CT: Dissection and Digestion for CTO Lesions

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I have nothing to disclosure..

Chronic total occlusion

CTO: Final frontier in interventional cardiology

-Leaving CTOs untreated is associated with poor prognosis

- George S et al. J Am Coll Cardiol 2014;64:235–43
- Carlino M et al, CatheterCardiovasc Interv 2015;85:771–8.

-Success rates of PCI in CTOs are usually moderate (70~80%), and failed revascularization increases the risk of adverse outcomes

-Careful selection of patients in which successful PCI for CTOs is important in clinical situation.

What Coronary CTA can do for CTO ?

- **Identification of CTO**
- **Predicting the clinical benefit from revascularization**
- **Pre-procedural Planning**
- **Predicting the procedural outcome of PCI**

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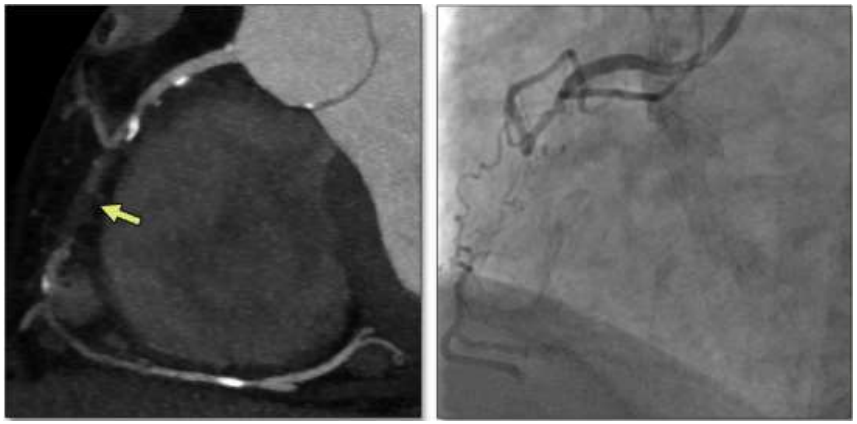
Identification and diagnosis of CTO

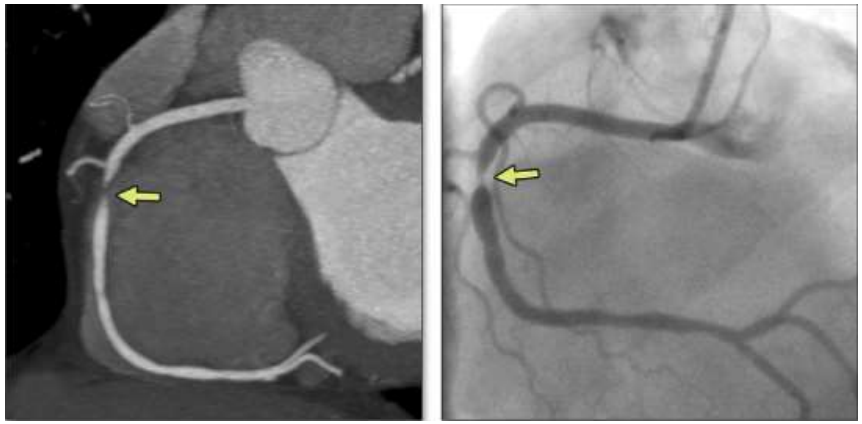
Diagnosis of CTO on coronary CTA

-CTOs are defined based on the angiographic criterion of antegrade blood flow interruption.

-On coronary CTA, a complete lack of contrast opacification within the coronary occlusion on MPR



CTO on coronary CTA and angiography

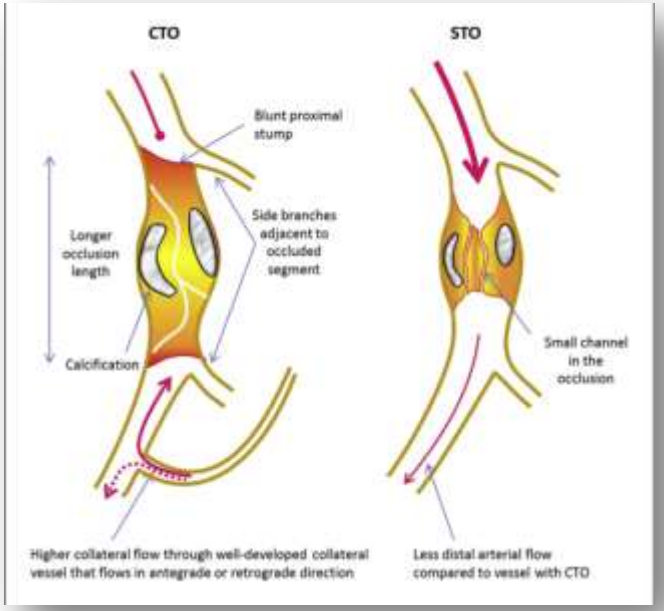


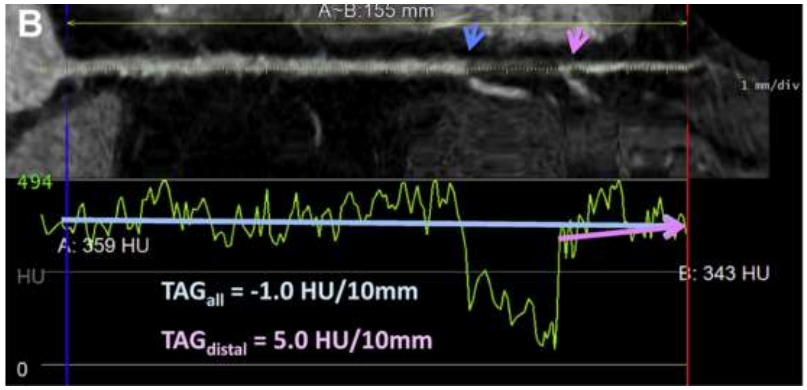
High grade stenosis on coronary CTA

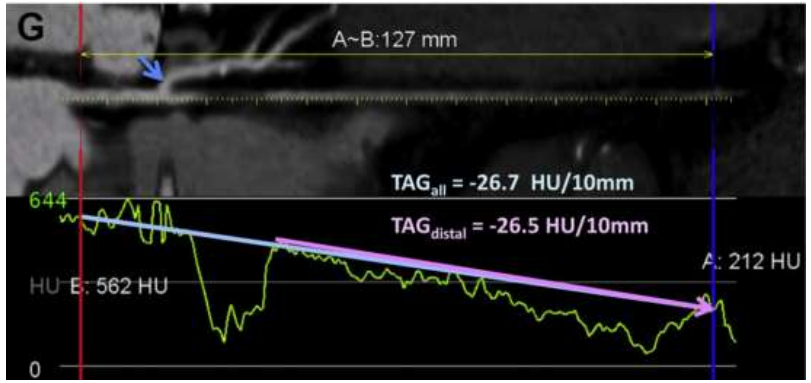
-Coronary CTA may have difficulty in differentiating high grade stenosis from complete occlusion (space resolution, distal vessel contrast)

-Lesion length ≥ 9 mm (or 15 mm) can be indicator of total occlusion

Reverse attenuation gradient sign







- **Transluminal attenuation gradient**
- **Reverse attenuation gradient sign can help to discrimination**

Choi JH et al, Noninvasive Discrimination of Coronary Chronic Total Occlusion and Subtotal Occlusion by Coronary Computed Tomography Angiography. *JACC Cardiovasc Interv*. 2015;8:1143–1153.

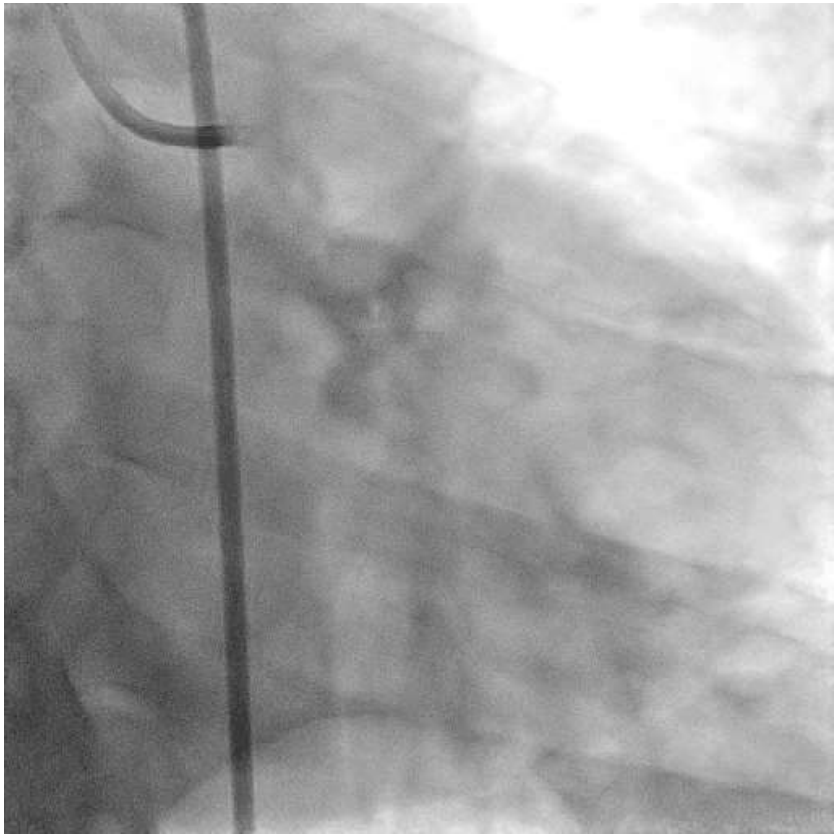
What Coronary CTA can do for CTO ?

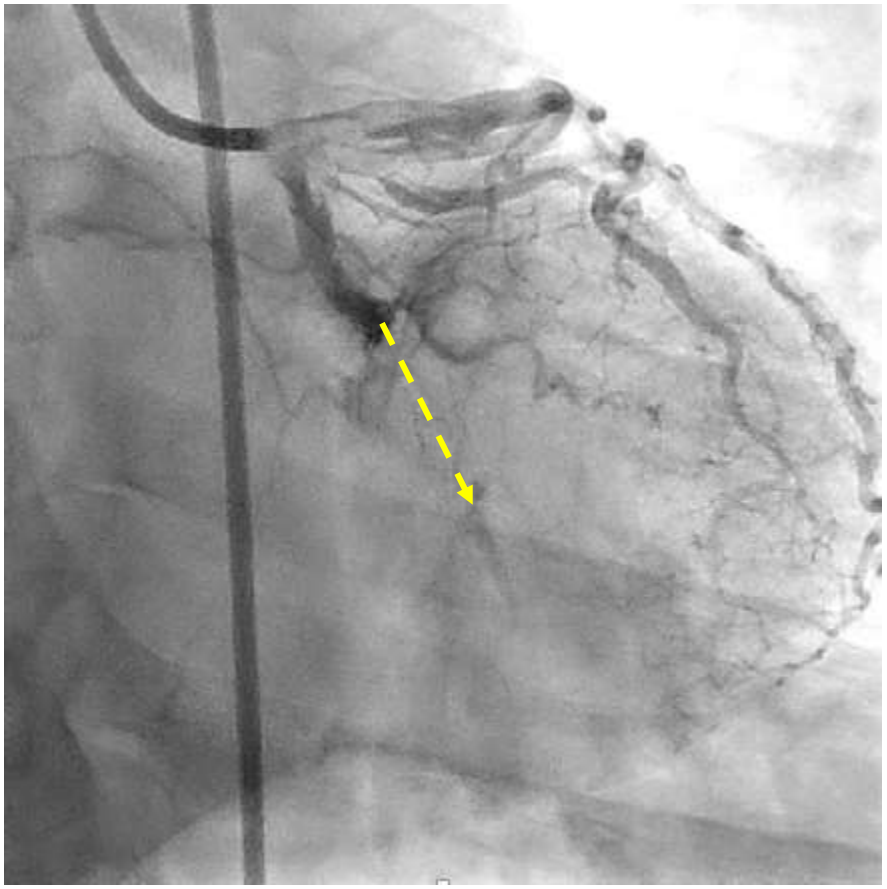
- **Identification of CTO**
  - **complete lack of contrast opacification, lesion length >9 mm, Reverse attenuation gradient**
- **Predicting the clinical benefit from revascularization**
- **Pre-procedural Planning**
- **Predicting the procedural outcome of PCI**

Pre-procedural planning

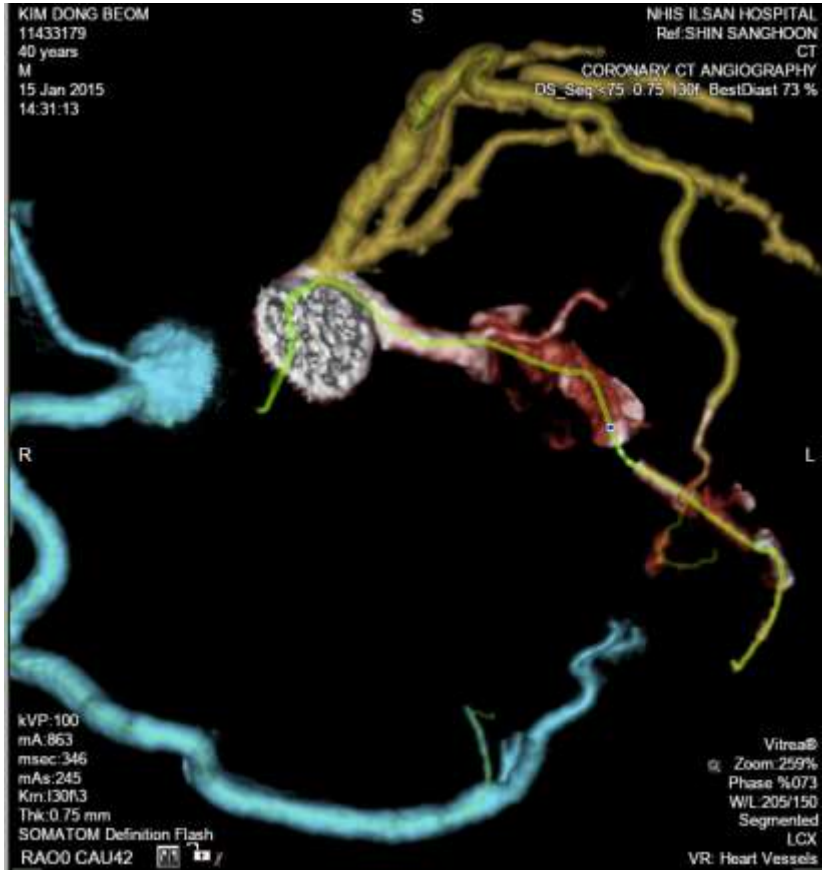
Case

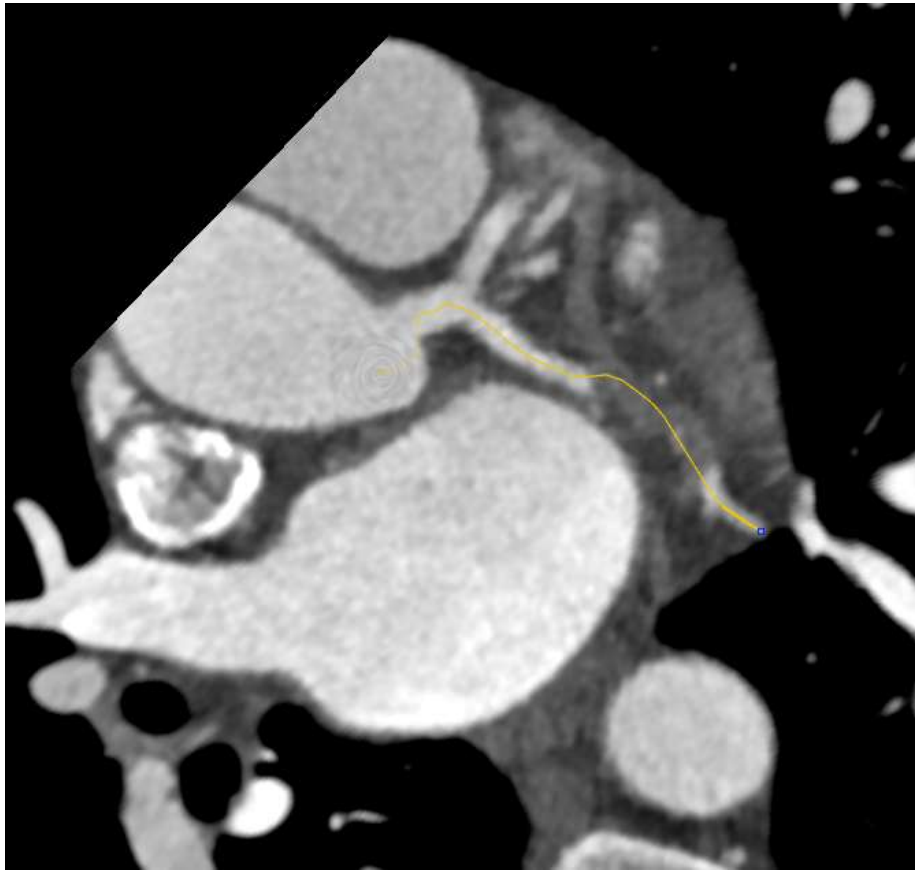
- 40-year male patient
- Exertional chest pain
- Dyslipidemia and current smoker



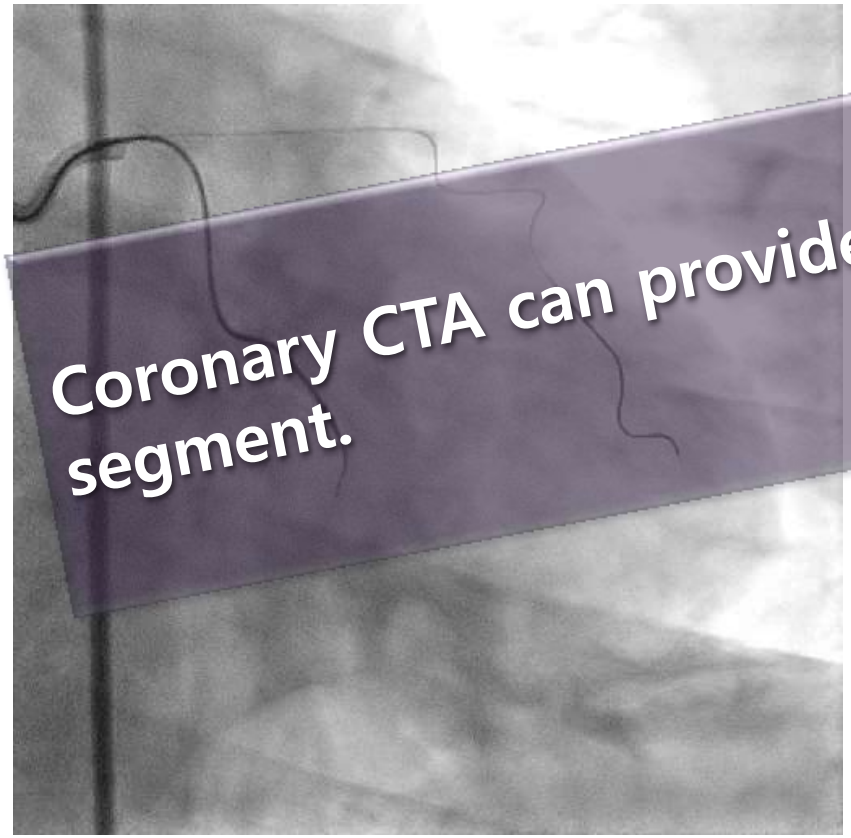


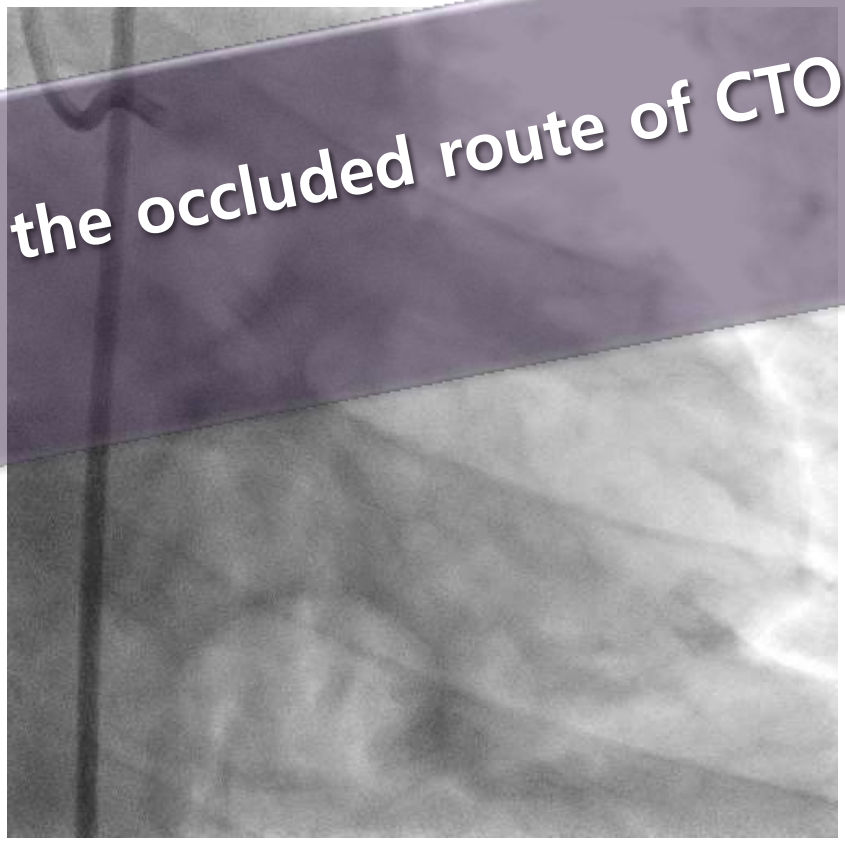
Coronary CTA





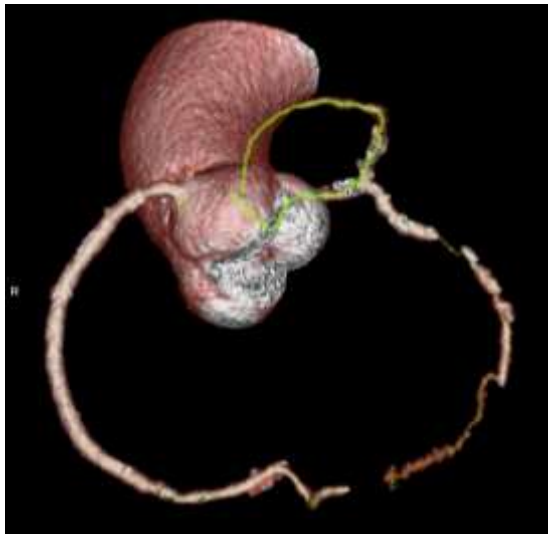
Case

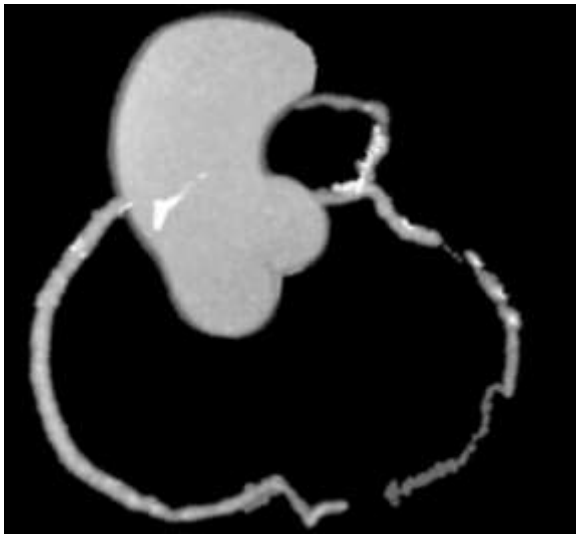


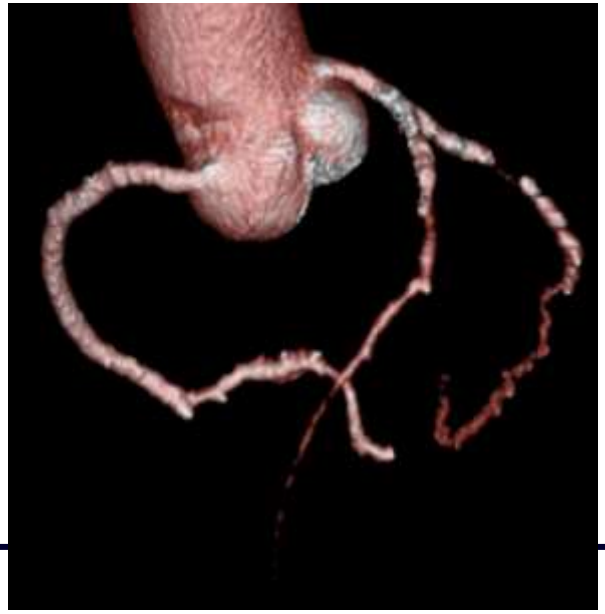


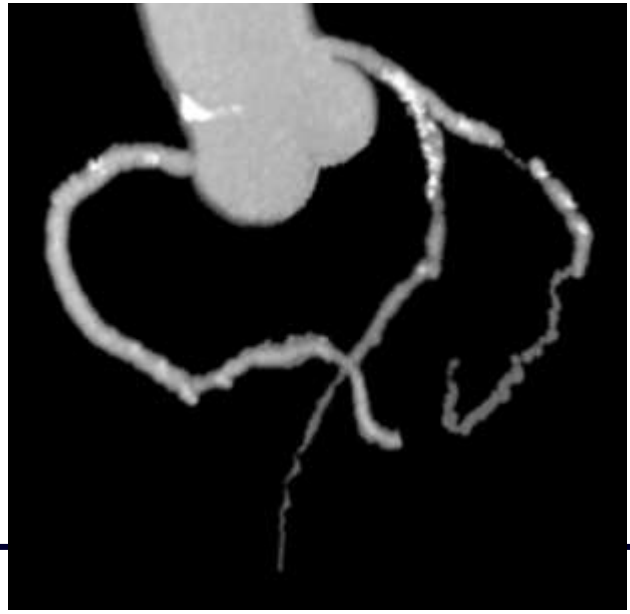
Coronary CTA can provide the occluded route of CTO segment.

Same angle images of CT



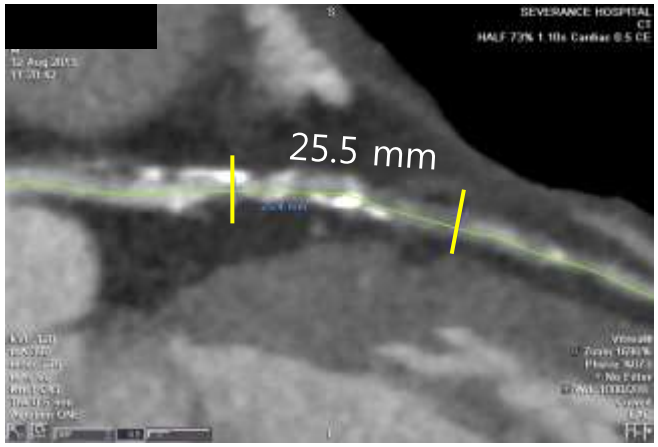


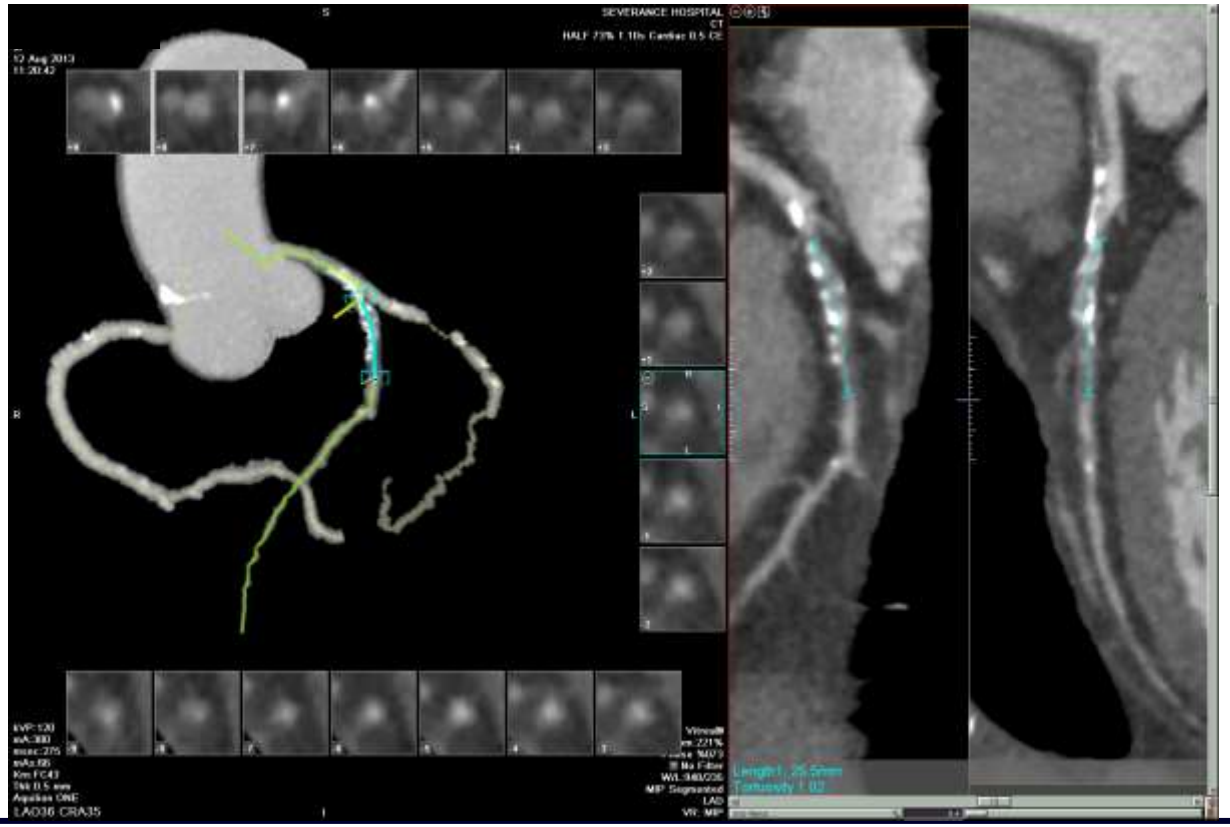




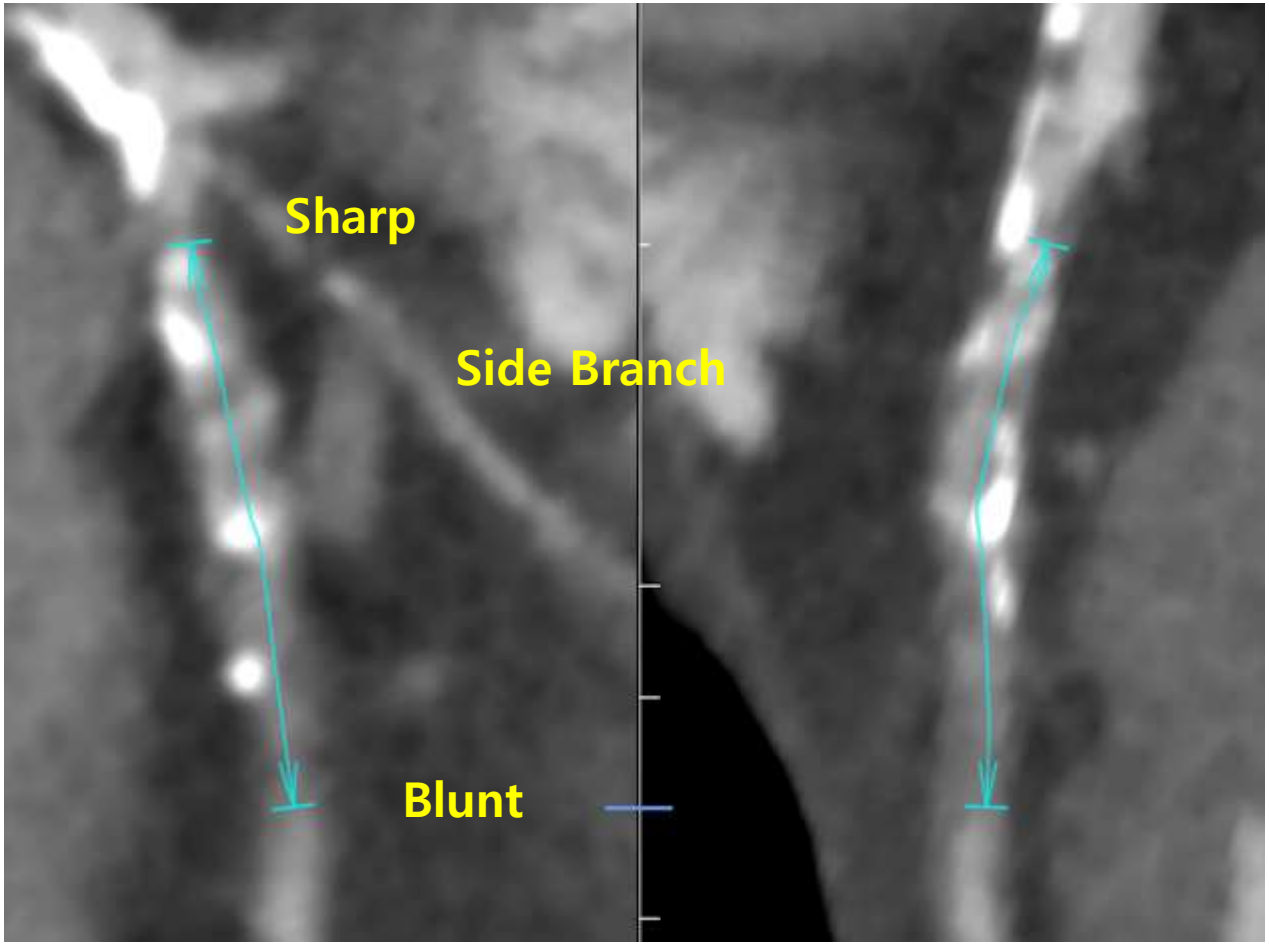
CTO length

- **CTO: the proximal and distal border of the CTO segment was defined by disappearance of the luminal continuity in MDCT**

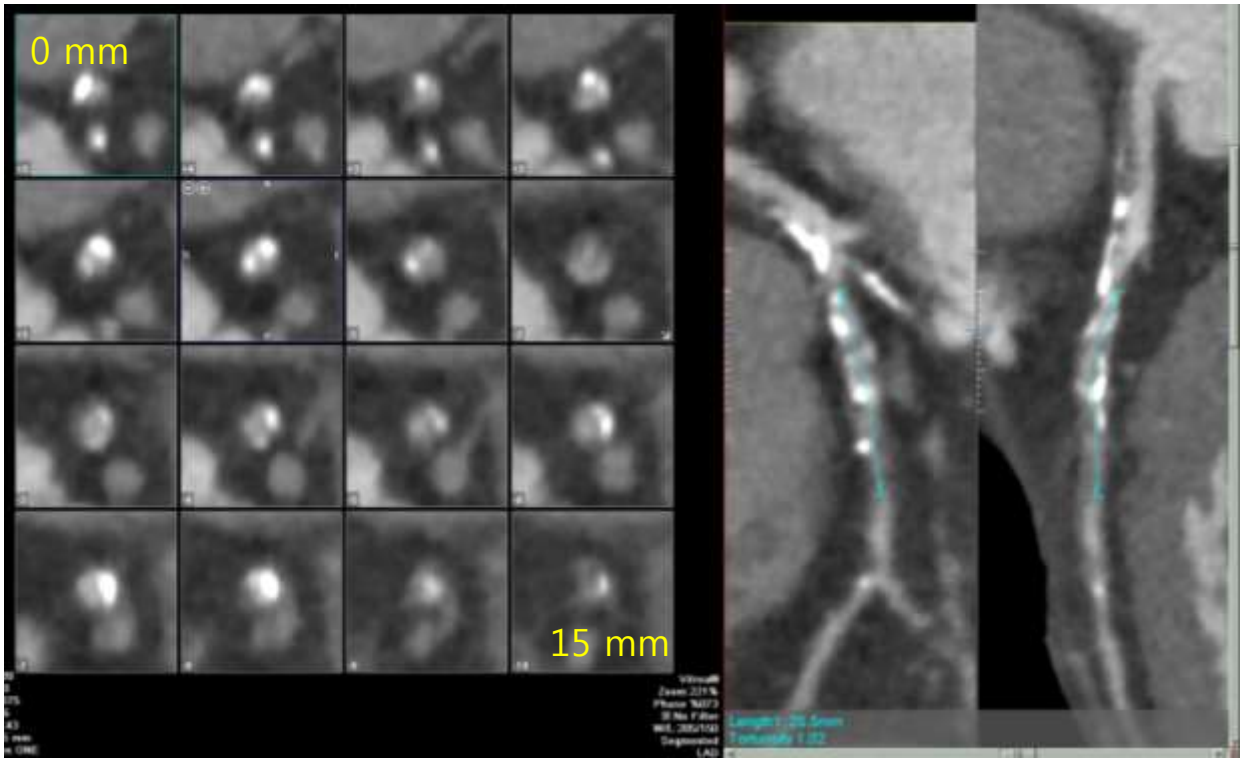




Shape of proximal and distal // Side Branch



Calcification



- Max calcification extent: <50%
- Calcification shape: semicircular
- Length of calcification:>50%

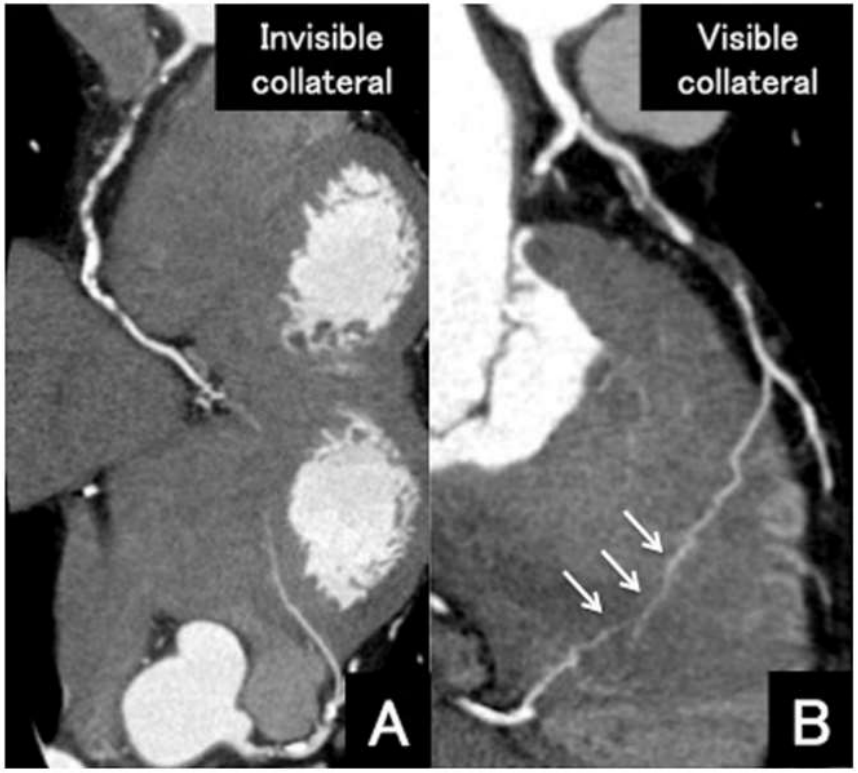
- Calcification at stump (+)

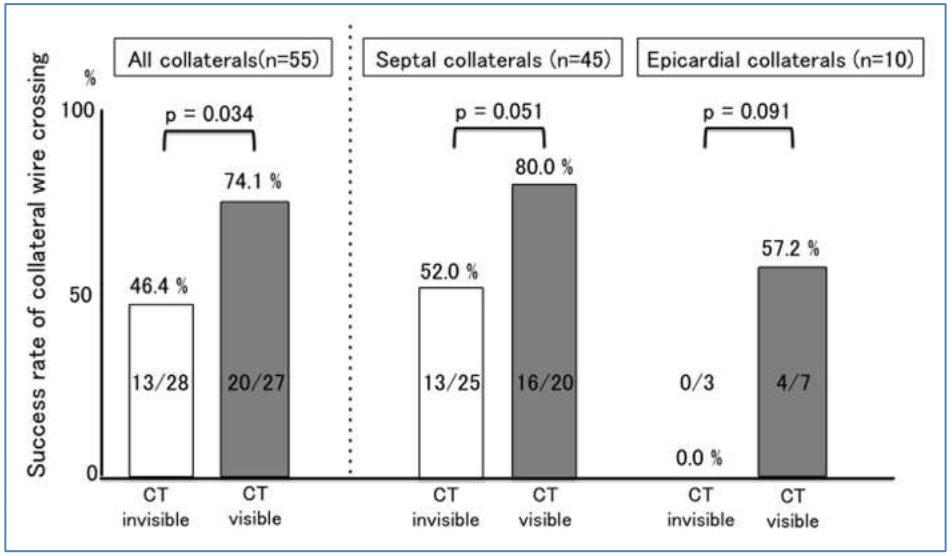
Calcification is the hallmark of a high difficulty level of CTOs.

difficulties at all steps: guide- wire passage, lesion pre-dilation, and adequate stent expansion

Coronary CTA is more sensitive to detect, quantify, and localize calcification compared with invasive angiography

Collateral Channel





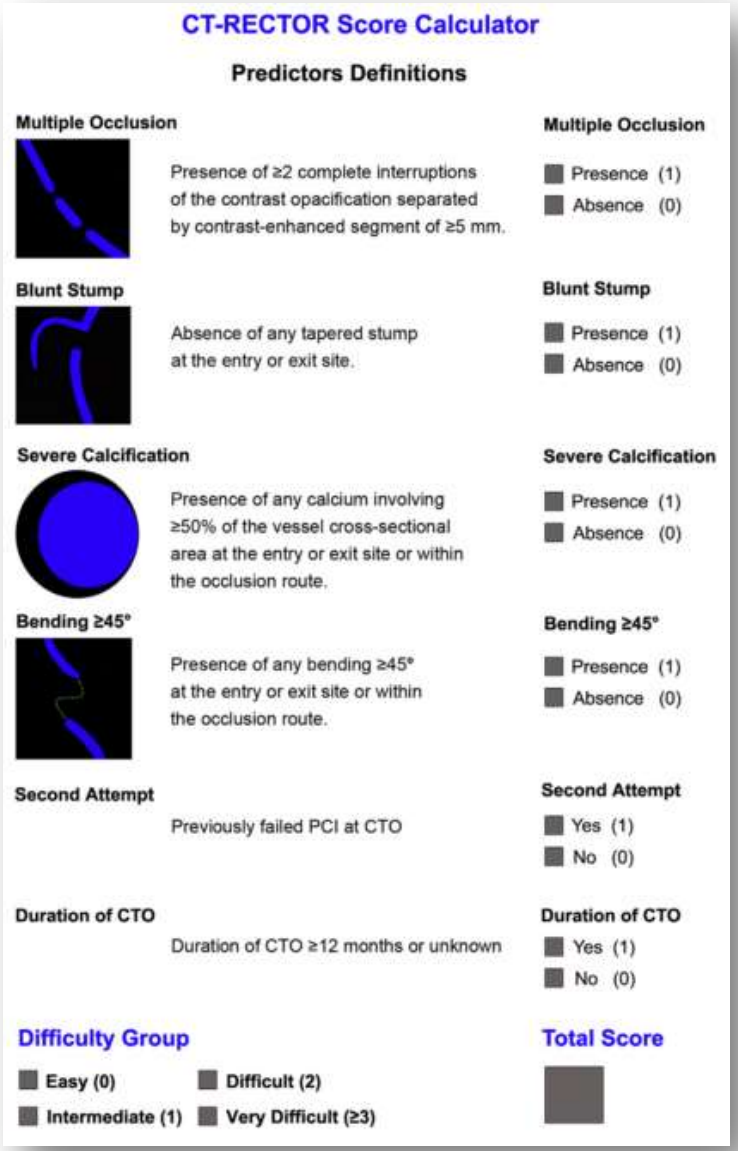
Sugaya T et al, Visualization of collateral channels with coronary computed tomography angiography for the retrograde approach in percutaneous coronary intervention for chronic total occlusion. *J Cardiovasc Comput Tomogr*. 2016;10:128-34.

What Coronary CTA can do for CTO ?

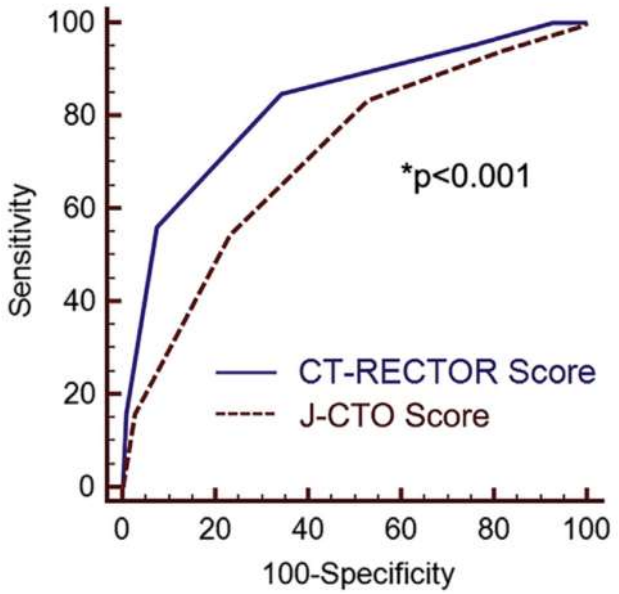
- **Identification of CTO**
  - **complete lack of contrast opacification, lesion length >9 mm, Reverse attenuation gradient**
- **Predicting the clinical benefit from revascularization**
- **Pre-procedural Planning**
  - **Occluded route, most vivid angle, length, side branch, calcification etc**
- **Predicting the procedural outcome of PCI**

Predicting procedural outcomes

Predicting Success



- **Successful guidewire (GW) crossing ≤30 min was set as an endpoint.**
- **A simple and accurate noninvasive tool for predicting time-efficient GW crossing that may aid in grading CTO difficulty before PCI.**



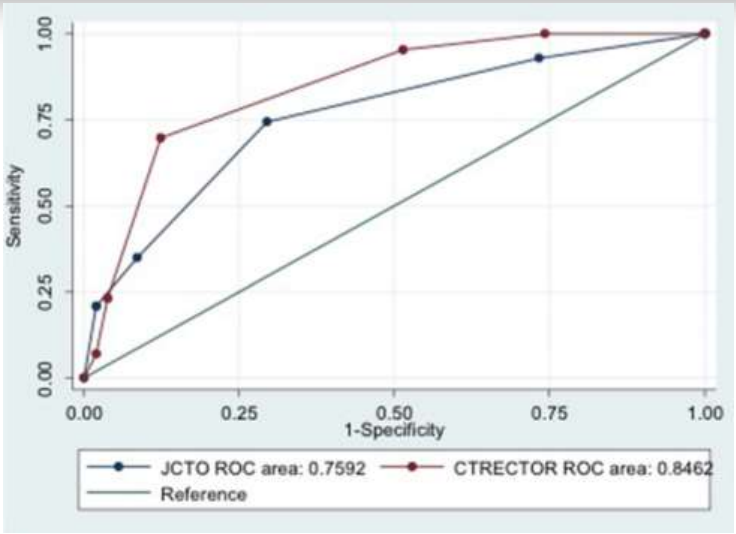
Opolski MP et al. Coronary computed tomographic prediction rule for time-efficient guidewire crossing through chronic total occlusion: Insights from the CT-RECTOR multicenter registry (computed tomography registry of chronic total occlusion revascularization). *JACC Cardiovasc Interv*. 2015;8:257–267.

Validation

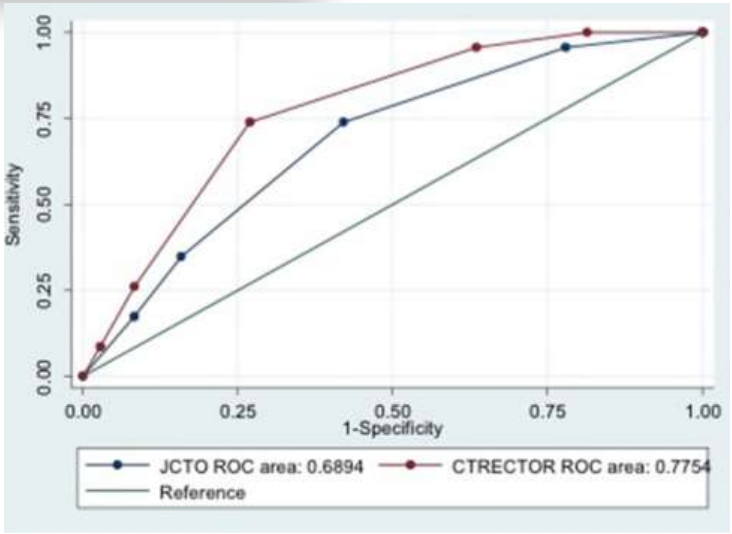
Comparison of CT-RECTOR and J-CTO scores to predict chronic total occlusion difficulty for percutaneous coronary intervention

Yahang Tan [a,b,1,2], Jia Zhou [a,c,1,2], Wei Zhang [a,1,2], Ying Zhou [a,d,1], Luoshan Du [e], Feng Tian [a,1], Jun Guo [a,1], Lian Chen [a,1], Feng Cao [a,1], Yundai Chen [a,*,1]

[a] Department of Cardiology, Chinese PLA General Hospital, China
[b] School of Medicine, Nankai University, China
[c] Department of Cardiology, Tianjin Chest Hospital, China
[d] Department of Cardiology, SHIJITAN Hospital, China
[e] Department of Radiology, Chinese PLA General Hospital, China



GW success ≤ 30 min.



Final procedure success

Compared with J-CTO, the CT-RECTOR scoring system provides amore accurate noninvasive tool for predicting time-efficient GW crossing and final procedure success.

Tan Y, Zhou J, Zhang W, Zhou Y, Du L, Tian F, Guo J, Chen L, Cao F, Chen Y. Comparison of CT-RECTOR and J-CTO scores to predict chronic total occlusion difficulty for percutaneous coronary intervention. *Int J Cardiol* [Internet]. 2017;235:169–175.

Periprocedural MI

Efficacy of Multidetector Computed Tomography to Predict Periprocedural Myocardial Injury After Percutaneous Coronary Intervention for Chronic Total Occlusion

A Multicenter Registry Study

Eisuke Usui,[1] MD, Tetsumin Lee,[1] MD, Tadashi Murai,[1] MD, Yoshihisa Kanaji,[1] MD, Junji Matsuda,[1] MD, Makoto Araki,[1] MD, Taishi Yonetsu,[2] MD, Yosuke Yamakami,[3] MD, Shigeki Kimura,[3] MD, *and* Tsunekazu Kakuta,[1] MD

Post-PCI cTnI or cTnT>20 times

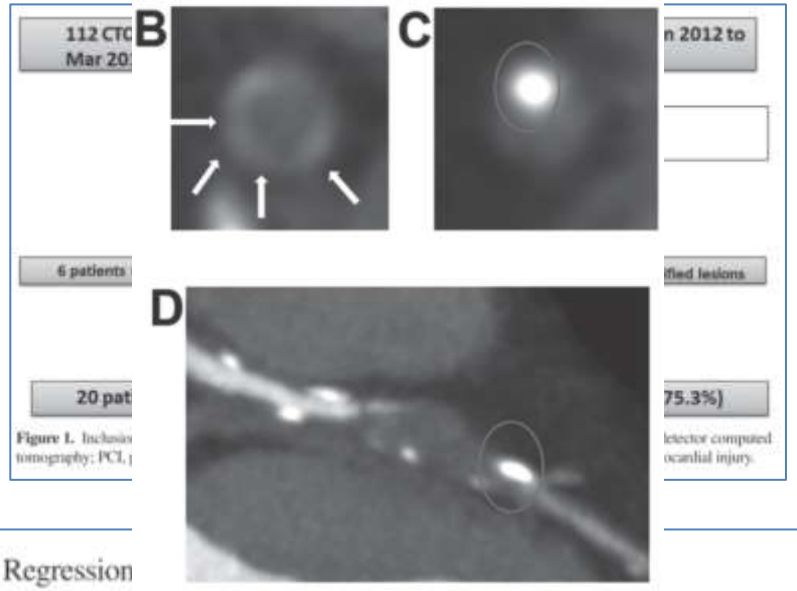


Table V. Univariate and Multivariate Logistic Regression

	Univariate logistic regression			Multivariate logistic regression model		
	OR	95% CI	*P*	OR	95% CI	*P*
LVDd	1.08	1.01–1.15	0.027			
Severe J-CTO score	4.75	1.13–19.9	0.033			
Napkin-ring sign	4.75	1.13–19.9	0.033	5.40	1.01–29.0	0.049
MDCT CTO length	1.08	1.01–1.08	0.005	1.04	1.01–1.08	0.023
Retrograde approach	5.78	1.87–17.8	0.002	4.45	1.28–15.4	0.019
Fluoroscopic time	1.01	1.00–1.02	0.007			
Contrast media volume	1.01	1.00–1.01	0.013			

The associated variables in univariate analyses ($P < 0.05$) were included in the multivariate model. CI indicates confidence interval; J-CTO, Japan CTO score; LVDd, left ventricular diastolic diameter; MDCT, multidetector computed tomography; CTO, chronic total occlusion; and OR, odds ratio.

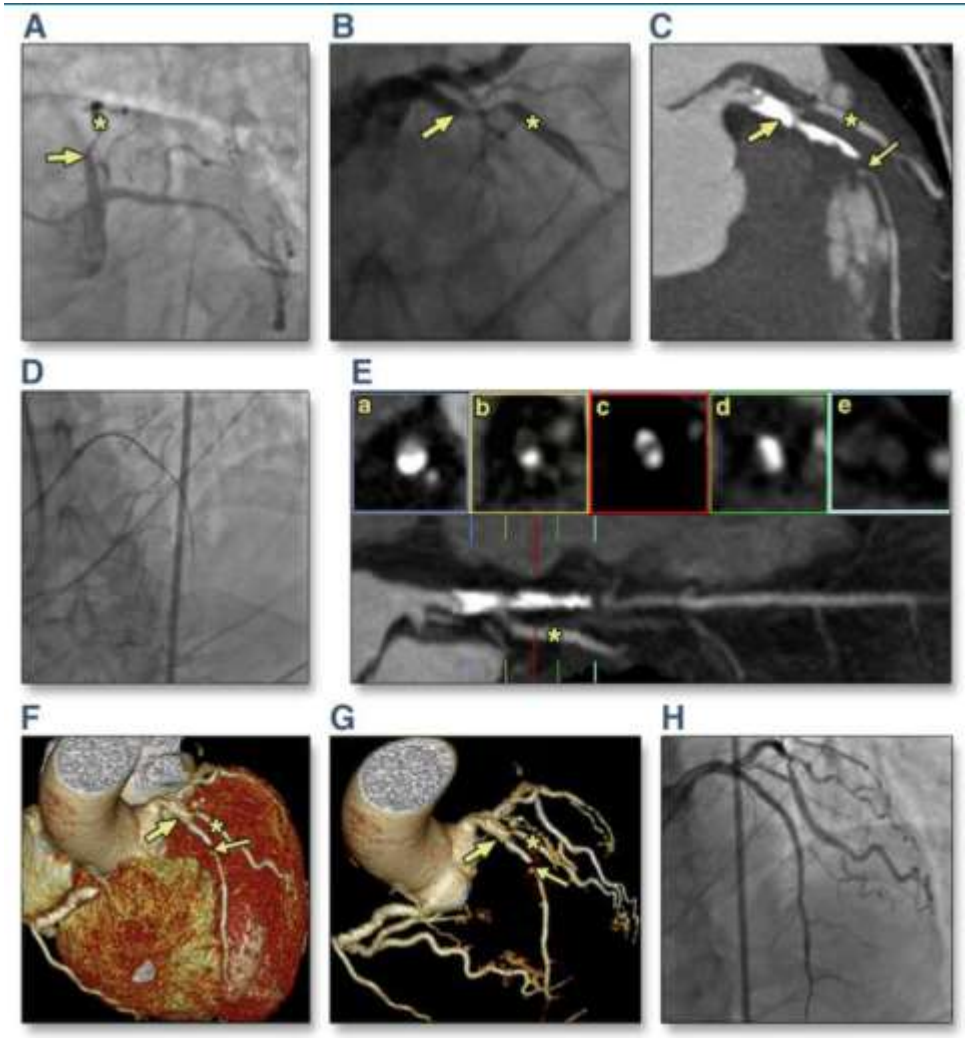
On MDCT, lesion length and the presence of the napkin ring sign were significantly associated with PMI

Usui E, Lee T, Murai T, Kanaji Y, Matsuda J, Araki M, Yonetsu T, Yamakami Y, Kimura S and Kakuta T. Efficacy of Multidetector Computed Tomography to Predict Periprocedural Myocardial Injury After Percutaneous Coronary Intervention for Chronic Total Occlusion. *Int Heart J.* 2017;58:16-23.

Can preprocedural Coronary CTA improve overall CTO PCI success rate?

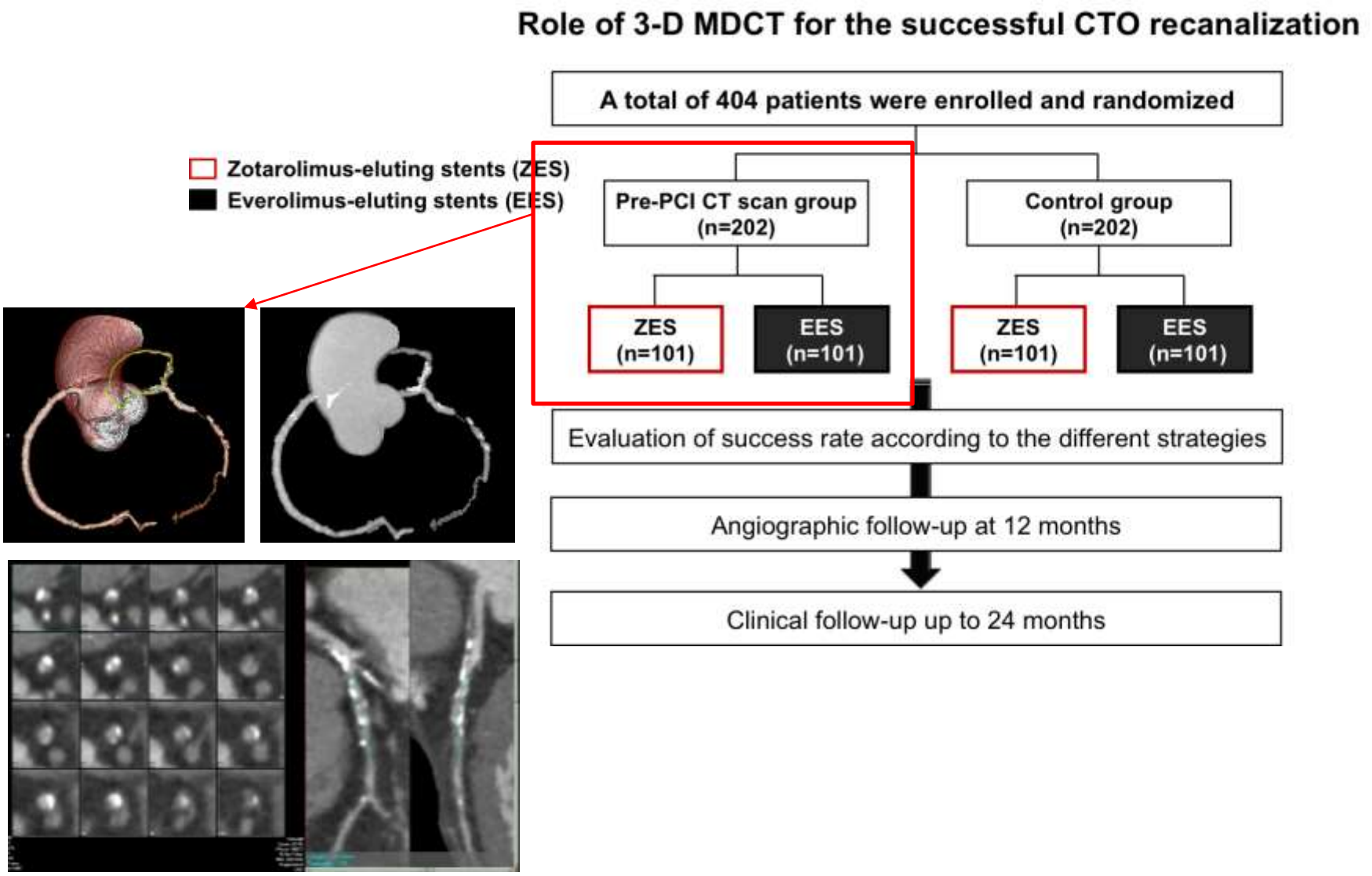
- **CT can better define bending, calcification, and the course of ambiguous CTOs. Luo et al. demonstrated that CT negative remodeling, length>32mm, and ostial/bifrucation lesion as predictors of failure.**

- **These features can guide directions of wires; and help anticipate hostile calcification and tortuosity, which may influence guidewire, microcatheter, and other device choices**



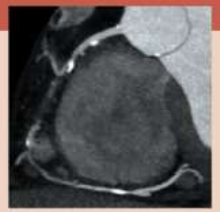
Luo C, Huang M, Li J, Liang C, Zhang Q, Liu H, Liu Z, Qu Y, Jiang J, Zhuang J. Predictors of Interventional Success of Antegrade PCI for CTO. *JACC Cardiovasc Imaging*. 2015;8:804–813.

Randomized CTO-CT study (enrolling)



Role of coronary CTA in the management of CTO

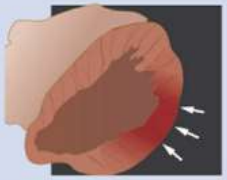
1 IDENTIFICATION OF CTO



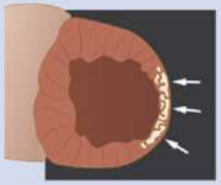
2 PREDICTING CLINICAL BENEFIT FROM REVASCULARIZATION

- Assessment of myocardial function

- Assessment of myocardial perfusion



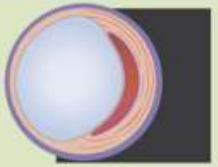
- Detecting myocardial scar



3 PREDICTING THE PROCEDURAL OUTCOME OF PCI

CT-RECTOR Score

- Calcification ≥50% CSA



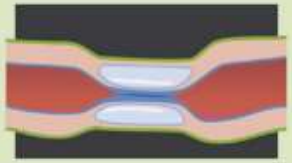
- Bending ≥45°

- Multiple occlusion sites

- Blunt stump

- Occlusion length

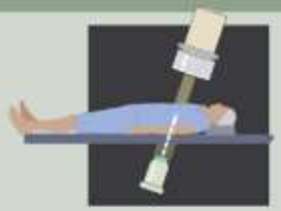
- Shrinkage/negative remodeling



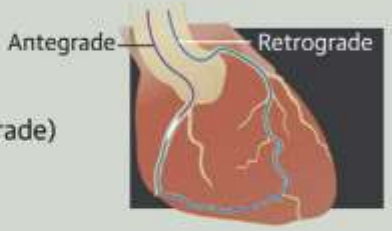
Role of coronary CTA in the management of CTO

4 PRE-PROCEDURAL PLANNING

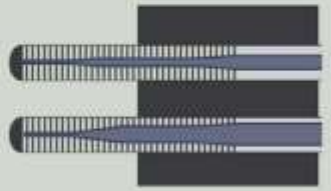
- Selection of the fluoroscopic projection angles without foreshortening



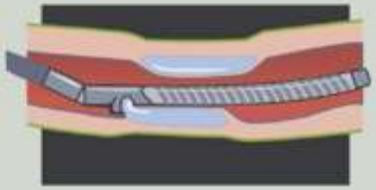
- Selection of the most suitable approach (antegrade vs retrograde)



- Selection of stiff flat or tapered wires



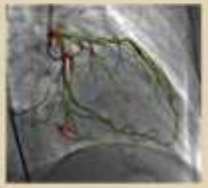
- Use of additional debulking devices



5 VISUALIZATION DURING THE PROCEDURE IN THE CATH LAB

- Coronary CTA data co-registration

- Integration of 3-dimensional coronary CTA and X-ray images (fusion technique)



6 LONG-TERM FOLLOW-UP (STENT PATENCY)

Conclusion

- **Invasive angiography can not always precisely define the occluded CTO segment**
  - **Proximal cap may be ambiguous**
  - **CTO segment may be tortuous**
  - **Flouroscopy has limited sensitivity for calcium**

- **Compared to x-ray angiography, preprocedural CCTA offers superior assessment of arterial course, tortuosity, and calcifications of CTO lesions, and can be leveraged to improve CTO PCI.**

- **Coronary CTA can characterize features that influence the success rate of PCI for CTOs**

Thank you for attention!!