

CTO Imaging Up-to-Date

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CTO Imaging

- MDCT
- CAG
- IVUS

The information from MDCT for CTO PCI

1. Distribution of calcified and non calcified area at CTO lesions
2. The 2 perpendicular angles of the X-ray system detector for wire manipulation
3. The images that CAG can not detect
 - a. Non CTO stump at entrance
 - b. Vessel route without calcification
 - c. No image at exit

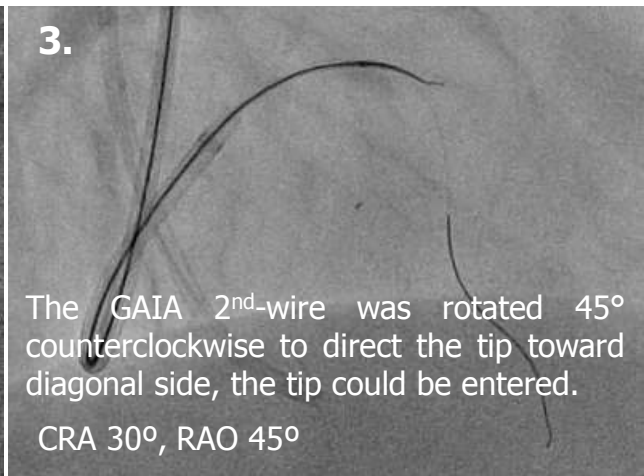
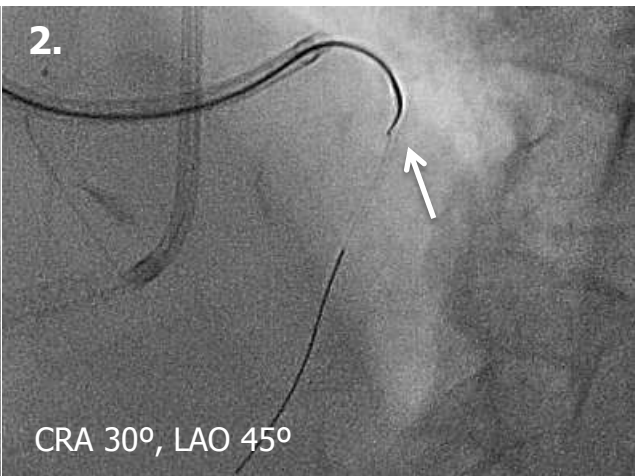
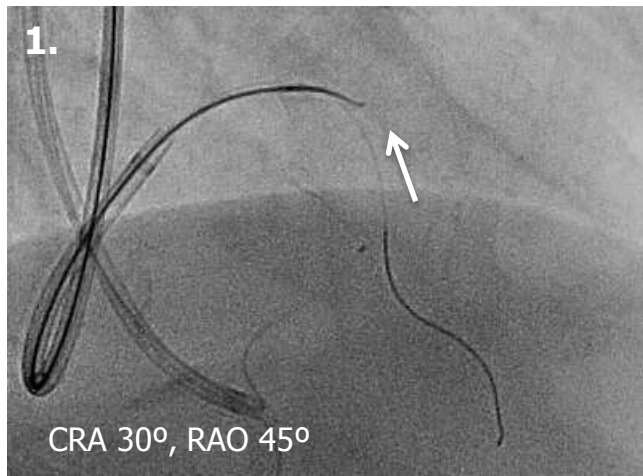
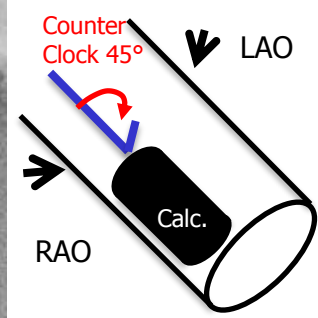
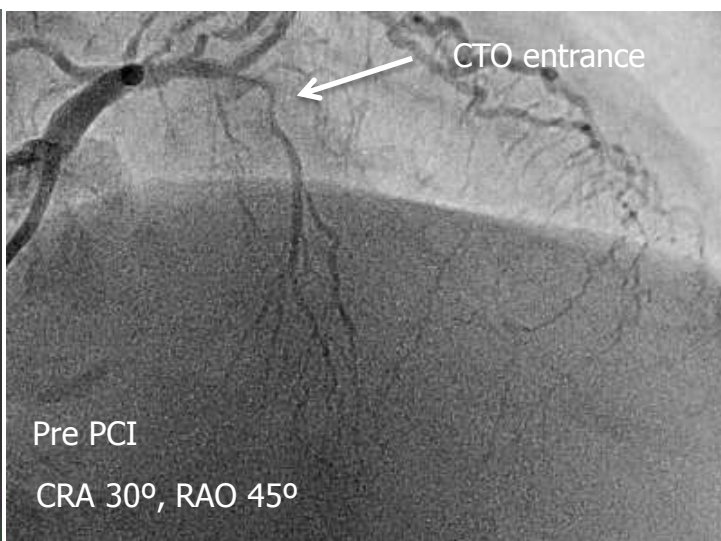
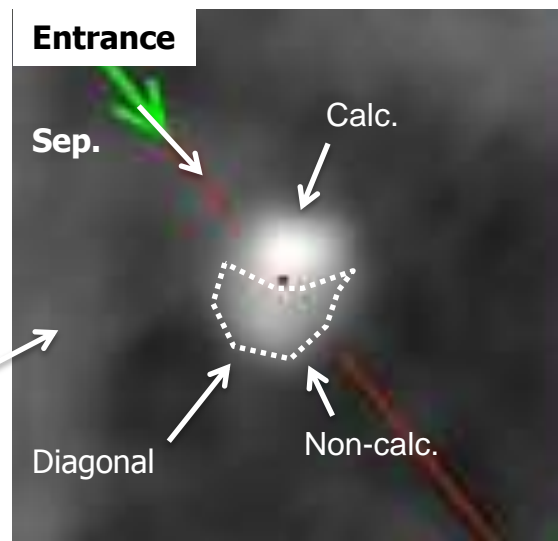
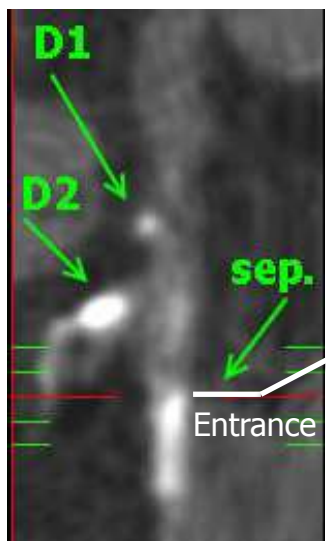
The information from MDCT for CTO PCI

1. Distribution of calcified and non calcified area at CTO lesions
2. The 2 perpendicular angles of the X-ray system detector for wire manipulation
3. The images that CAG can not detect
 - a. Non CTO stump at entrance
 - b. Vessel route without calcification
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MDCT showed the distribution of calcified and non calcified area at the entrance of CTO.

The information from MDCT

- ① Entrance was located just after the septal branch
- ② Non-calc. area was located at the diagonal side
- ③ Perpendicular angle of angiographic image was from CRA 45° LAO 45° to RAO 45° from entrance to exit



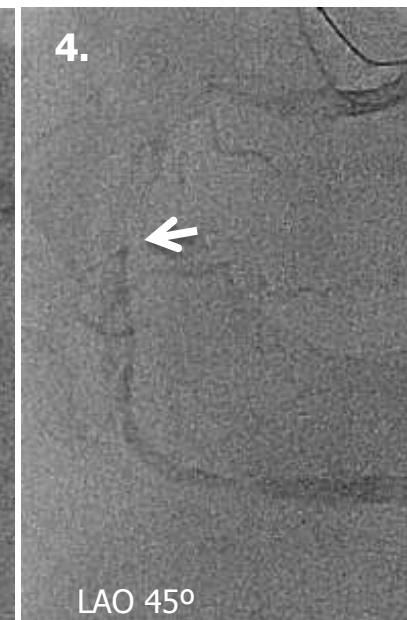
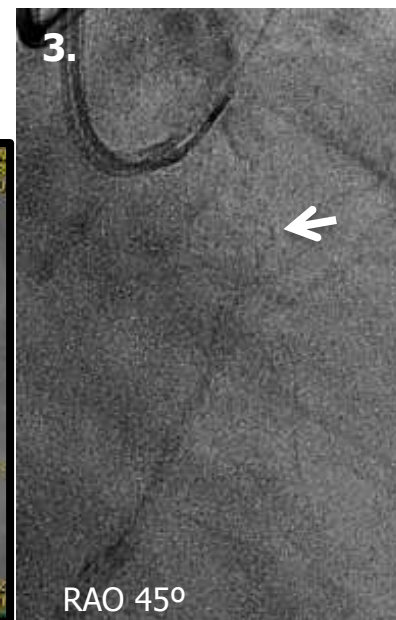
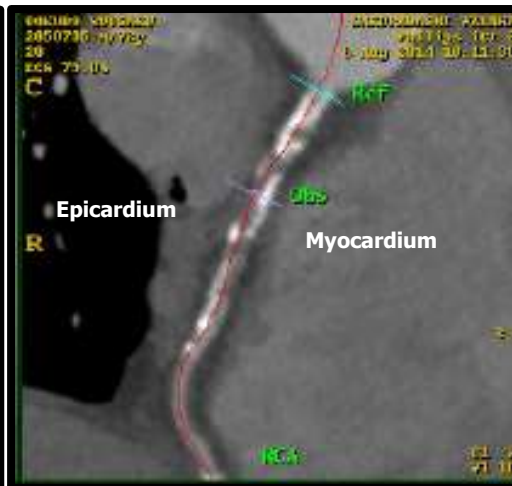
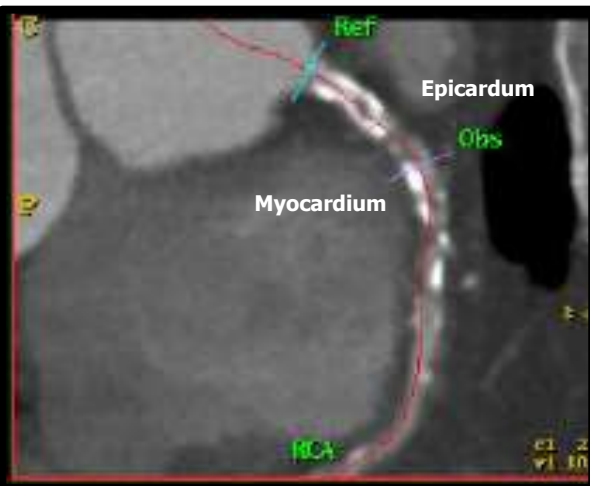
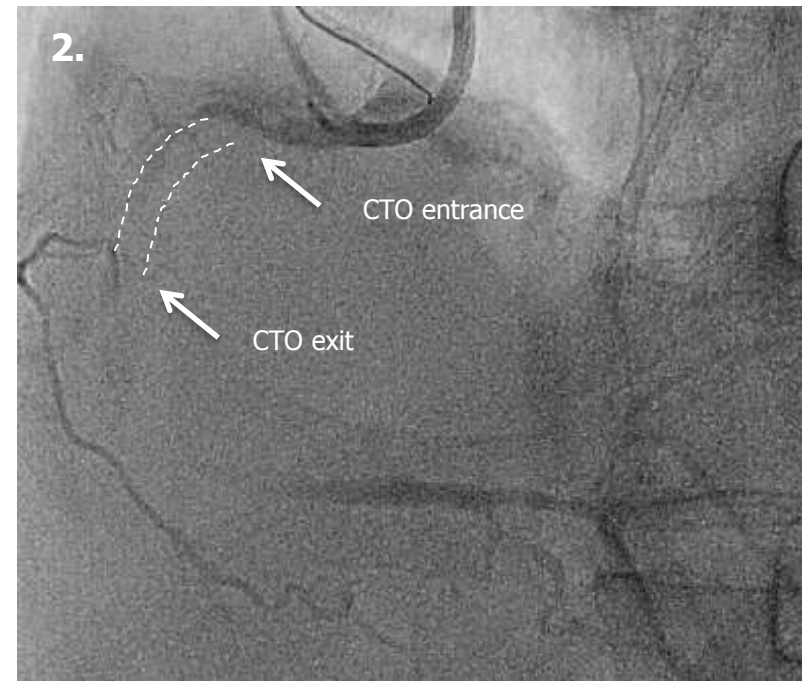
The GAIA 2nd-wire was rotated 45° counterclockwise to direct the tip toward diagonal side, the tip could be entered.

CRA 30°, RAO 45°

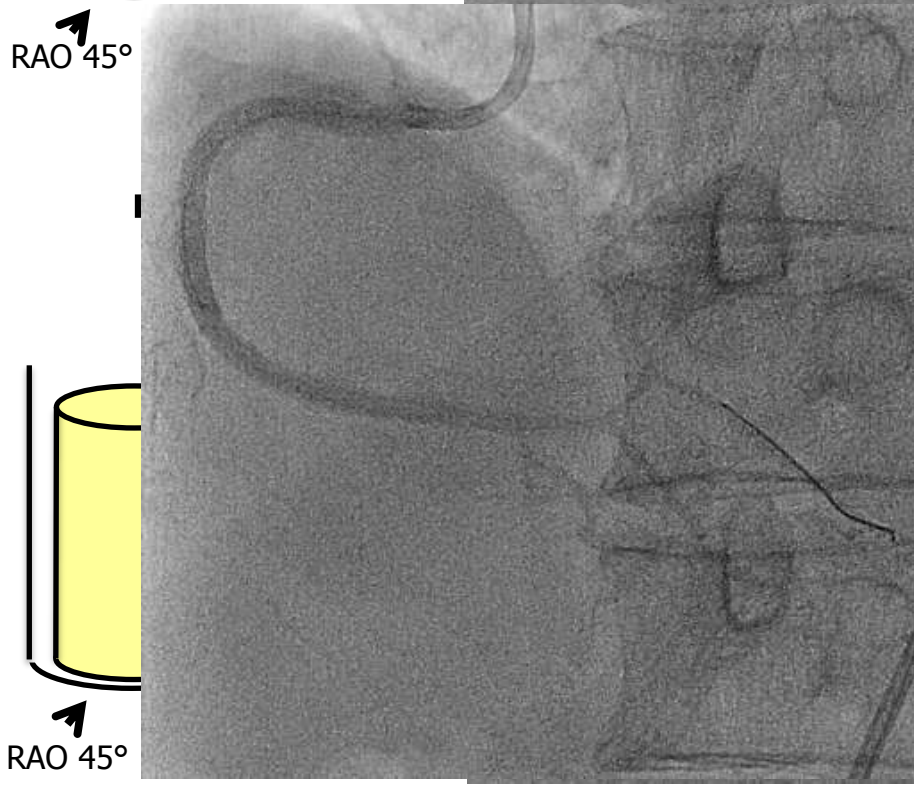
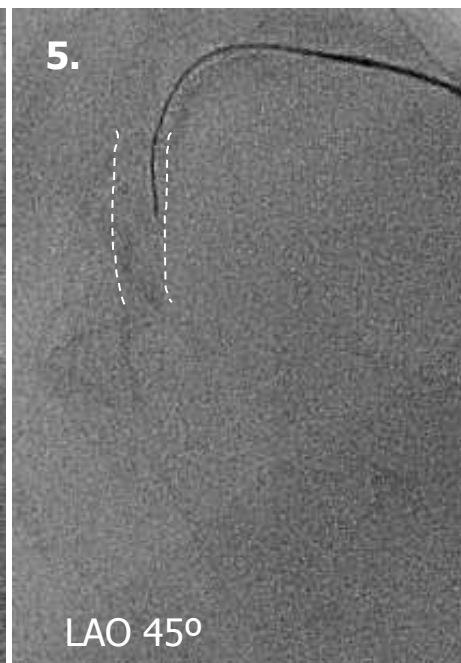
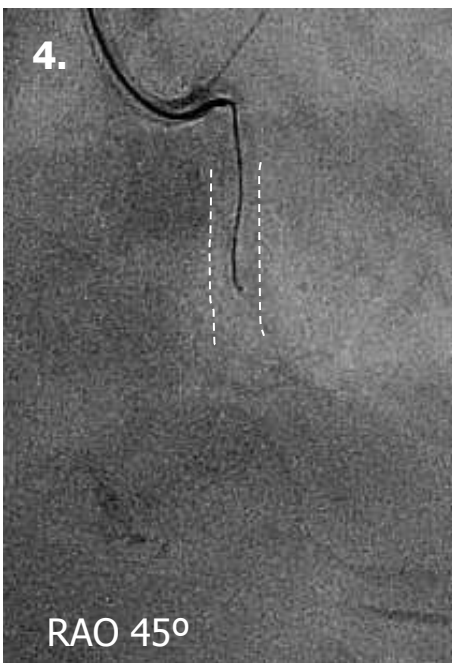
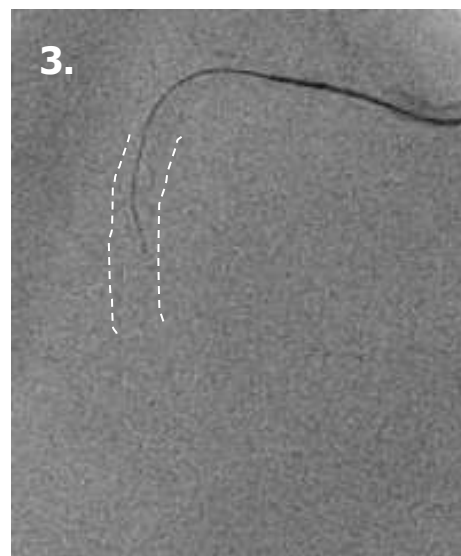
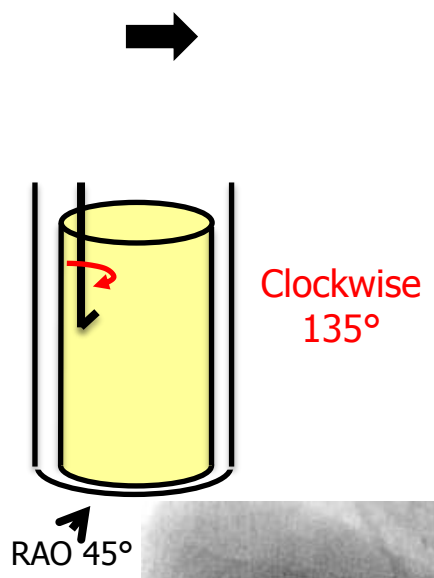
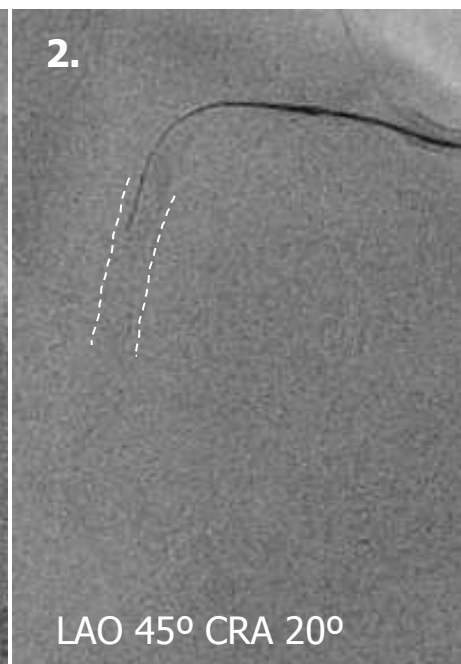
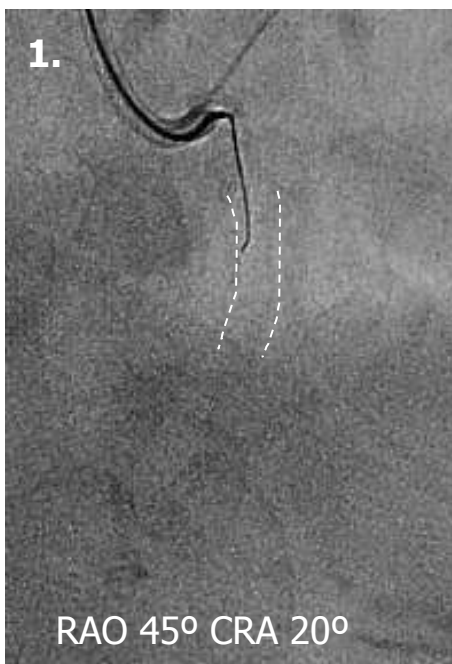
MDCT showed the distribution of calcified and non calcified area at the body of CTO.

The information from MDCT

- ① Non-calc. area was located at the center of the vessel from the entrance to body.
- ② Perpendicular angle of angiographic image was from LAO 45° to RAO 45° at the exit.



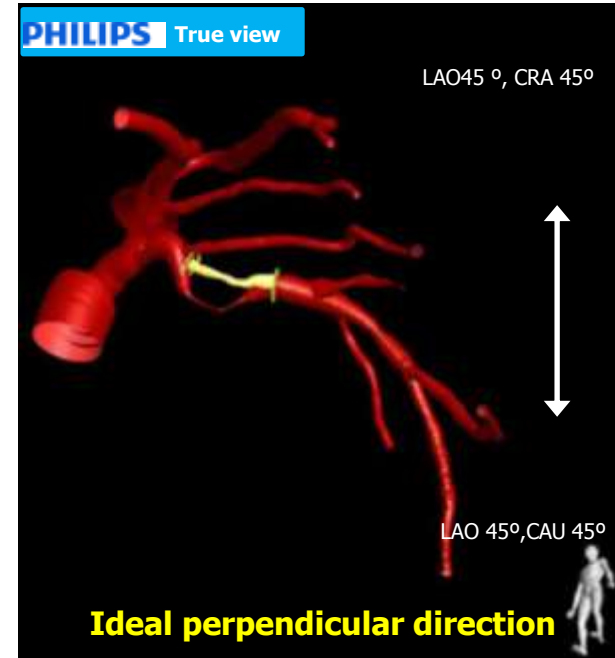
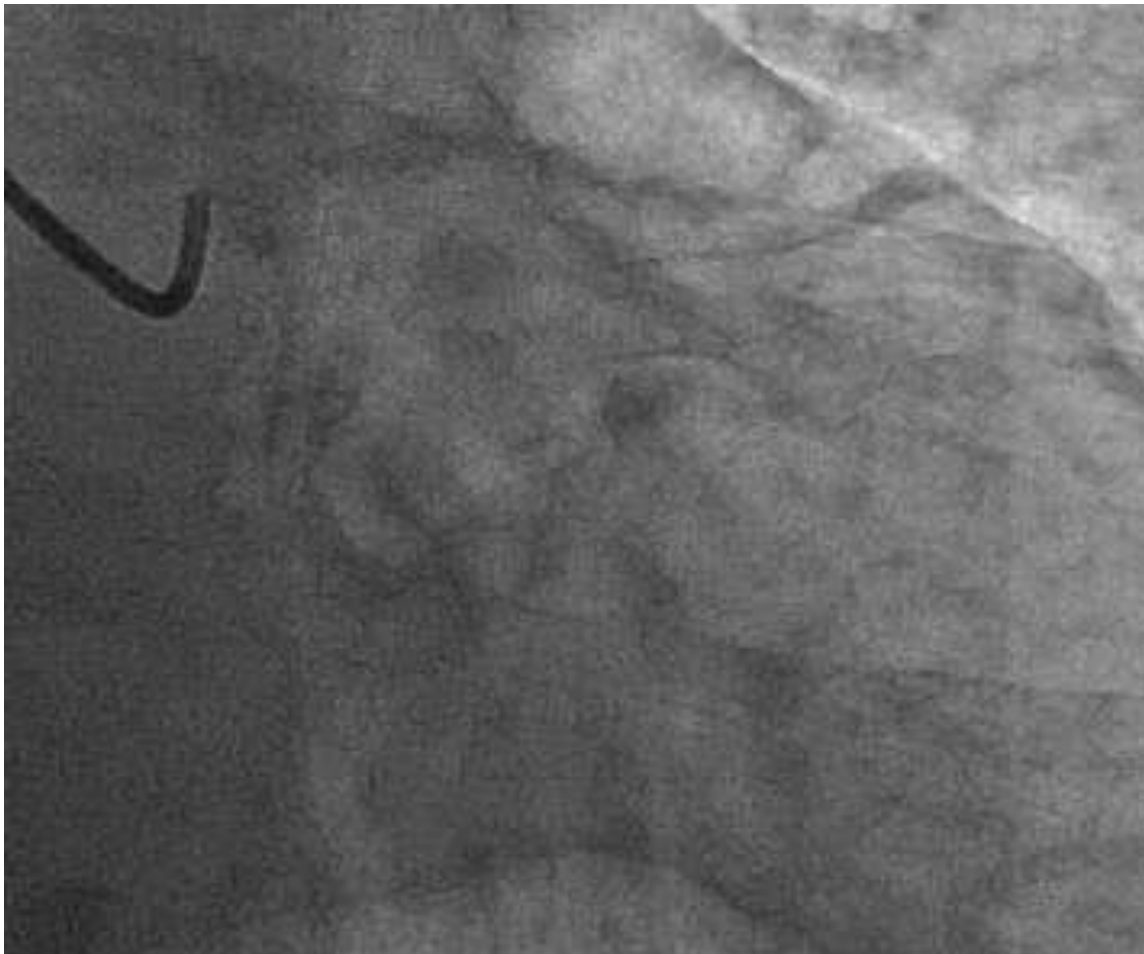
A Conquest 12g wire was traced at the center of the vessel by the 3D wiring method.



MDCT showed the perpendicular angle of angiographic images.

Information of angiogram and MDCT

1. Entrance of CTO
2. Location of calcification
3. Ideal perpendicular direction of the X-ray system detector



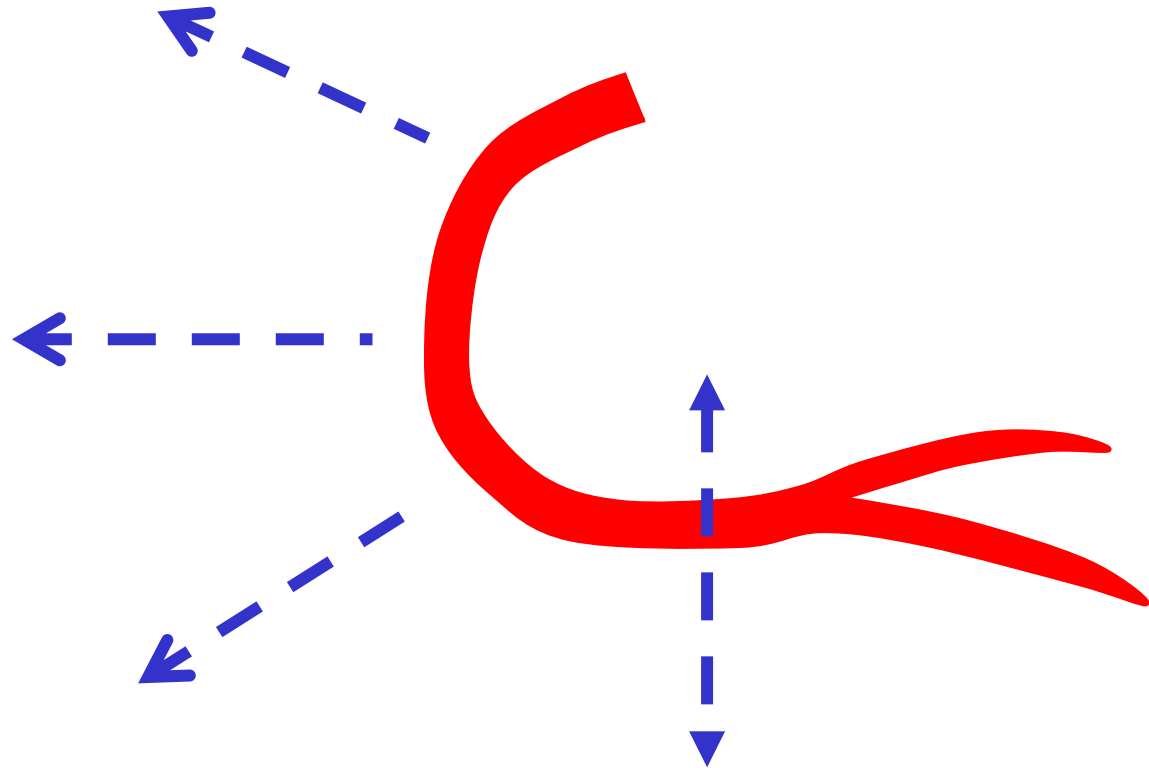
The information from CAG for CTO PCI

1. Location and shape of the entrance and exit of CTO.
2. Distribution of calcified area at CTO lesions.
3. Perpendicular angle of angiographic images.
4. During wiring, 3D metal image of the wire against target can be constructed using the 2 perpendicular angles of the X-ray system detector.

The information from angiography for CTO PCI

1. Location and shape of the entrance and exit of CTO.
2. Distribution of calcified area at CTO lesions.
3. Perpendicular angle of angiographic images.
4. During wiring, 3D metal image of the wire against target can be constructed using the 2 perpendicular angles of the X-ray system detector.

When the coronary is the plain level on the monitor, the angiographic image informs you the subsequent perpendicular direction.

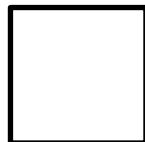
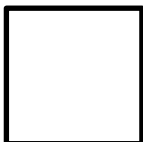


RAO 30°

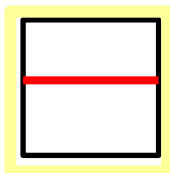
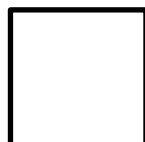
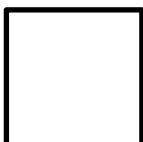
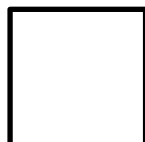
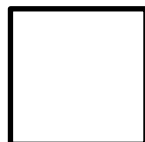
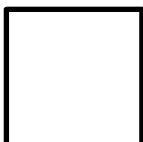
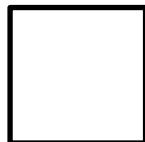
LAO 60°

Ideal X-ray detector rotation direction to get the perpendicular angle

CRA 45°
RAO 45°



CRA 45°
LAO 45°



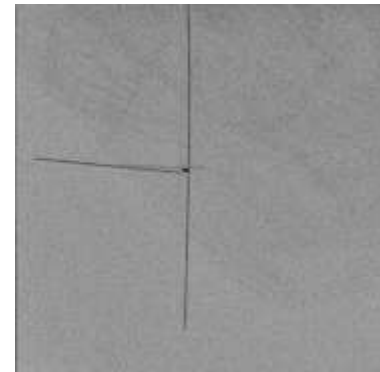
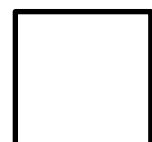
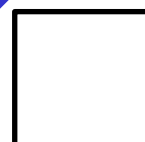
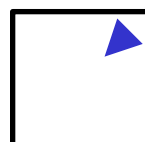
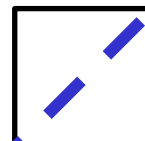
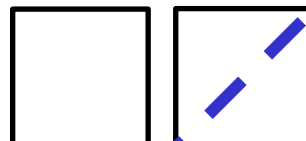
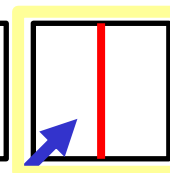
CAU 45°
RAO 45°

CAU 45°
LAO 45°

CRA 45°
RAO 45°



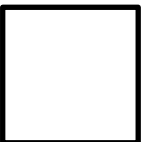
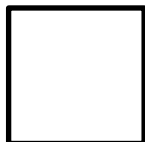
CRA 45°
LAO 45°



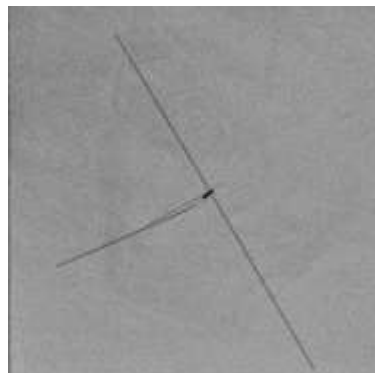
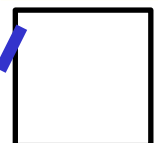
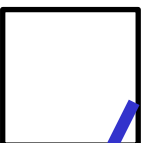
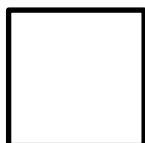
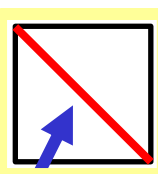
CAU 45°
RAO 45°

CAU 45°
LAO 45°

CRA 45°
RAO 45°



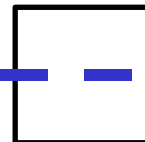
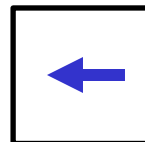
CRA 45°
LAO 45°



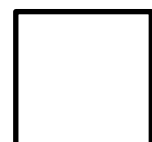
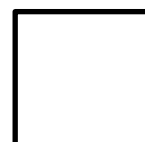
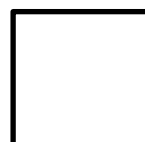
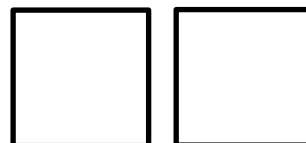
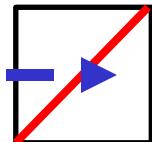
CAU 45°
RAO 45°

CAU 45°
LAO 45°

CRA 45°
RAO 45°



CRA 45°
LAO 45°



CAU 45°
RAO 45°

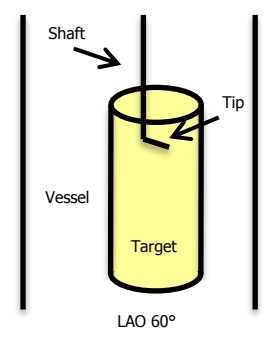
CAU 45°
LAO 45°

Under 2 perpendicular angles of angiographic images, 3D image of the wire against the target can be constructed.

3D wiring: Concept and advantage

When you advance GW to the target, there are 2 rotation directions to reach the target, *i.e.*, **clockwise or counterclockwise**.

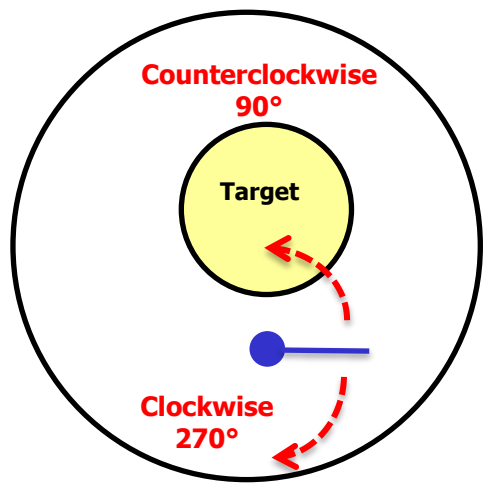
Longitudinal image



RAO 30°

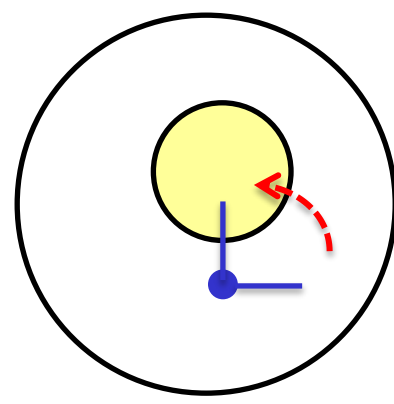


Cross-sectional image



LAO 60°

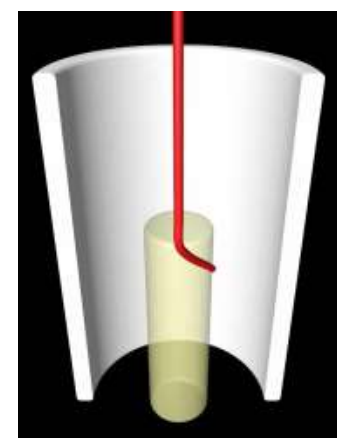
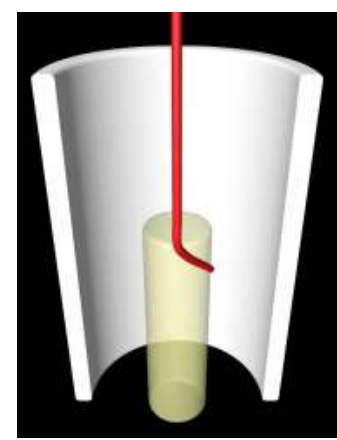
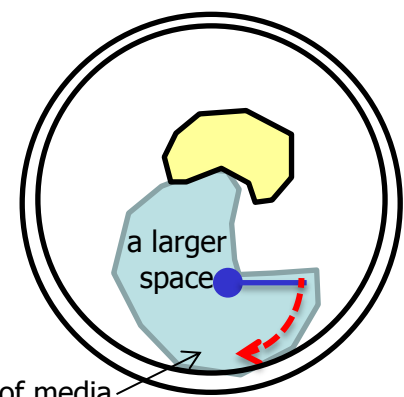
Correct direction



Clockwise 270°

- Not accurate GW control
- Creation of a larger space, compressing the target and not supporting the GW during target penetration.
- Advancement of the GW into the sub-intimal space.

Incorrect direction



Target

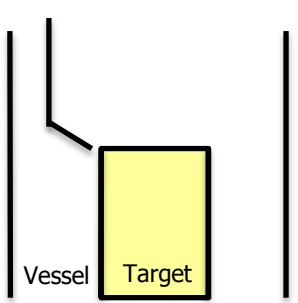
- Route in CTO body
- CTO exit
- Retrograde GW

Under 2 perpendicular angles of angiographic images, 3D image of the wire against target can be constructed.

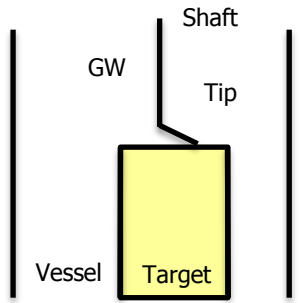
2 perpendicular angles of the X-ray system detector

Mid-RCA image

Pattern 1

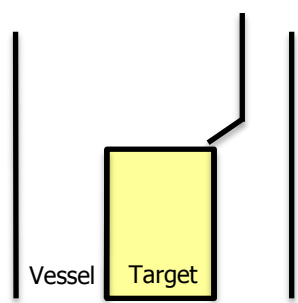


RAO 30°

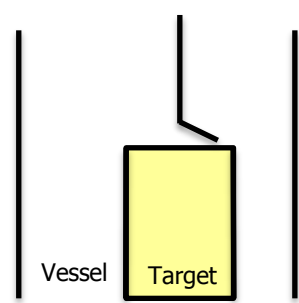


LAO 60°

Pattern 2

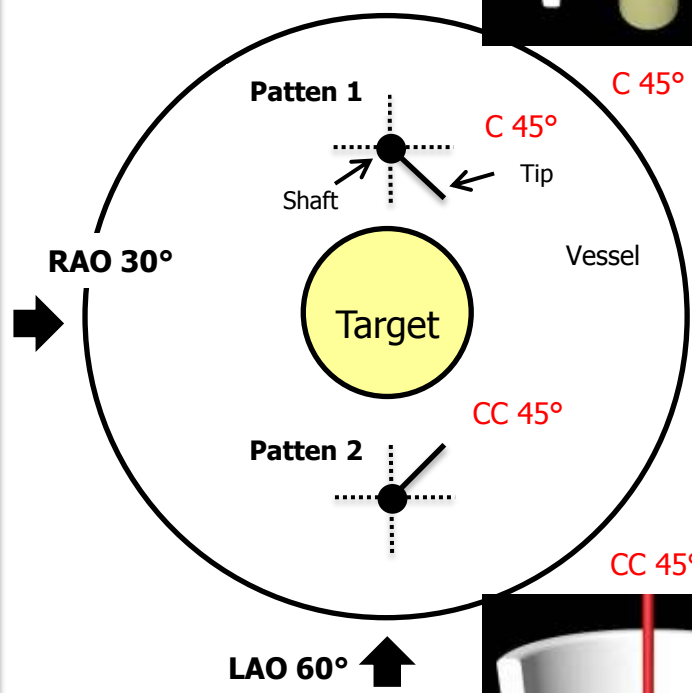


RAO 30°

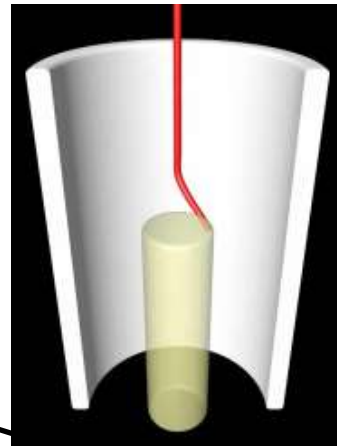


LAO 60°

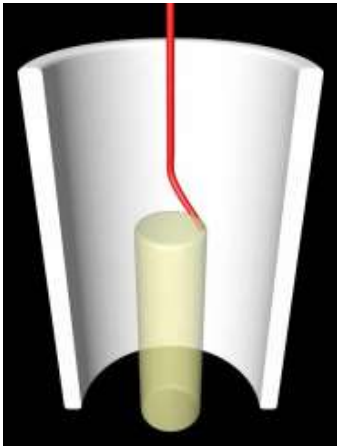
Cross-sectional image (Like IVUS image)



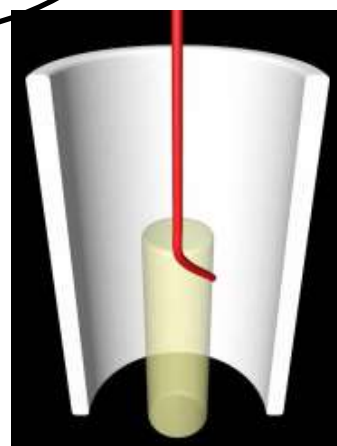
C = Clockwise
CC = Counterclockwise



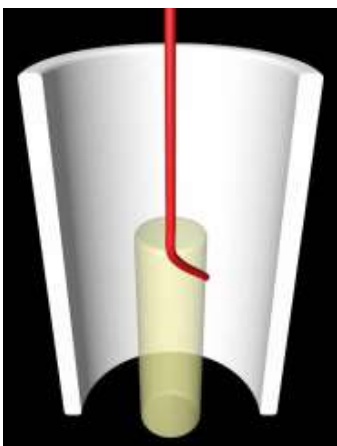
C 45°



CC 315°



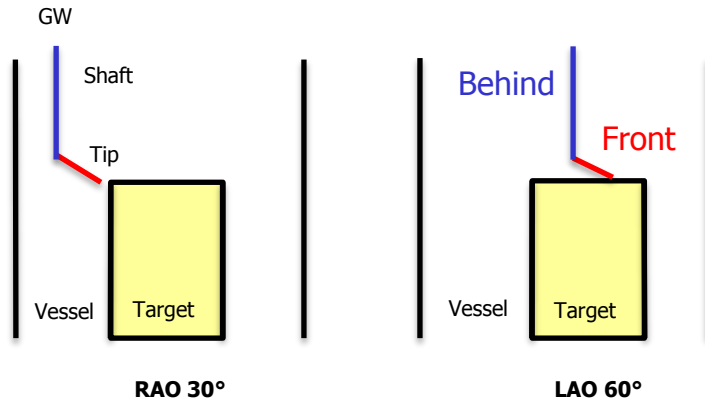
CC 45°



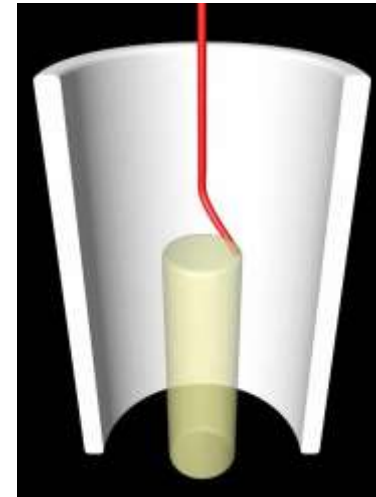
C 315°

Divide the wire into the shaft and tip sections.

Pattern 1

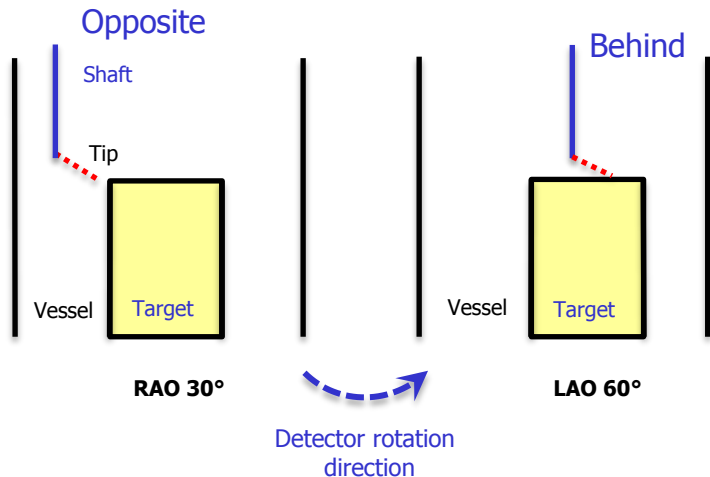


Clockwise 45°

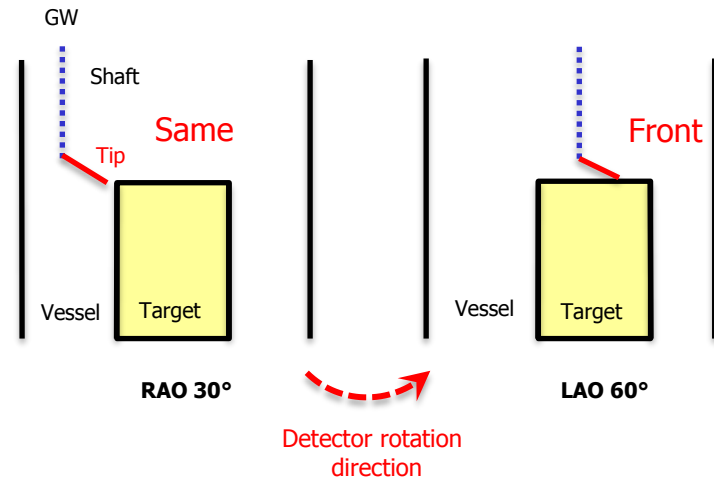


3D image rule is used. "The object (shaft or tip) is always in front (behind) after it is rotated in the same (opposite) direction as the direction of detector rotation."

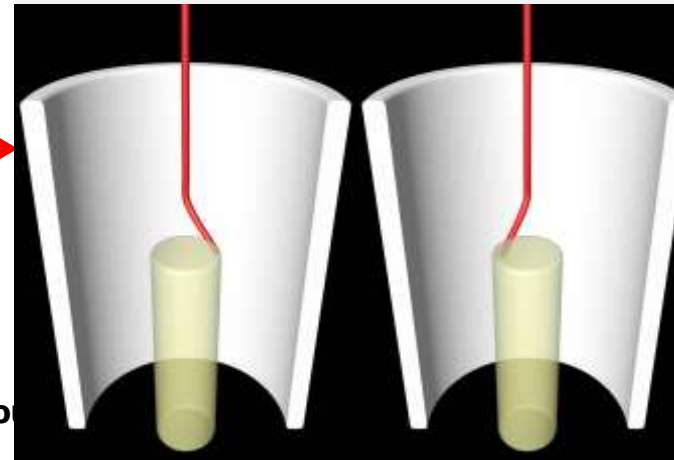
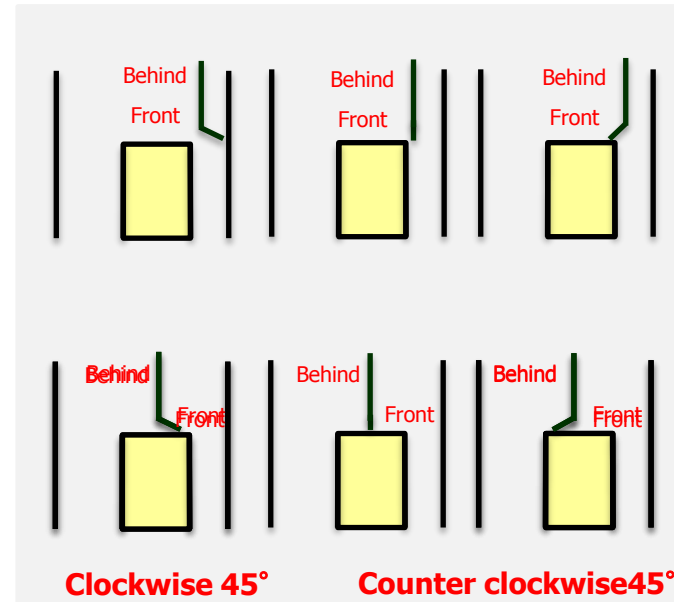
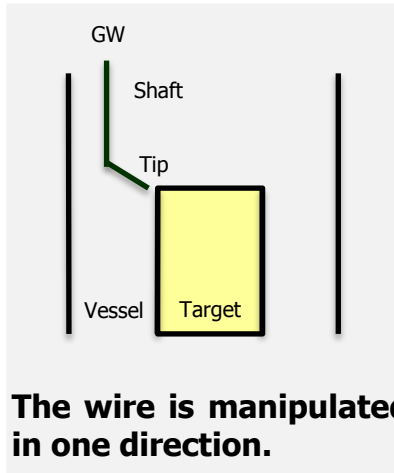
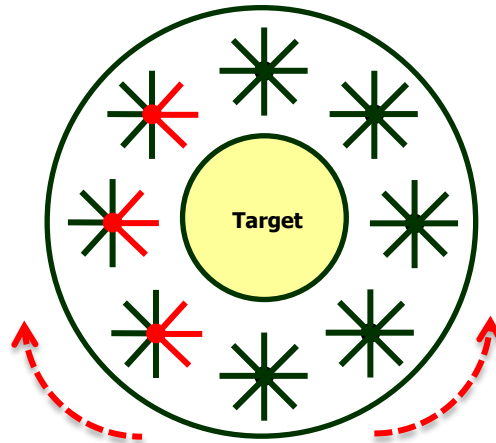
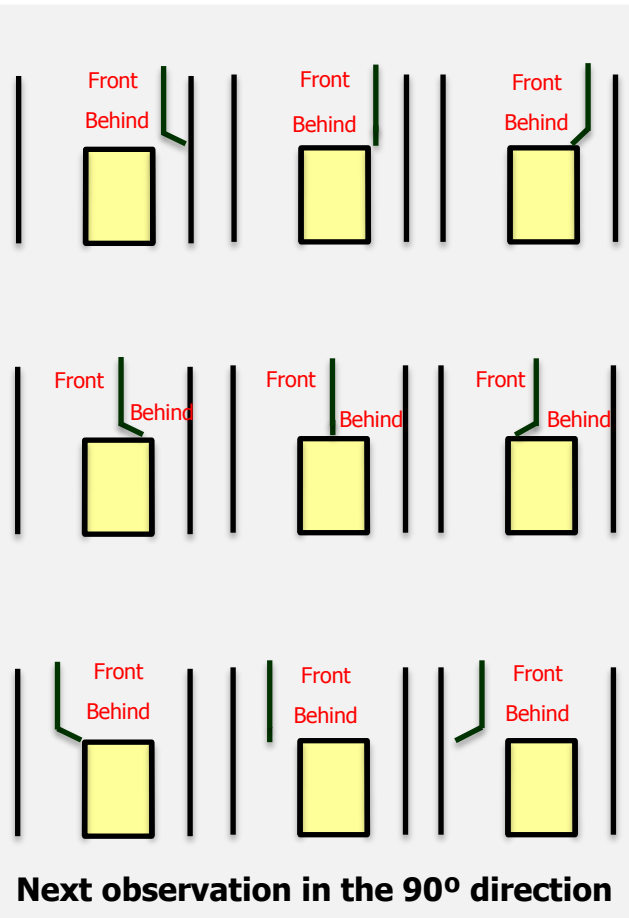
The **shaft** direction is determined with the relation to the target, and consider the same or opposite side for the detector rotation direction.



The **tip** direction is determined by itself and consider the same or opposite side for the detector rotation direction.



3D image rule is used. "The object (shaft or tip) is always in front (behind) after it is rotated in the same (opposite) direction as the direction of detector rotation."



When you rotate the detector to the **left**,

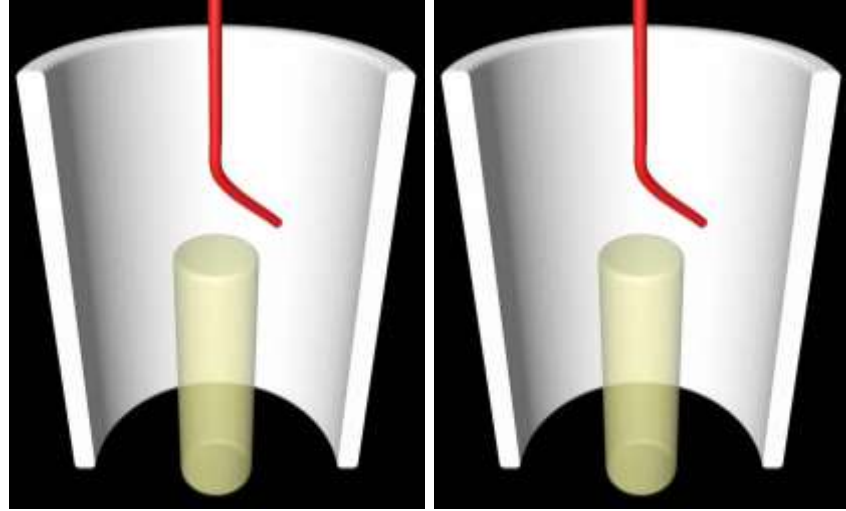
1. The shaft is in **front** of the target.
2. The tip is facing away from the observer (**behind**).

When you

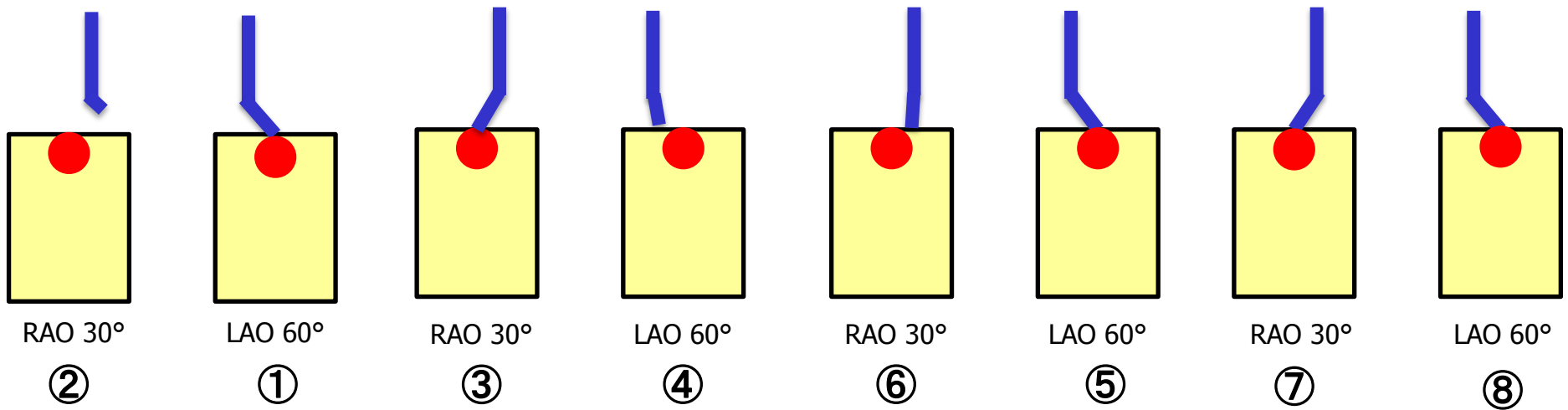
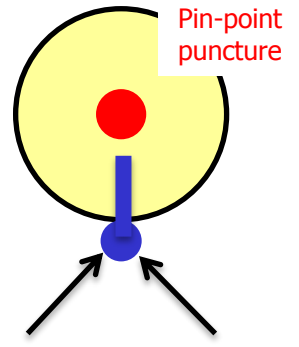
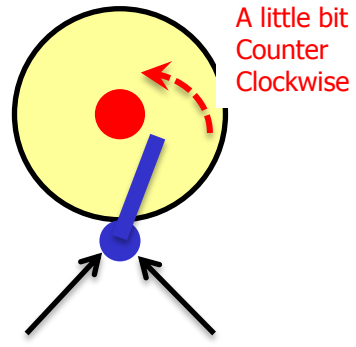
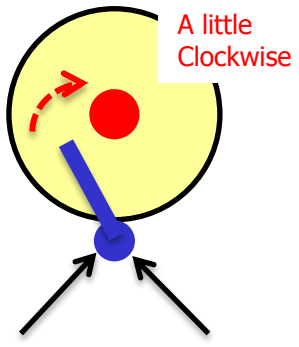
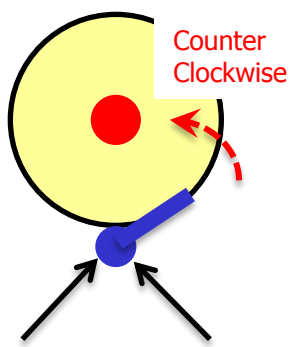
1. The shaft is **behind** the target.
2. The tip is facing toward the observer (**front**).

Accurate wire manipulation during 3D wiring

- ✓ See the center of the target and identify the accurate positional relationship between the wire and the target.
- ✓ Repeat the 3D wiring.
- ✓ Do the pin-point puncture.



Mid RCA image



3D wiring by using the 2 perpendicular angles of radiographic images

Retry case of Proximal RCA CTO

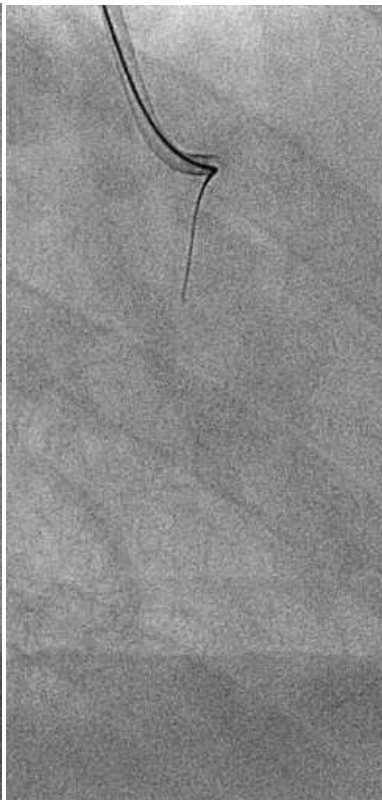
A GAIA 3rd and a Conquest 12g could not penetrate the distal fibrous cap.

Pin-point puncture with a Conquest 8-20g

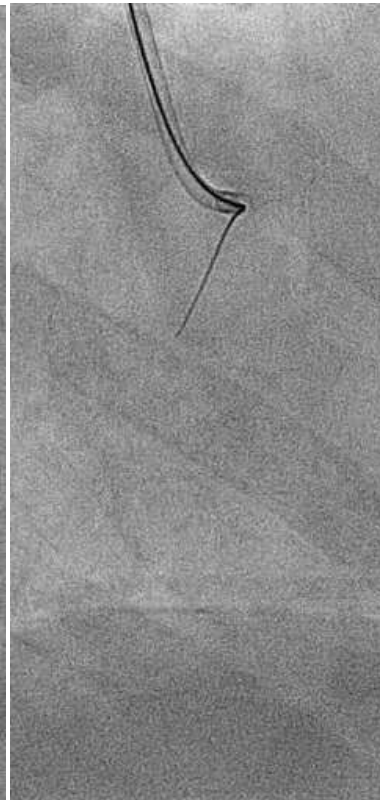
LAO 60°



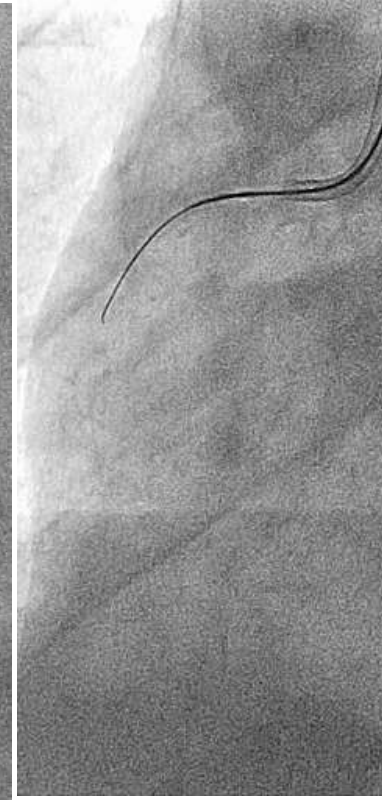
RAO 30°



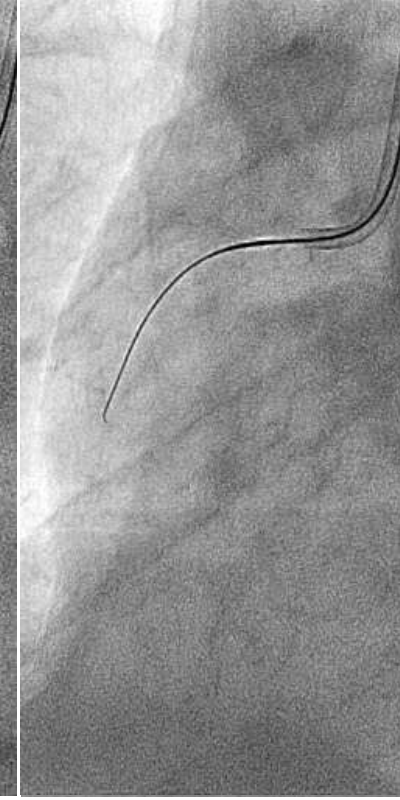
RAO 30°



LAO 60°



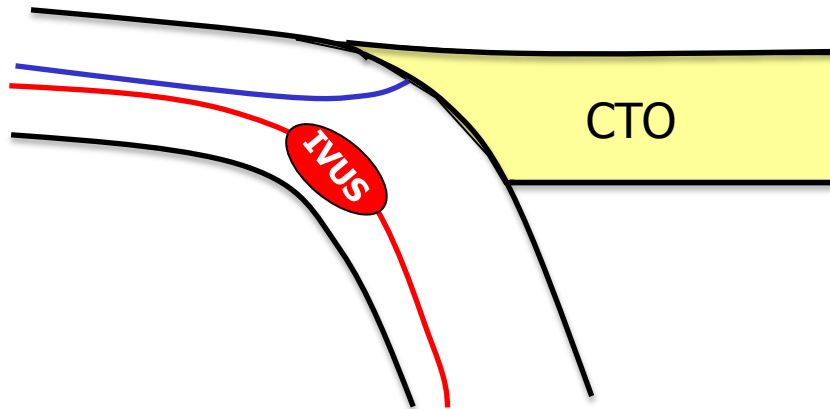
LAO 60°



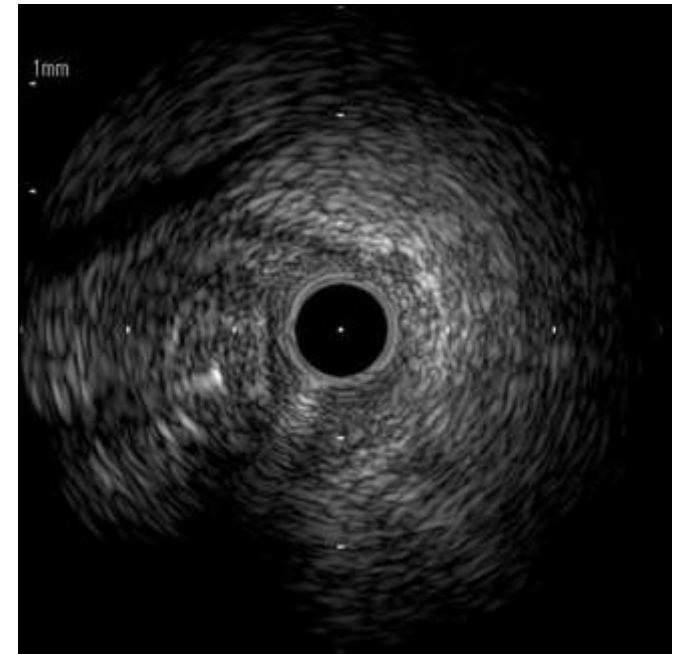
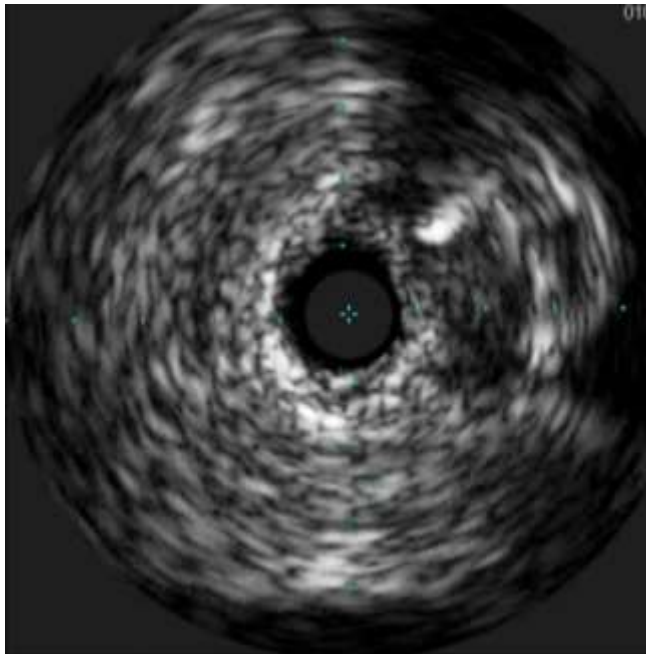
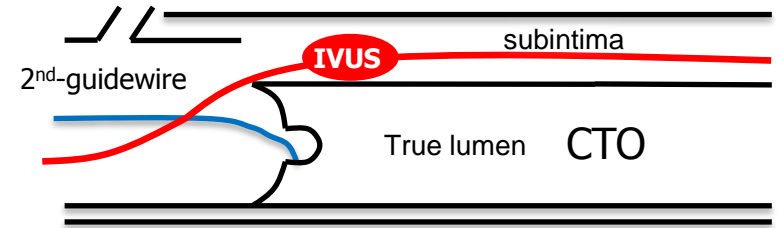
IVUS-guided wiring for CTO PCI

Navigation of the guidewire into the true lumen under IVUS observation

- IVUS observation from the side branch.



- IVUS observation from the subintimal space.

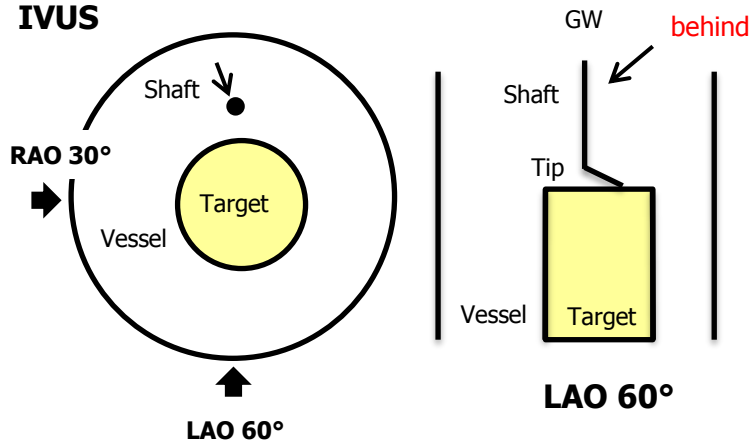


Under IVUS guidance, 3D image can be also constructed from the only one angel of the X-ray system

One angle of the X-ray system detector

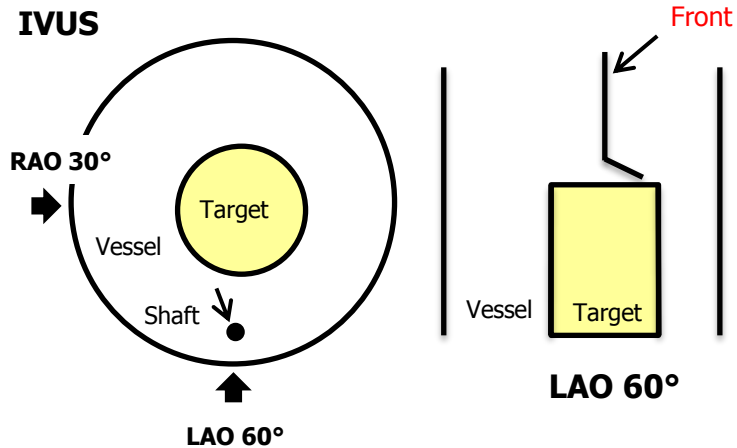
Pattern 1

IVUS

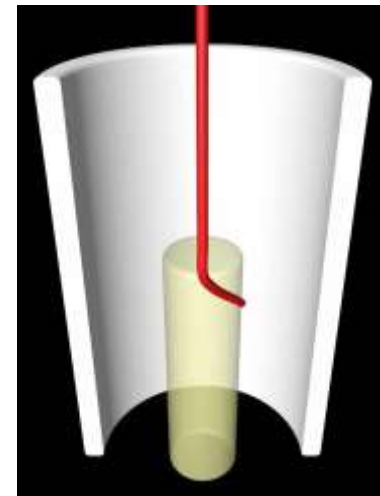
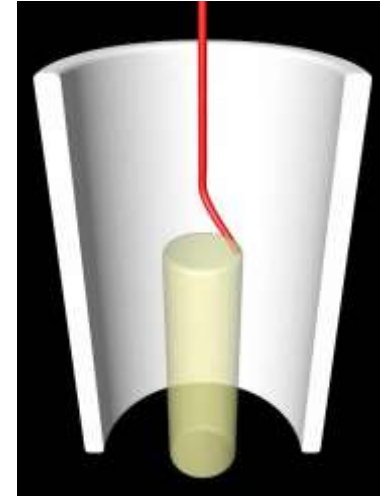
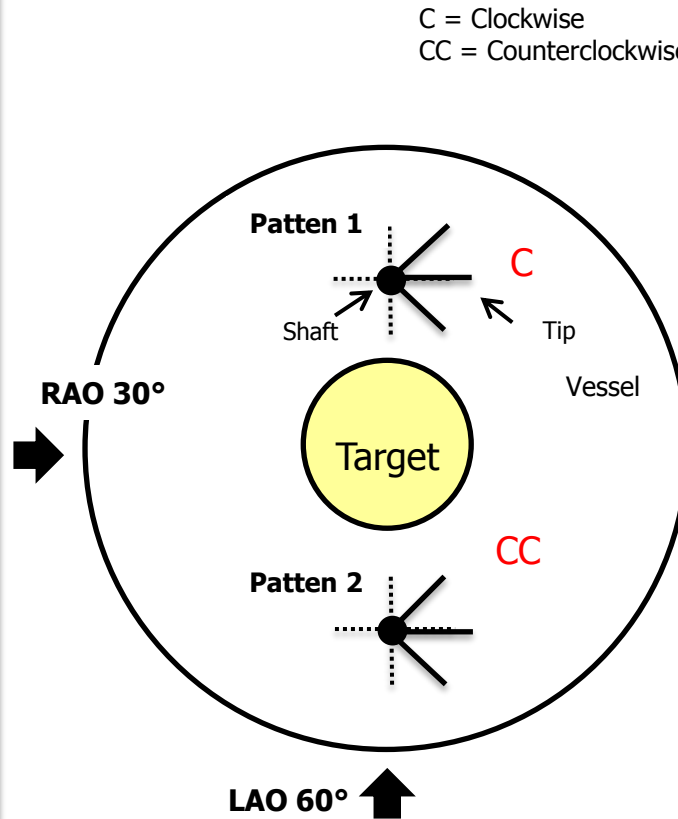


Pattern 2

IVUS



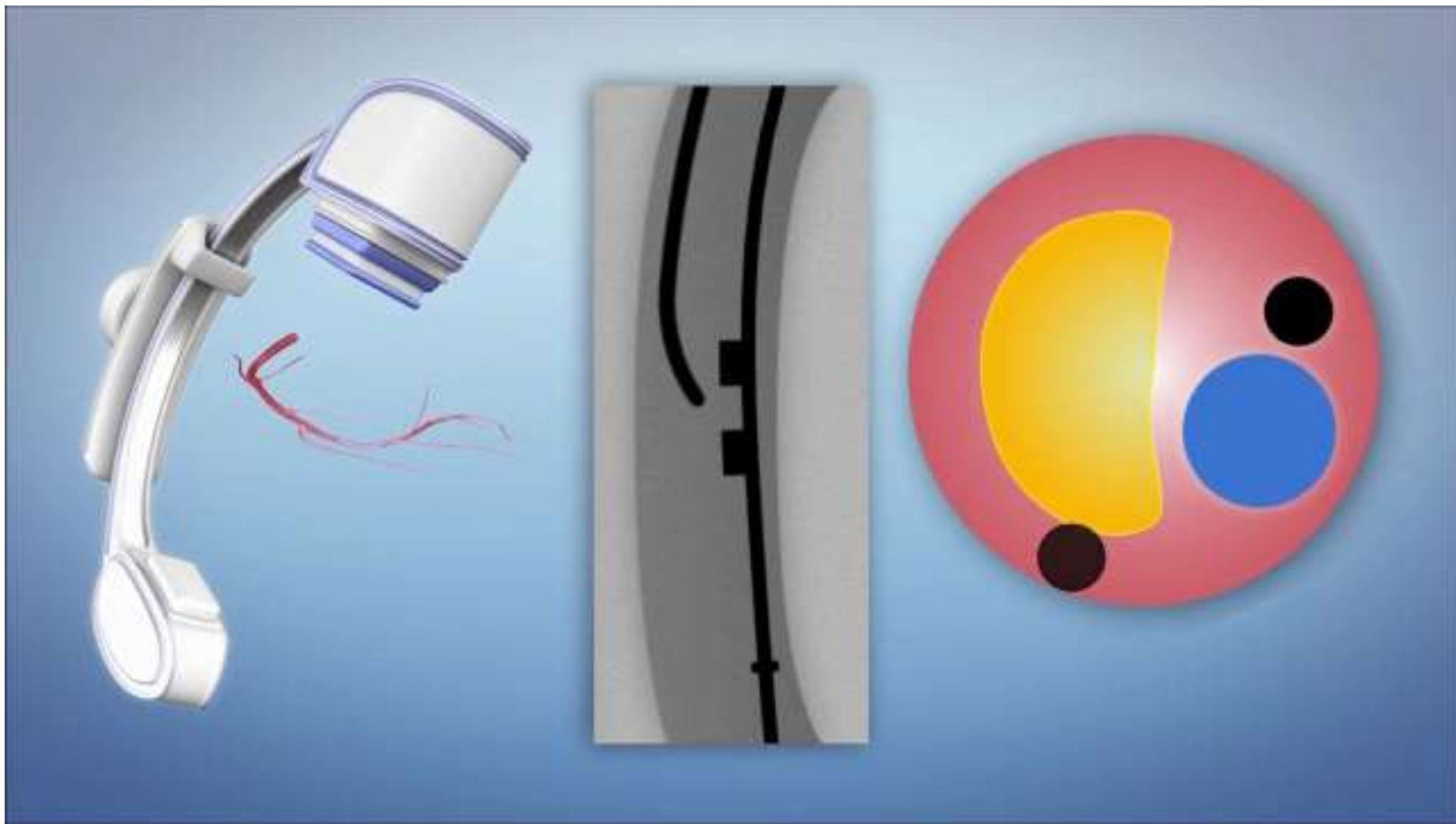
Cross-sectional image
(Like IVUS image)



Under IVUS guidance, the wire manipulation under 3D image can be performed from the only one angel of the X-ray system

Angiographic image

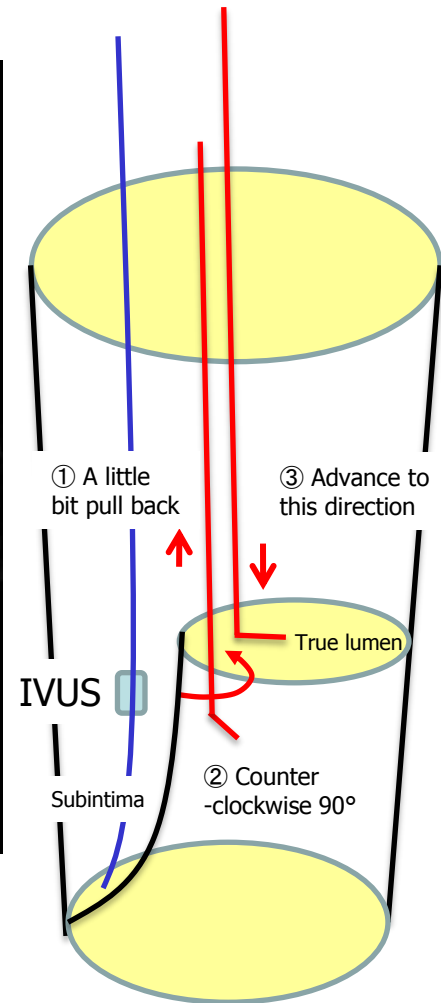
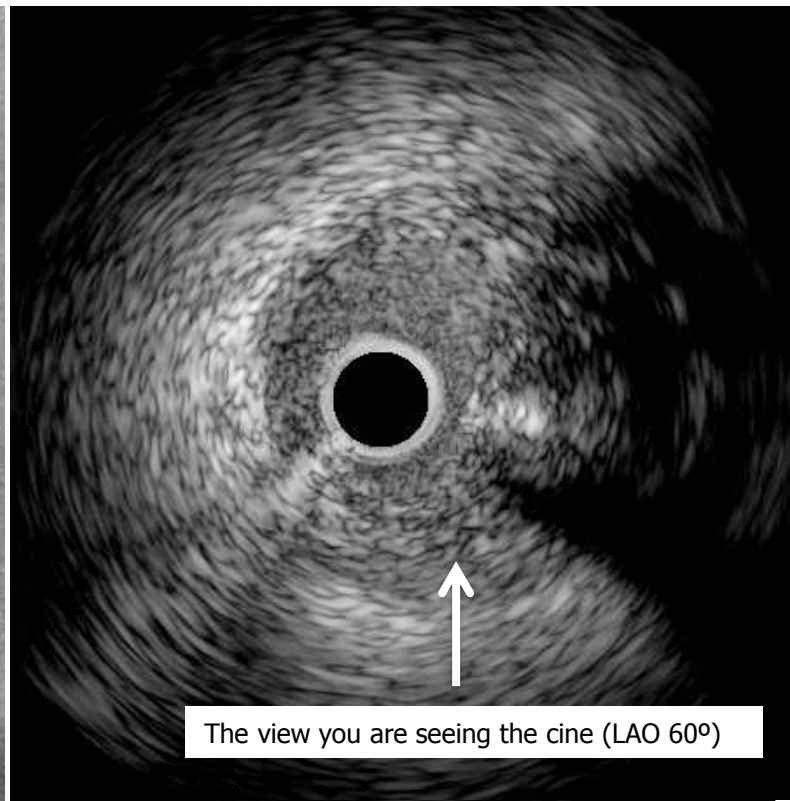
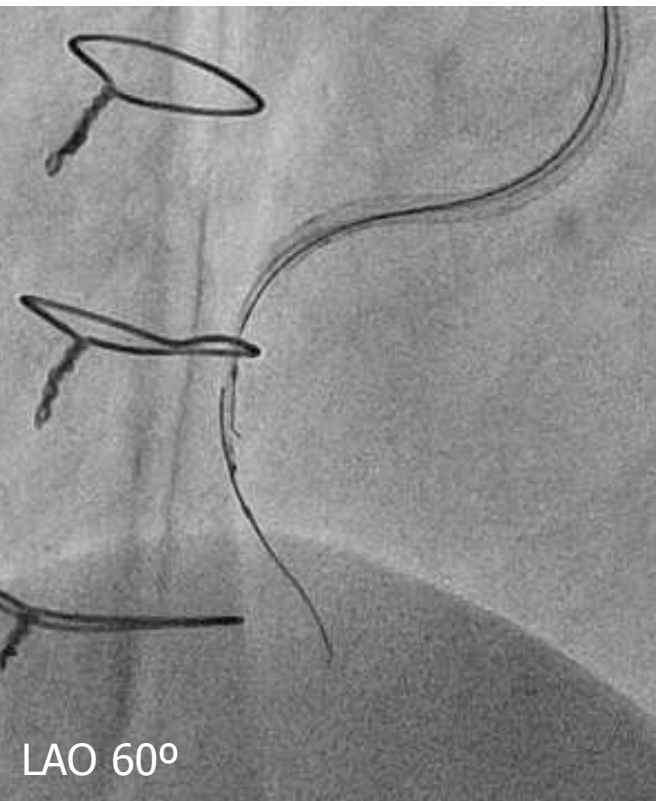
IVUS image



3D wiring by using the angiographic and IVUS images

The Conquest-pro wire was navigated into the true lumen with 3D wiring while constructing a 3D image by using the cine and Navifocus WR IVUS.

Mid. RCA CTO



Summary

Because of the technological advancement of the CTO specific guidewires and micro-catheters etc., the adequate use of the imaging devices (MDCT, CAG, IVUS) increases the possibility of intentional guide-wire manipulation during CTO PCI.