

# Intraprocedural CT imaging: What is the New for Success

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# We Already Know...

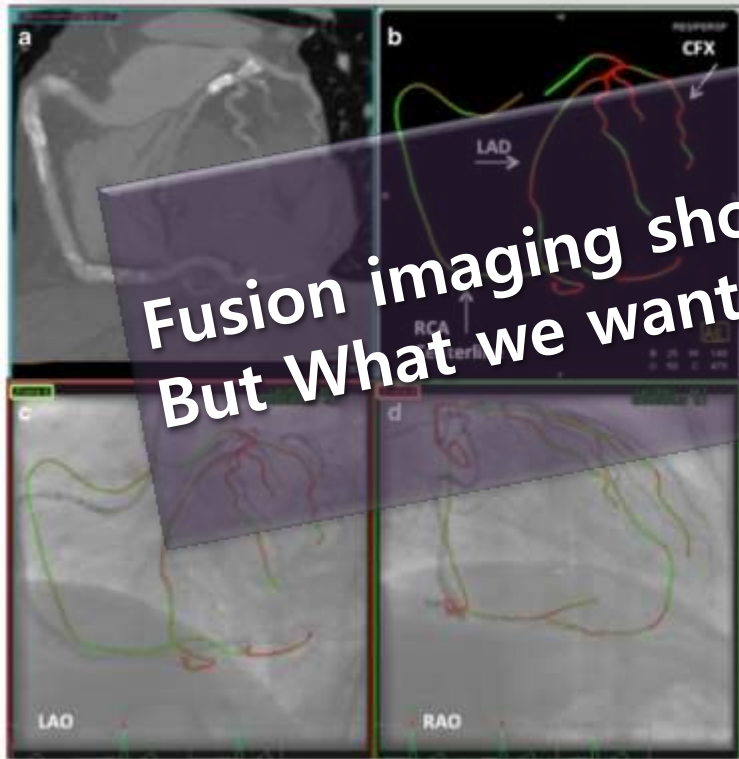
- Coronary CTA can provides lots of information **Before the procedure**
  - Identification and diagnosis of CTO
  - Predicting the clinical benefit from revascularization
  - Pre-procedural Planning
  - Predicting the procedural outcome of PCI
- What about the ‘**During the procedure**’

*What information can CT give during the procedure?*

# Coregistration

## Real-time fusion of coronary CT angiography with x-ray fluoroscopy during chronic total occlusion PCI

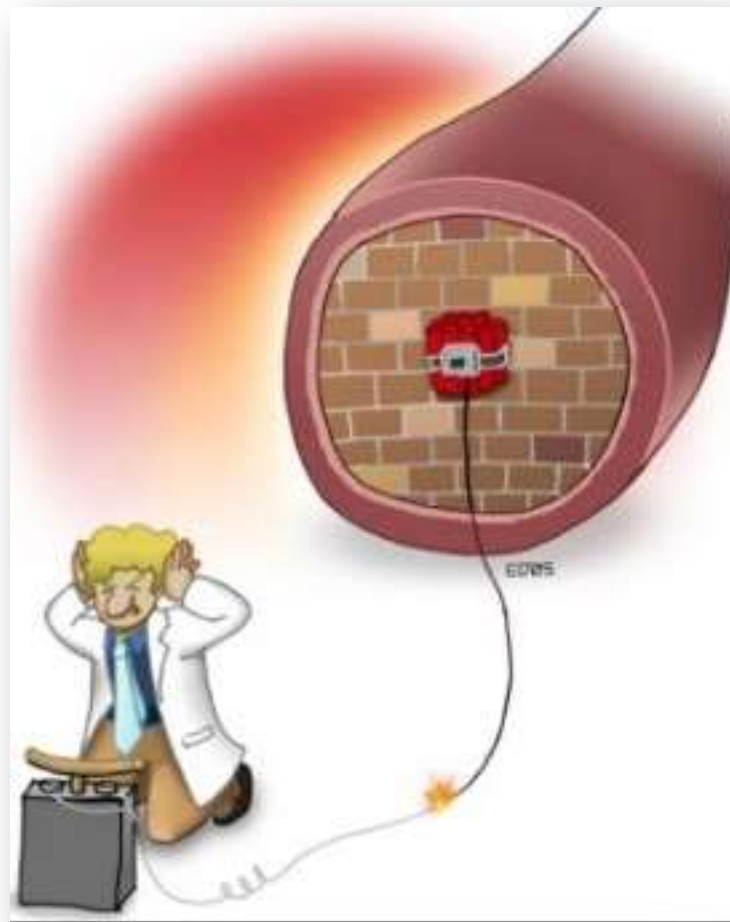
Brian B. Ghoshhajra<sup>1</sup> · Richard A. P. Takx<sup>1</sup> · Luke L. Stone<sup>2</sup> · Erin E. Girard<sup>3</sup> ·  
Emmanouil S. Brilakis<sup>4</sup> · William L. Lombardi<sup>5</sup> · Robert W. Yeh<sup>2</sup> · Farouc A. Jaffer<sup>2</sup>



Fusion imaging shows the way of CTO vividly,  
But what we want to know is where the wire goes' ...

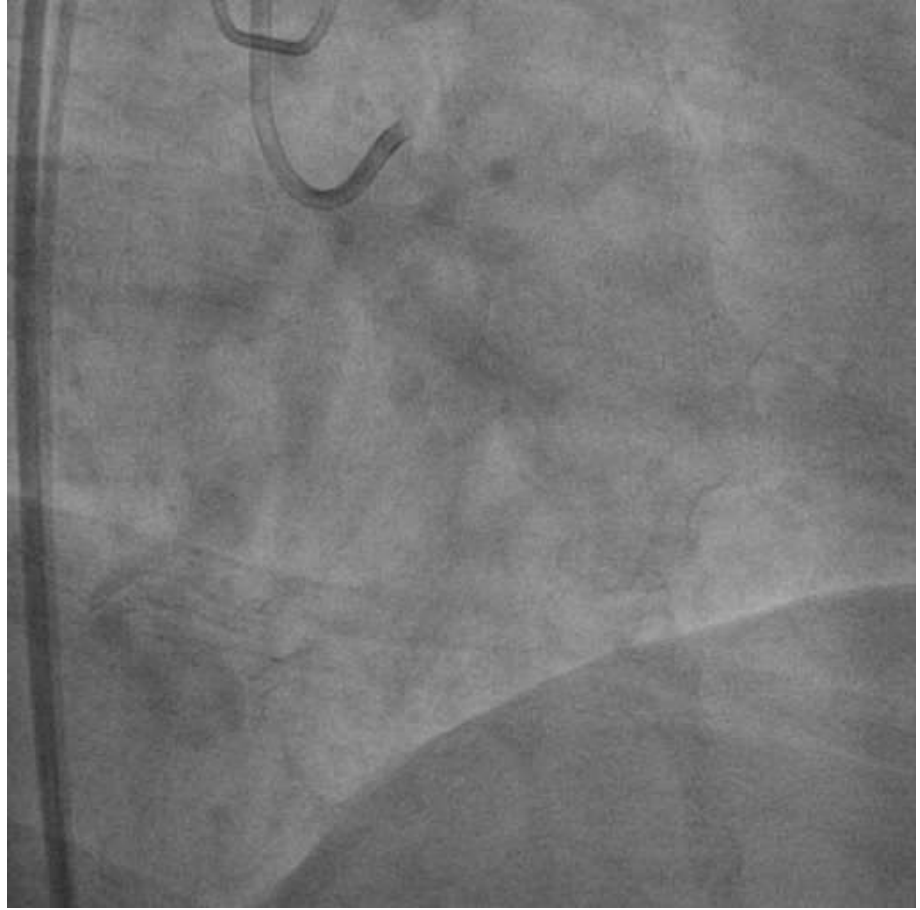
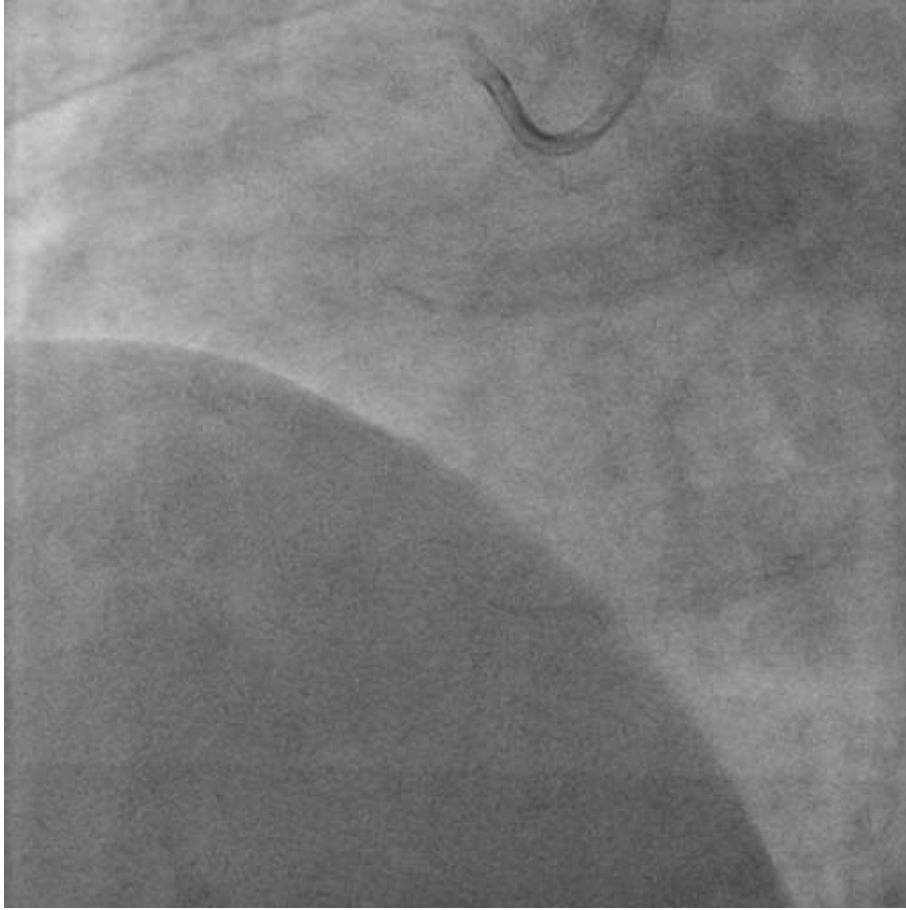
- 24 patients who underwent CTO PCI using the prototype CT fusion software, and 24 consecutive CTO PCI patients without CT guidance served as a control group.
- Overall CTO success rates and procedural outcomes remained similar between the two groups, despite a trend toward higher complexity in the fusion CTA group.

# For the successful CTO intervention



- ✓ **Safe Guidewire crossing** of the CTO lesion is the key !
- ✓ **The location of guidewire** is most important !
- ✓ However, not easy to identify the location of guidewire within CTO segment

# Case. M/49 RCA long-segment CTO

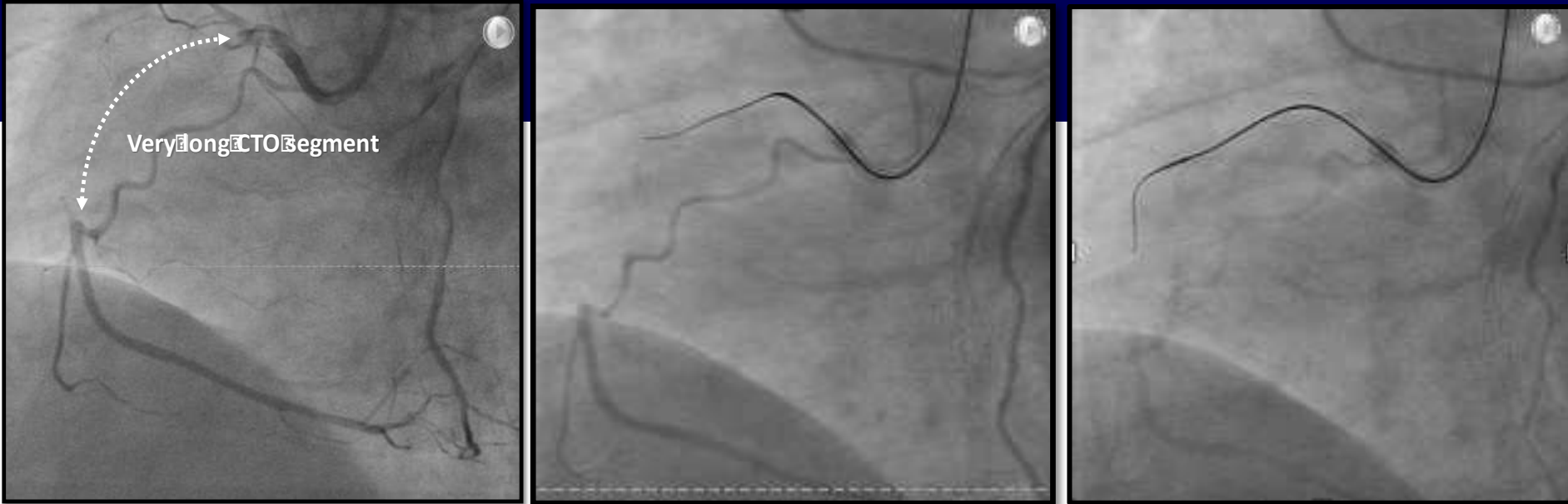


## Start anterograde CTO wiring !

Very long CTO segment

- .... Where are we?
- Guidewire in the true lumen or not?
- No confidence ... resultant hesitation and dangerous next procedures...



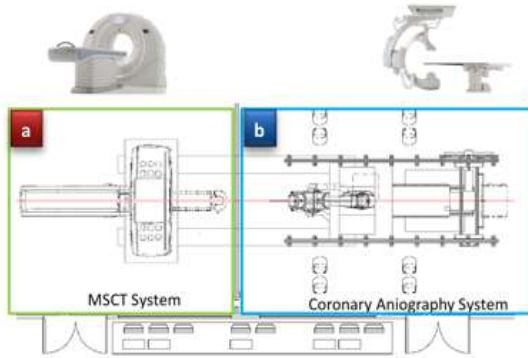


- **How to confirm “tip location in CTO”?**
  - **Conventional methods ... check with angiogram by contralateral injection**
  - **Imaging tools like IVUS or OCT ...**
    - ✓ These can do only after wire crossing by predilation of uncertain location, closely related with the perfect procedural failure.
    - ✓ ... still limitation in viewing the cross sections in the wire-tip-level

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

# Intraprocedural coronary CT angiography (CCTA) ?

## Severance Hospital



- Originally from CT scanning at ER (for emergency intervention) or radiologic cath room (for cancer or neurologic diseases).

- **CCTA system**

1. 640 MDCT applying double-slice technology (Aquilion ONE, Toshiba Medical Systems) (a)
  2. + Coronary angiography system (b)
- allows for CT scan during intervention **without moving the patient on the table.**





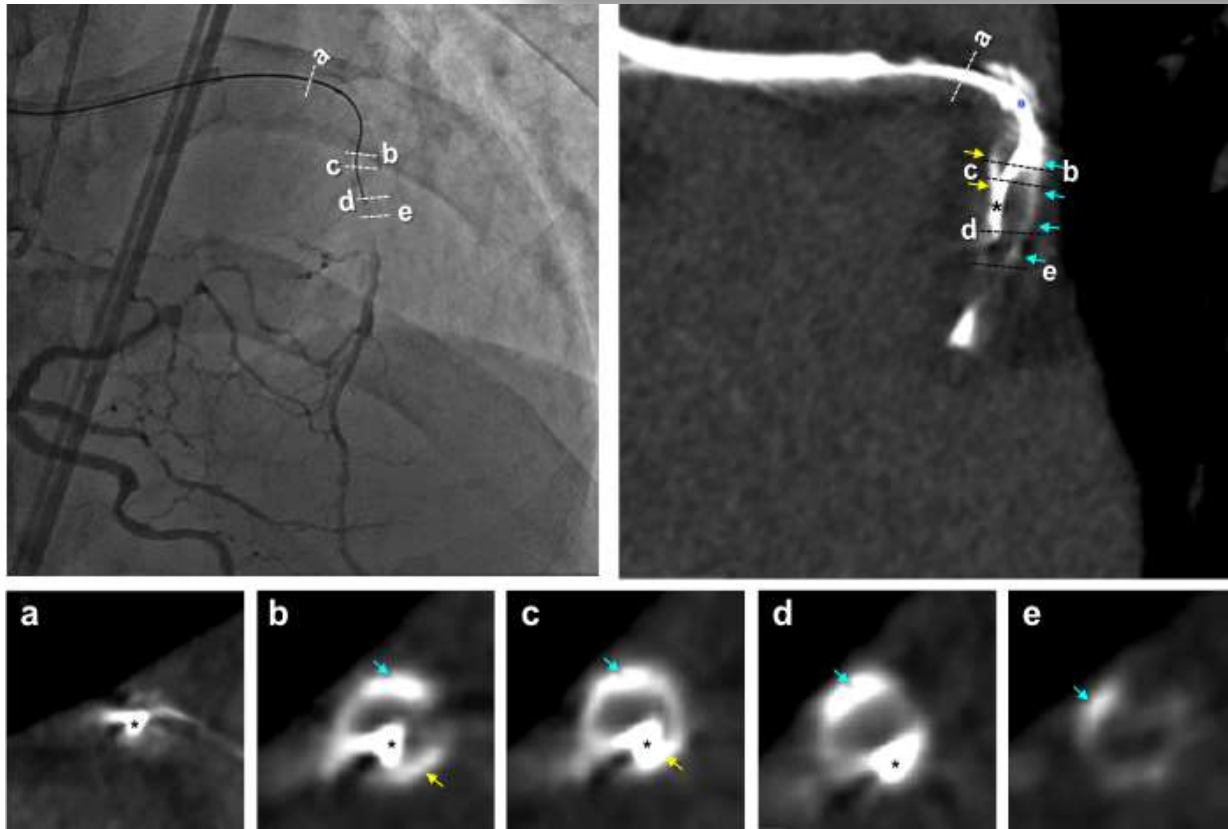
Published world 1st case!

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

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The accompanying supplementary data are published online at: [http://www.pci-online.com/insertion/intervention/ahead\\_of\\_print/201505-01](http://www.pci-online.com/insertion/intervention/ahead_of_print/201505-01)



- ✓ **Cross-sectional CCTA images showed the location of the guidewire, where the guidewire was slightly deviated but definitely differentiated from the calcified vessel wall.**

The asterisks and blue and yellow arrows indicate the guidewire and calcified plaques, respectively.

# Usefulness of Intraprocedural Coronary Computed Tomographic Angiography During Intervention for Chronic Total Coronary Occlusion

Byeong-Keuk Kim, MD, PhD<sup>a</sup>, Iksung Cho, MD<sup>a</sup>, Myeong-Ki Hong, MD, PhD<sup>a,b</sup>, Hyuk-Jae Chang, MD, PhD<sup>a</sup>, Dong-Ho Shin, MD, DrPh<sup>a</sup>, Jung-Sun Kim, MD, PhD<sup>a</sup>, Sanghoon Shin, MD<sup>c</sup>, Young-Guk Ko, MD<sup>a</sup>, Donghoon Choi, MD, PhD<sup>a</sup>, and Yangsoo Jang, MD, PhD<sup>a,b,\*</sup>

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Although intraprocedural coronary computed tomographic angiography (CCTA) allows for scanning during intervention without relocation of the patient, studies have yet to report on its use during chronic total occlusion (CTO) intervention. Therefore, we investigated the role of CCTA during CTO intervention, particularly whether CCTA could be used to evaluate the location of guidewires. A total of 61 patients scheduled for elective CTO intervention were consecutively enrolled and underwent CCTA and on-site analyses during intervention. Transverse axial and the curved multiplanar images in a 360-degree view were interactively used together to identify the location of guidewires, along with the adjustment of window condition. Intracoronary contrast injection was used for specific cases requiring enhancement of the distal part of the CTO. Most CCTAs were performed to confirm the location of a single guidewire; CCTA was also performed to evaluate parallel (3 patients) or retrograde wires (5 patients). The initial identification rate for guidewire location was 56% with immediate transaxial images, but it significantly increased to 87% after interactive on-site uses of the curved multiplanar images ( $p < 0.001$ ). Cases in which guidewire location could be predicted with CCTA evaluation show a numerically higher success rate than those that could not (83% vs 63%) but not statistical significance ( $p = 0.174$ ). The mean time for CCTA evaluation and mean radiation dose were 8.6 minutes and 2.9 mSv, respectively. No specific complications occurred after CCTA and CTO procedures. Intraprocedural CCTA for identifying the location of the guidewires is feasible and safe when used for various CTO procedural steps. © 2016 Elsevier Inc. All rights reserved. (Am J Cardiol 2016;117:1868–1876)

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# Objectives

- **To investigate the role of intraprocedural coronary computed tomography angiography (CTA) during CTO intervention, particularly whether intraprocedural coronary CTA could be used to evaluate the location of guidewires.**

# Methods (1)

- A prospective single-center
- Study Population

**Between January and December 2014, a total of 61 patients who were scheduled for elective CTO intervention were consecutively enrolled and then underwent CCTA and on-site analyses of CCTA images during intervention.**

- Inclusion criteria

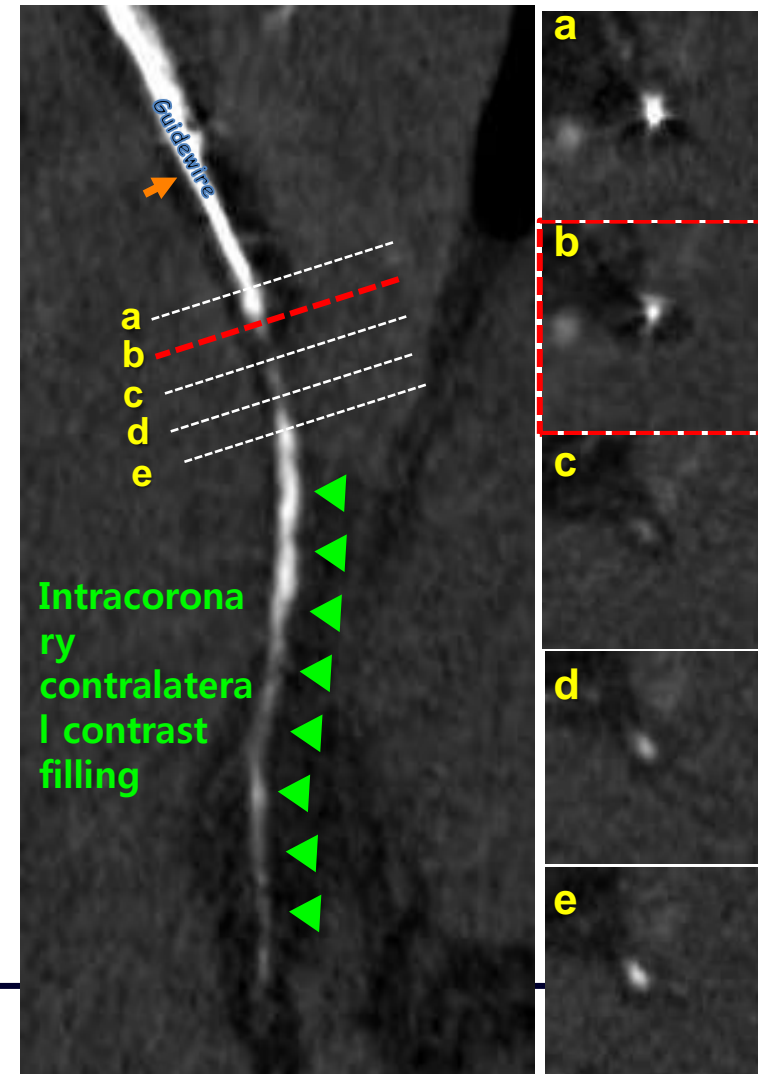
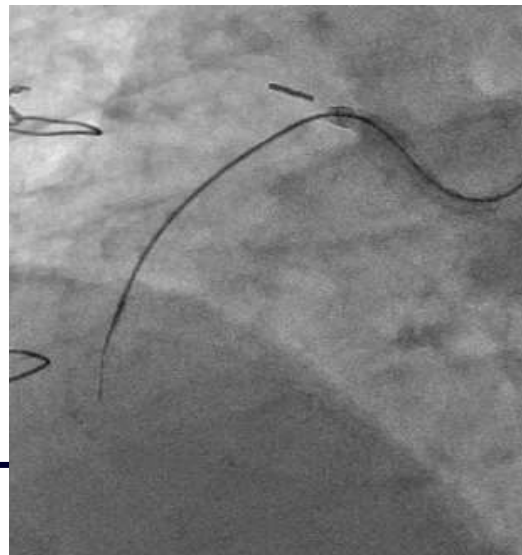
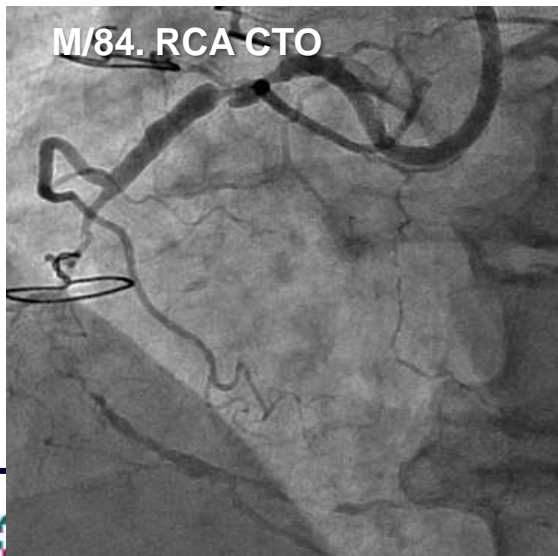
**All patients without specific contraindications for CT scanning were allowed (No specific inclusion conditions !).**



# Strategy improving the identification of guidewire

- Intracoronary contrast-injection during CCTA**

- The behind CTO segment, which could not be prominent on CCTA, was enhanced during CCTA (30 mL of mixed contrast medium at 5 mL/s flow rate)
- The more clear differentiation was enable.
- ... enable to know the further course of wire





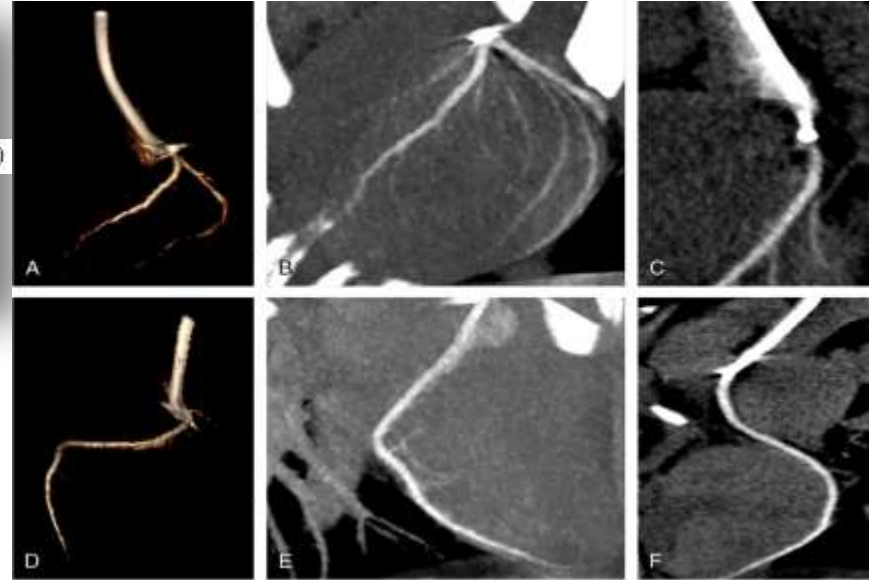
# Intracoronary contrast injection

## 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)

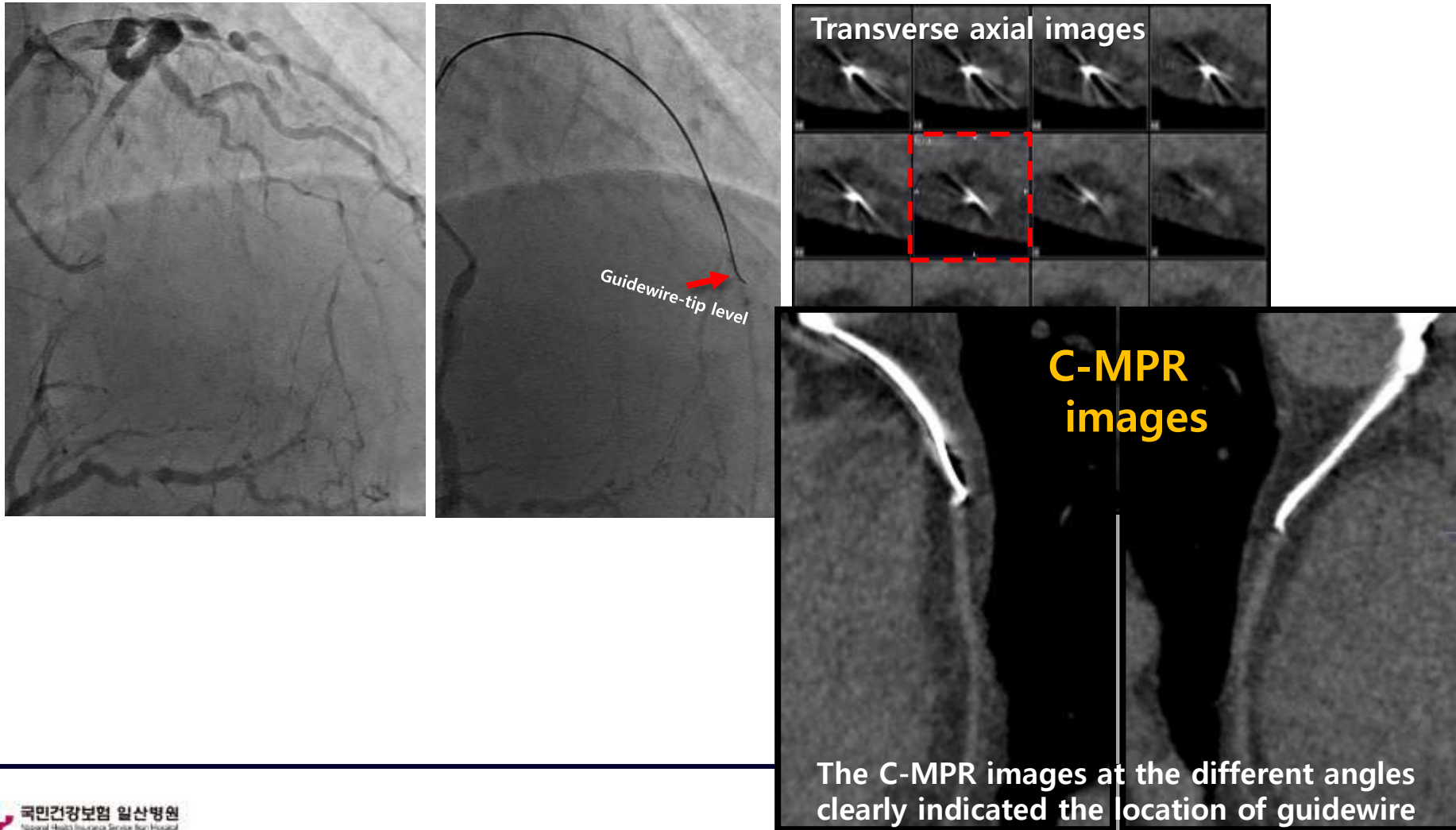
Youngtaek Hong, BS,\* Sanghoon Shin, MD,† Hyung-Bok Park, MD,‡§ Byoung Kwon Lee, MD,||  
Reza Arsanjani, MD,¶ Brian ó Hartaigh, PhD,# Seongmin Ha, BS,# Yeonggul Jang, BS,\*  
Byunghwan Jeon, BS,\* Sunghye Jung, BS,\* Se-Il Park, PhD,\*\* Ji Min Sung, PhD,††  
Hackjoon Shim, PhD,‡‡ and Hyuk-Jae Chang,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



# Strategy improving the identification of guidewire

- Image reconstruction, Curved multiplanar reconstruction (MPR) images

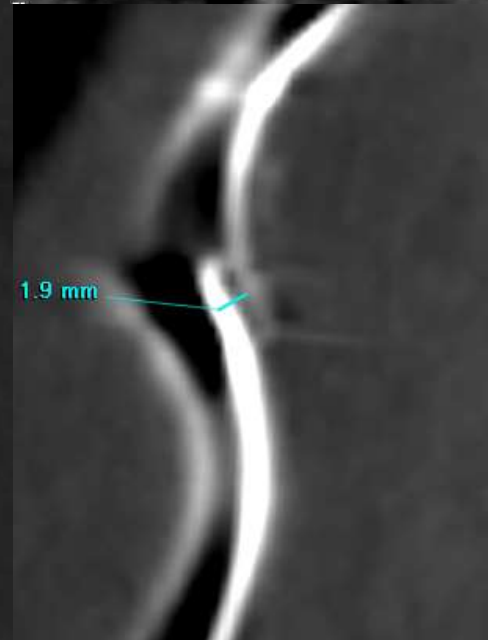
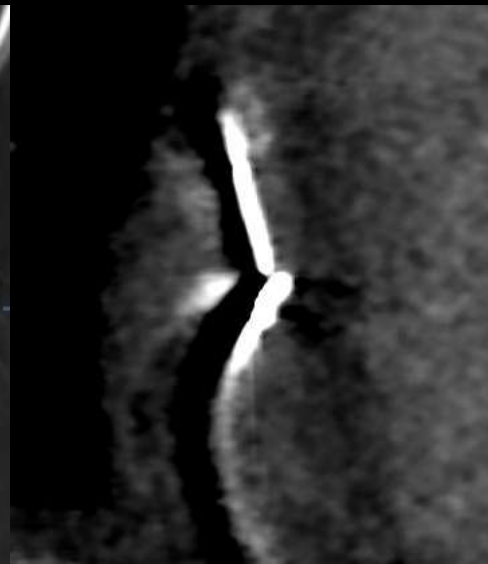
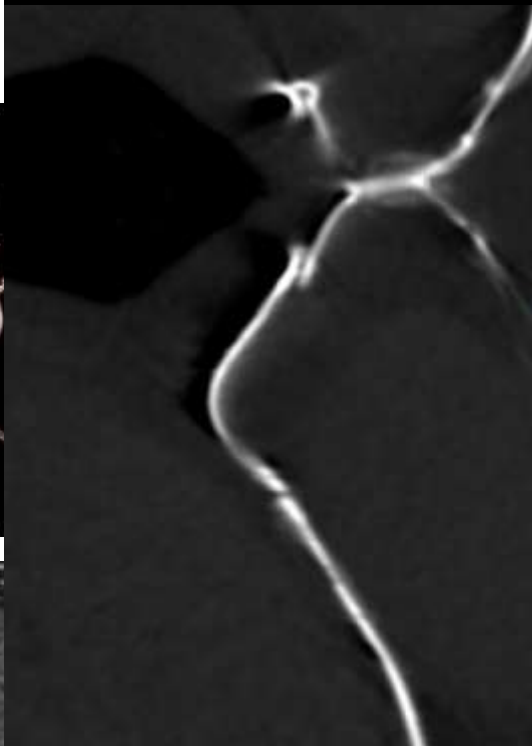
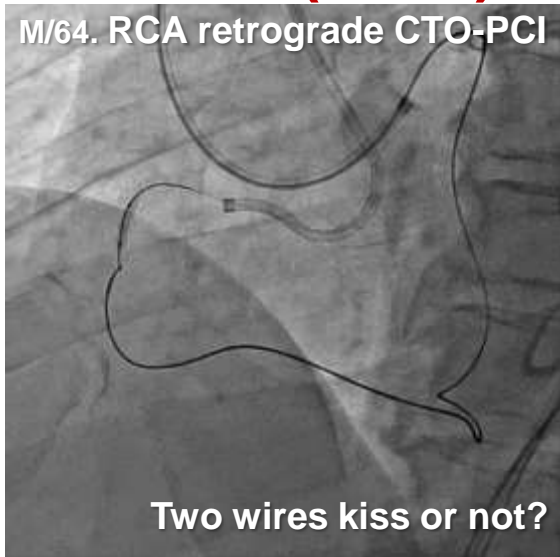


# Strategy improving the id

- Image reconstruction, Cu
- struction (MPR) images

## C-MPR images & adjustment of window depth & level

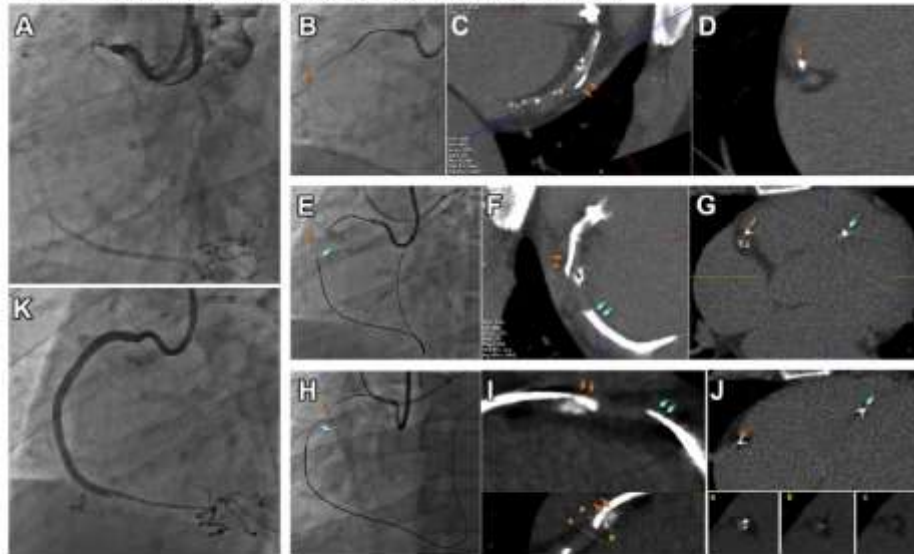
M/64. RCA retrograde CTO-PCI



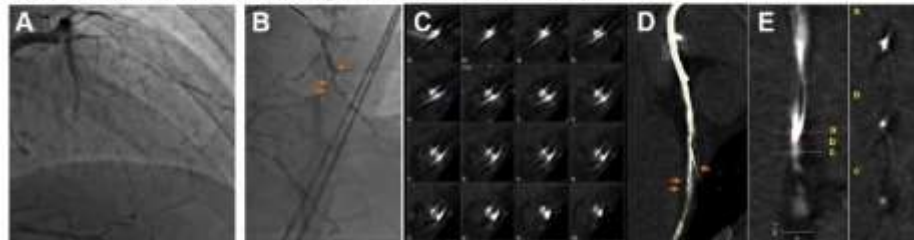
# CCTA application for the various CTO intervention

(besides single-wire status)

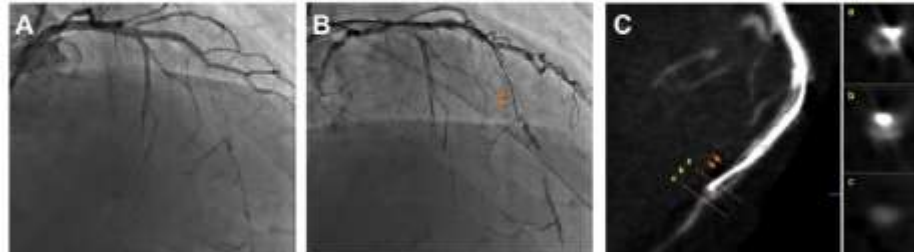
## #1. CCTA evaluation during retrograde intervention



## #2. CCTA evaluation during parallel wire technique



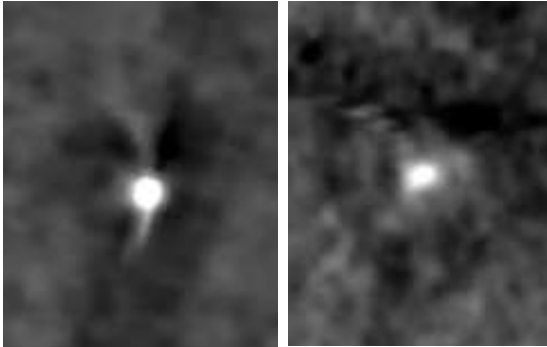
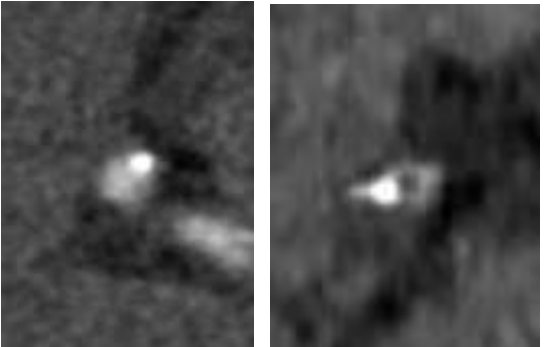
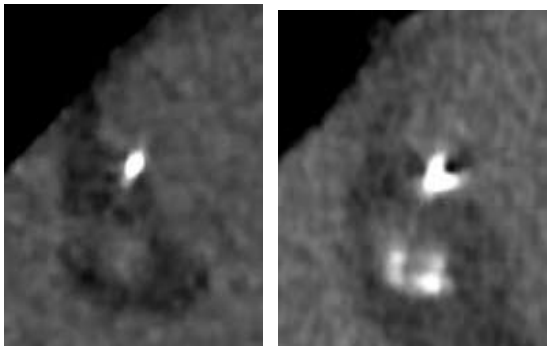
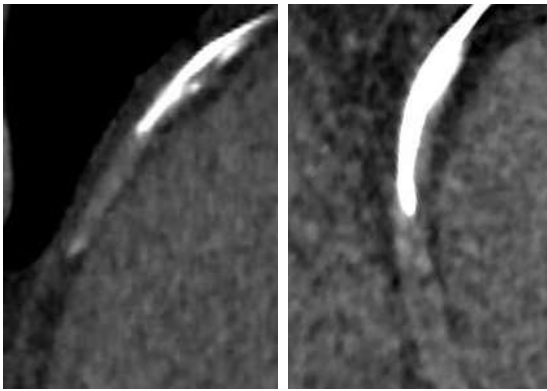
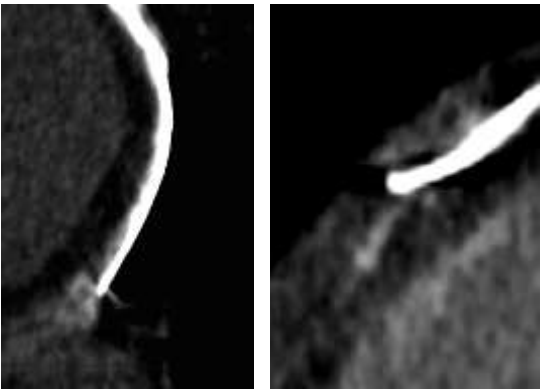
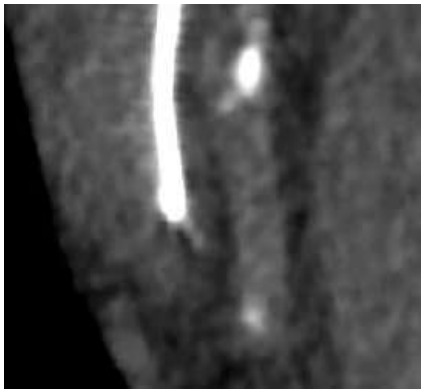
## #3. Stent CTO lesion





# Classification of the location of the guidewires based on the CCTA

Selected CCTA images were transferred to a workstation (Vitrea fx 6.4, Vital Images)

	A. Intraplaque zone	B. Subintimal zone	C. Outside-vessel zone
Transverse axial images			
C-MPR images			
	Located <b>inside the vessel and clearly differentiated from vessel wall</b>	The guidewire-tip was deviated to the lateral vessel wall and not differentiated from the vessel wall	The guidewire was completely out of the vessel wall.



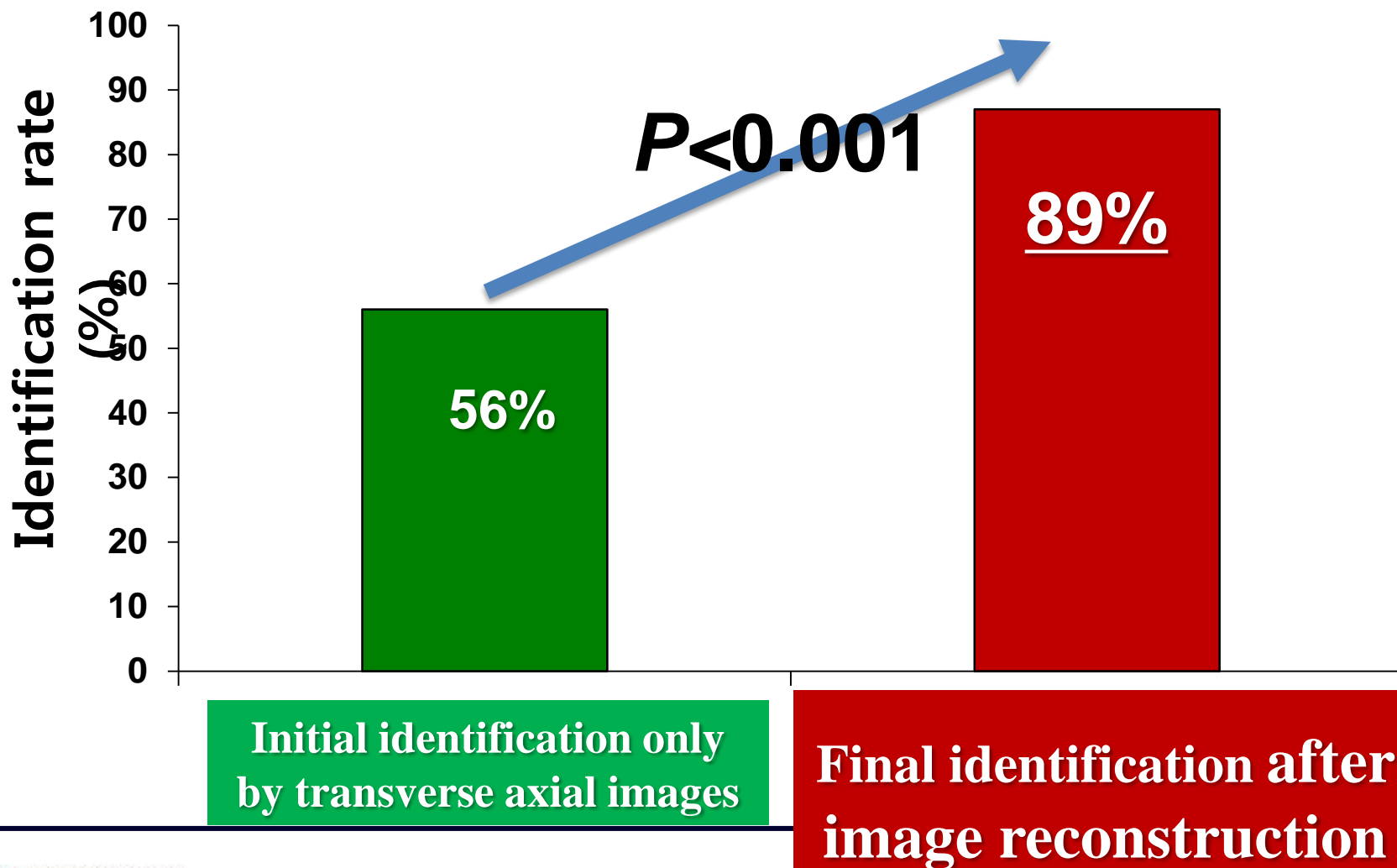
# Results; Baseline Characteristics

Variables	61 patients
Age /Male	62 ± 11 years / 88%
Body mass index (kg/m <sup>2</sup> )	26 ± 3
DM/ Hypertension	39% / 71%
Prior MI / PCI / CABG	13% / 36% / 5%
EF (%)	57 ± 13
<i>CTO lesion &amp; procedural characteristics</i>	
J-CTO score ≥3 (very difficult)	51%
CTO vessels, LAD	43%
Stent CTO	8%
Approach, Retrograde	23%
Contralateral angiogram	80%
Total procedure time (min)	101.3 ± 60.2
Total contrast volume used (mL)	361.3 ± 112.6
Total radiation dose (mSV)	110.5 ± 77.9

# Results; Summary of CCTA (1)

Variables	61 patients
<b>Total number of CCTA evaluation</b>	<b>72</b>
→ Multiple CCTA during intervention	16%
<b>Use of intracoronary contrast injection</b>	<b>48%</b>
Status of guidewire during CCTA	
Single anterograde wire	89%
<b>Parallel wires</b>	<b>4%</b>
<b>Anterograde and retrograde wires</b>	<b>7%</b>
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%

Comparison of *identification rate* regarding the guidewire location



# Results; Summary of CCTA (3)

Variables	61 patients
Time for scanning and moving the CCTA system	8.6±2.1 min
Time for CCTA analyses including data transfer	8.5±1.9 min
Radiation dose for CCTA	2.9±1.5 mSv
Actual contrast volume used for CCTA (mL)	1.1±0.4 mL
Intraprocedural or in-hospital complications after any of the CCTA and CTO interventions	0%

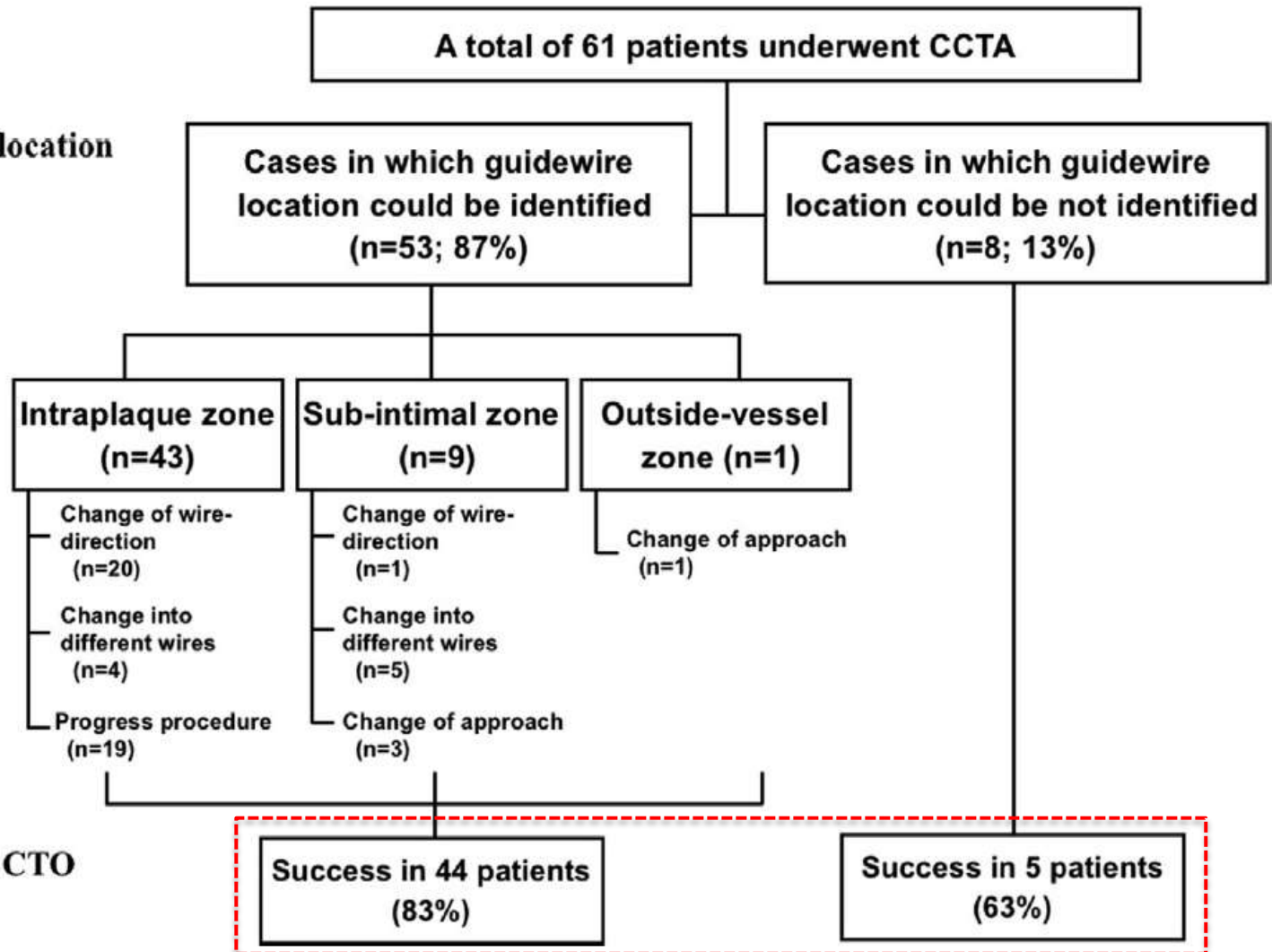
# Comparison of the success rates according to the CCTA findings

- Identification of the location of guidewire

- Possible location of guidewire tip

- Further procedures

- Final success rate of CTO intervention





# Limitation

- **The classification regarding possible locations of guidewire (A. Intraplaque zone / B. Subintimal zone / C. Outside-vessel zone) could be arbitrary.**
- **Because of blooming artifact, motion artifact, the wire can hard to see perfectly.**
- **To confirm the real location of guidewires, the validating test will be needed.**

# Summary & Conclusion

- This study was **the first to investigate** the implications of **intraprocedural CCTA for CTO** intervention.
- **Intraprocedural CCTA for identifying the location of the guidewires is feasible and safe** when used for various CTO procedural steps.
- **Intracoronary catheter-based contrast-injection and combined assessment of axial and C-MPR images** at different angles were also helpful for determination of guidewire location.

**Thank you for your  
attention**