

How to Interpret Coronary Angiography and CT Angiography for CTO Intervention

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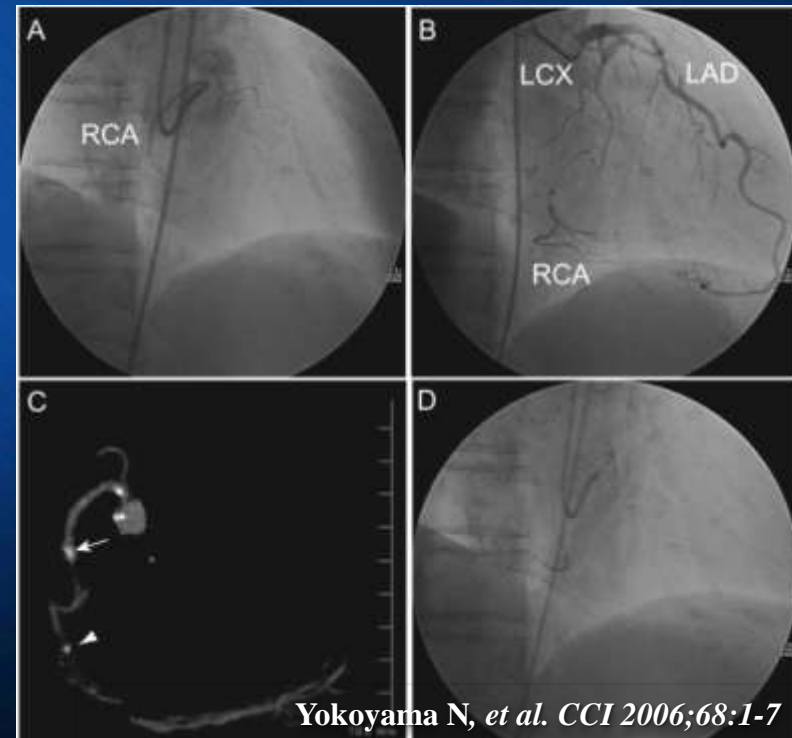
- **CT Angiography can tell us what Coronary Angiography cannot show for CTO Intervention !!!**



1. CT scan can show the course of CTO

- By angiogram, we can not know ...
 - how CTO course goes, even with contralateral injection
 - more difficult in case of long-CTO
- CT scan can tell us how CTO course goes & what the hidden route is within CTO segment !

Good for long or tortuous CTO

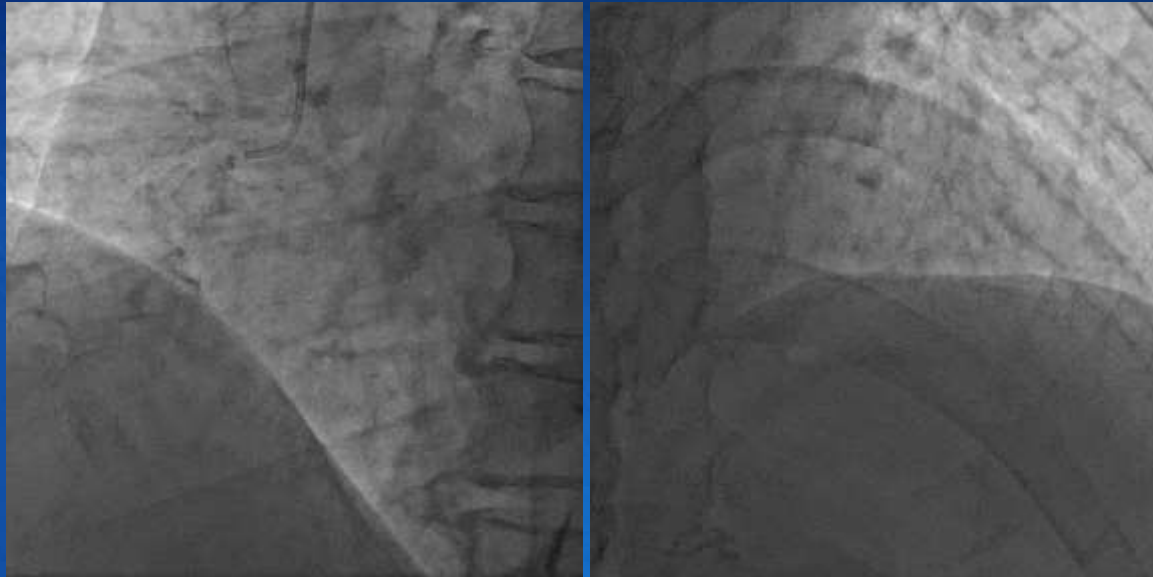


Yokoyama N, et al. CCI 2006;68:1-7



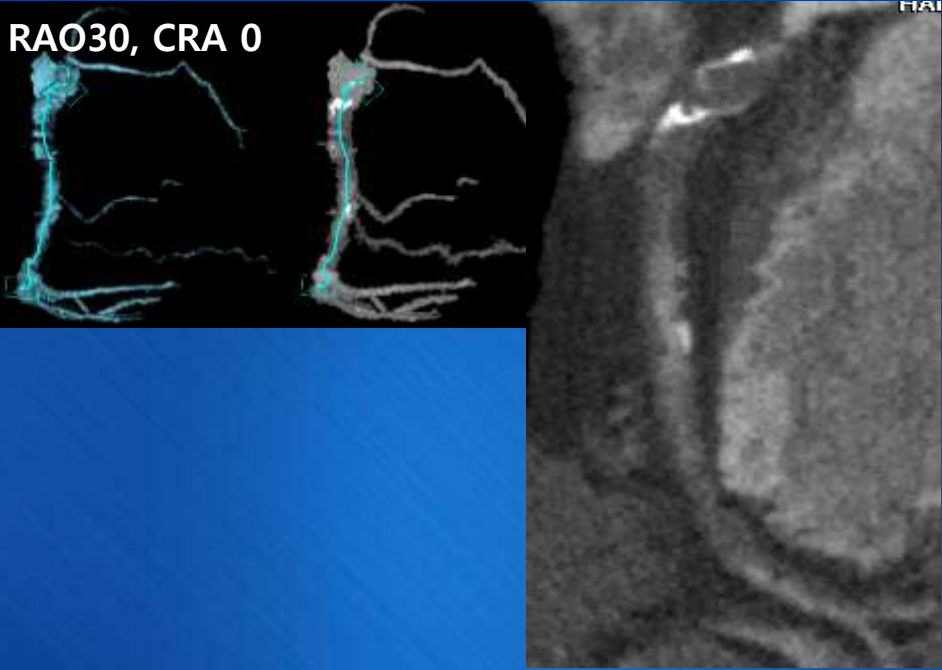
Case 1. **M/61** RCA-CTO

- C.C : Exertional angina for 1 year
- Risk factors : HTN, DM, Dyslipidemia / Echo : No RWMA (EF=74%)

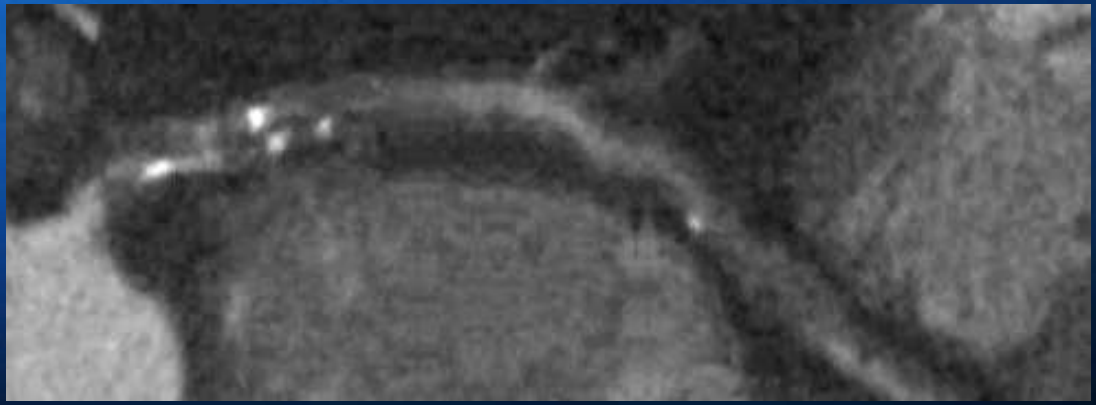


- *Diffuse long-length CTO*
- *Ostial CTO*
- *The course of CTO was not visualized even with contralateral injection ...*

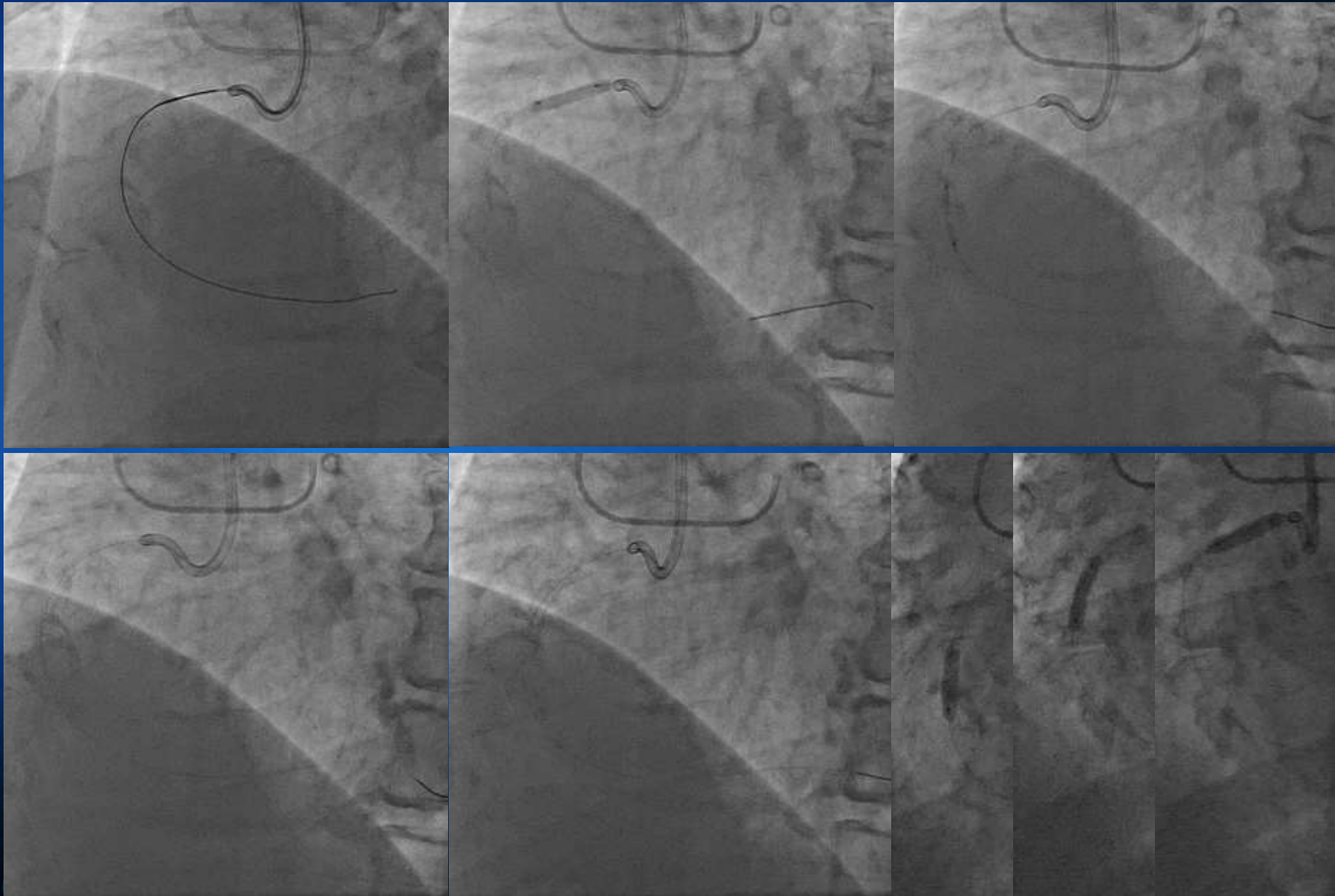
Pre-CTO CT angiography ; matching CT-images with CAG at same angle



- Minimal calcium on, even with long CTO
- Very straight course



Antegrade CTO intervention; → XTA → ultimate ... Preballoon & Stenting (4.0x22 mm Integrity), Post-balloon



Final CAG

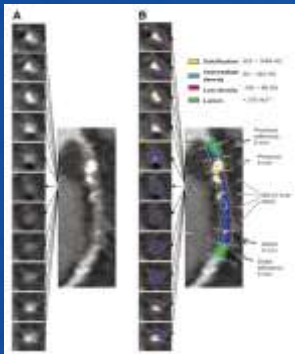


Stent: Resolute integrity 4*15 @ os-pRCA, Resolute integrity 4*38 @ p-mRCA



2. CT scan can provide the detailed information of calcification

Calcification... Hallmark of a high difficulty & a core of CT-guided CTO intervention !



	OR	95% CI	P value
CTO duration >12-months or unknown	3.00	1.39 – 6.46	0.005
Lesion length >18.4 mm	2.70	1.14 – 6.38	0.024
Segmental radiologic density >139 HU	2.73	1.16 – 6.41	0.021

Evaluation of Calcification by CT

Success case

CTO failure case

Calcium-related parameters:

- **RCa (regional calcium) score / volume / equivalent mass = 56.0/ 45.4/ 10.8**
- **% CaA/CSA (relative calcium area at the most calcified cross section of CTO) = 27.1%**

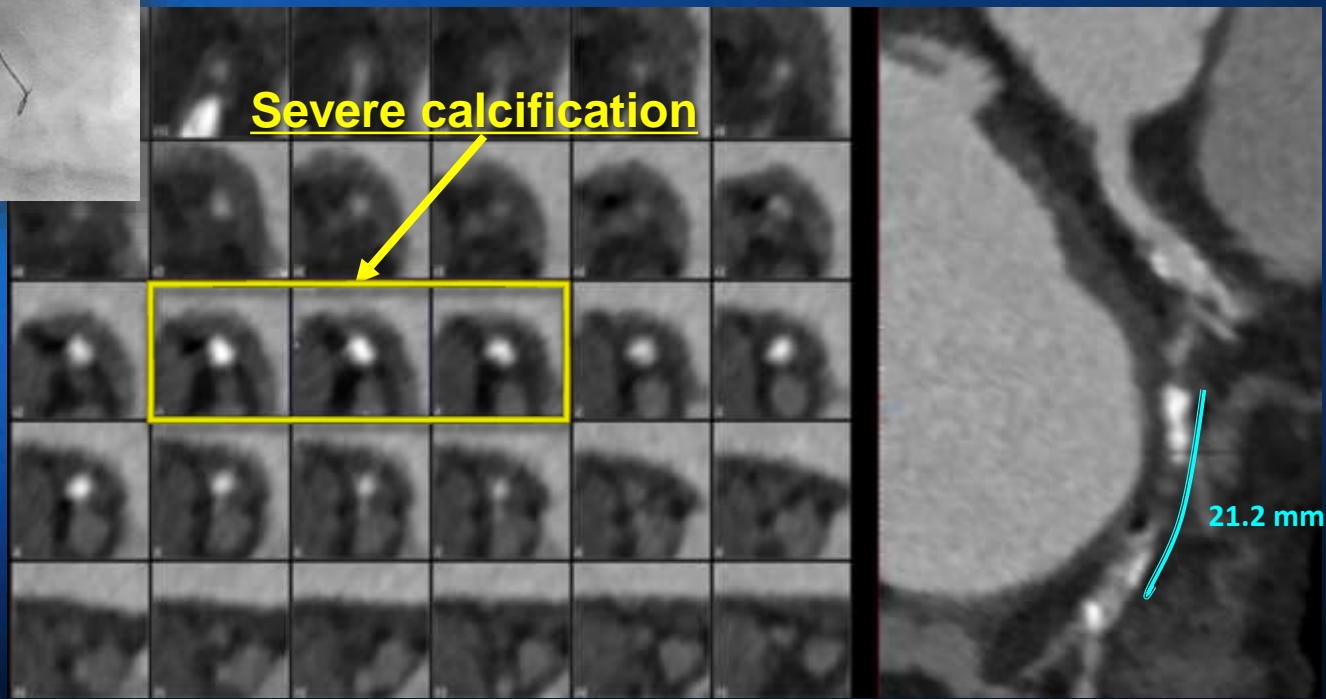
- **RCaS = 161.6, RCaV = 120.2, RCaEq = 30.3,**
- **%CaA/CSA = 69.1%**

	HR	95% CI	P
Multivariate regression analysis			
Stump calcification	13.4	0.89 – 201.46	0.061
% Ca area / CSA	18.5	1.19 – 283.96	0.037

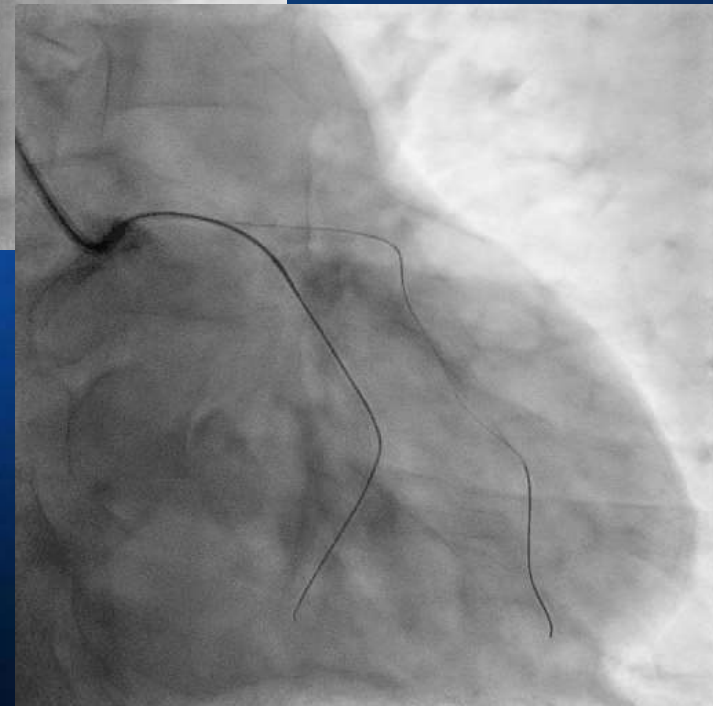
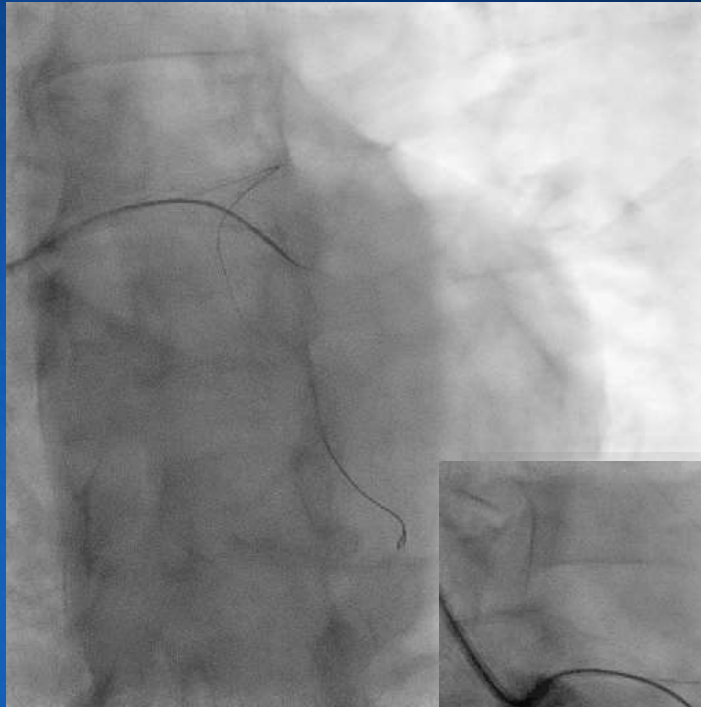
Conclusions:
 Precise quantification of regional calcification and measurement of the occluded segment by MDCT is the most important predict for procedural outcomes of CTO PCI.

Case 2. M/54 LCX CTO

- Risk factors; DM, HTN, s/p PCI of RCA dt AMI
- Echocardiography
 - RWMA / Reduced LV systolic function (EF=36%)

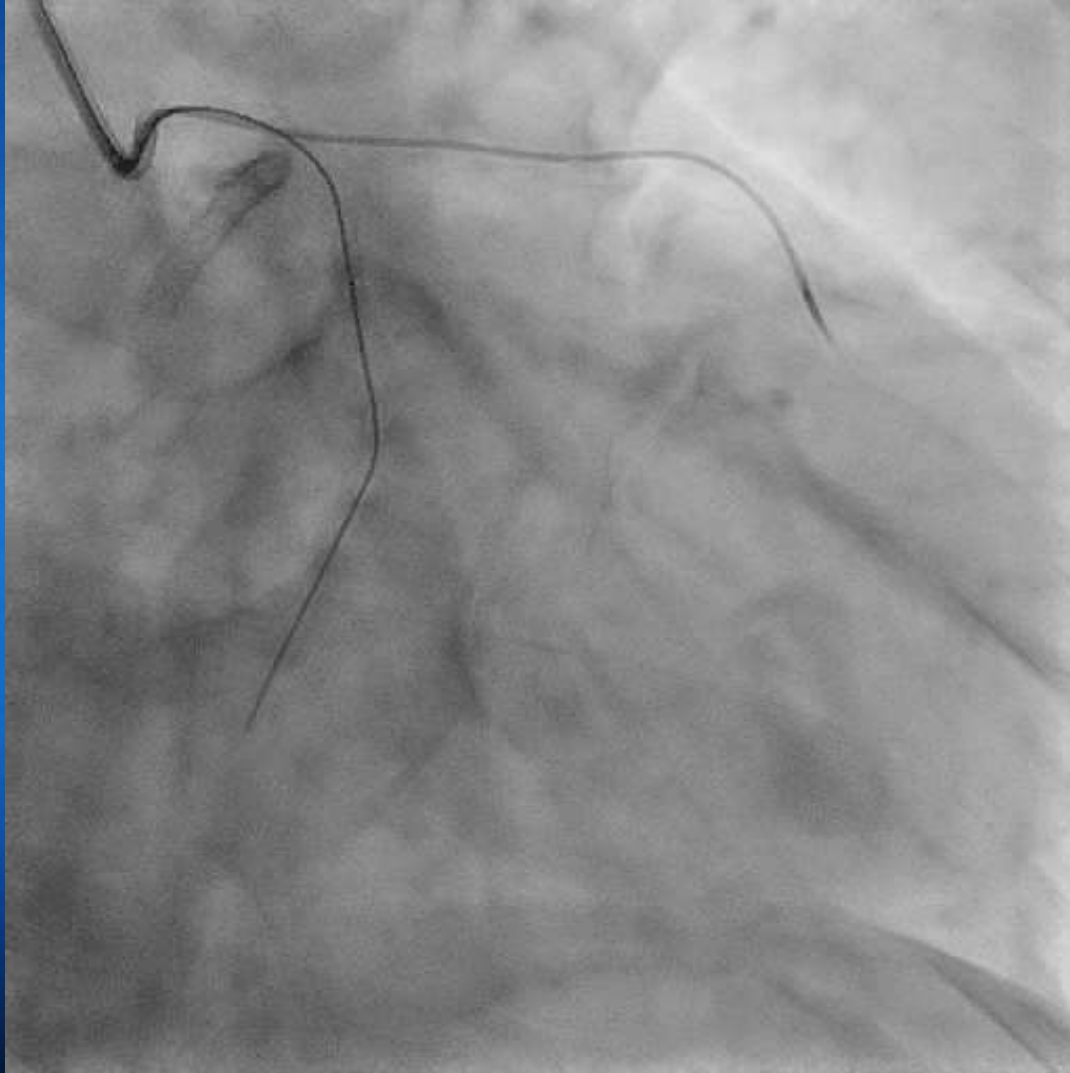


Start antegrade PCI with minimal efforts & preparation of retrograde in case of the antegrade failure



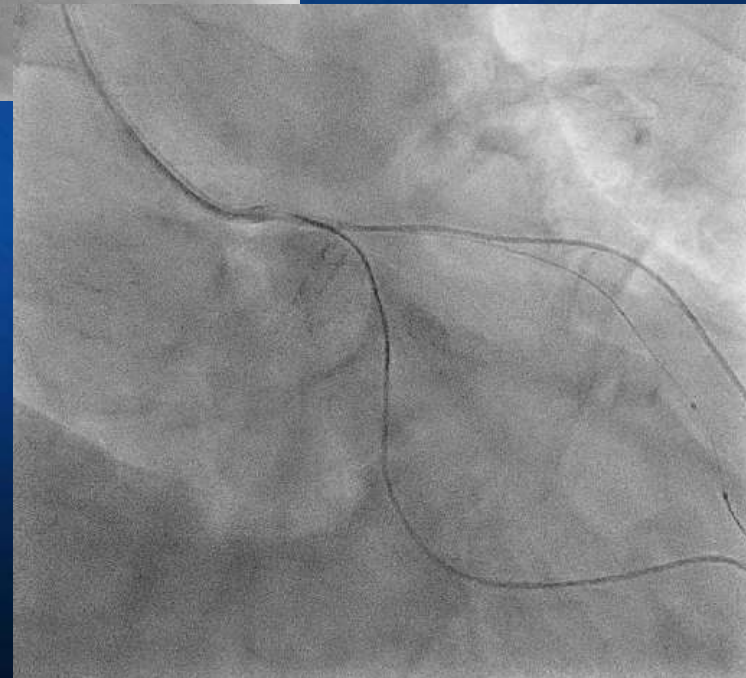
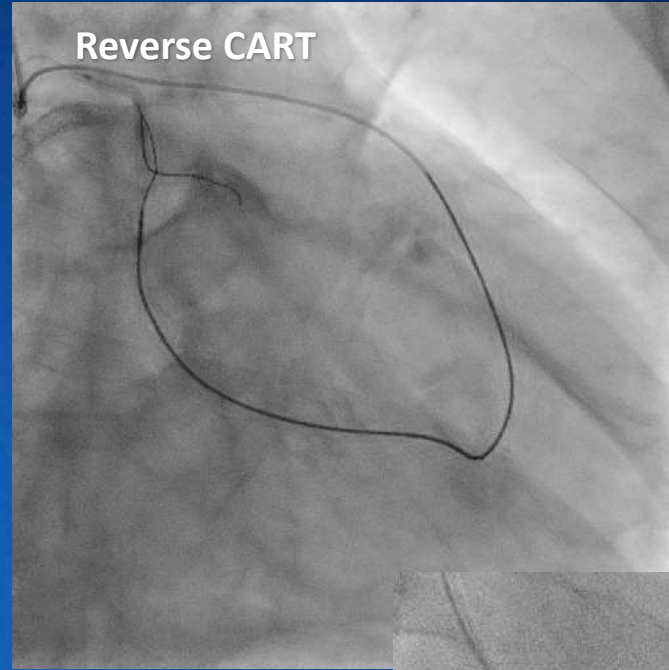
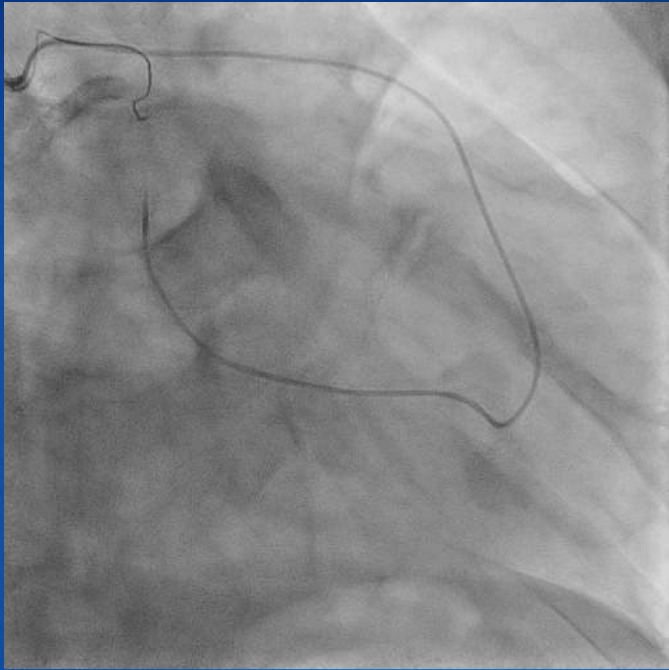
- Sion blue → Fielder XTA under Corsair → Gaia 2nd

Immediate change into retrograde approach using previously selected collateral channel

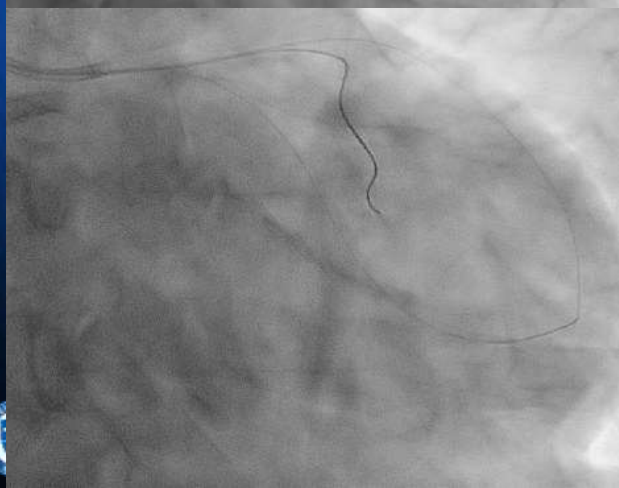


Retrograde approach using Corsair

Retrograde approach using ipsilateral epicardial collateral



- 2.5 x 15 mm balloon

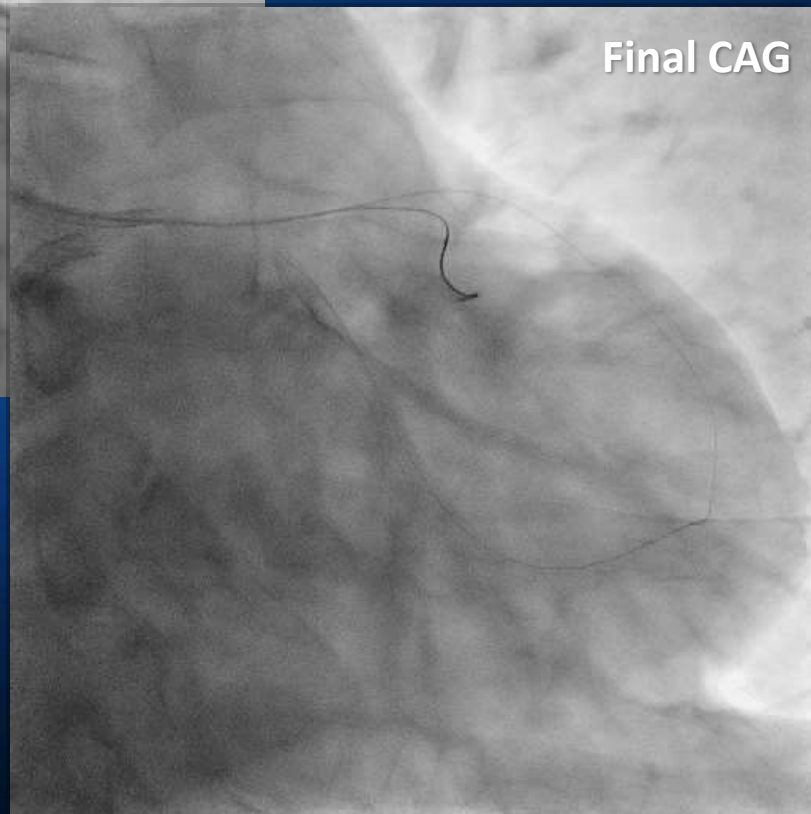
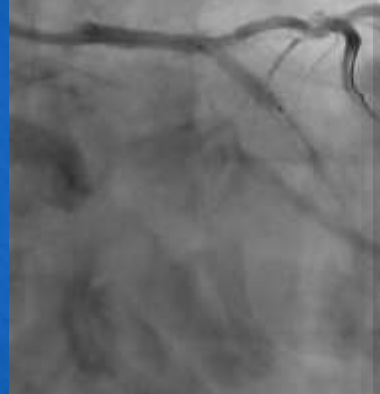


Pre-balloon & Stenting

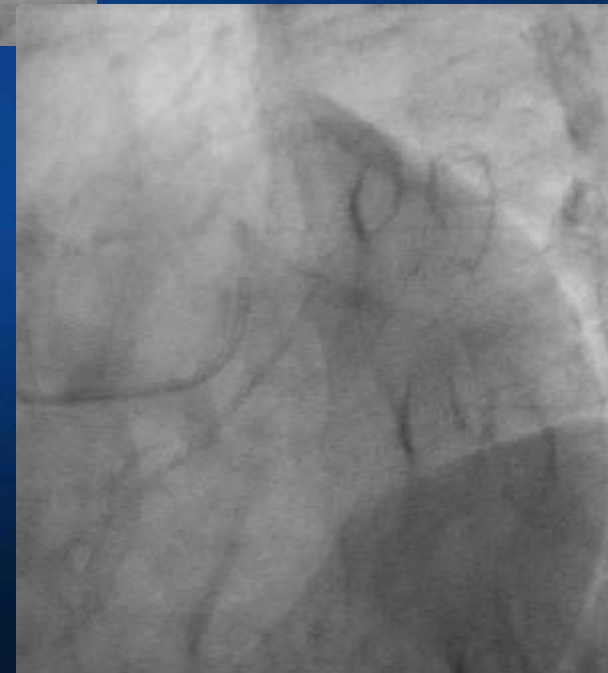
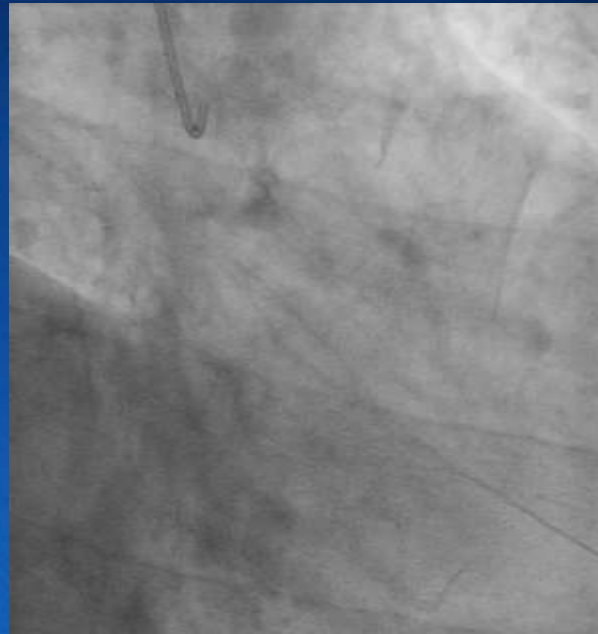
- 2.5 x 40 mm Orsiro stent



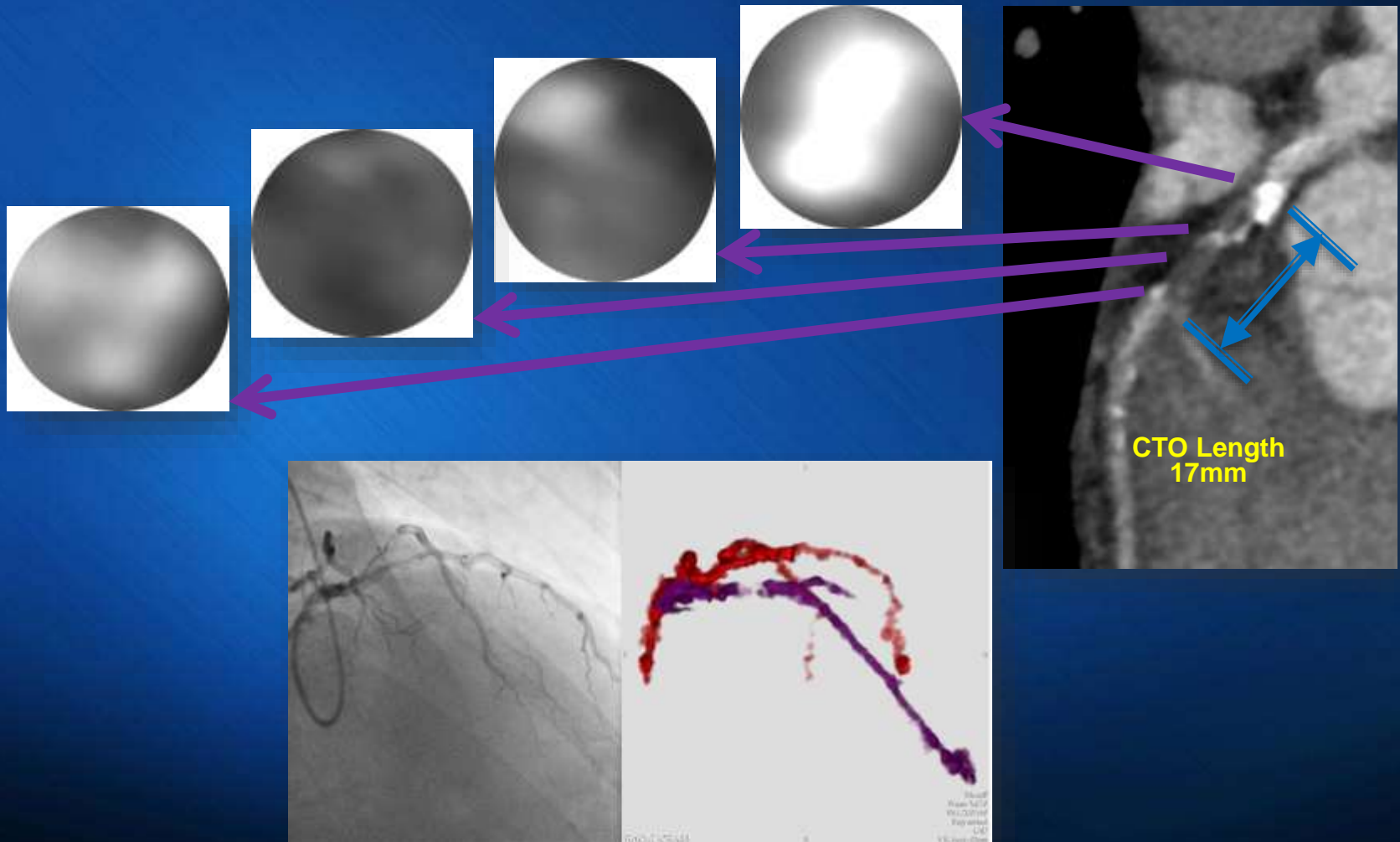
- 2.75 x 15 mm Orsiro stent



CASE 3. LAD CTO



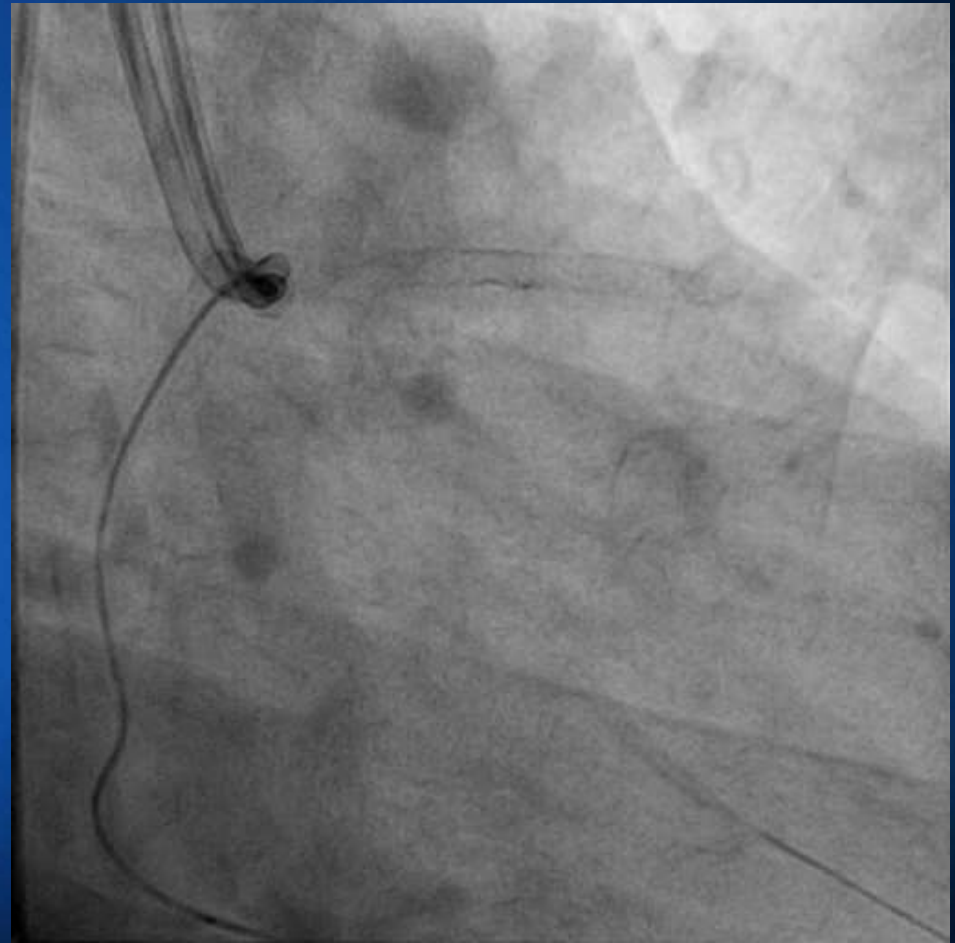
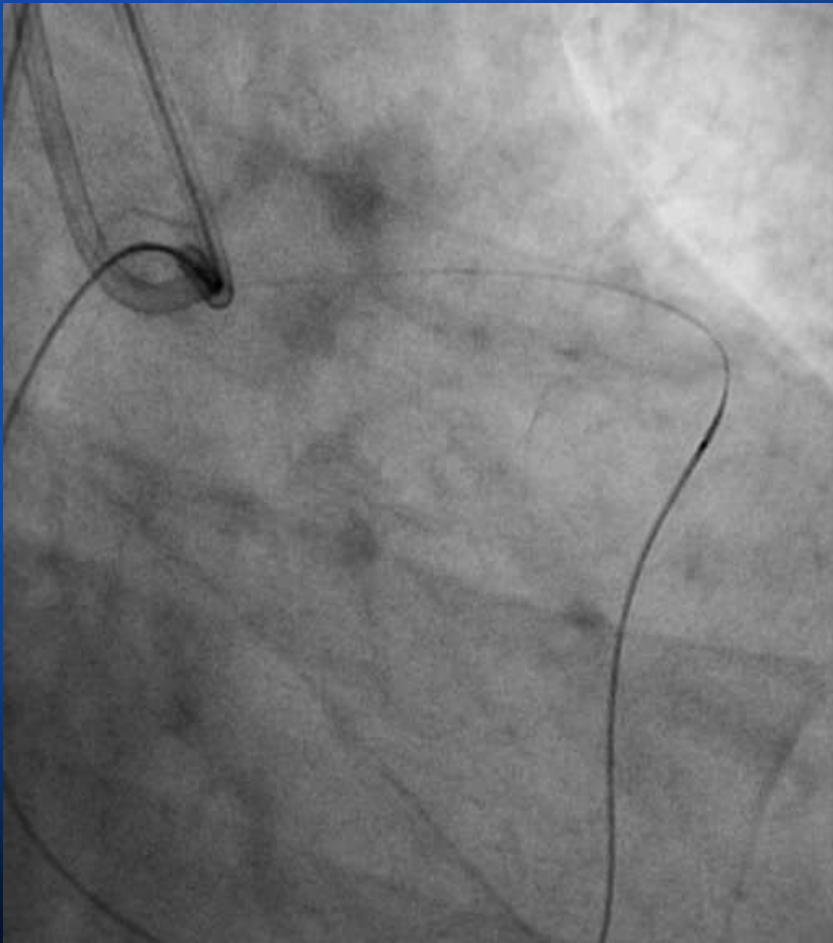
Anatomical information by CT angiography



CTO Length
17mm



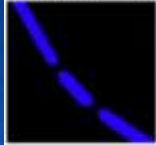
Successful CTO revascularization via initial retrograde approach



CTO score for the prediction of success (based on the CT findings)

Predictors Definitions

Multiple Occlusion



Presence of ≥ 2 complete interruptions of the contrast opacification separated by contrast-enhanced segment of ≥ 5 mm.

Multiple Occlusion

- Presence (1)
- Absence (0)

Blunt Stump

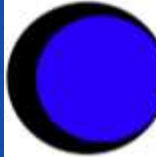


Absence of any tapered stump at the entry or exit site.

Blunt Stump

- Presence (1)
- Absence (0)

Severe Calcification

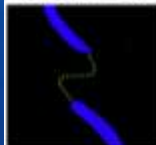


Presence of any calcium involving $\geq 50\%$ of the vessel cross-sectional area at the entry or exit site or within the occlusion route.

Severe Calcification

- Presence (1)
- Absence (0)

Bending $\geq 45^\circ$



Presence of any bending $\geq 45^\circ$ at the entry or exit site or within the occlusion route.

Bending $\geq 45^\circ$

- Presence (1)
- Absence (0)

Second Attempt

Previously failed PCI at CTO

Second Attempt

- Yes (1)
- No (0)

Duration of CTO

Duration of CTO ≥ 12 months or unknown

Duration of CTO

- Yes (1)
- No (0)

Difficulty Group

- Easy (0)
- Intermediate (1)
- Difficult (2)
- Very Difficult (≥ 3)

Total Score



KCCT Score: definition and scoring system

Version 1

1. Blunt proximal entry site



1 point

Tapered proximal entry site



0 point

2. Proximal adjacent side branch



1 point

No side branch adjacent to proximal entry site



0 point

3. Occlusion length ≥ 15 mm



1 point

Occlusion length < 15 mm



0 point

4. Bend $> 45^\circ$ in CTO segment



1 point

Bend $\leq 45^\circ$ degree or bend in non-CTO segment



0 point

5. Severe calcification



Peripheral calcification: maximal encircling $\geq 180^\circ$ and CSA $\geq 50\%$

1 point

or



Calcification with encircling $< 180^\circ$ or CSA $< 50\%$, or no calcification

0 point



Central calcification (360° and CSA = 100%)

2 point

6. Reattempt of previously failed CTO PCI

1 point

0 point

7. Occlusion duration ≥ 12 month or unknown

1 point

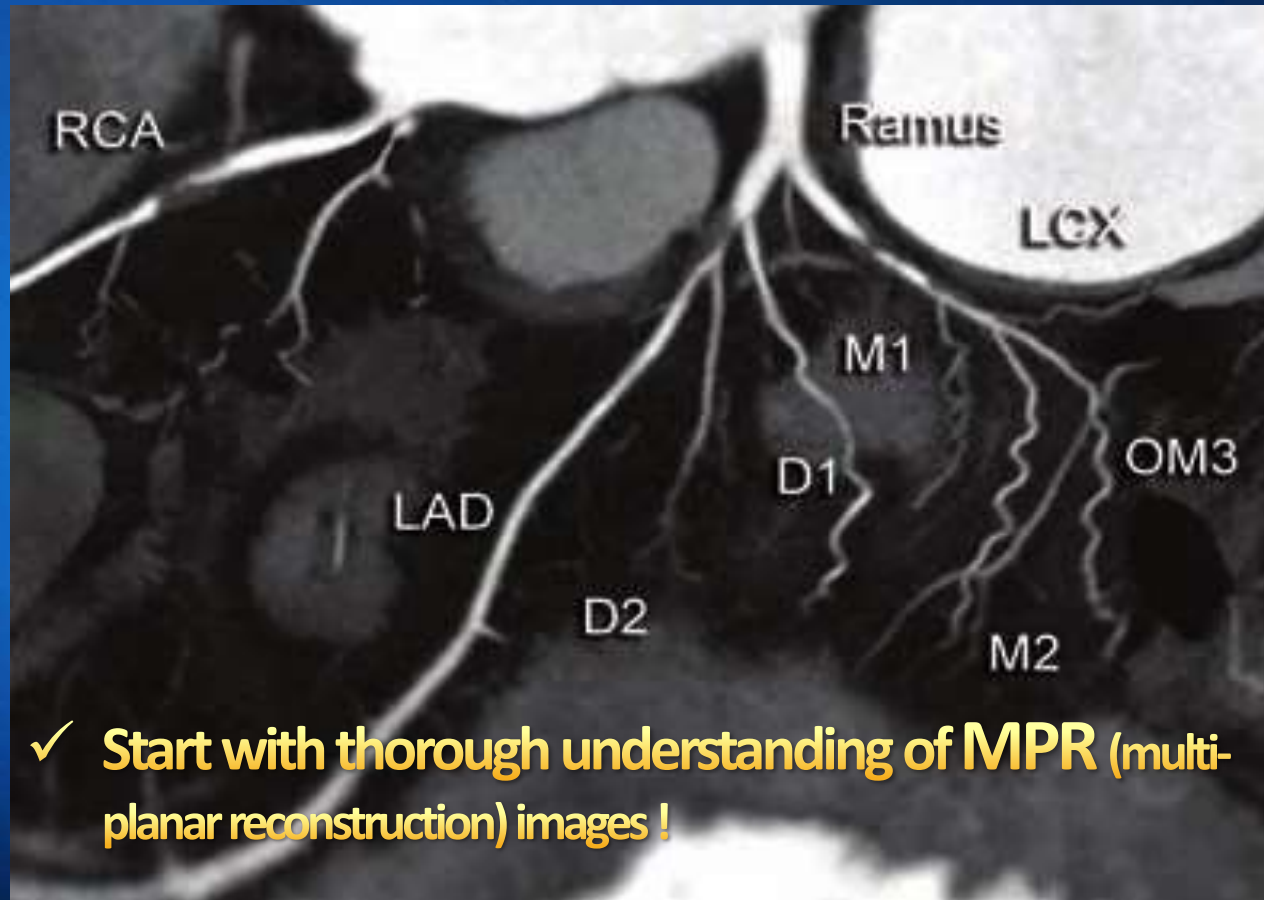
0 point

Difficulty category and total score

Total score (sum of all points) = points

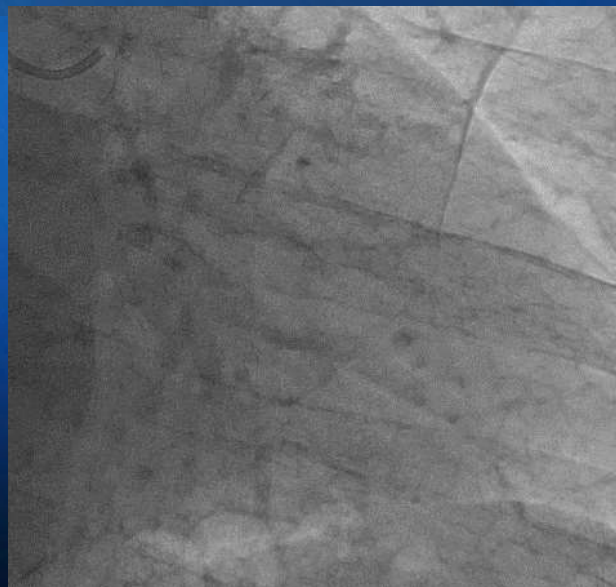
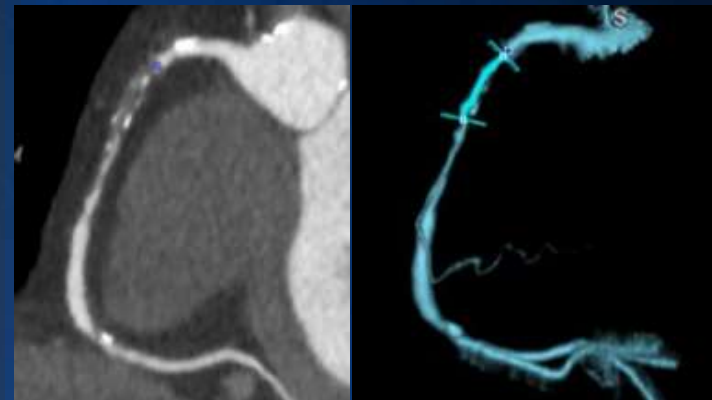
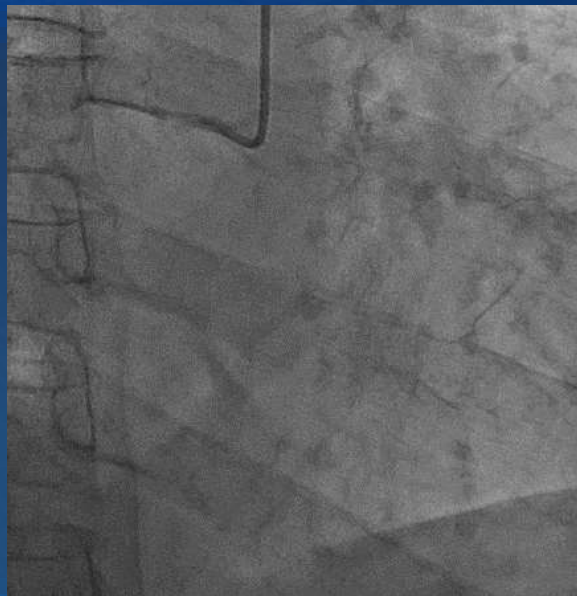
Category: Easy (0) Intermediate (1) Difficult (2) Very difficult (3) Extremely difficult (≥ 4)

3. CT scan can guide the further CTO procedures

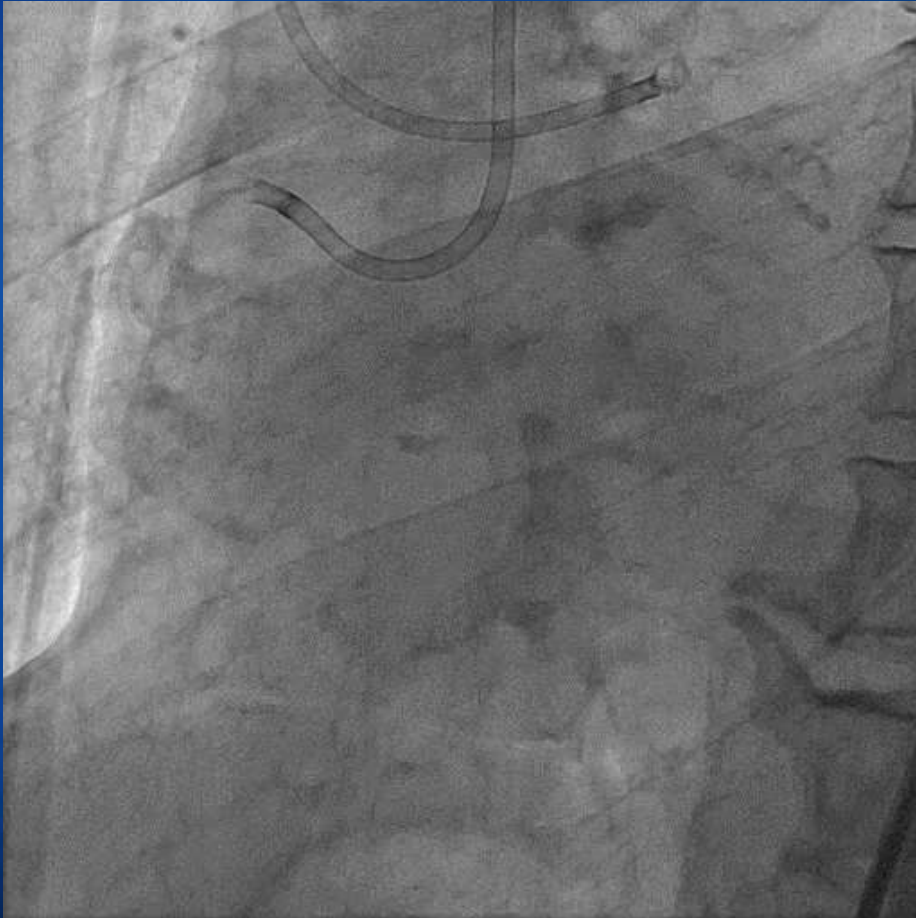


Case 4. M/70 ● CTO at RCA

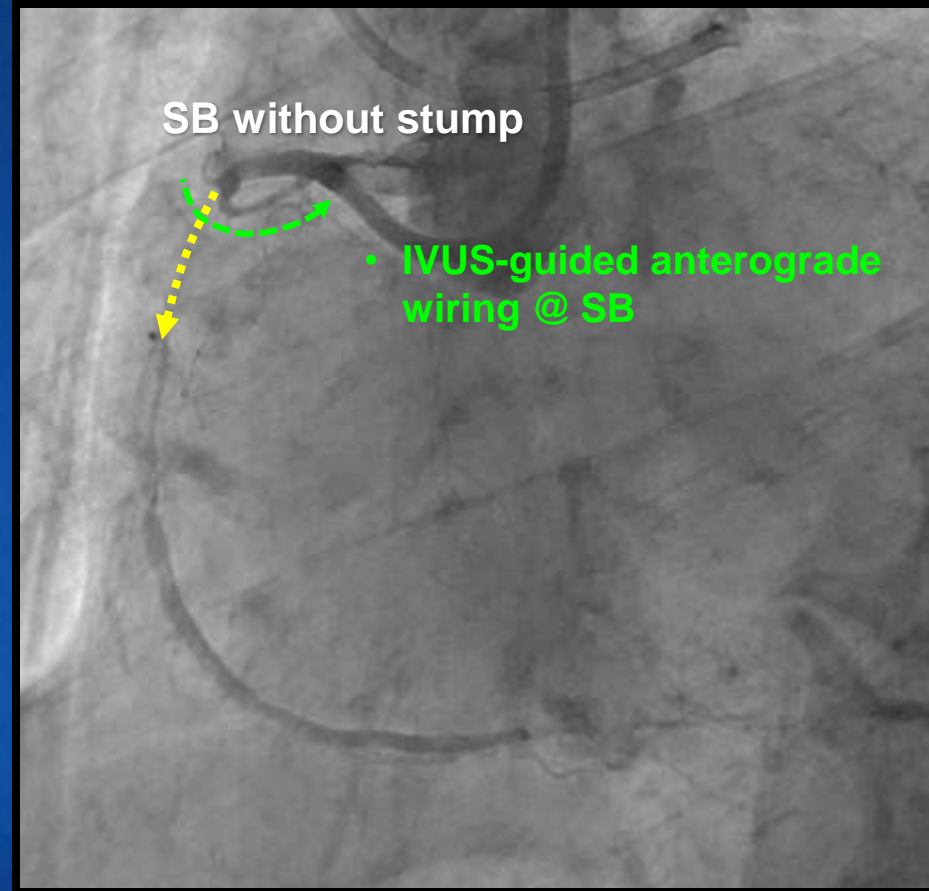
- Risk factors; HTN, dyslipidemia
- Echocardiography
 - RWMA / Reduced LV systolic function (EF=36%)



Start with Anterograde approach



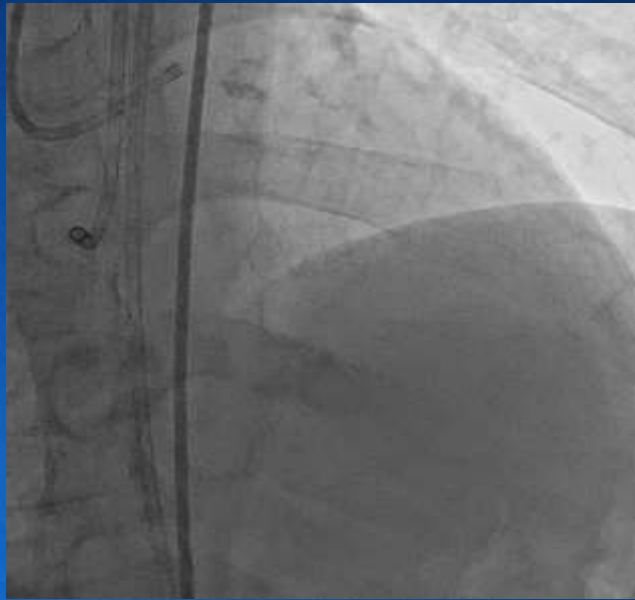
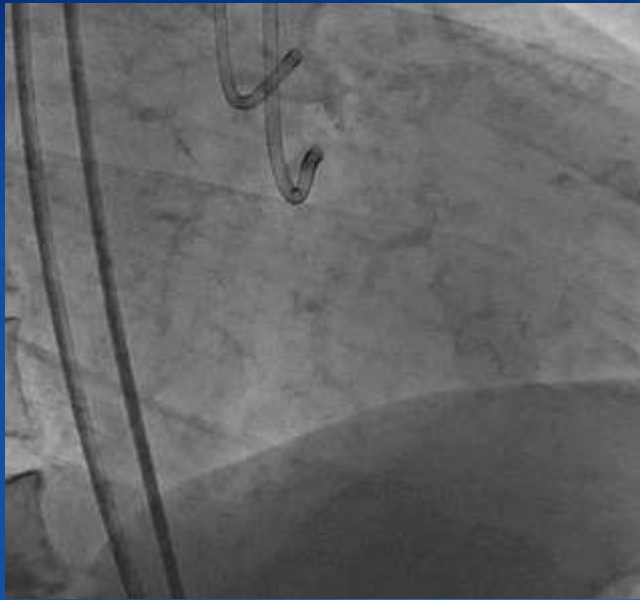
Lt - XB3.5 7Fr
Rt - sAL-1 8Fr



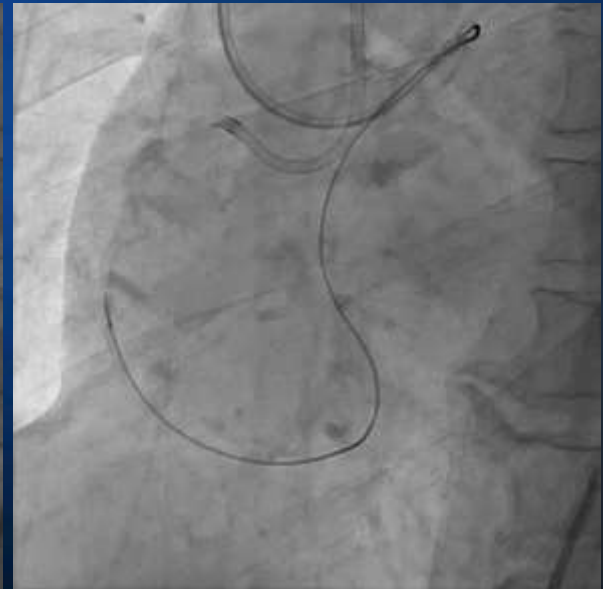
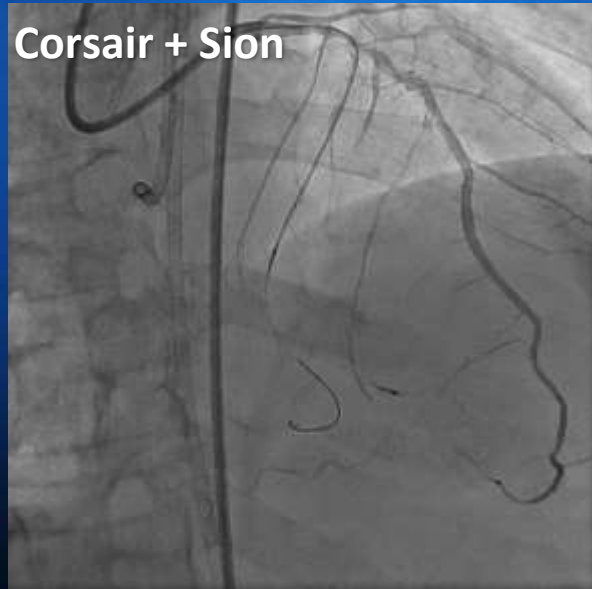
- Failed IVUS-crossing
- Antegrade wiring, failed
- Change into retrograde PCI



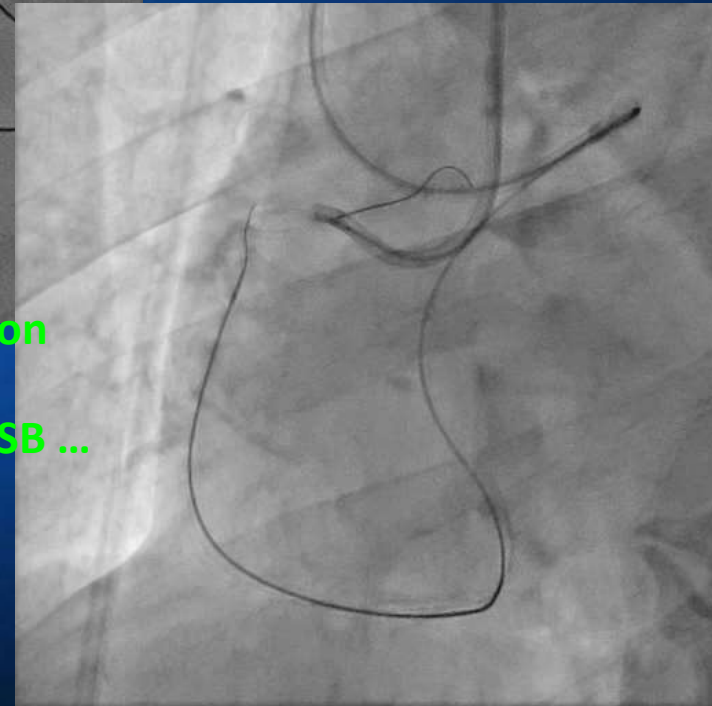
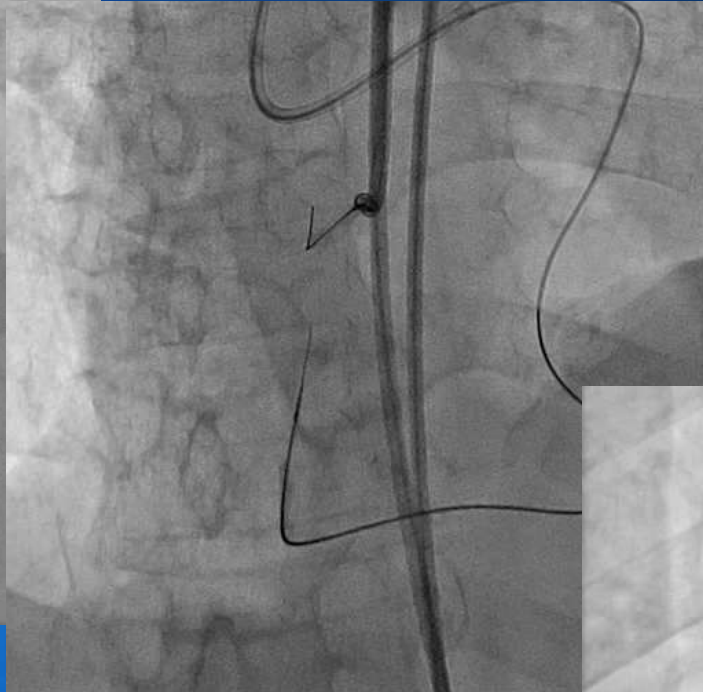
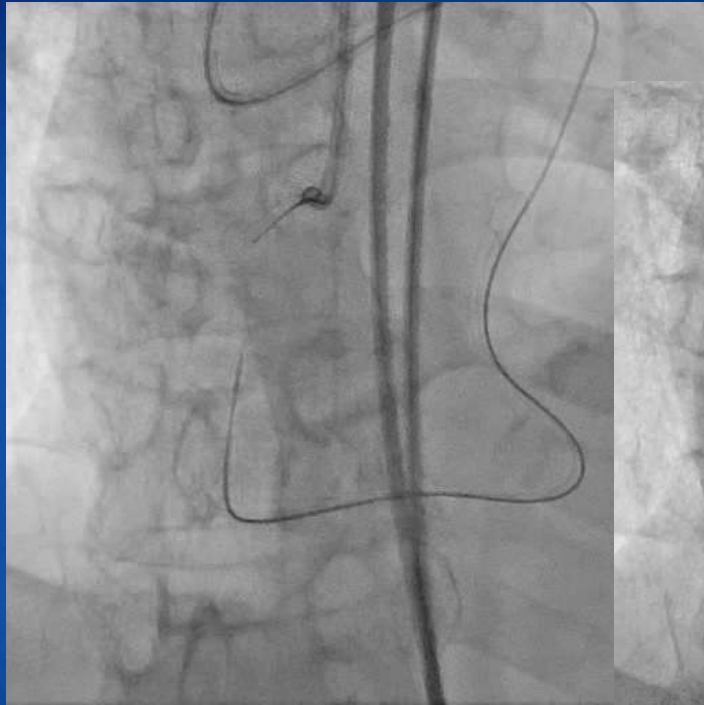
Retrograde approach



Corsair + Sion



Start antegrade preparation

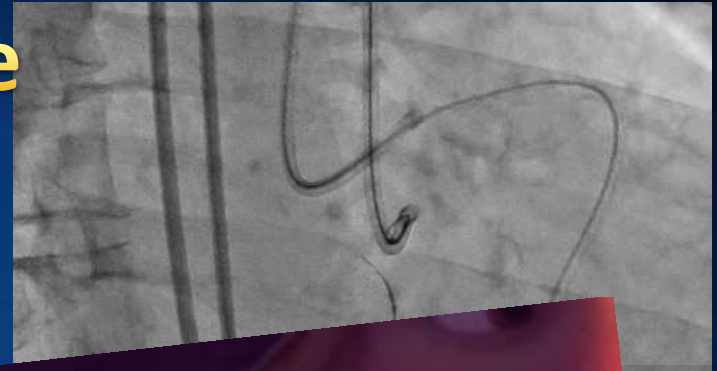
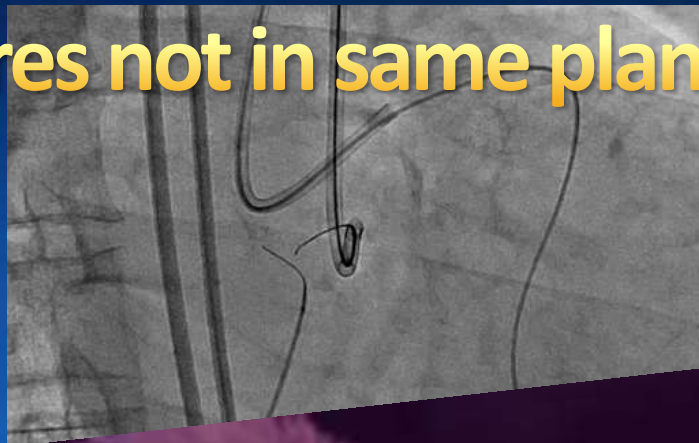


- Difficulty of wire navigation (XT-R, G 1st)
→ Antegrade wire, only to SB ...

- advance retro-wire (XT-R → G 1st)



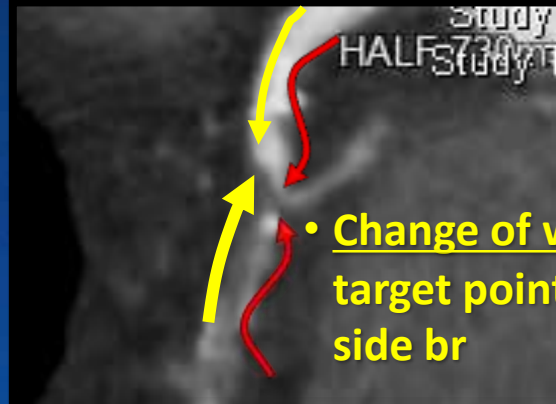
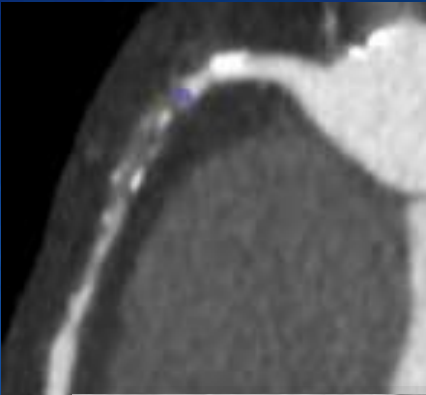
Two wires not in same plane



what
do we
do now?

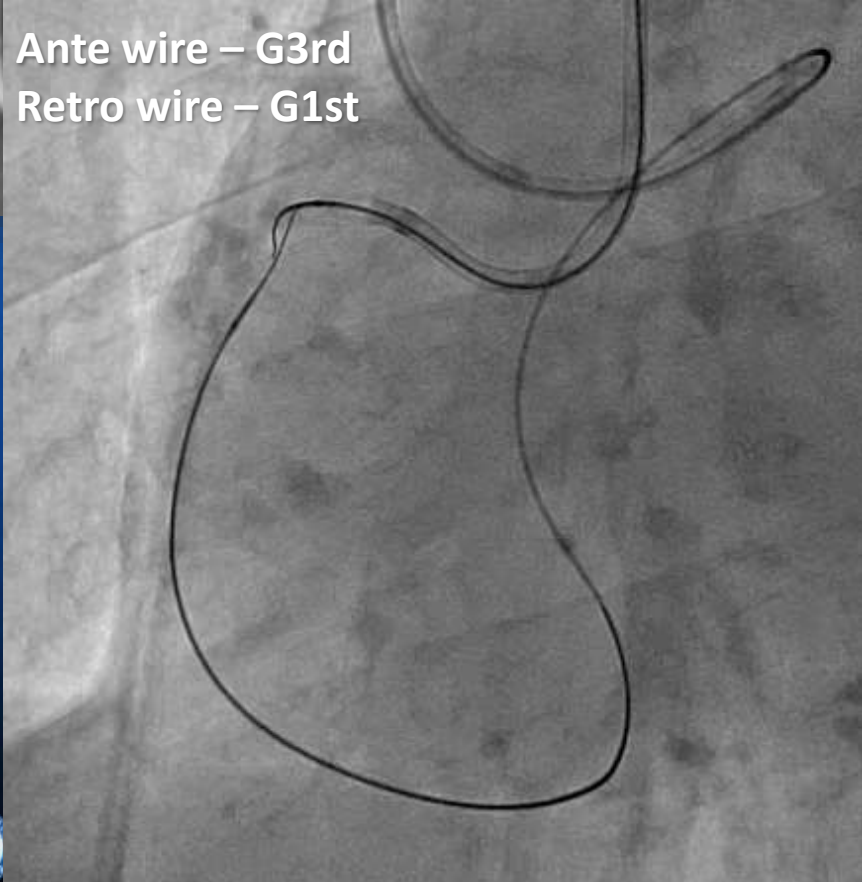


Review of MPR images

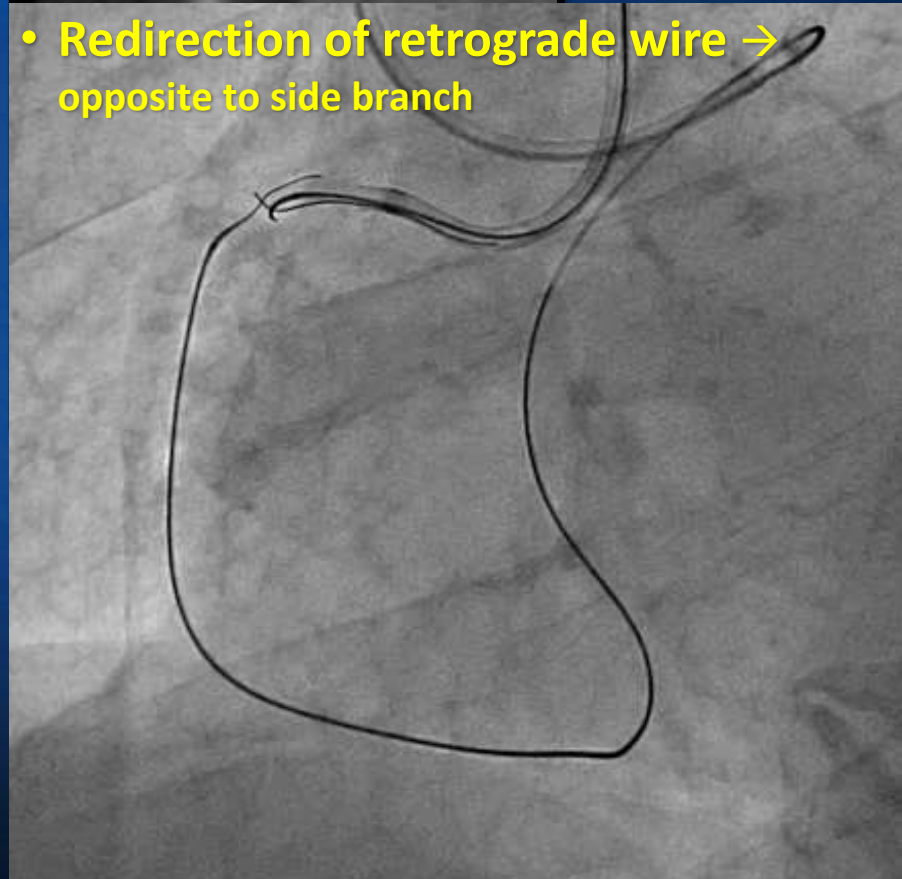


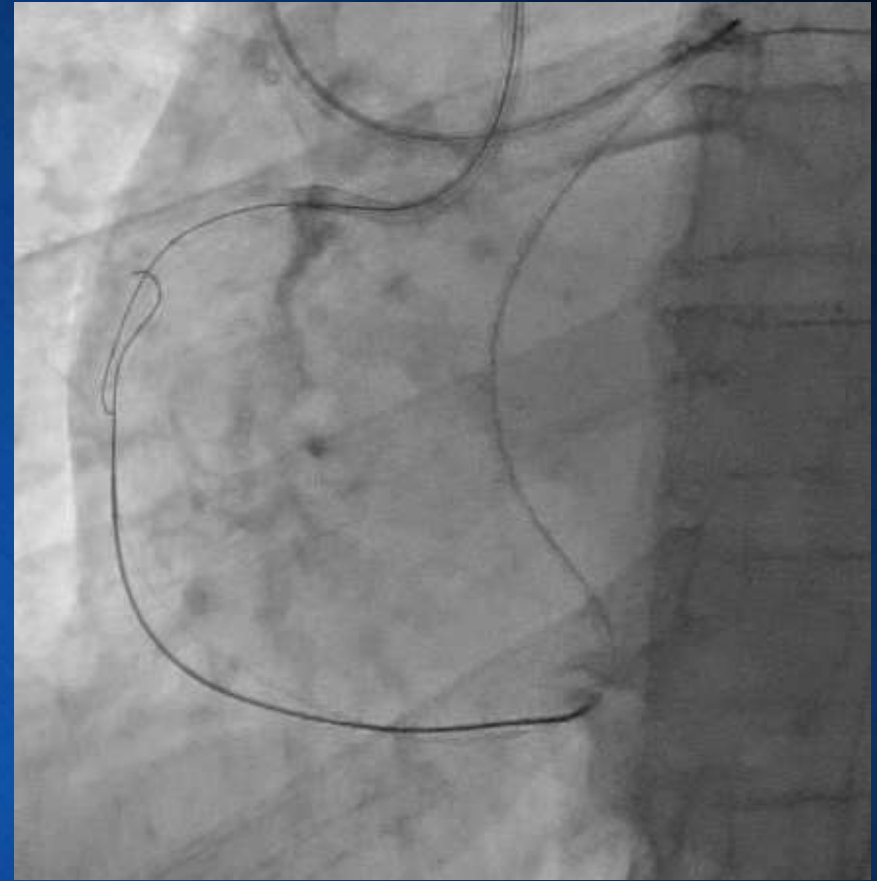
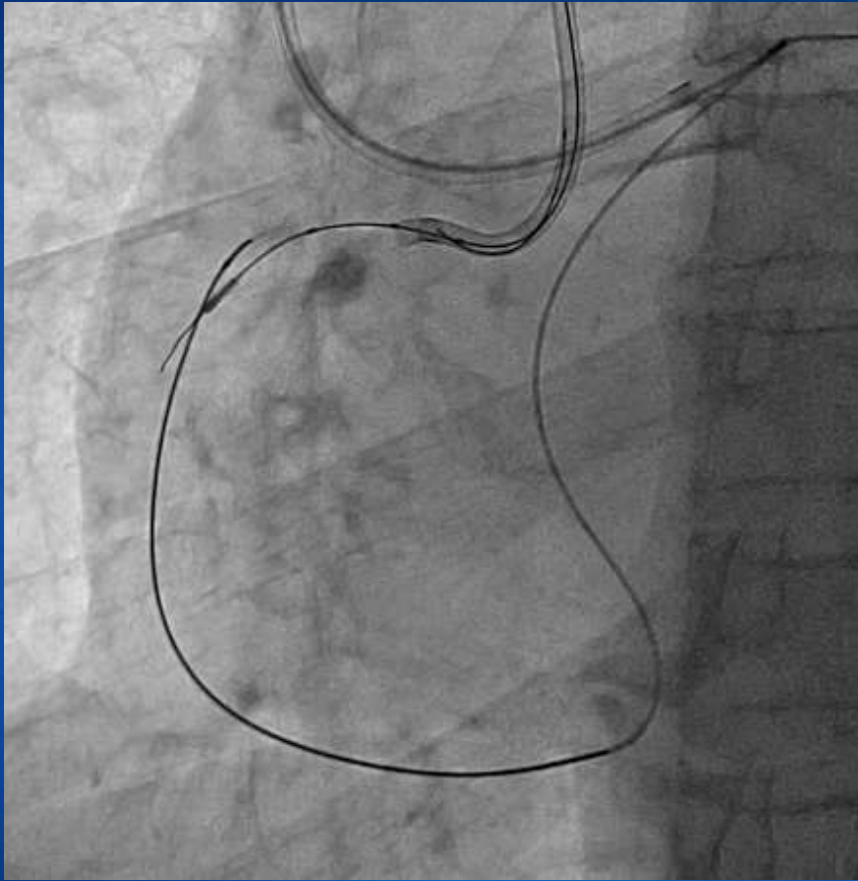
- Change of wire direction
target point → opposite to side br

- Ante wire – G3rd
- Retro wire – G1st



- Redirection of retrograde wire →
opposite to side branch



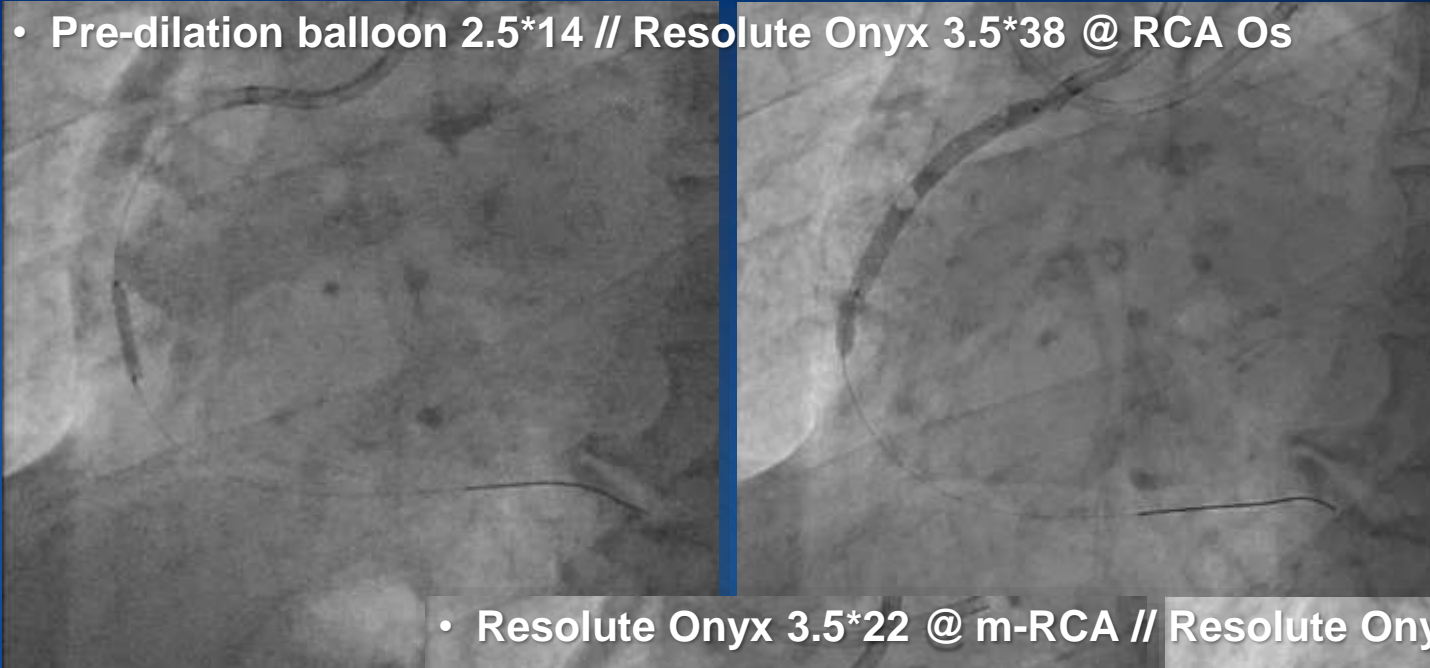


- **Redirection of antegrade wire**
 - Gaia 3rd → Congest pro → UB 3
- **IVUS confirmation of the location of 2 wires**

- **Reverse CART (balloon 2.5x15)**

Pre-dilation & Stenting

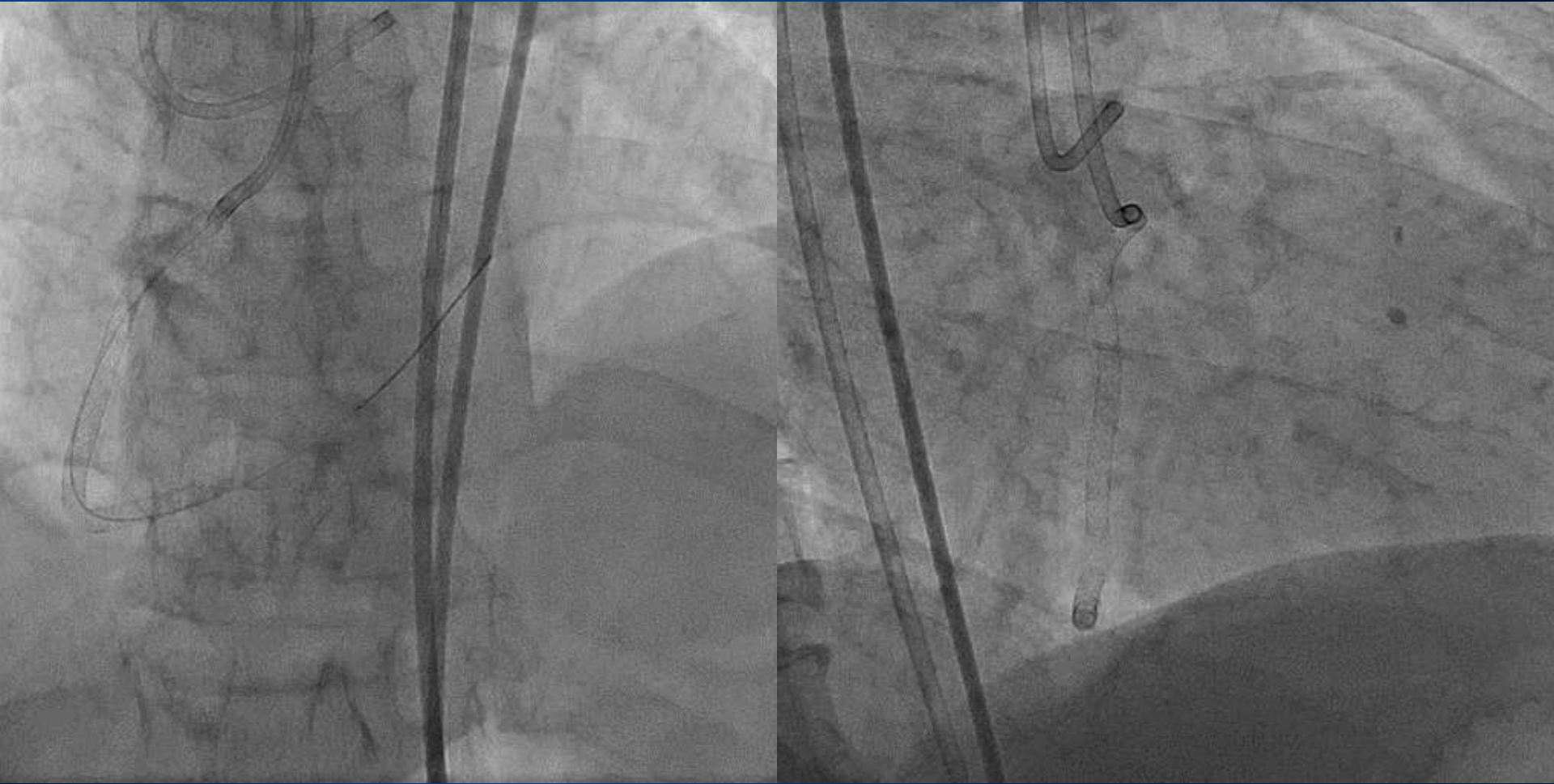
- Pre-dilation balloon 2.5*14 // Resolute Onyx 3.5*38 @ RCA Os



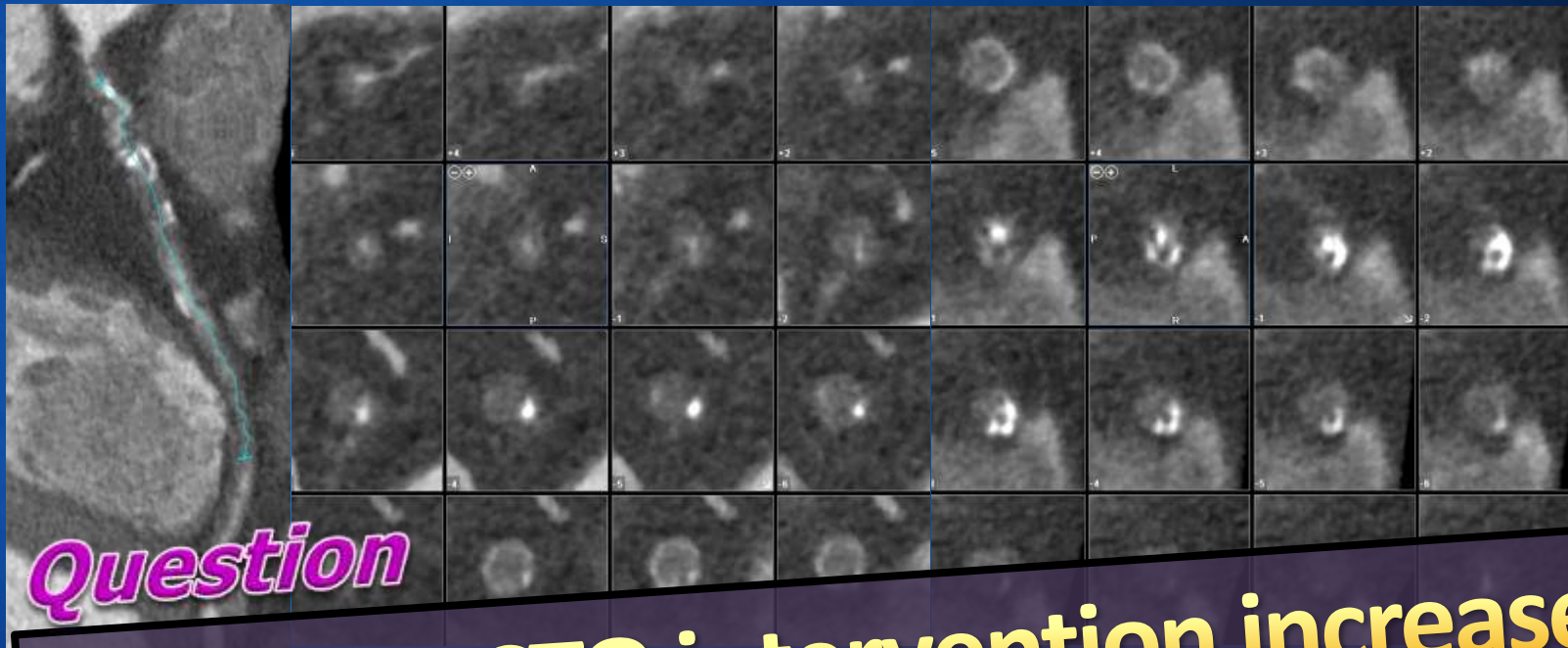
- Resolute Onyx 3.5*22 @ m-RCA // Resolute Onyx 3.0*22 @ d-RCA



Final angiography



4. CT scan can measure vessel diameter & area, similar to IVUS



CT-guide CTO intervention increase success rate?

- Proximal reference diameter: 7.8mm
- Distal reference diameter: 6.2mm
- Vessel diameter in CTO lesion: 7.5mm

Role of CT scan for the successful CTO PCI; a randomized comparison between 3D CT-guided PCI vs. conventional treatment; CT-CTO trial

Objective

- To evaluate whether pre-procedural 3D CT scan can improve the successful recanalization in the treatment of CTO compared with conventional treatment

Primary end points

- Incidence of the successful CTO recanalization between pre-PCI CT scan group vs angio-guide group

Prospective, Open label, Multicenter, Randomized study

A total of 404 patients will be enrolled and randomized

Pre-PCI CT scan group
(n=202)

Control group
(n=202)

ZES
(n=101)

EES
(n=101)

ZES
(n=101)

EES
(n=101)

Evaluation of success rate according to the different strategies

Angiographic follow-up 12 months & Clinical follow-up to 24 months

- Current status, 394 (98%)/404 patients enrolled (Nov. 2018).
→ Final results will be issued in 2019 !



CT Angiography can tell us what CAG cannot show for CTO Intervention !!!

1. CT scan can show the courses of CTO.

CTO length and course, and anatomy of CTO segment and adjacent structures

2. CT scan can provide the detailed information of calcification.

3. CT scan can guide the further CTO procedure.

4. CT scan can measure vessel diameter & area, similar to IVUS. (including plaque characteristics)

- ✓ **CT angiography could be used for the improvement of CTO success** (The randomized CT-CTO trial could tell the exact roles of pre-CTO CT scan for the CTO success.)

With the Love of God, Free Humankind from Disease and Suffering

Severance

**Thank you for
your attention!**

