

Tips and tricks for shortening procedure time

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Disclosure Statement of Financial Interest

Within the past 12 months, I have had a financial interest/arrangement or affiliation with the organization(s) listed below.

Affiliation/Financial Relationship

- Grant/Research Support
- Consulting Fees/Honoraria
- Major Stock Shareholder/Equity
- Royalty Income
- Ownership/Founder
- Intellectual Property Rights
- Other Financial Benefit

Company

- None
- Asahi Intecc,
- None
- None
- None
- None
- None

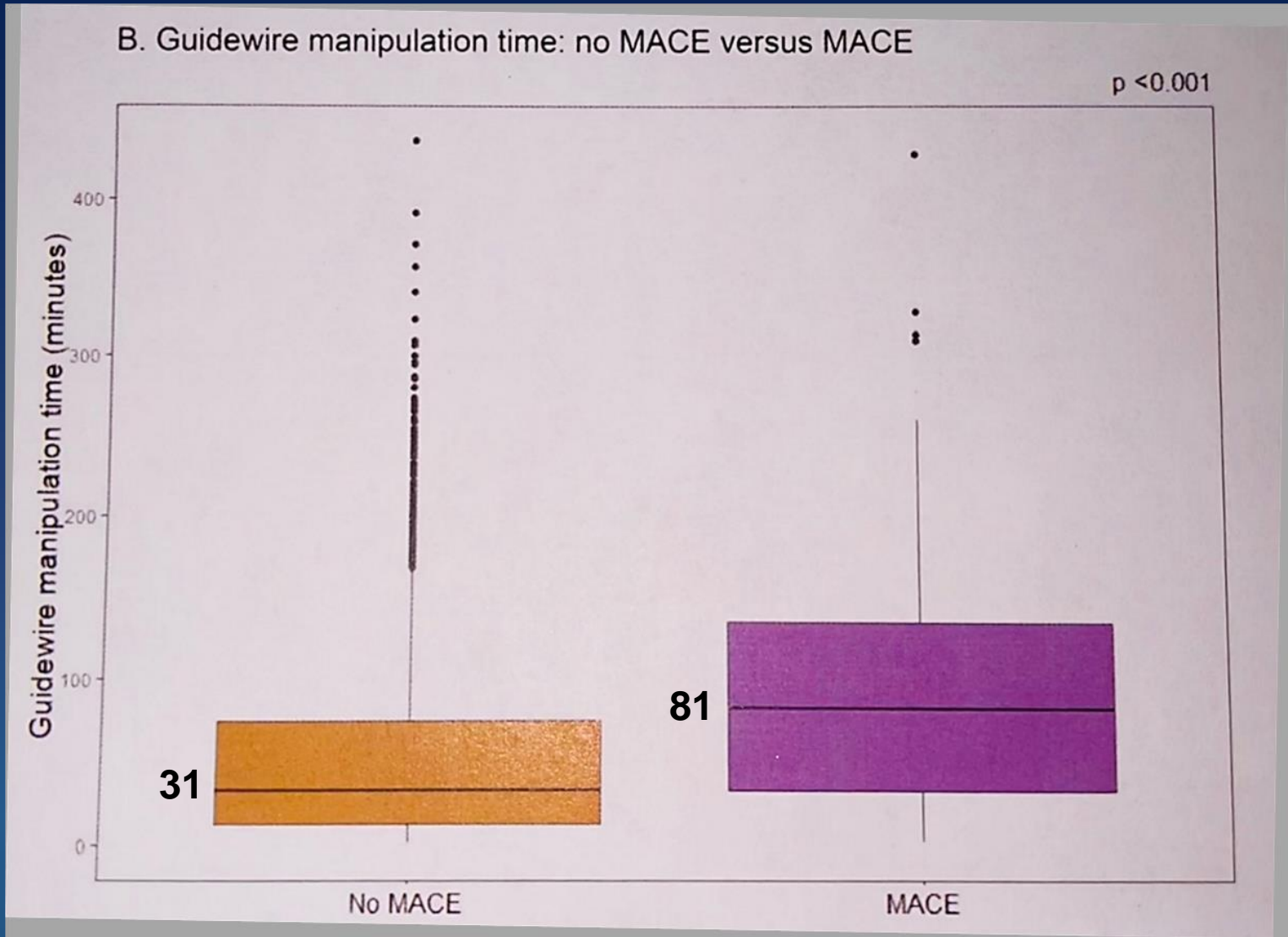
CTO PCI is needed a balance of safe, success, and procedure time.

Appropriate procedure time will have benefits on those points:

- Radiation exposure
- Invasion of the patient (bleeding, hemodynamic state, sedation, etc.)
- Operator fatigue and concentration
- Medical staff fatigue and concentration
- Device number
- Operation room charge fee, etc.



Longer time procedure has a possibility of MACE.



- ## Elements of MACE
1. Anatomical complexity
 2. Patient back ground
 3. Procedure time
- Otheres

How long is appropriate procedure time?

Median procedure time from Japanese CTO expert registry:

- Primary antegrade 2hs
- Primary retrograde 3hs

TABLE 2 Procedural Characteristics and In-Hospital Clinical Outcomes

	Overall (N = 5,843)	Primary Antegrade (n = 4,281)	Primary Retrograde (n = 1,562)	p Value
GW success	5,420 (92.8)	4,035 (94.3)	1,385 (88.7)	<0.01
Technical success	5,291 (90.6)	3,942 (92.1)	1,349 (86.4)	<0.01
Procedural success	5,218 (89.3)	3,900 (91.1)	1,318 (84.4)	<0.01
Stent size				<0.01
<2.5 mm	382 (6.5)	328 (7.7)	54 (3.5)	
2.5-2.9 mm	1,088 (18.6)	880 (20.6)	208 (13.3)	
3.0-3.4 mm	1,670 (28.6)	1,218 (28.5)	452 (28.9)	
≥3.5 mm	1,977 (33.8)	1,329 (31.0)	648 (41.5)	
Total stent length, mm	62.6 ± 30.0	58.3 ± 28.6	74.4 ± 30.5	<0.01
Number of stents	2.1 ± 0.9	2.0 ± 0.9	2.4 ± 0.9	<0.01
GW manipulation time, min	60 (23-120)	40 (17-90)	113 (72-170)	<0.01
Procedural time, min	140 (91-205)	120 (81-180)	190 (145-255)	<0.01
Contrast volume, ml	215.3 ± 100.9	209.8 ± 99.4	230.1 ± 103.5	<0.01
Reasons for technical failure	552 (9.4)	339 (7.9)	213 (13.6)	<0.01
GW did not pass	425 (7.3)	248 (5.8)	177 (11.3)	<0.01
Device did not pass	29 (0.5)	22 (0.5)	7 (0.4)	0.75
Poor runoff of distal artery	68 (1.2)	48 (1.1)	20 (1.3)	0.62
Major side branch occlusion	22 (0.4)	16 (0.4)	6 (0.4)	1.0
Others	26 (0.4)	18 (0.4)	8 (0.5)	0.64
In-hospital adverse outcomes				
MACCE	88 (1.5)	52 (1.2)	36 (2.3)	<0.01
Death	18 (0.3)	11 (0.3)	7 (0.4)	0.24
Procedure-related death	1 (0.0)	1 (0.0)	0 (0.0)	0.55
Non-procedure-related death	15 (0.3)	8 (0.2)	7 (0.4)	0.08
Unknown	2 (0.0)	2 (0.0)	0 (0.0)	0.39
Stroke	11 (0.2)	8 (0.2)	3 (0.2)	0.97
Myocardial infarction	58 (1.0)	31 (0.7)	27 (1.7)	<0.01
Acute stent thrombosis	11 (0.2)	7 (0.2)	4 (0.3)	0.47
Emergent CABG	2 (0.0)	1 (0.0)	1 (0.1)	0.46
Emergent PCI	7 (0.1)	6 (0.1)	1 (0.1)	0.46
Other complications				

	Overall (N = 5843)	Primary Antegrade (n = 4281)	Primary Retrograde (n = 1562)	p Value
GW manipulation time, min	60 (23-120)	40 (17-90)	113 (72-170)	<0.01
Procedural time, min	140 (91-205)	120 (81-180)	190 (145-255)	<0.01

GW = guidewire; MACCE = major adverse cardiac and cerebrovascular events; Other complications as in Table 1.

Rescue retrograde or primary retrograde which is better in terms of procedure time?

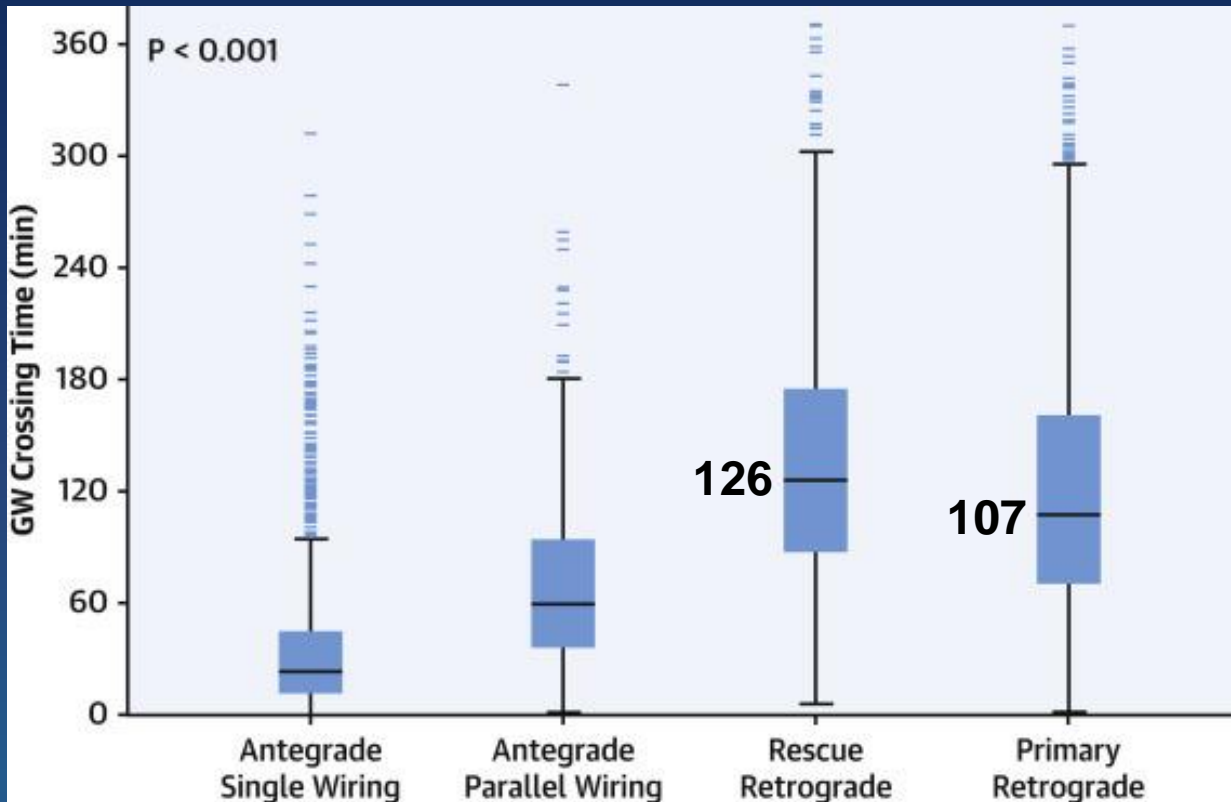


Figure 4. Frequency Distribution of Successful GW Crossing Time for Each CTO-PCI Strategy

- Basically antegrade procedure has a priority comparing retrograde.
- If this case have a indication of retrograde, primary retrograde will be better in terms of procedure time.

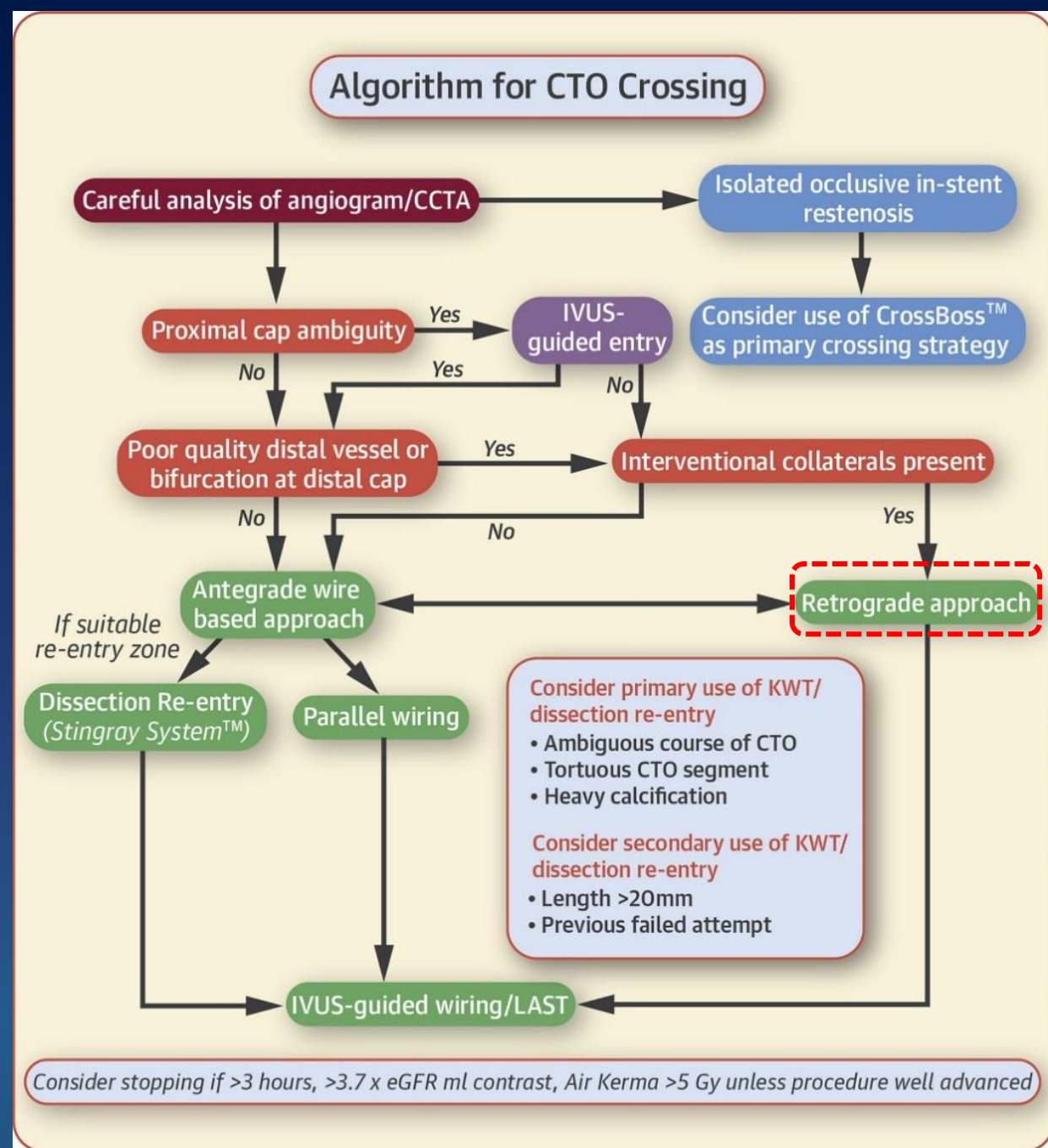
Median successful guidewire crossing time of single wiring and parallel wiring in the antegrade alone approach were 23 min (IQR: 11 to 44 min) and 60 min (IQR: 36 to 97 min), and rescue retrograde approach and primary retrograde approach were 126 min (IQR: 87 to 174 min) and 107 min (IQR: 70 to 161 min), respectively ($p < 0.001$).

When we use retrograde approach from the perspective of anatomy.

Key words:

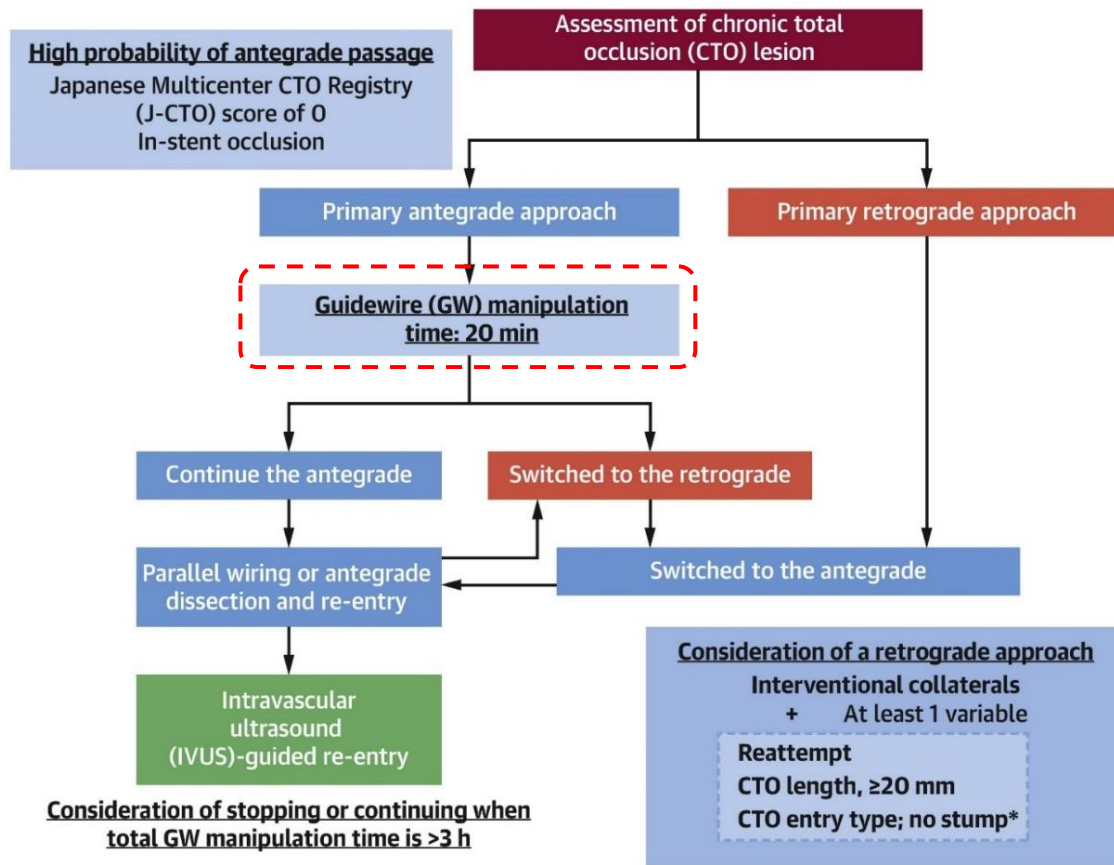
- Poor quality distal vessel
- Bifurcation at distal cap
- Ambiguous course
- Tortuous CTO segment
- Heavy calcification
- Length > 20mm

*will be reconsidered by tip detection method and plasma mediated ablation.

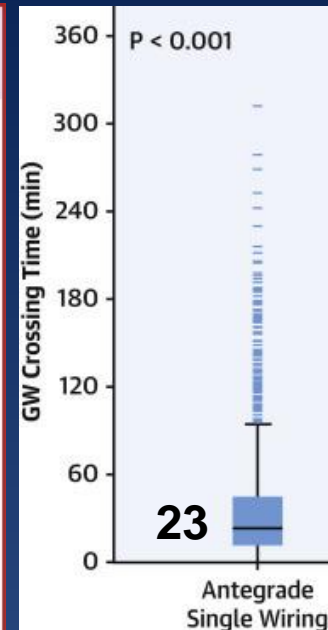


When is a timing to change a manner during procedure?

CENTRAL ILLUSTRATION: A Novel Algorithm for Treating Coronary Chronic Total Occlusion



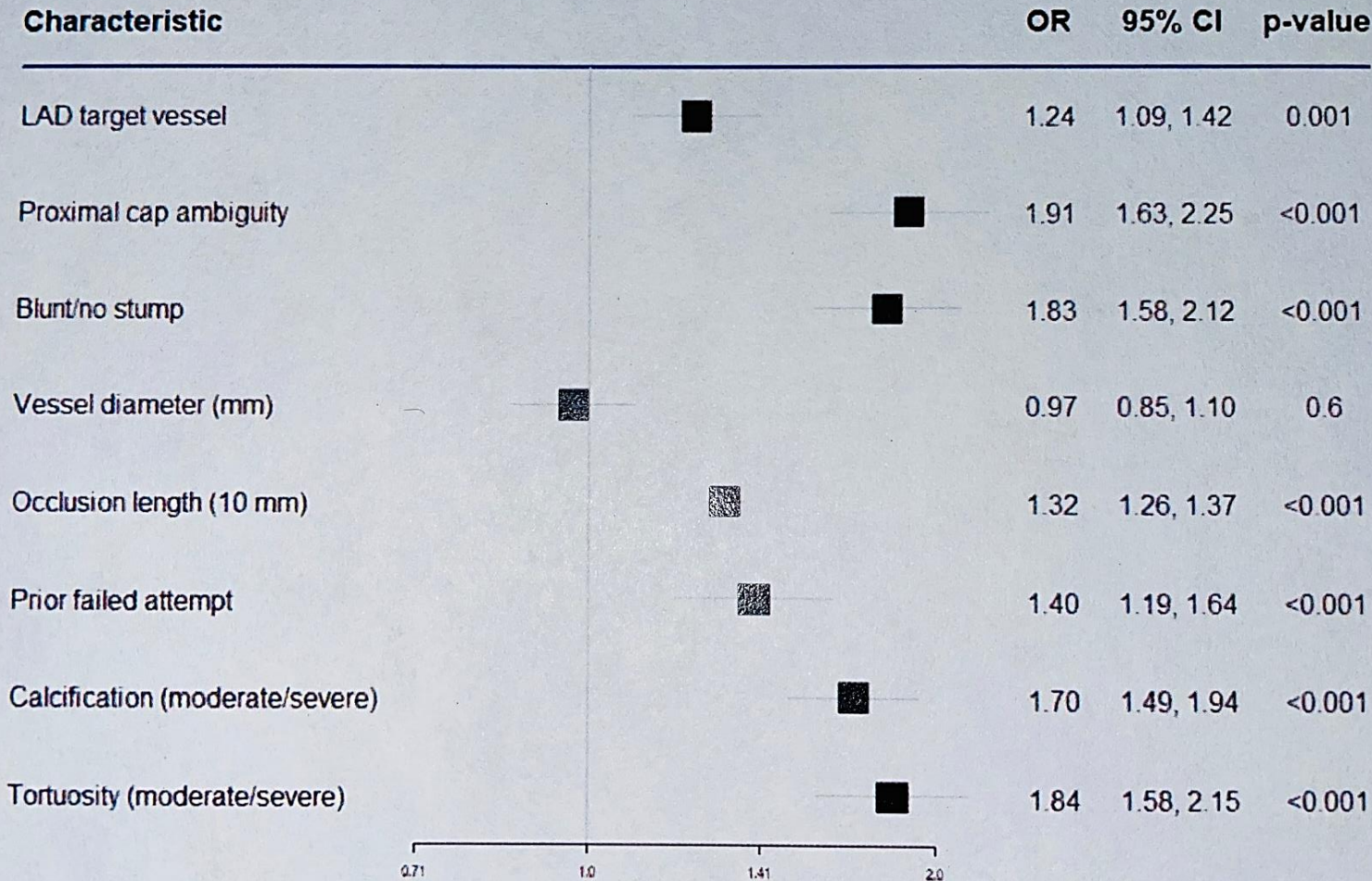
Tanaka, H. et al. J Am Coll Cardiol. 2019;74(19):2392-404.



A view point of “time management” during procedure, “20min” will be one of time milestone for antegrade single wire procedure.

Median successful guidewire crossing time of single wiring in the antegrade alone was 23 min (IQR: 11 to 44 min).

What is a risk of long time procedure.



Forest plot of multivariable analysis of parameters associated with guidewire manipulation time ≥ 30 minutes in patients with primary antegrade approach.


Risks of long time procedure

- Proximal cap ambiguity
- Blunt/no stump
- Calcification
- Tortuosity


Especially complex anatomy needed an appropriate planning. How to manage those problems?

CENTRAL ILLUSTRATION: Contemporary Issues in Chronic Total Occlusion Percutaneous Coronary Intervention

INDICATIONS



SYMPTOMATIC IMPROVEMENT
(angina, dyspnea, and depression)
IMPROVEMENT IN QoL
and physical performance
ISCHEMIA RELIEF

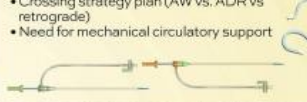



PROCEDURAL PLANNING

EVALUATION

- Low-mag diagnostic angiogram with no panning
- Evaluation of occlusion complexity (proximal cap, calcification, tortuosity, length, bifurcation at distal cap, quality of distal vessel, presence of interventional collaterals)
- Vascular access and guide catheter support plan
- Crossing strategy plan (AW vs. ADR vs retrograde)
- Need for mechanical circulatory support


PLAN

COMPLICATION MANAGEMENT

Syndrome based approach


- Hypotension
- ST-segment deviation, chest pain, ischemia
- Equipment entrapment / loss



IMPORTANCE OF INTRAVASCULAR IMAGING

Should be strongly considered in every CTO PCI for:

- Evaluation of intraplaque vs. extraplaque tracking
- Assessment of plaque composition before lesion preparation
- Vessel sizing for stenting
- Stent optimization



FUTURE DIRECTIONS

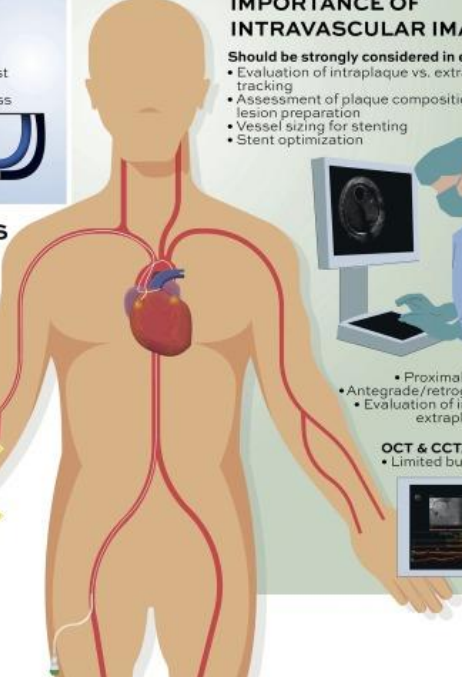
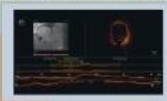
- NEW DEVICES
- NEW TECHNIQUES
- OUTCOME RESEARCH
- TEACHING & LEARNING

IVUS

- Proximal cap puncture
- Antegrade/retrograde re-entry
- Evaluation of intraplaque vs. extraplaque tracking after crossing

OCT & CCTA

- Limited but useful applications

Azzalini, L. et al. J Am Coll Cardiol Interv. 2022;15(1):1-21.



We have a procedural planning time before starting procedure.

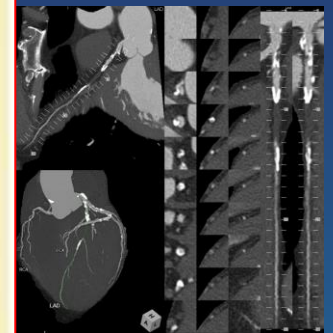
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PLAN



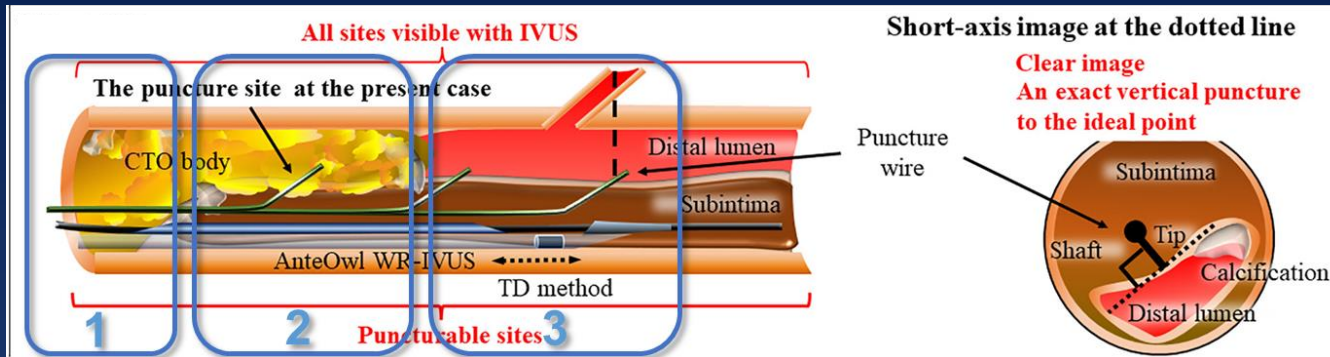


Tips and tricks

Key points:

1. Preparing many tips
2. Sorting tips with considering safety and effectiveness
3. Estimating limitation of each procedures for the next

The procedure time of Tip Detection Method



TD 3 patterns

1. Intra plaque to intra plaque
2. Extra plaque to intra plaque
3. Extra plaque to distal lumen

TABLE 1 Continued

Patient #	Strategies Prior to AWI and Wiring Time (min)	Wiring Time in AWI (min)	Pre-Dilatation t Advance AD-IVUS
1	AWE 19	4	Consair
2	AWE 10	5	Firecross
3	AWE 25	8	1-mm balloon → Co
4	AWE 13	9	Consair
5	AWE 21	5	Consair
6	AWE 6 → RWE 96	19	Consair
7	AWE 73 → RWE 53	5	Consair
8	AWE 40	8	Consair
9	AWE 15	5	1.5-mm balloon → Co
10	AWE 68	8	Consair
11	AWE 65	4	Consair
12	AWE 28	2	1.5-mm balloon → Co
13	AWE 36	4	Consair
14	AWE 32	8	Consair
42		15	1-mm balloon → Co

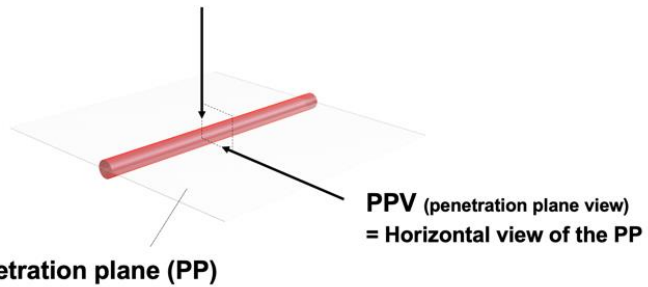
Wiring time: 2 to 19min
Median: 5min

AWI = ante-awire intracoronary angiography; AWI-IVUS = AnteOwl WR intravascular ultrasound; AWE = ante-awire Japanese chronic total occlusion score; LAD = left anterior descending coronary artery; RWE = retrograde guidewire escalation.

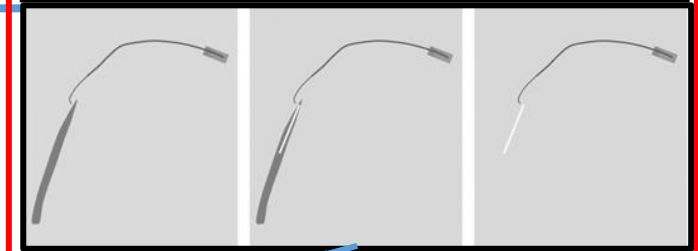
These will appear in the CTO PCI area in the near future

Penetration Plane method

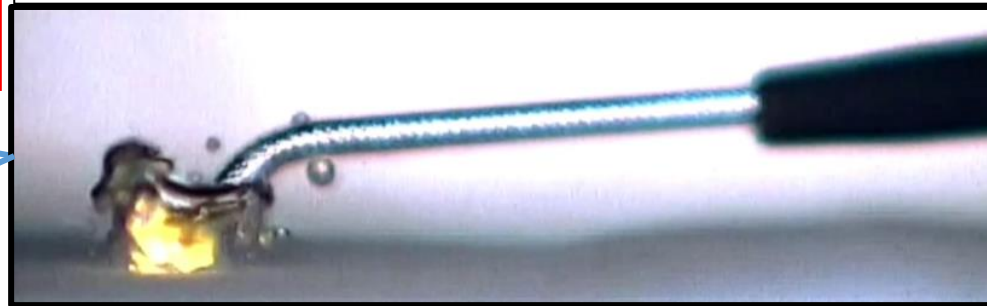
OPV (objective perpendicular view)
= Vertical view of the PP



Distal true lumen mapping

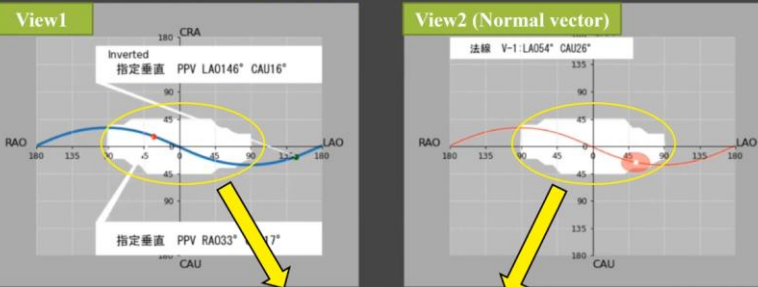


Plasma mediated ablation (PMA) system



Axis-vector analysis software

Ve: RAO 92 CAU 59



Movable range of C-arm

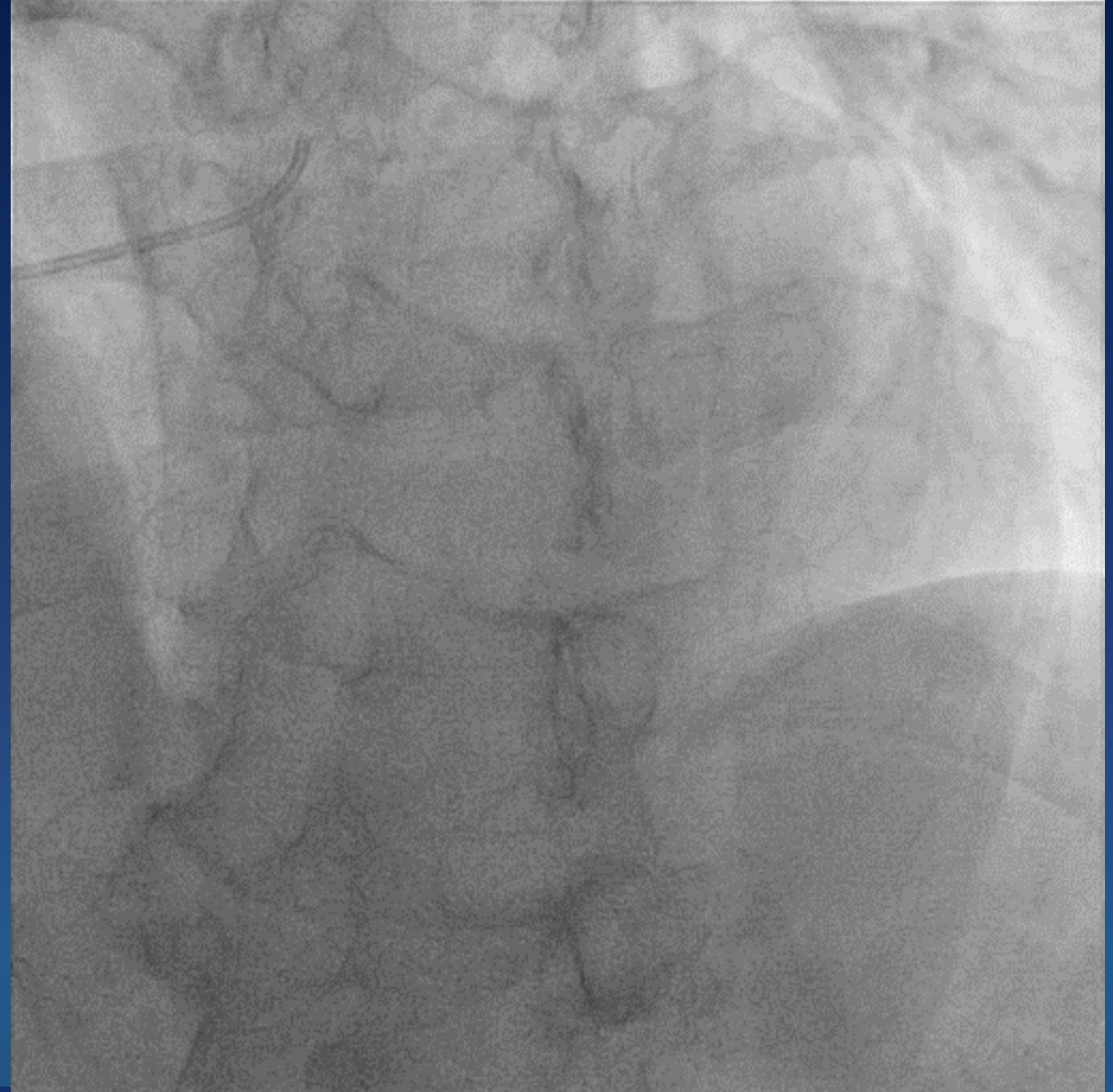
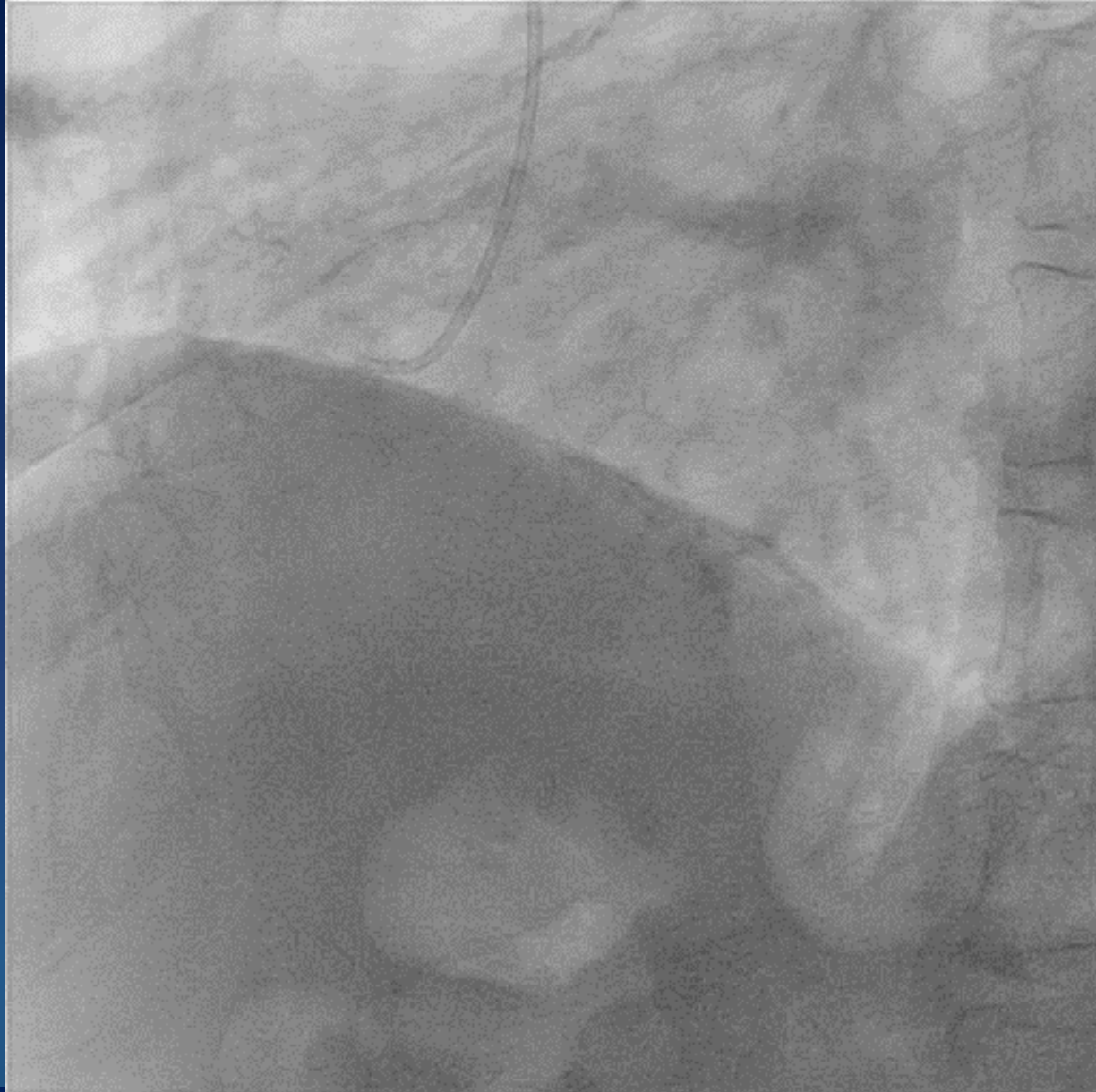
All systems are linked

ECG-synchronized fluoroscopy



By courtesy of Dr. M. Habara
"Plasma Mediated Ablation System" and "Software programs"
presented in the slides are not regulatory approved in Japan.

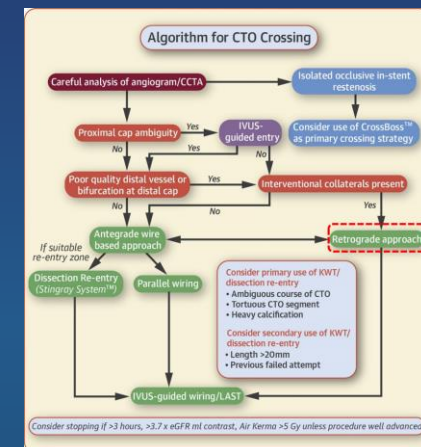
RCA CTO

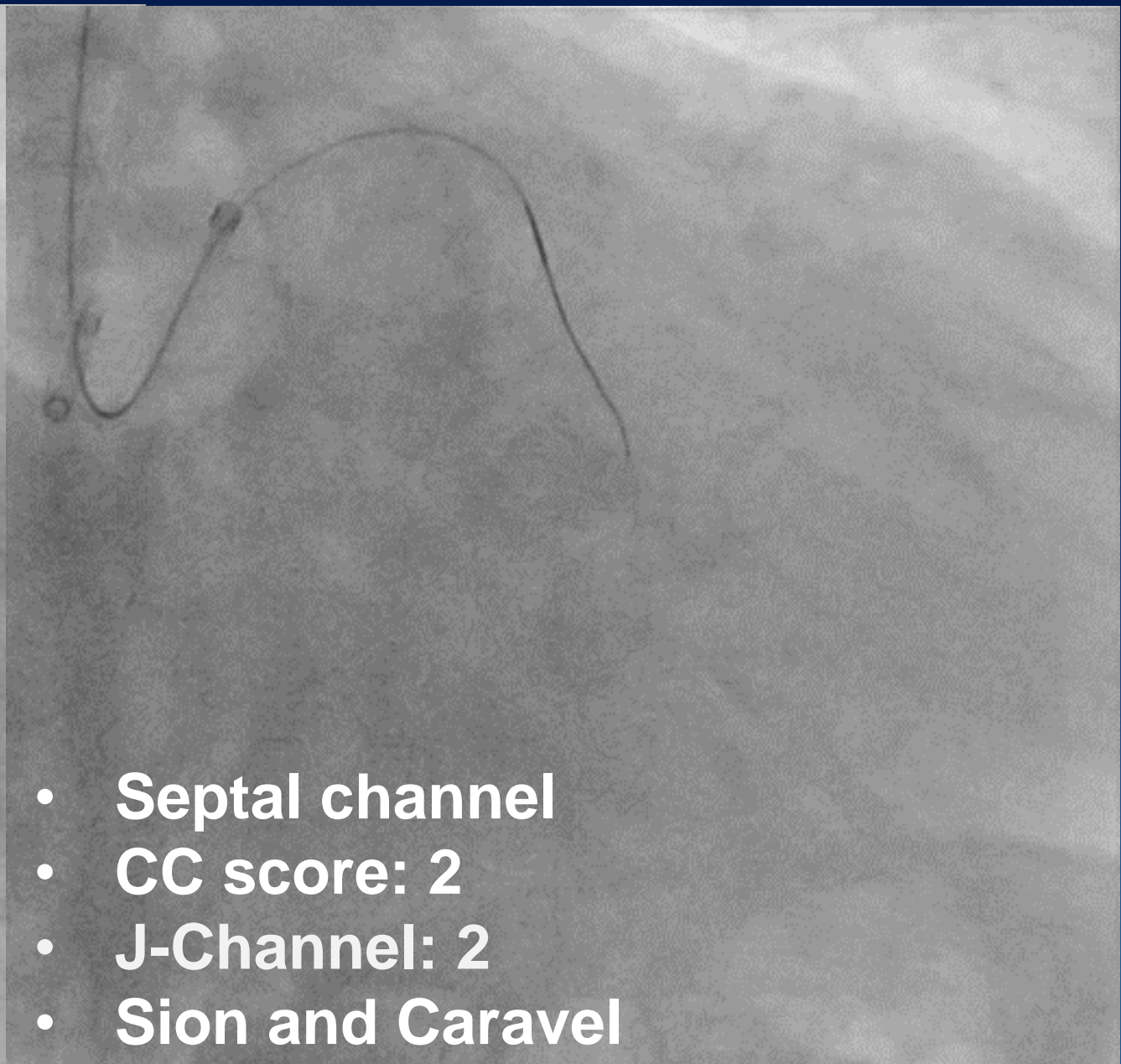
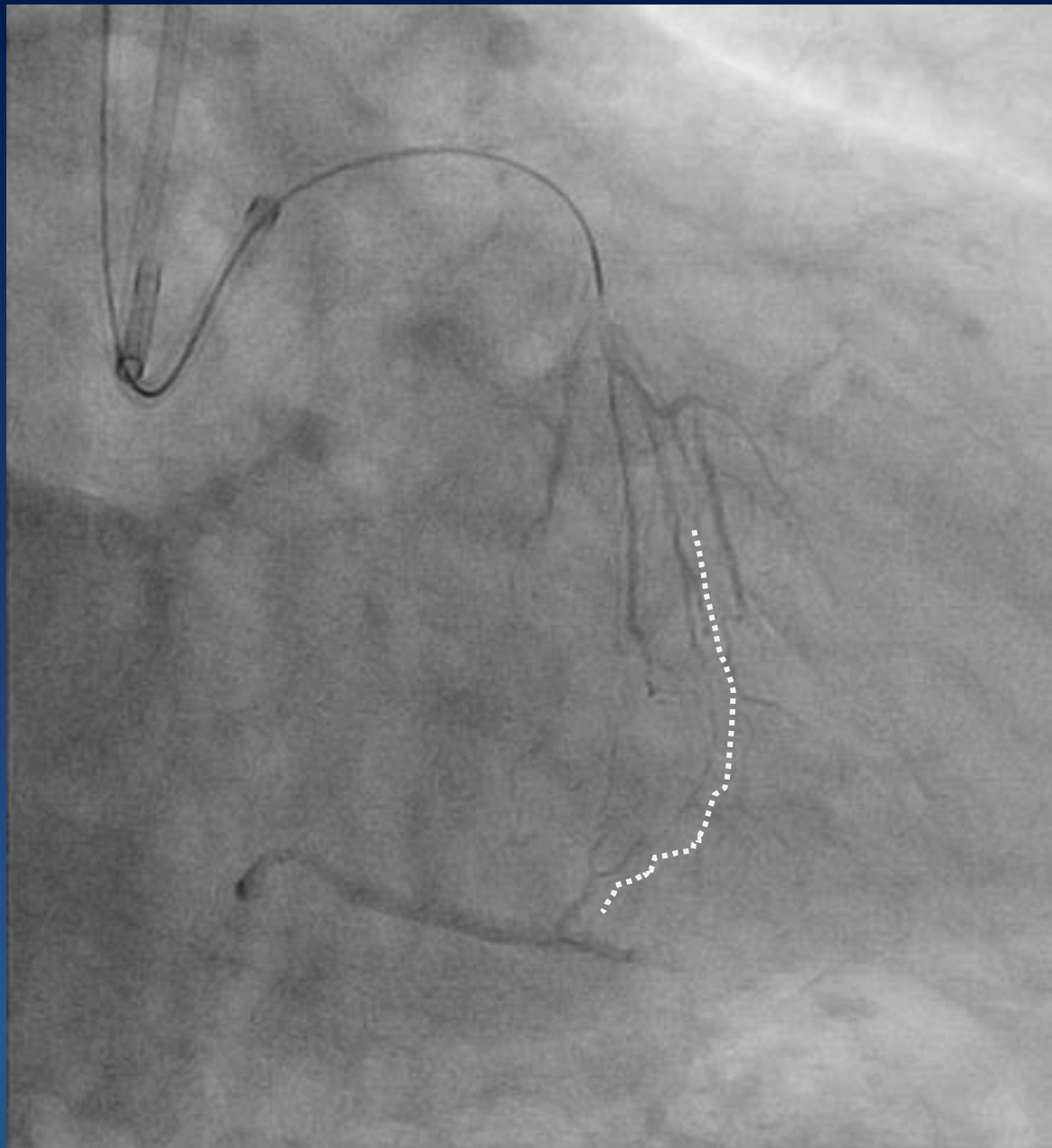




Long RCA CTO

- Tapered entry
- Calcification at CTO exit
- Exit have a major bifurcation
- Low EF
- Renal insufficiency





- Septal channel
- CC score: 2
- J-Channel: 2
- Sion and Caravel

Huang's CC score

“Larger size and lesser tortuosity” is better.

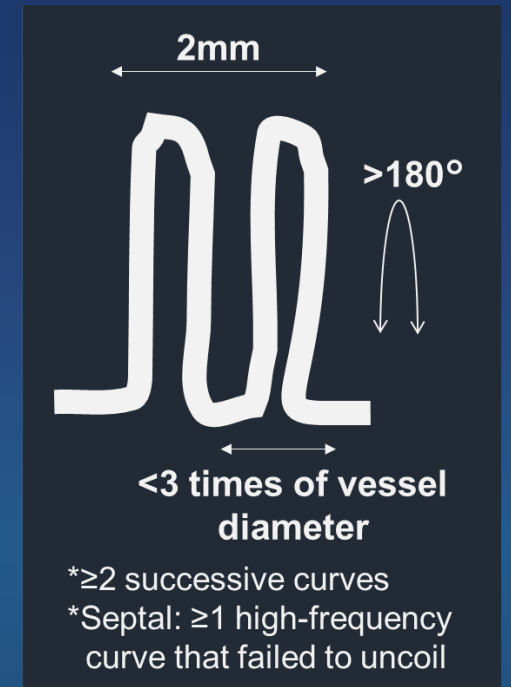
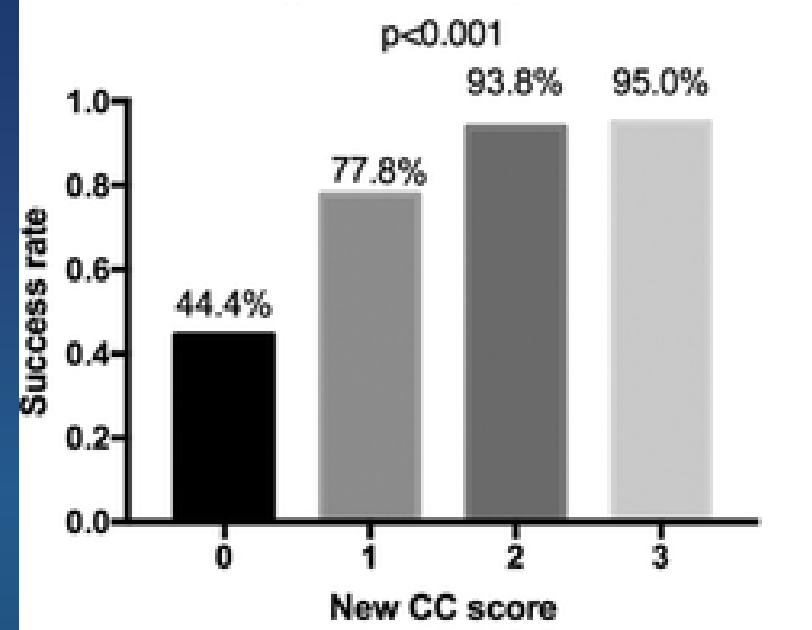
Table 4. Univariable and Multivariable Analyses for Predictors of Technical Success

	Univariable		Multivariable	
	OR (95% CI)	P Value	OR (95% CI)	P Value
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.

Assigning 2 points to lack of tortuosity and 1 point to large size (CC2) for each CC,

A CC tracking success by new CC score



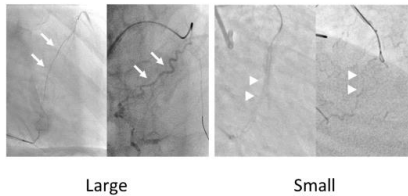
J-Channel Score

Focus on vessel properties (septal / non-septal) .

J-Channel Score

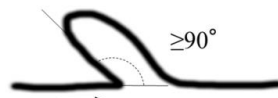
A. CC Vessel Size

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



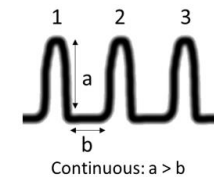
B. Reverse Bend

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



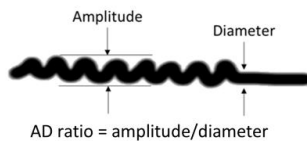
C. Continuous Bends

- 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 on vertical frame as type of CC.

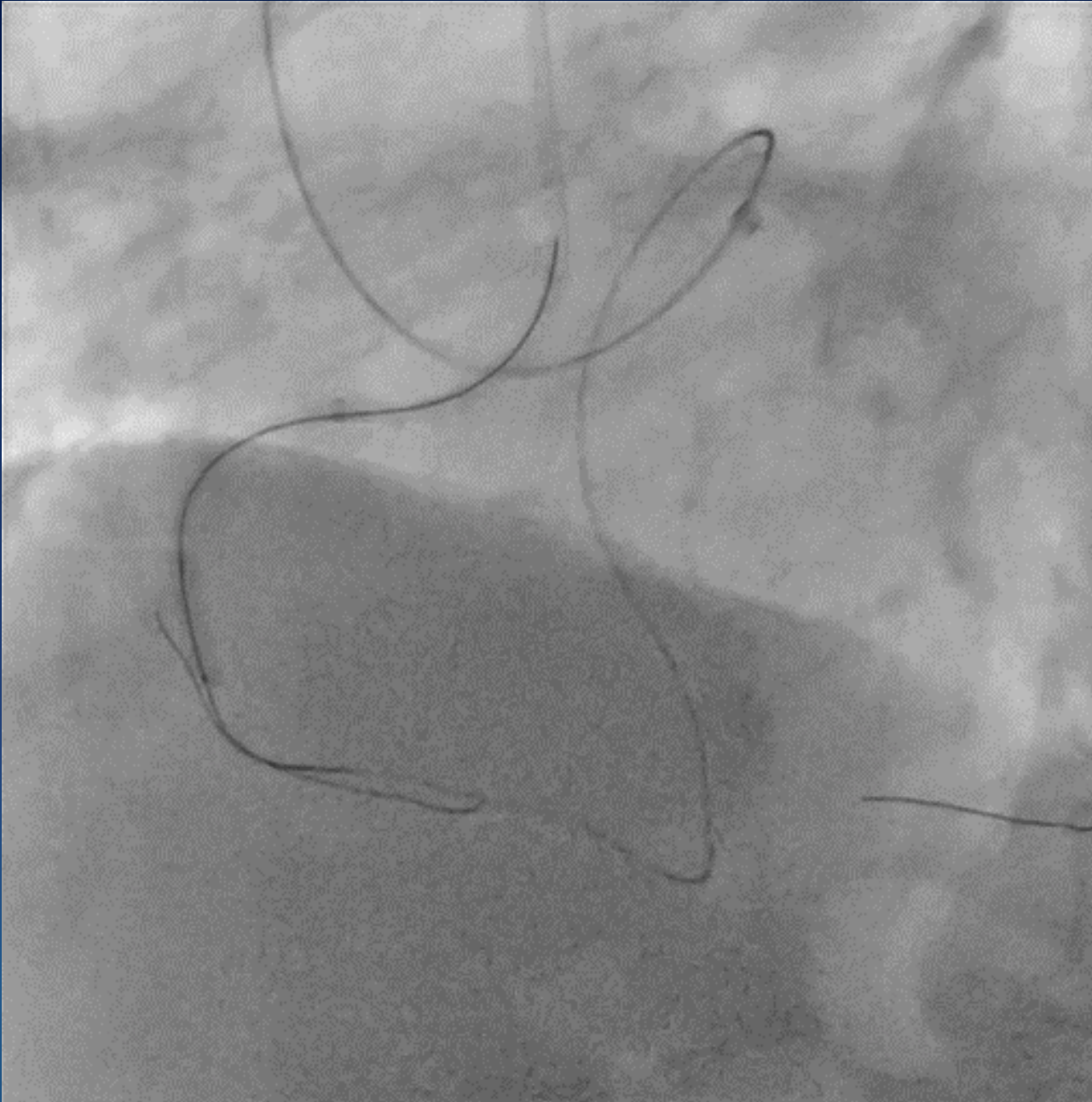
3rd Estimate difficulty.



How to estimate "actual 3D" morphology?

GW cross ability

- Easy: 90%
- Intermediate: >50%
- Difficult: 20%



RCART failed

Gaia Next 2

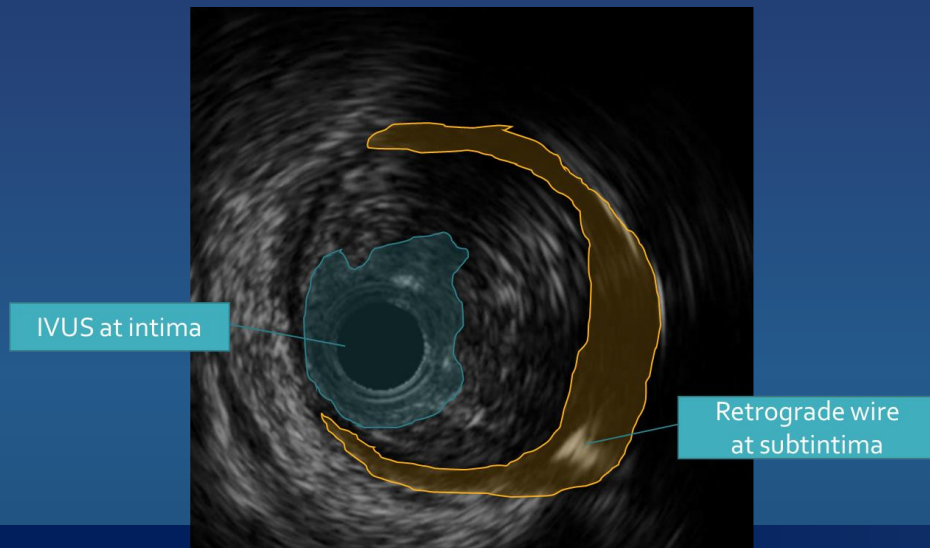
What is the next option?

1. **IVUS guided RCART**
 2. Changing guide wire
 3. Using guide extension
 4. Using large size balloon
 5. Changing meeting point
- Others

IVUS guidance for Reverse CART

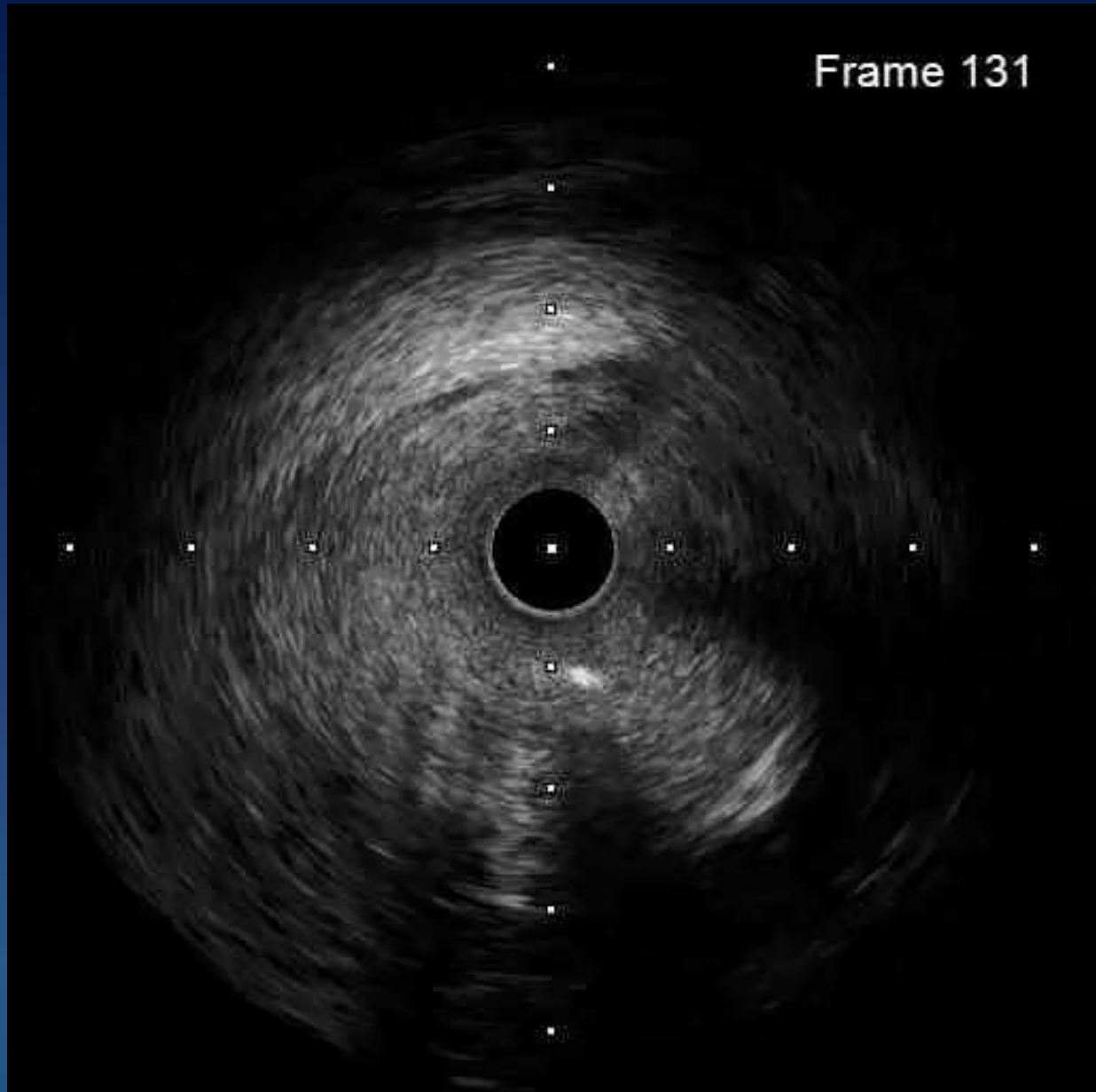
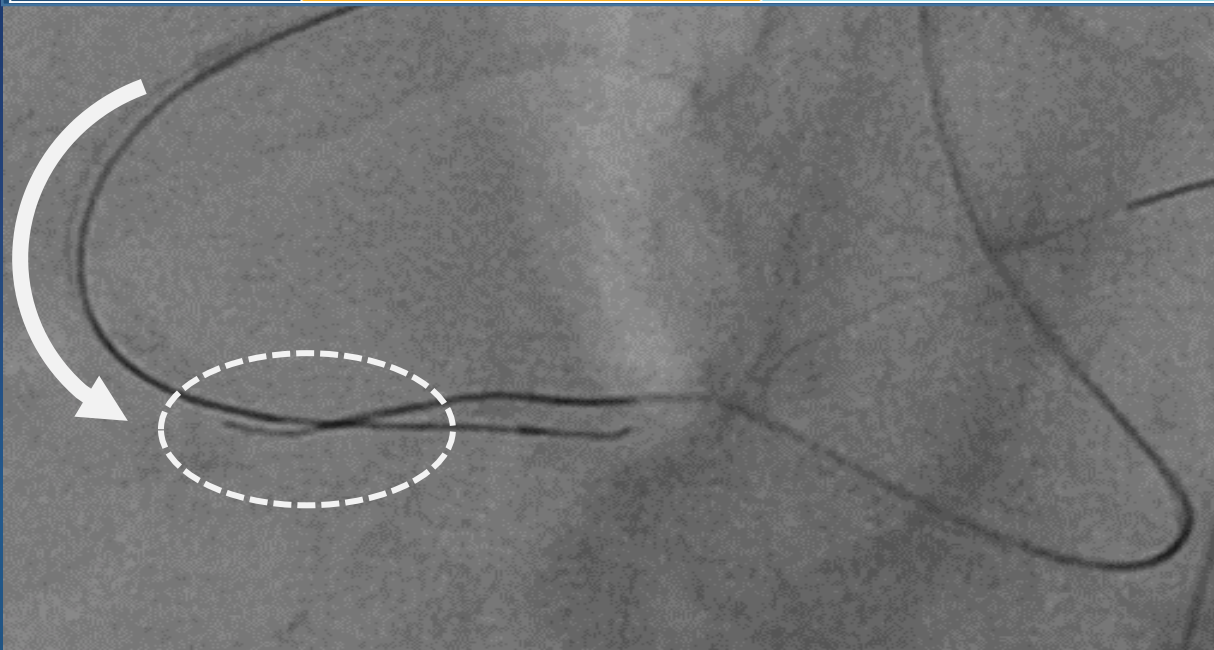
Benefits:

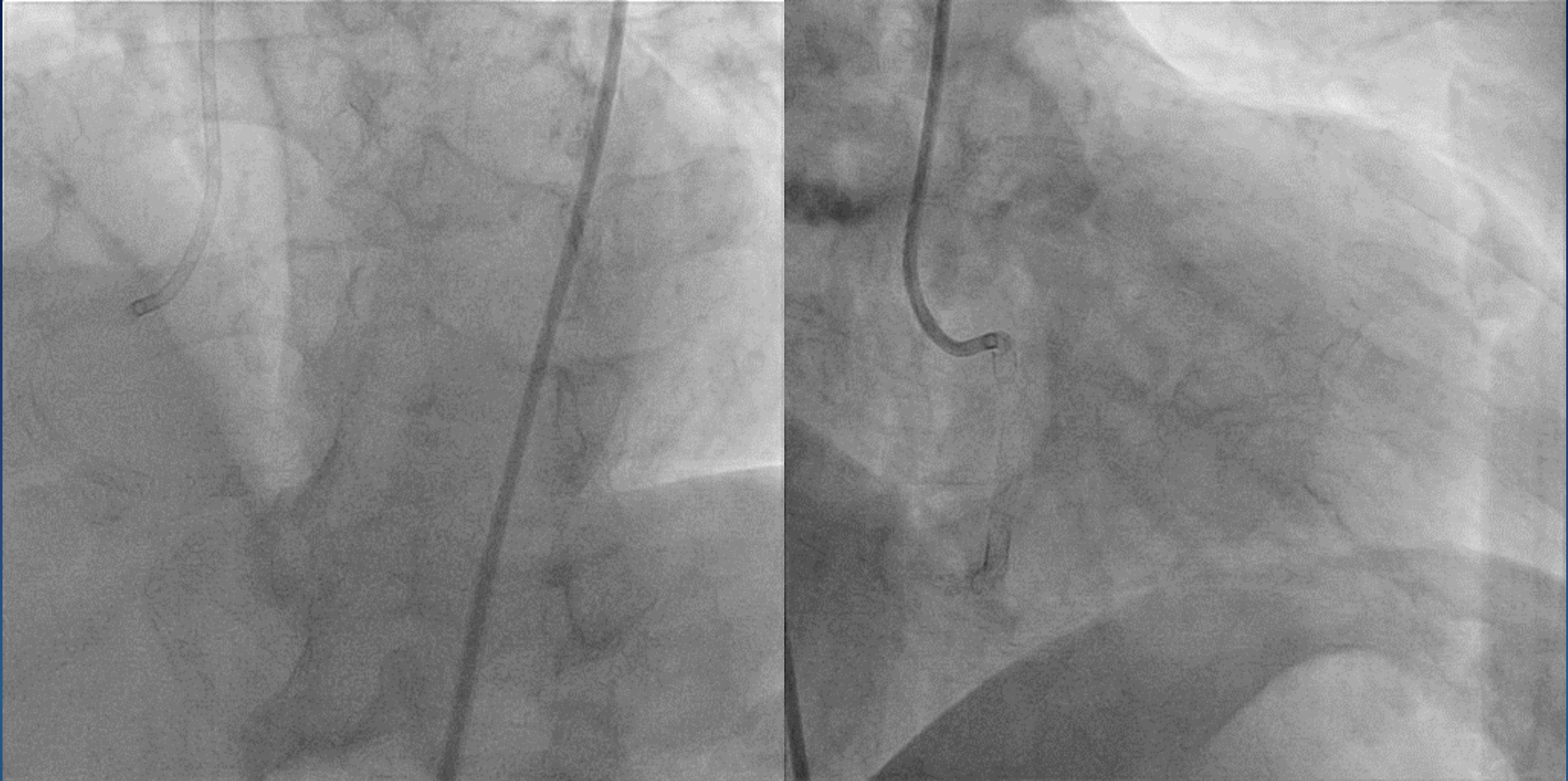
1. Recognizing wire positions of retrograde and antegrade.
2. Estimating vessel size for optimal balloon size.



Antegrade \ Retrograde	Intima	Subtintima
Intima	Easy to make connection	Difficult to make connection
Subtintima	Difficult to make connection	Easy to make connection

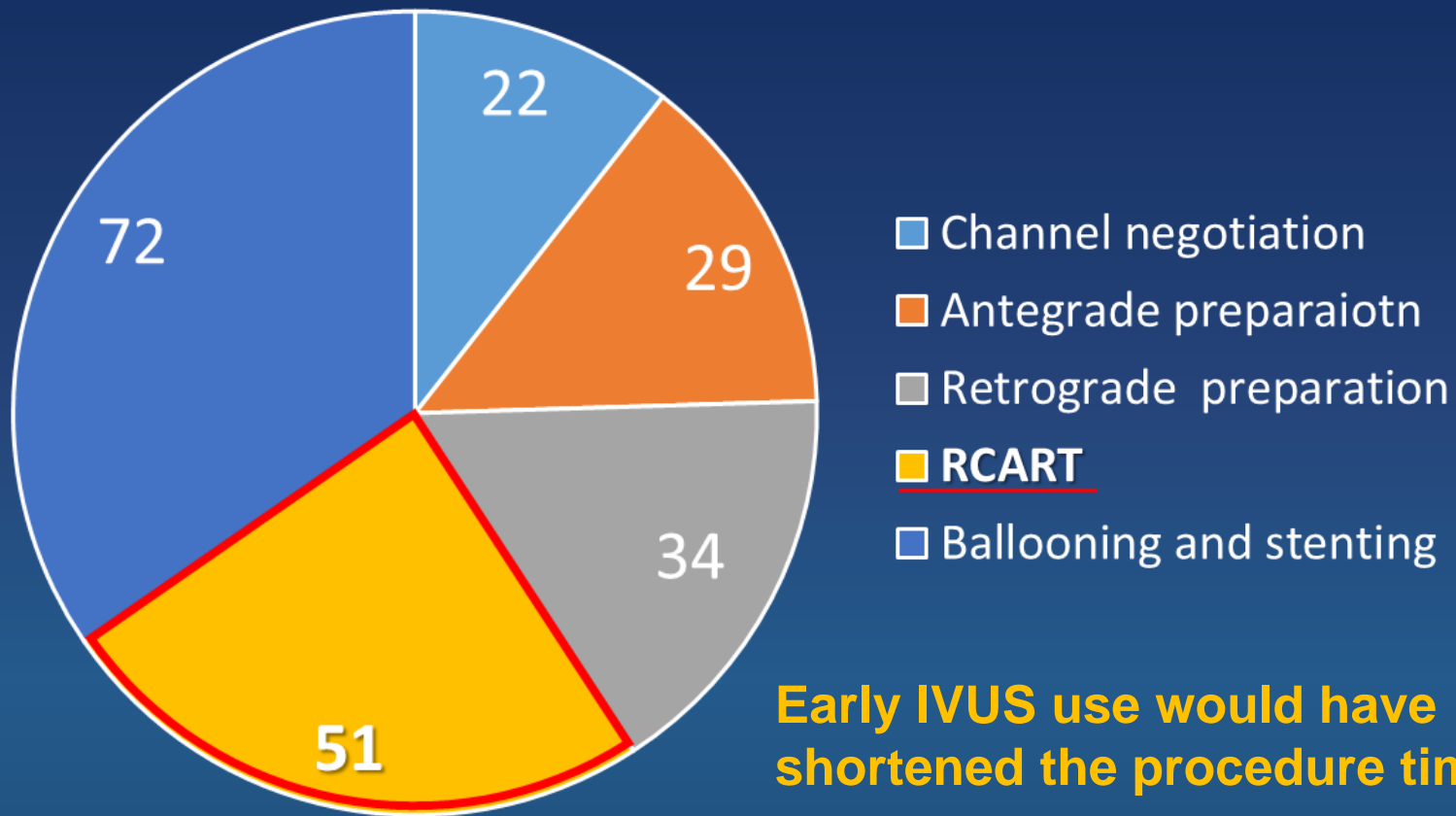
Antegrade Retrograde	Intima	Subintima
Intima	Easy to make connection	Difficult to make connection
Subintima	Difficult to make connection	Easy to make connection



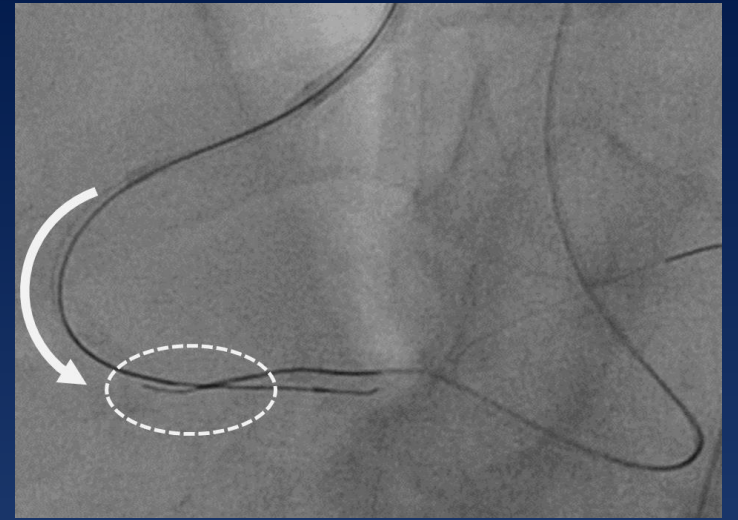


Review: Time allocation

CTO PCI (208min)



Early IVUS use would have shortened the procedure time.



Take Home Message

-Tips and tricks for shortening procedure time

- Before starting procedure, considering procedure plan is important for shorting procedure time.
- During procedure, actual elapsed time will suggest the timing of changing strategy.
- Sorting tips in terms of safety and effectiveness and estimating each procedure limitations are key of shortening procedure time.

