Role of Intraoperative CT During CTO PCI

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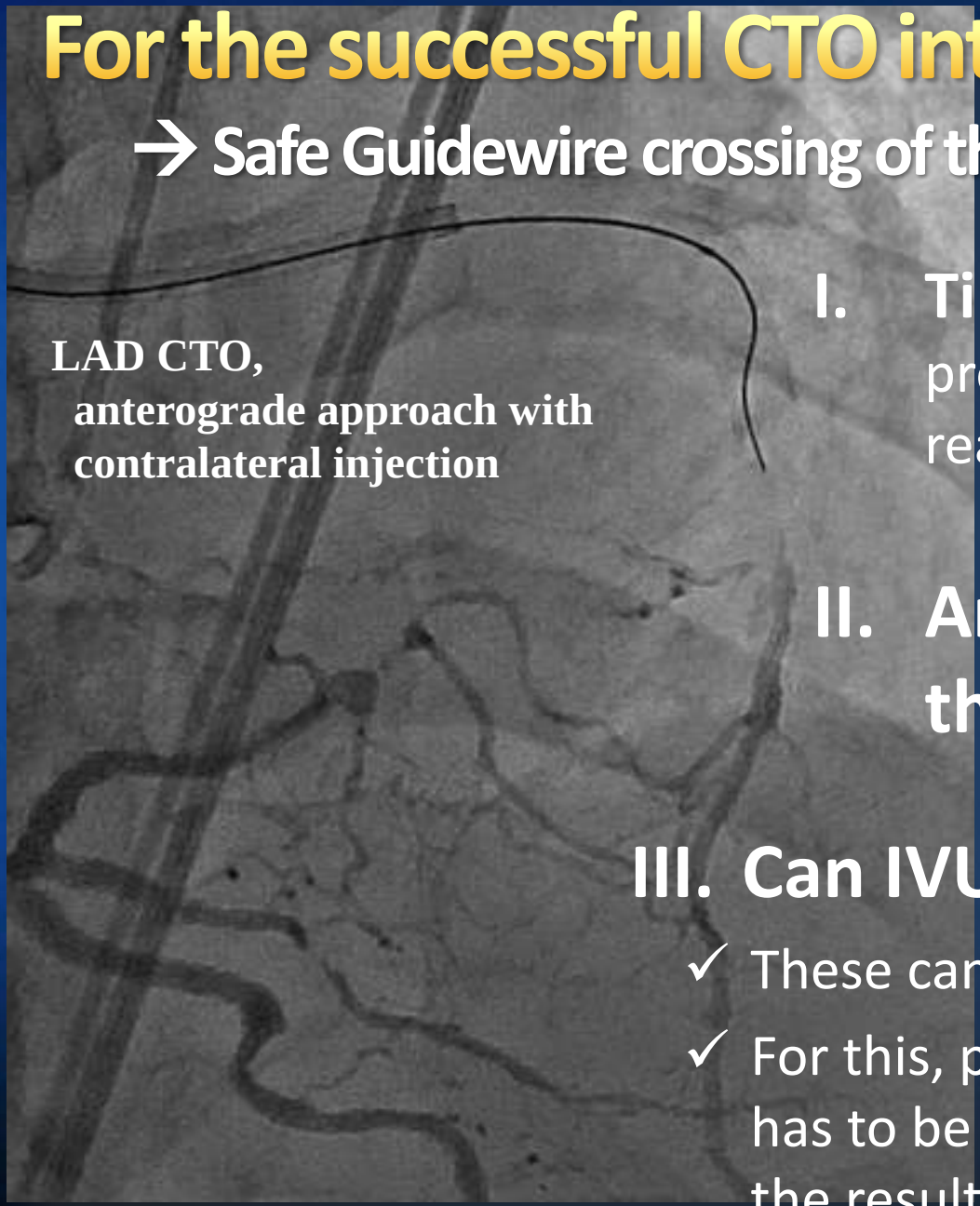
For the successful CTO intervention …

→ Safe Guidewire crossing of the CTO lesion is the key !



LAD CTO,
anterograde approach with
contralateral injection

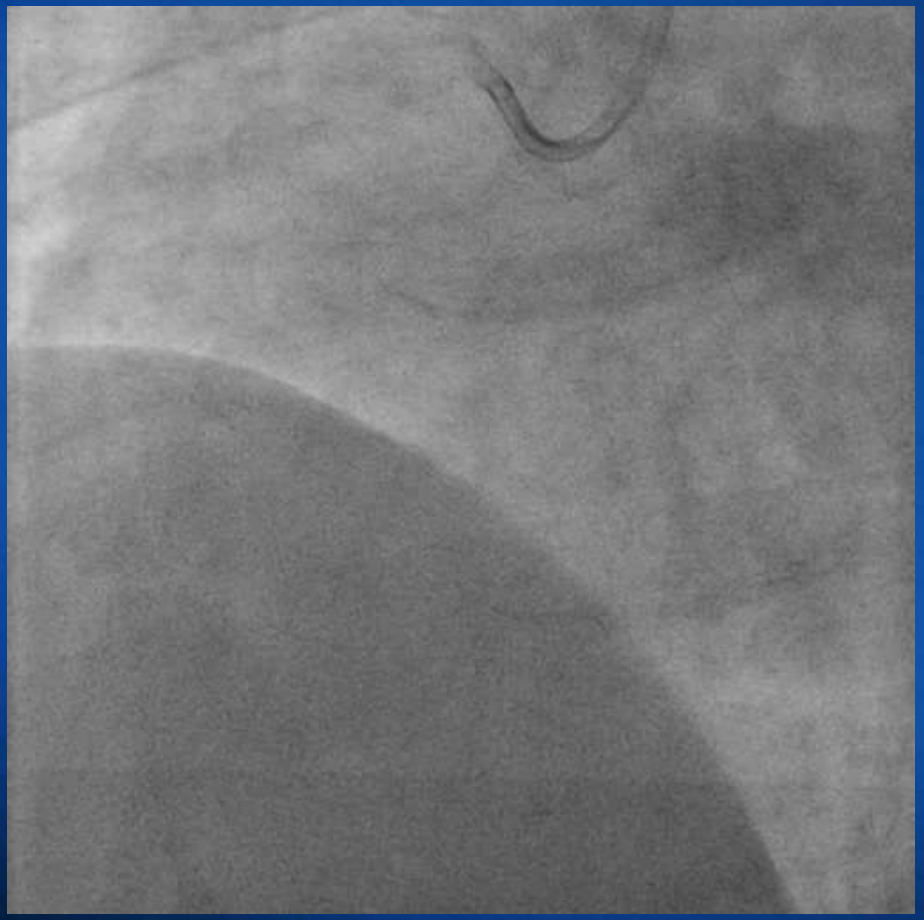
I. **Tip of the Guidewire,**
properly crossing CTO and
reaching to distal true lumen?

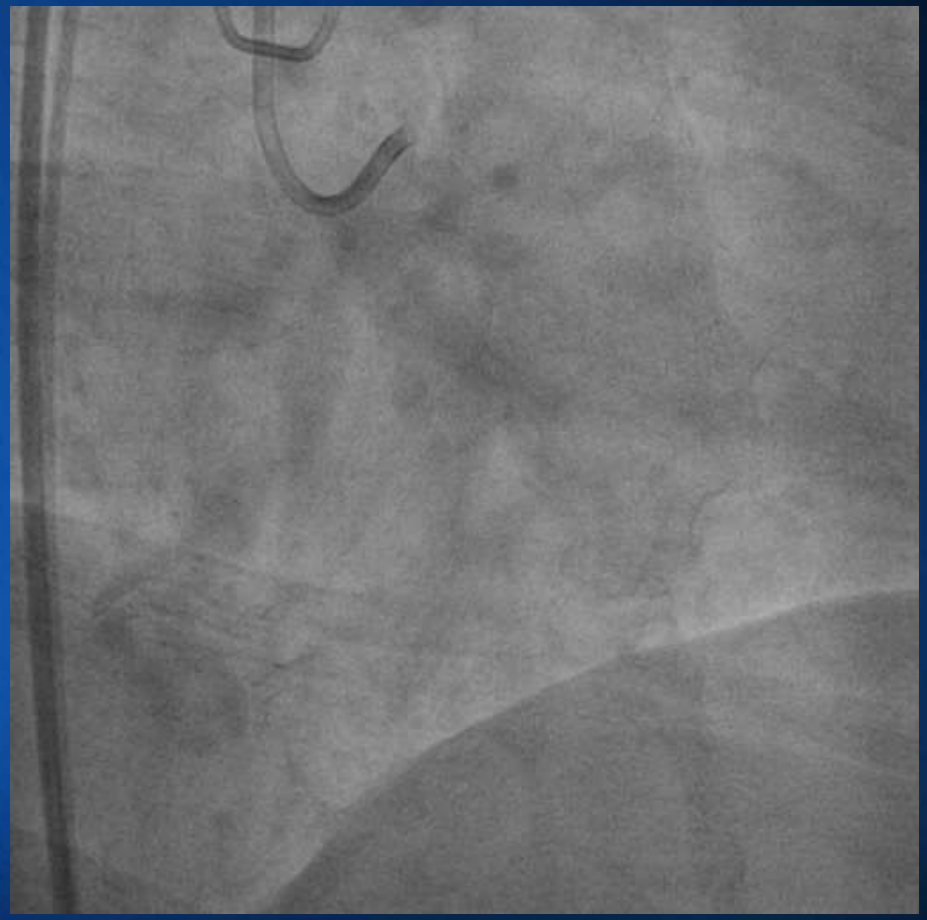
II. **Any tool for confirming this?**

III. **Can IVUS or OCT do?**

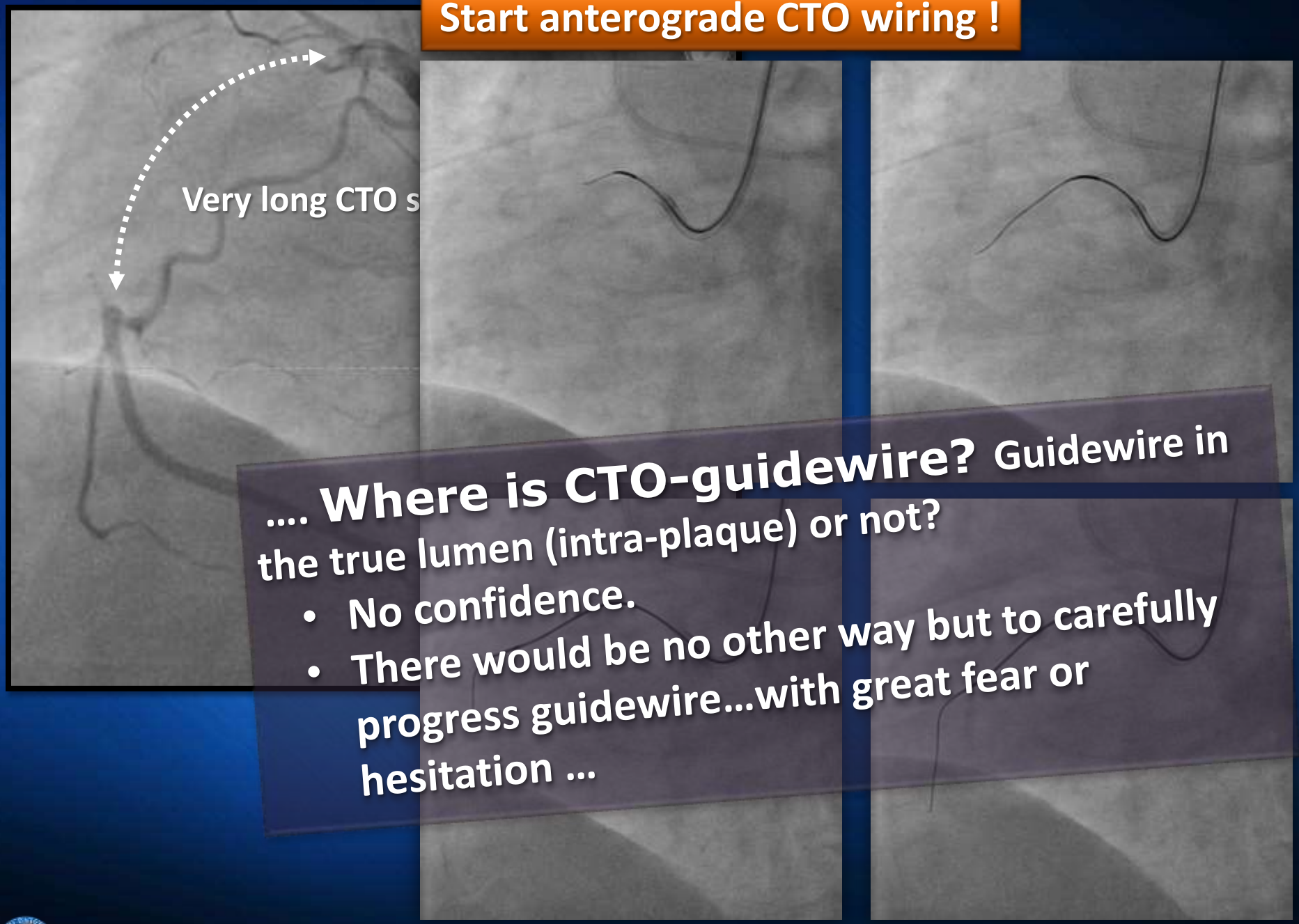
- ✓ These can do only after wire crossing.
- ✓ For this, predilation of uncertain location has to be done … closely related with the resultant procedural failure.

Case. M/49 RCA long-segment CTO



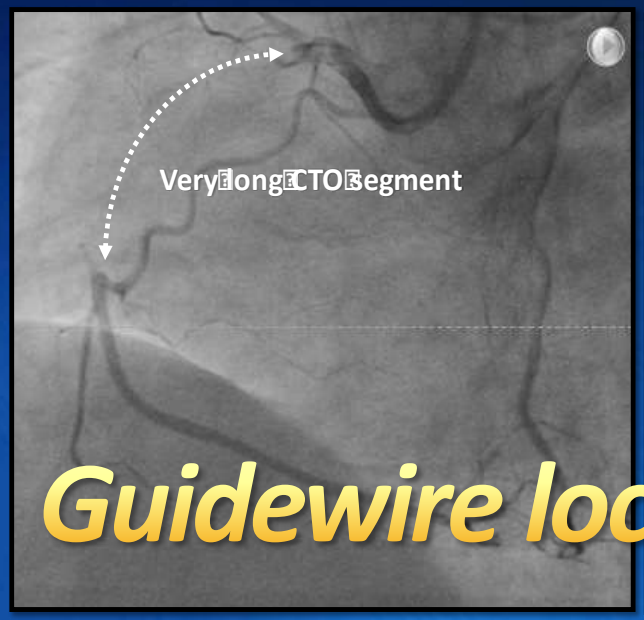


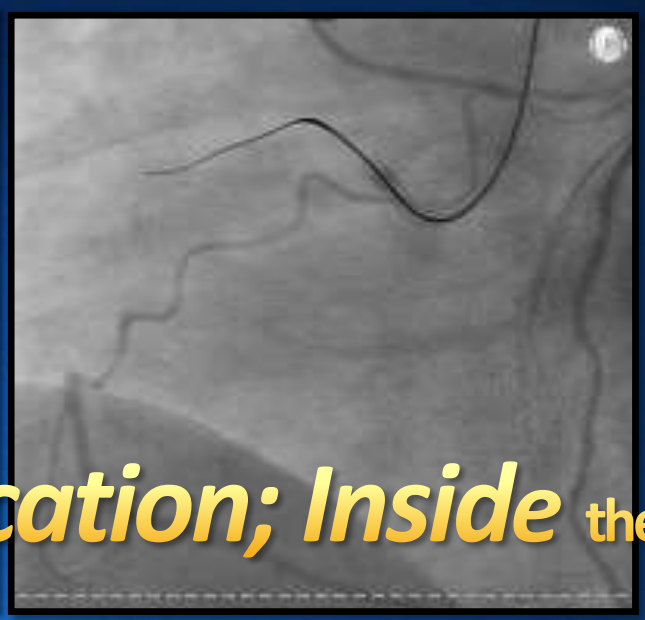
Start anterograde CTO wiring !

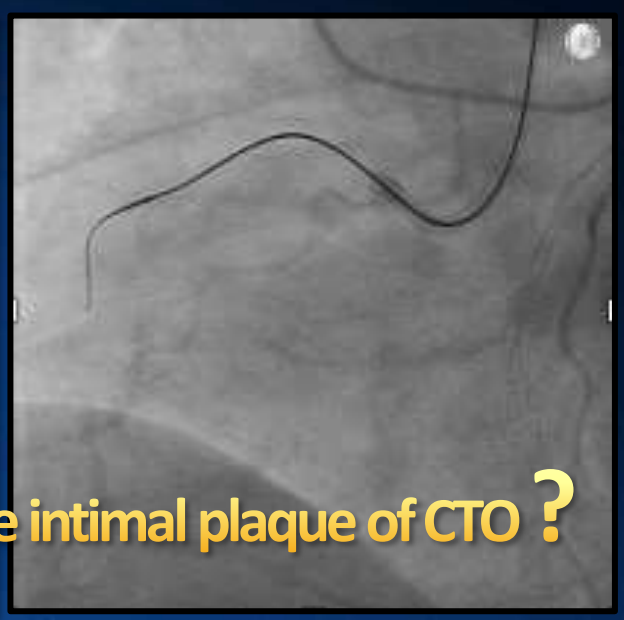


…. **Where is CTO-guidewire?** Guidewire in the true lumen (intra-plaque) or not?

- No confidence.
- There would be no other way but to carefully progress guidewire…with great fear or hesitation …





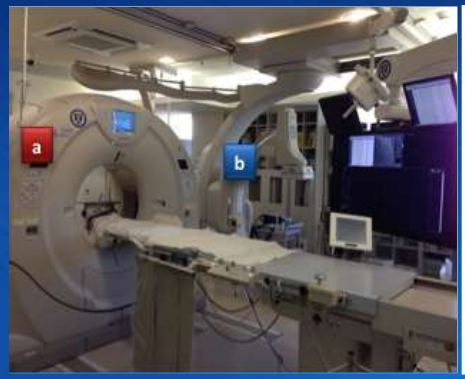


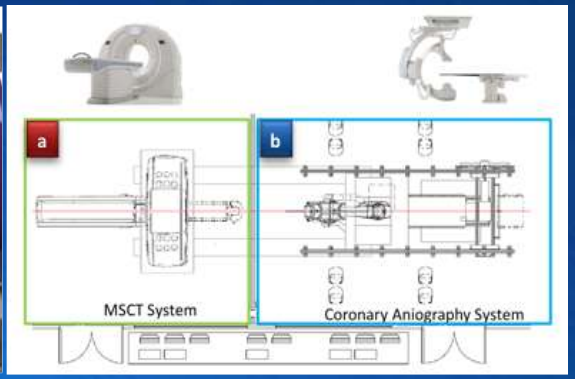
Guidewire location; Inside the intimal plaque of CTO ?

- How to **confirm "tip location in CTO"**?
  - Conventional methods … check with angiogram by contralateral injection
  - Imaging tools like IVUS … identify the location of guidewires only after complete lesion-passage … still limitation in viewing the cross sections in the wire-tip-level

→ **We need the new methods for this !!!**

Coronary computed tomographic angiogram (CCTA) system





- Originally from the CT scanning at ER allowing emergent intervention or cath room for the workup for solid cancer or neurologic diseases.

- CCTA system comprises a 640 MSCT applying double-slice technology (Aquilion ONE, Toshiba Medical Systems) (a) and CAG system (b), and allows for CT scan during intervention without moving the patient on the table.

1. CCTA findings regarding the location of guidewire without contrast
--- Large vessel CTO

1-1. Immediate Cross-sectional CCTA images

Published world 1st case!

Role of intraprocedural coronary computed tomographic angiography in percutaneous coronary intervention of chronic total occlusion

Byeong-Keuk Kim[1], MD, PhD; Satoru Sumitsuji[2], MD; Iksung Cho[1], MD; Myeong-Ki Hong[1,3], MD, PhD; Jung-Sun Kim[1], MD, PhD; Hyuk-Jae Chang[1], MD, PhD; Yangsoo Jang[1,3]*, MD, PhD

1. Severance Cardiovascular Hospital, Yonsei University College of Medicine, Seoul, South Korea; 2. Osaka University, Osaka, Japan; 3. Severance Biomedical Science Institute, Yonsei University College of Medicine, Seoul, South Korea

The accompanying supplementary data are published online at: http://www.pcronline.com/eurointervention/ahead_of_print/201505-01

A 55-year-old man diagnosed with chronic total occlusion (CTO) of the left anterior descending artery was admitted, and we attempted antegrade CTO intervention using bilateral femoral injection (**Figure 1A-Figure 1C**). When the guidewire was deemed to have reached the end of the distal CTO (**Figure 1D**), coronary computed tomographic angiography (CCTA) without contrast injection was performed. This involved a 640 multislice CT scanner applying double-slice technology (Aquilion ONE™; Toshiba Medical Systems, Otawara, Japan) and a coronary angiography system which allows a CT scan to be evaluated during intervention without the need to move the patient on the table (**Figure 1E-Figure 1K, Moving image 1**). CCTA clearly showed the location of the wire tip in intimal plaques, where the guidewire was slightly deviated but definitely differentiated from the calcified vessel wall (**Figure 1G-Figure 1I**). After correction of the direction, we confidently advanced the guidewire, successfully crossing the CTO lesion, and finished 3.0×38 mm stent implantation (**Figure 1L**). Total radiation dose was 33.34 mSv and the dose for CCTA was 1.55 mSv.

Conflict of interest statement

The authors have no conflicts of interest to declare.

Online data supplement

Moving image 1. Real operation of the CCTA system.

Figure 1. *Coronary angiogram with bilateral injection (A & B) and pre-procedural curved multiplanar reformation image (C). White arrows demonstrate CTO of the LAD with severe calcification. When the guidewire reached the distal lesion of the CTO, just before the distal true lumen (D), an intraprocedural CCTA was performed on site without contrast injection (E). Matching cross-sectional CCTA images showed the location of the guidewire in the coronary artery including CTO segments (F-J). Cross-sectional CCTA images at the wire tip level clearly showed the guidewire inside the intimal plaque of the CTO (H & I). The asterisks and blue and yellow arrows indicate the guidewire and calcified plaques, respectively. The CCTA system in the catheterisation room (K) comprised a CT scanner (a) and a coronary angiography system (b). Final post-procedural angiogram after successful stent implantation (L).*

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IMAGE IN CARDIOLOGY

EuroIntervention 2015;11-online

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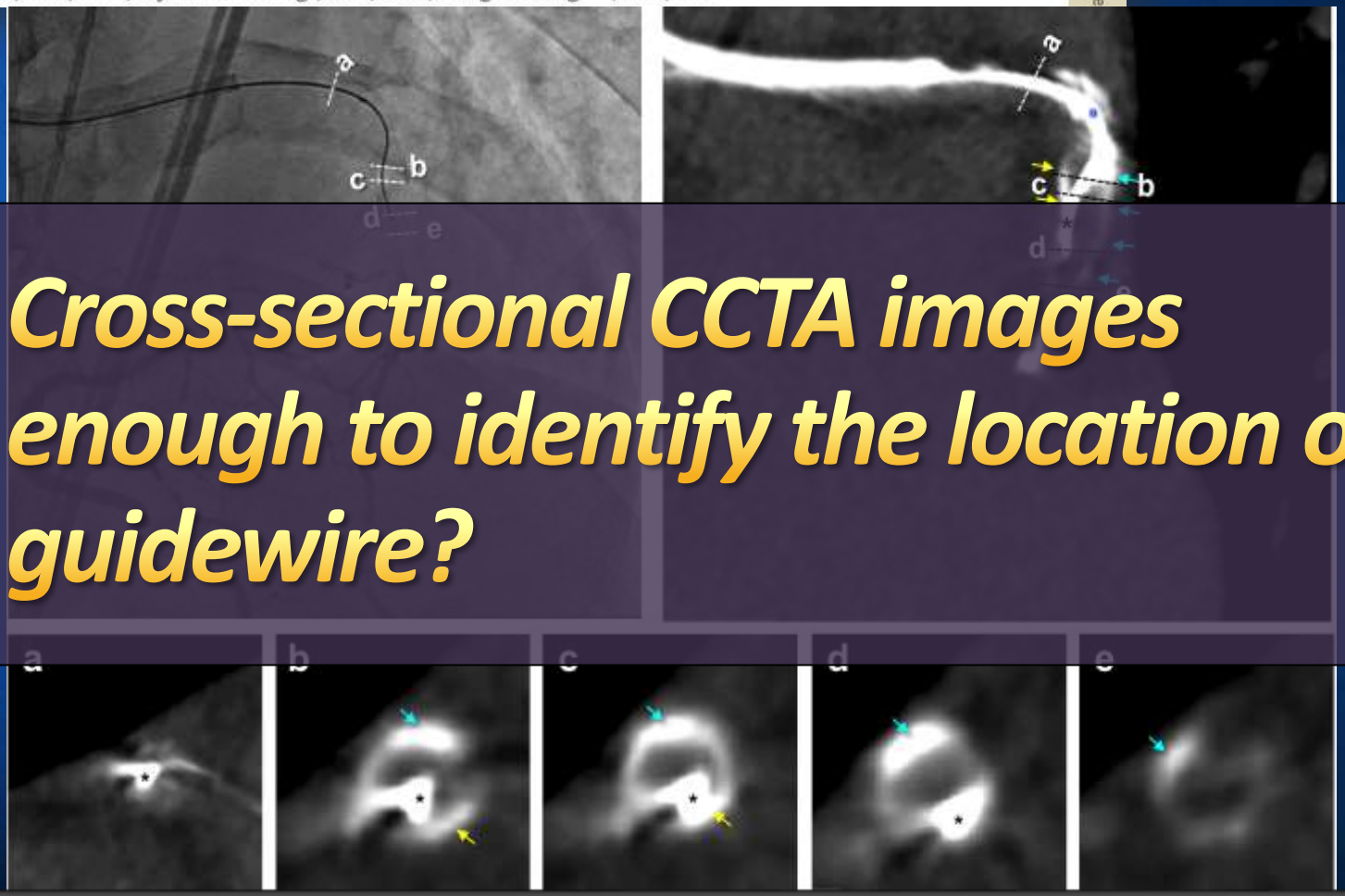
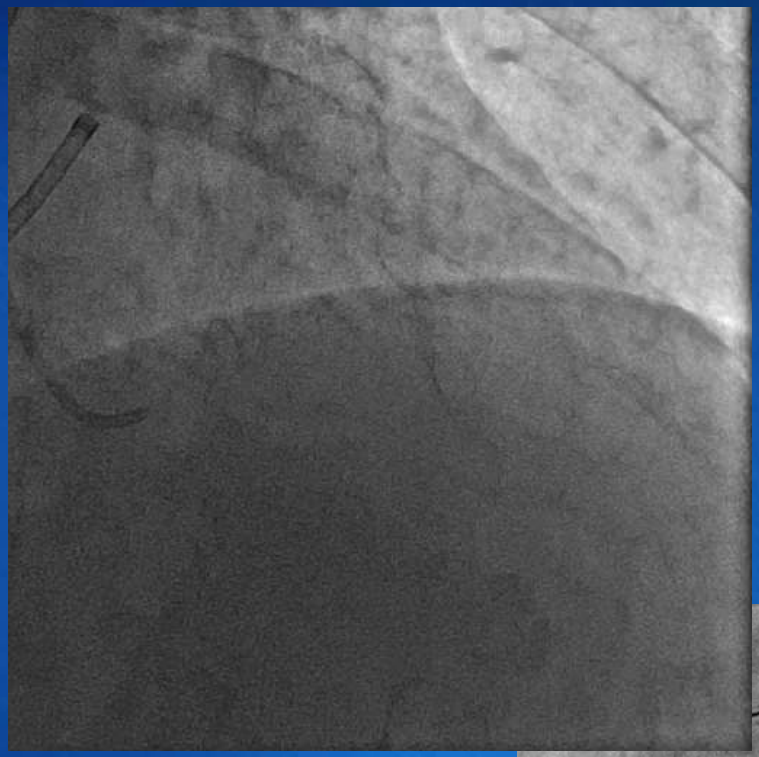
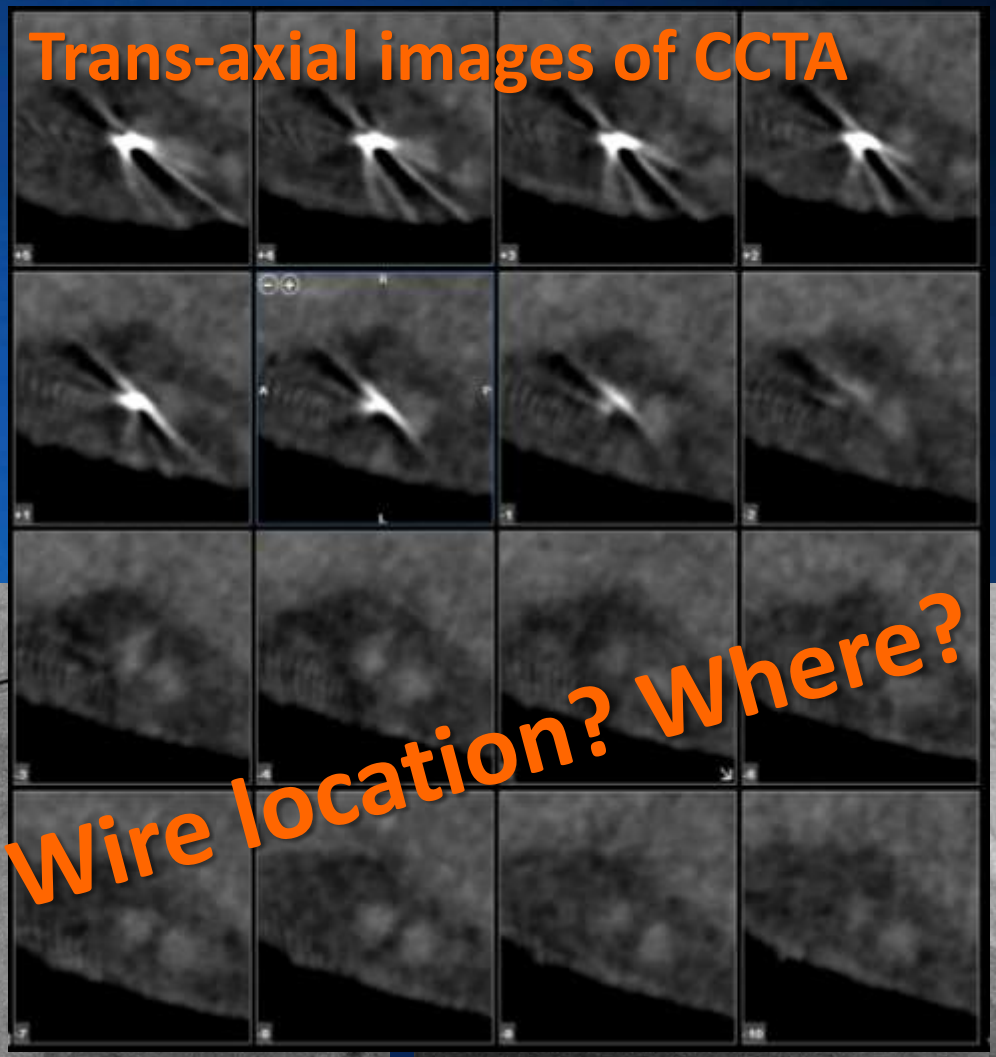


✓ *Cross-sectional CCTA images enough to identify the location of guidewire?*

✓ **Matching cross-sectional CCTA images showed the location of the guidewire in the coronary artery including CTO segments. Cross-sectional CCTA images at the wire tip level clearly showed the guidewire inside the intimal plaque of the CTO. The asterisks and blue and yellow arrows indicate the guidewire and calcified plaques, respectively.**

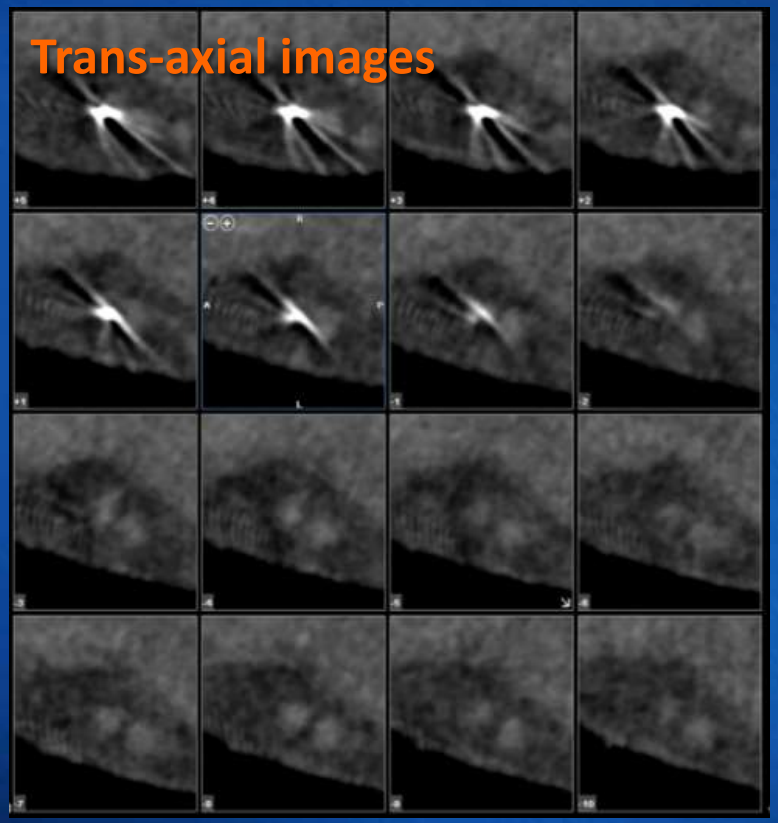
Case. M/54. LAD CTO



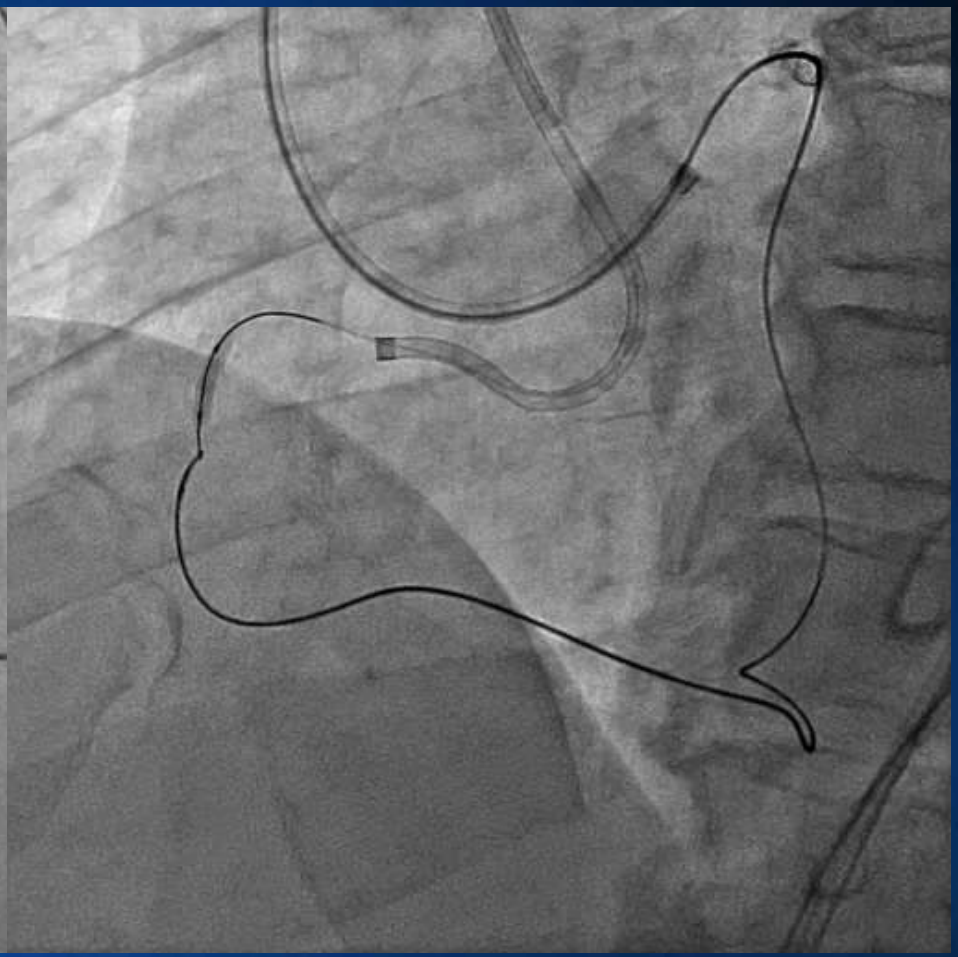


Strategy 1. for improving the identification of guidewire

Image reconstruction, Curved multiplanar reconstruction images

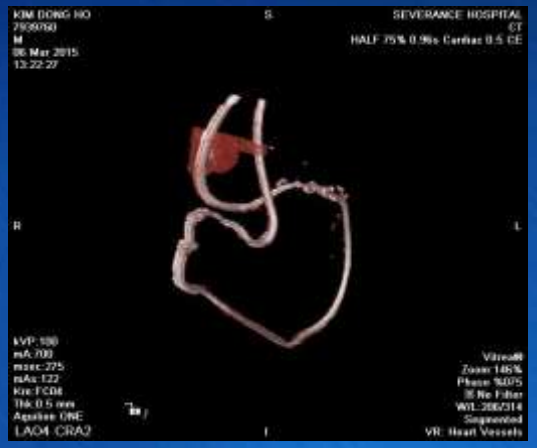


Case. M/64. RCA CTO Retrograde PCI for RCA CTO



- Antegrade: Caravel + 014" G/W : Sion Blue → Gaia (second) → Balloon at pRCA → Conquest Pro → Conquest Pro 12 → Anchor balloon + 014" G/W : Conquest Pro 12 + Buddy 014" G/W : Conquest Pro 12
- Retrograde :Corsair + 014" G/W : Sion → Suoh → Sion blue -> Progress 200T → Conquest Pro 12 → Progress 200T → Sion blue→ Gaia (Third) → Fielder XT-R

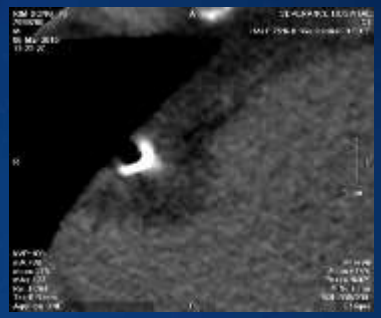
Intraprocedural CCTA, trans-axial images



? ; where?



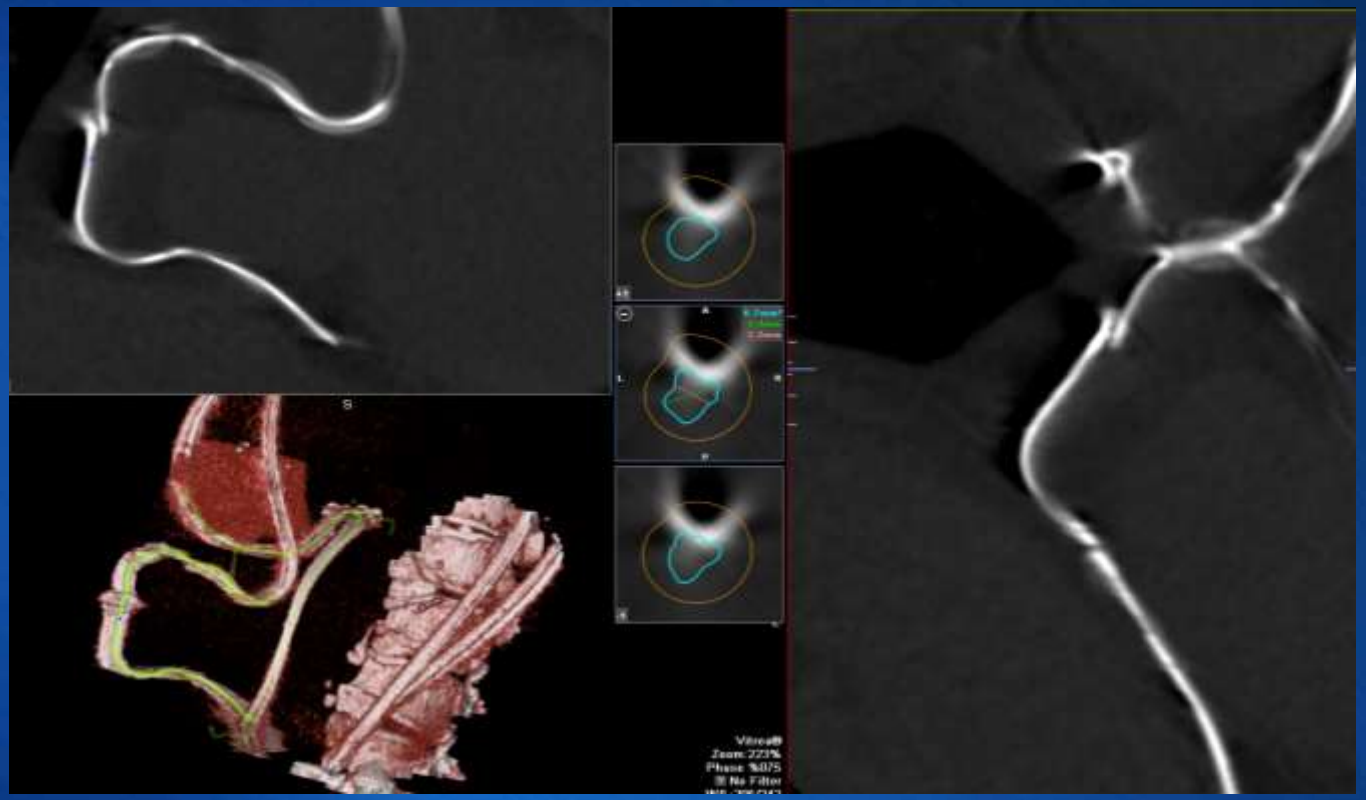


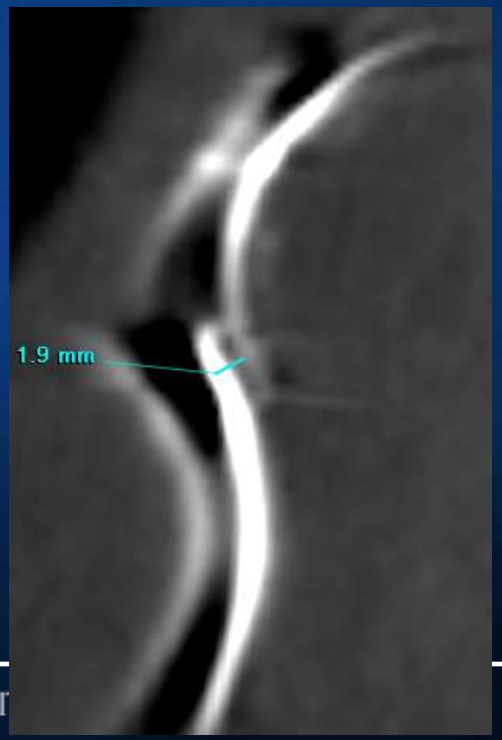





Strategy for improving the identification of guidewire

Image reconstruction, Curved multiplanar reconstruction images





2. Contrast injection to define the distal vessel lumen to confirm the right position of guidewire

--- *Small vessel CTO*

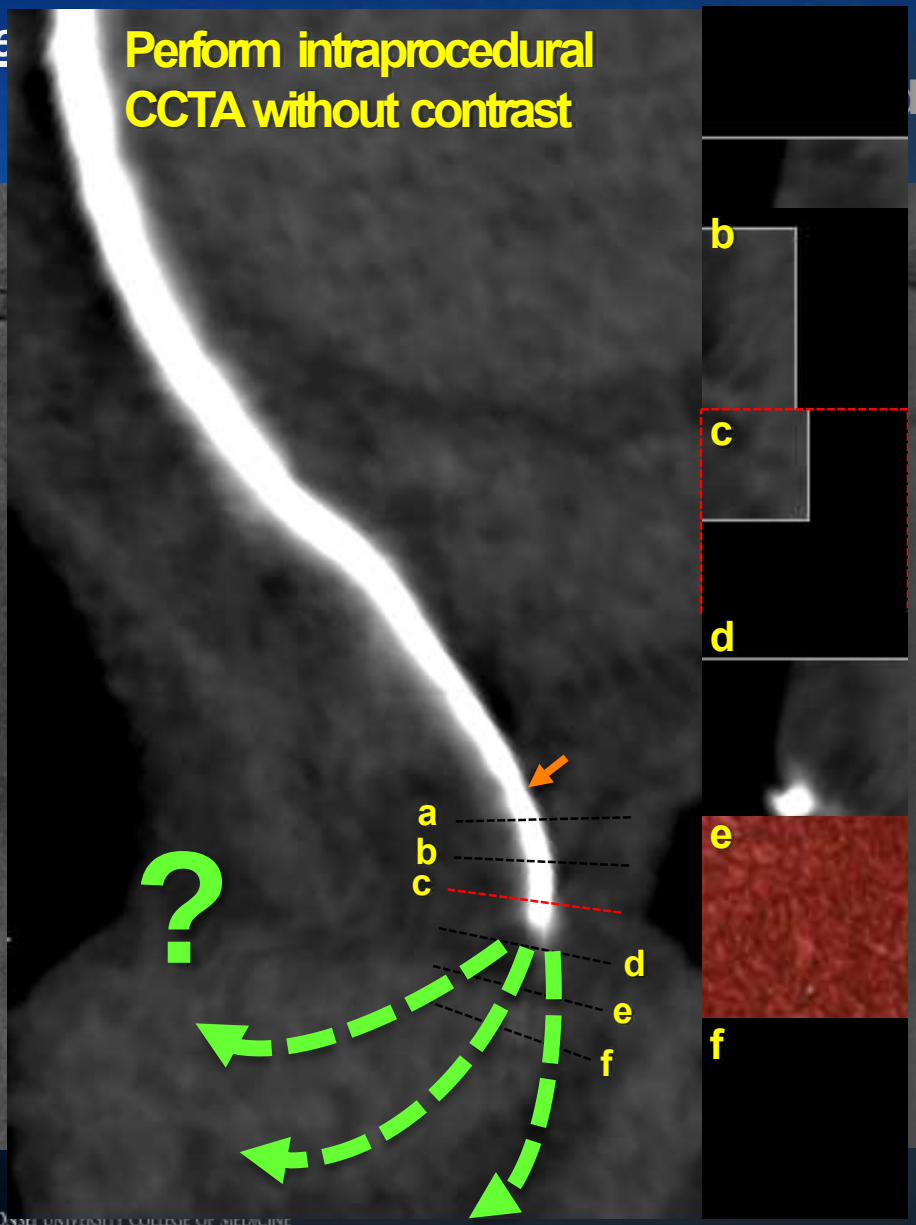
Contralateral intracoronary contrast injection with 1/20 dilution

Strategy for improving the identification of guidewire

Case

LCx

...le CTO PCI with antegrade injection



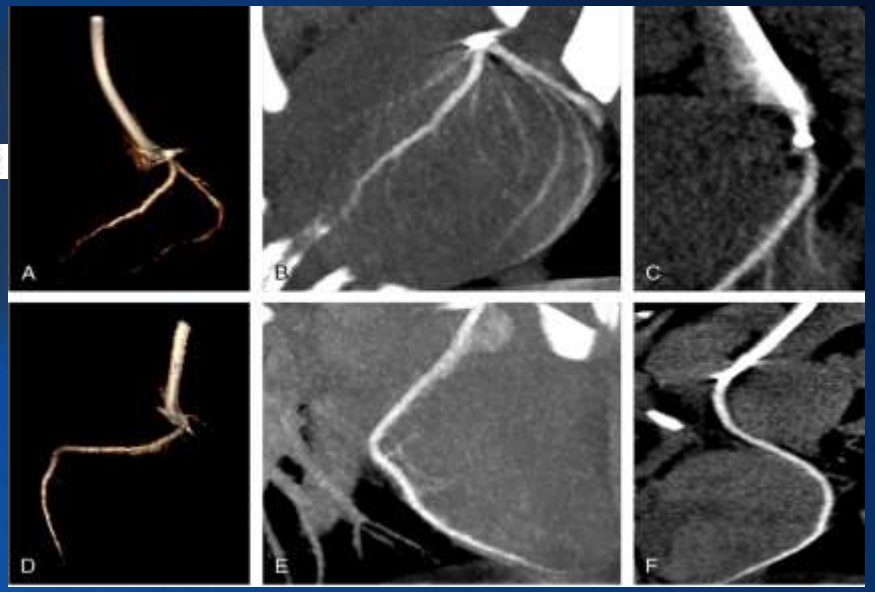
Intracoronary contrast injection

Feasibility of Selective Catheter-Directed Coronary Computed Tomography Angiography Using Ultralow-Dose Intracoronary Contrast Injection in a Swine Model

(*Invest Radiol* 2015;50: 449–455)

Youngtaek Hong, BS, Sanghoon Shin, MD,† Hyung-Bok Park, MD,‡§ Byoung Kwon Lee, MD,‖ Reza Arsanjani, MD,¶ Briain ó Hartaigh, PhD,# Seongmin Ha, BS,# Yeonggul Jang, BS,* Byunghwan Jeon, BS,* Sunghee Jung, BS,* Se-Il Park, PhD,** Ji Min Sung, PhD,†† Hackjoon Shim, PhD,‡‡ and Hyuk-Jae Chang, MD, PhD§¶¶*

- Simultaneous selective CCTA scan with an injection of 13.13 mgI/mL of modulated contrast medium at multiple different injection rates including 2, 3, and 4 mL/s and different total injection volumes of either 20 or 30 mL.



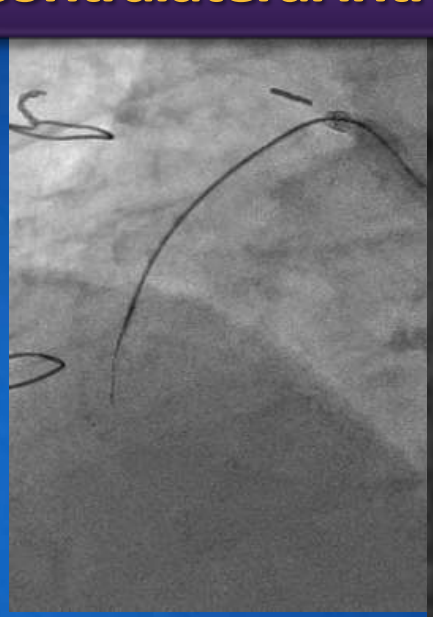
- **For the enhancement of distal CTO part, the intracoronary contrast injection was used during CCTA**; 30 mL of mixed contrast medium at 5 mL/s flow rate.

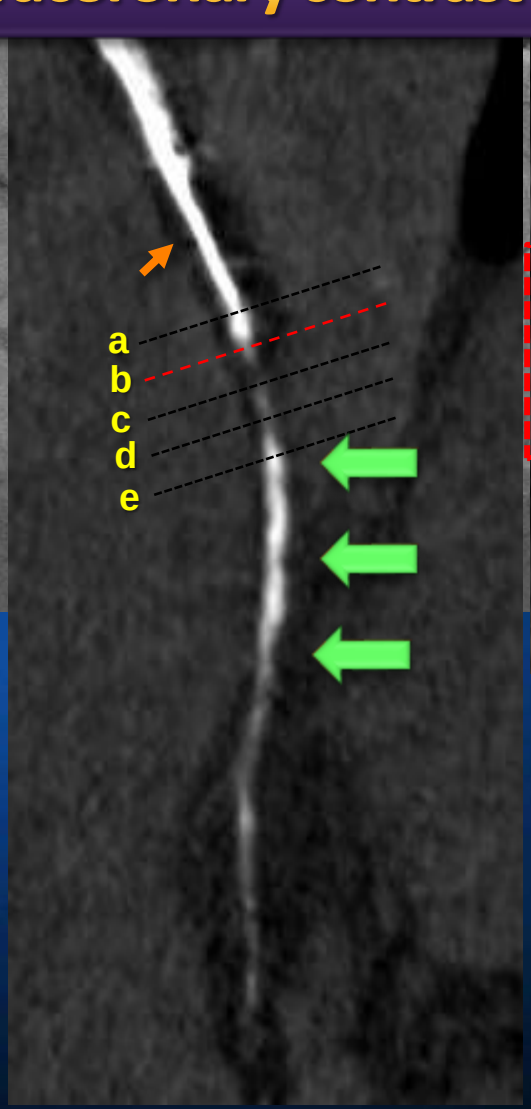
  → The more **clear differentiation between guidewire and vessel wall within CTO segment** was enable by enhancing the behind CTO segment and the guidewire-tip-level.

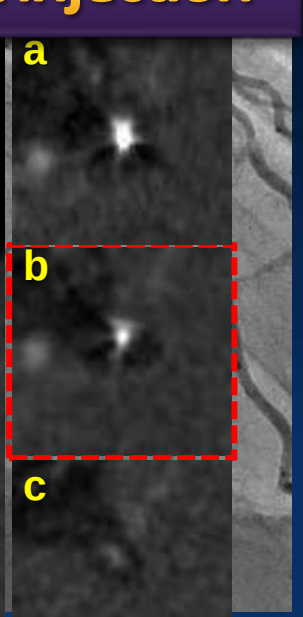
Case M/84. RCA CTO

Strategy for improving the identification of guidewire

Scanning with "contralateral intracoronary contrast injection"





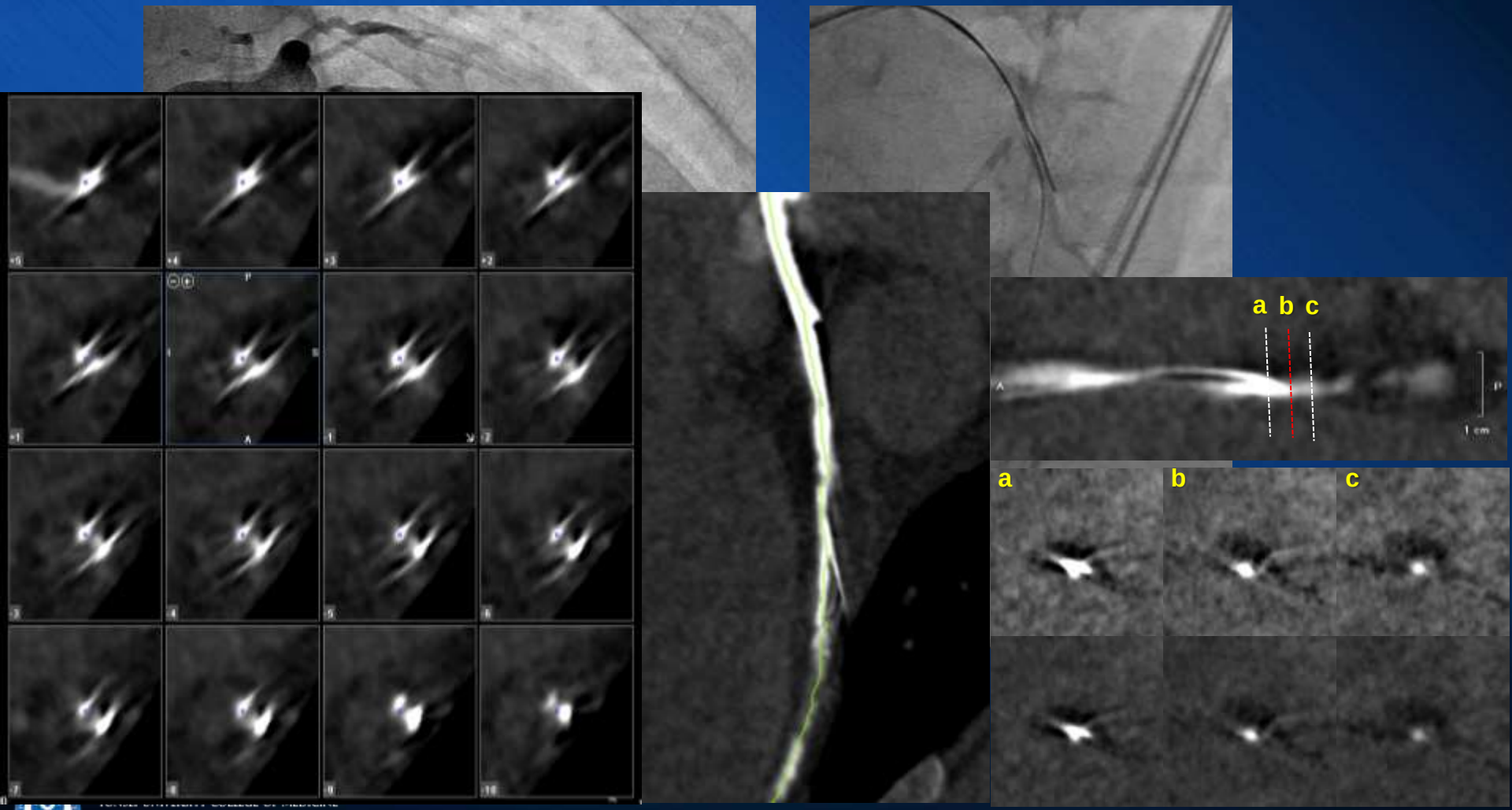


3. Confirmation of "Guidewire Tip Location" *in various situations.*

CCTA under various situations - I

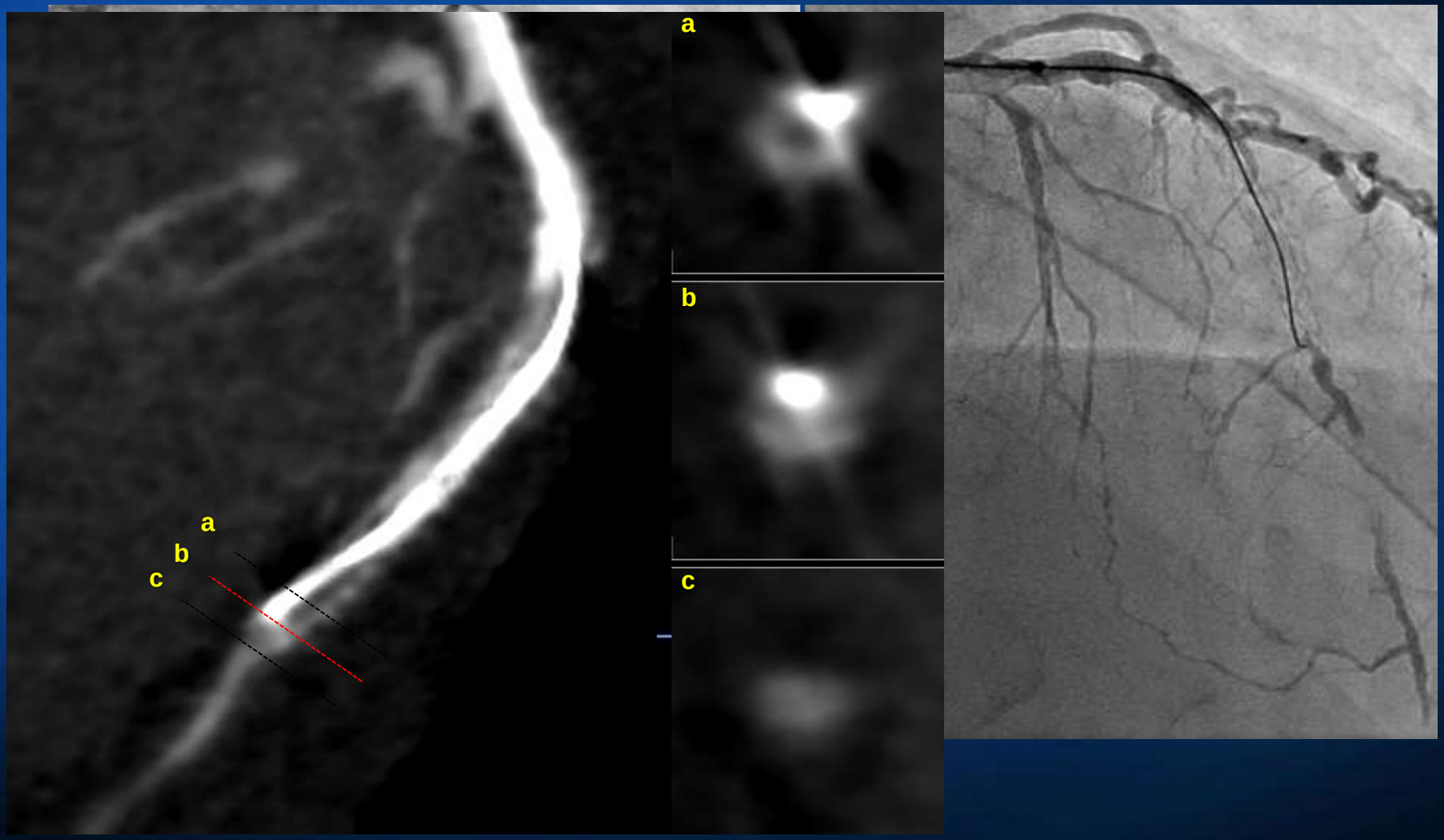
#1. CCTA evaluation during retrograde PCI, as shown in prior case.

#2. CCTA evaluation during parallel wire technique



CCTA under various situations - II

#3. Stent CTO lesion



4. Can CCTA guide CTO intervention as practical way?

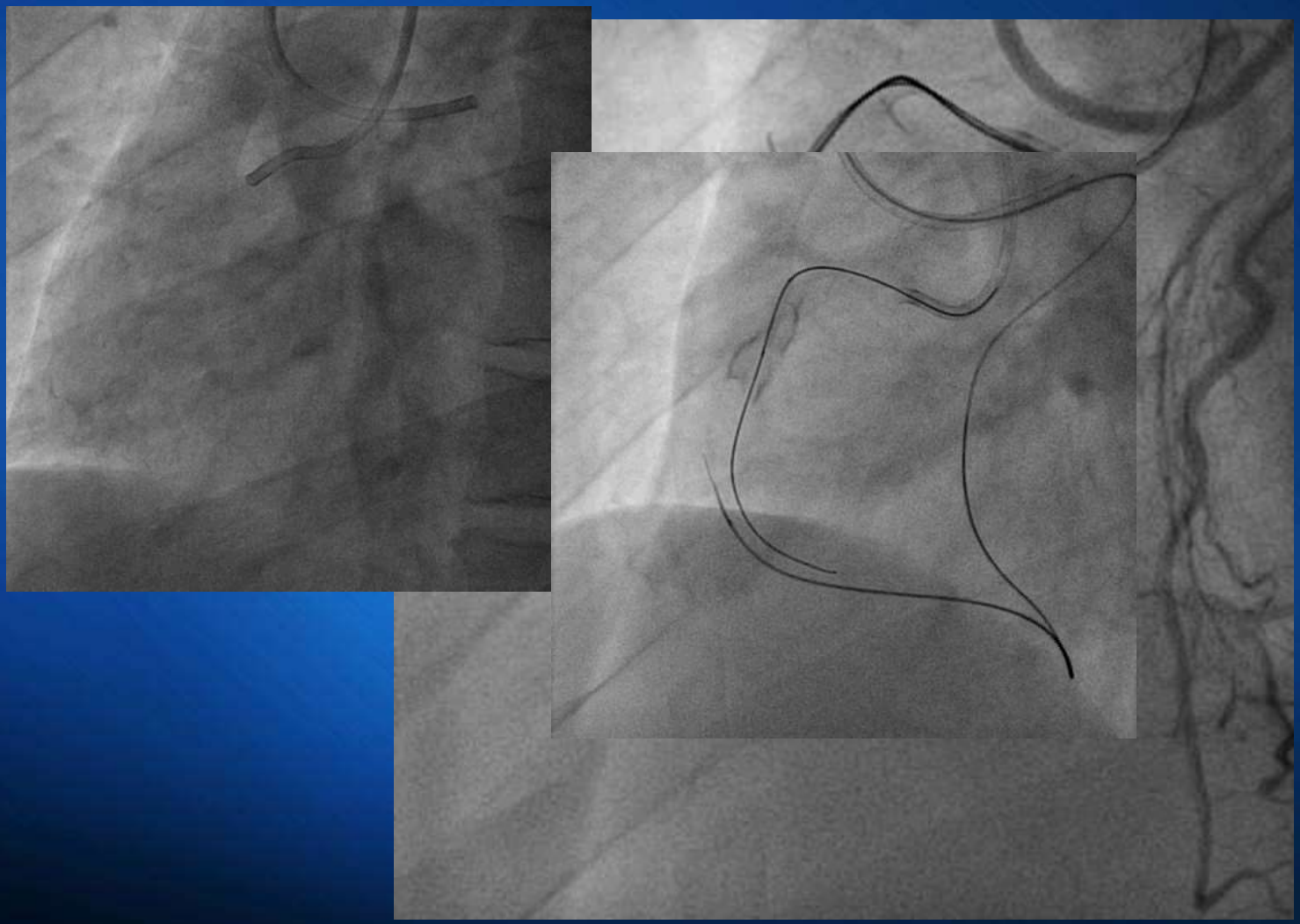
Application of intraprocedural CCTA for retrograde CTO intervention

Case . M/37 yrs

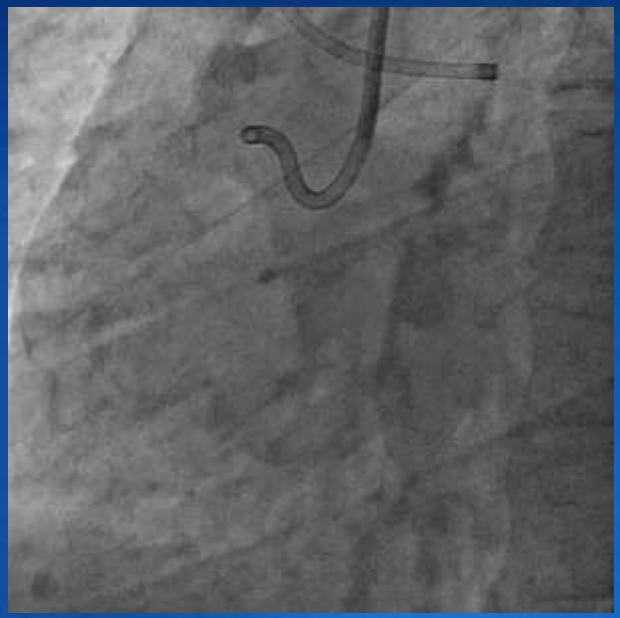
- CC: Stable angina
- P/Hx: CAD 1VD (CTO at RCA os.), failed PCI (‘12.03)
- Risk factor; Heavy smoker
- Echo : EF=56%, RCA territory RWMA (hypokinesia)

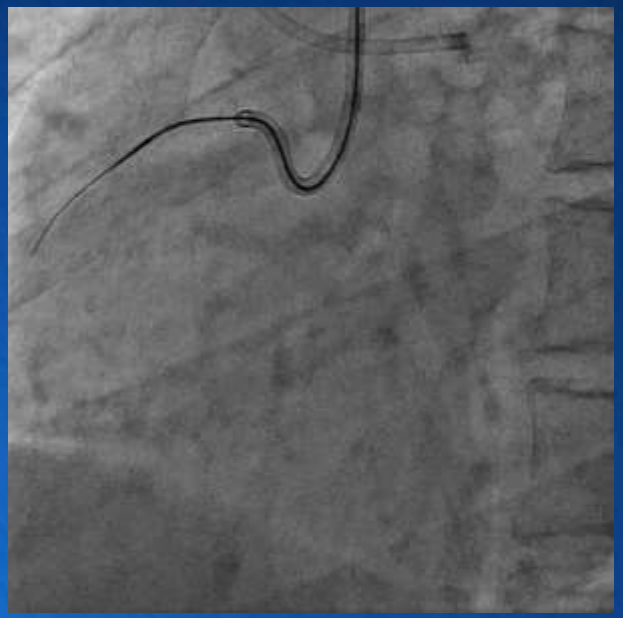
Prior attempt;

Retrograde & Anterograde approach… Failed

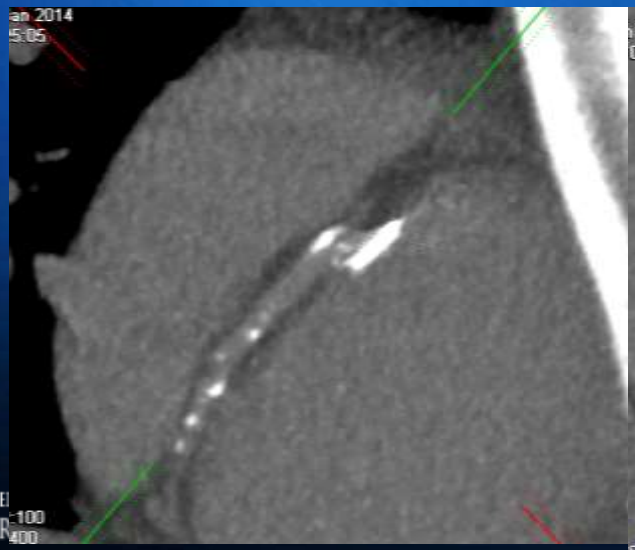


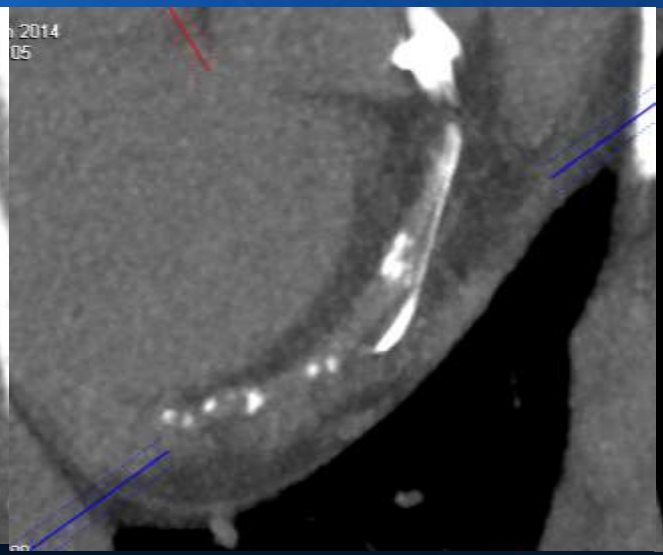
Re-attempt for CT-guided CTO intervention

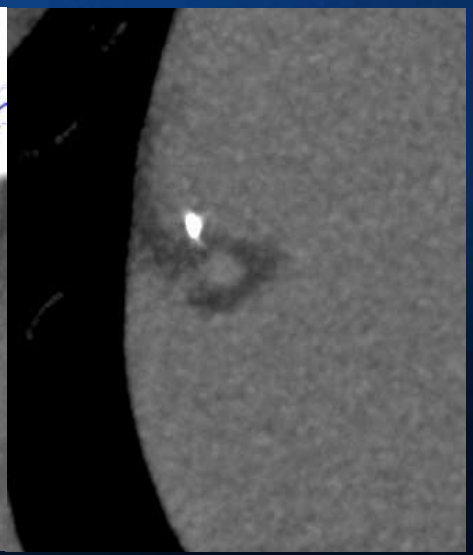




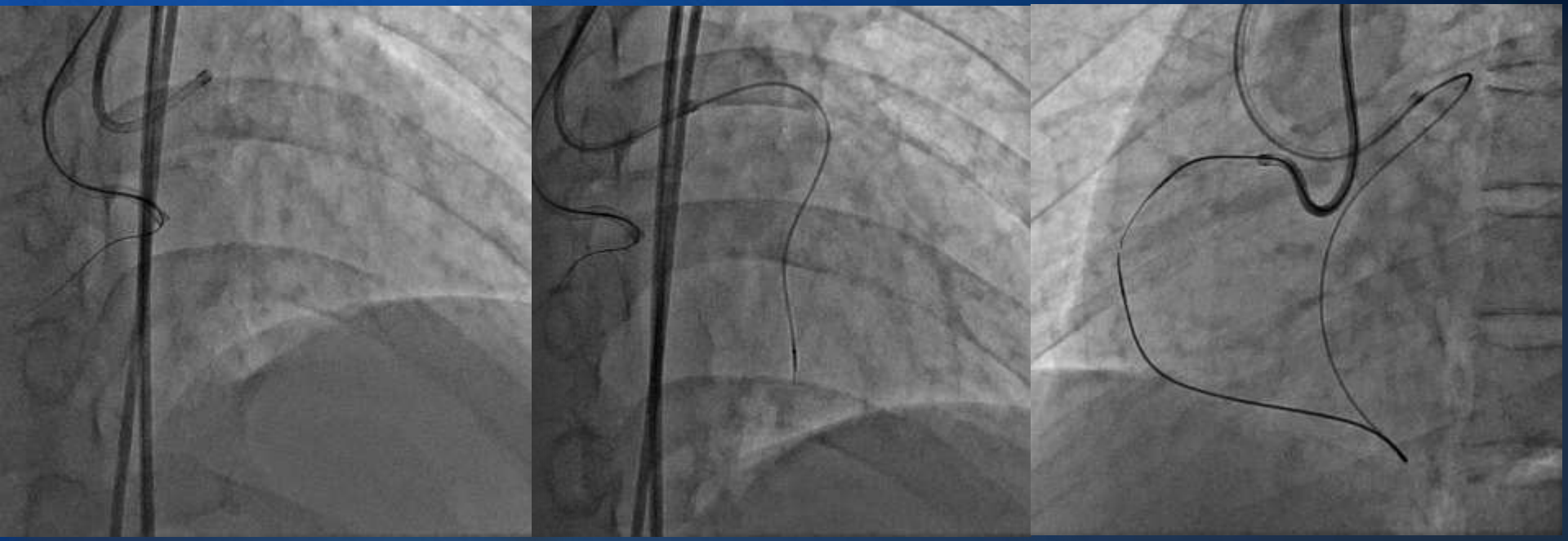
1st Intra-procedural CCTA … failure confirmed by CCTA



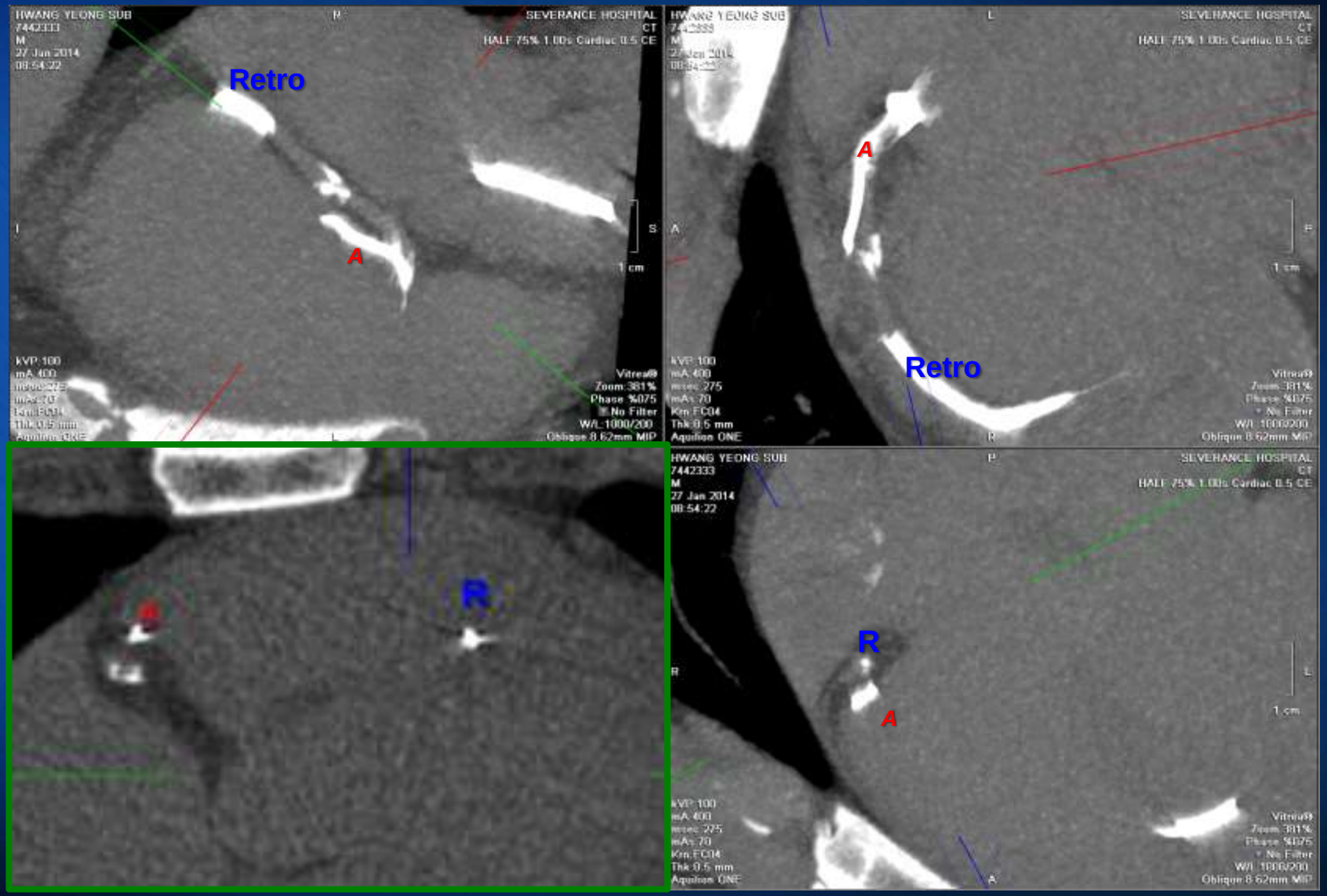




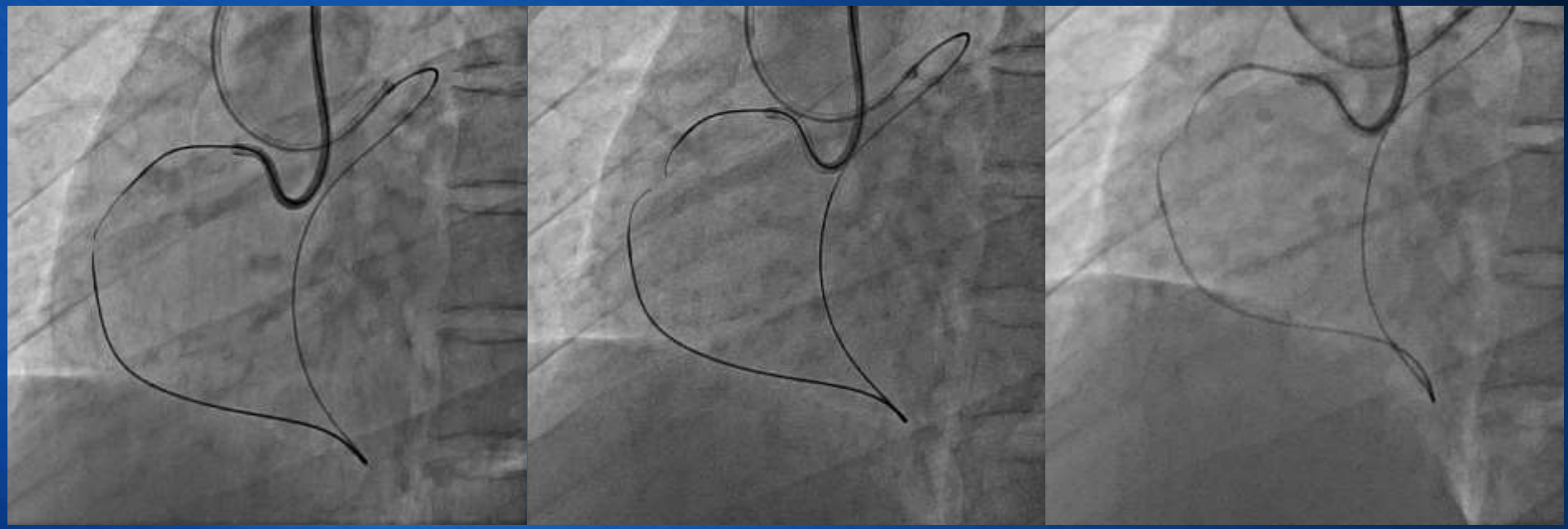
Change into retrograde approach based on the CCTA findings



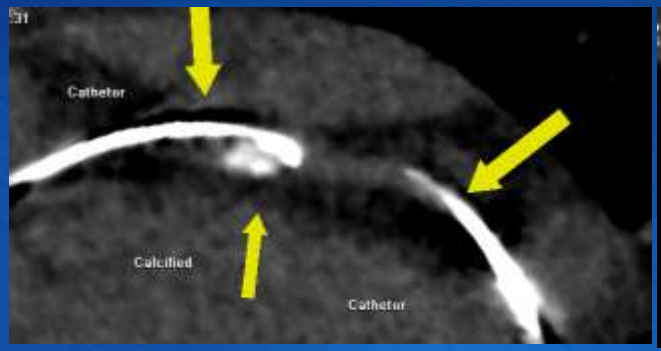
2nd Intraprocedural CCTA during CTO PCI

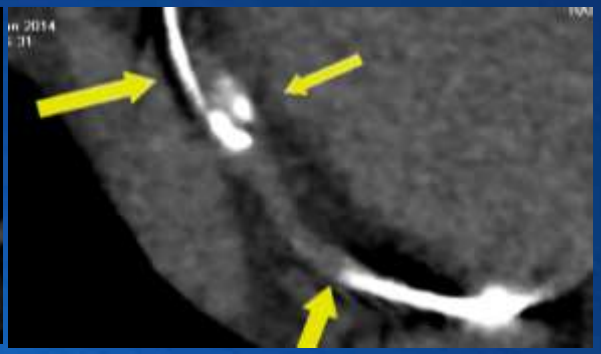


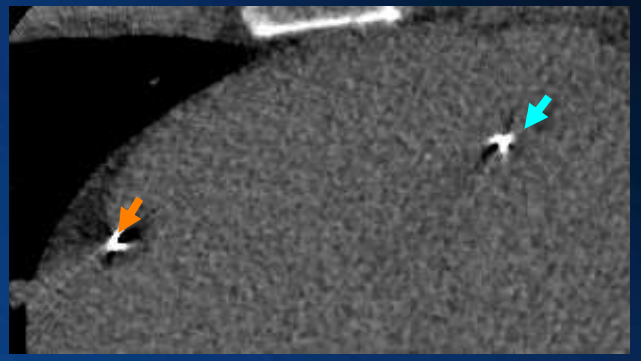
Kissing-wiring for the entrance anterograde wire into the true lumen

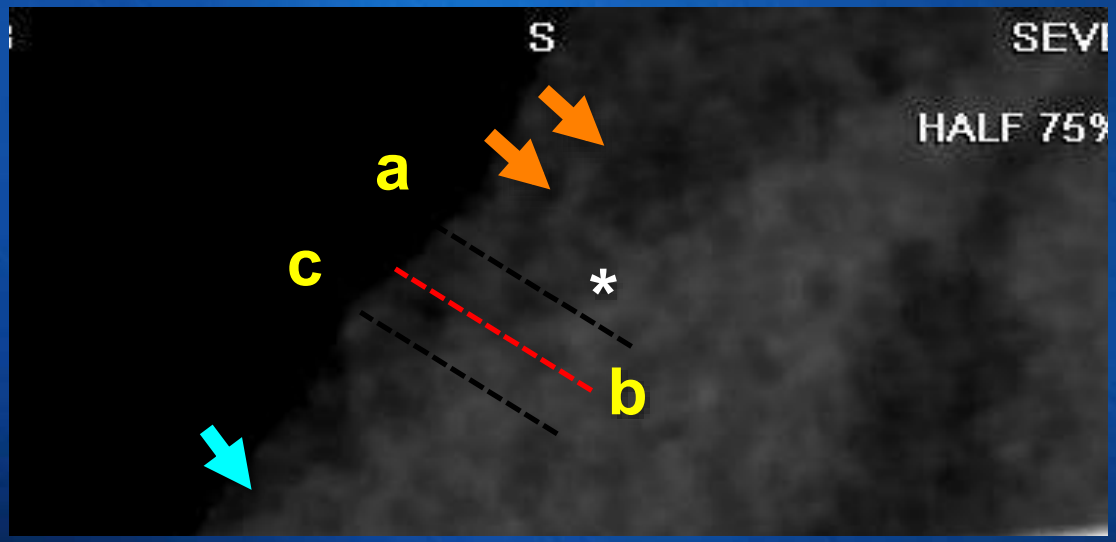


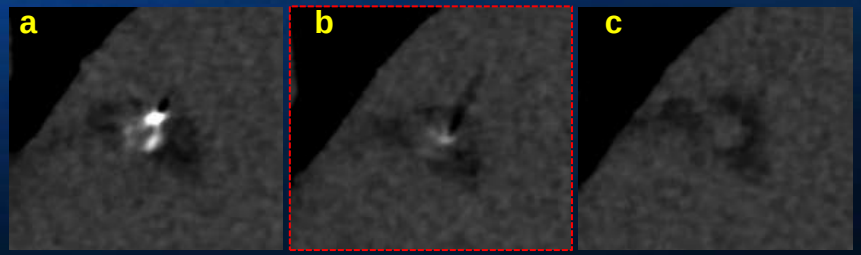
3rd Intraprocedural CCTA during PCI



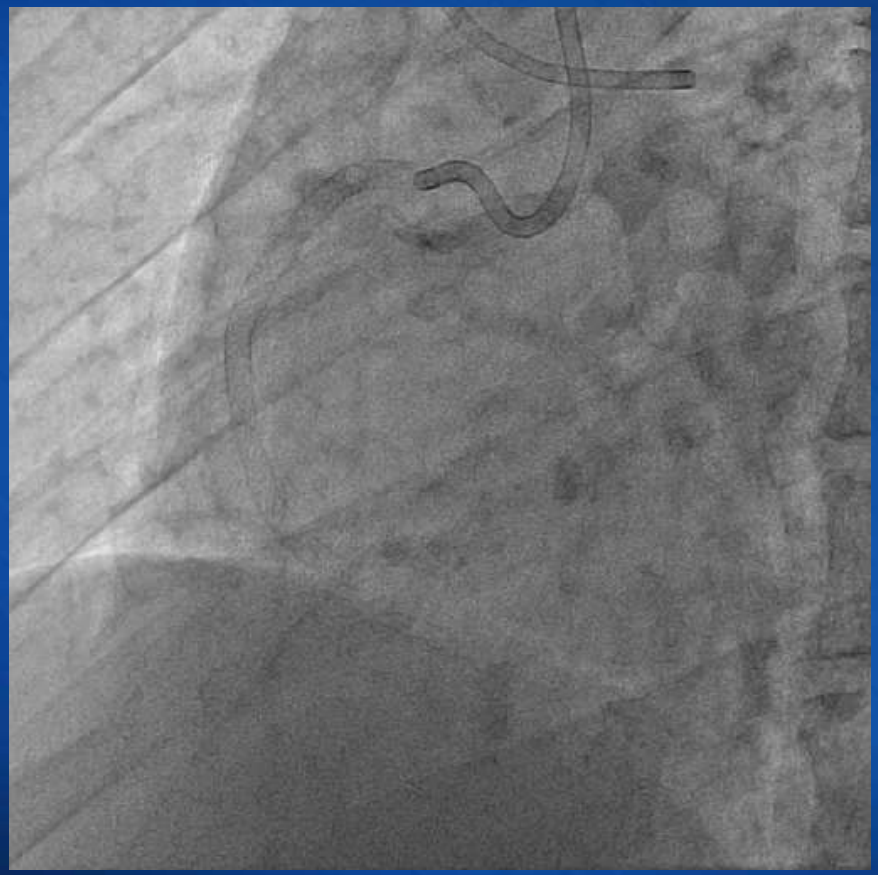


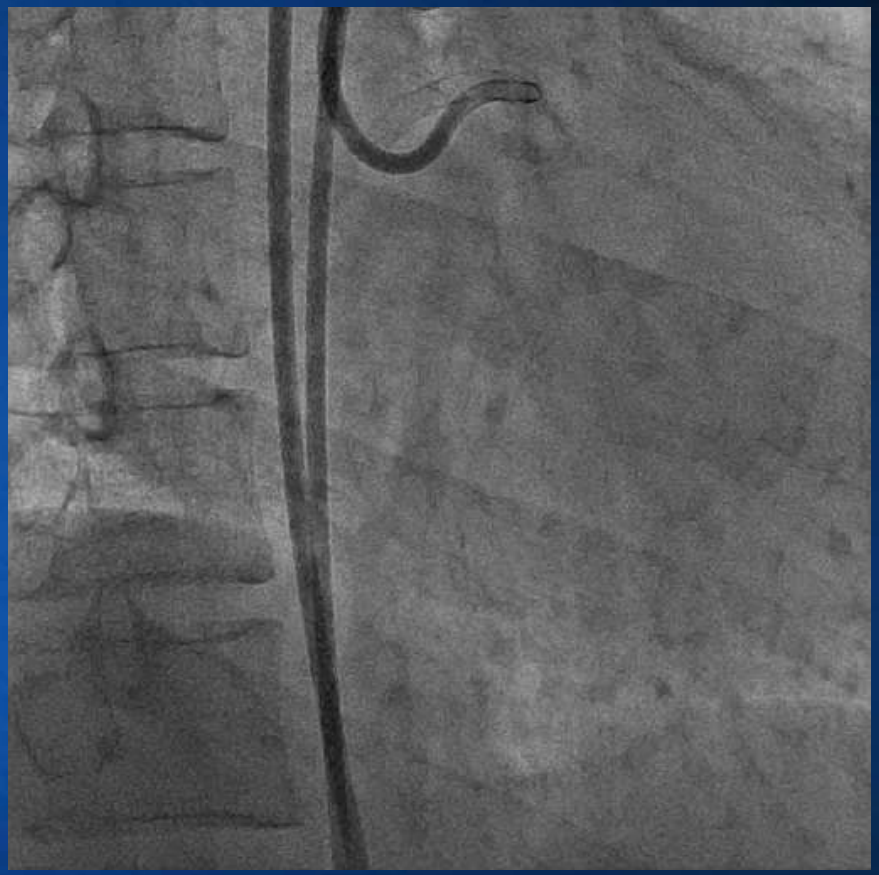






Final angiography

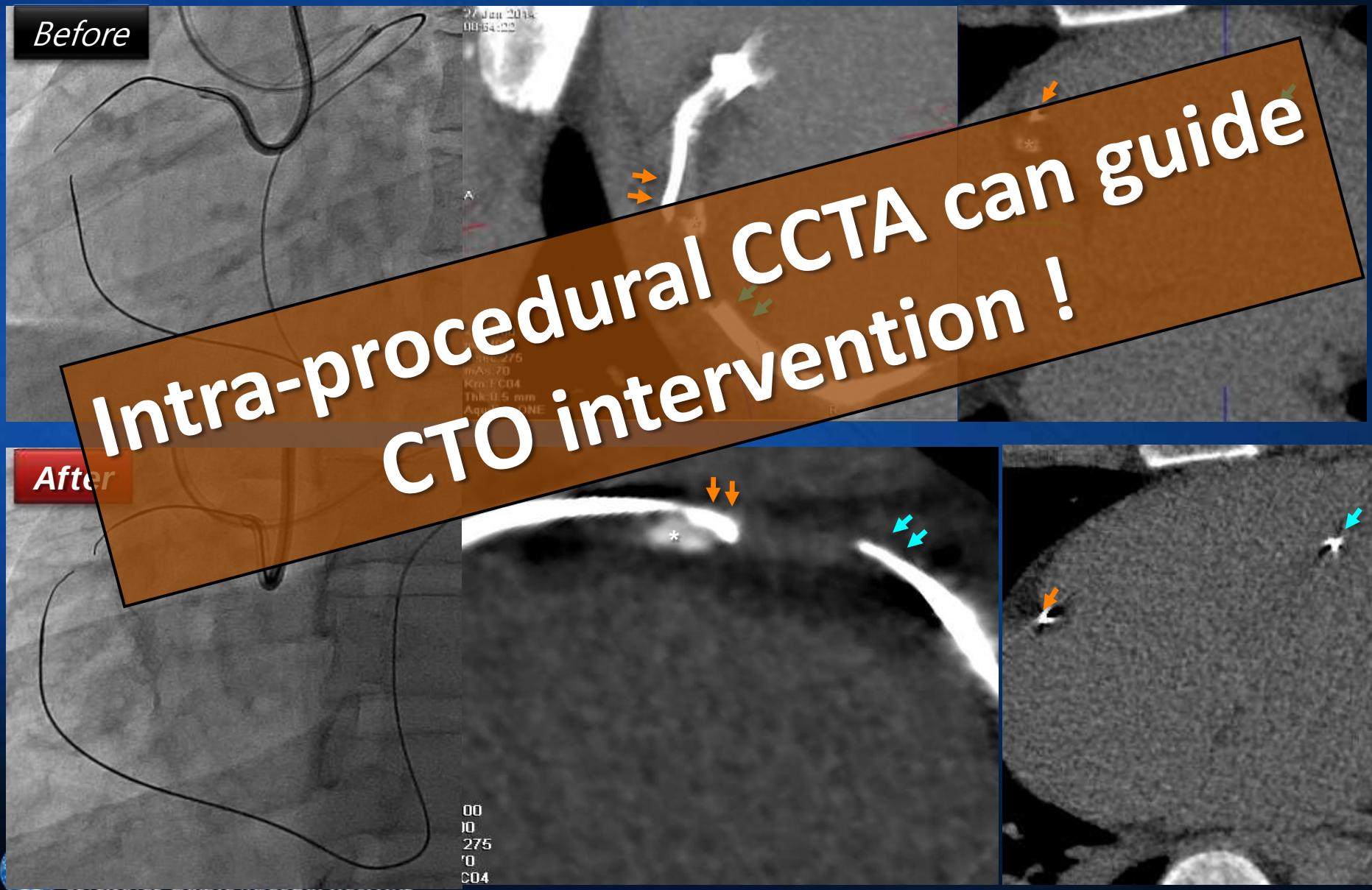




3.5 x 15 & 38 mm Resolute Integrity implantation

CCTA Confirmed the "Way of Guide-wire" in CTO.

→ Based on this CT findings, CTO intervention successfully finished.



5. Outcomes of intraprocedure CCTA for CTO till now

CVIT CT registry (single-center prospective study)

Data of intra-procedure CCTA for CTO

- Objectives

To investigate the role of intraprocedural CCTA during CTO intervention, especially whether CCTA could evaluate the location and path of CTO guidewires.

- Population

Between 2014 and 2015, a total of 61 patients with CTO who underwent intraprocedural CCTA during CTO intervention were consecutively enrolled for this study.

Kim BK, Jang Y. 2016 Am J Cardiol in-press

Summary of CVIT CT registry

Baseline Characteristics

Variables	61 patients
Age, years /Male, n (%)	61.5±10.5 / 88%
Body mass index, kg/m^2	25.7±3.2
DM/ Hypertension	39% / 71%
Myocardial infarction	13%
Prior PCI / CABG	36% / 5%
EF, %	57±13
eGFR, ml/min/1.73 m^2	80.0±15.1
CTO lesion characteristics	
CTO vessels, LAD	43%
Stent CTO	8%
Approach, Retrograde	23%
Vascular accesses, Both femoral arteries	62%
Contralateral angiogram	80%
Successful CTO intervention	80%

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Summary of CCTA

2016 Manuscript submitted

Variables	61 patients
Total number of CCTA evaluation	**72**
Multiple CCTA during intervention, n (%)	10 (16%)
Use of intracoronary contrast injection during scanning, n (%)	29 (**48%**)
Status of guidewire during CCTA, n (%)*	
Single anterograde wire	89%
Parallel wires	4%
Anterograde and retrograde wires	7%
Initial identification only by transverse axial images	56%
→ **Final identification by multiple modalities**	**87%**
Further next procedures after CCTA, %	
Progress of CTO guidewire	34%
Change of the direction of guidewire-tip	33%
Change into different guidewires	26%
Change of CTO approach	7%

Safety concerns; radiation dose, time, contrast volume

Variables	61 patients
Total time for scanning and moving the CCTA system	8.6±2.1 min
Radiation dose for CCTA	2.9±1.5 mSv
Total diluted contrast volume used (mL)	28.5±9.7 mL
Actual contrast volume used (mL)	1.1±0.4 mL

- *A more specific data will be presented at the 2016 EuroPCR.*

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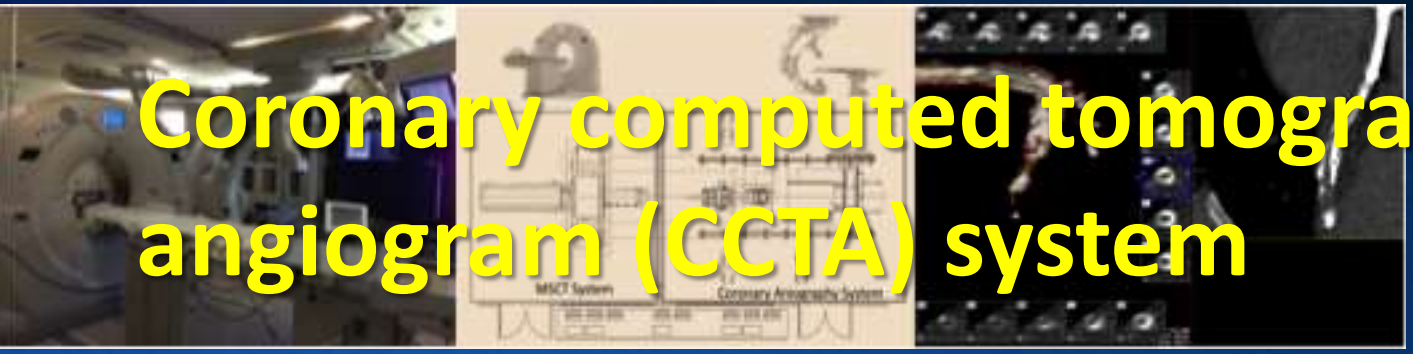

Coronary computed tomographic angiogram (CCTA) system

- ✓ Intraprocedural CCTA for the identification of the location and path of guidewires during CTO intervention was feasible and safe on various CTO intervention.
- ✓ Intracoronary catheter-based contrast injection and the combined assessment of axial and the curved MPR images on the different angles were helpful to recognize the location of guidewires.
- ✓ Intraprocedural CCTA could guide CTO intervention and contribute to the successful procedures.
- ✓ Need to solve the resolution and radiation issue with CCTA

Thank you for your attention