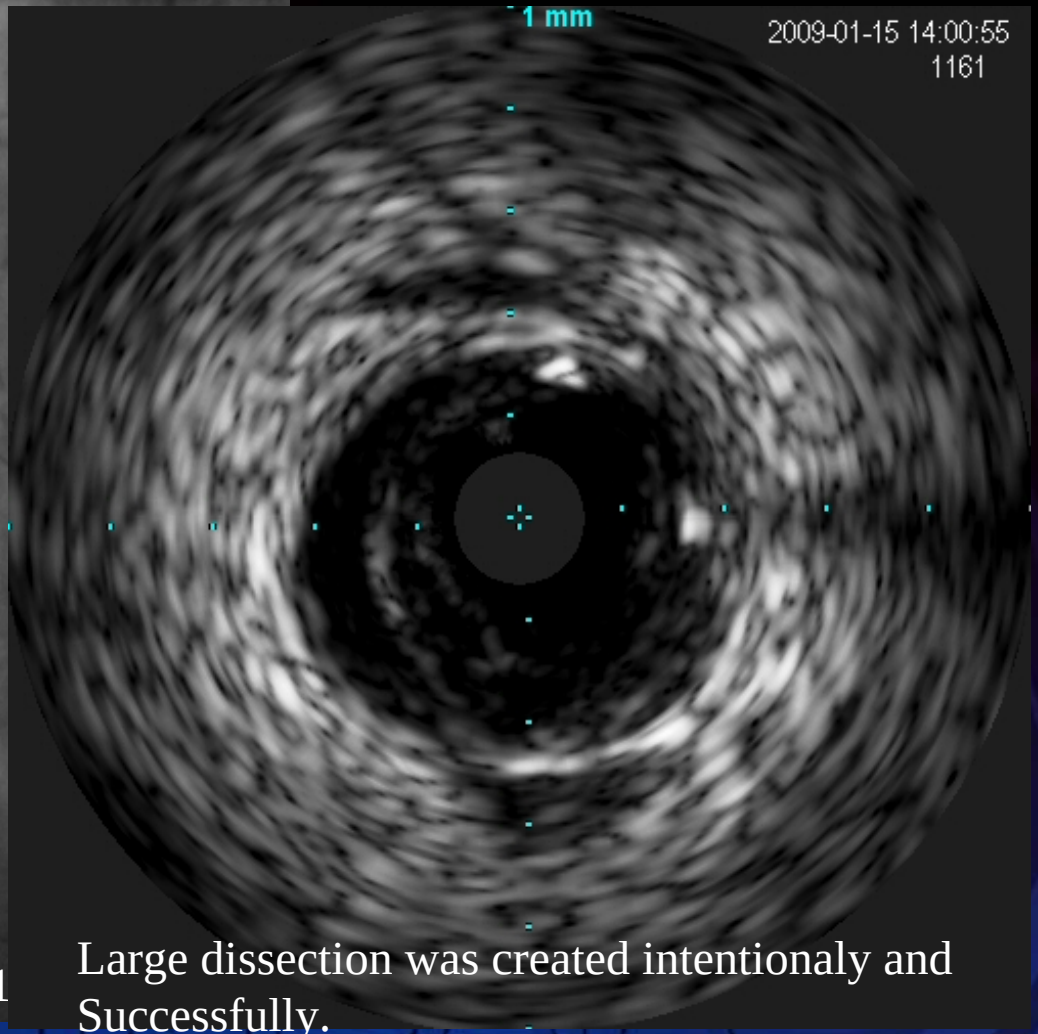


IVUS finding after 3.5mm balloon dilatation

CTO procedure（4）

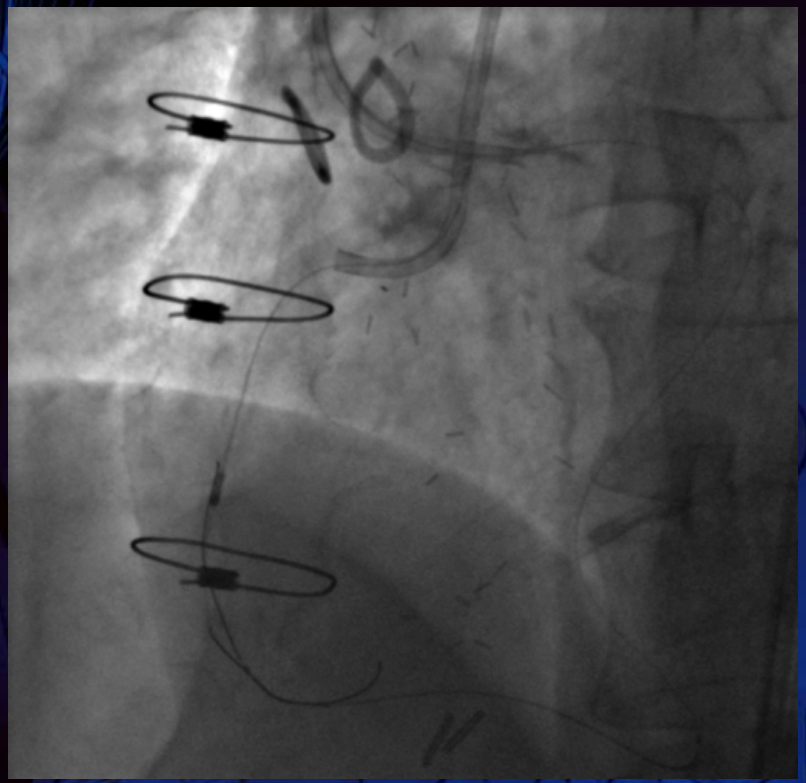


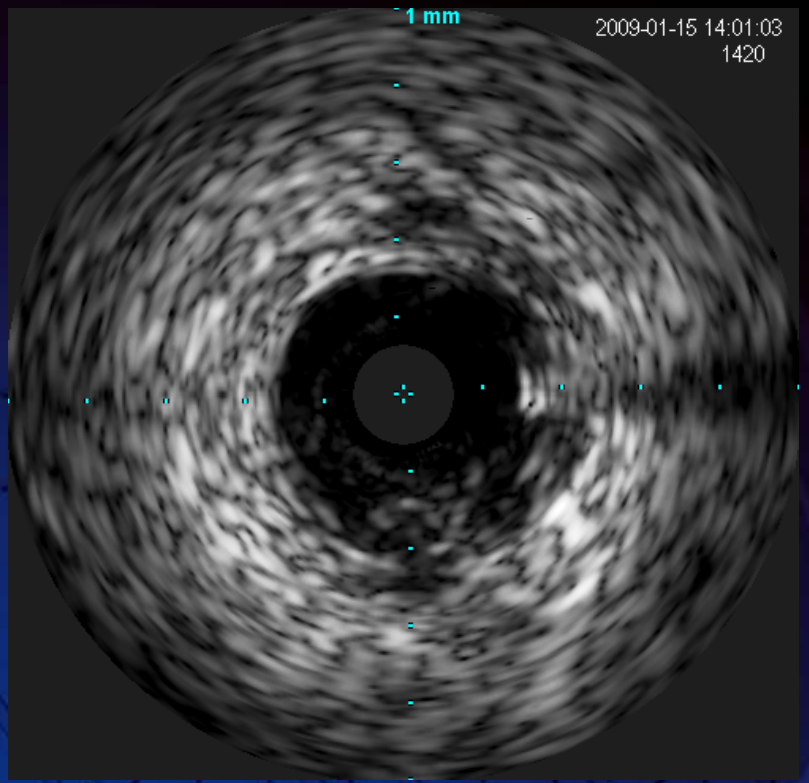
Cutting balloon 3.5x15mmx1



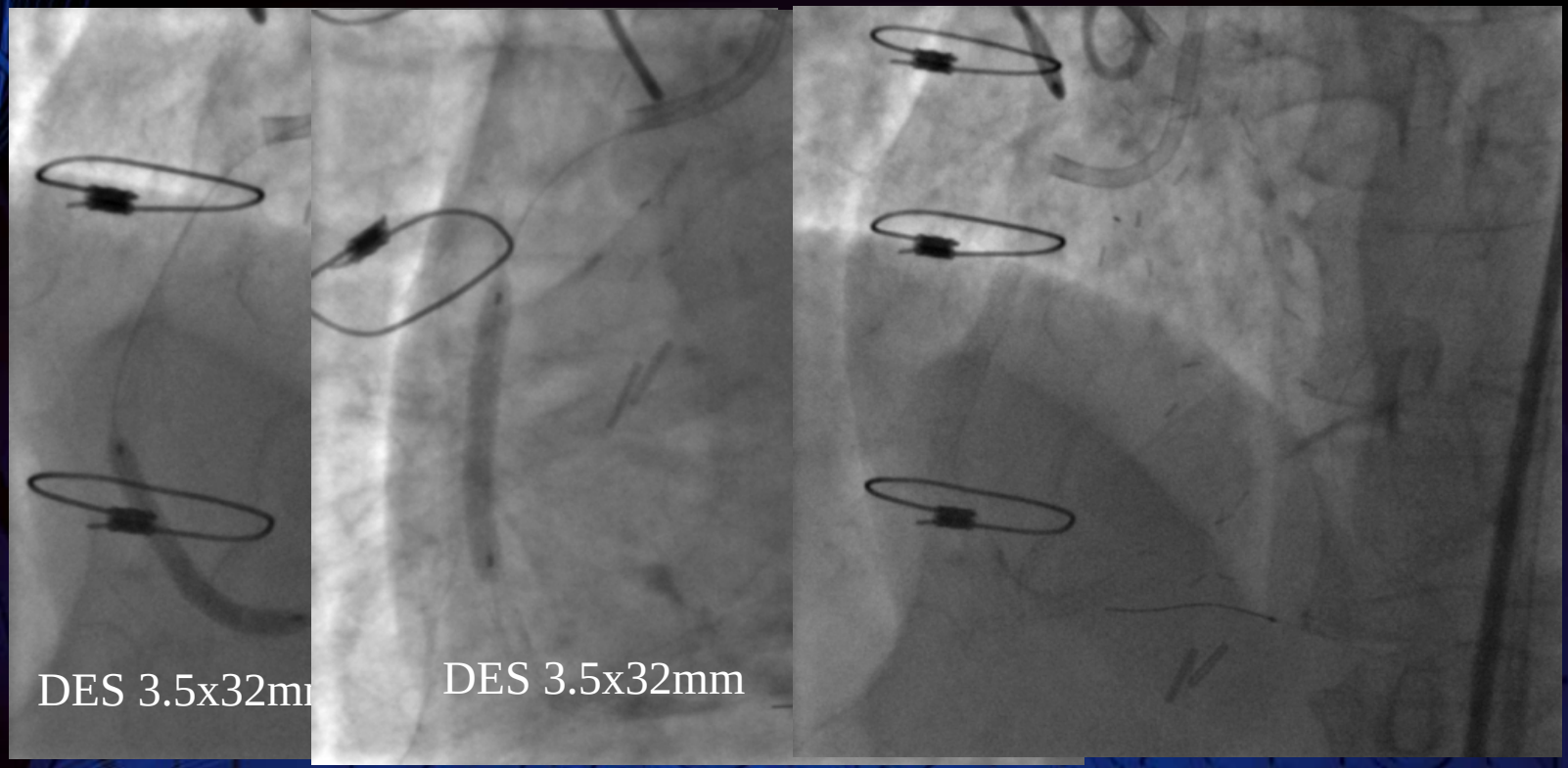
Large dissection was created intentionaly and Successfully.

CTO procedure（5）

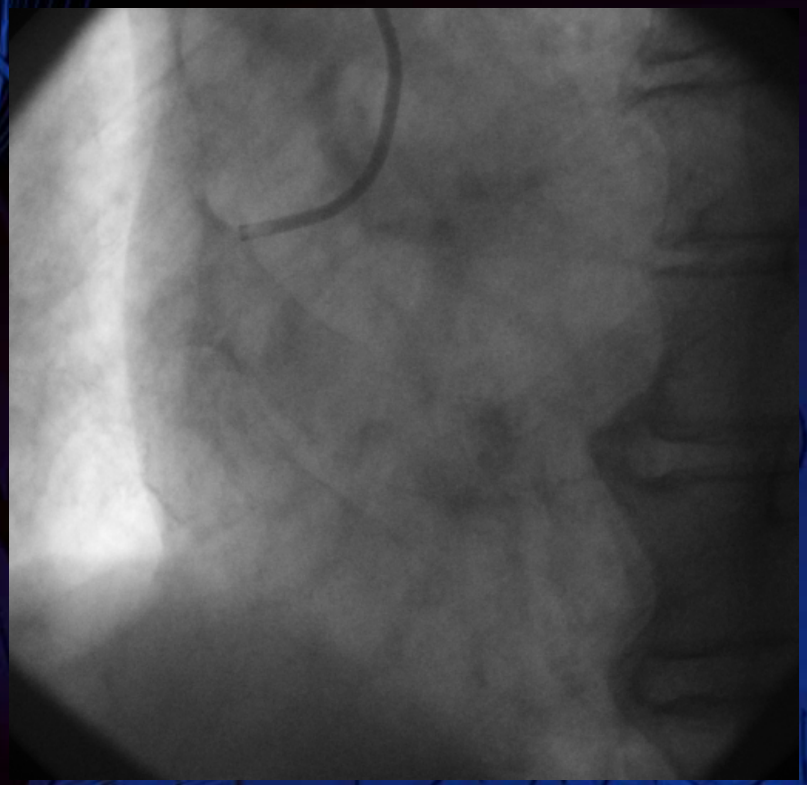




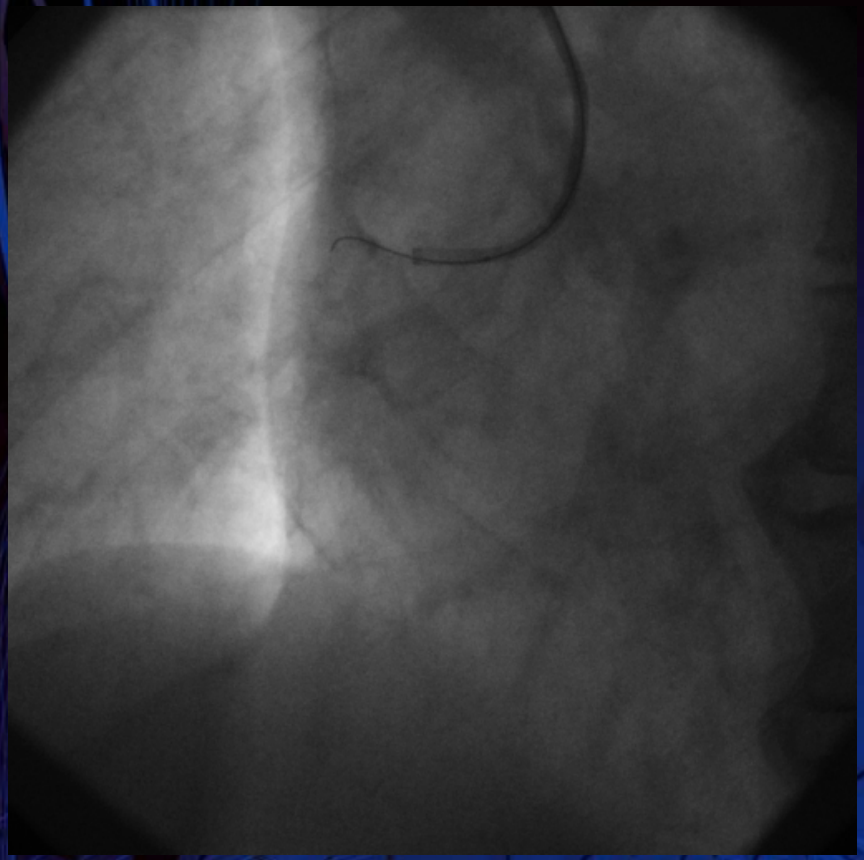
CTO procedure（6）



CASE 3

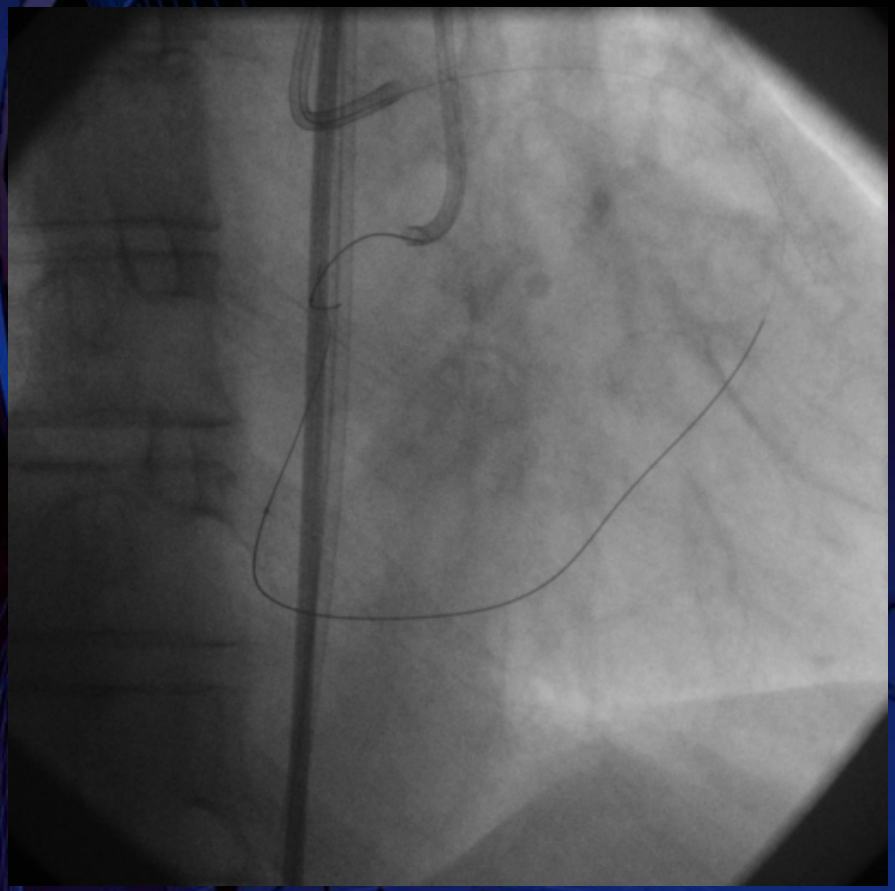


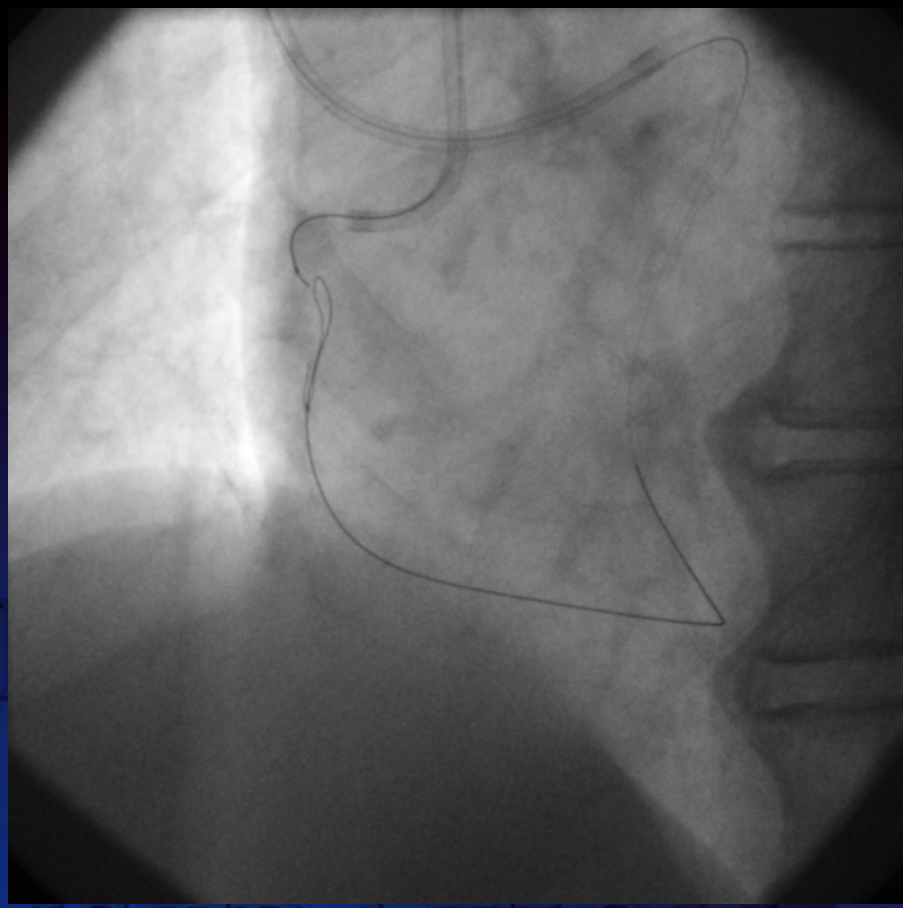
- Male 78y/o
- effort Angina
- 2VD
- 08/JUN
  DES in LAD
- Target lesion
  RCA ostial CTO
  retry case
- CRF cre 2.0



CASE 3

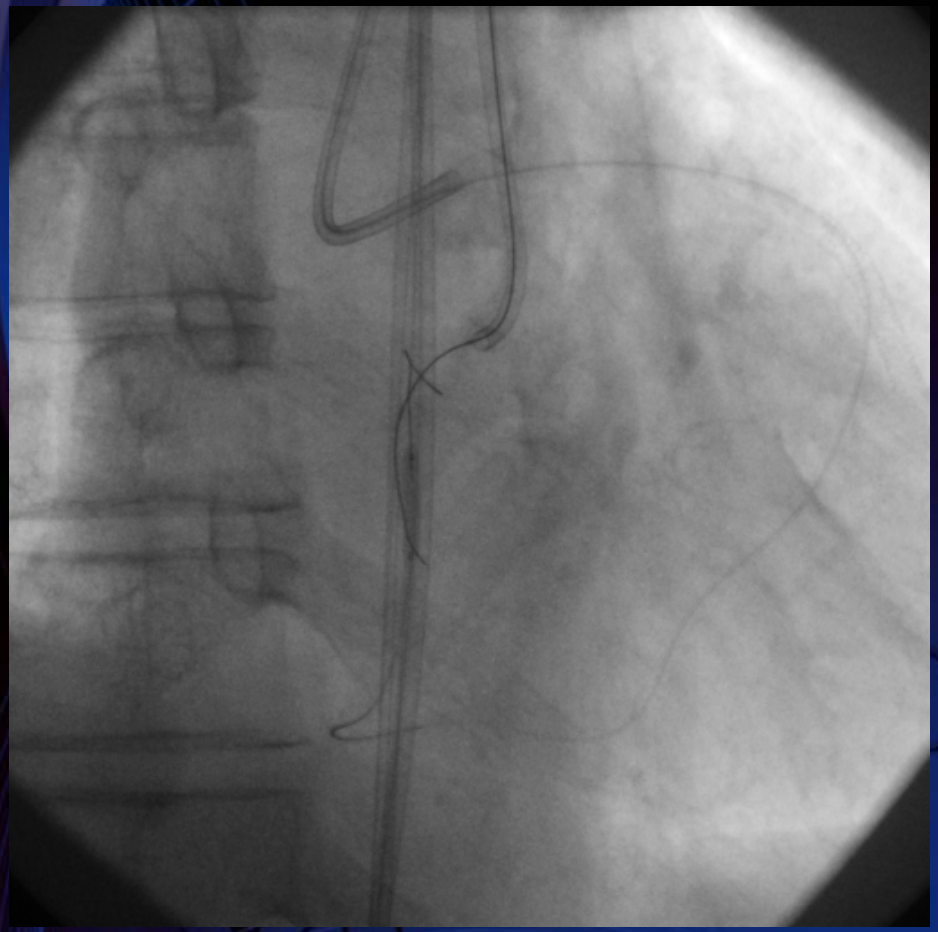
- Male 78y/o
- effort Angina
- 2VD
- 08/JUN
  DES in LAD
- Target lesion
  RCA ostial CTO
  retry case
- CRF cre 2.0

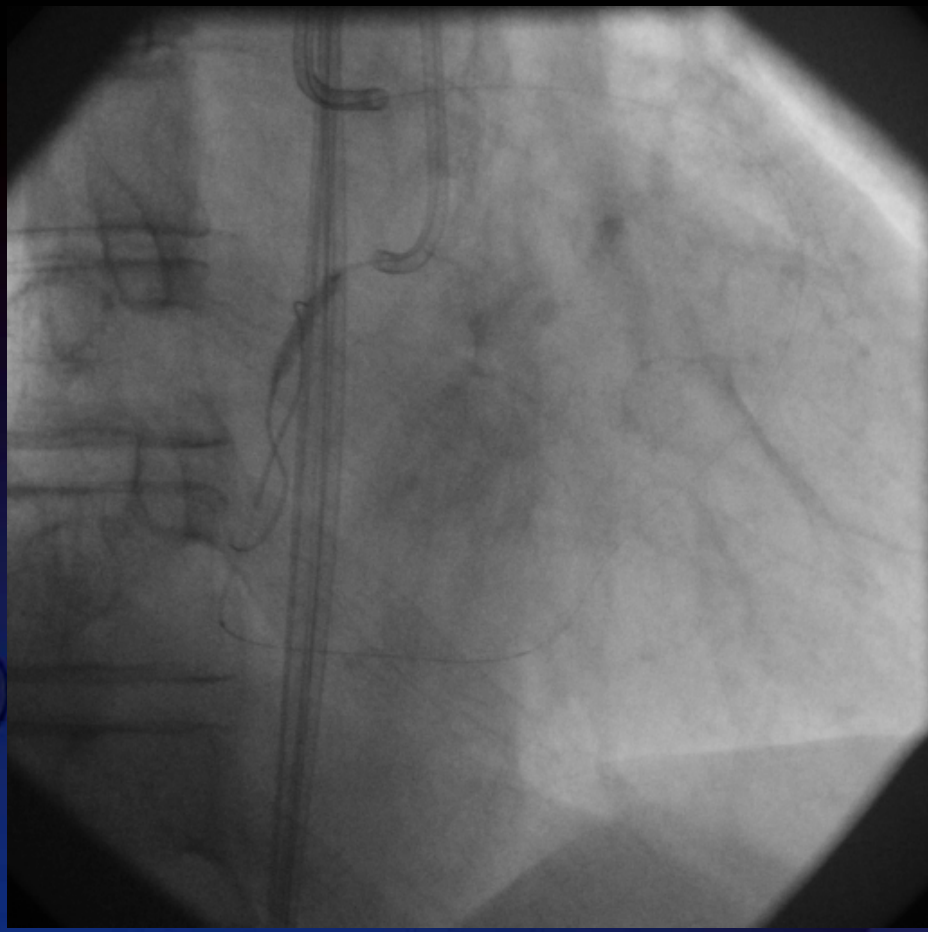




failed kissing wire technique

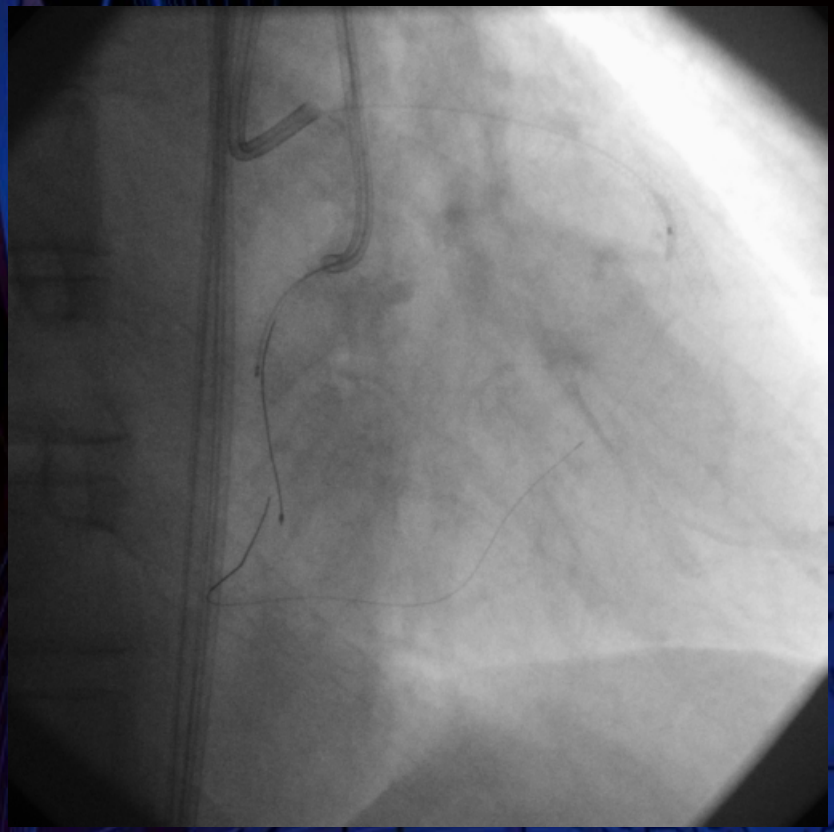
failed knuckled wire technique

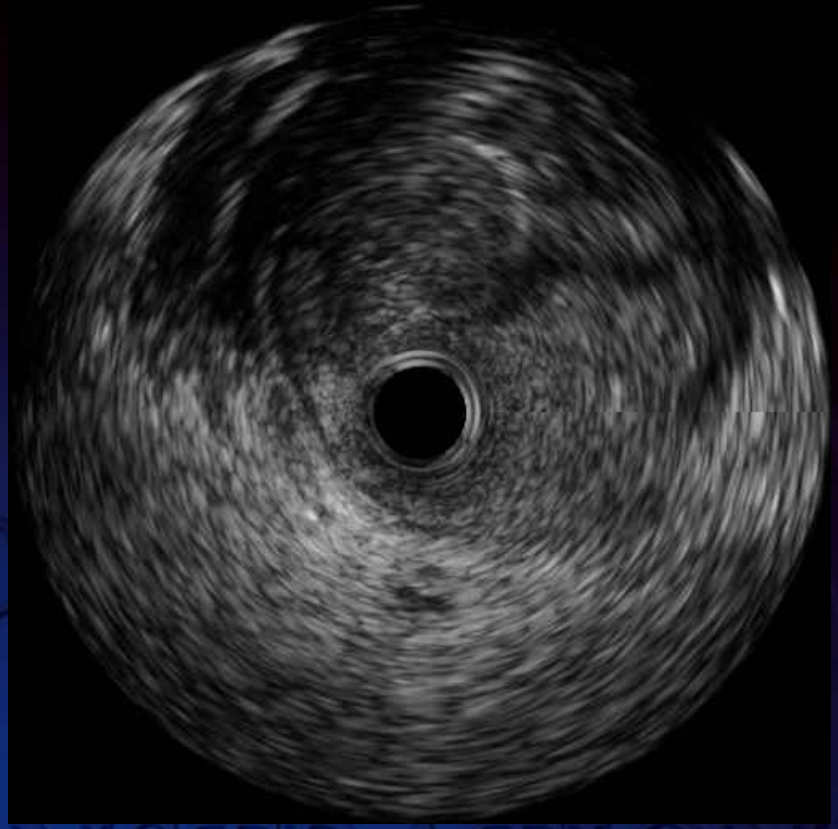




failed CART technique

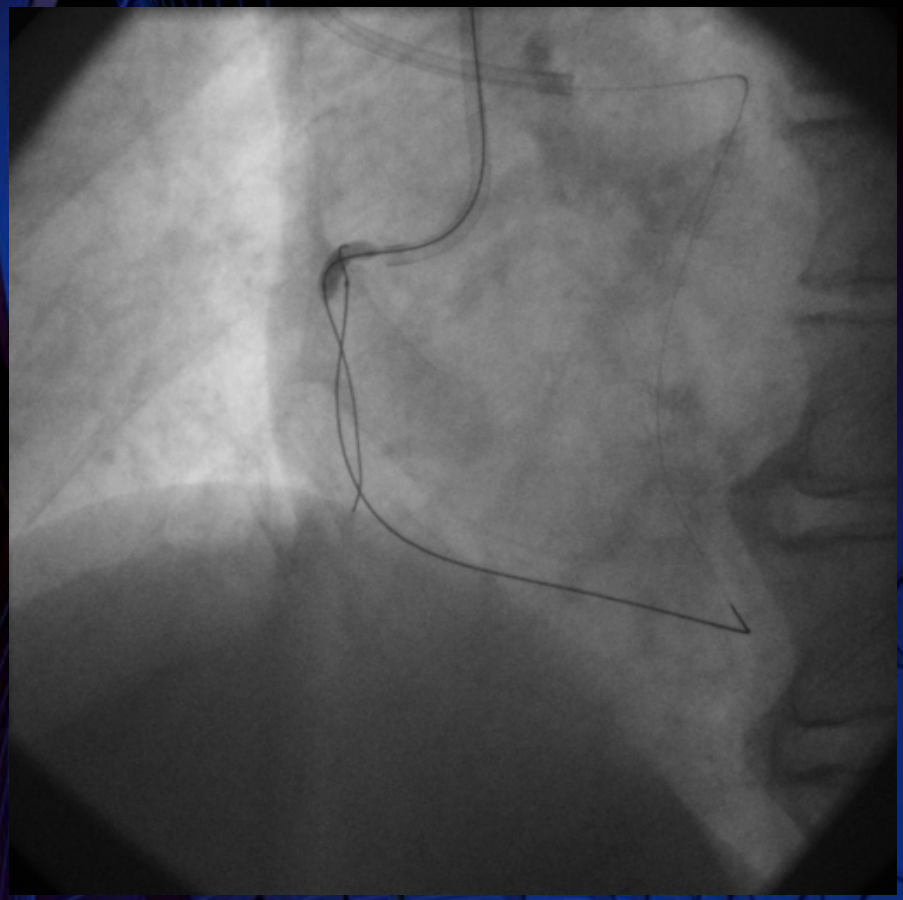
failed reverse CART technique

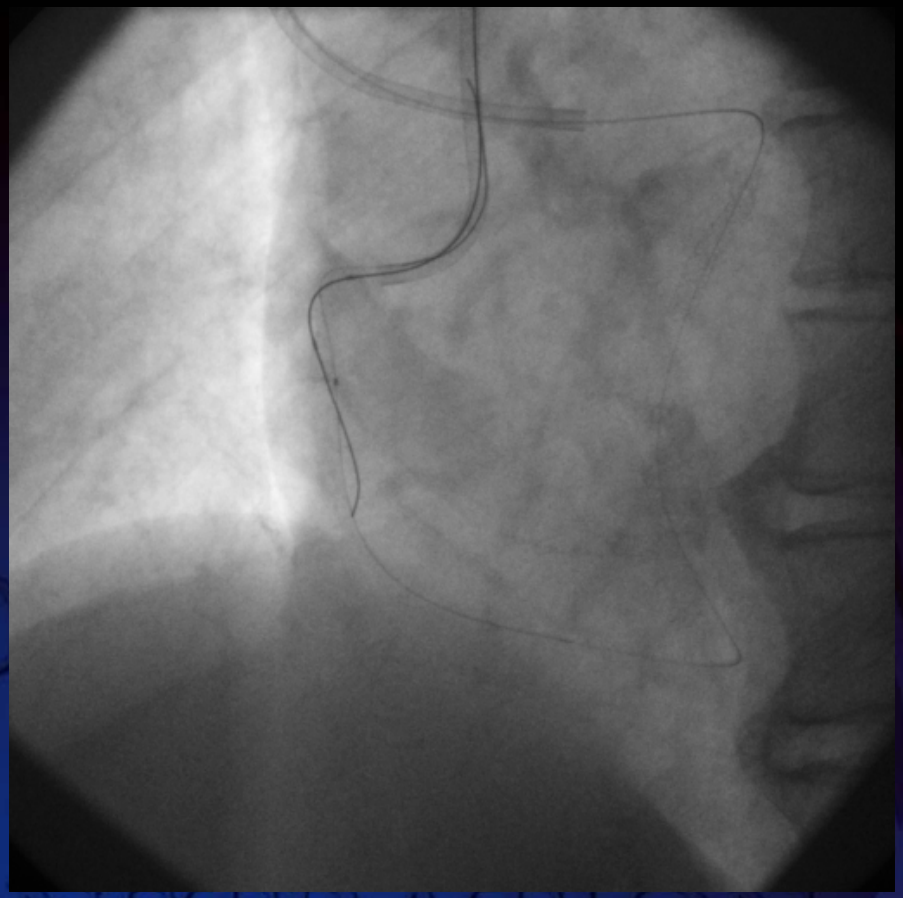




IVUS (Atlantis PRO2)

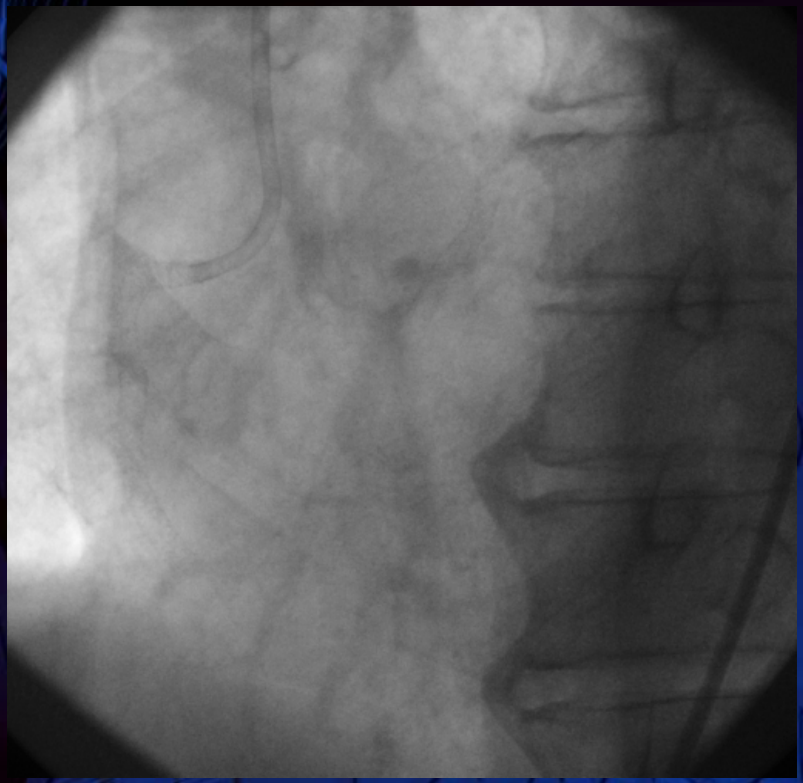
CTO procedure（5）

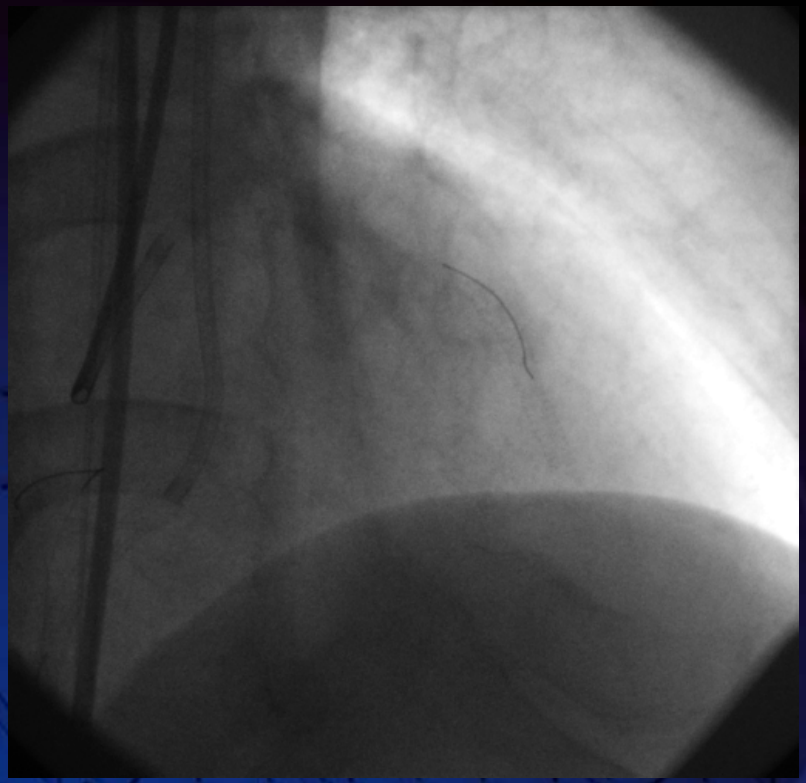




Reverse CART (balloon size 2.5mm →3.5mm)

retro G.W. Successful passage





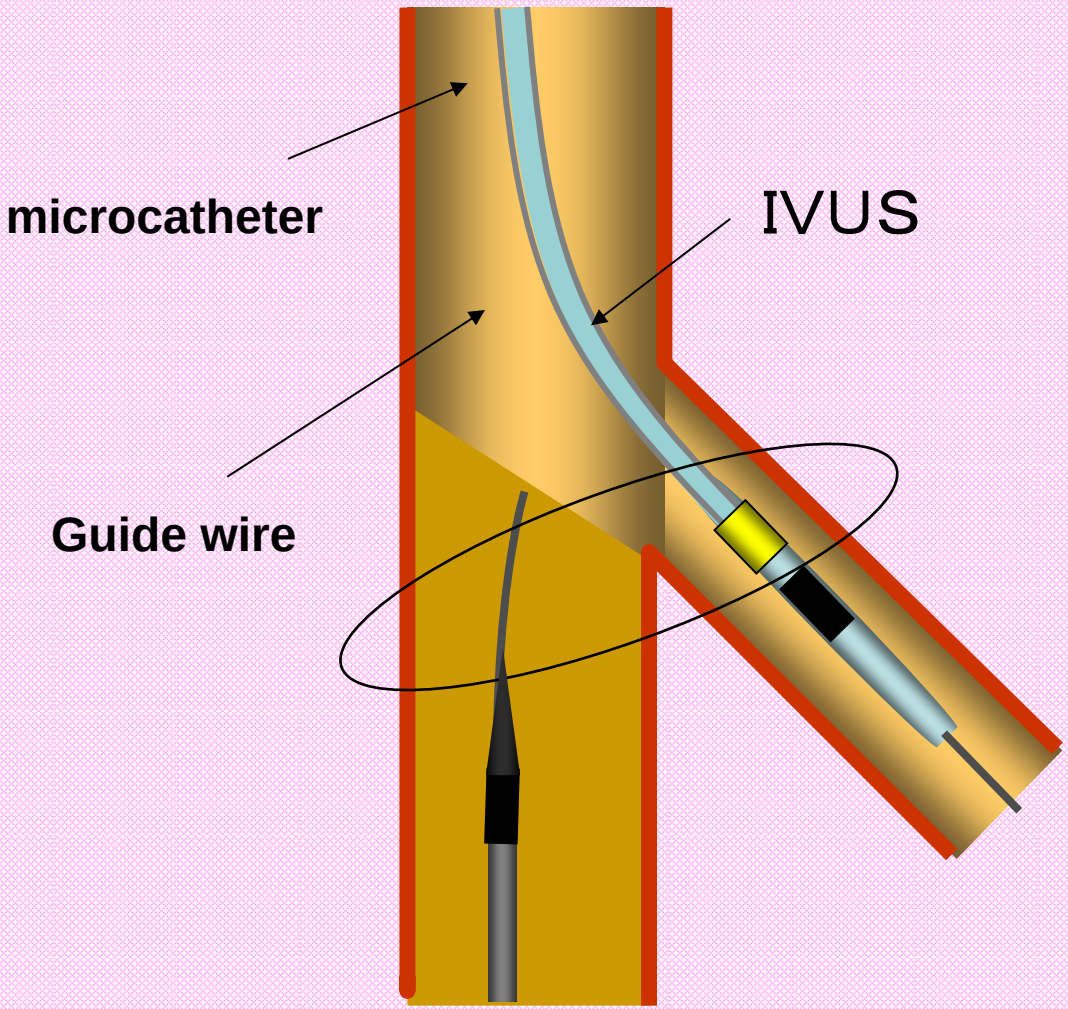
DES 3.5x32mm x2 by IVUS guidance

final angiogram

Total dye volume 50cc

Application of IVUS for CTO PCI

- To detect entry point of bifurcated CTO lesions
- IVUS guided wiring
  - 1)followed after failed parallel wire technique
  - 2)in reverse CART procedure
  - 3) Retrograde guidewire passage


microcatheter
IVUS
Guide wire

Case : Male in his 60's

Target Lesion : proximal LAD
Point : CTO

Diagnosis : OMI

Risk Factor : HT, dyslipidemia, current smoker

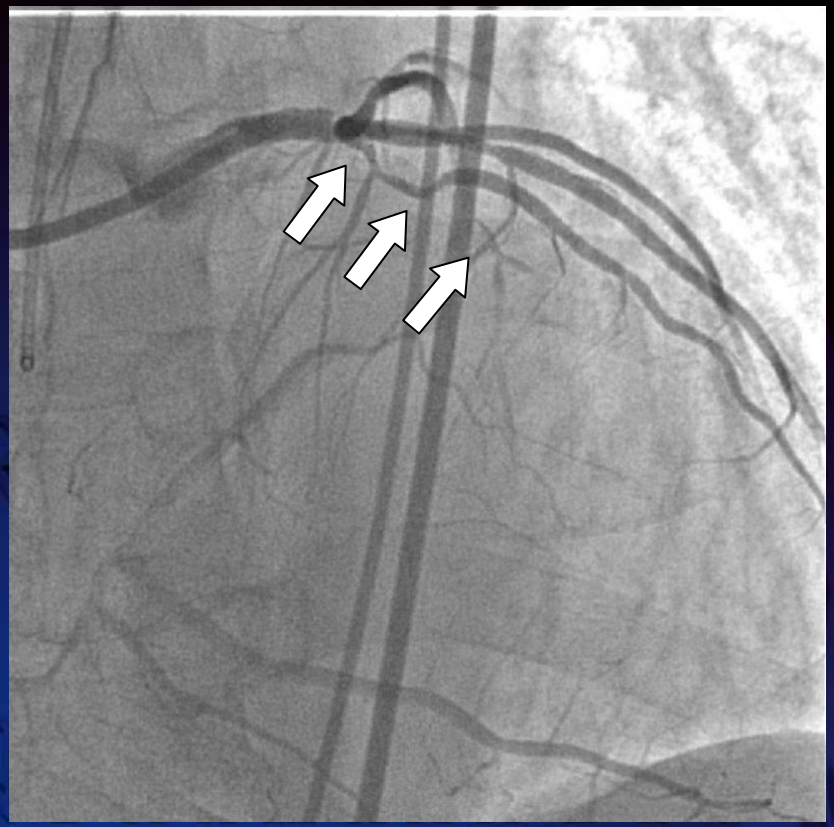
Present illness

2008.12.2 admission due to AMI (other hospital)
emergency CAG proximal RCA total,
proximal LAD total (CTO)
emergency PCI to proximal RCA
VISION φ4.0x28mm total ⇒ 0%

2008.12.6 PCI to CTO of LAD (other hospital)
antegrade approach ⇒ failure

2009.2.6 PCI to CTO of LAD
retrograde approach
(collateral from RCA) ⇒ failure

UCG: inferior severe hypokinesis, EF 35%



Control CAG: LCA

RAO Cau

LAO Cau

Control CAG: RCA

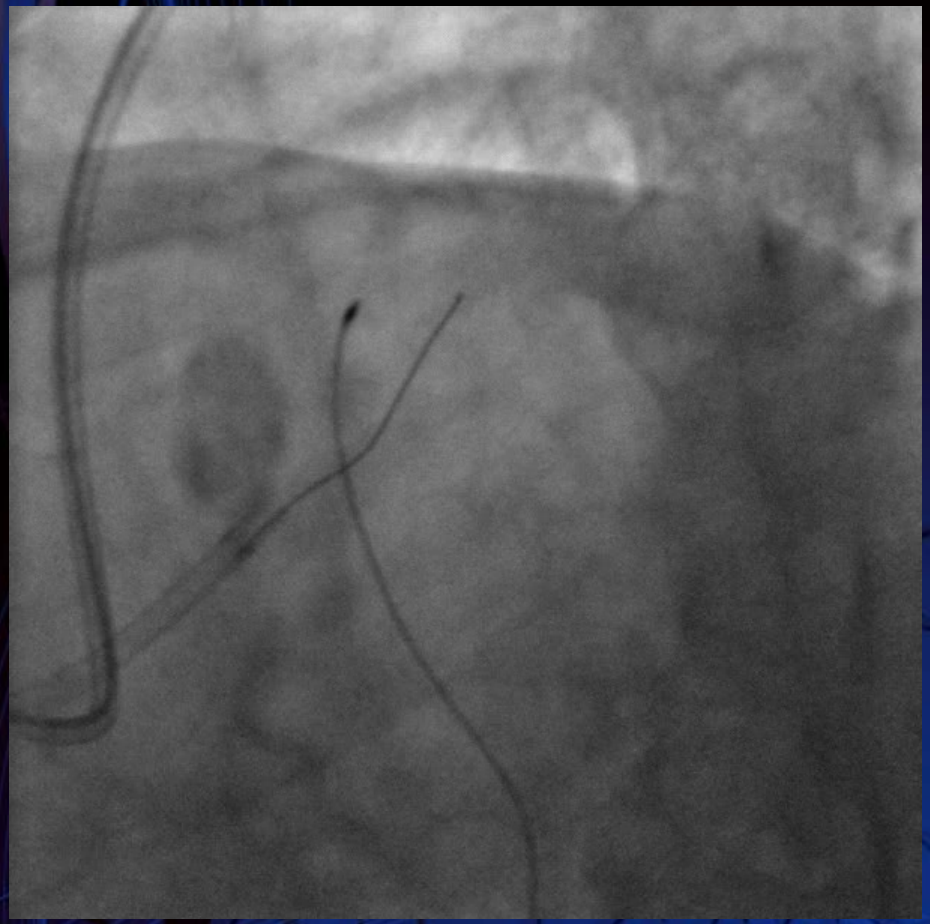
RAO Cau

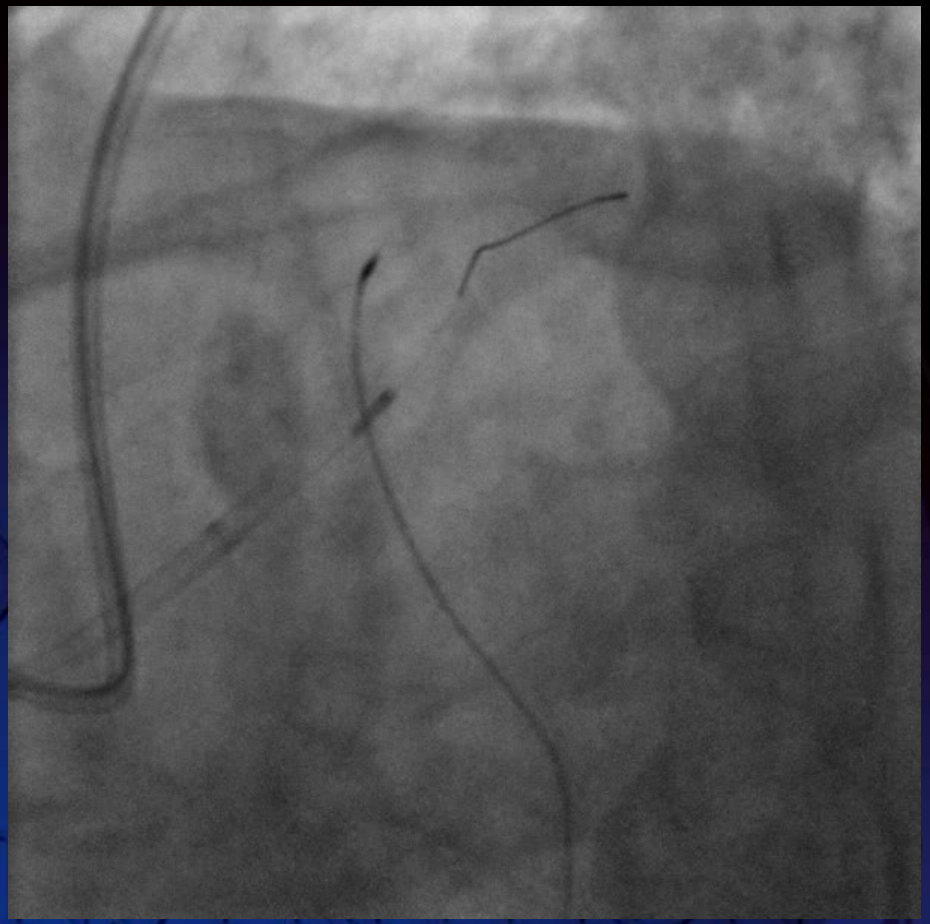
RAO Cra

CTA

AP Cra

Antegrade Approach





Rt femoral A 8Fr sheath

G/C : EBU3.5 SH 8Fr

HL G/W: ADVANCE LITE

IVUS Guide Wiring (Antegrade)

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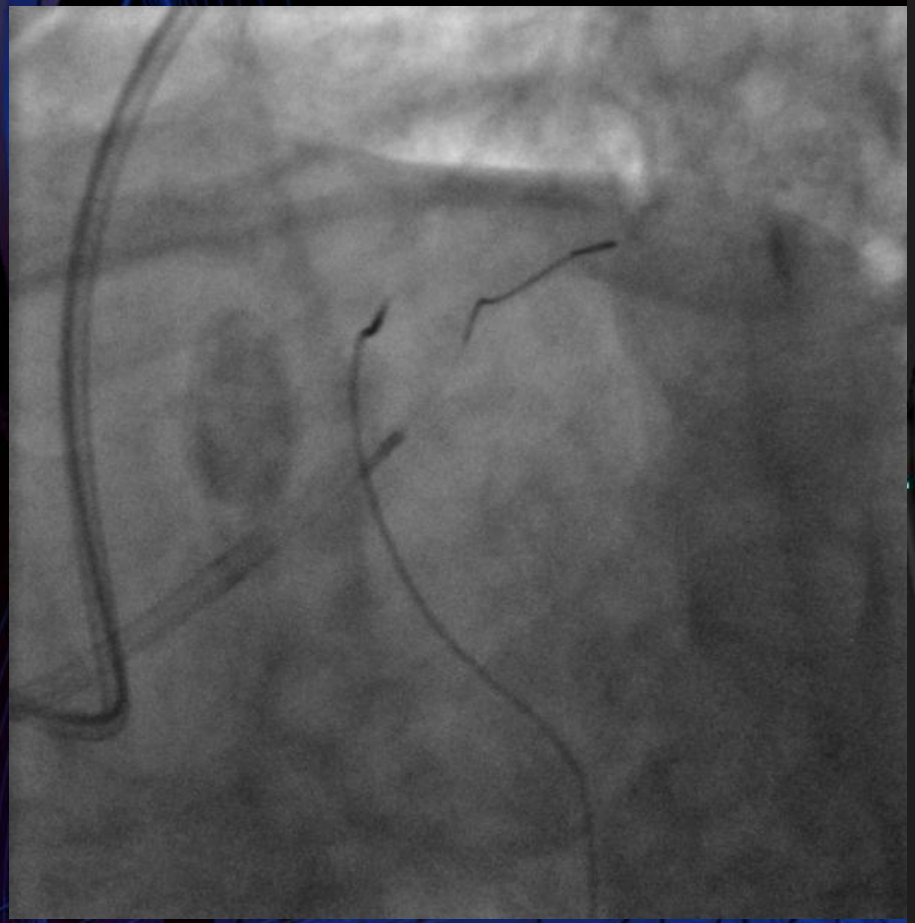
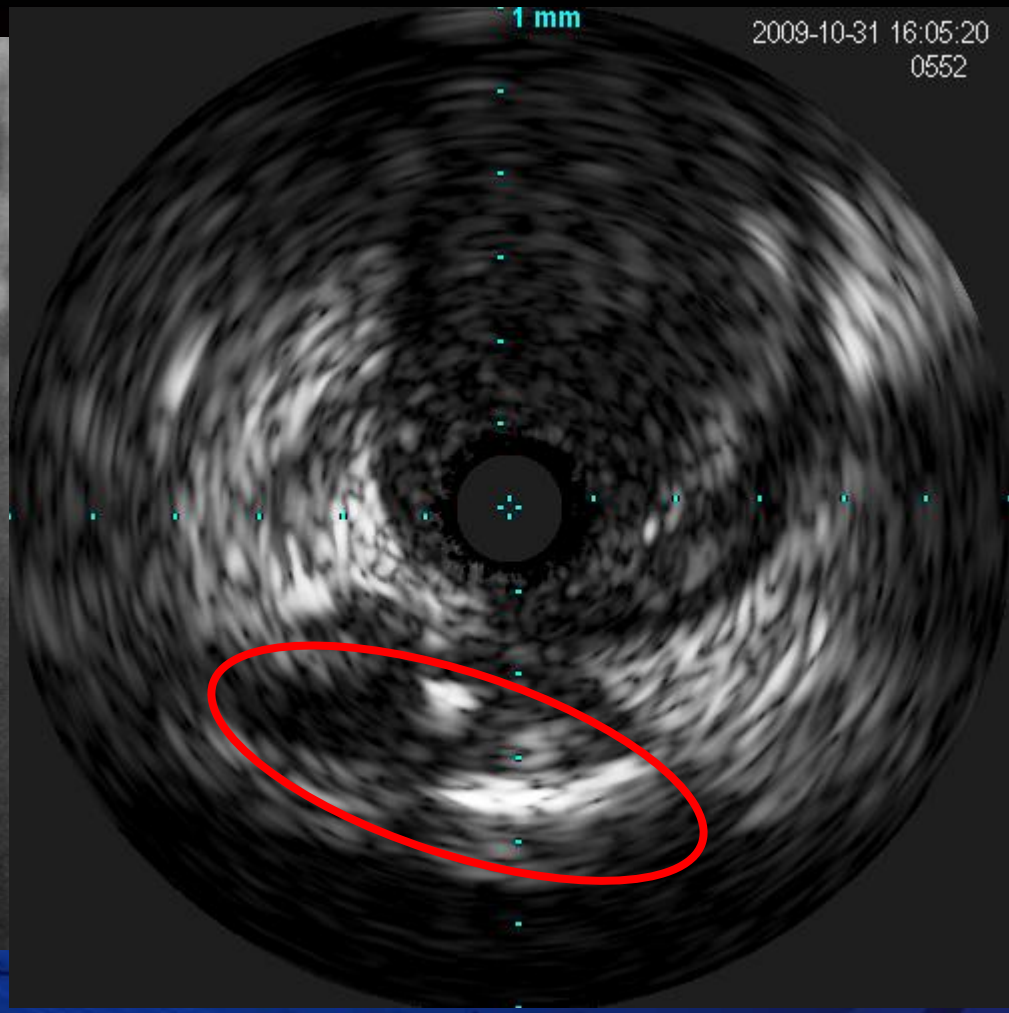
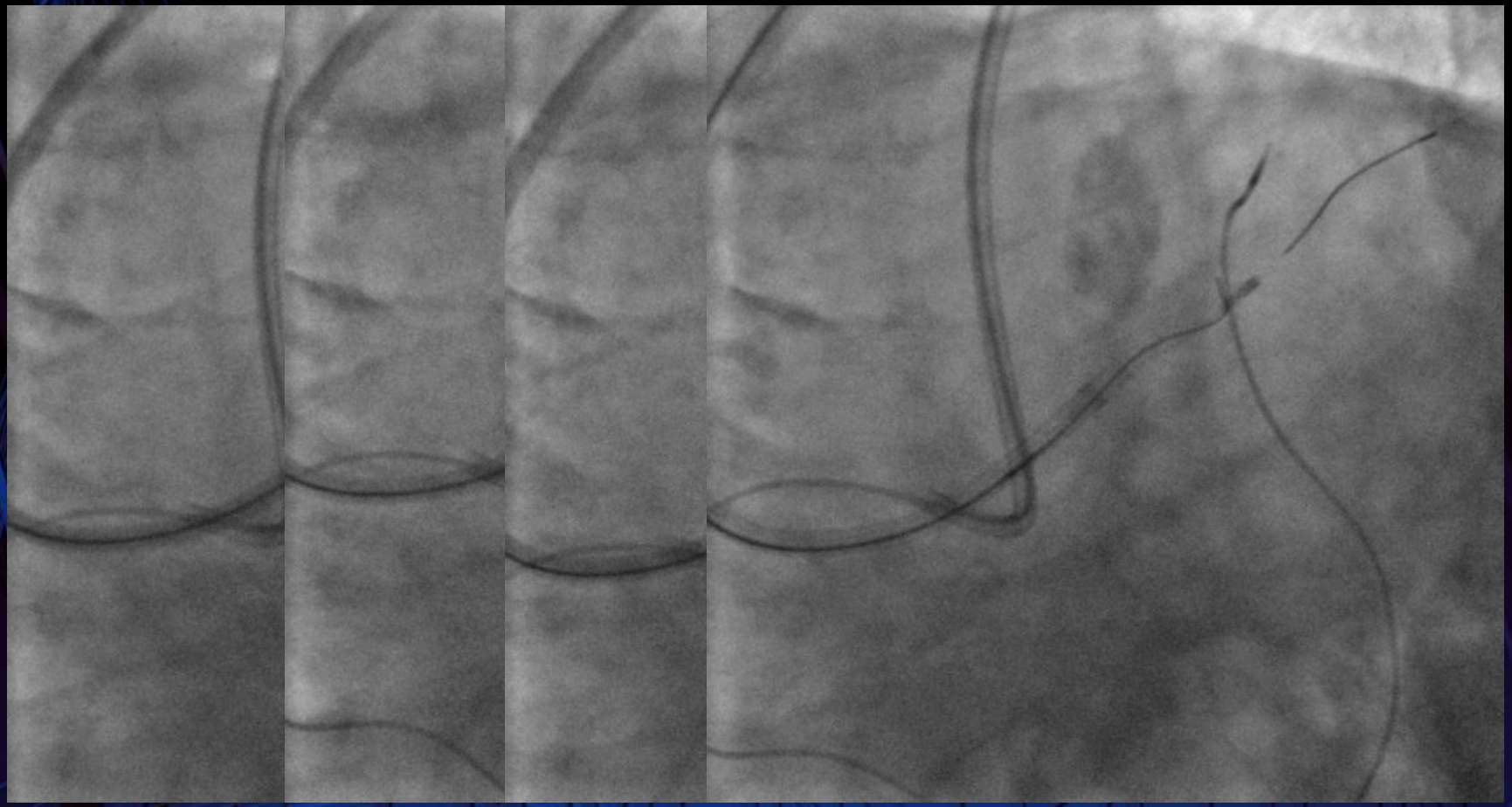




HL G/W: ADVANCE LITE

IVUS : VOLCANO Eagle Eye Gold

IVUS Guide Wiring (Antegrade)



M/C: Corsair G/W: miracle3→ConquestPro

IVUS Guide Wiring (Antegrade)

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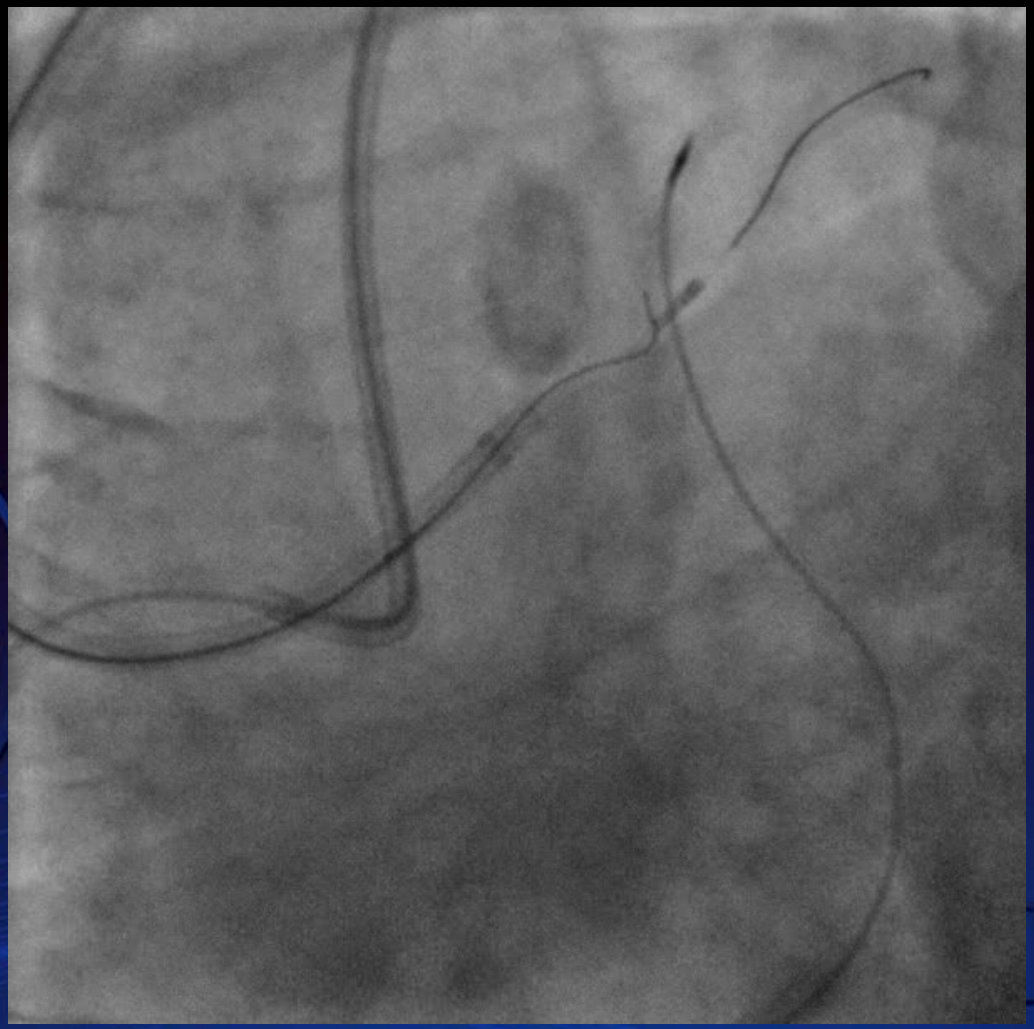
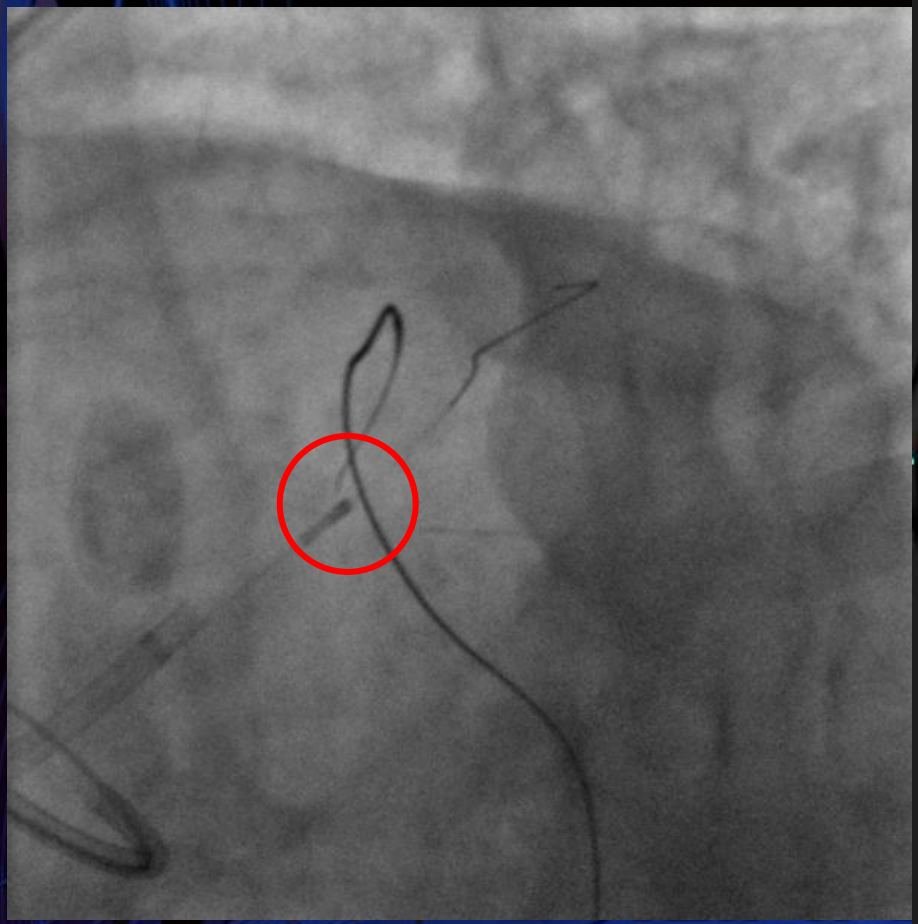
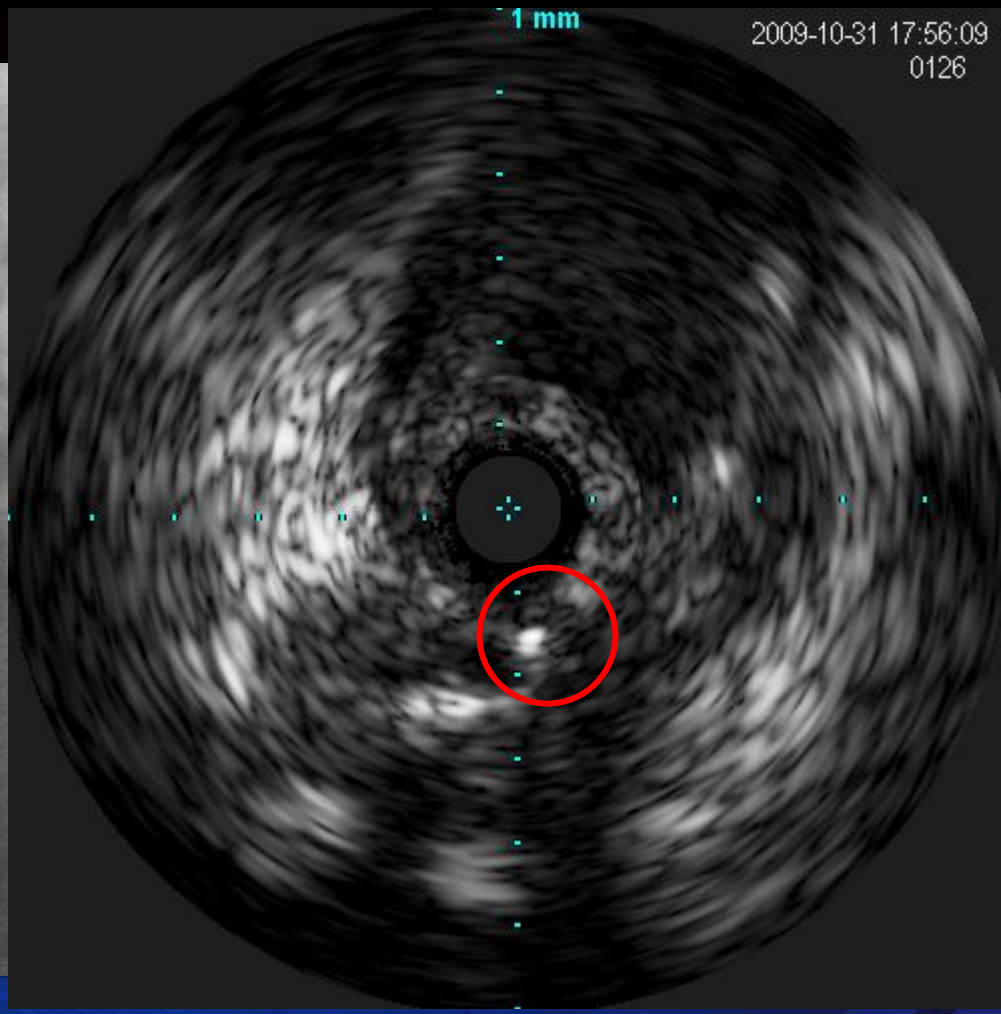


M/C: Corsair G/W: miracle3→ConquestPro→Fielder FC→miracle3

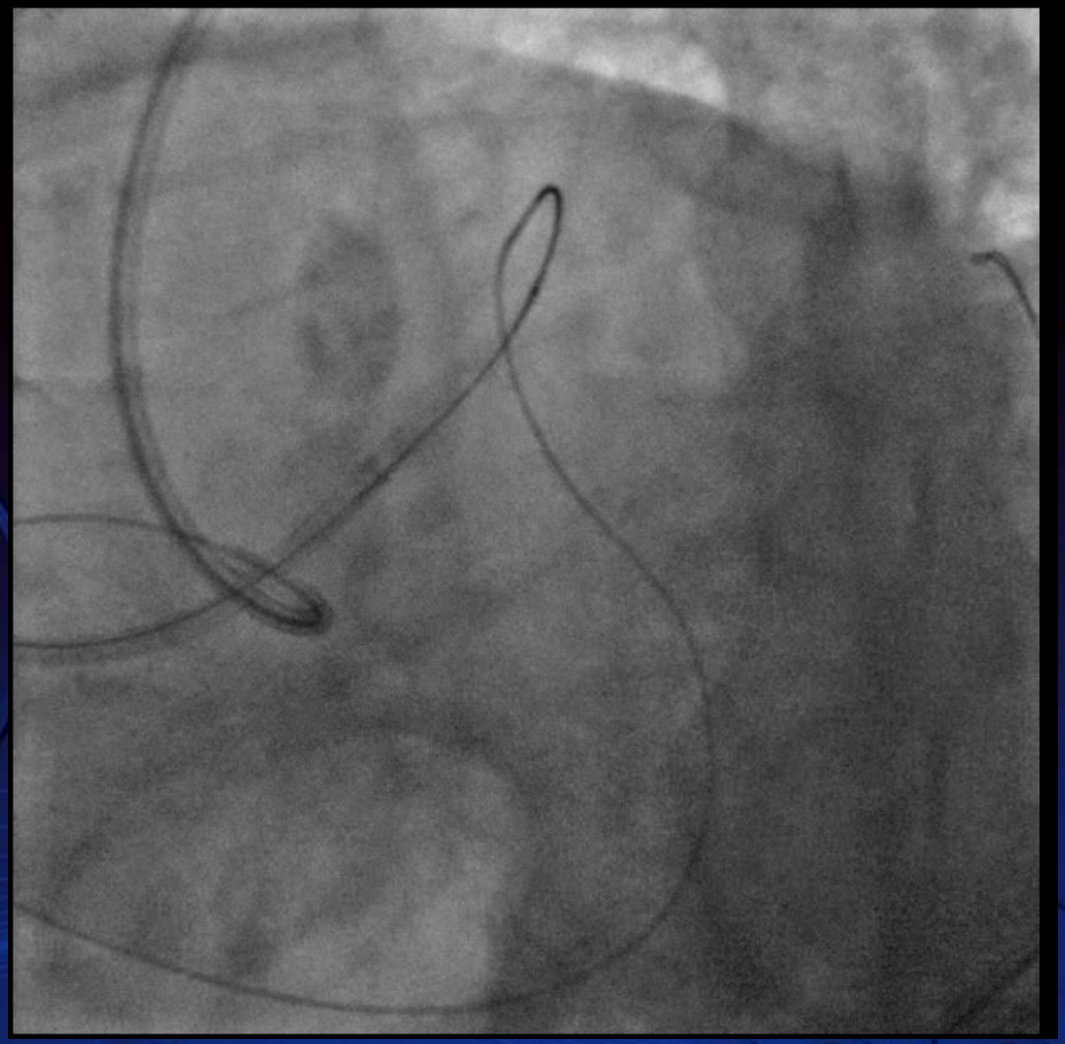
IVUS Guide Wiring (Retrograde)





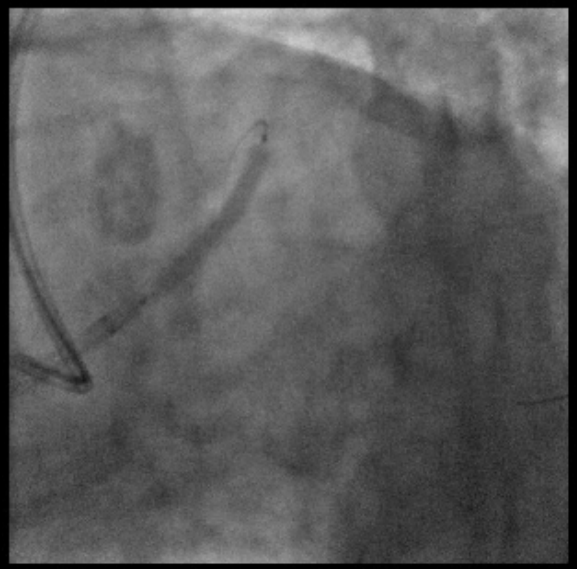
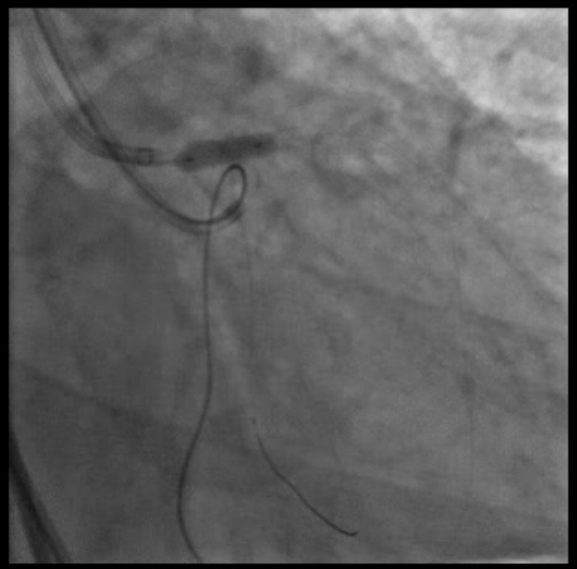
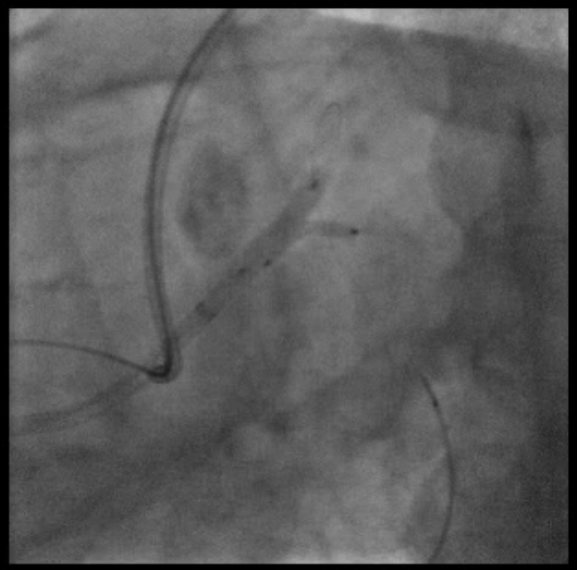
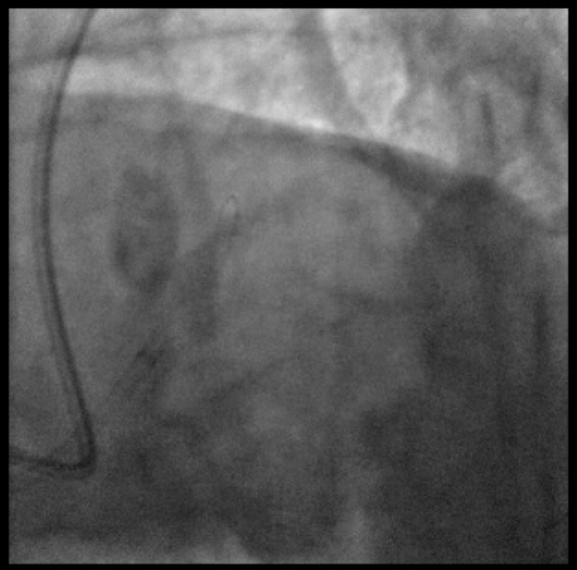
M/C: Corsair G/W: miracle3→ConquestPro→ConquestPro8-20

Retrograde wire crossing



M/C: Corsair　G/W: ConquestPro8-20→Rotafloppy

Stenting

STENT : φ3.5x28 DES　　Post dila : φ4.0x15 Firestar

KBT : LAD; φ4.0x15 Firestar, LCX; φ2.5x15 Firestar

- I showed four CTO cases treated with IVUS guided retrograde procedure with different IVUS findings.

- Accurate evaluation of IVUS finding is helpful to decide appropriate next strategy which leads successful final result.

- IVUS guided reverse CART procedure is also promising technique to save contrast dyne consumption and so good application for CKD cases.

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Hokkaido Social Insurance Hospital