

Pre-procedural Planning for Complex CTO PCI; *focused on the role of CT scan*

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Disclosure

- received speaker honoraria from ASAHI intecc, Medtronic, Abbott Korea, Boston Sci, and Biotronic Korea

The most important things for the successful CTO

from the lecture by **Yangsoo Jang** @ 2015 CTO camp



1. Prepare CTO angiogram for interventional collaterals before finishing diagnostic angiogram (for every Interventionalists).
2. Review angiogram thoroughly and repeatedly !!!
3. Perform pre-procedural Coronary CT.
4. Perform dual injection for true CTO (single injection only for short lesion and contrast island).

Pre-procedural Planning for success of the complex CTO ?

Pre-procedural CT scan for the complex CTO together with CAG review

10. Be ready for the treatment of the complications during CTO PCI.

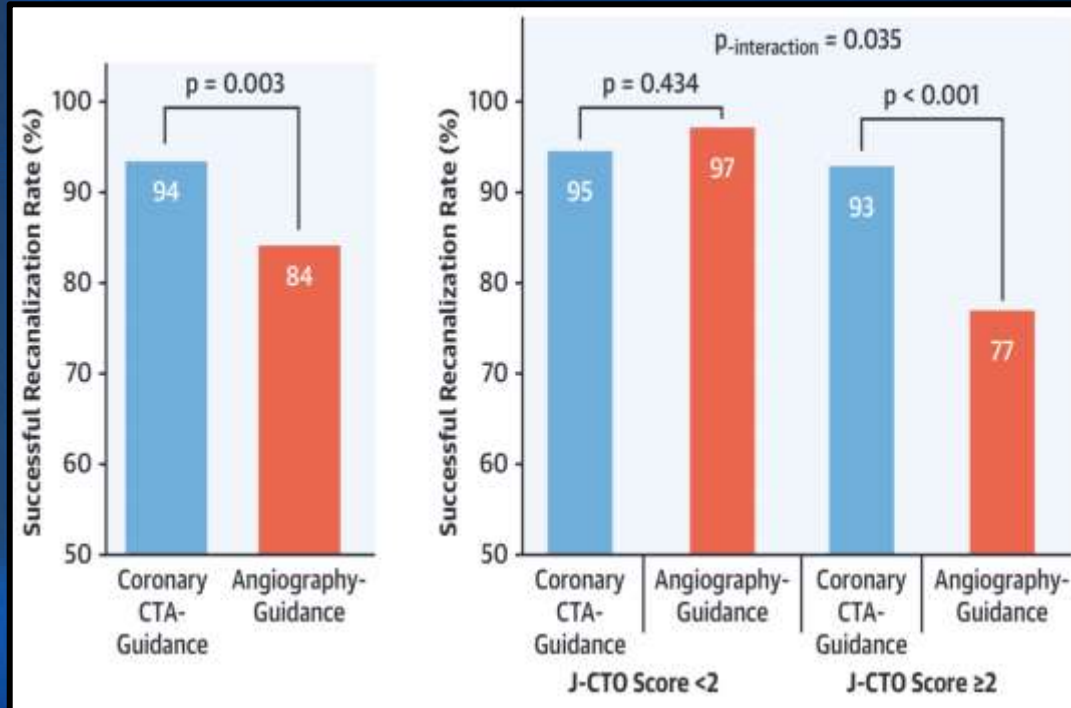
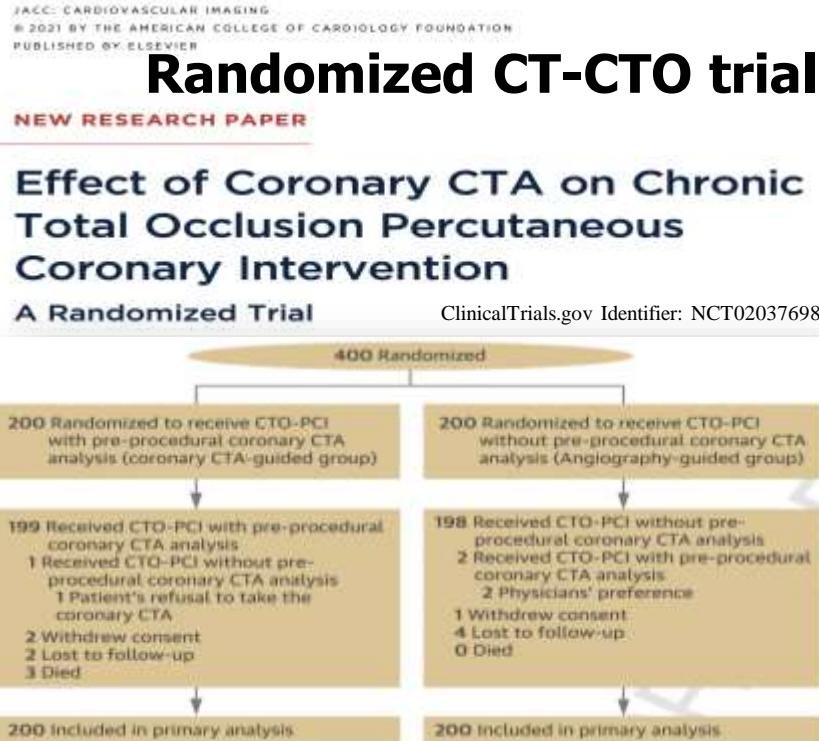


Could **pre-procedural CT scan** improve success rate of the **complex/difficult CTO**?

- Primary endpoint: **Rate of the successful recanalization**

Final TIMI flow grade ≥ 2 and $\leq 30\%$ residual stenosis on the final CAG without death or fatal complications during the procedure requiring emergent operation.

Randomized CT-CTO trial



- Conducted at 12 centers in South Korea
- Hypothesis; **The success rate of CTA guidance would be superior** to the angiography guidance

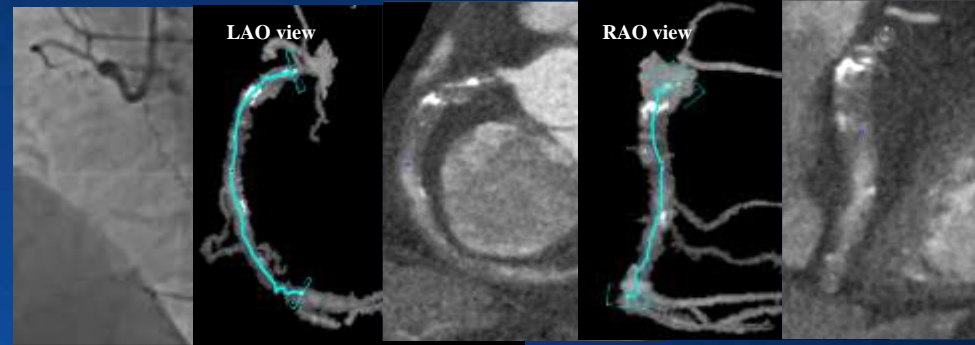
CONCLUSIONS Pre-procedural CT-guidance for CTO resulted in higher success rates with numerically fewer immediate complications such as coronary perforations or PPMI than angiography guidance. Higher success rates were more prominently observed in patients with CTO who had a high J-CTO score than those who did not.



Pre-procedural CT Analyses from CT-CTO trial

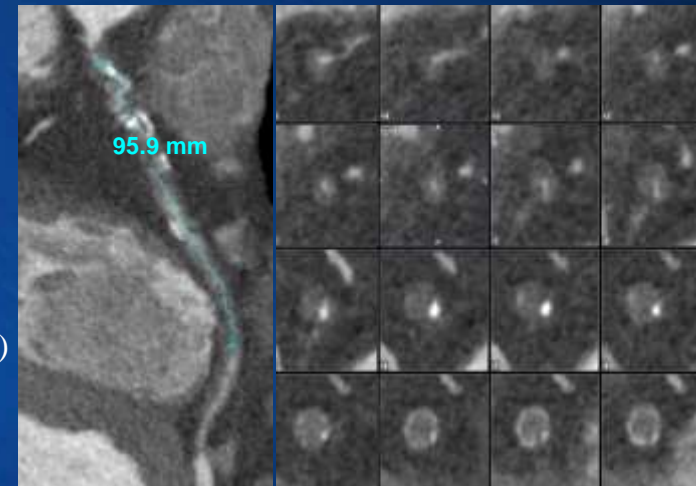
1. Making two orthogonal CT images matching with CAG; 3-D volume rendering and MPR images corresponding to 2 orthogonal views

- **CTO courses** (how CTO course goes & what the hidden route is within CTO segment)
- **Anatomical location associated with side branches**



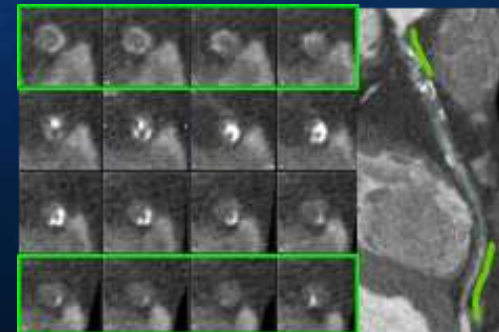
2. Qualitative and quantitative analyses of CTO from MPR images

- 1) CTO length and the shapes of proximal & distal CTO ends
 - 2) Calcification; longitudinal & cross-sectional analyses
 - Maximal cross-sectional extent; $<50\%$ or $\geq 50\%$
 - Length of calcification with cross-sectional extent $\geq 50\%$
 - Calcification shape; semicircular $<180^\circ$, circular $\geq 180^\circ$, or 360° (full moon)
 - Location of calcium on CTO lesion
- “Geographic calcification-mapping”



3. Analyses of the segments around CTO

- Check the size of vessel and lumen and the tortuosity in proximal and distal reference segments



CCTA guidance for complex CTO (J-CTO ≥ 2)

- **Blunt stump or long tortuous CTO;**



Pre-procedural CCTA could show the exact anatomical location related with the adjacent SB and the courses from proximal to distal CTO cap.

- **Reasons for recanalization failure in CT-CTO trial**

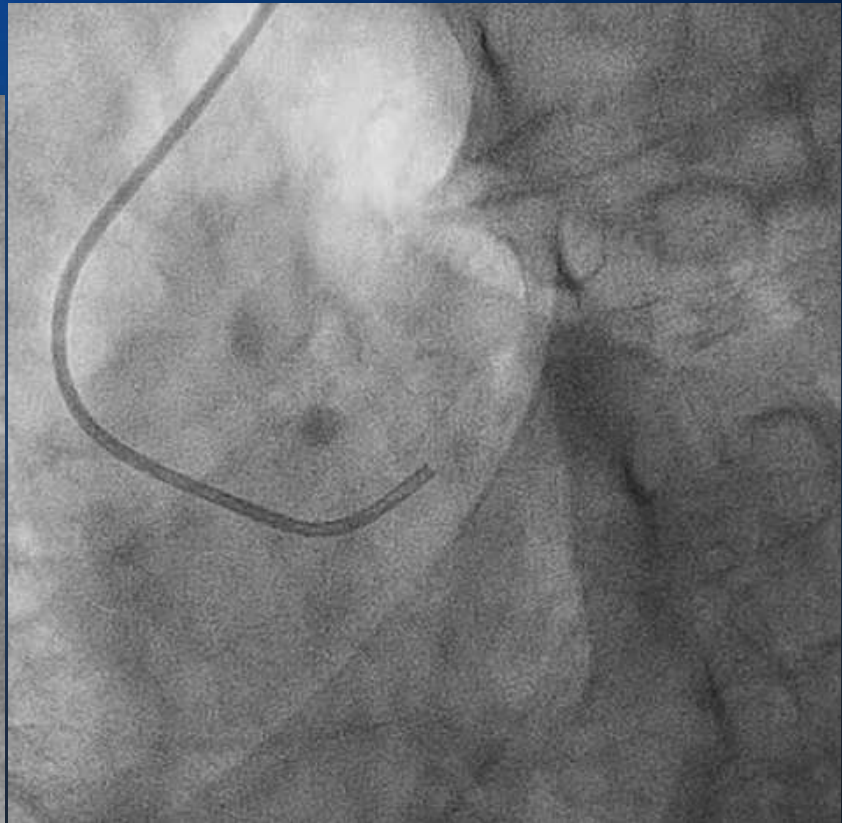
<i>Reasons for failure</i>	CCTA-guidance N=13	Angiography-guidance N=32	<i>P</i>
No. of failed antegrade-only approach	10	17	
Wiring to false lumen and fail to enter to true lumen	7 (70)	8 (47)	0.247
Failure to advance the cap or the CTO segment	1 (10)	2 (12)	0.260
Failure to enter the cap due to anatomical ambiguity	0	6 (35)	0.033
Failure to achieve TIMI grade flow ≥ 2 after stenting	2 (20)	1 (6)	0.888

JACC Cardiovasc Imaging;14:1993-2004

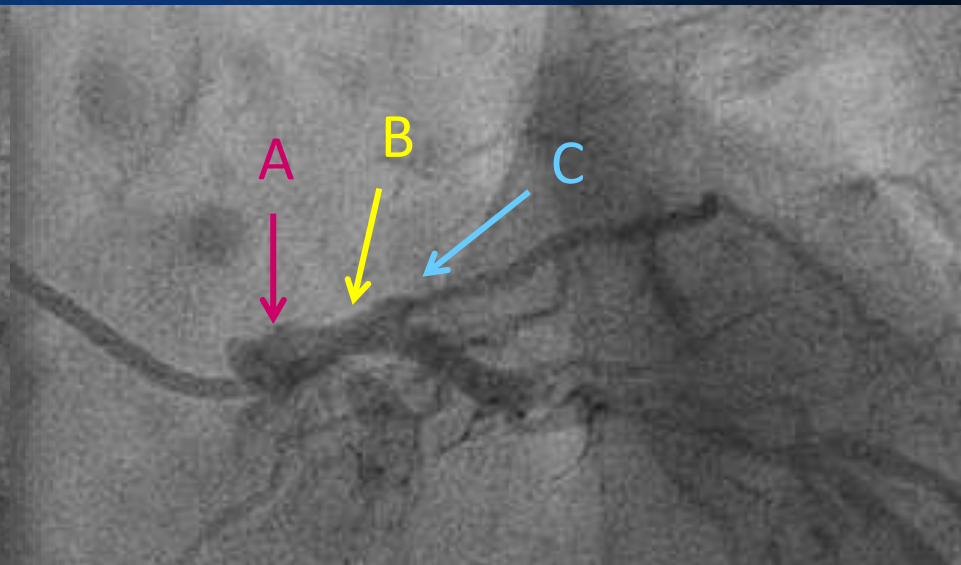
Case 1: Aorto-ostial CTO, invisible coronary artery ostium from CAG

M/61, LVEF 40%

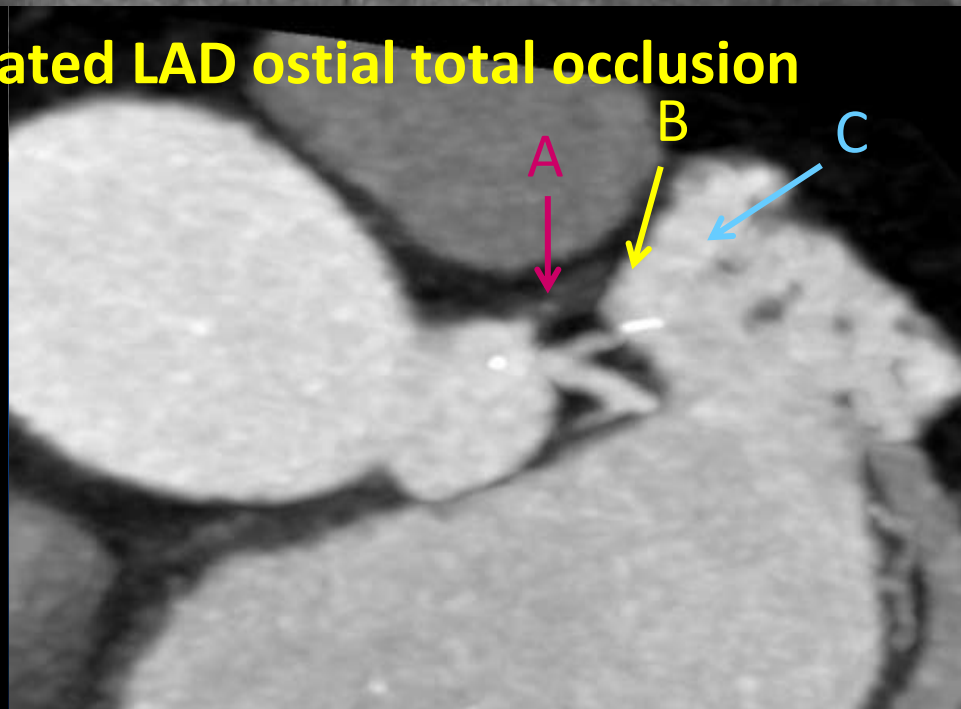
Where is LAD ostium?
Ambiguous CTO anatomy



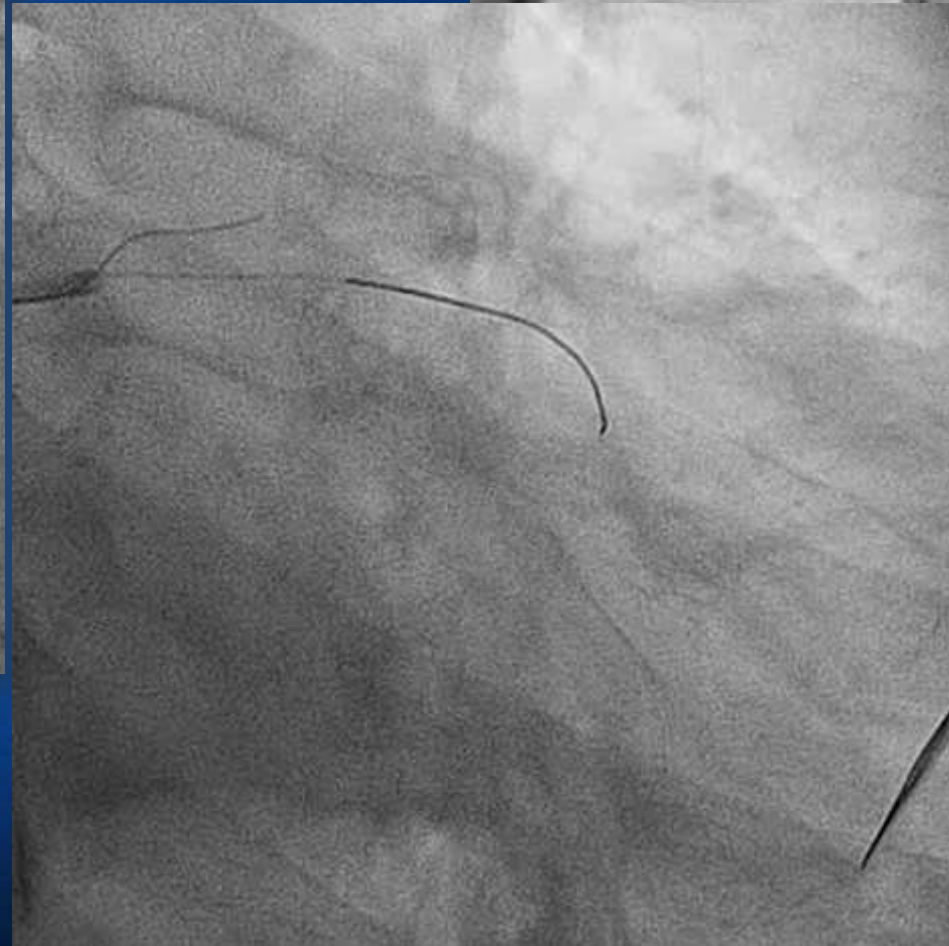
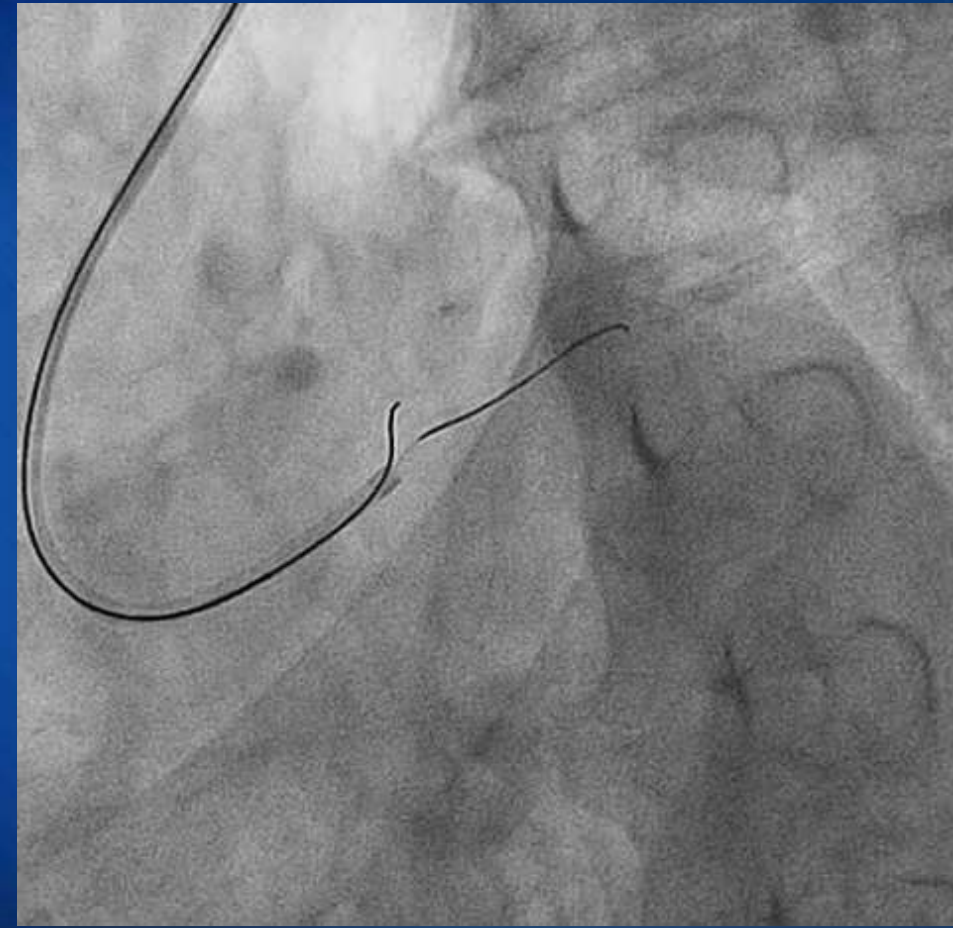
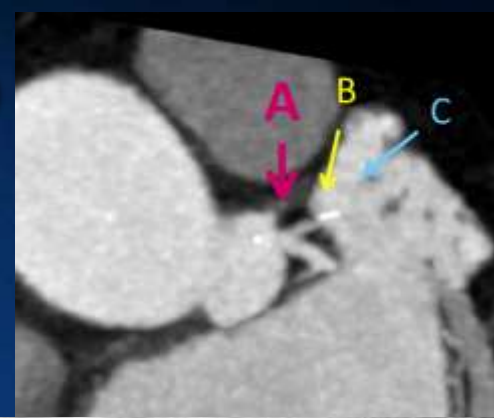
Where is the LAD ostium ?



CT revealed nearly hidden separated LAD ostial total occlusion



CT-guided wire-puncture of LAD-Os CTO



- LAD: Ultimate 3 → Fielder XT → Miracle 6
- LCX: Sion



Final CAG after stenting



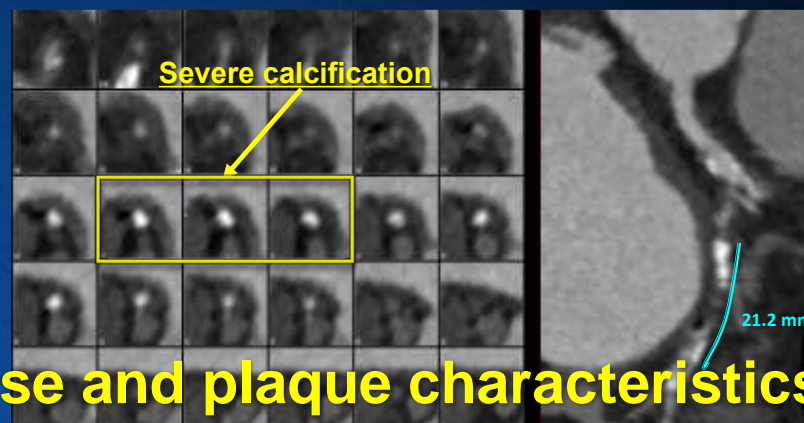
✓ **Pre-CTO CT scan would be helpful to identify the ambiguous CTO entry (similar role like wiring under IVUS).**

CCTA guidance for complex CTO (J-CTO ≥ 2)

○ CTO with severe calcification;



Calcification arc 180-360° & CSA $\geq 50\%$



- **CCTA \rightarrow visualizing CTO course and plaque characteristics (calcification geometry)**

Be helpful for navigating & selecting the proper wires and devices

Reasons for recanalization failure in CT-CTO trial	CCTA-guidance N=13	Angiography-guidance N=32	<i>P</i>
No. of failed hybrid approach (antegrade & retrograde)	3	15	
Failure to cross collaterals with retrograde wire	3 (100)	7 (47)	0.090
Failure to enter distal cap with retrograde wire	0	2 (13)	0.502
Failure to deliver the supporting device	0	1 (7)	0.645
Failure to meet both wires on the same plane	0	4 (27)	0.310
Failure to achieve TIMI grade flow ≥ 2 after stenting	0	1 (7)	0.645



Case 2: Retried RCA-CTO, CT-guided CTO

- M/48 ... 178cm / 84Kg / 2.03m²
- Dx ... stable angina, Previously failed RCA-CTO
- Risk factor ... CVA (Mar 2022), current –smoker
- TTE (2022.03) : RWMA (RCA territory), EF 61%

Previous CAG (Aug 2022)

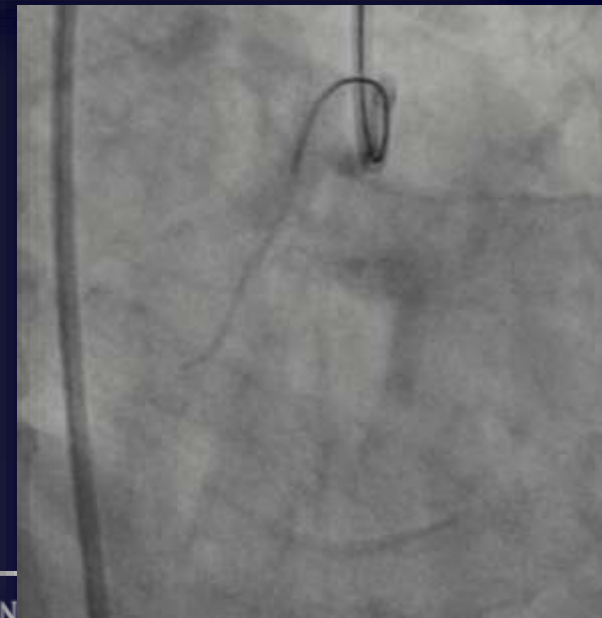
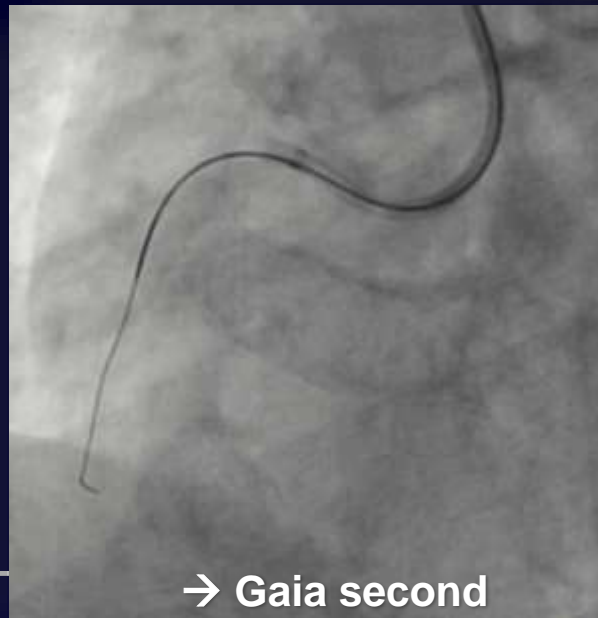


Ad hoc RCA-CTO PCI (2022.08.01)

Rt. CFA c 7 Fr sheath
G/C : SAL 7-1 SH



Corsair Pro + XT-A



→ Gaia second

Pre-procedural Planning for Retry of RCA-CTO

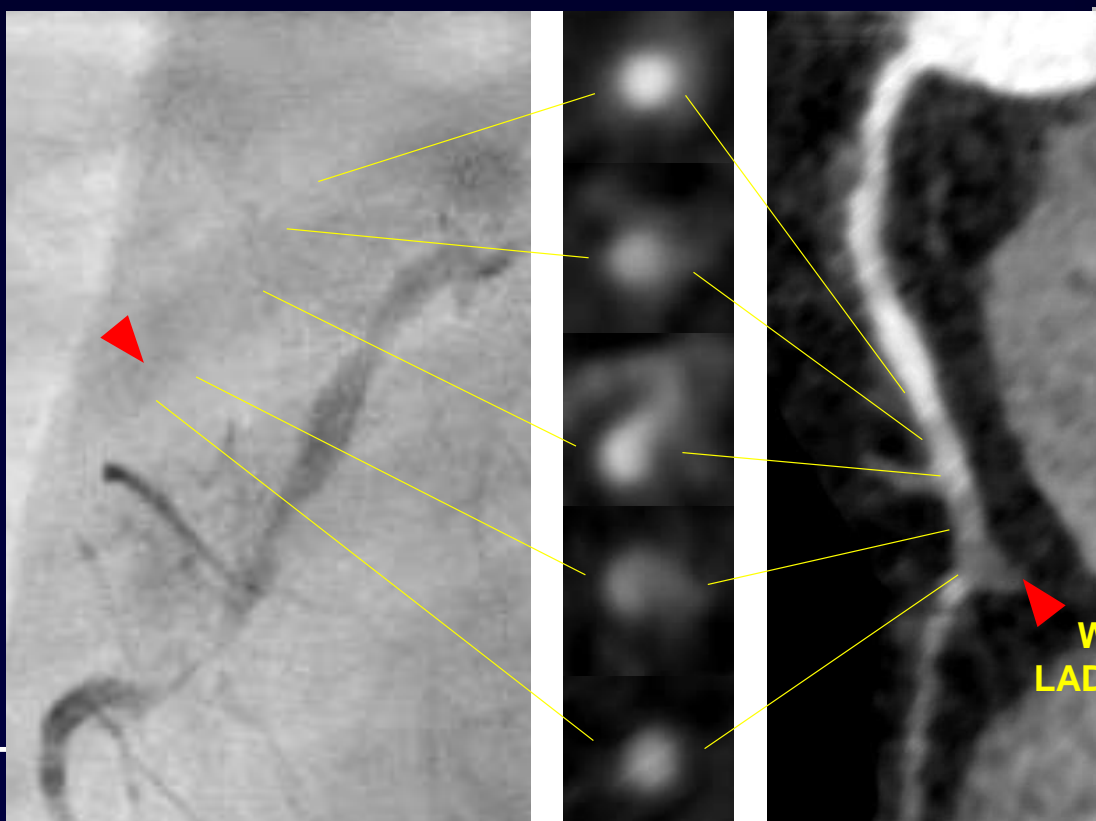
LAO 40



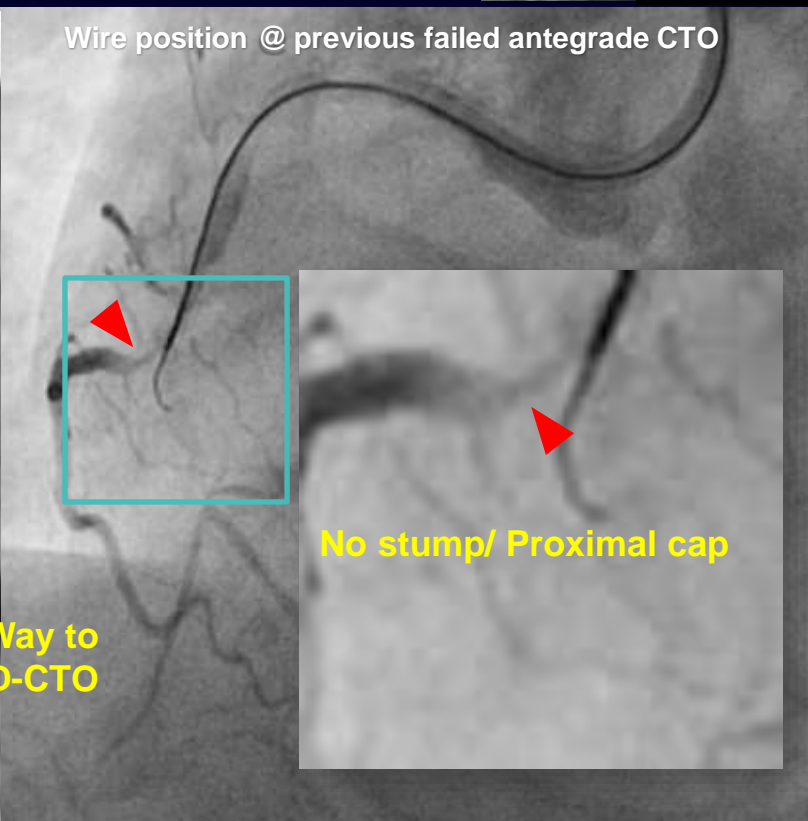
RAO 30



CTO lesion: 15.5 mm



Wire position @ previous failed antegrade CTO



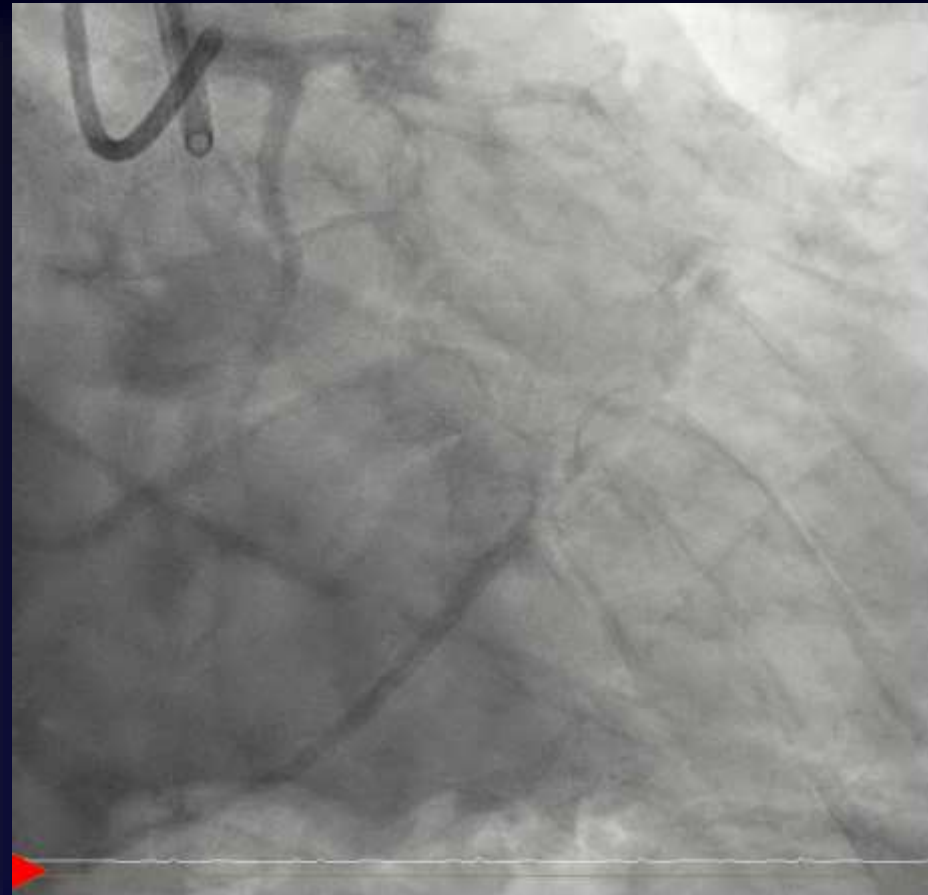
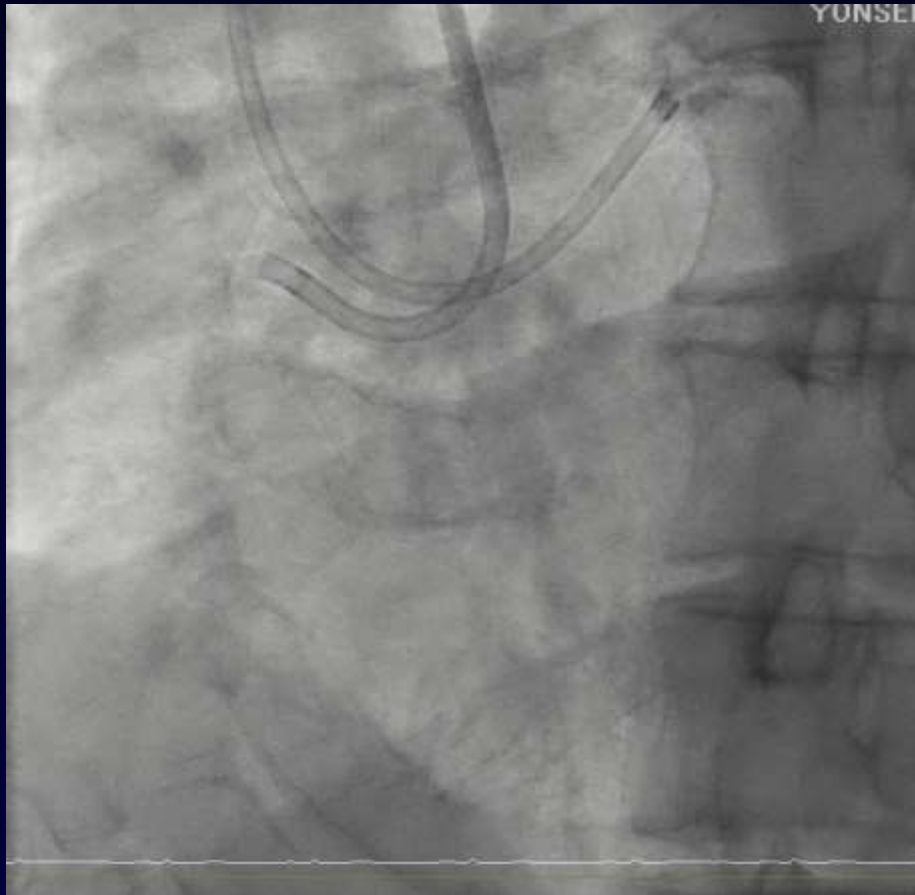
Way to LAD-CTO

No stump/ Proximal cap

Retry of previously failed RCA-CTO (2022.10.13)

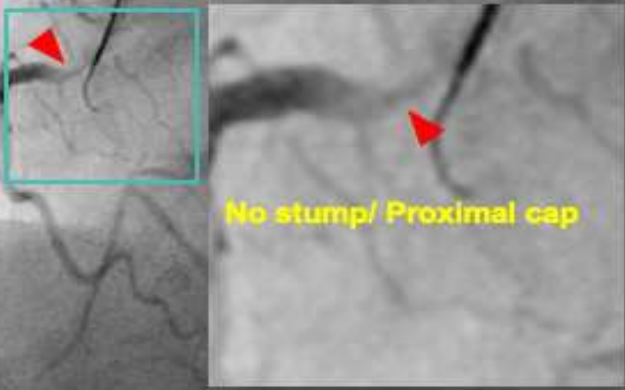
Antegrade : Rt. CFA c 8 Fr sheath : SAL 8-1 SH

Retrograde : Lt. CFA c 7 Fr sheath : SPB 7-3.5 SH

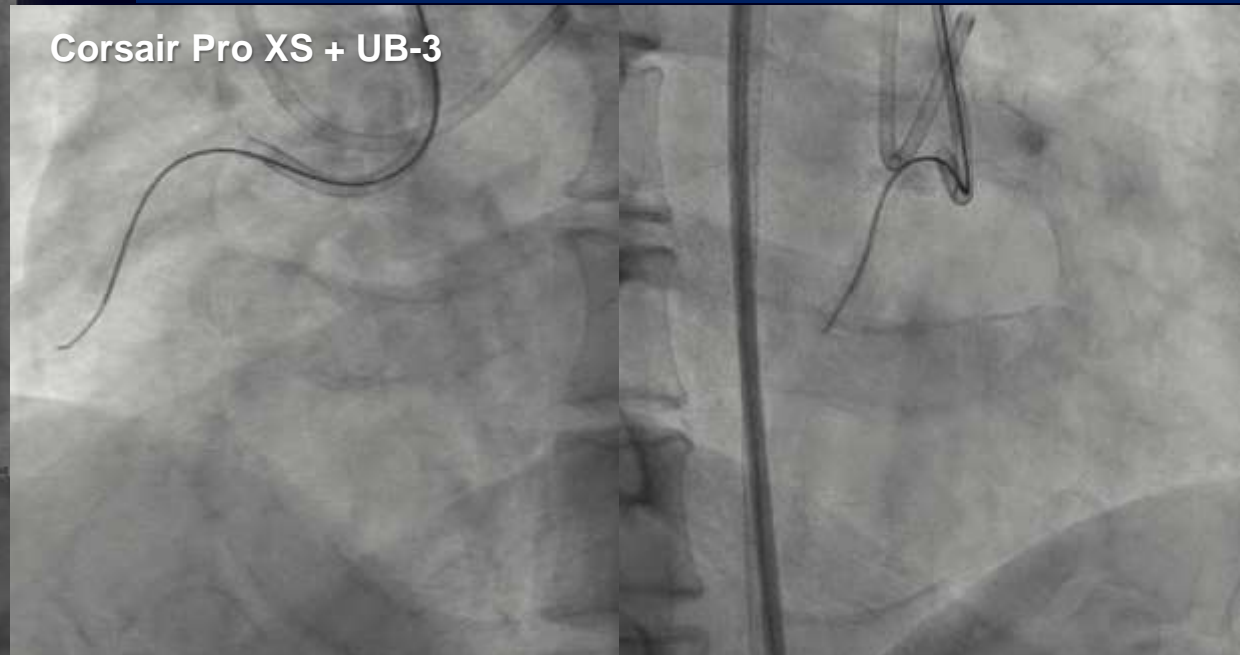


Wire position @ previous failed antegrade CTO

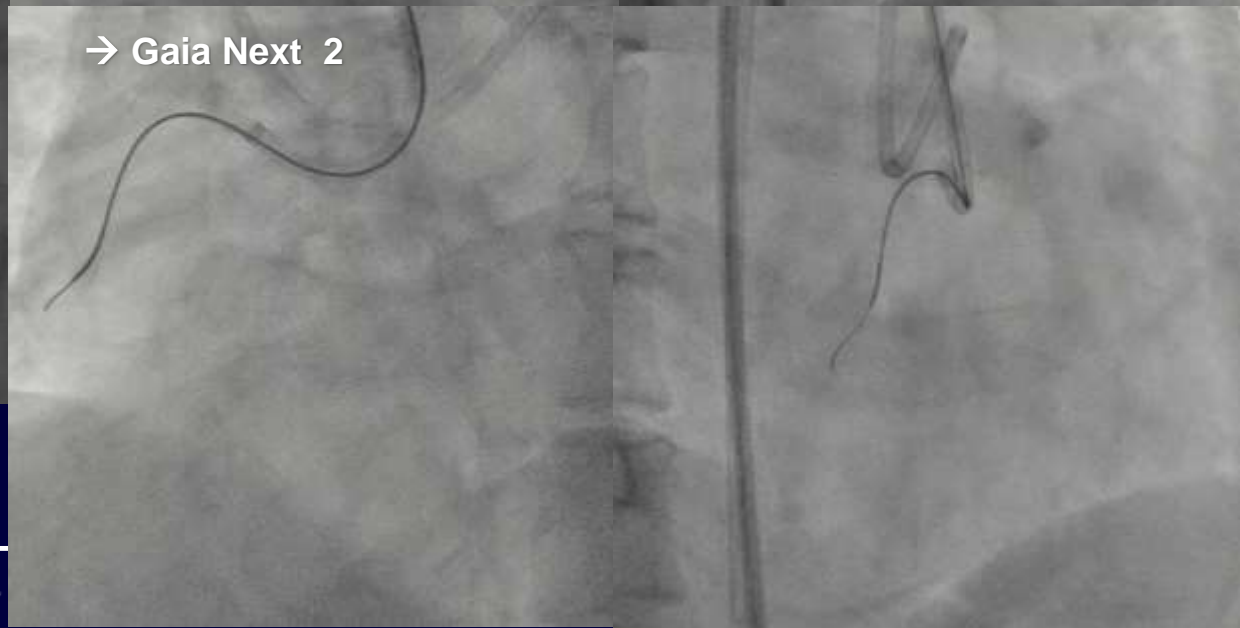
Retry of previously failed RCA-CTO Antegrade preparation



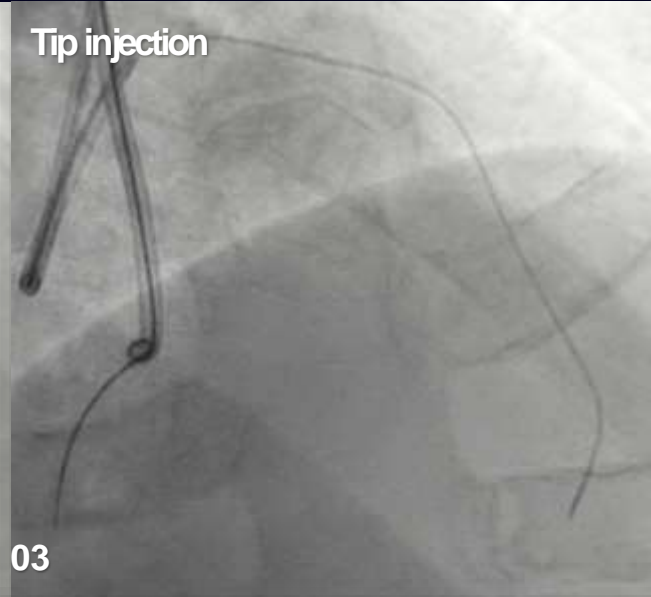
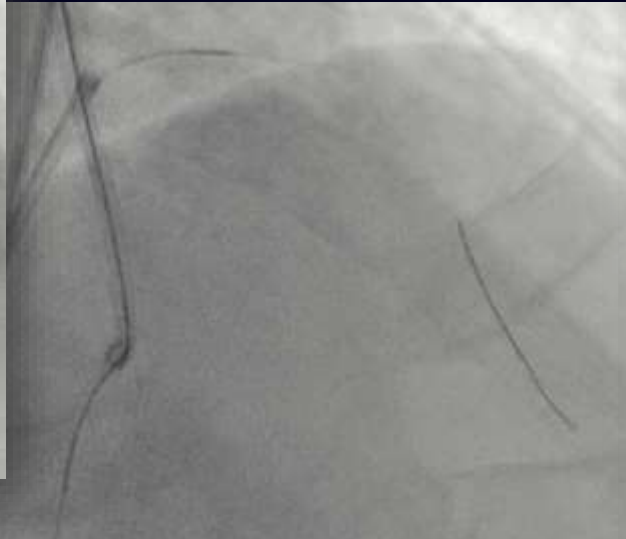
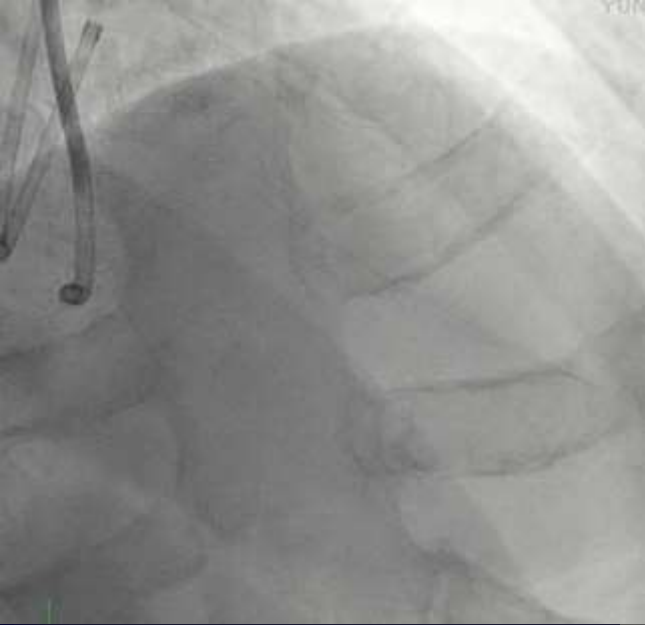
Corsair Pro XS + UB-3



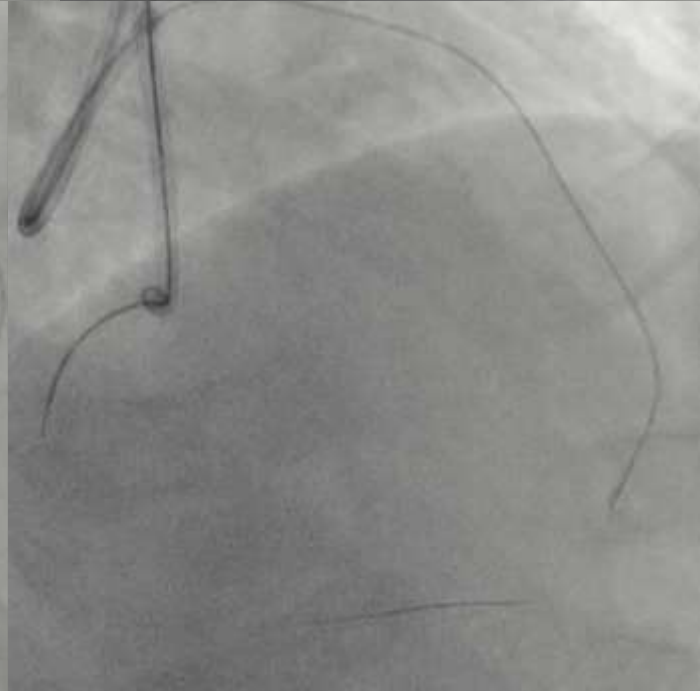
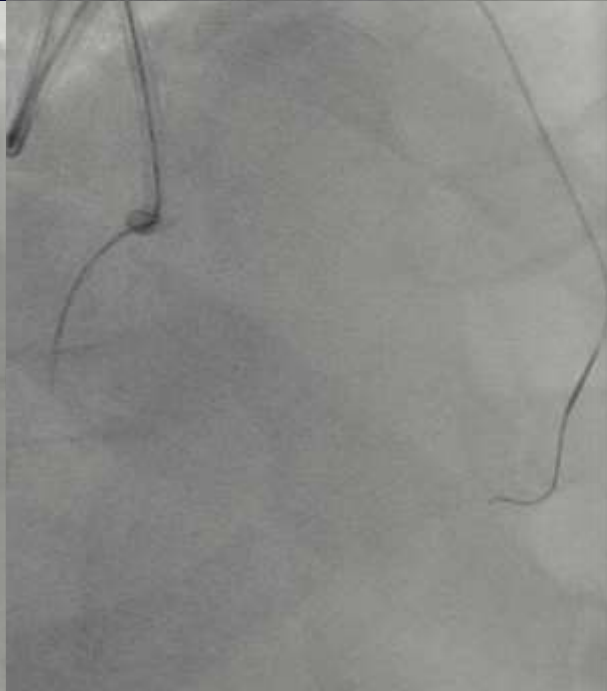
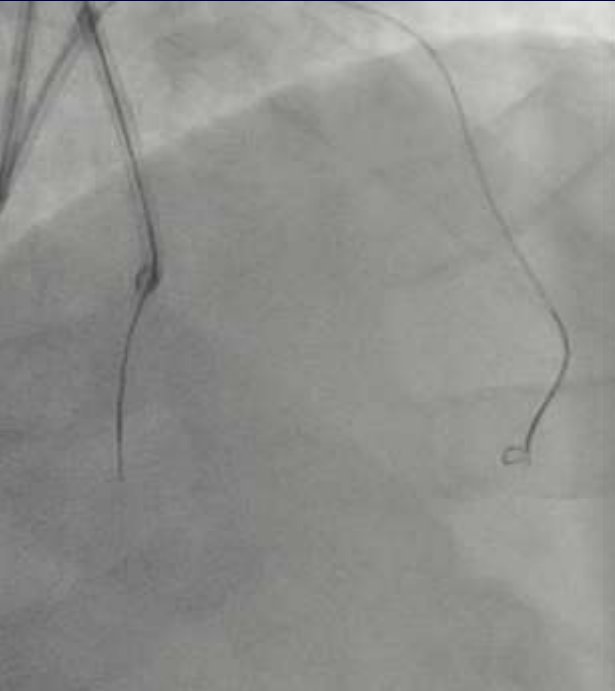
→ Gaia Next 2



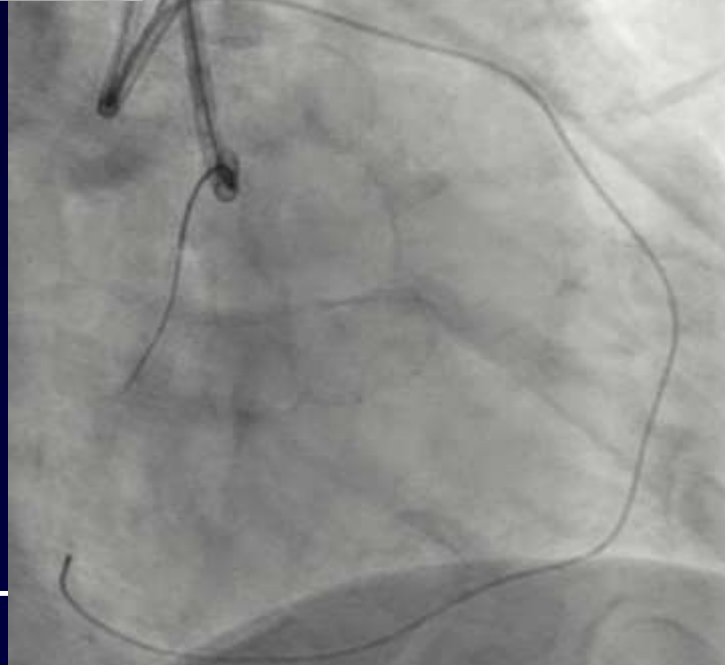
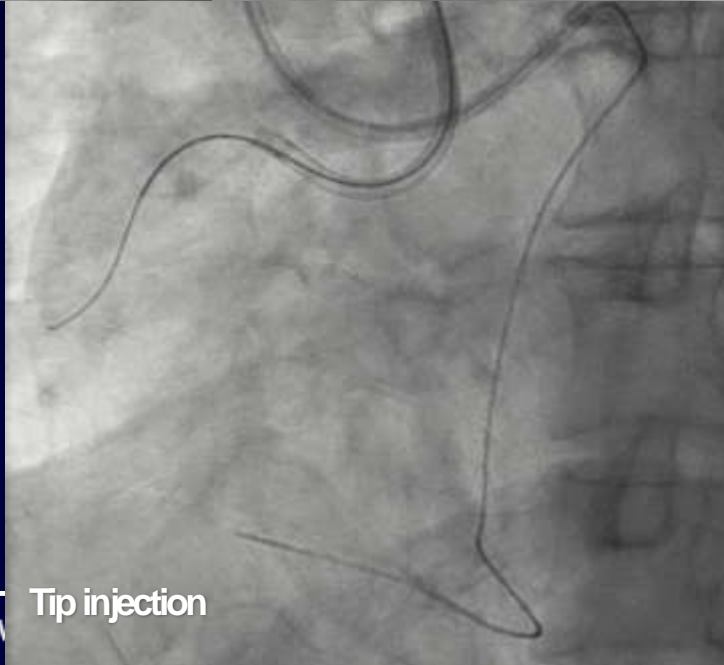
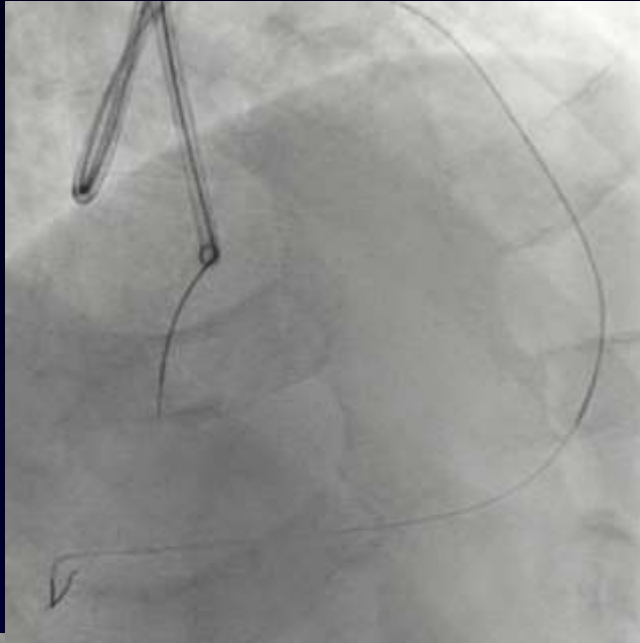
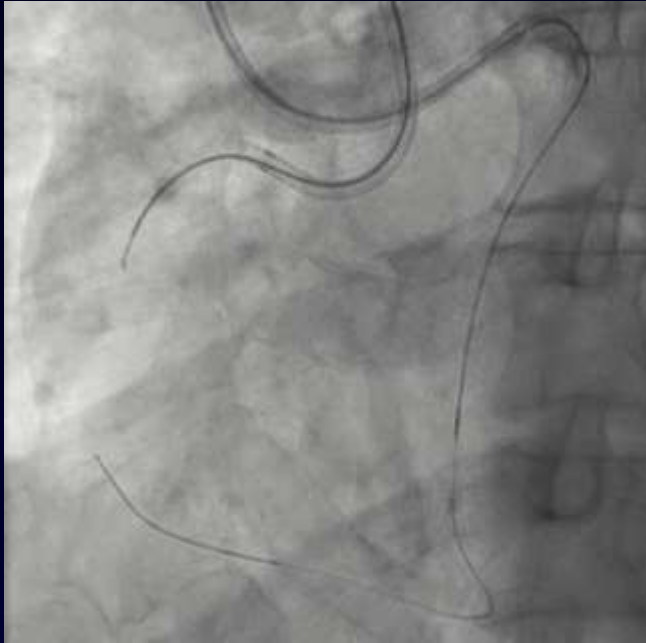
Retrograde; Septal wiring



Corsair Pro XS: Runthrough → SUOH 03



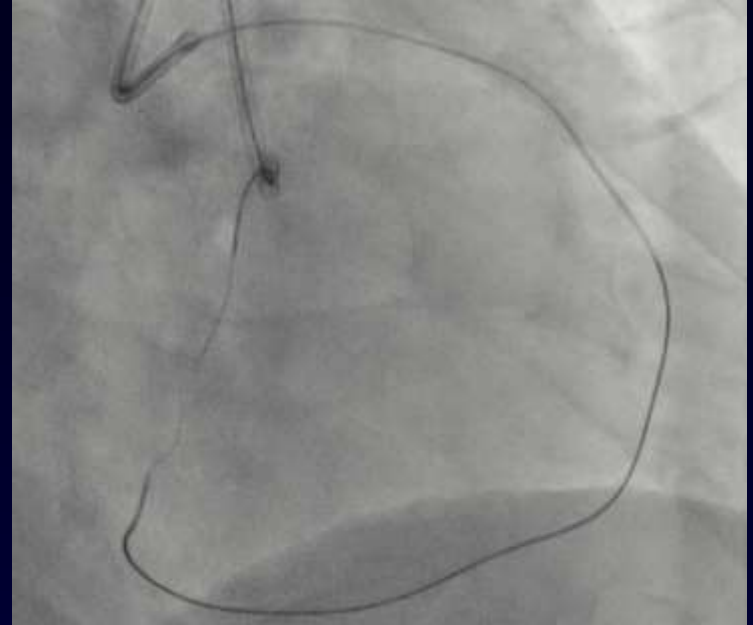
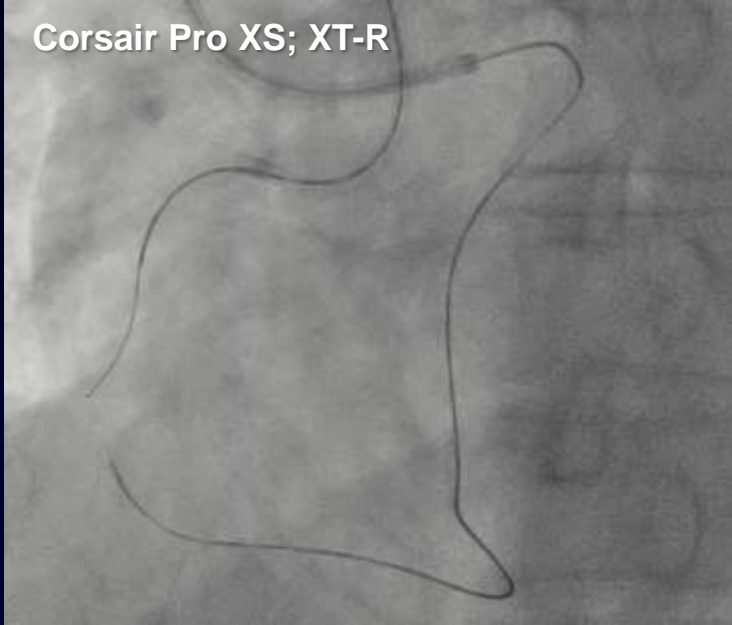
Retrograde CTO; Advancement of retrograde Corsair



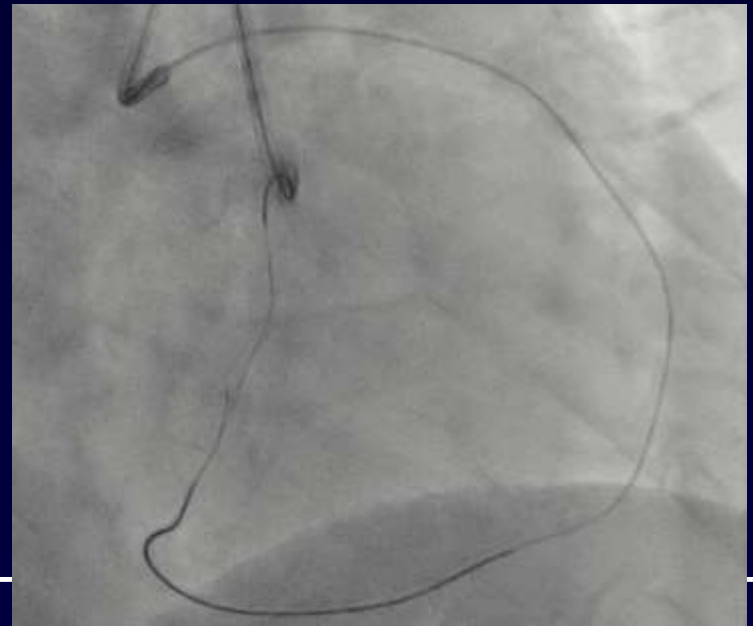
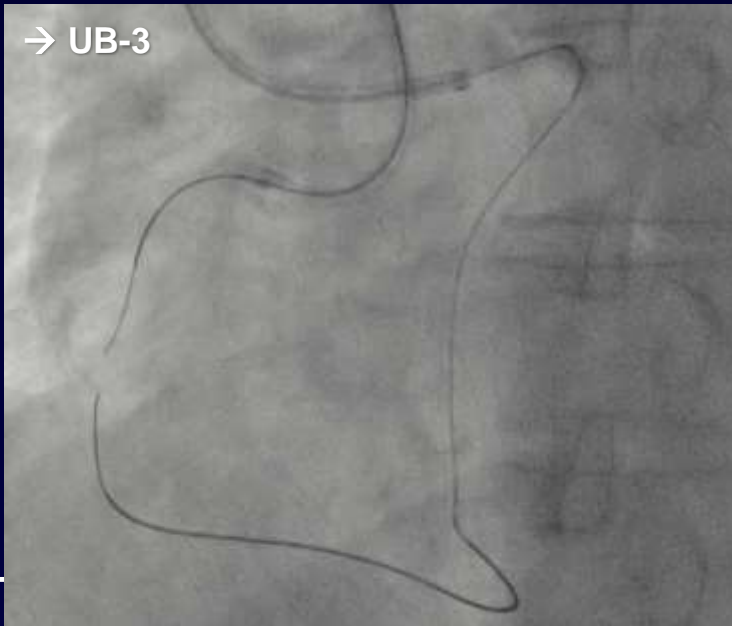
Tip injection

Retrograde CTO; Retrograde wiring

Corsair Pro XS; XT-R

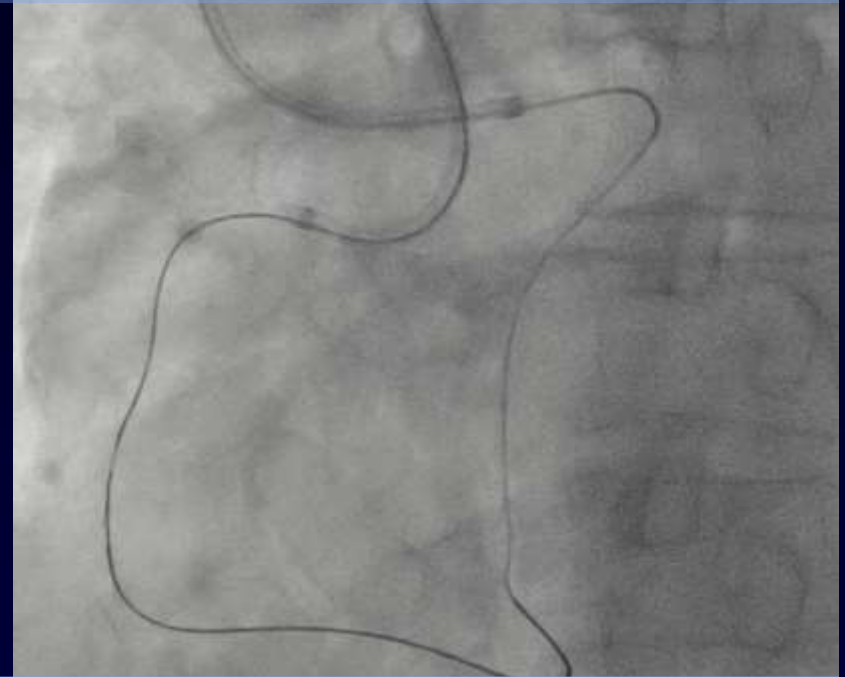
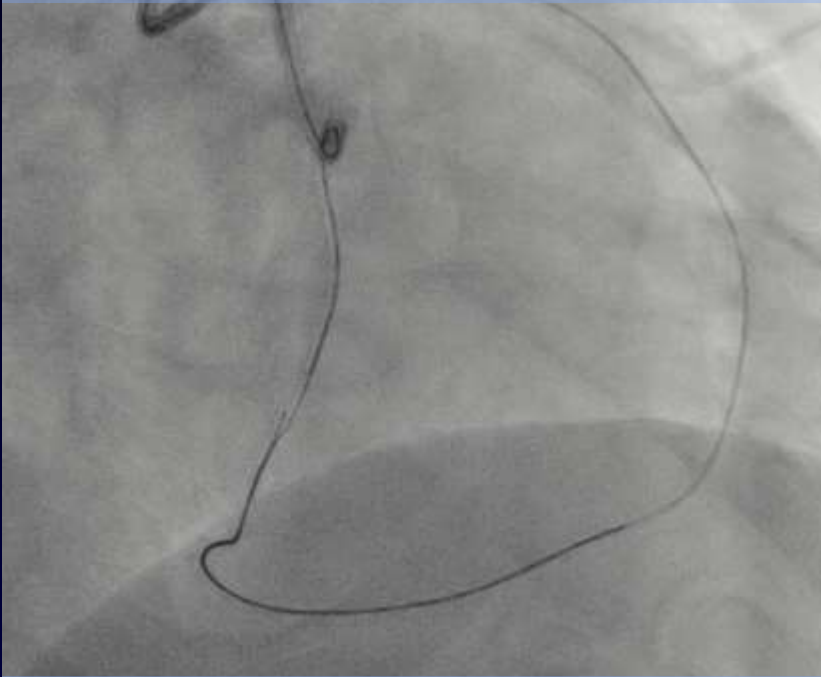


→ UB-3



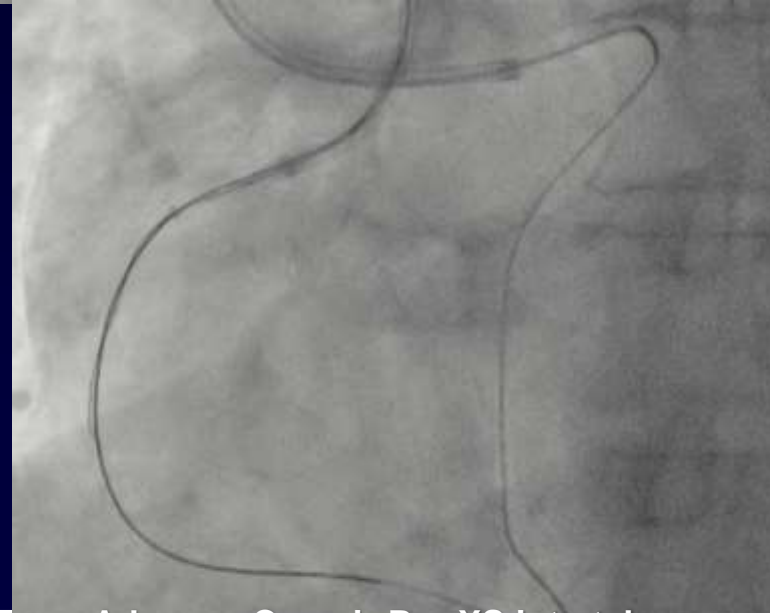
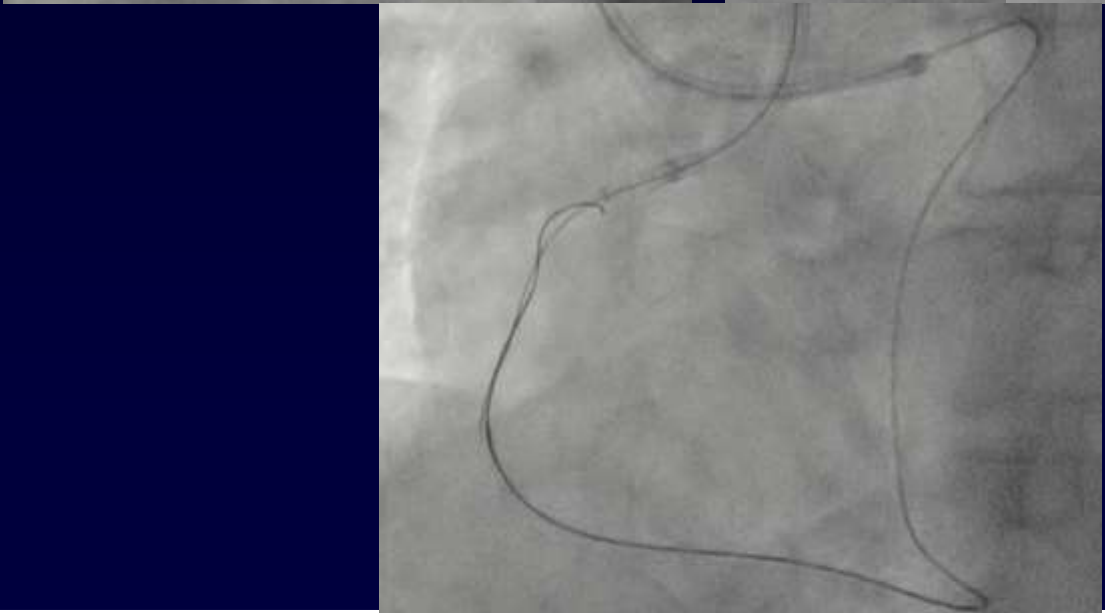
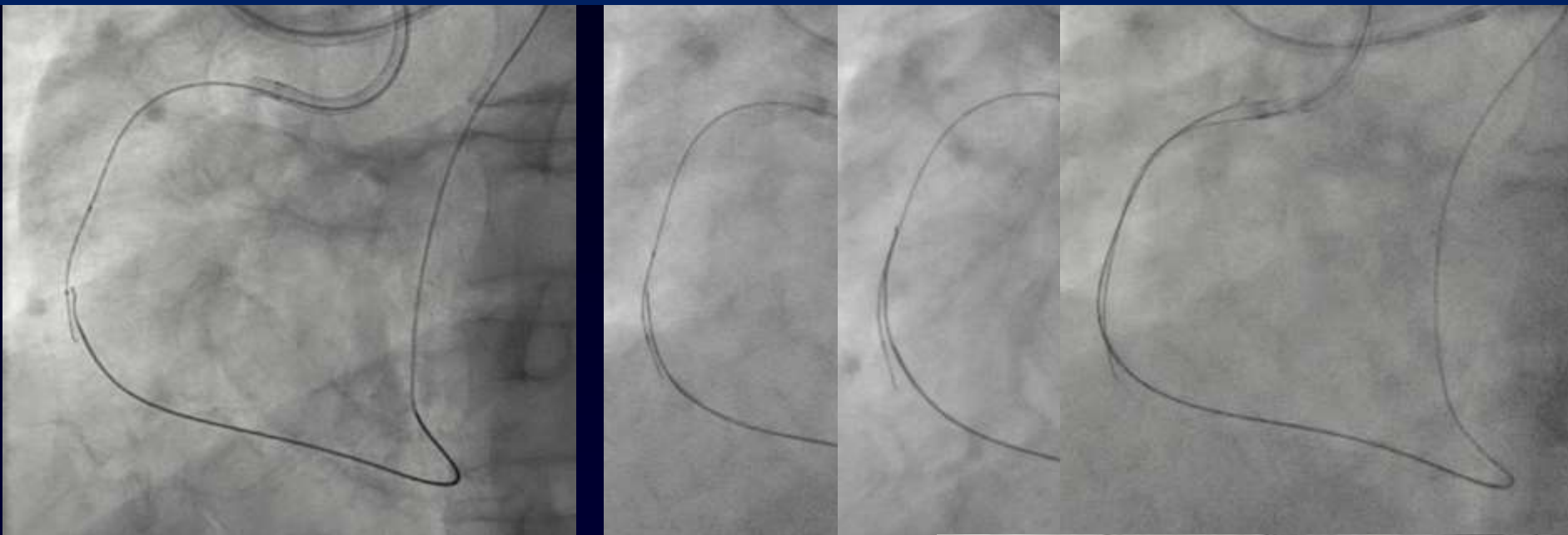
Retrograde CTO; Both retrograde & antegrade wiring

Antegrade approach : Corsair Pro XS 135cm + Gaia Next 2



Retrograde approach : Corsair Pro XS 150cm + UB-3

Retrograde CTO; Reverse CART & Externalization

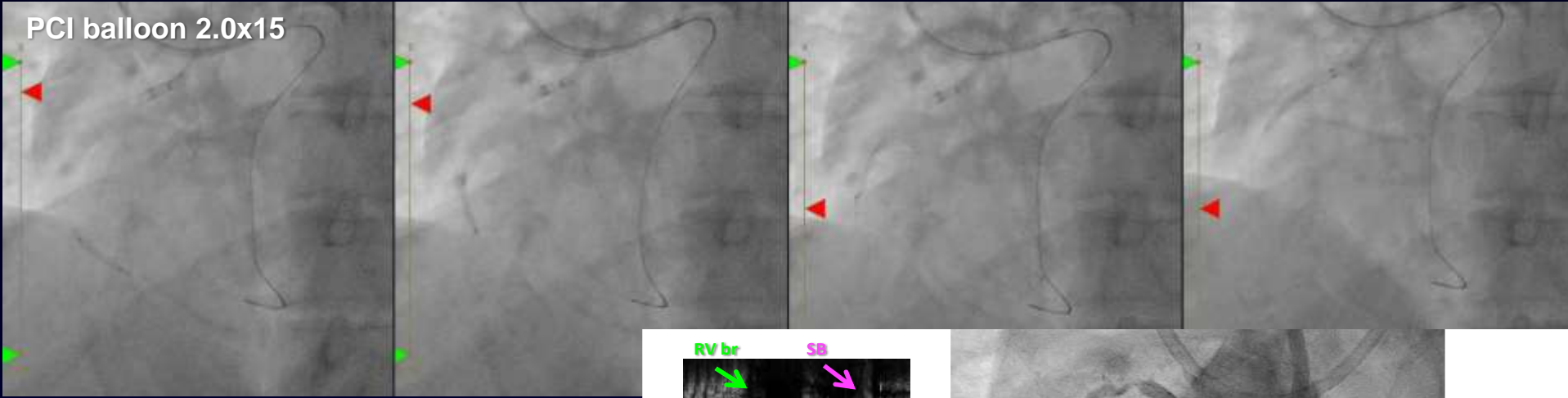


SEVERANCE CAR

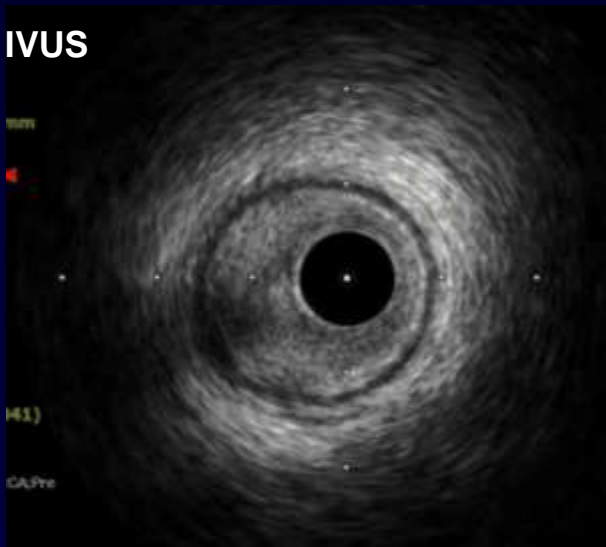
Advance Corsair Pro XS into telescope
Externalization with RG 3

Pre-dilation & IVUS evaluation

PCI balloon 2.0x15



IVUS



RV br **SB**

8.10

1

4

2

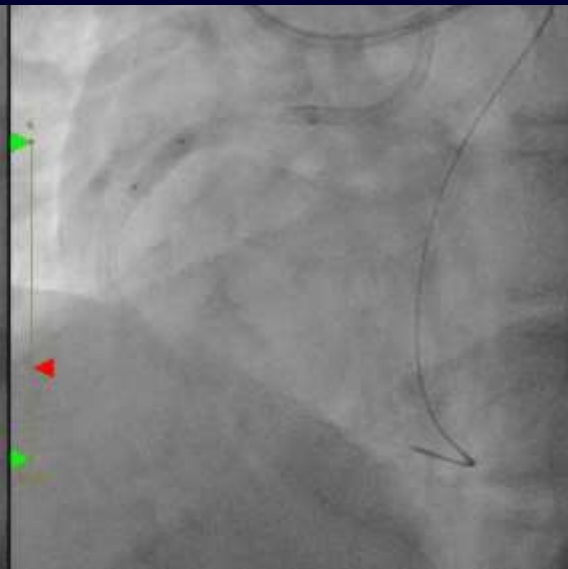
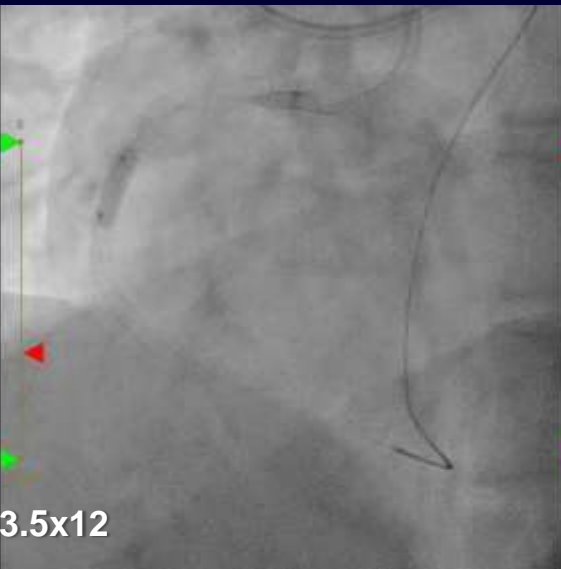
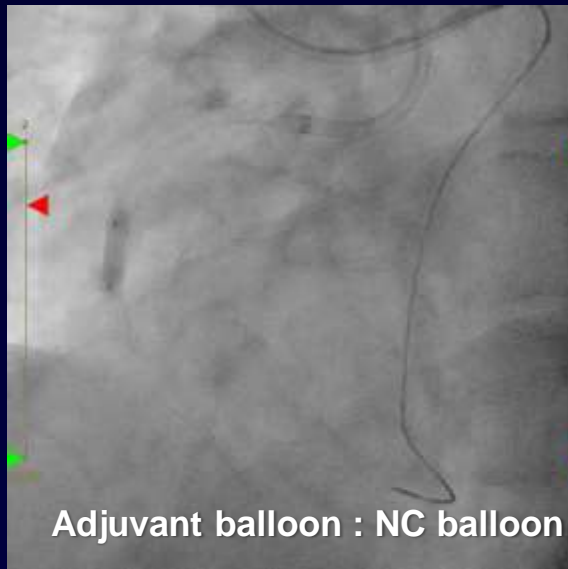
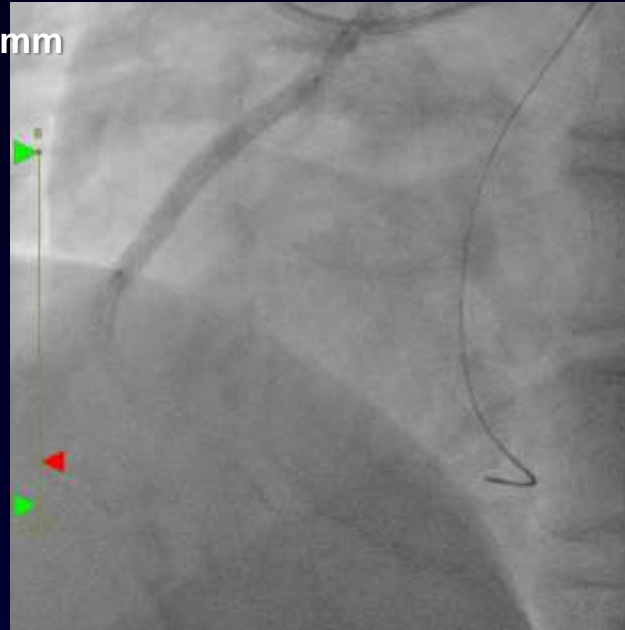
3

5

SB

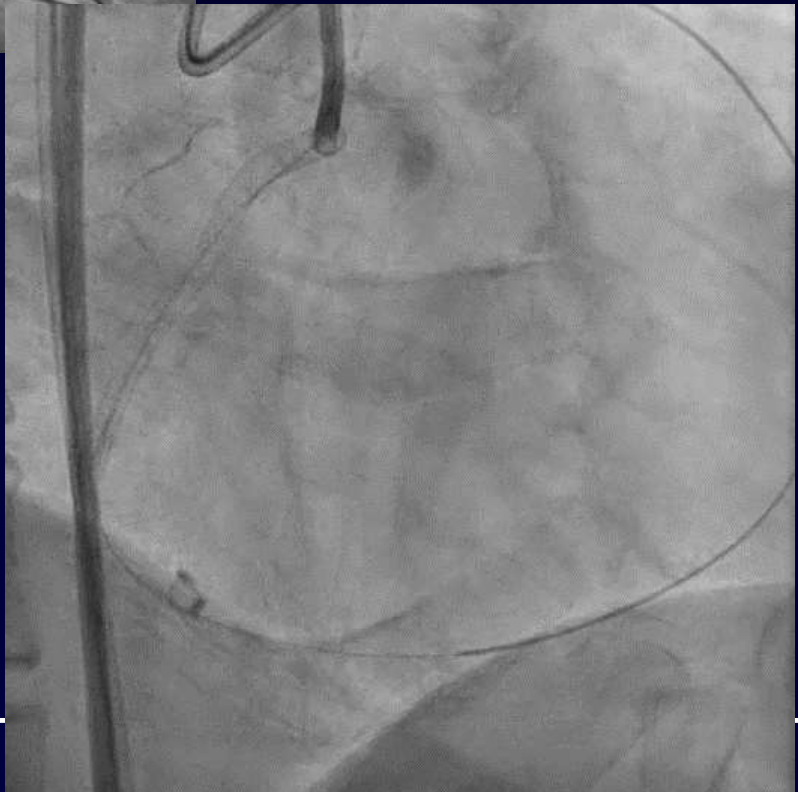
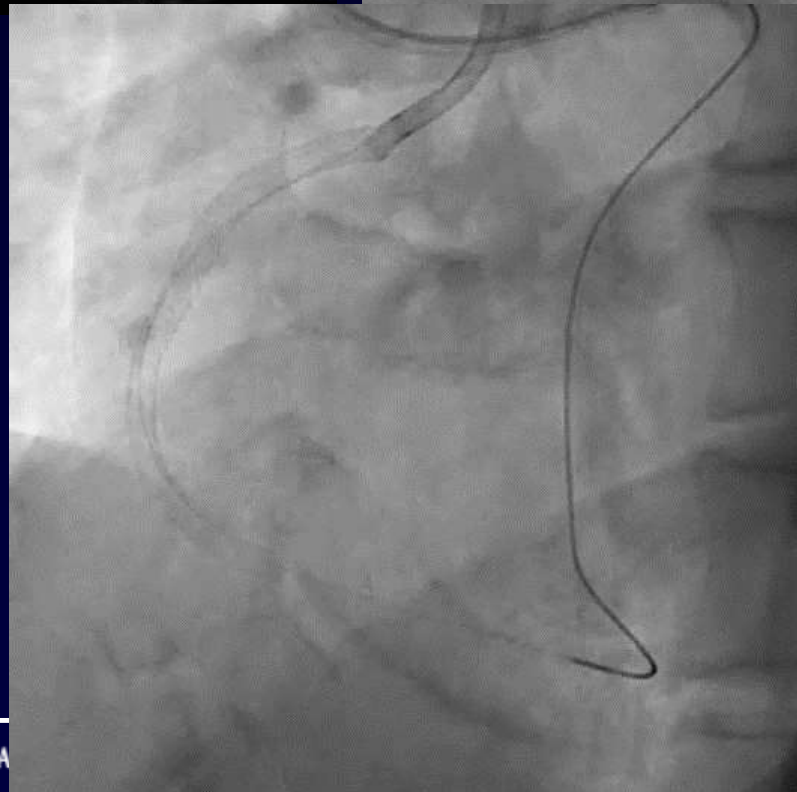
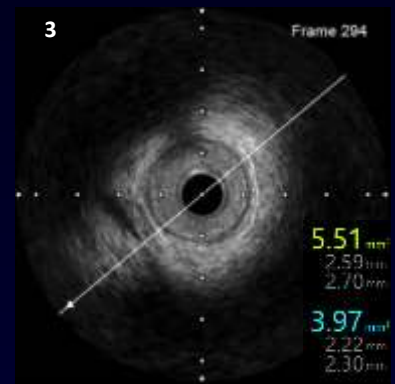
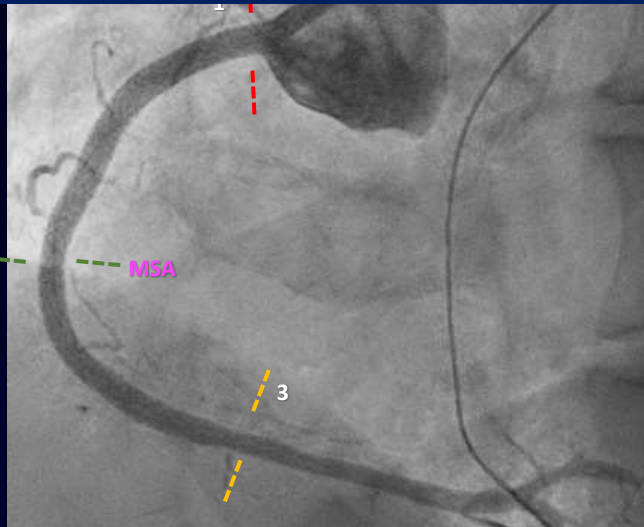
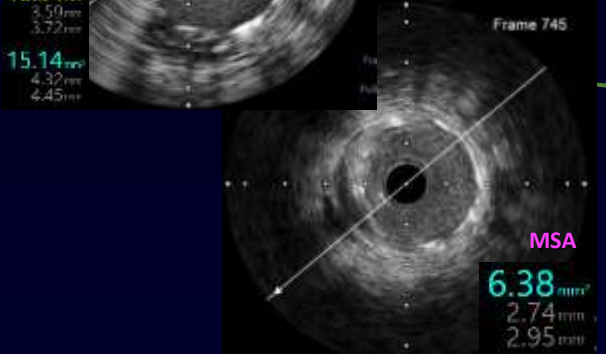
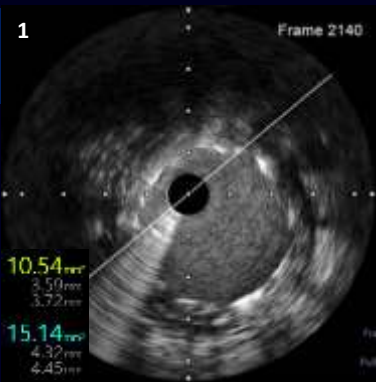
Stenting & post-dilation

Resolute onyx 3x38 mm & 3.5x38 mm



Adjuvant balloon : NC balloon 3.5x12

Final IVUS & CAG



Procedural characteristics & outcomes in CT-CTO trial

	CCTA-guidance (N=200)	Angio-guidance (N=200)	p Value
Total procedure time, min	80 (55-120)	80 (60-110)	0.981
Total crossing time, min	45 (24-81)	52 (30-85)	0.147
Antegrade-only crossing time, min	44 (20-72)	47 (28-80)	0.042
Fluoroscopic time, min	35 (22-62)	36 (26-56)	0.909
Successful recanalization	187 (94%)	168 (84%)	0.003
Successful retrograde CTO-PCI	45/48 (94%)	34/49 (69%)	0.002
Coronary perforation \geqtype II	2 (1%)	8 (4%)	0.055
Post-procedural peak CK-MB, ng/ml	4.6 \pm 7.2	6.8 \pm 31	0.342
Post-procedural CK-MB elevation \geq 10 x UNL	0 (0%)	4 (2%)	0.123

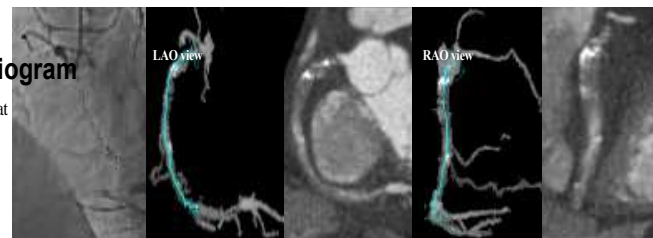


Pre-procedural Planning for Complex CTO

- As the pre-procedural planning, the angiographic review is essential for the treatment of CTO.
- In case of the complex/difficult CTO, **pre-procedural CT planning is helpful and significantly associated with a higher CTO success** with a **lower trend of complications (esp. coronary perforation, PPMI)** and a **high efficiency (less time in antegrade CTO)**, confirmed in the randomized **CT-CTO trial**.
- A thorough understanding of CCTA images (CTO course, anatomical location, calcification analyses) will help to understand the reasons of failure, to plan the CTO strategy, and resultantly to cause fully understanding of angio-review.

1. Making two orthogonal CT images matching with angiogram

- CTO courses (how CTO course goes & what the hidden route is within CTO segment)
- Anatomical location associated with side branches



2. Qualitative and quantitative analyses of CTO from MPR images

- 1) CTO length and the shapes of proximal and distal CTO ends
 - 2) Calcification; longitudinal & cross-sectional analyses
 - Maximal cross-sectional extent & length of calcification with cross-sectional extent $\geq 50\%$
 - Calcification shape; circular $\geq 180^\circ$, or 360° (full moon)
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- “Geographic calcification-mapping”

