

When to Go Retrograde?

Insights from a Pooled Analysis of CTO PCI

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CTO-PCI Success rates



Mid-2000s

50-70%

Prasad et al. JACC 2007
Joyal et al. AJC 2010
Mehran et al. JACC CI 2011



Nowadays

85-90%

Karpalotis et al. Circ CI 2016
Habara et al. CCI 2016
Suzuki et al. JACC CI 2017
Konstantinidus et al. Circ CI 2018
Wu et al. Heart Lung Circ 2020



The evolution of CTO-PCI

- **Refinement of equipment:** guidewires (Miracle, Conquest, XT, Gaia, Gaia Next), microcatheters (Corsair, Caravel)
- **Development of novel techniques:** parallel wiring, IVUS-guided rewiring, antegrade dissection and reentry, retrograde approach
- **Understanding of the CTO pathology and the mechanism of guidewire manipulation within CTO:** guide wire deflection, whipping motion

	Retrograde summit	Retrograde summit general	Expert Registry	AP-CTO	RECHARGE	PROGRESS
					(Hybrid)	(Hybrid)
Year	2012-2013	2017	2014-2015	2016	2014-2015	2012-2017
Cases	3229	476	2596	497	1253	3055
Age	67.8 ± 10.4	69.1 ± 11.2	66.9 ± 10.9	61.4 ± 11	66 ± 11	65 ± 10.1
Male	83.20%	81.70%	86.10%	88.40%	86%	85%
Re-attempt	10.0%	7.6%	20.6%	34.4%	21.0%	20.2%
Syntax	-	-	15.9 ± 8.6	-	-	-
J-CTO	1.6 ± 1.1	2.0 ± 1.1	2.0 ± 1.1	2.9 ± 1.2	2.2 ± 1.3	2.4 ± 1.3
Success rate						
GW success	89.6%	-	92.0%	-	-	-
Technical success	-	91.2%	89.9%	93.8%	89.0%	86.8%
Procedure success	88.4%	88.7%	88.8%	89.9%	86.0%	85.0%
Procedure time	149.4 ± 85.4	156.3 ± 92.2	160.4 ± 89.6	100 (60-140)	90 (60-120)	123 (81-188)
Contrast volume	227.3 ± 104.6	180.0 ± 90.2	230.8 ± 89.6	250 (180-320)	250 (180-340)	270 (200-360)
MACCE	0.5%	1.7%	-	3.8%	2.6%	3.0%
In-hospital death	0.2%	0.7%	0.2%	0.2%	0.2%	0.9%
Myocardial infarction	0.1%	1.1%	1.2%	3.4%	2.2%	1.1%
Acute stent thrombosis	0.2%	0.4%	0.2%	0.4%	-	-
Stroke	0.1%	0.0%	0.2%	0.2%	0.2%	0.3%
Emergent CABG	0.1%	0.4%	0.0%	0.0%	-	0.2%
Emergent PCI	0.0%	0.0%	0.2%	0.0%	-	0.4%
Coronary perforation (Tamponade)	3.0% (0.3%)	3.0%(0.4%)	(0.4%)	1.8% (0.2%)	(1.3%)	(0.85%)
First Crossing strategy						
Antegrade procedure	78.0%	85.0%	72.2%	70.0%	77.0%	75.4%
Retrograde procedure	22.0%	15.0%	27.8%	30.0%	17.0%	16.2%
ADR procedure	0.0%	0.0%	0.0%	0.0%	7.0%	8.4%
Final Crossing strategy						
Antegrade procedure	77.0%	78.1%	62.7%	59.4%	58.0%	52.0%
Retrograde procedure	23.0%	21.2%	37.2%	39.3%	24.0%	27.1%
ADR procedure	0.0%	0.6%	0.0%	1.0%	18.0%	20.9%

Retrograde approach improved success in complex CTO

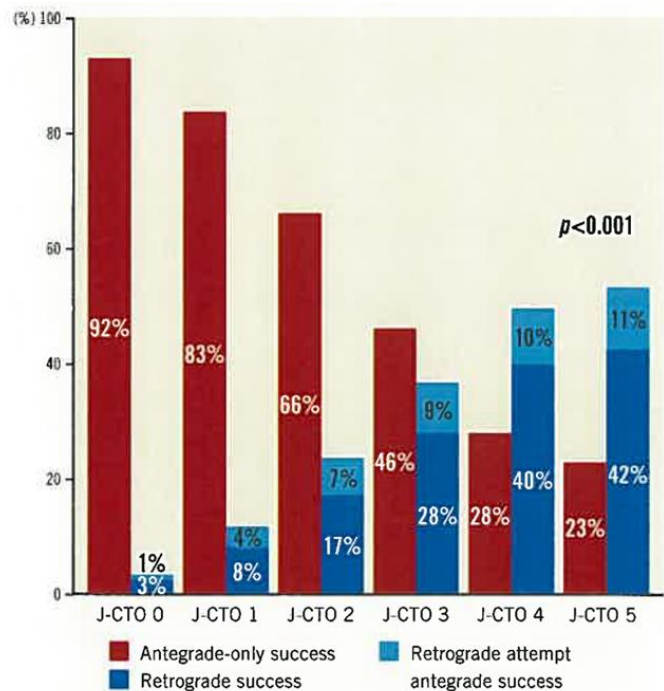
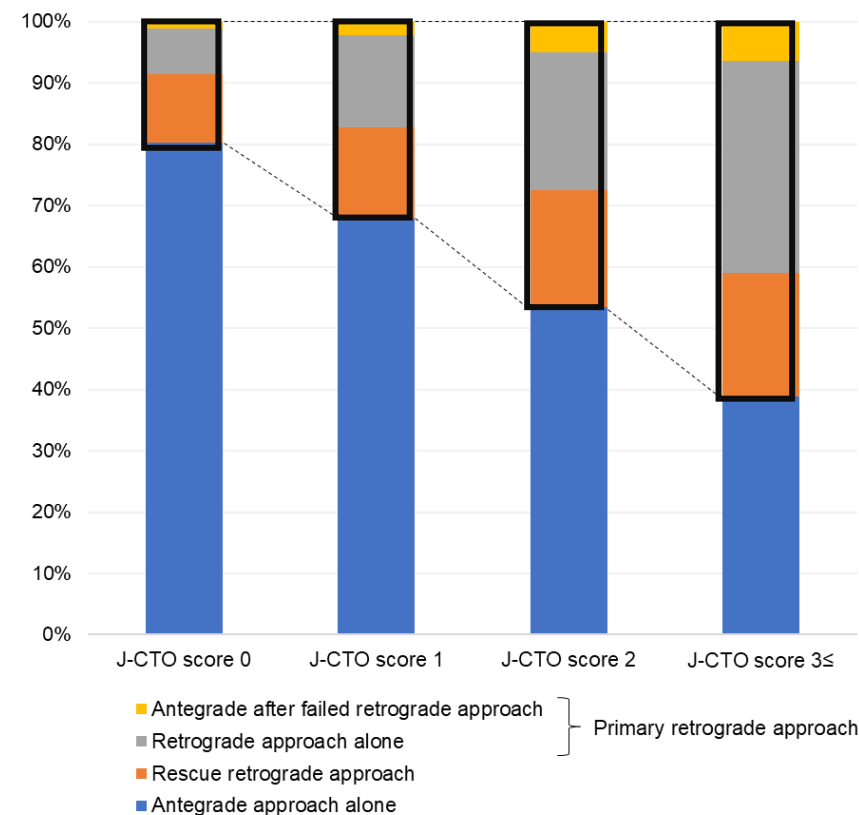


Figure 1. Technical success of CTO interventions with the retrograde approach (n=1,515) compared to antegrade-only interventions (n=2,686) stratified by the J-CTO score.

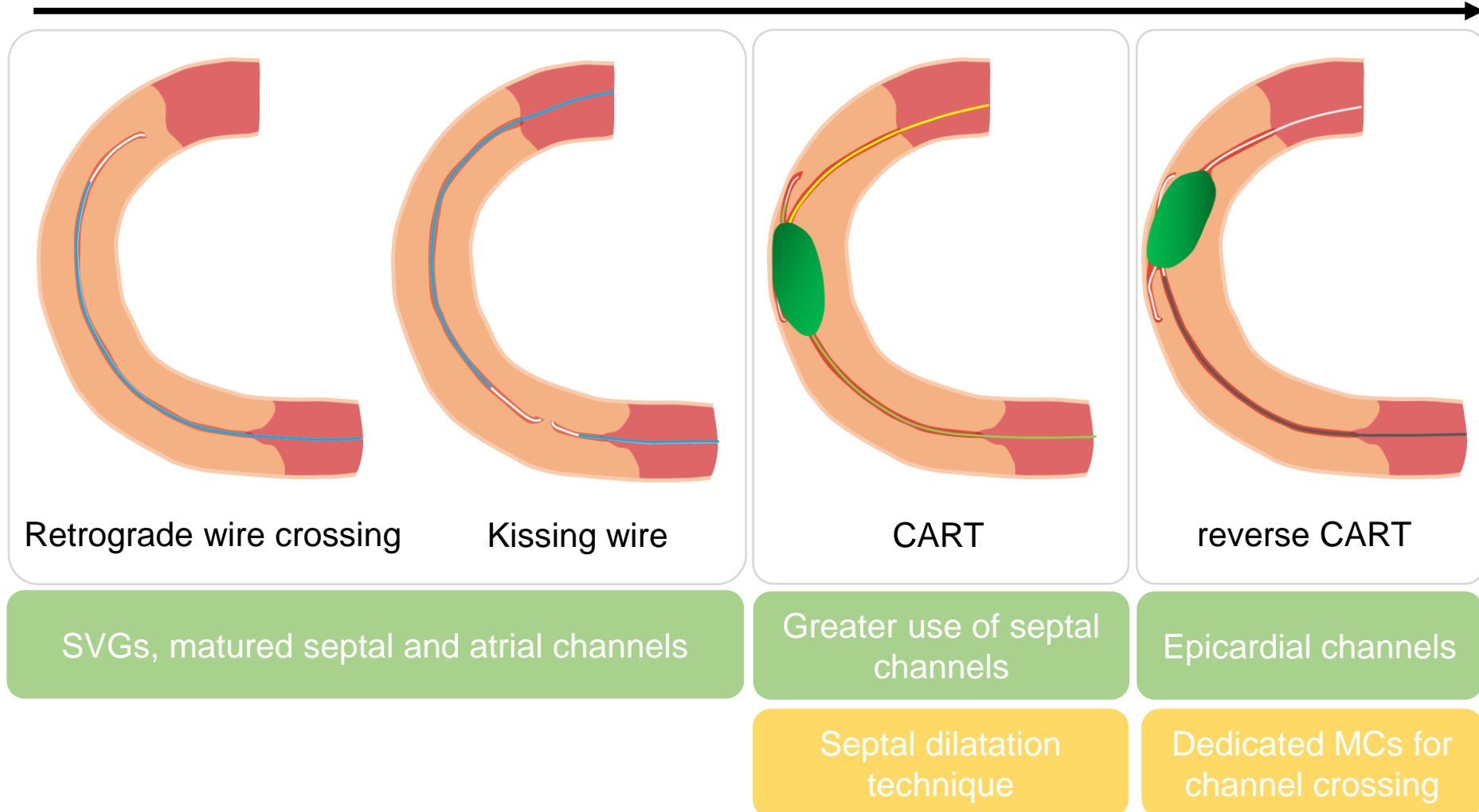


History of retrograde CTO PCI

Early 1990s

2006

2009



reverse CART in contemporary retrograde CTO PCI

Table 1. Retrograde approach in recently published CTO PCI series from Europe, the USA and Japan.

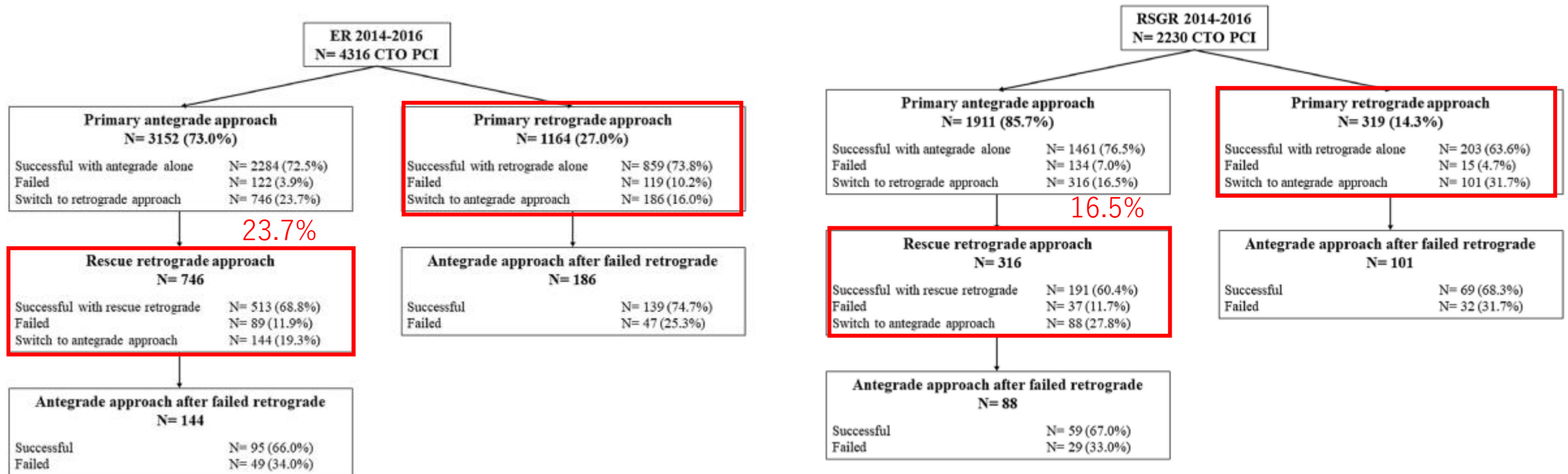
Country/region	Europe			USA			Japan		
Year	2011	2015	2016	2012	2016	2017	2013	2013	2017
Study	Galassi et al ^{13,22}		Maeremans et al ²⁴	Karpaliotis et al ^{19,23}		Sapontis et al ²⁵	Tsuchikane et al ²¹	Yamane et al ²⁰	Suzuki et al ²⁶
Retrograde CTO PCI, n (%)	234 (12)	1,582 (16)	207 (17)	462 (34)	539 (41)	NA	801 (27)	378 (25)	1,206 (46)
Overall technical success in retrograde PCI, %	65	75	75	81	85	NA	85	84	84
Distribution of retrograde wire crossing strategies									
Reverse CART, %	–	16.0	67	46	62	70	55.2	42.1	62.4
CART, %	31.8	13.9	3	11.5	2.7	–	6.4	12.0	0.7
Retrograde wire crossing, %	37.2	31.2	28	NA	19	30	22.9	23.3	16.3
Kissing wire, %	22.3	22.0	NA	NA	3.3	–	15.5	22.6	17.7
CART: controlled antegrade and retrograde tracking technique; CTO: chronic total occlusion; NA: not assessed; PCI: percutaneous coronary intervention									

The light of the retrograde approach

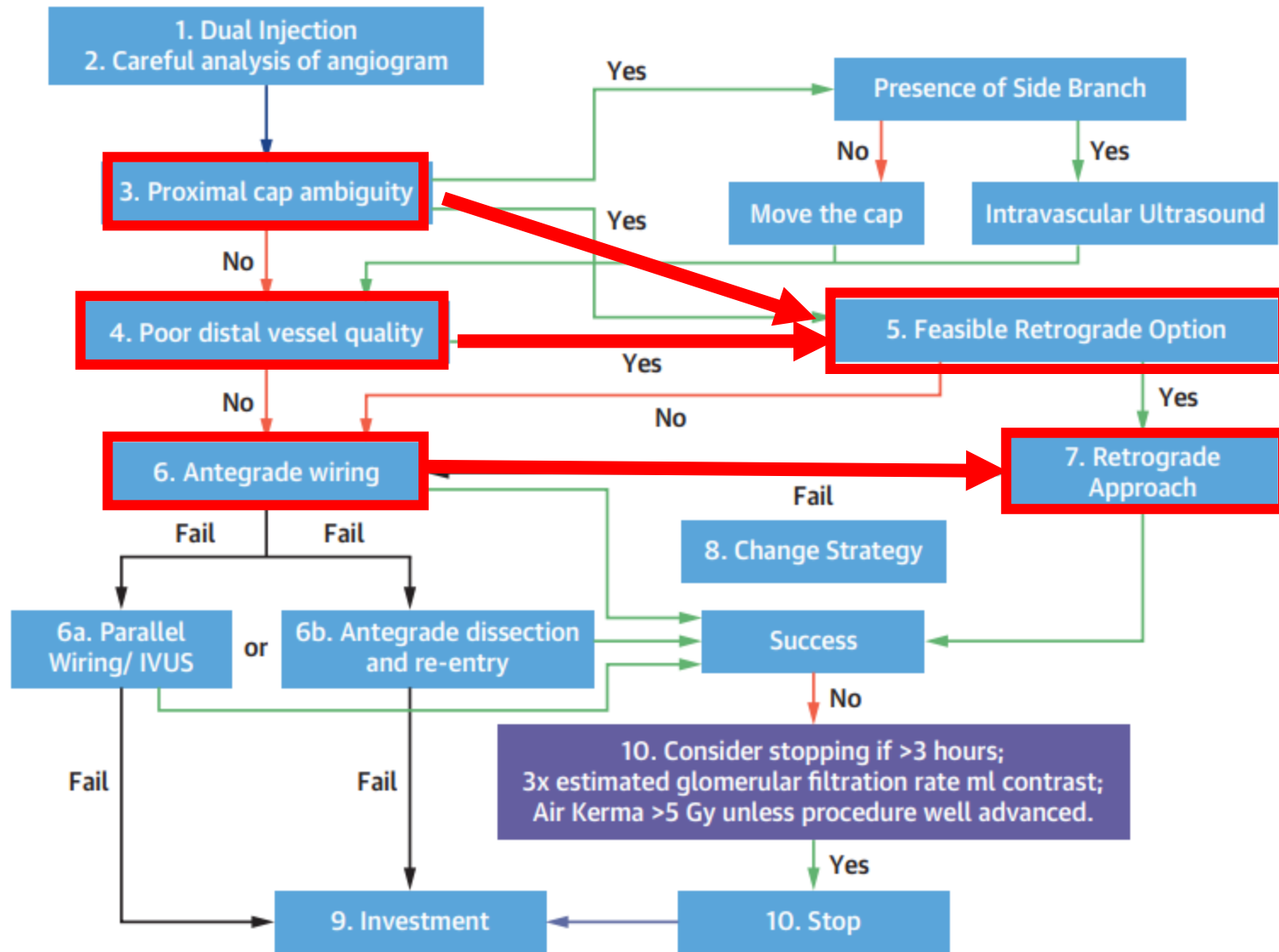
- High success rates especially in **complex CTO where the antegrade approach is not technically feasible or fails**
- More promising and efficient recanalization in **CTO with poor quality distal vessel or significant side branches at the distal cap**
- Lower contrast consumption in **patients with chronic kidney disease**

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CENTRAL ILLUSTRATION The Global Chronic Total Occlusion Crossing Algorithm



Indication of Retrograde procedure

□ Proximal cap ambiguity

- ✓ With side branch → IVSU guide puncture
- ✓ Without side branch → Retrograde procedure or Move the cap



□ Feasible retrograde option

- ✓ Collateral channel
- ✓ Distance from channel connection to CTO exit
- ✓ Angle from distal lumen to CTO exit

Successful guidewire crossing via collateral channel at retrograde percutaneous coronary intervention for chronic total occlusion: the J-Channel score

Wataru Nagamatsu^{1*}, MD; Etsuo Tsuchikane², MD, PhD; Yuji Oikawa³, MD; Satoru Sumitsuji⁴, MD; Yasumi Igarashi⁵, MD, PhD; Ryohei Yoshikawa⁶, MD; Makoto Muto⁷, MD; Hisayuki Okada⁸, MD, PhD; Osamu Katoh⁹, MD

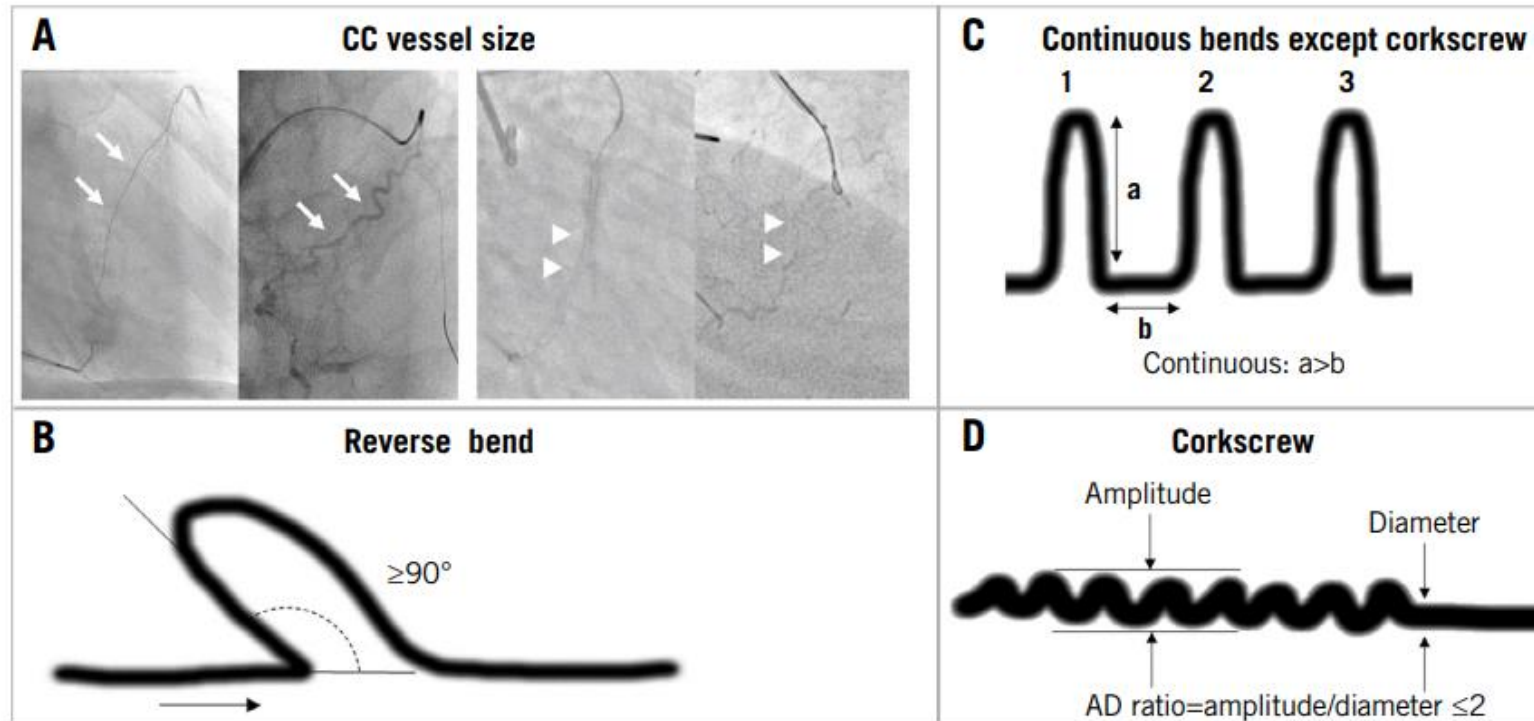
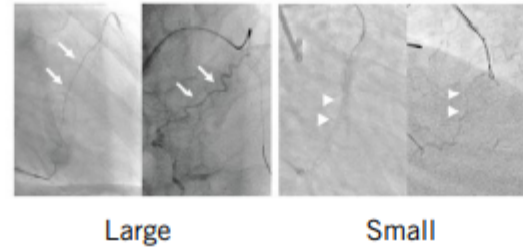


Figure 1. Definitions of angiographic findings. A) Arrows = large size CC such as CC2; arrowheads = small size CC such as CC1. Large vessel size was defined as CC2. Small vessel size was defined as CC0 or CC1. CC grade (CC0-2) was proposed by Werner¹³. B) The reverse bend was described as a part of a bend folded at an angle of $>90^\circ$. C) Continuous bend was defined as the height of a bend (a) exceeding the length between bends (b), that is, when a is $>b$. At least three continuous bends, except corkscrew morphology, were termed as variables of continuous bends. D) Corkscrew was defined as three or more continuous bends with a ratio of vessel amplitude/vessel diameter (AD ratio) ≤ 2 . CC: collateral channel

J-Channel score

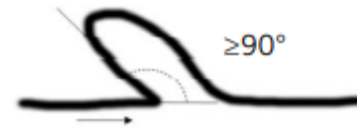
A CC Vessel size

- Large (CC2)
- Small (CC0 or CC1)



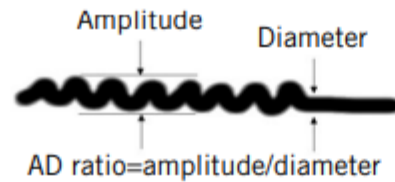
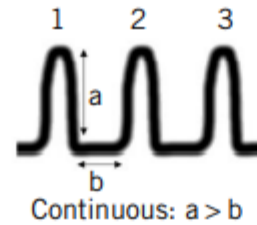
B Reverse bend

- None: $<90^\circ$
- Yes: $\geq 90^\circ$



C Continuous bends

- None: ≤ 2
- Yes: ≥ 3



D Corkscrew

- None
- Yes: continuous bends ≥ 3 with AD ratio ≤ 2

	Septal	Non-septal
CC Vessel size: <i>Small</i>	2	3
Reverse bend: <i>Yes</i>	1	1
Continuous bends: <i>Yes</i>	1	0
Corkscrew: <i>Yes</i>	0	1
Total score		

Category of difficulty (total score)

- Easy: 0
- Intermediate: 1-2
- Difficult: ≥ 3

How to use:

1st Classify CC into type of CC

2nd Sum up numbers of vertical frame as type of CC

3rd Estimate difficulty

Figure 5. Summary of the J-Channel score. The J-Channel score as a difficulty estimating tool for CC GW crossing success from the Japanese CTO PCI Expert Registry. CC grades (CC0-2) were proposed by Werner¹³. CC: collateral channel

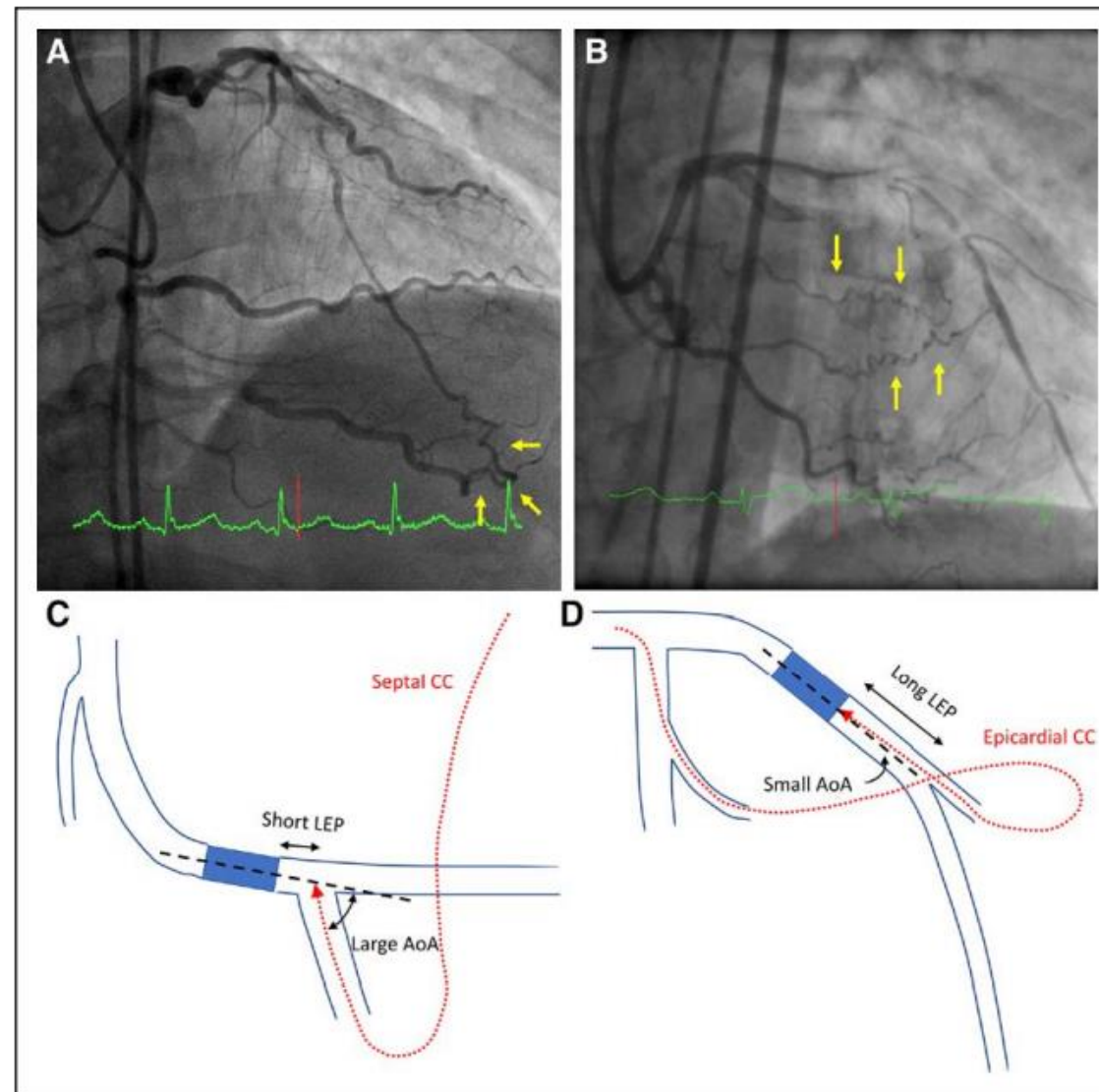
Collateral Channel Size and Tortuosity Predict Retrograde Percutaneous Coronary Intervention Success for Chronic Total Occlusion

Ching-Chang Huang, MD; Chih-Kuo Lee, MD; Shih-Wei Meng, MD;
Chi-Sheng Hung, MD, PhD; Ying-Hsien Chen, MD; Mao-Shin Lin, MD, PhD;
Chih-Fan Yeh, MD; Hsien-Li Kao, MD

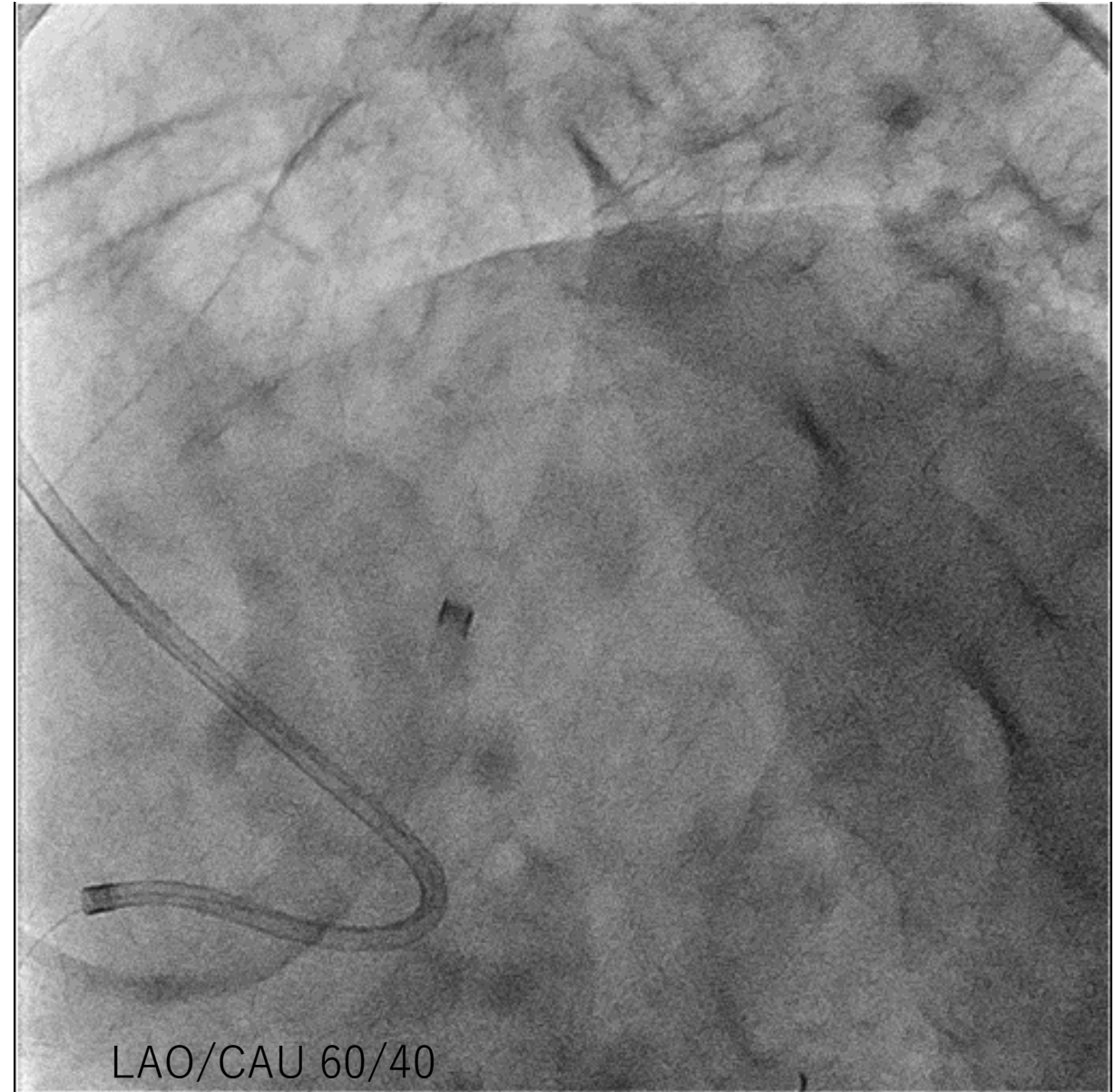
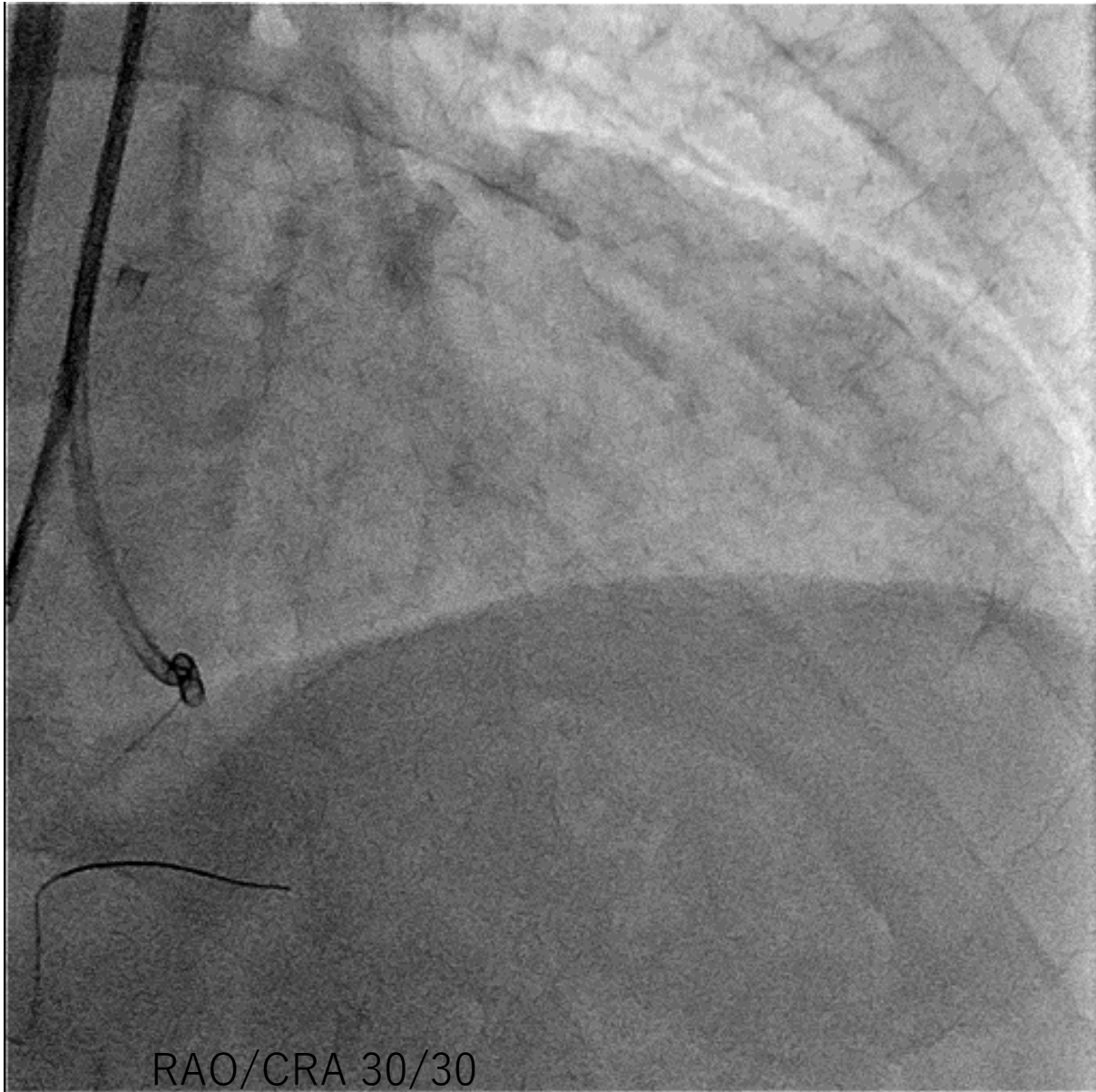
Table 4. Univariable and Multivariable Analyses for Predictors of Technical Success

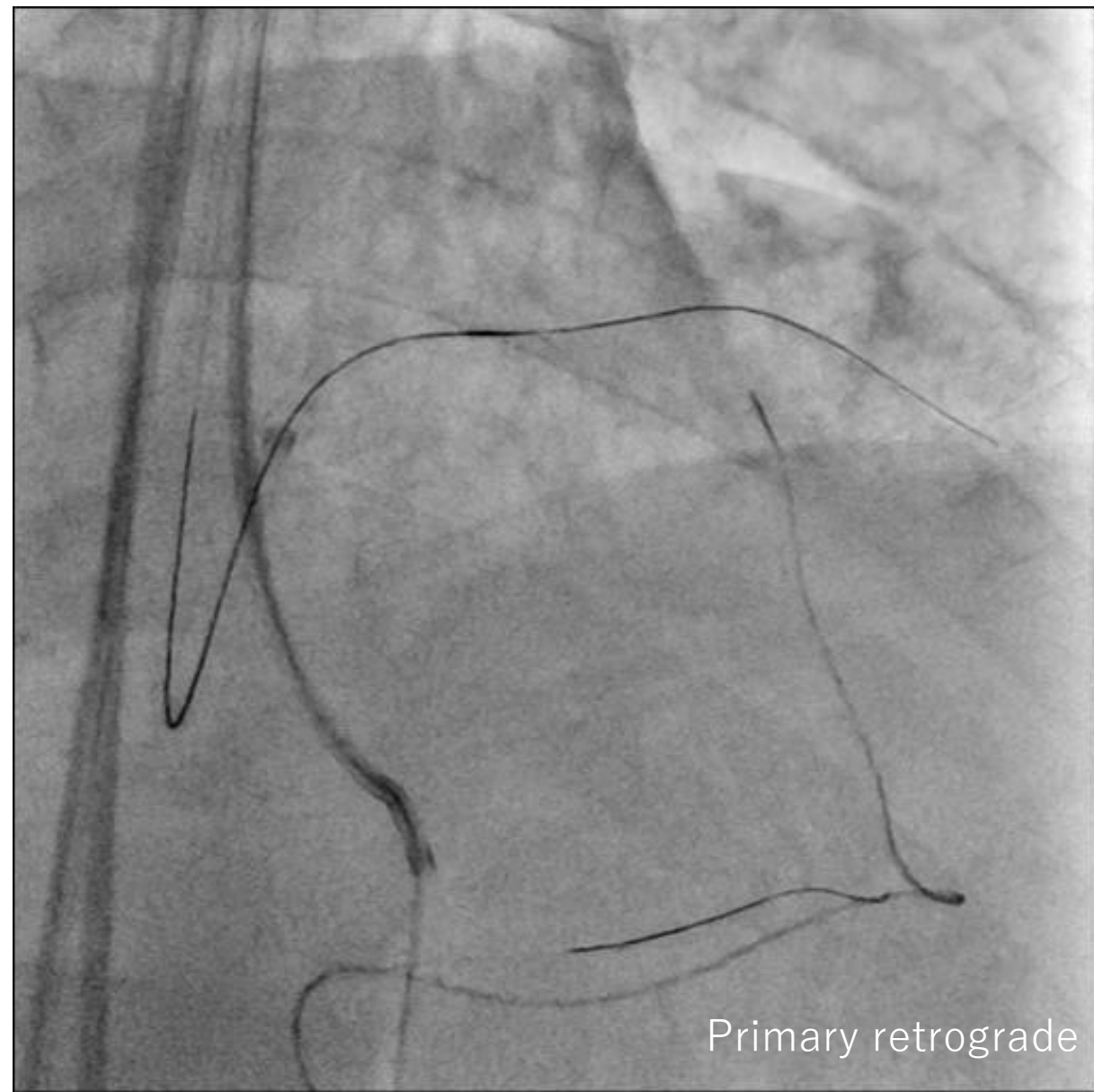
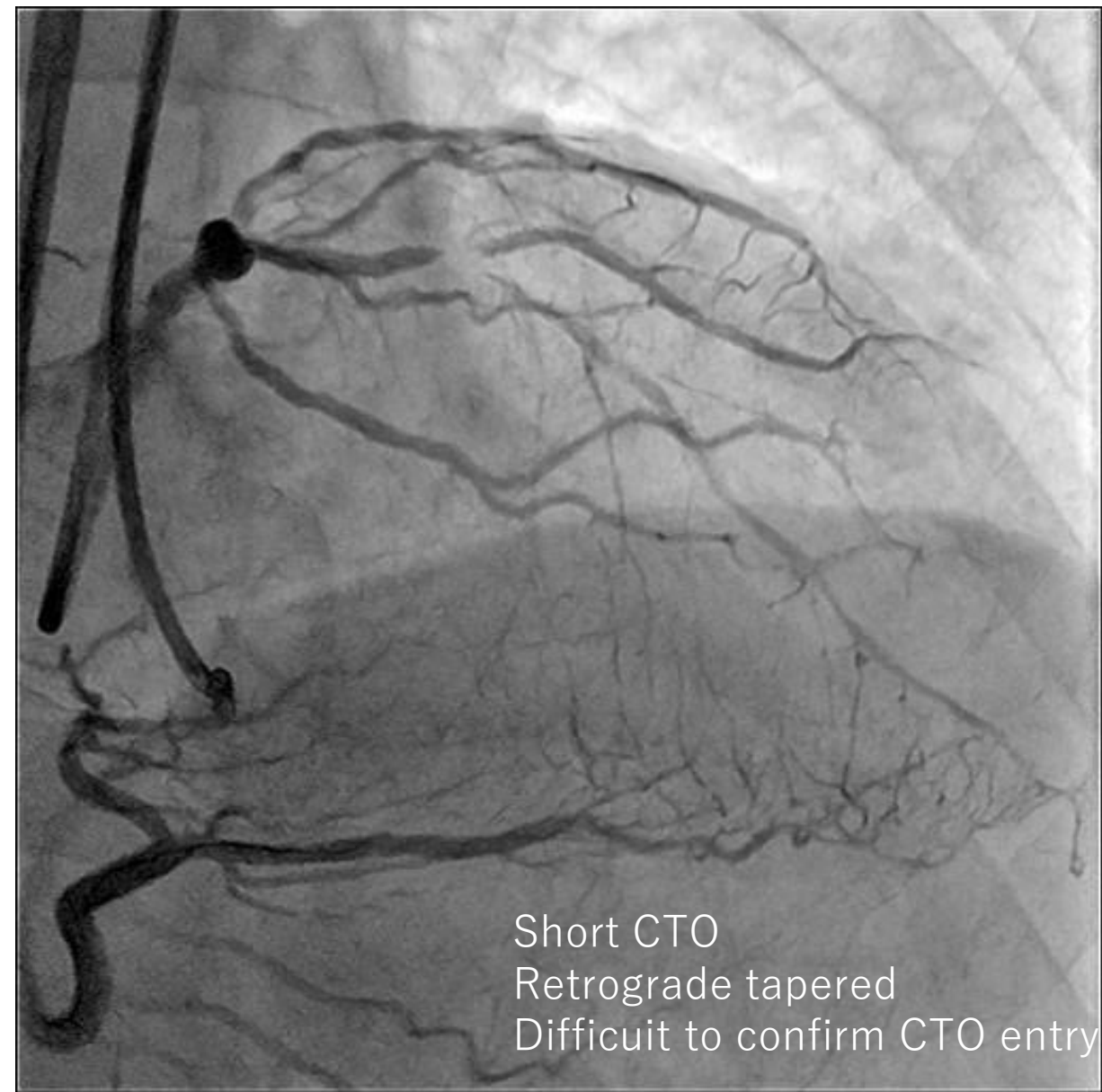
	Univariable		Multivariable	
	OR (95% CI)	PValue	OR (95% CI)	PValue
Large size	3.14 (1.6–6.14)	0.001	2.27 (1.08–4.75)	0.029
Lack of tortuosity	6.75 (3.26–14)	<0.001	5.87 (2.76–12.5)	<0.001
AoA<45°	1.79 (0.92–3.51)	0.088	1.18 (0.55–2.49)	0.661
LEP >5 mm	0.79 (0.27–2.28)	0.663		
AVG	0.77 (0.32–1.82)	0.545		
Epicardial	1.22 (0.61–2.45)	0.574		
Septal	0.97 (0.51–1.85)	0.917	0.88 (0.42–1.83)	0.737
J-CTO score	0.71 (0.45–1.11)	0.135		
First CC attempted	1.71 (0.67–4.37)	0.257		

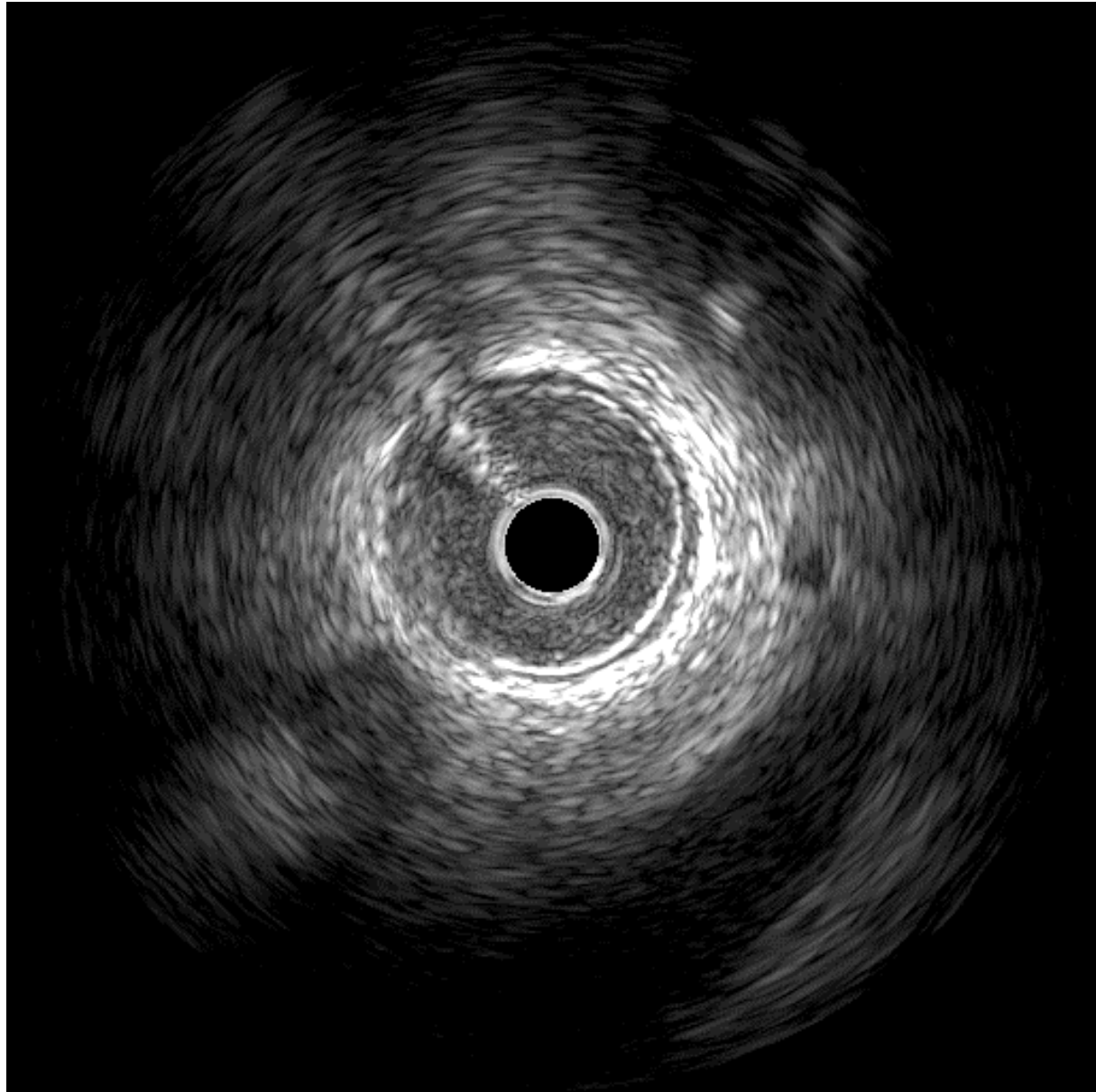
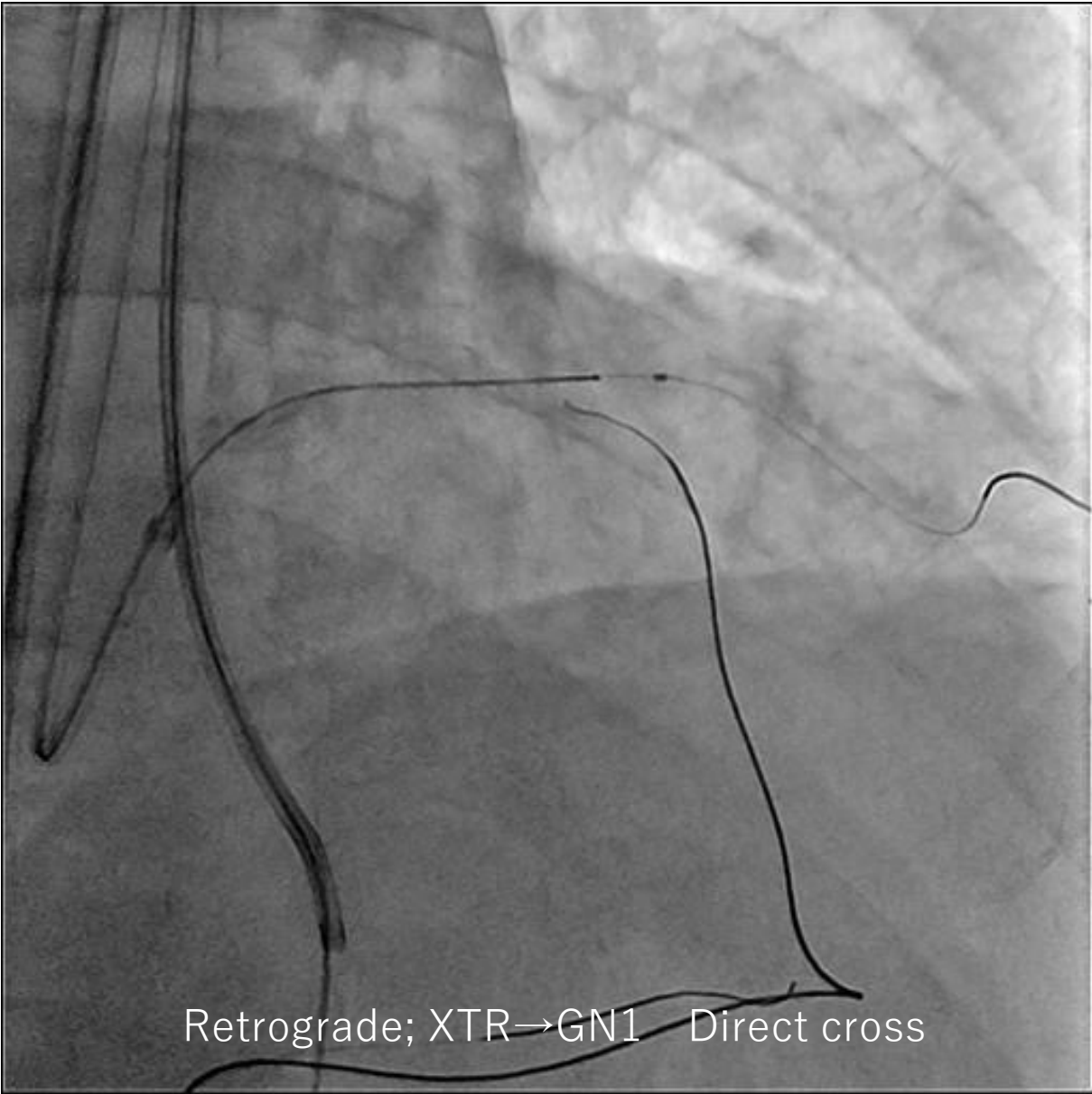
AoA indicates angle of attack; AVG, atrioventricular groove; CC, collateral channel; CI, confidence interval; CTO, chronic total occlusion; J-CTO, Multicenter CTO Registry of Japan; LEP, length to emerging point; and OR, odd ratio.

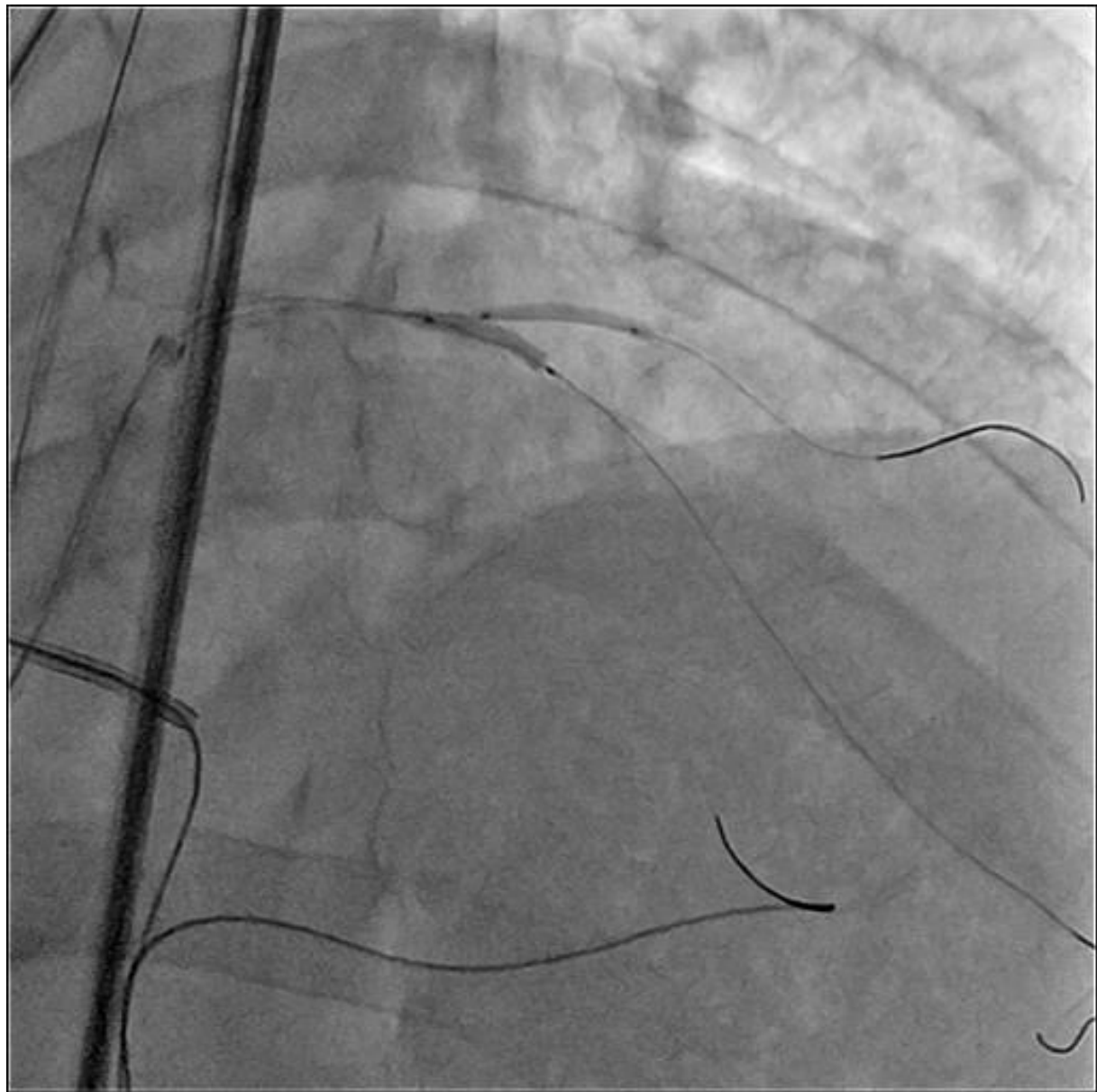


Case: 70 y.o Male LAD-CTO

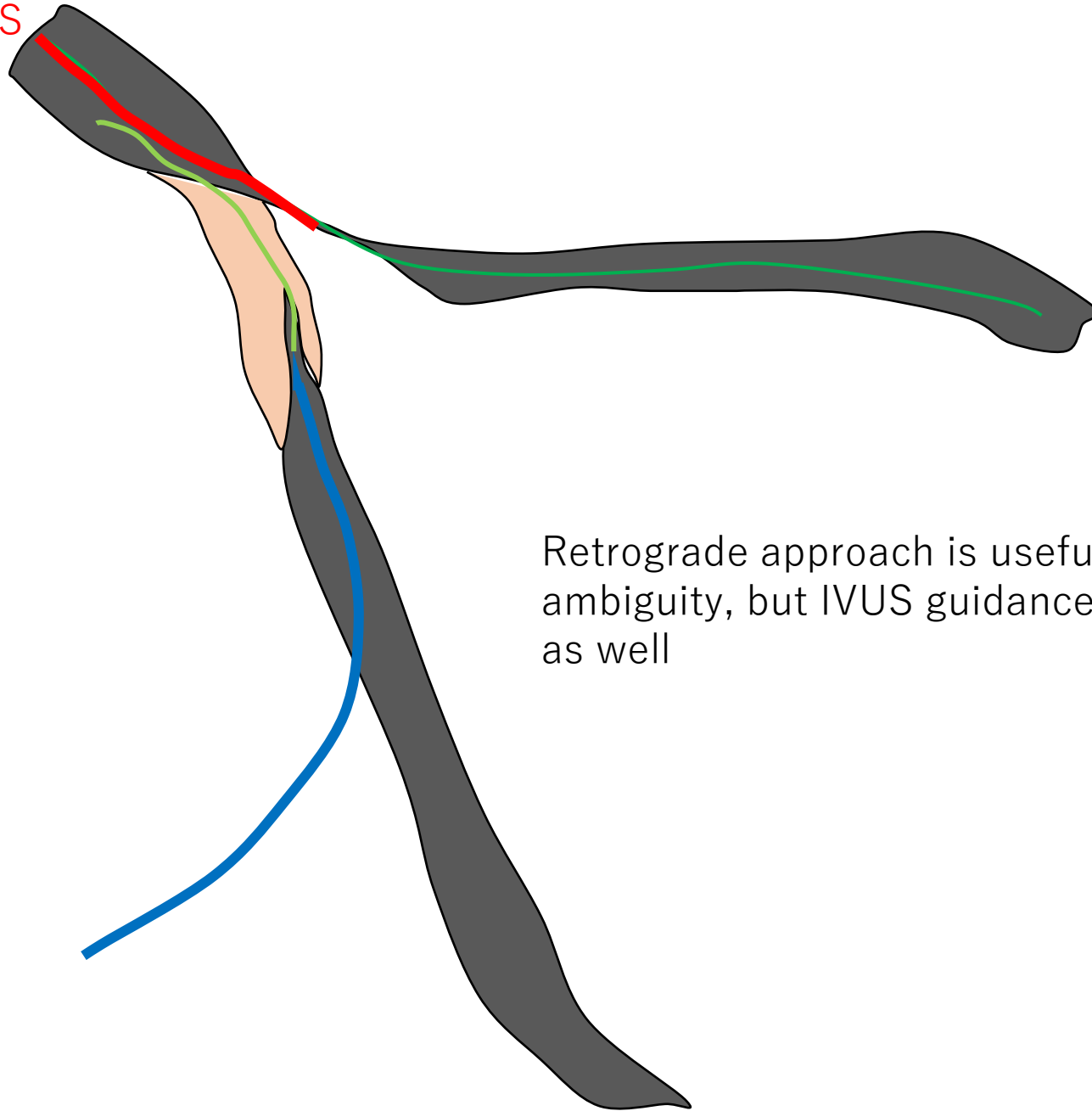








IVUS



Retrograde approach is useful when the proximal cap ambiguity, but IVUS guidance is mandatory in this case as well

Indication of Retrograde procedure

❑ Poor distal vessel quality

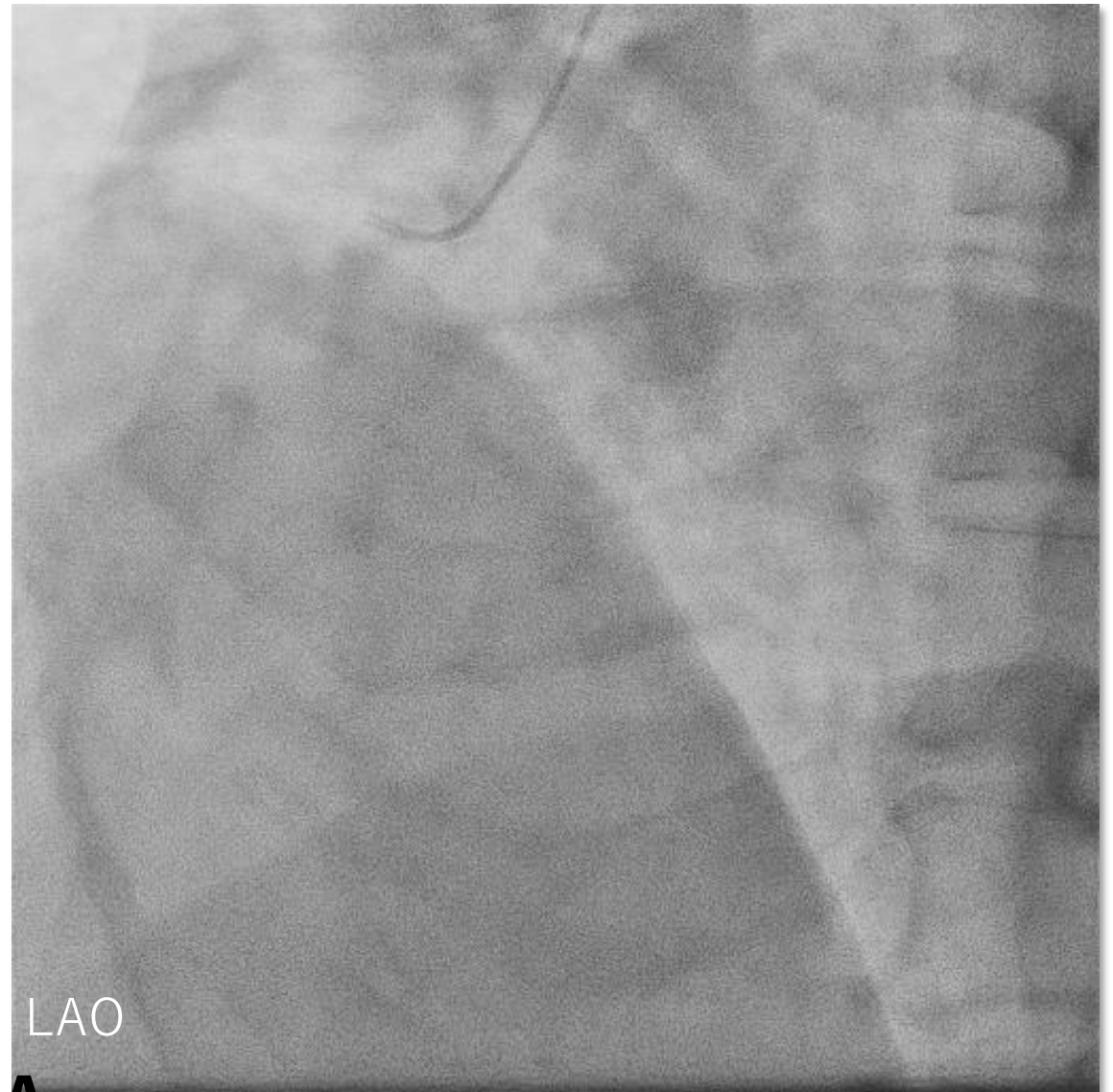
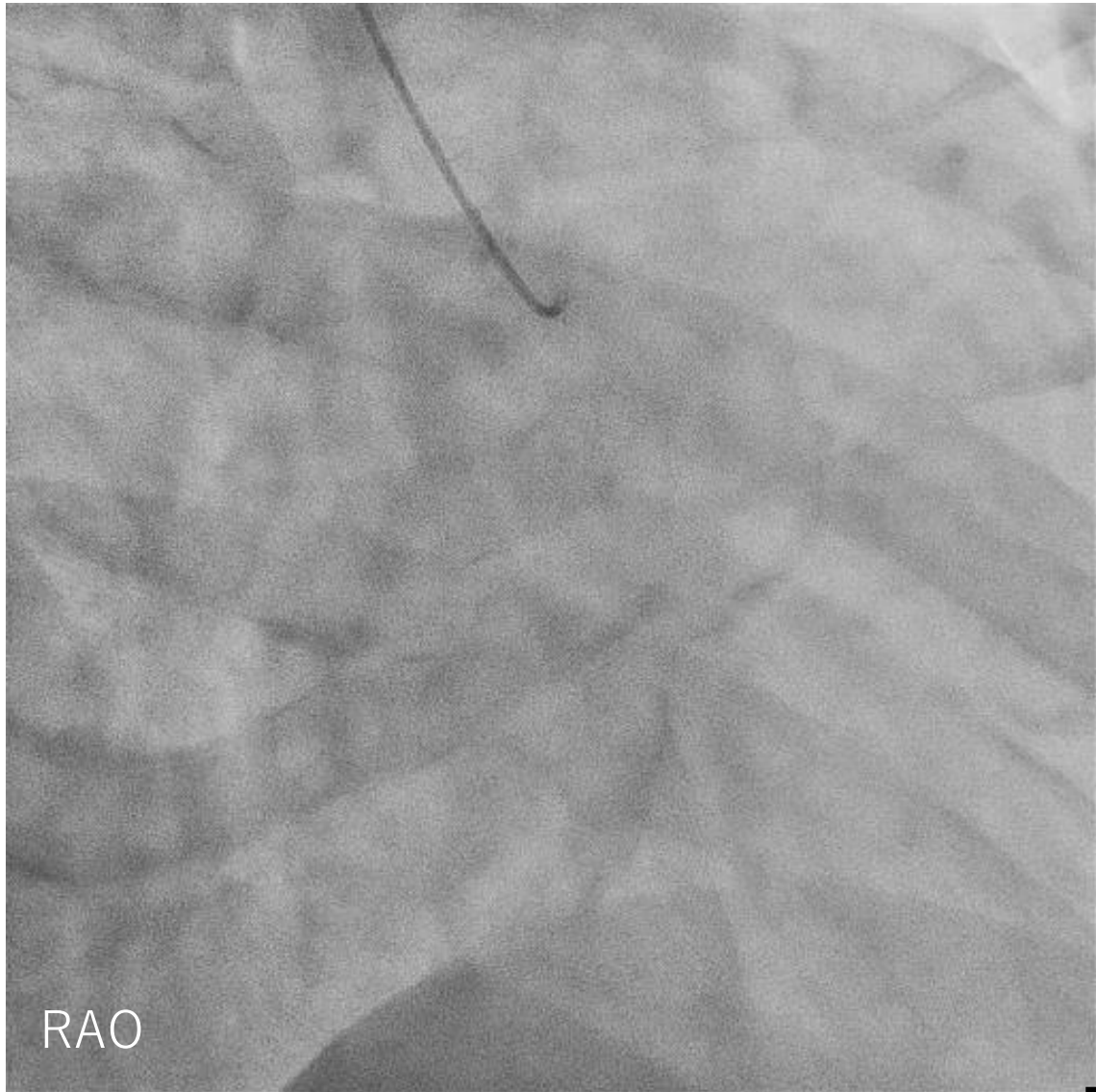
- ✓ Not clear (Multi-supply, severe stenosis at distal site)
- ✓ Diffuse plaque (narrowing)the



❑ Feasible retrograde option

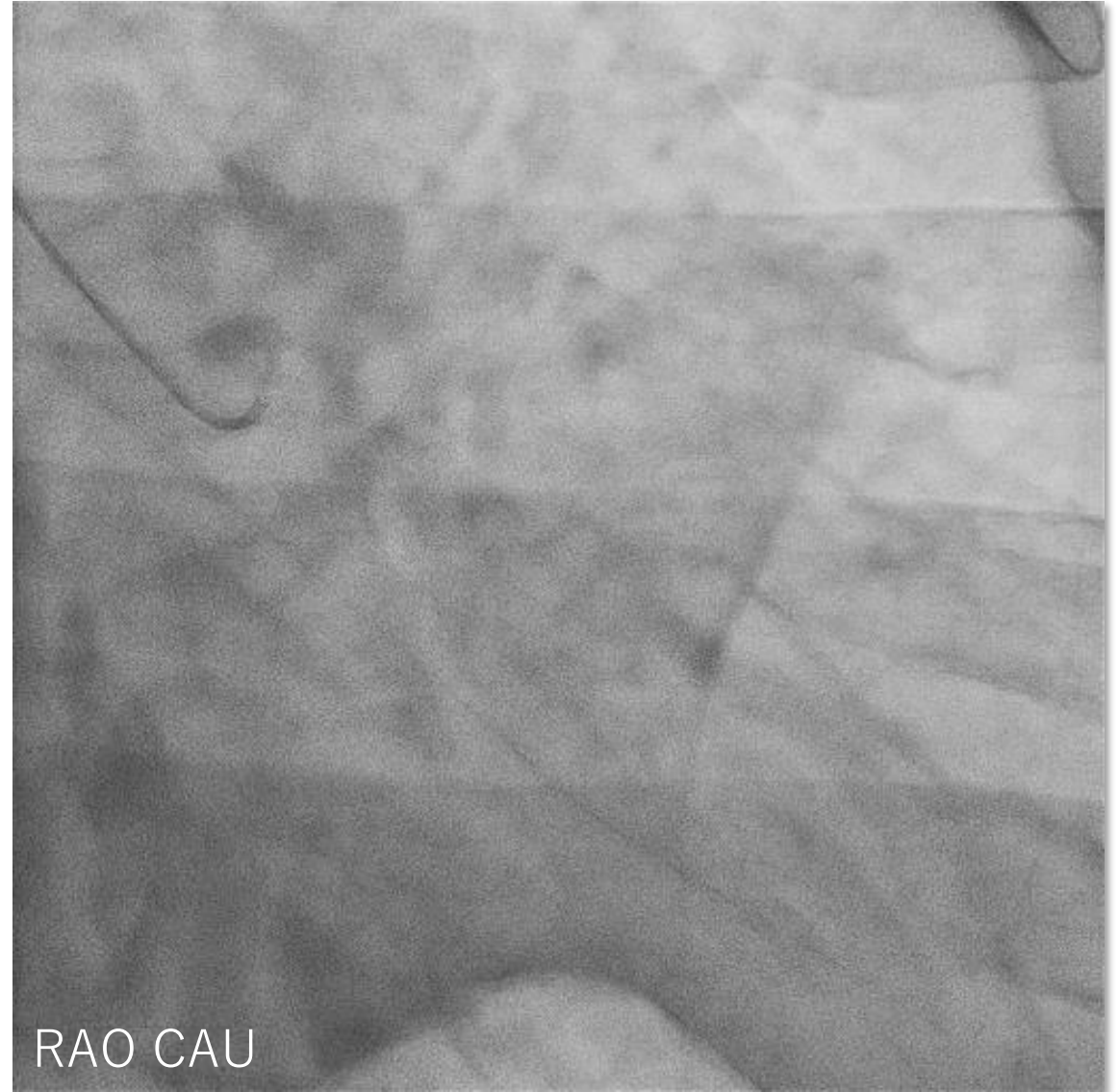
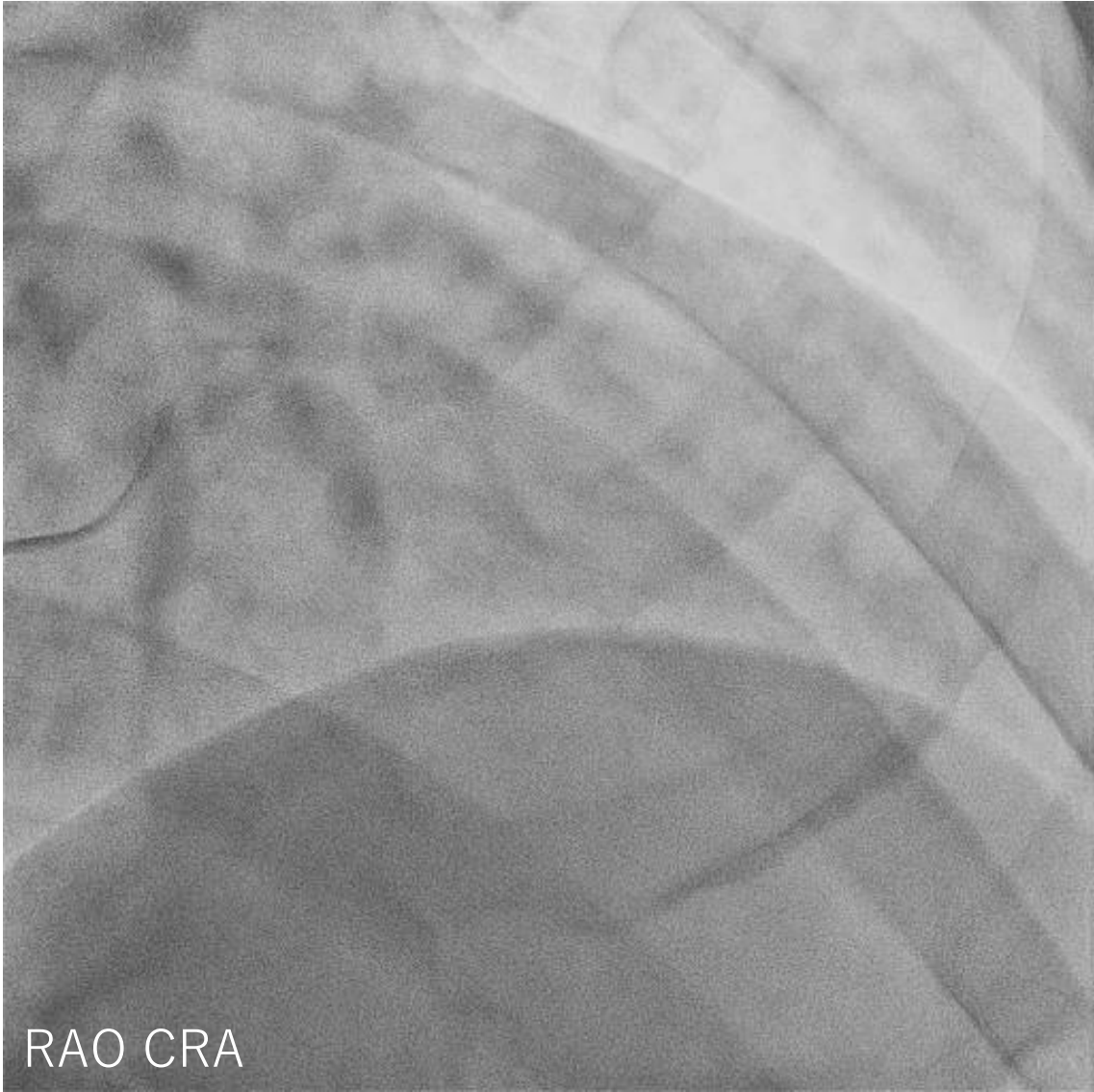
- ✓ Collateral channel
- ✓ Distance from channel connection to CTO exit
- ✓ Angle from distal lumen to CTO exit

Case: 50 y.o Male RCA-CTO

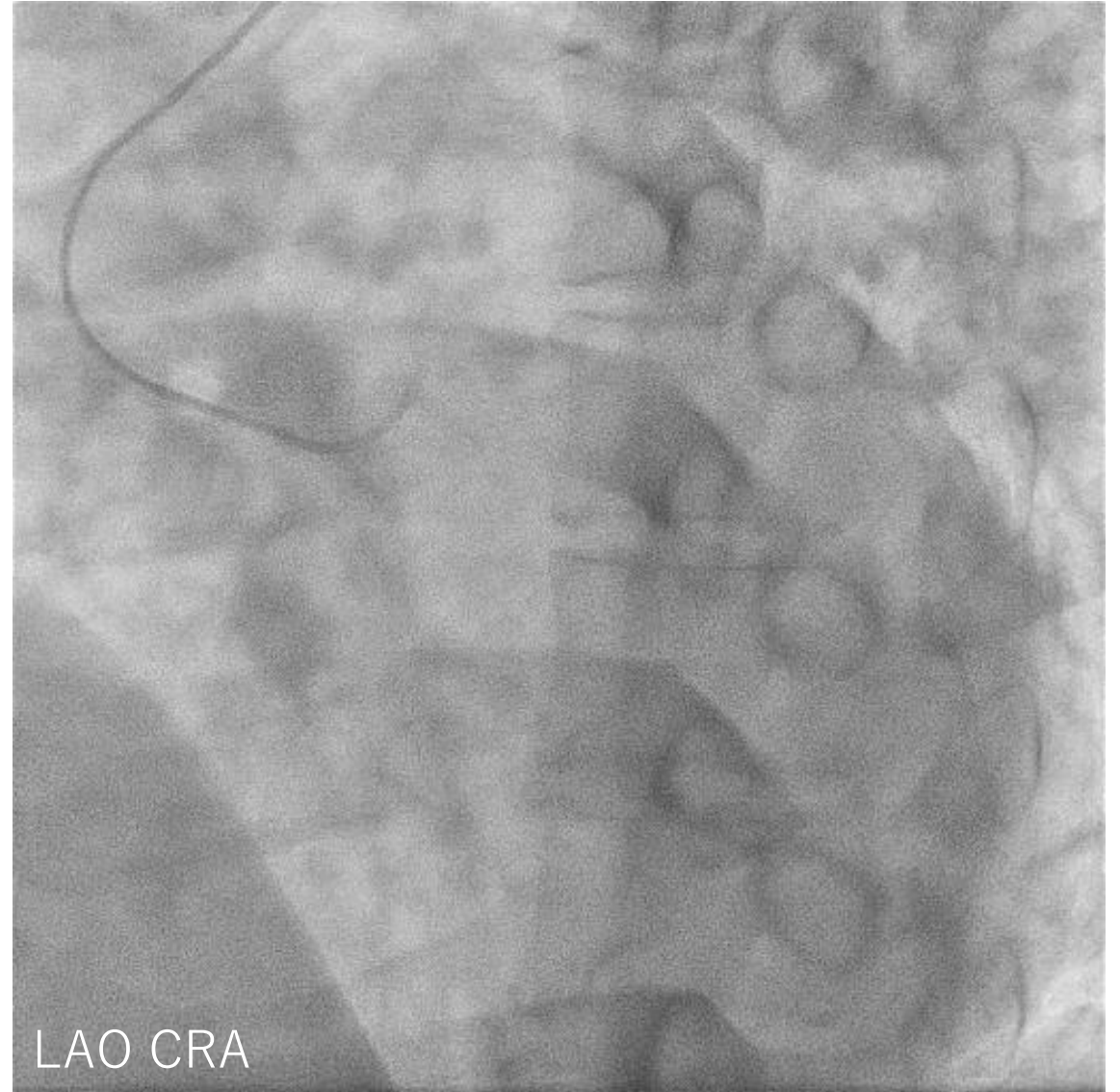
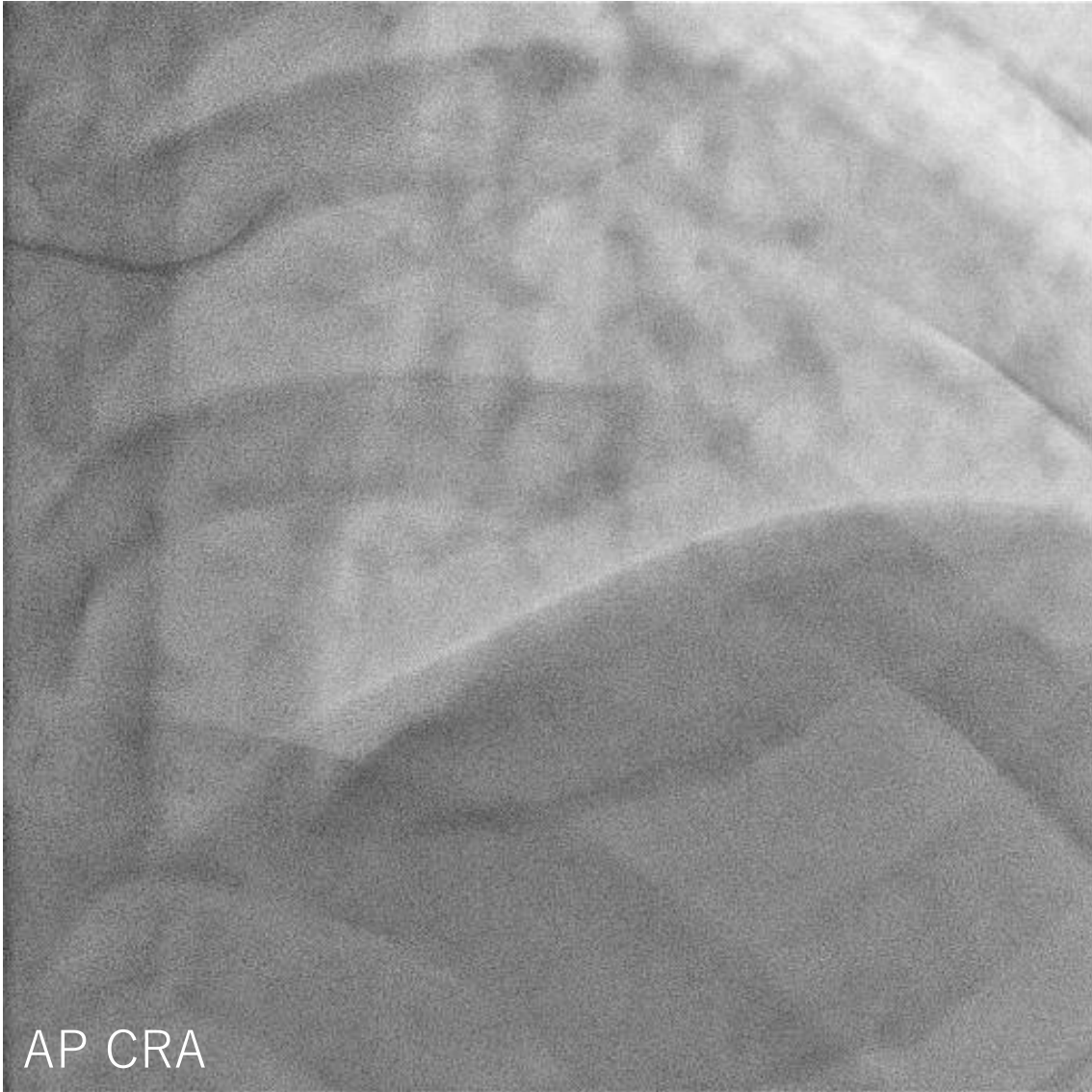


RCA

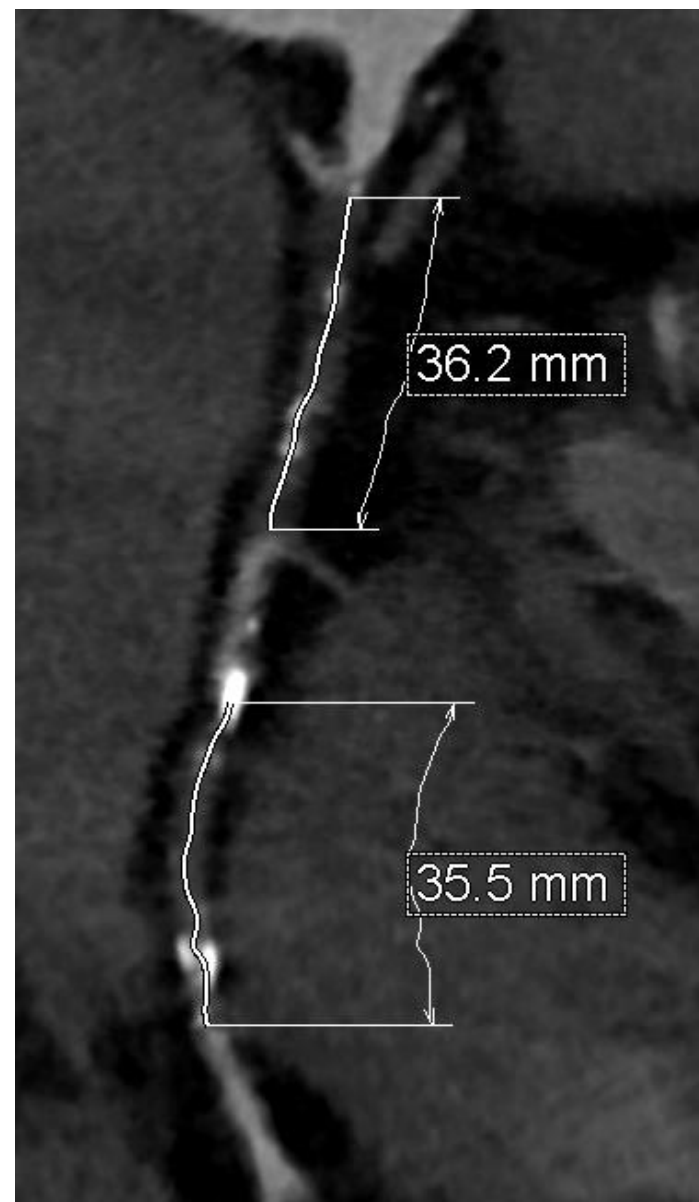
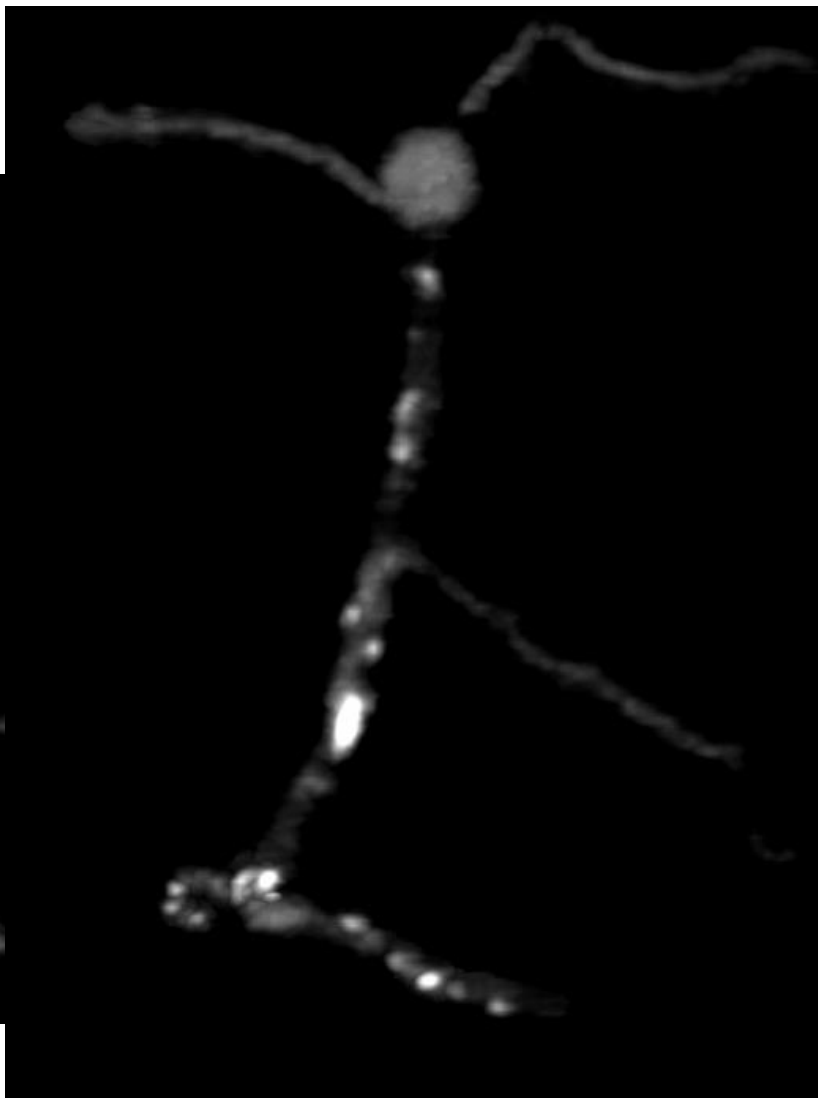
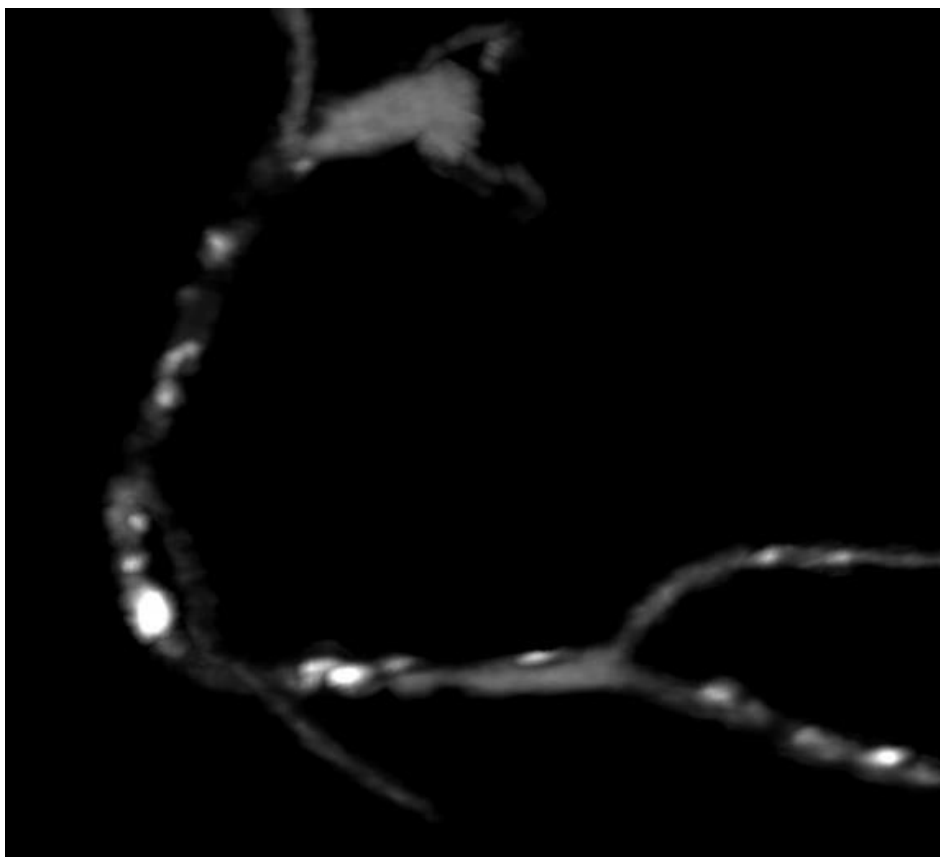
Case: 50 y.o Male



Case:50 y.o Male



Cardiac CT



Indication of Retrograde procedure

❑ Poor distal vessel quality

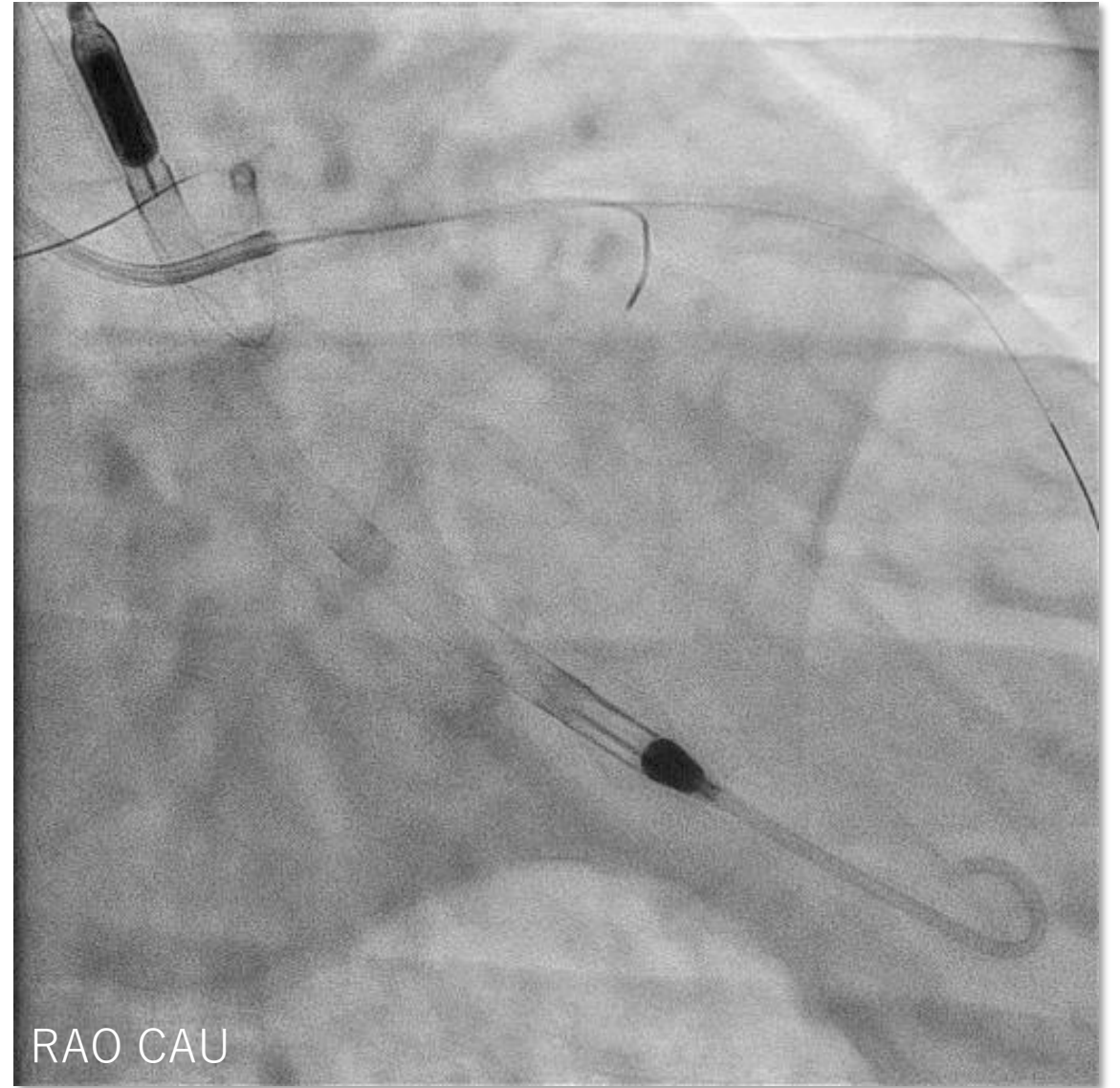
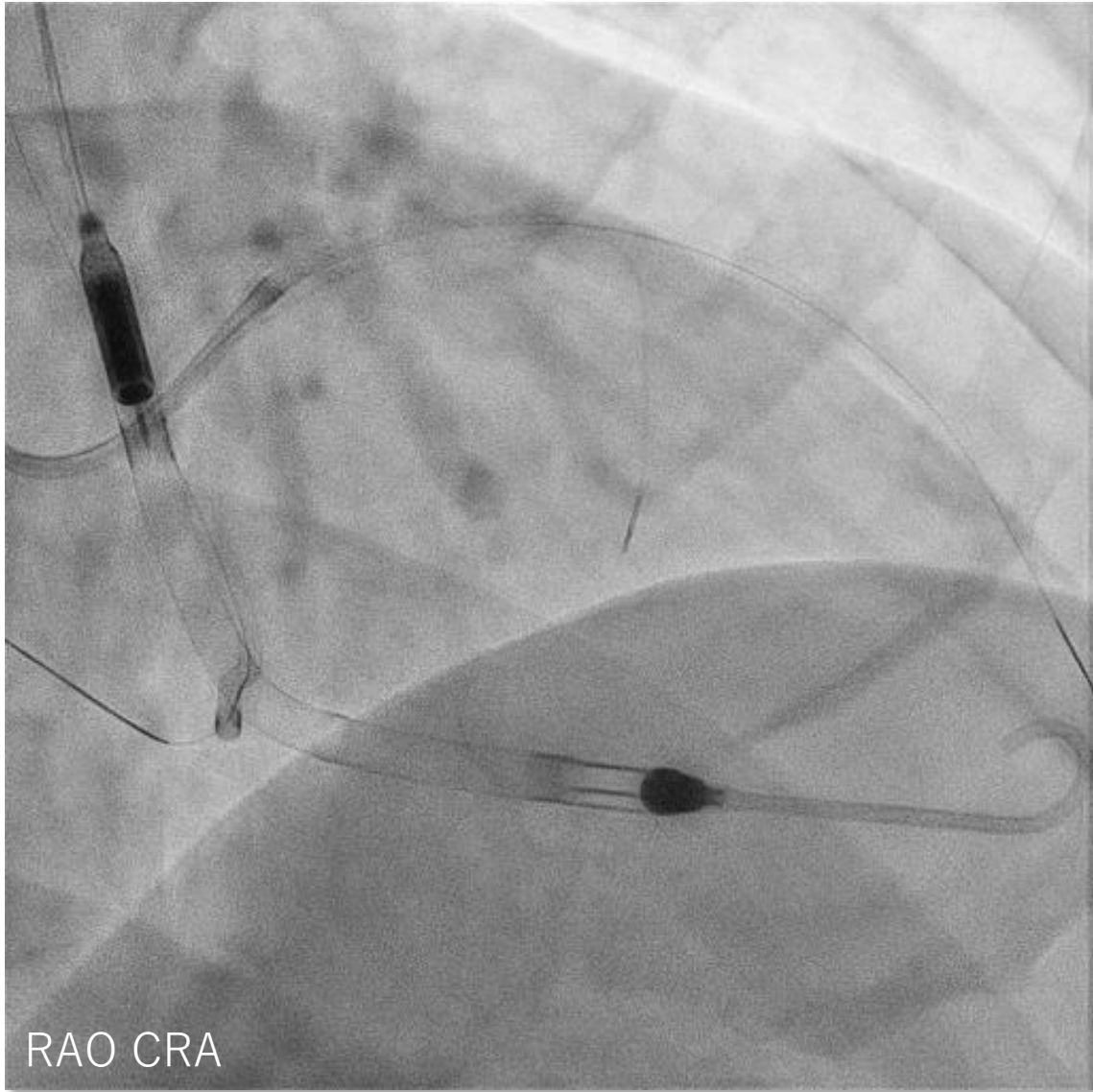
- ✓ Not clear (Multi-supply, severe stenosis at distal site)
- ✓ Diffuse plaque (narrowing)the



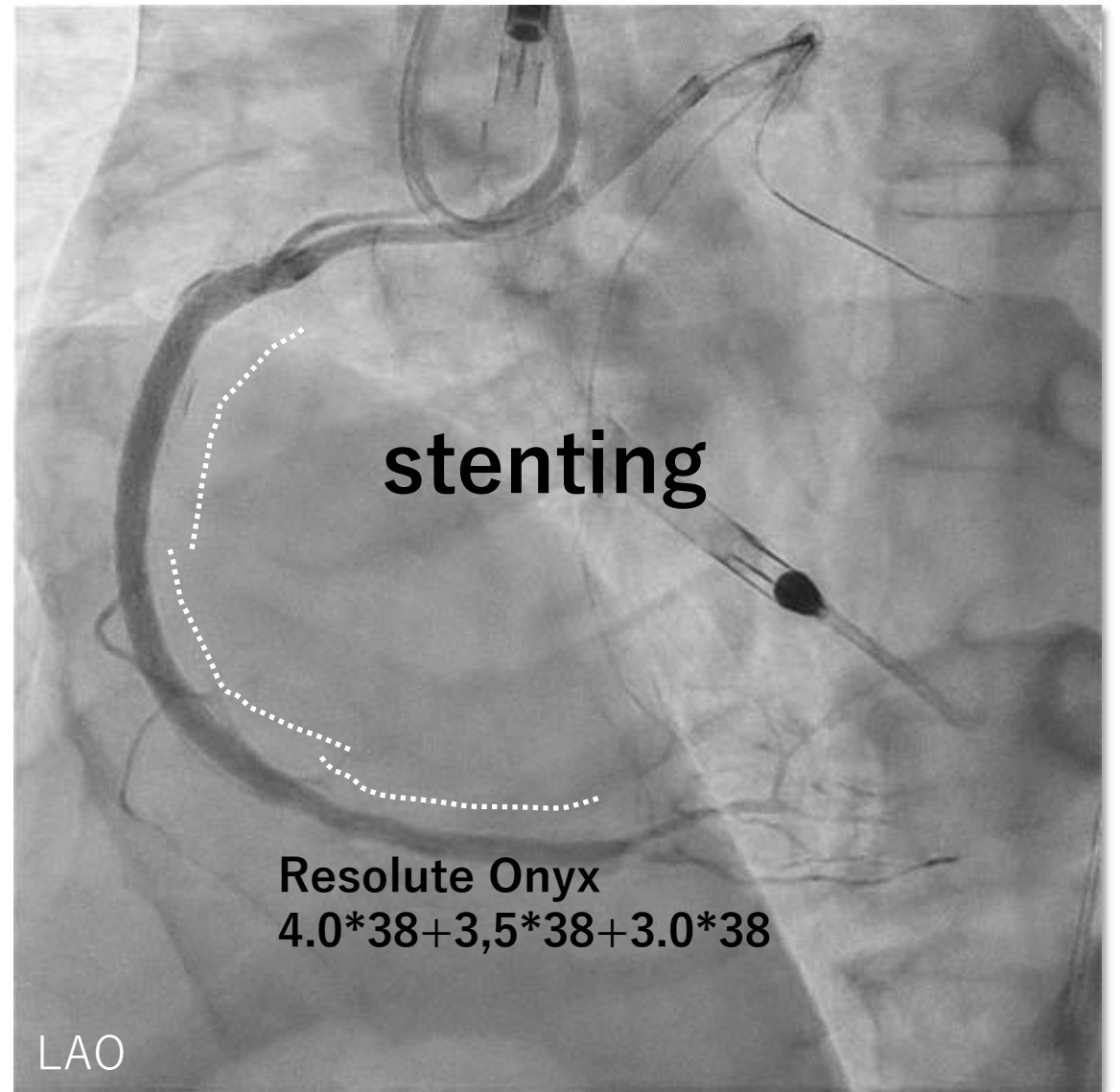
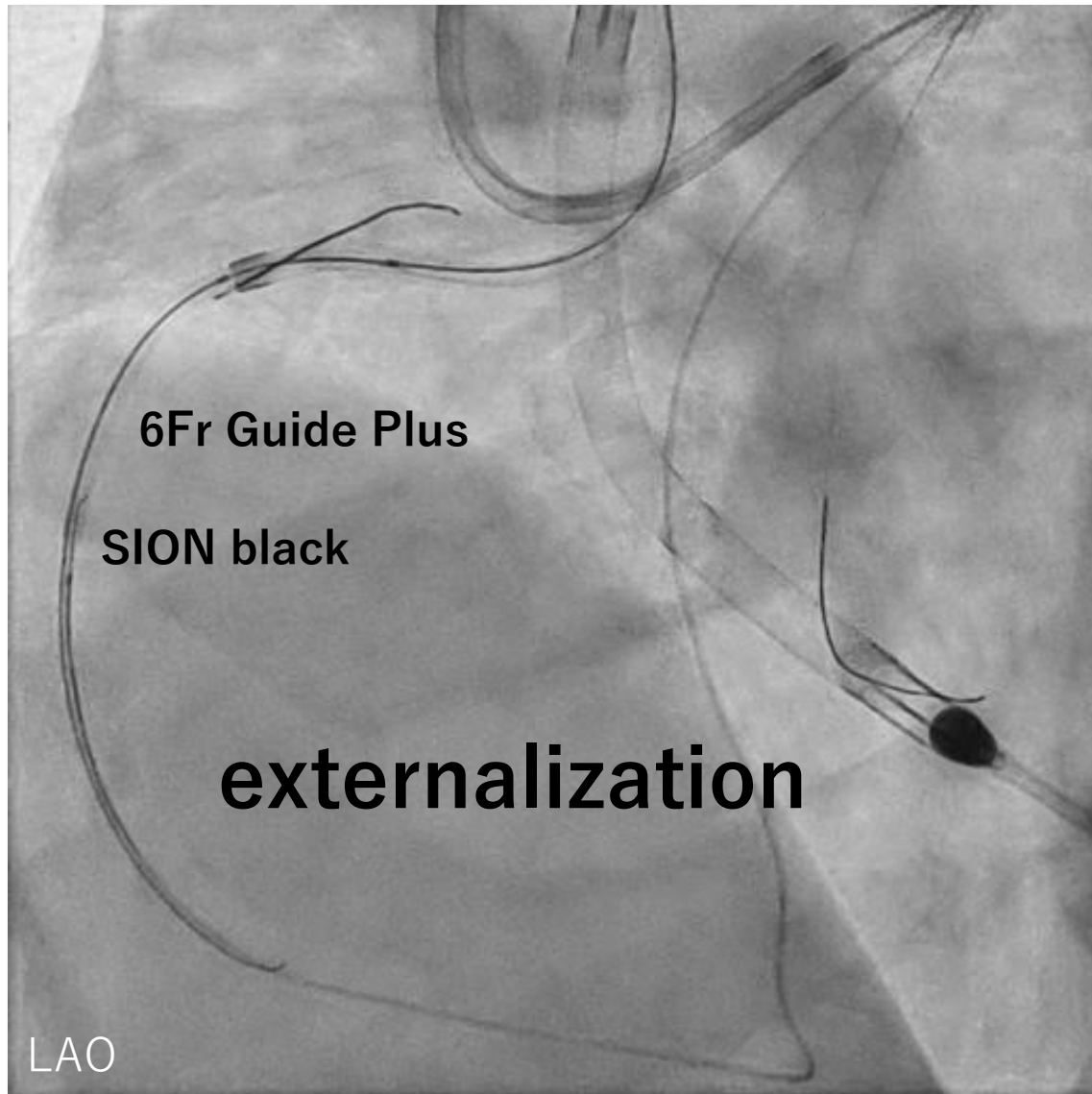
❑ Feasible retrograde option

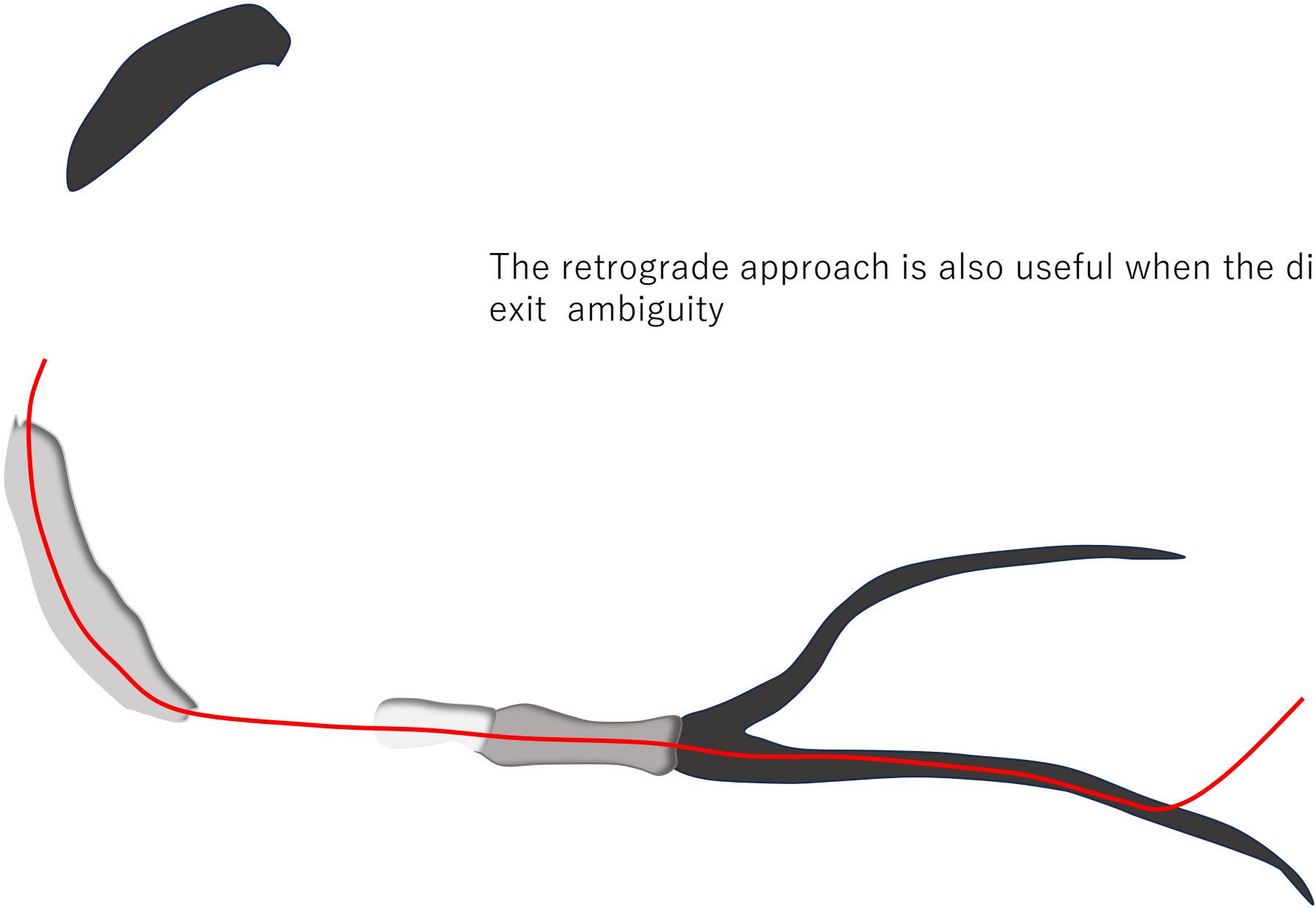
- ✓ Collateral channel
- ✓ Distance from channel connection to CTO exit
- ✓ Angle from distal lumen to CTO exit

Primary retrograde approach via septal channel



Reverse CART





The retrograde approach is also useful when the distal exit ambiguity

Indication of Retrograde procedure

❑ Failure of antegrade penetration

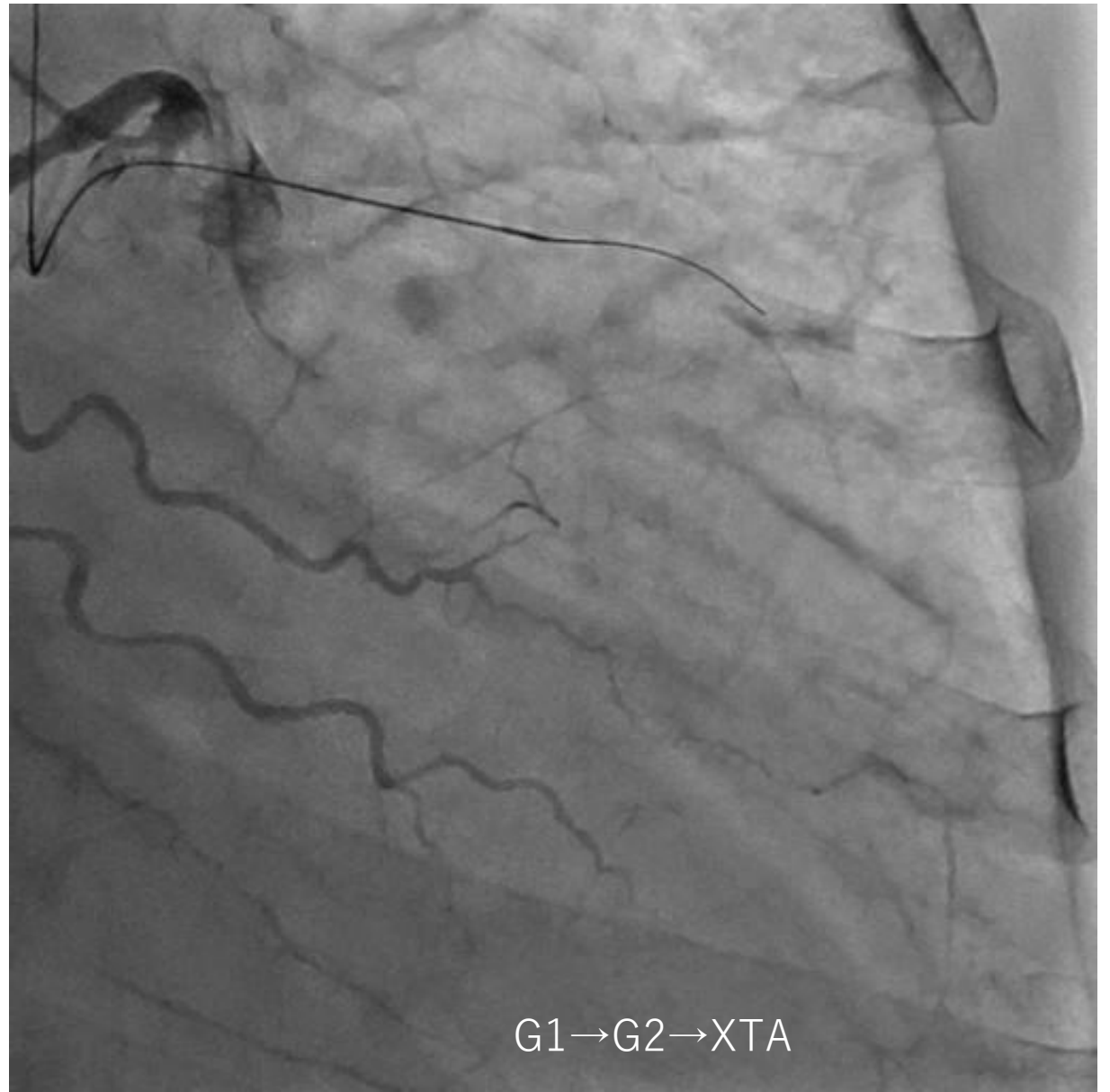
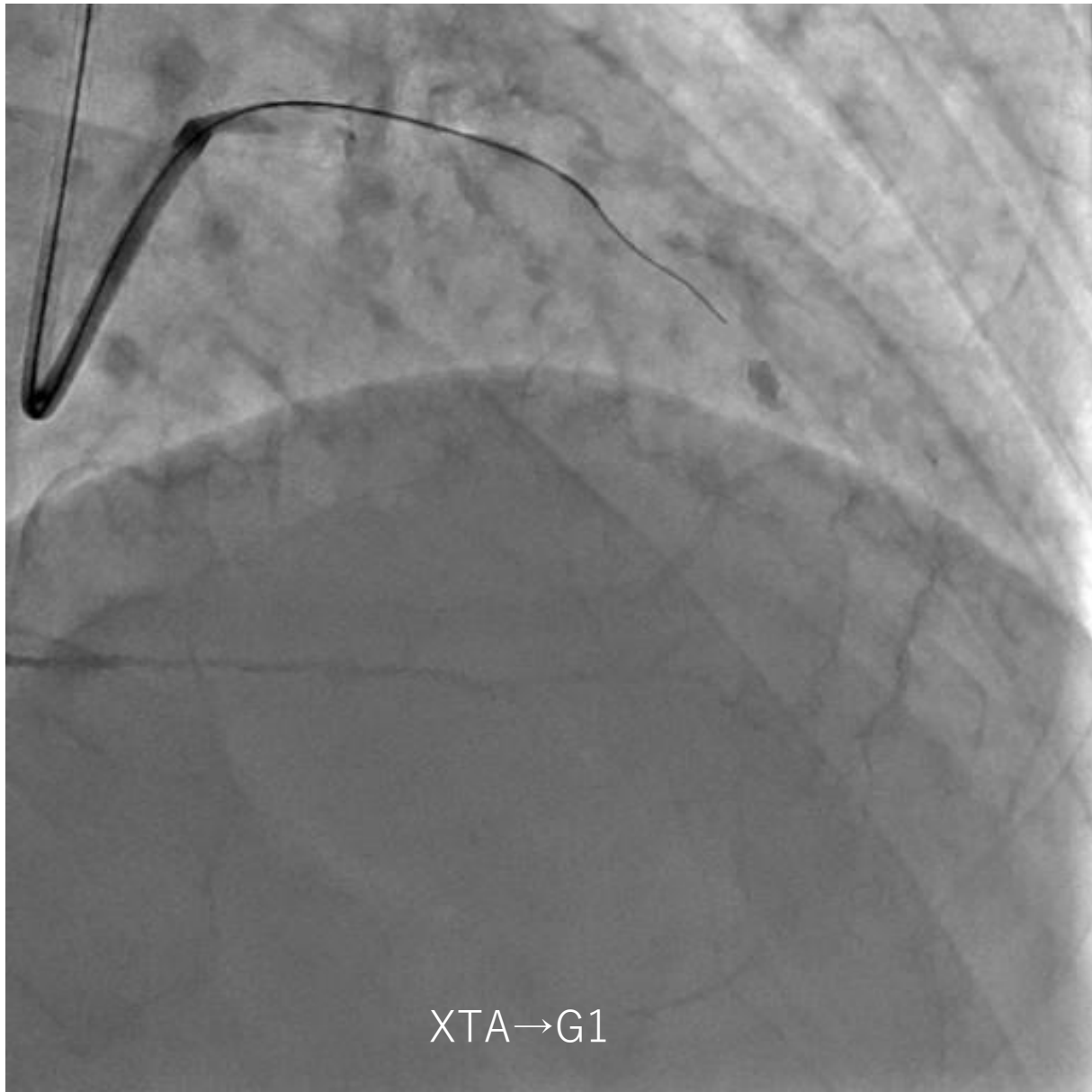
- ✓ Pararrel wire technique
- ✓ IVUS guide re-wiring
- ✓ ADR

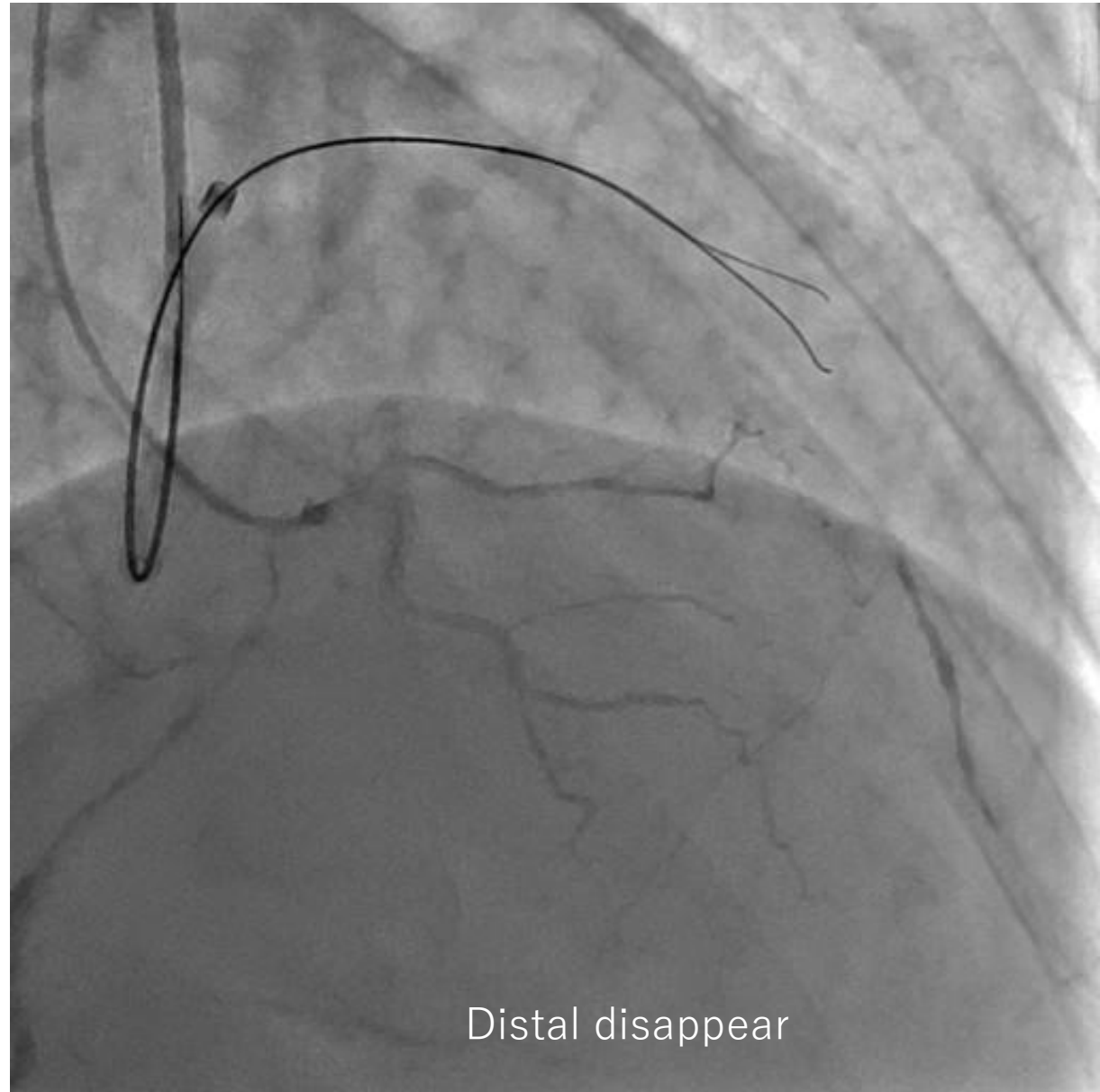
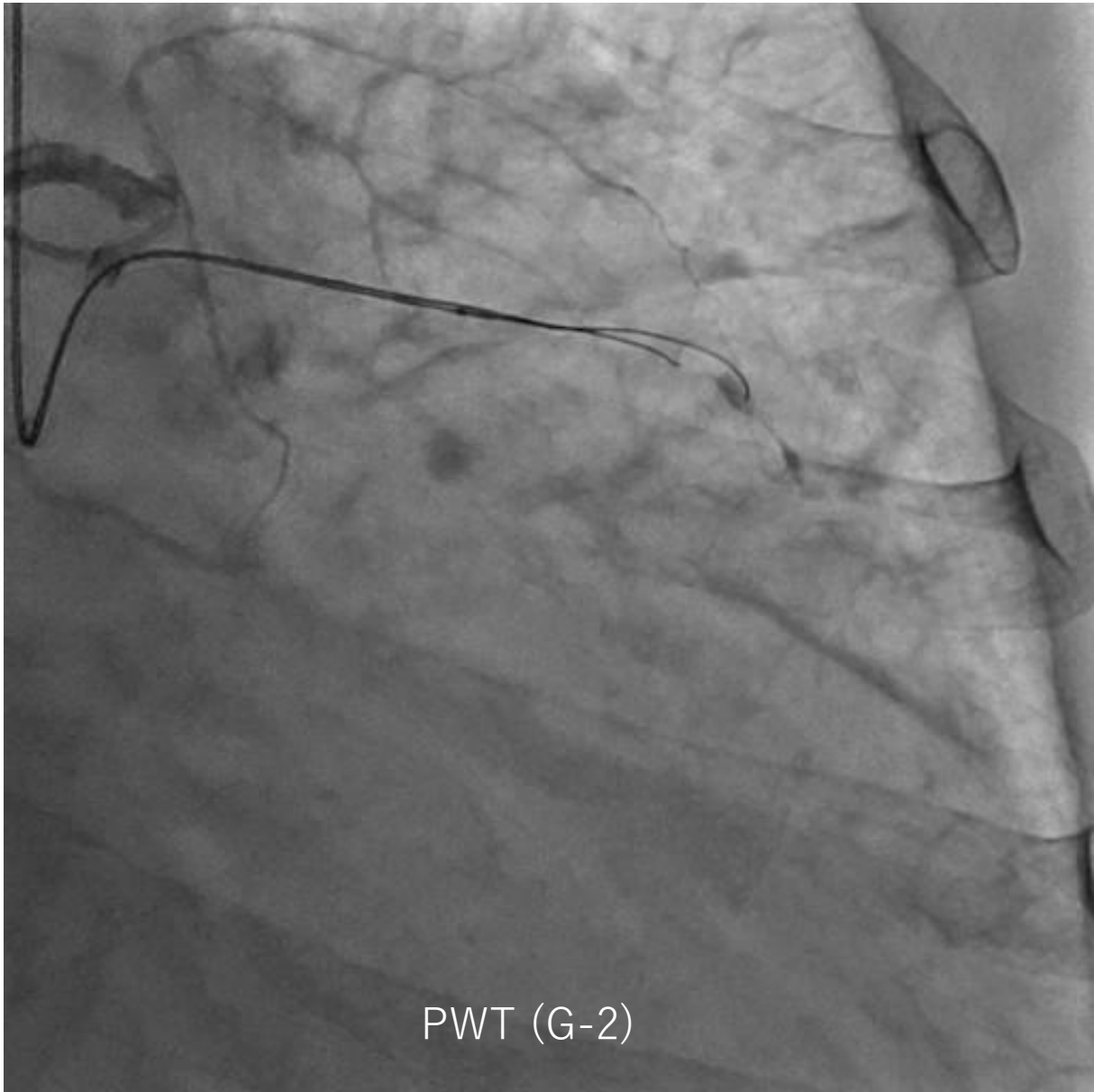


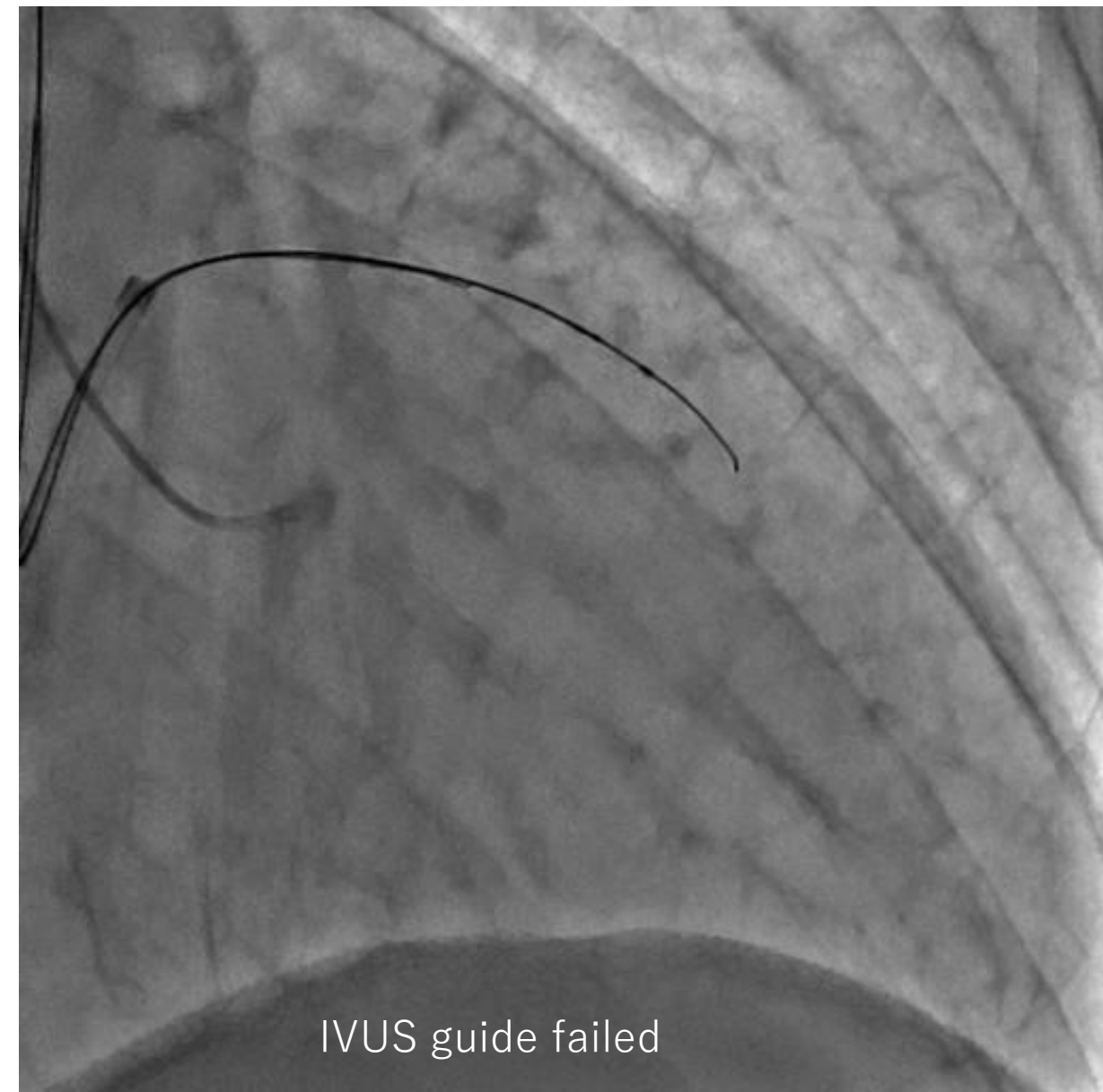
❑ Rescue retrograde procedure

Case: 30 y.o Male LAD-CTO

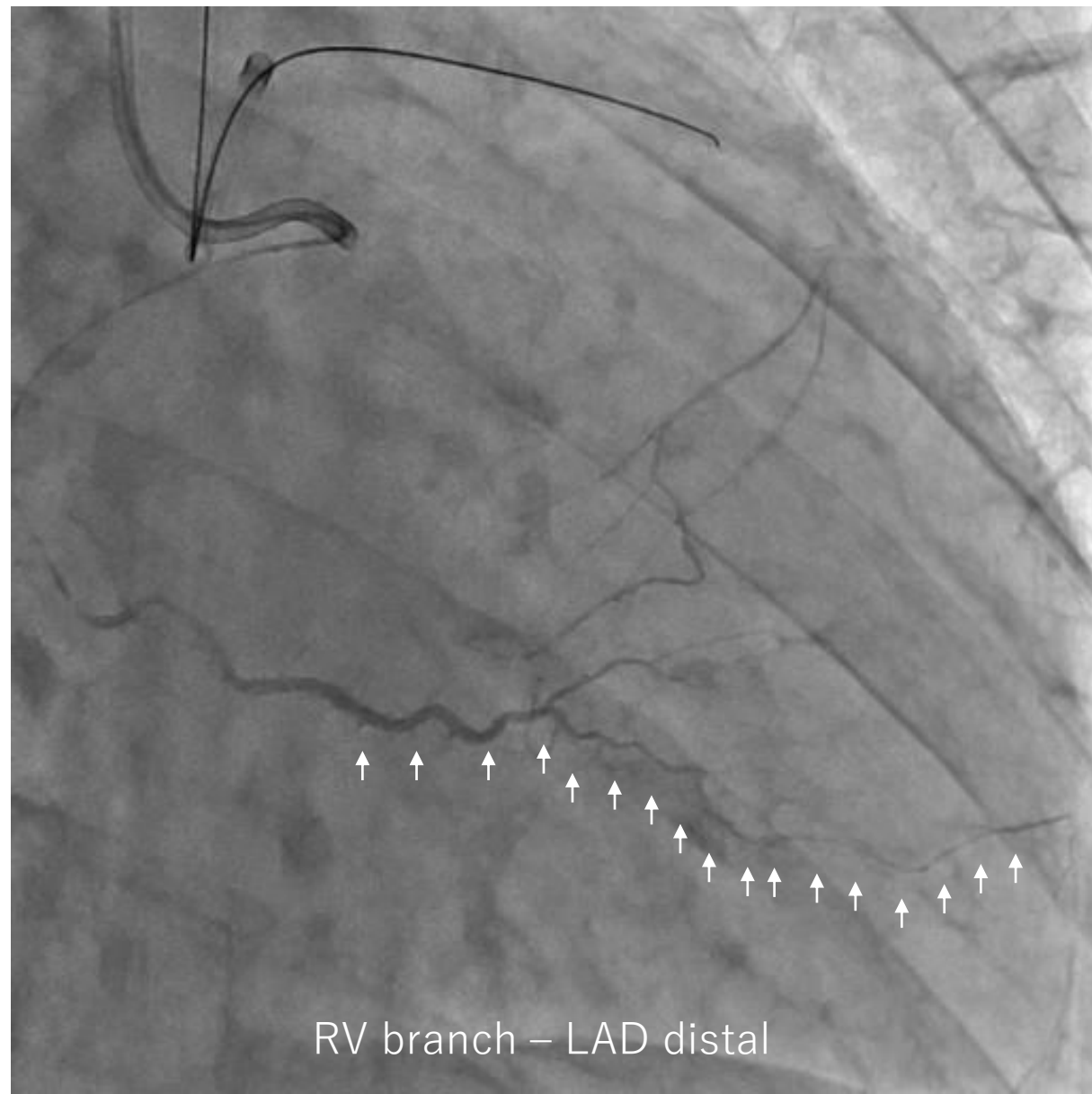






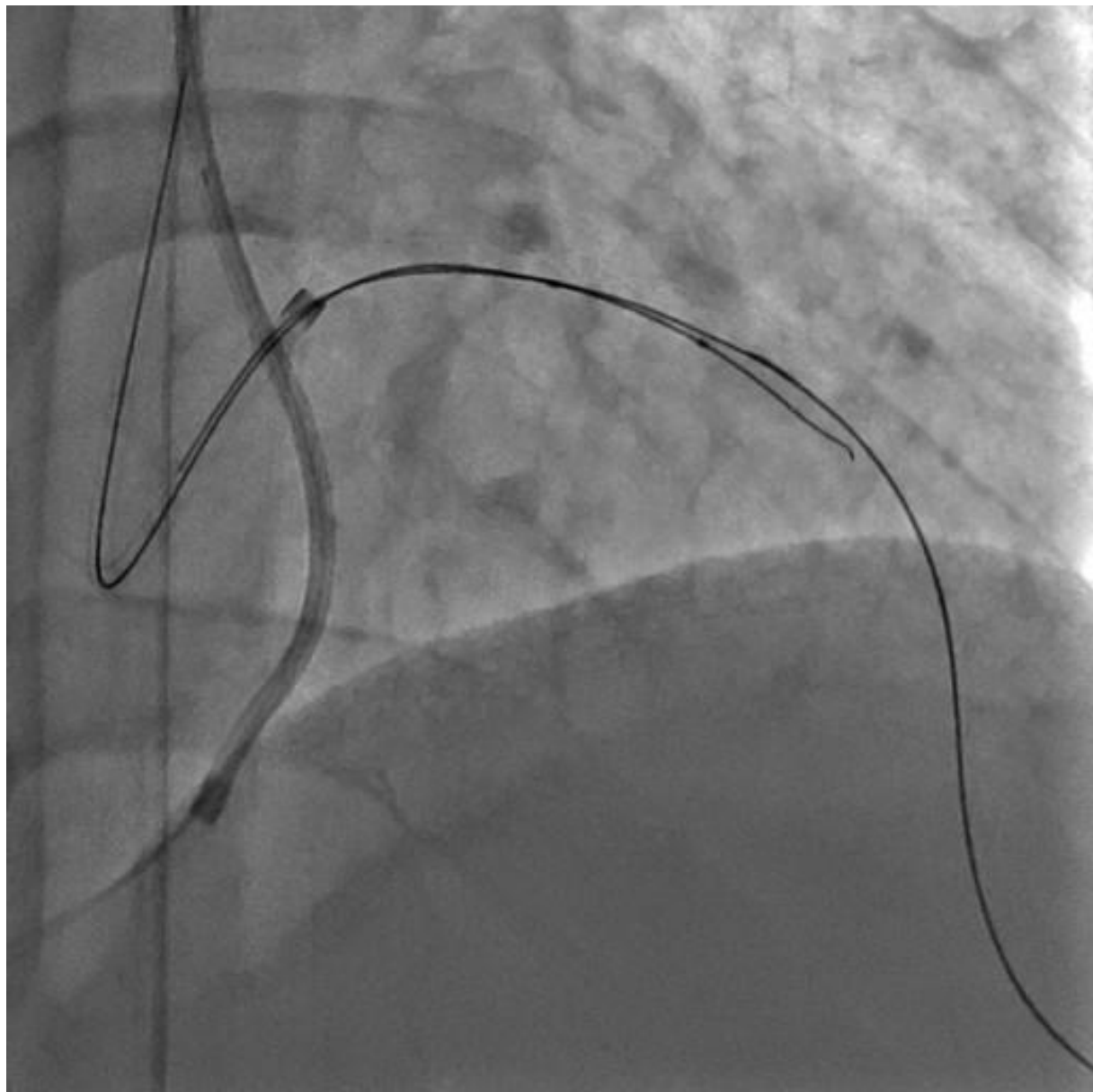
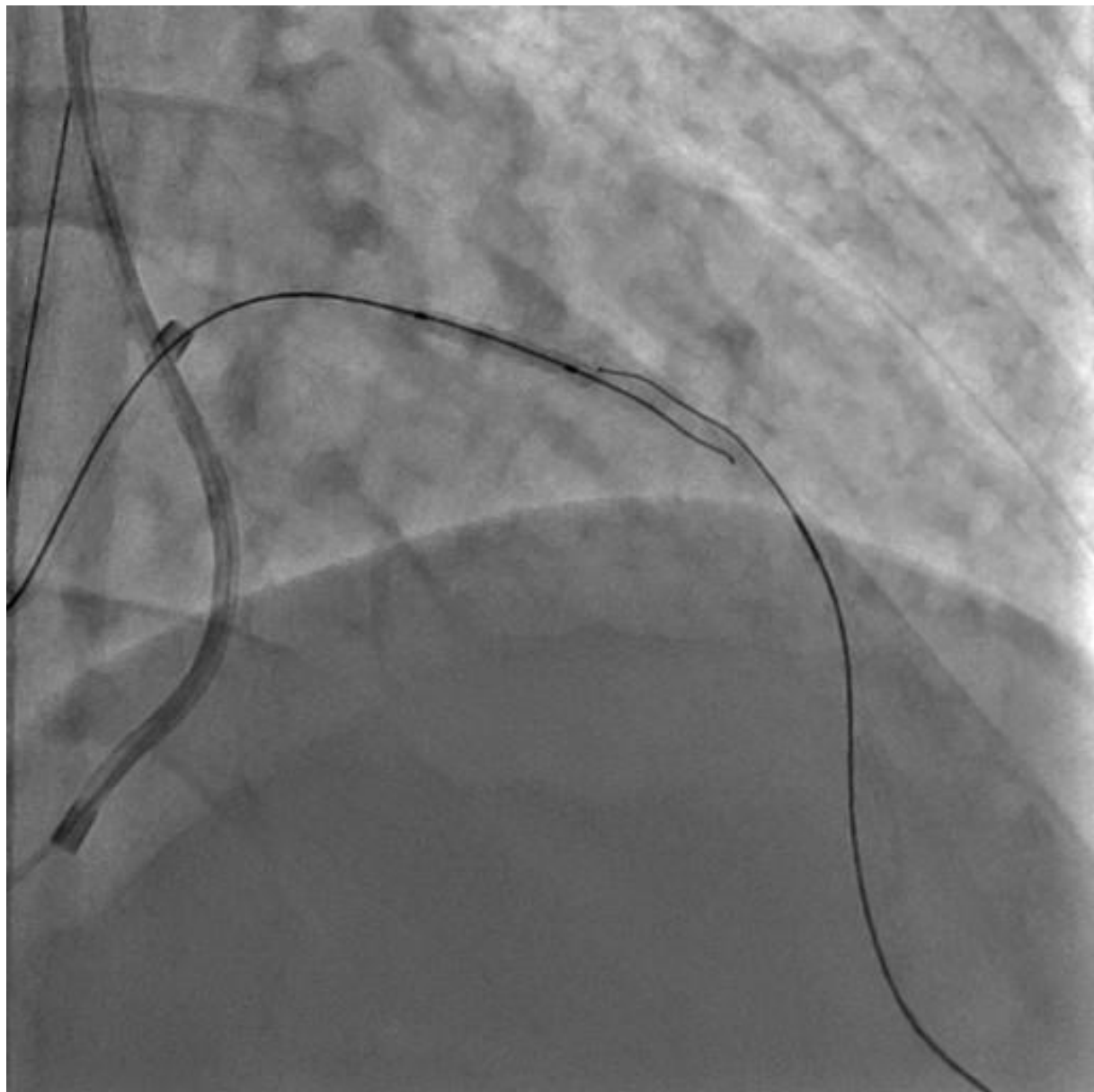


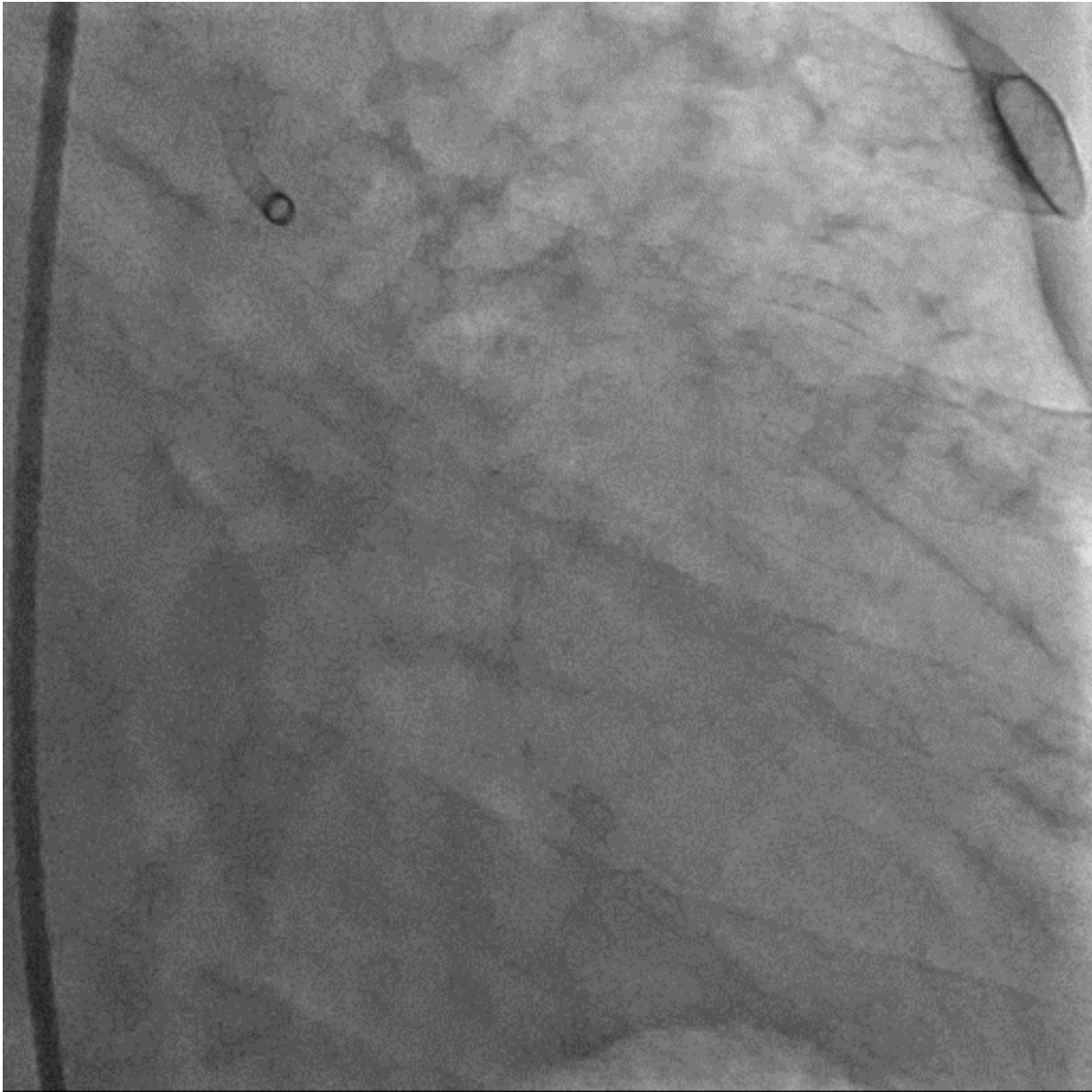
IVUS guide failed



RV branch – LAD distal

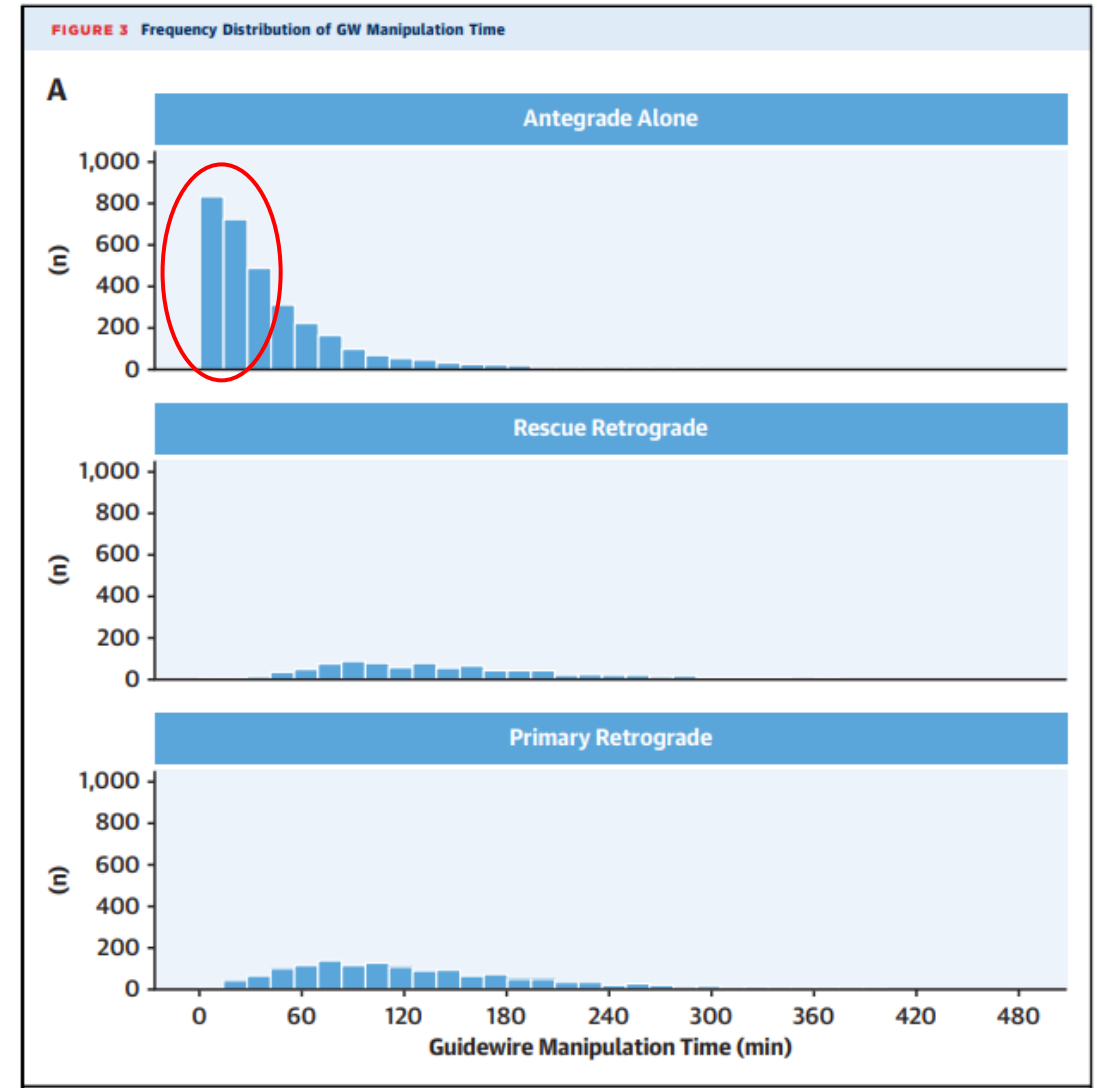
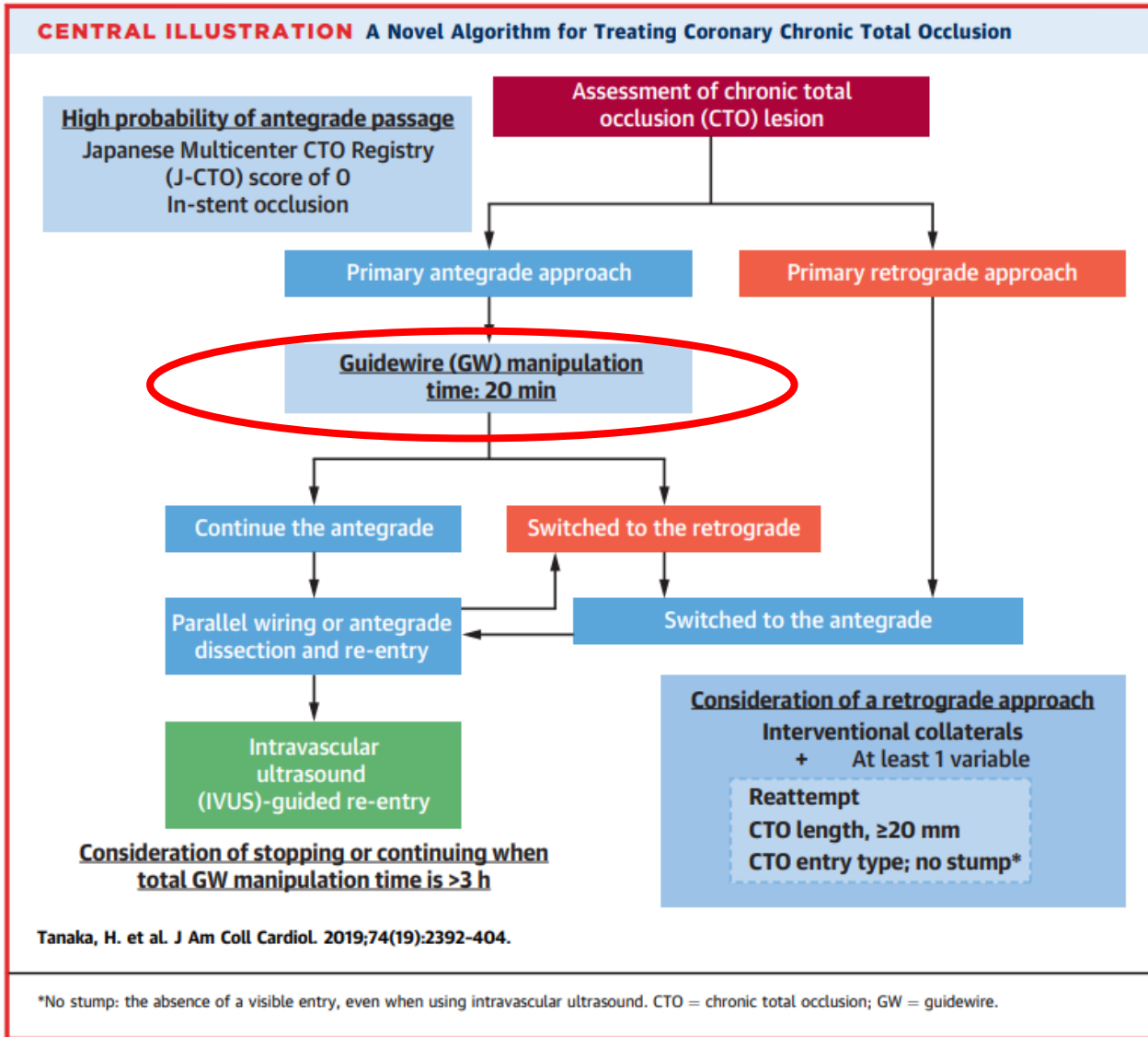






How long can we continue GW manipulation ?

The median successful crossing time of antegrade single wire was 23minthe



How long can we continue GW manipulation ?

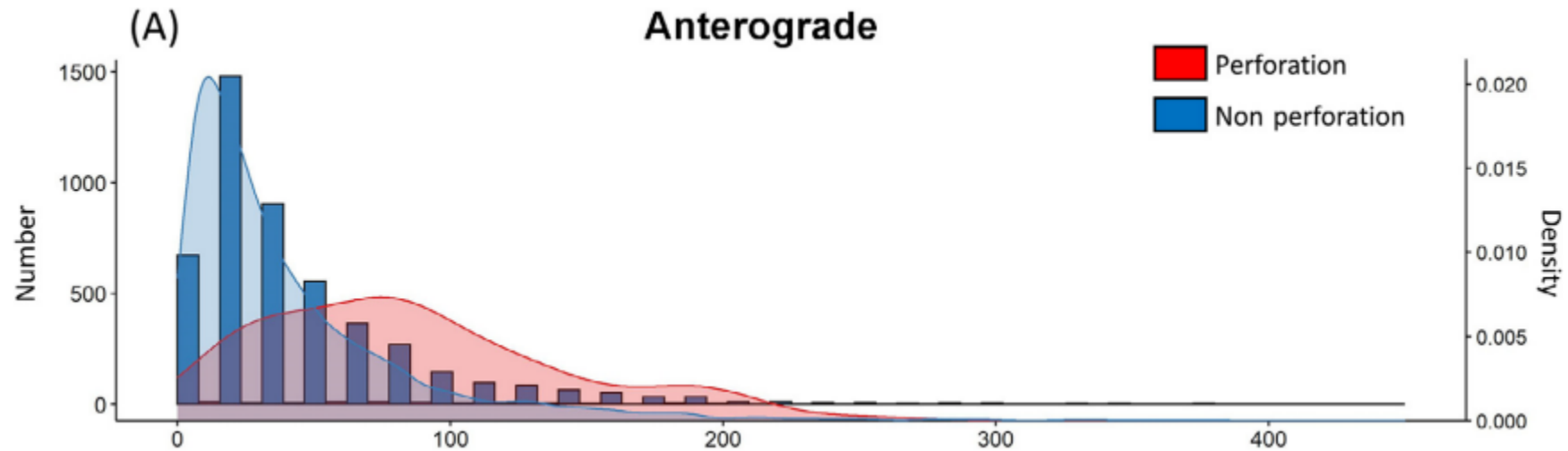
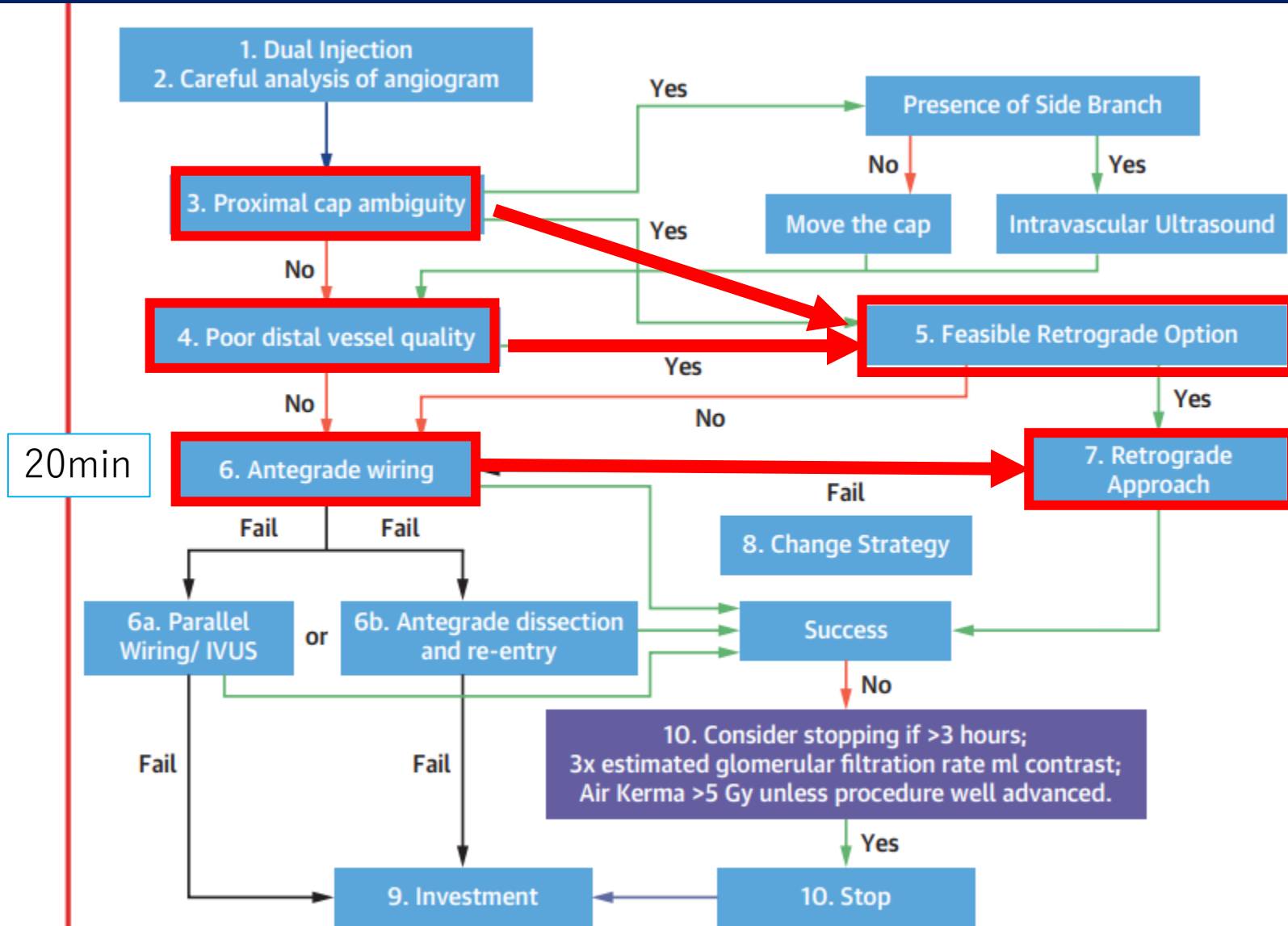


Table 5
Multivariate analysis for the occurrence of perforation

	Univariate			Multivariate		
	OR	95% CI	P value	OR	95% CI	P value
<i>Antegrade</i>						
Age (per 10 year)	1.3	1.07-1.60	<0.0001	1.35	1.10-1.69	<0.0001
History of CABG	2.96	1.62-5.40	0.0002	1.99	1.05-3.78	0.03
RCA lesion	2.21	1.43-3.41	0.0002	2.26	1.42-3.59	<0.0001
Tortuosity of CTO lesion	1.75	1.08-2.86	0.03	1.15	0.68-1.96	0.60
De novo lesion	3.65	1.48-9.04	0.02	4.85	1.92-12.27	<0.0001
CTO length ≥ 20 mm	1.67	1.01-2.57	0.02	1.37	0.87-2.14	0.17
Use of stiff guidewire	4.06	2.59-6.35	<0.0001	2.59	1.60-4.19	<0.0001
Guidewire manipulation time >60 min	6.67	4.27-10.40	<0.0001	4.84	3.01-7.77	<0.0001
<i>Retrograde</i>						
Age (per 10 year)	1.29	1.14-1.46	<0.0001	1.31	1.15-1.49	<0.0001
Non-LAD lesion	1.61	1.17-2.23	0.003	1.44	1.03-2.00	0.03
Use of polymer-jacketed guidewire	3.91	2.94-5.20	<0.0001	4.03	3.02-5.37	<0.0001
Use of epicardial collateral	1.72	1.33-2.24	<0.0001	1.85	1.41-2.41	<0.0001

OR = odds ratio; CI = confidence interval; other abbreviations as in Table 1.

When to Go Retrograde?



Thank you for your kind attention.