

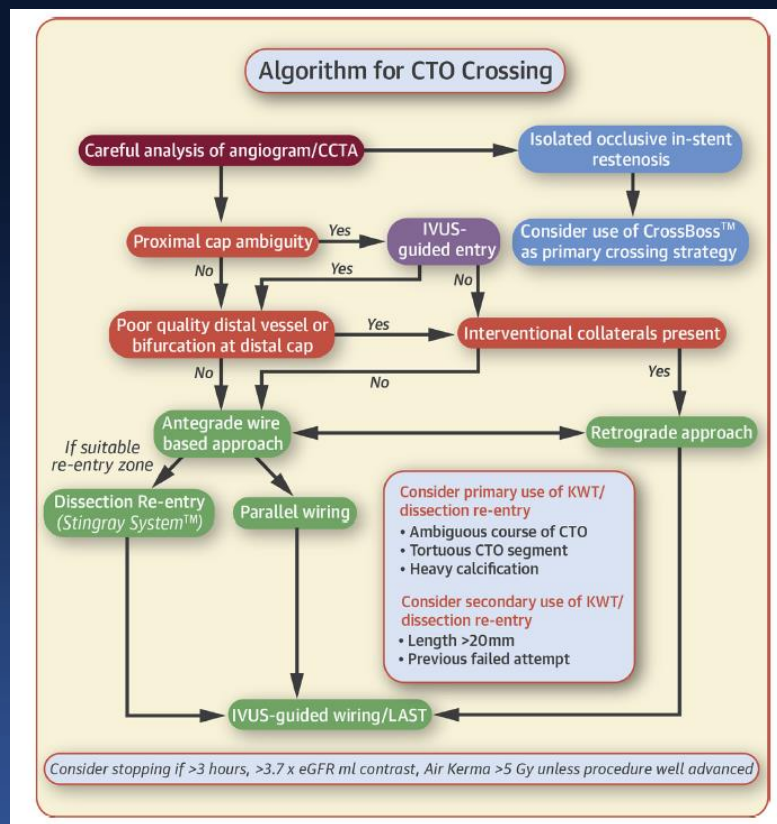
The Retrograde approach step by step

Seung-Whan Lee, MD, PhD

Asan Medical Center,
University of Ulsan College of Medicine, Seoul, Korea

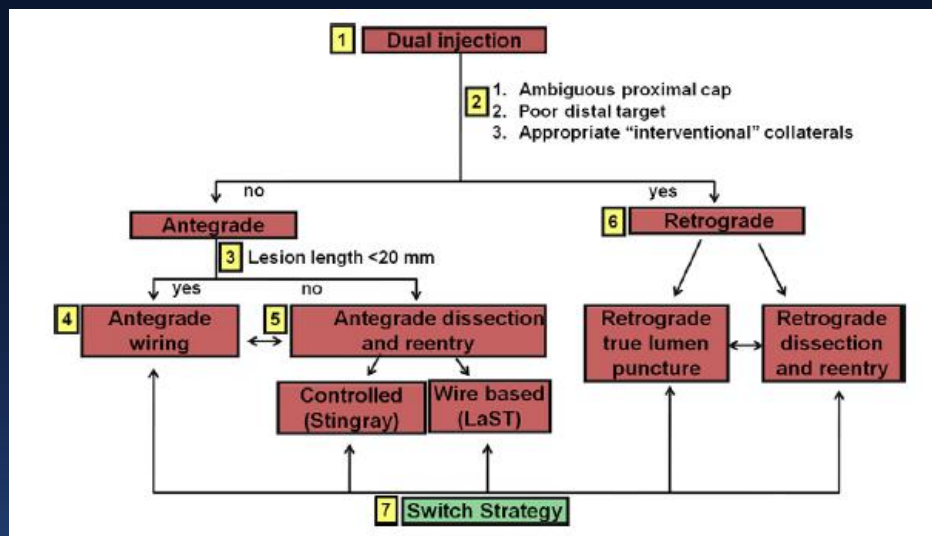
Indication for the retrograde approach

AP-CTO



J Am Coll Cardiol Interv 2017;10:2135–43

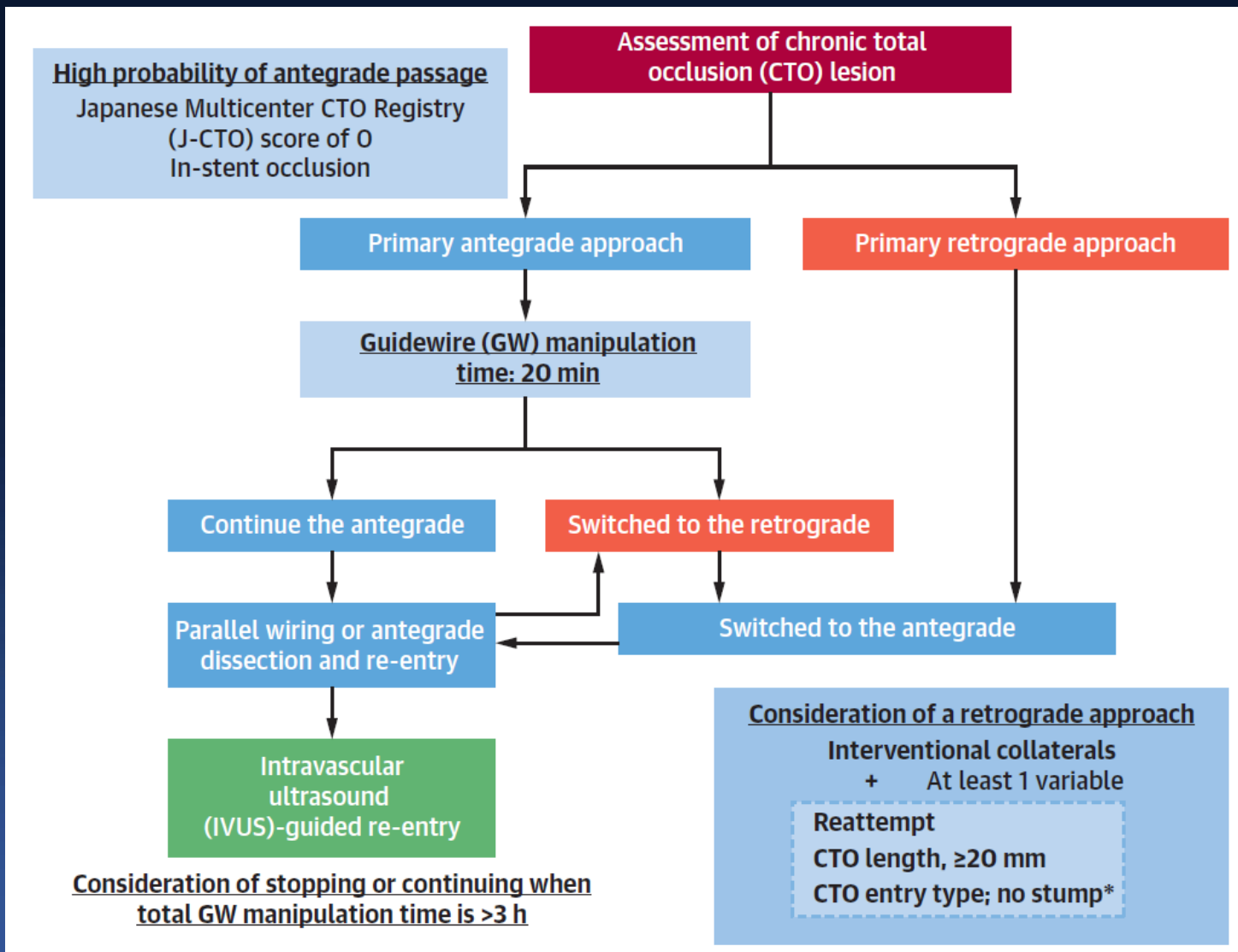
Hybrid



JACC Cardiovasc Interv 2012;5(4):367-79

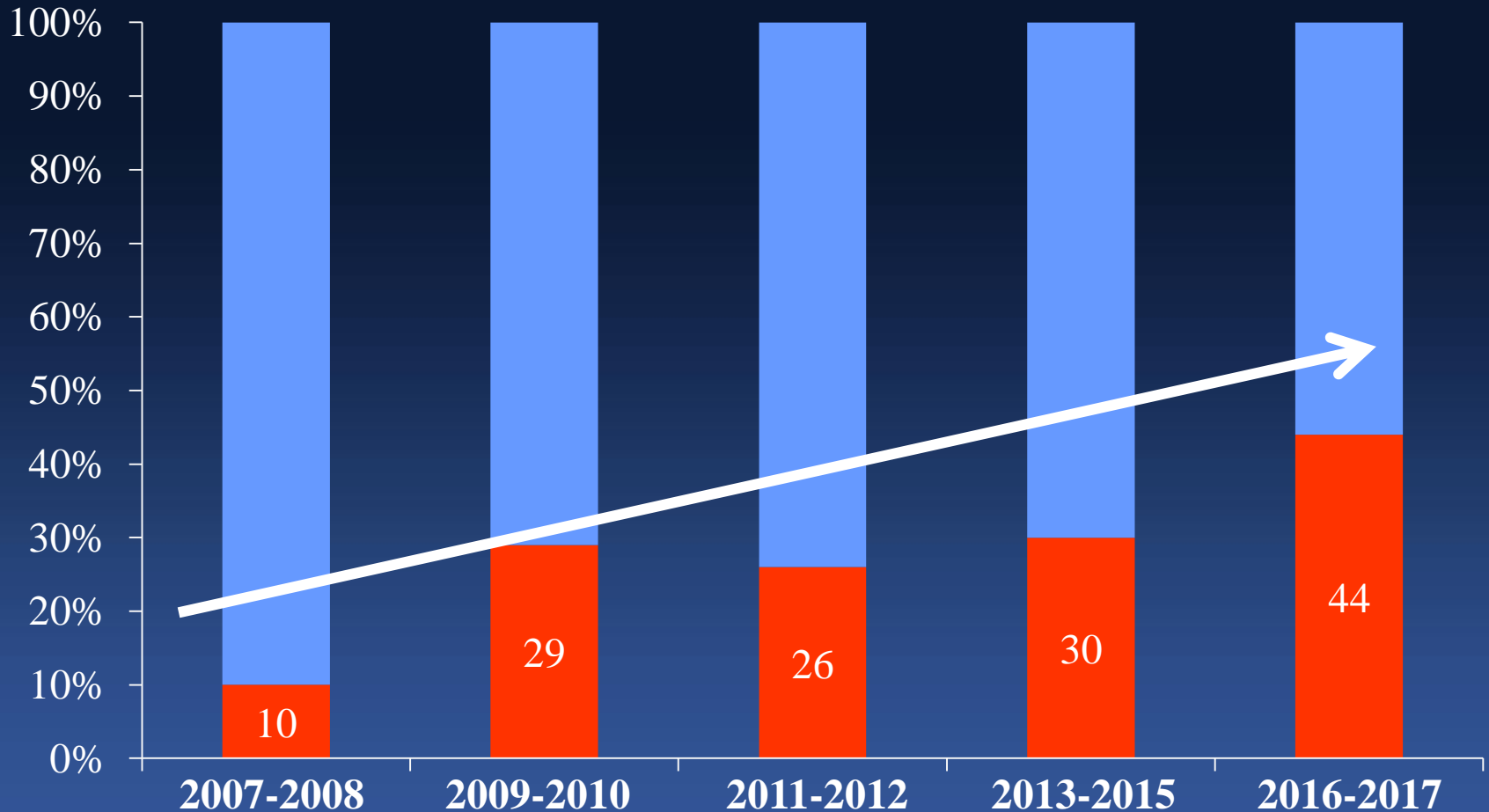
- Ambiguous proximal cap
- Poor distal target
- Interventional collaterals

A Novel Algorithm for Treating Coronary CTO



*No stump: the absence of a visible entry, even when using IVUS

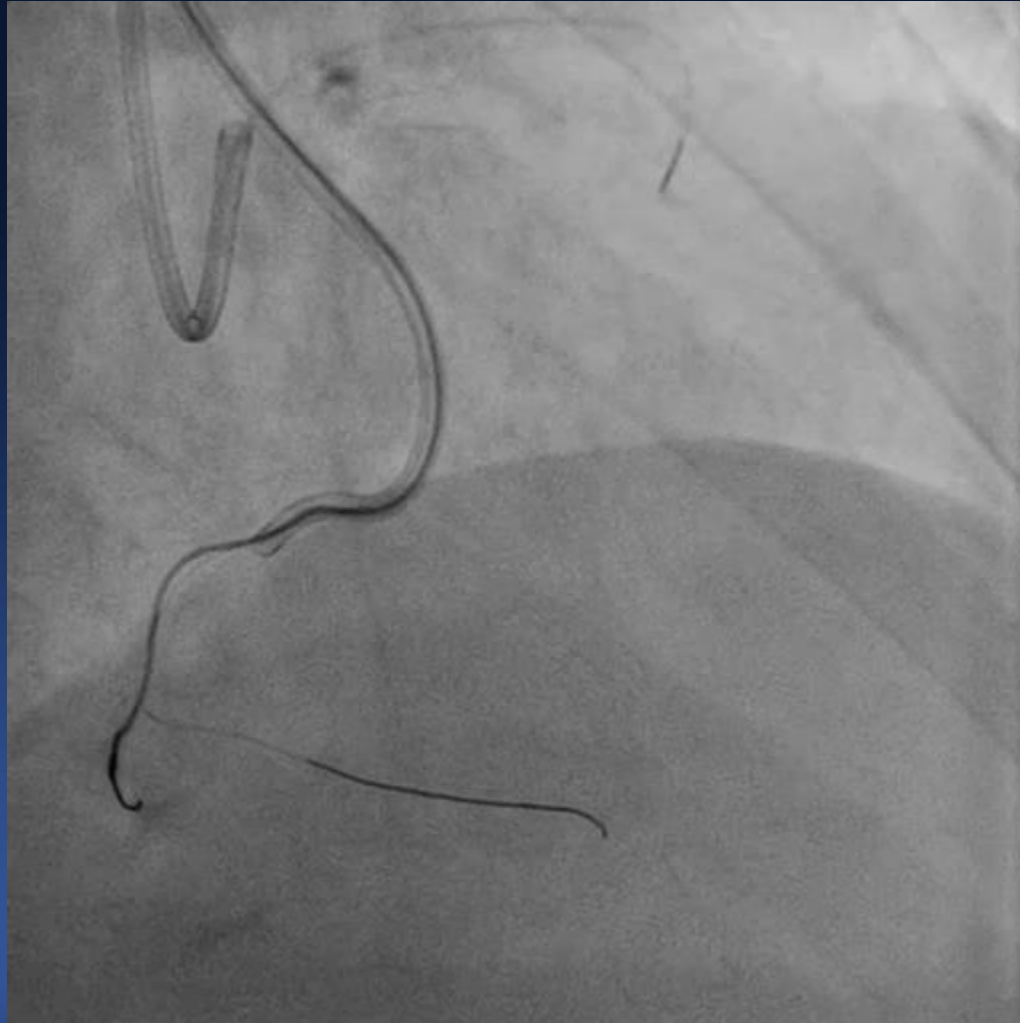
Retrograde approach



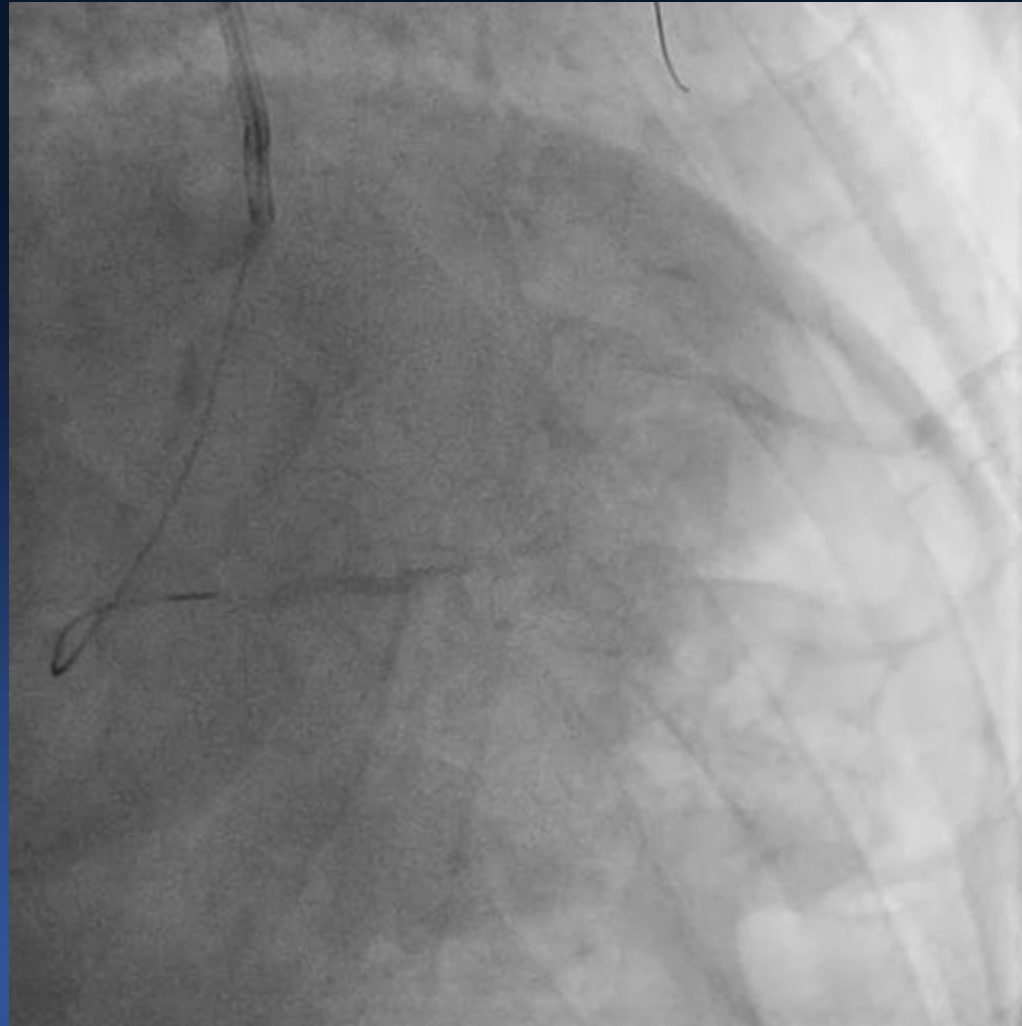
Selective angiography

- Not necessary for all cases
- Necessary for ambiguous channel course
- Confirm for blood regurgitation
- Proximal channel portion preferred
- Caution for channel damage (R->L septal or epicardial channel)

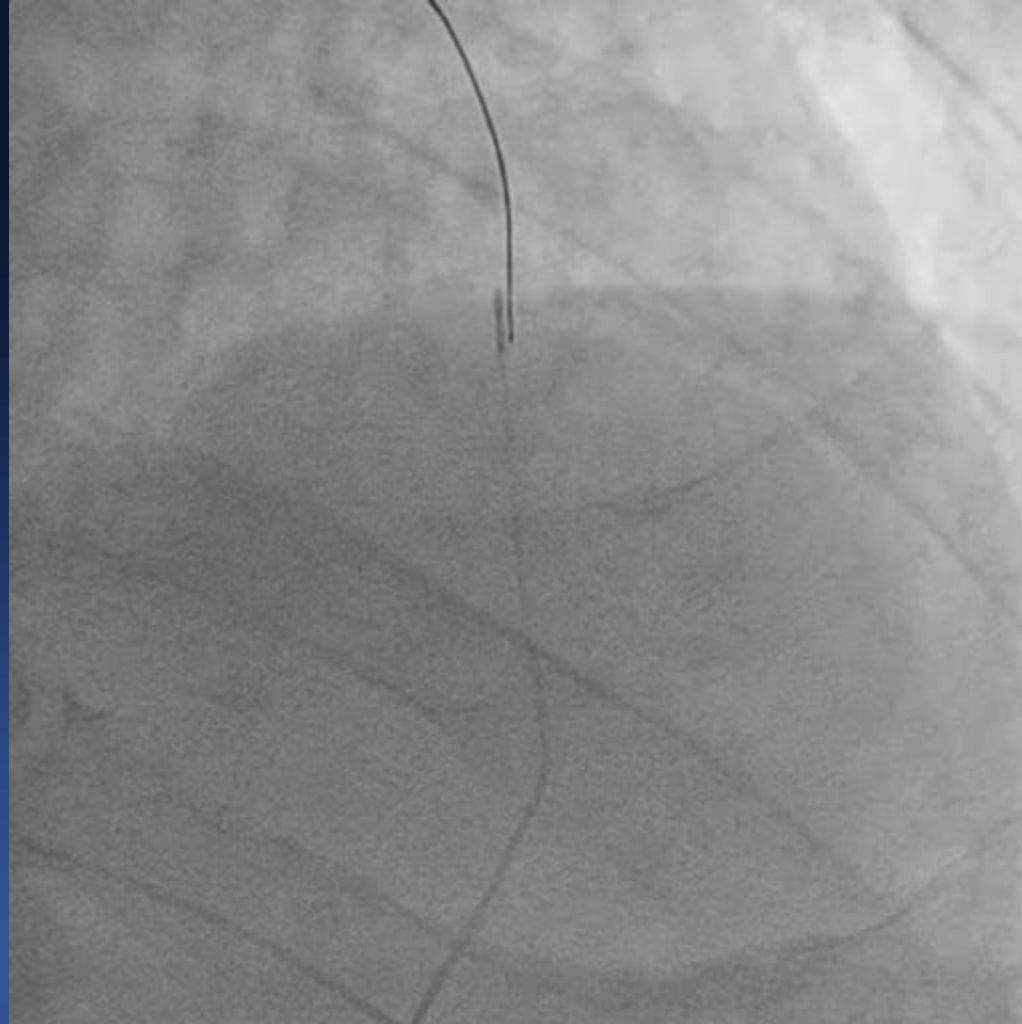
Tip angiography



Tip angiography

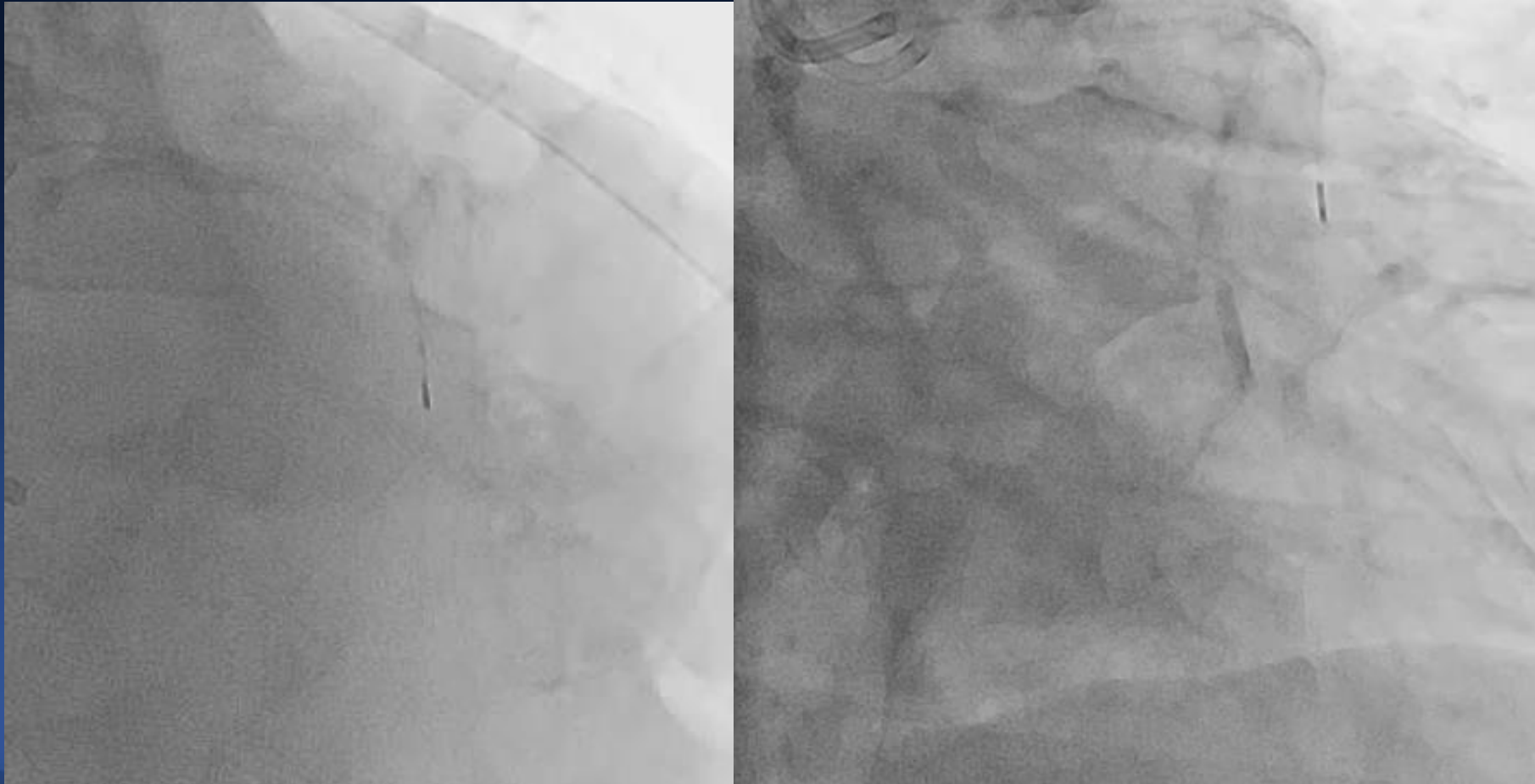


Retrograde distal cap tip angiography

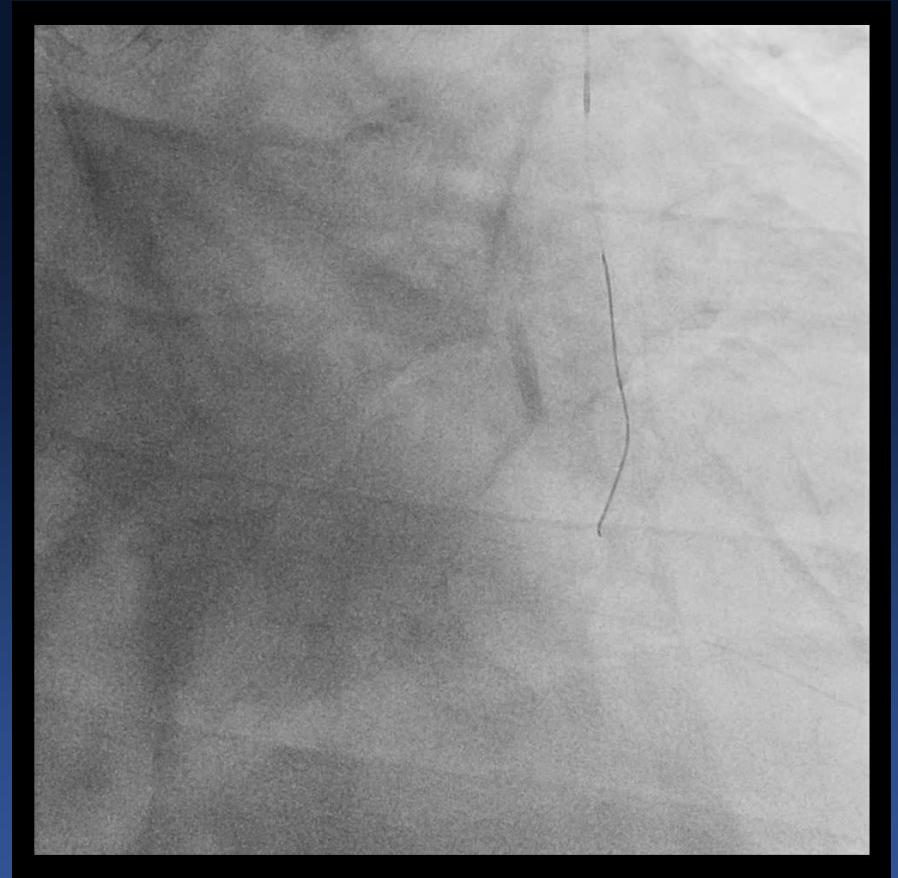
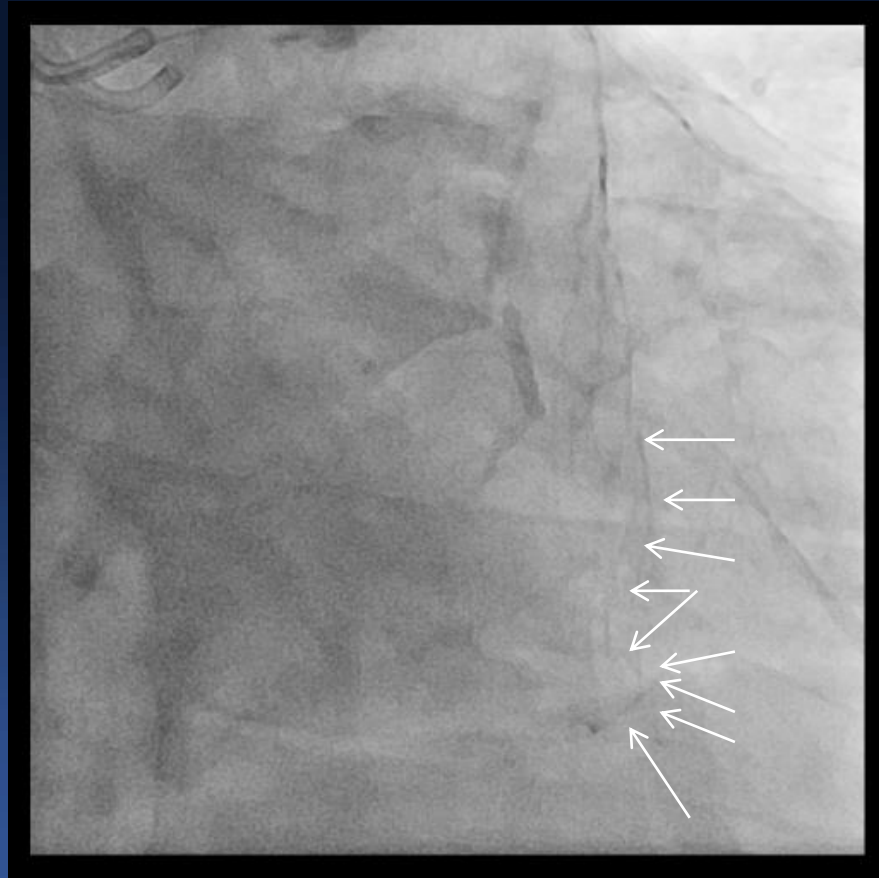


Ambiguous septal channel

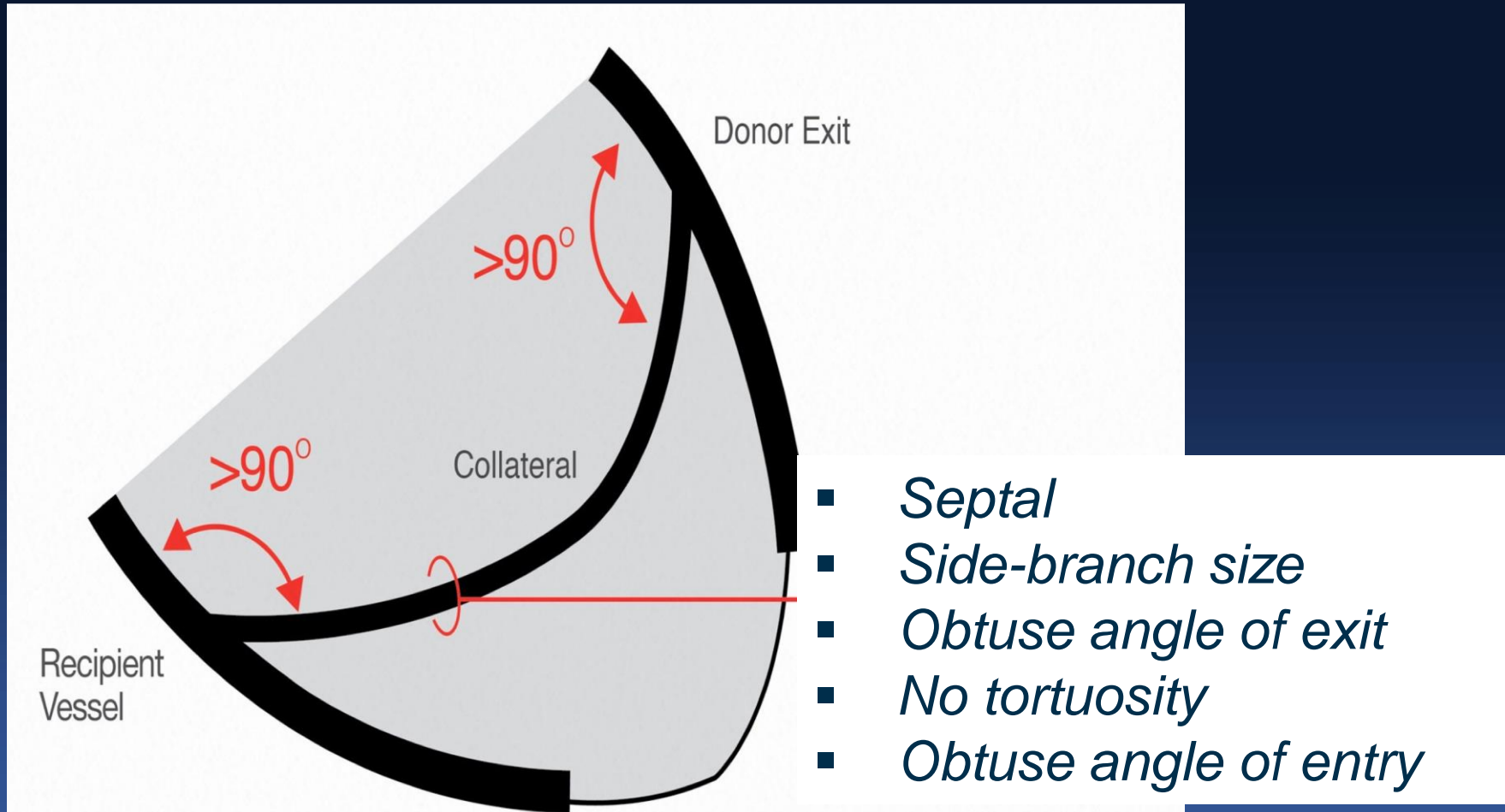
RAO cranial, ambiguous connection RAO caudal make it clear



Ambiguous septal channel



The Optimal Collateral



Collateral channel wiring

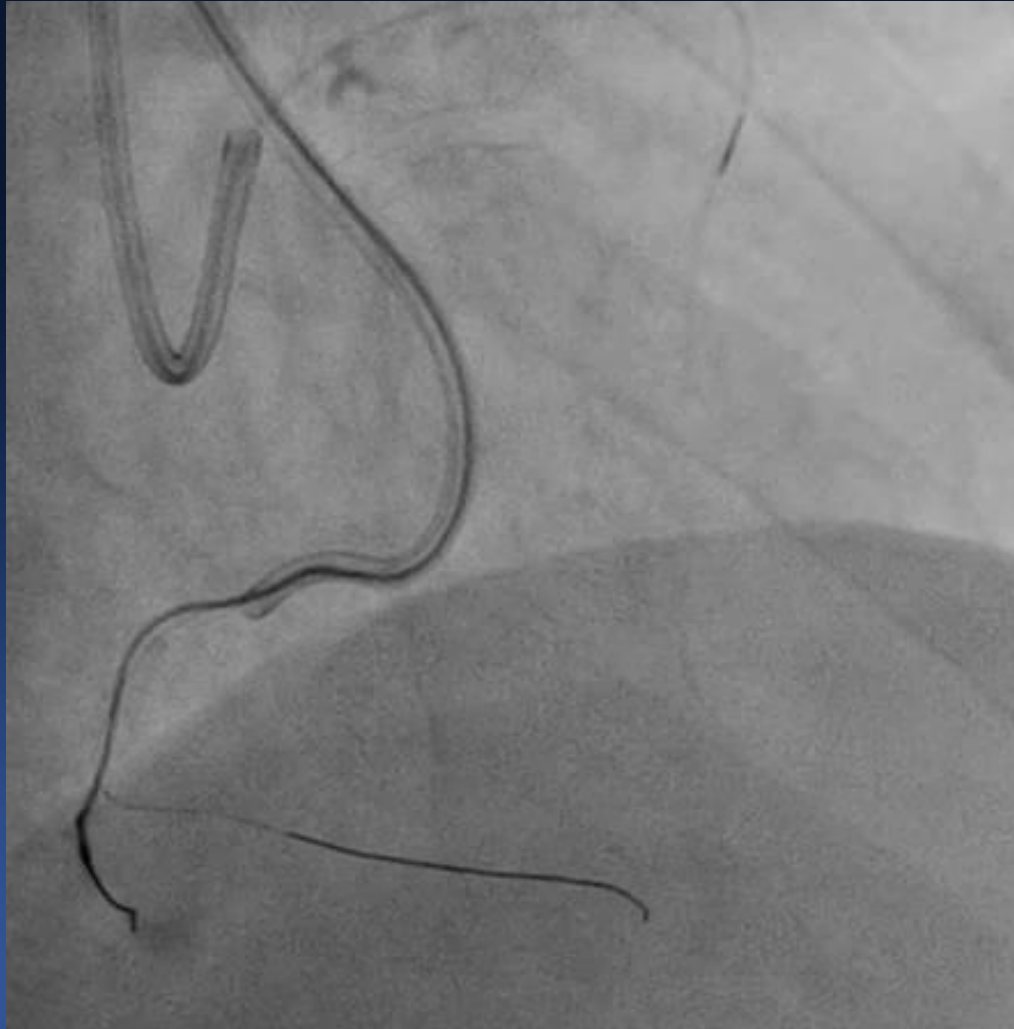
- Initial wire: Sion
- Tortuous channel: Souh03 or Sion black
- Small channel: Fielder XT-R
- Sometimes new wire is working if failed

Table 2. Tips for channel crossing.

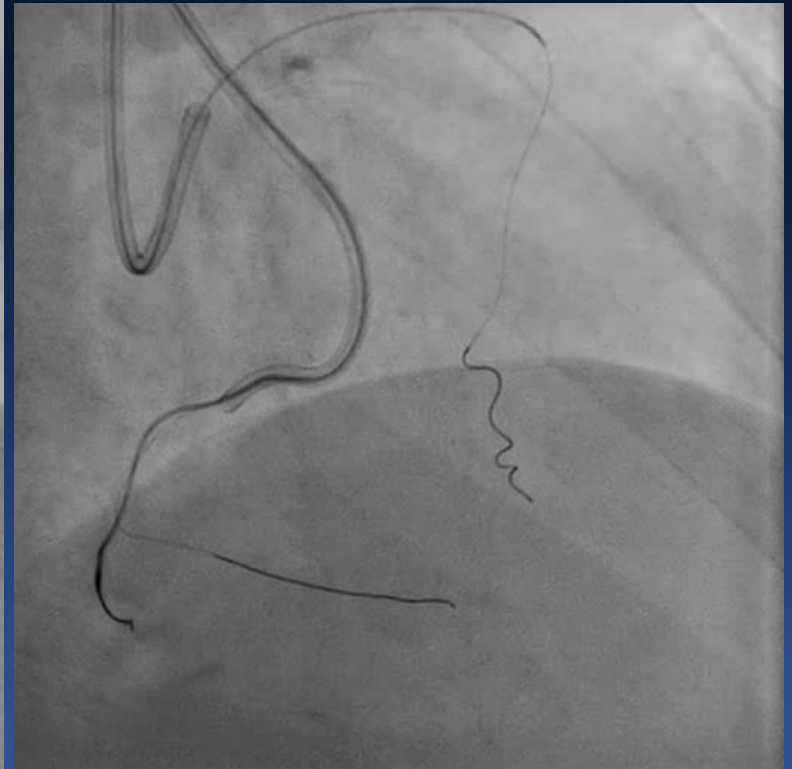
Channel	Angio	Tips	First wire	Second choice small channel	Second choice for tortuous channel	Third choice for tortuous channel
L → R septals	Selective injection*	Further distal selective injection with rotational angiogram	SION	XT-R	SUOH 03	SION black
R → L septals	Non-selective injection (or via twin lumen)	Twin lumen catheter to overcome retroflex ostium	SION	XT-R	SUOH 03	SION black
Epicardial	Selective injection*	Microcatheter follows the wire technique	SUOH 03	XT-R/SION	SION/XT-R	SION black if large epicardial channel

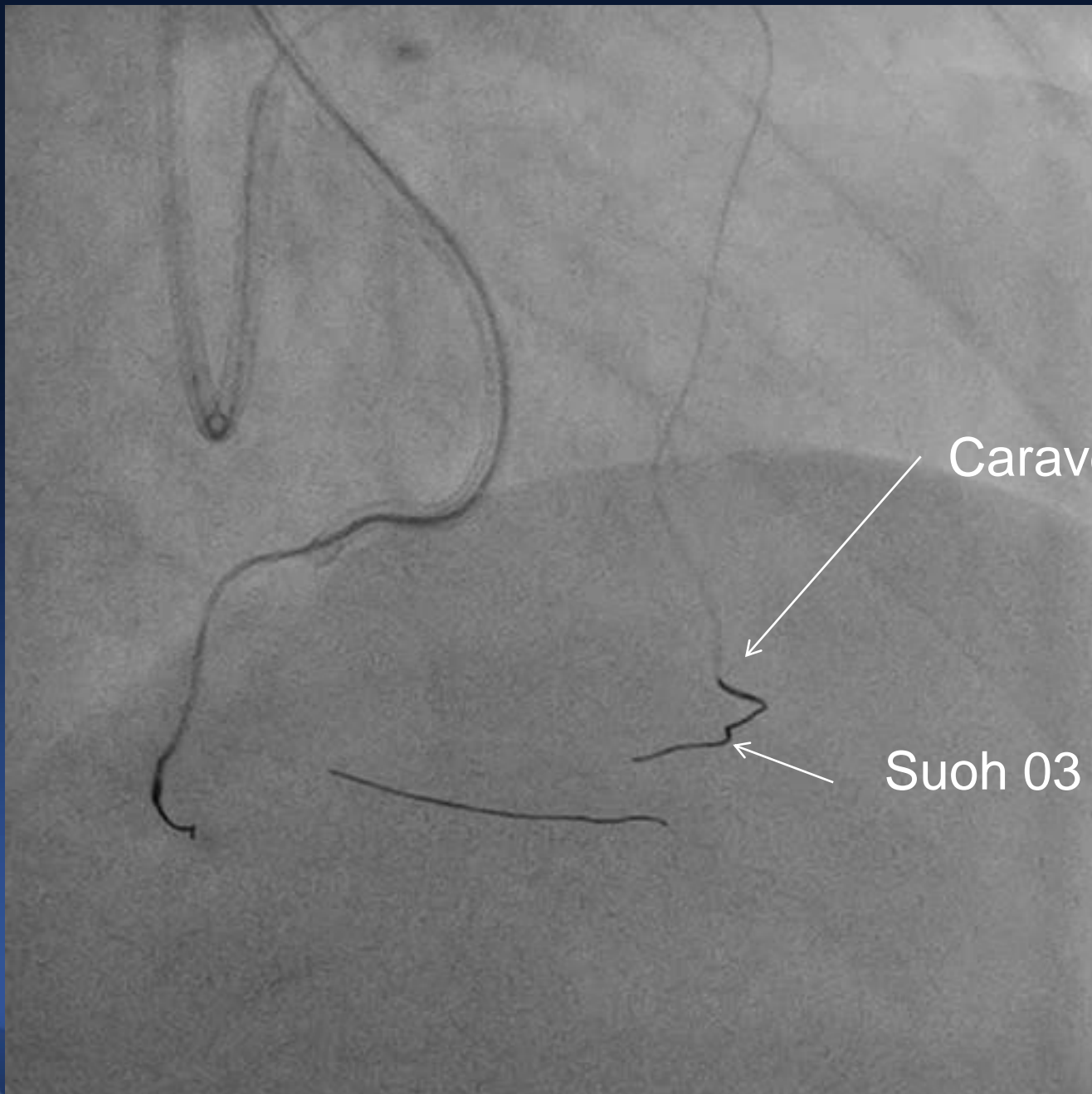
* Selective angiography should be performed with biplane or rotational angiography.

Tortuous septal channel (Suoh 03)



Caravel/Sion wire: failed



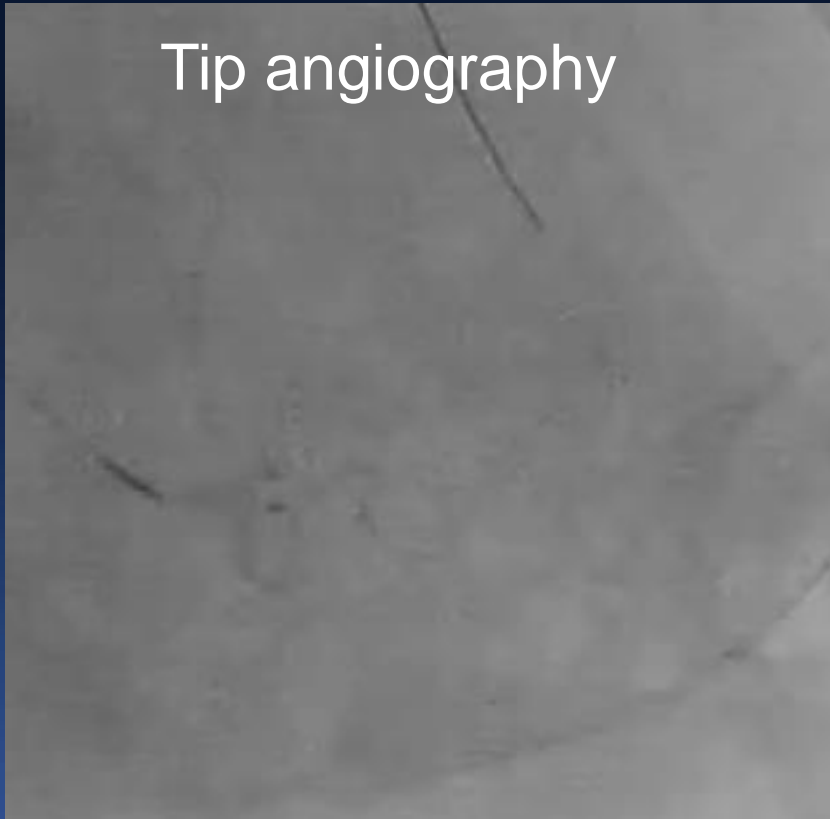


Caravel

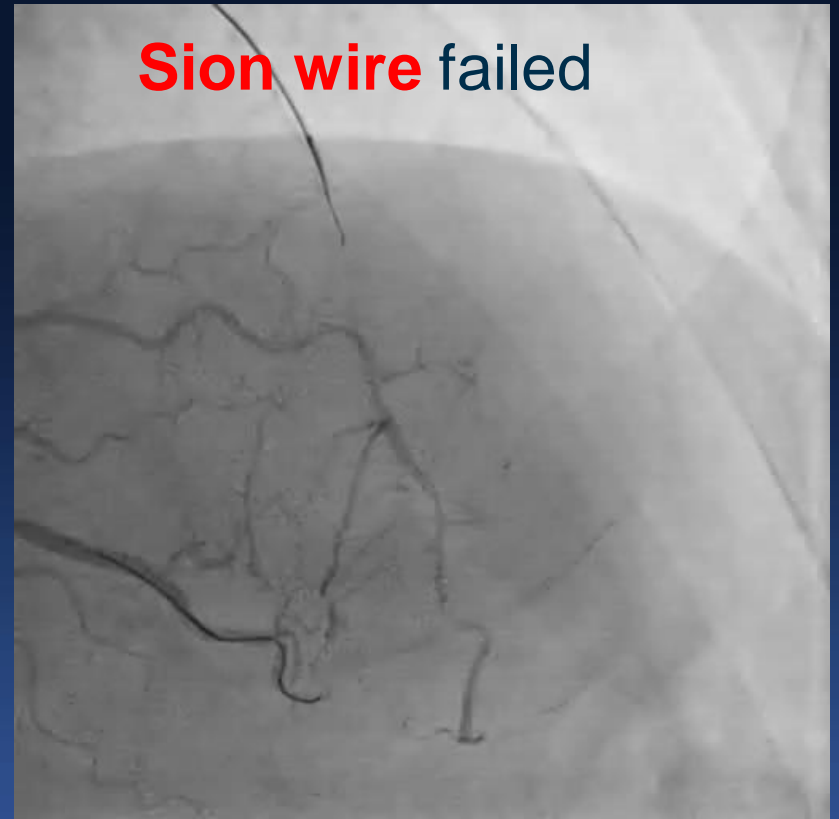
Suoh 03 wire

Tortuous septal channel

Tip angiography



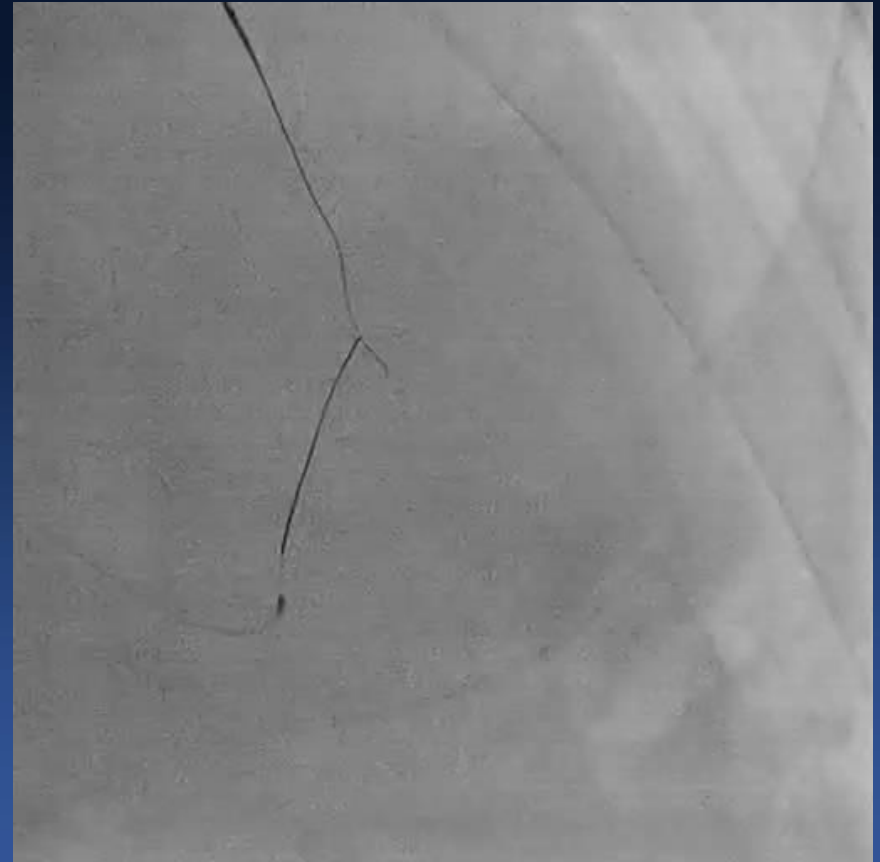
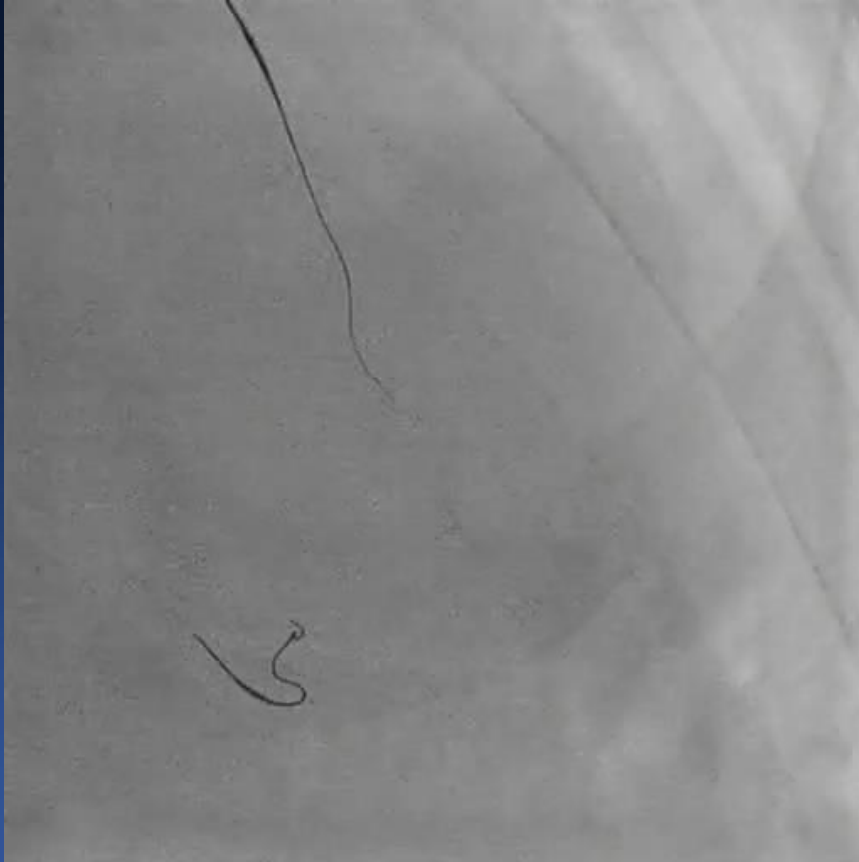
Sion wire failed



Tortuous septal channel

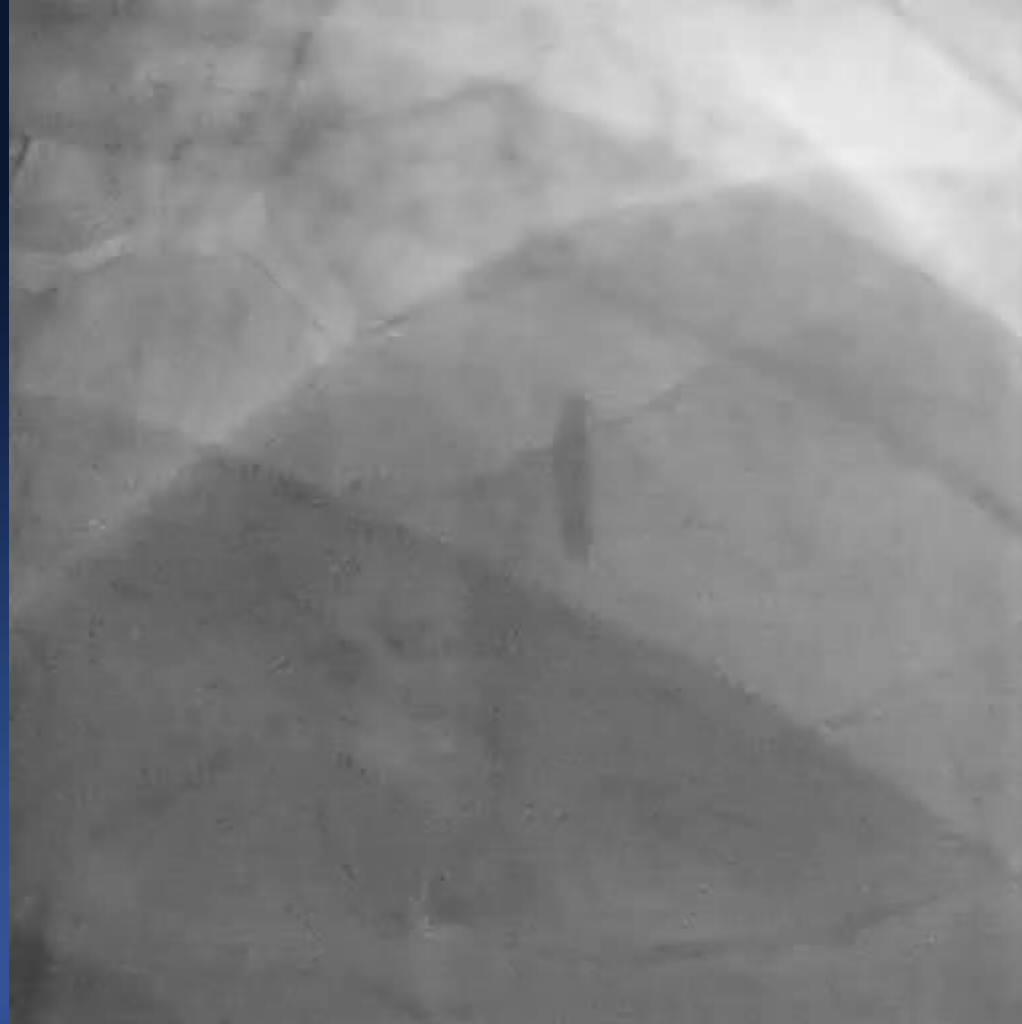
Suoh03 wire failed:

poor forward power → **Sion black** succeed



Mid LAD CTO

Septal to septal channel



Corsair, fielder XT: failed



Caravel: Tip angiography



Sion/Suoh03 failed



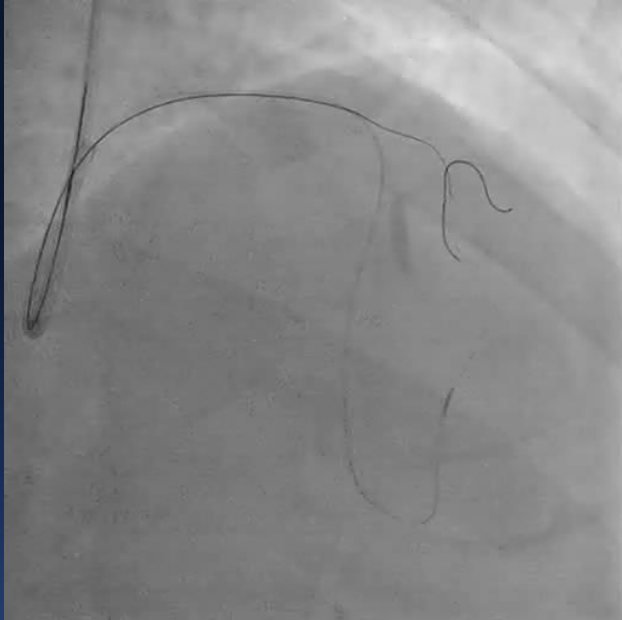
Sion black/blue failed



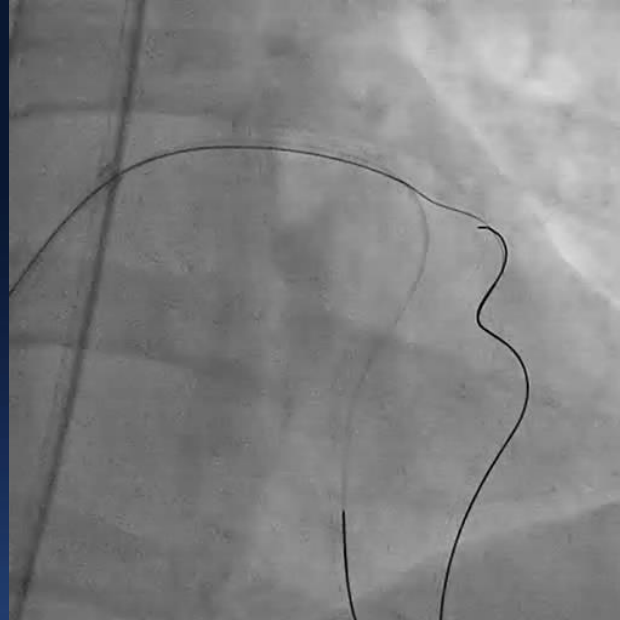
Suoh 03 success



Caravel advance



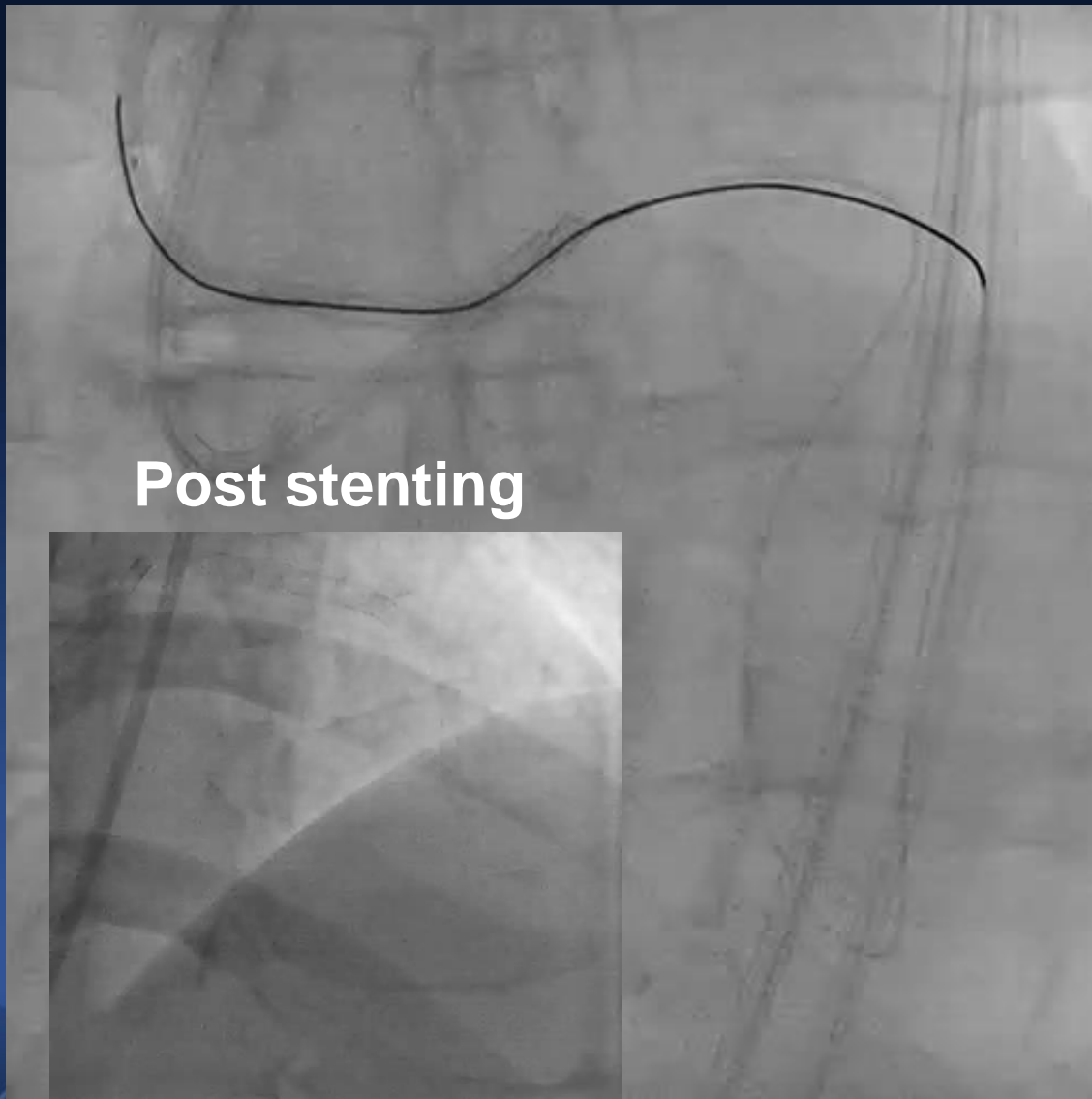
Retrograde direct Wiring: UB3 wire



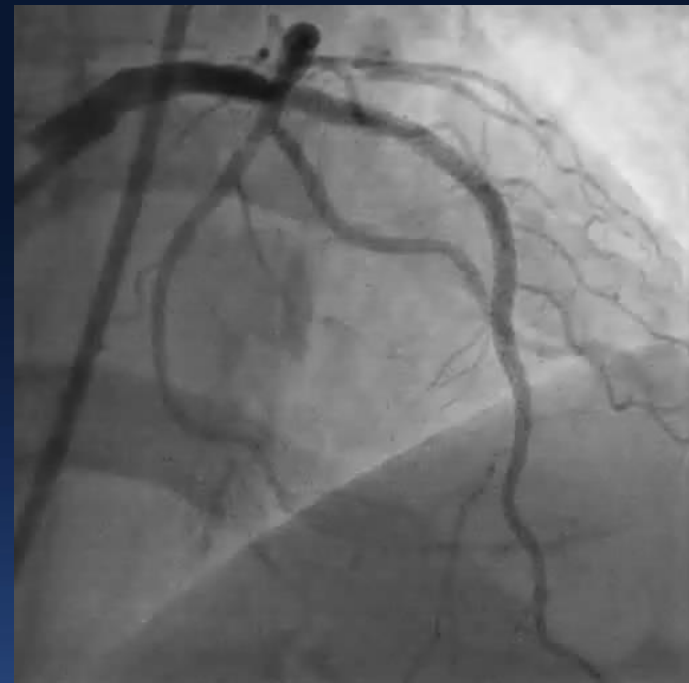
Contralateral guiding Wiring (pingpong guiding)



**Caravel advance
To contralateral guiding**



Septal perforation



No pericardial effusion

Microcatheter thru channel


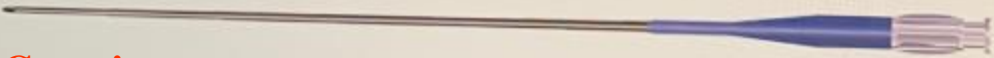



- Initial MC: Corsair, Finecross, Caravel
- Next: Turnpike LP
- 3rd option: 1.0 or 1.25 mm balloon
- 4th option: anchor balloon or Guide extension

Table 3. Tips for crossing microcatheter through channel.

Channel	Corsair/Turnpike will not cross	Switched microcatheter will not cross	Failure to cross after balloon dilatation
L → R septal	Switch to Caravel/Turnpike LP*	1.25 mm balloon to dilate channel	Side branch anchor balloon
R → L septal			Beware too tortuous PDA to septal channel angle
Epicardial		Switch to Finecross	Beware too small channel

* If septal ostium stented → dilate septal ostium with small balloon.

MC profile

		Outer	Inner	Tip-cathe	Rotate
Pro					
Corsair		Large	Small	Hard	
Caravel		Small	Large	Hard	X
Finecross		Small	Large	Soft	X

Microcatheter Collateral Channel Tracking Failure in Retrograde Percutaneous Coronary Intervention for Chronic Total Occlusion: Incidence, Predictors, and Management.

Zhong X¹, Ge L, Ma J, Huang D, Yao K, Zhang F, Lu H, Yan Y, Huang Z, Qian J, Ge J.

⊕ Author information

Abstract

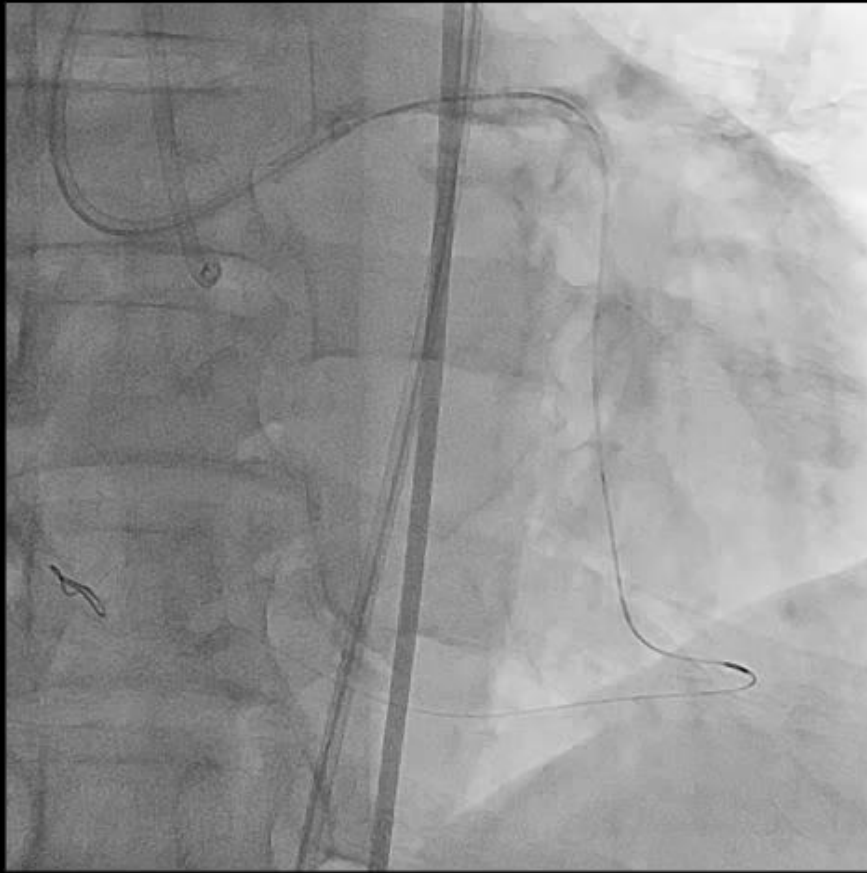
AIMS: This study sought to demonstrate the incidence, predictors, and management of microcatheter collateral channel (CC) tracking failure in retrograde percutaneous coronary intervention (PCI) for chronic total occlusion (CTO) lesions.

METHODS AND RESULTS: Prospectively collected data from 371 consecutive retrograde CTO-PCI procedures between March 2015 and January 2018 were retrospectively analyzed. The incidence of initial microcatheter CC tracking failure was 22.5% in 280 procedures with wire CC tracking success. For septal collaterals, CC grade 0-1 collaterals (odds ratio [OR]: 8.3; $p < 0.001$), channel entry angle $< 90^\circ$ (OR: 13.0; $p = 0.001$), channel exit angle $< 90^\circ$ (OR: 44.3; $p = 0.004$), and Finecross MGTM as initial microcatheter (OR: 2.7; $p = 0.032$) were independently related to initial microcatheter CC tracking failure. Meanwhile, the only predictor for epicardial collaterals was CC 1 collaterals (OR: 26.9; $p < 0.001$). Frequently applied solutions included microcatheter switching (61.9%), and microcatheter switching combined with GuidezillaTM (14.3%) or anchoring balloon technique (6.3%).

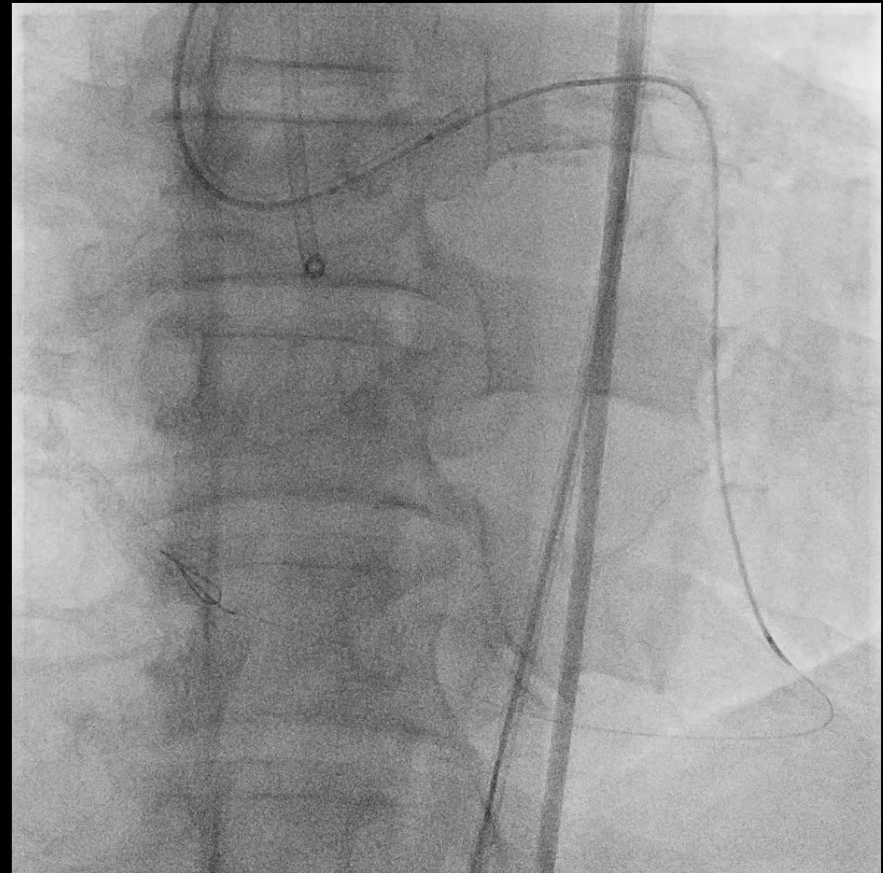
CONCLUSIONS: Initial microcatheter CC tracking failure was found in nearly one quarter of procedures after wire CC tracking success. Independent angiographic predictors for initial microcatheter CC tracking failure included CC 0-1 collaterals, channel entry angle $< 90^\circ$, and channel exit angle $< 90^\circ$ for septal collaterals, CC 1 collaterals for epicardial collaterals.

MC collateral channel tracking failure

Caravel: channel cross failure



Corsair: channel cross success



MC collateral channel tracking failure

For septal collaterals,

CC grade 0-1 collaterals,

Channel entry angle $< 90^\circ$,

Channel exit angle $< 90^\circ$,

Finecross MG as initial microcatheter

For epicardial collaterals

CC 1 collaterals

Solutions

Microcatheter switching (61.9%),

Microcatheter switching combined with Guidezilla (14.3%)

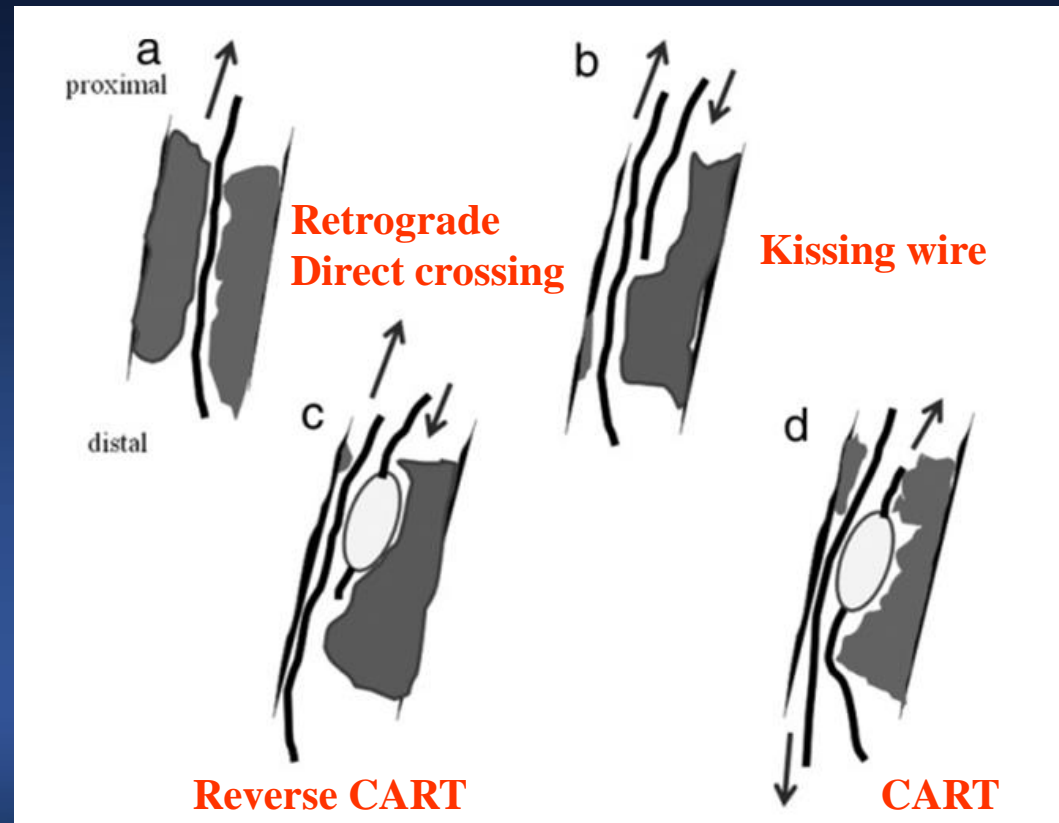
Anchoring balloon technique (6.3%).

Retrograde CTO segment passing

Retrograde Wire passing techniques

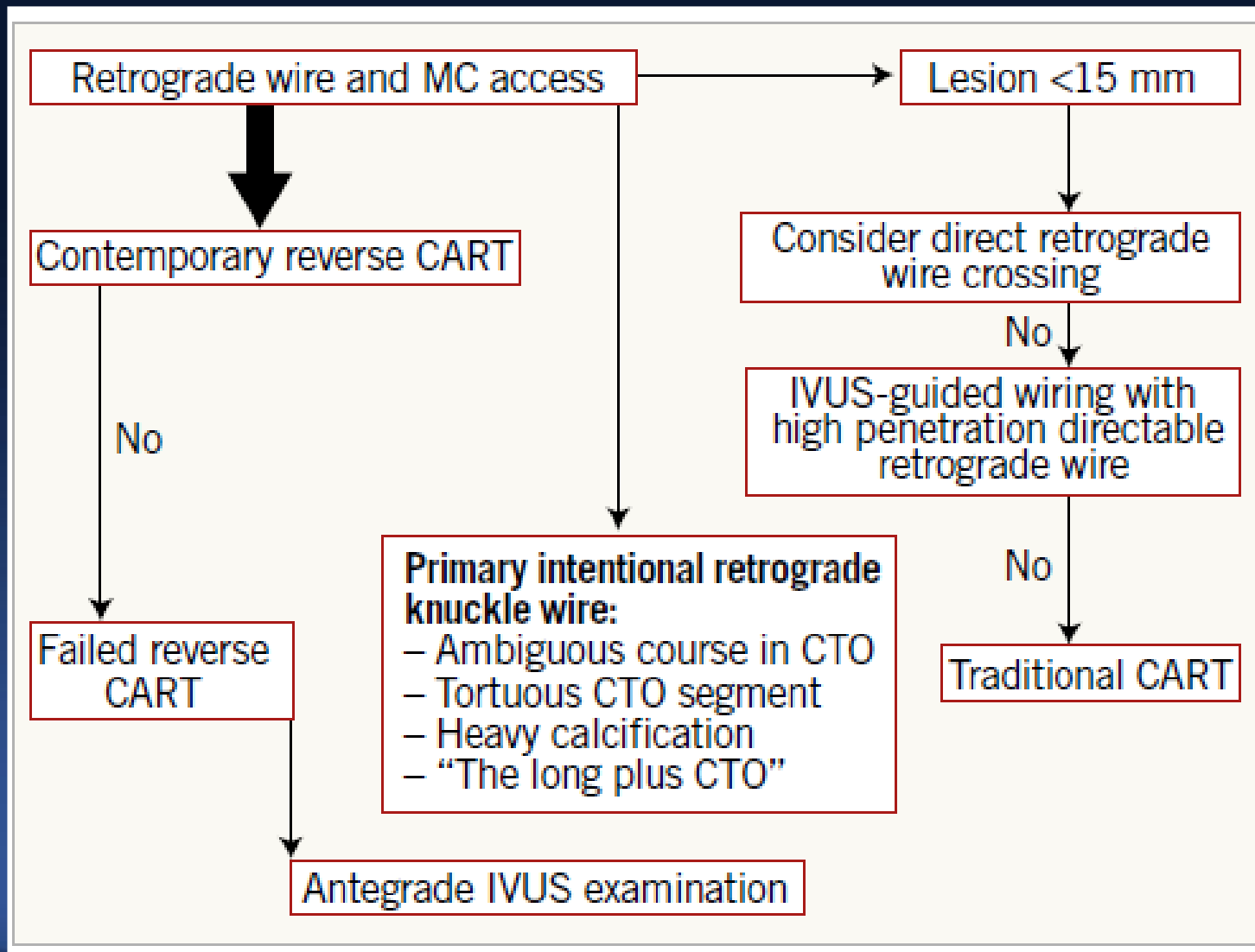
- **Retrograde direct wire crossing**: short lesion length (< 15 mm) (a)
- **Kissing wire technique** : bidirectional wiring (b)
- **Knuckle wire** : long, calcific, tortuous, unknown course
- **CART technique**: rarely used currently (d)
- **Reverse CART**: for bidirectional wire connection (c)

Conventional
Contemporary (directed)
Modified (extended)



APCTO club

Algorithm for crossing a CTO lesion via the retrograde approach



Wire strategy for retrograde CTO seg crossing

- Direct crossing: short segment CTO ($\leq 15-20$ mm)
- Reverse CART: Relatively long segment
- Knuckle wire: failed wire escalation, ambiguous, long, or calcific CTO
- Unclear wire position: IVUS use

Which wire ?

Retrograde CTO segment crossing wire

2016. May to 2019 Dec (CTO-PCI, n=298)

Retrograde attempt (n=121, 40.6%)

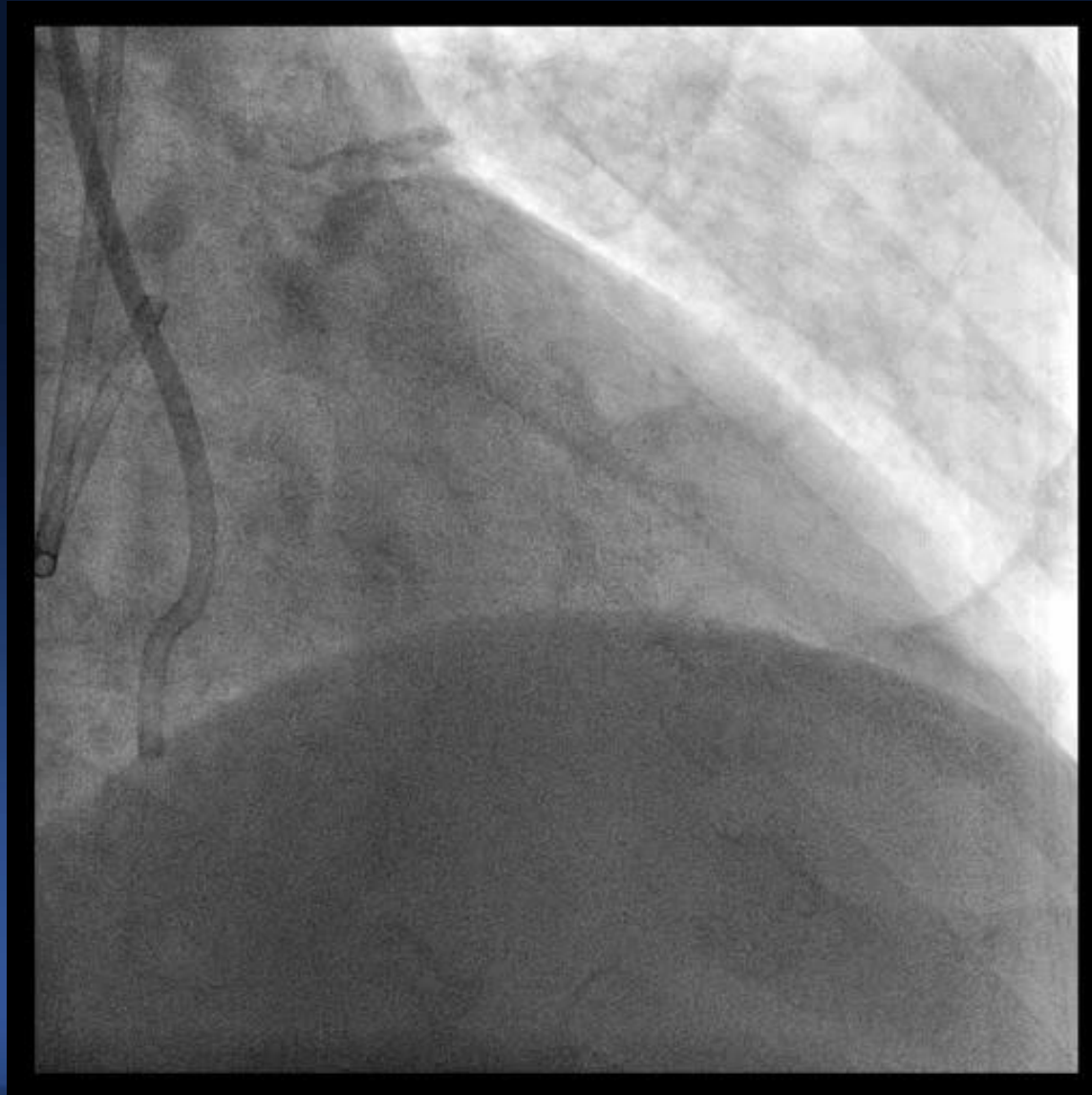
Retrograde CTO Crossing wire	N=56
Suoh 03	1 (rCART)
Sion series	5 (rCART:3, direct crossing:2)
Fielder XT	11 (19.6%)
UB3(n=14)/Gladius(n=2)	16 (28.6%)/14 (25%)/2 (2.6%)
Gaia series	22 (39.3%)
Gaia 1	3
Gaia 2	16
Gaia 3	3
Conquest pro	1

70%

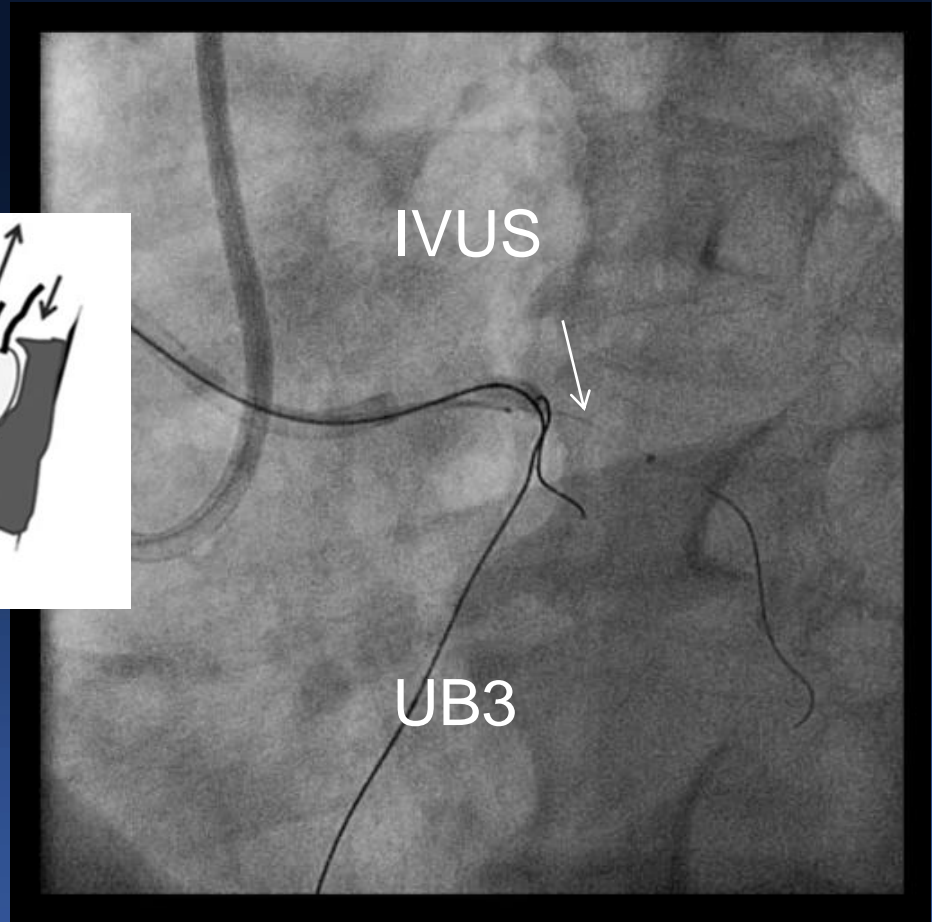
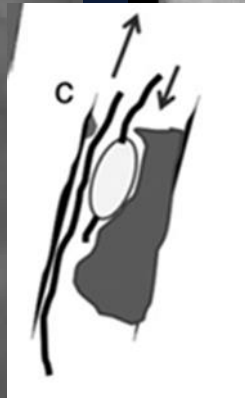
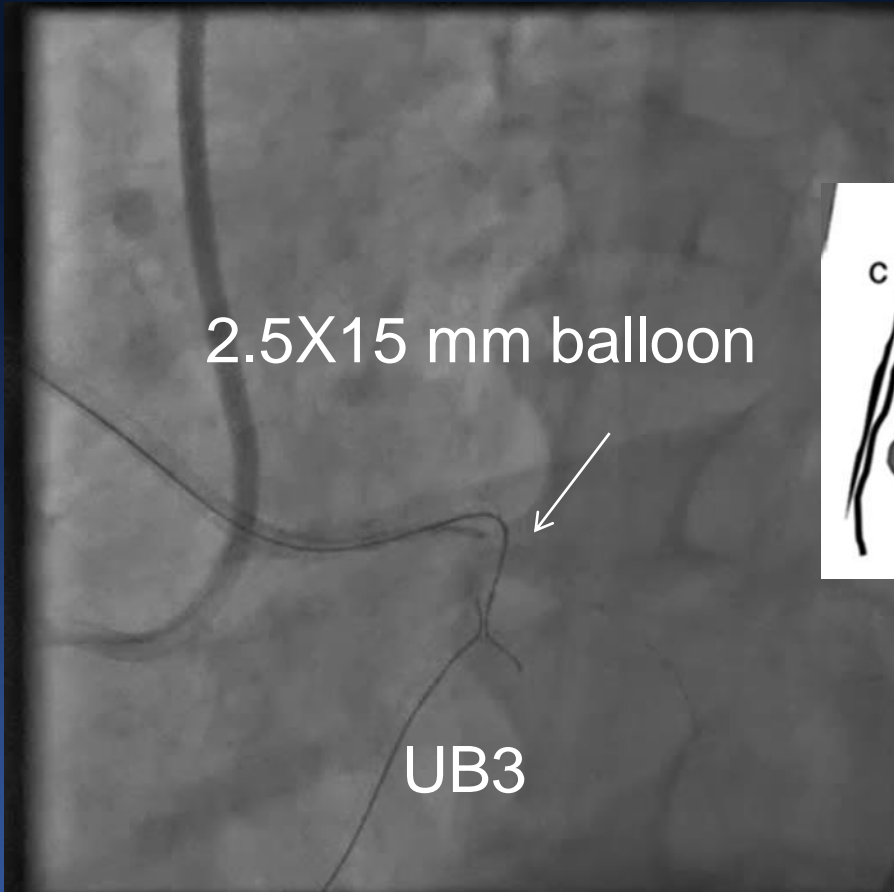
Wire choice for retrograde CTO seg crossing

- Ambiguous CTO : Fielder XT, UB3, Gladius
- Clear CTO segment: Gaia 2 wire, preferred

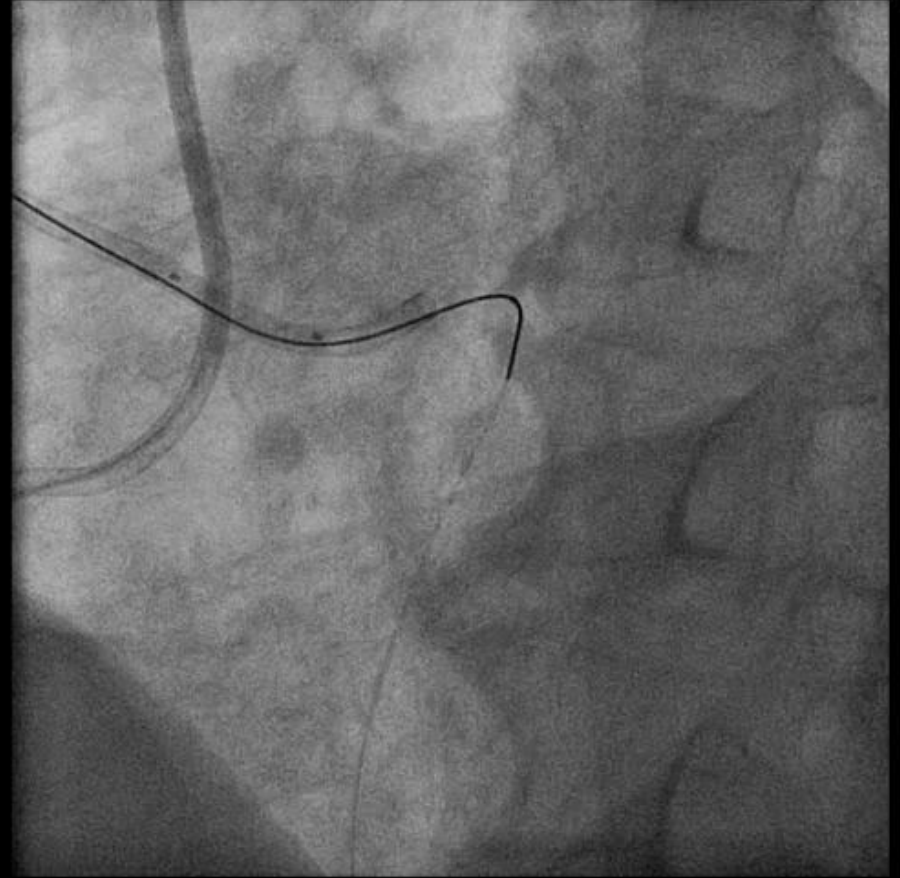
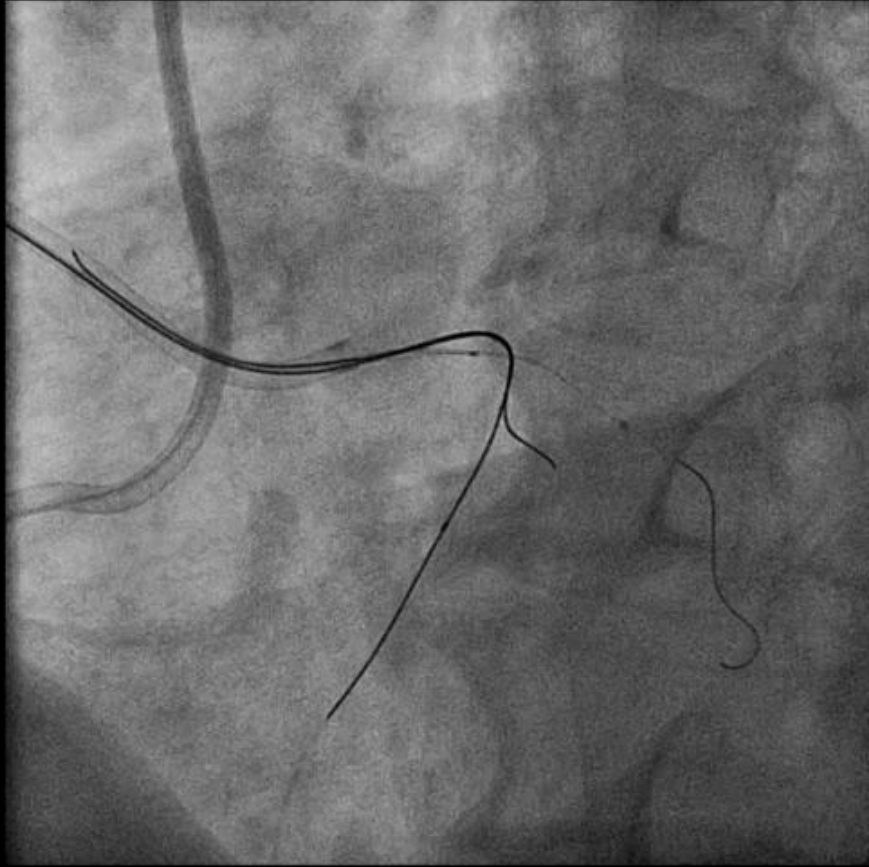
Baseline angiography



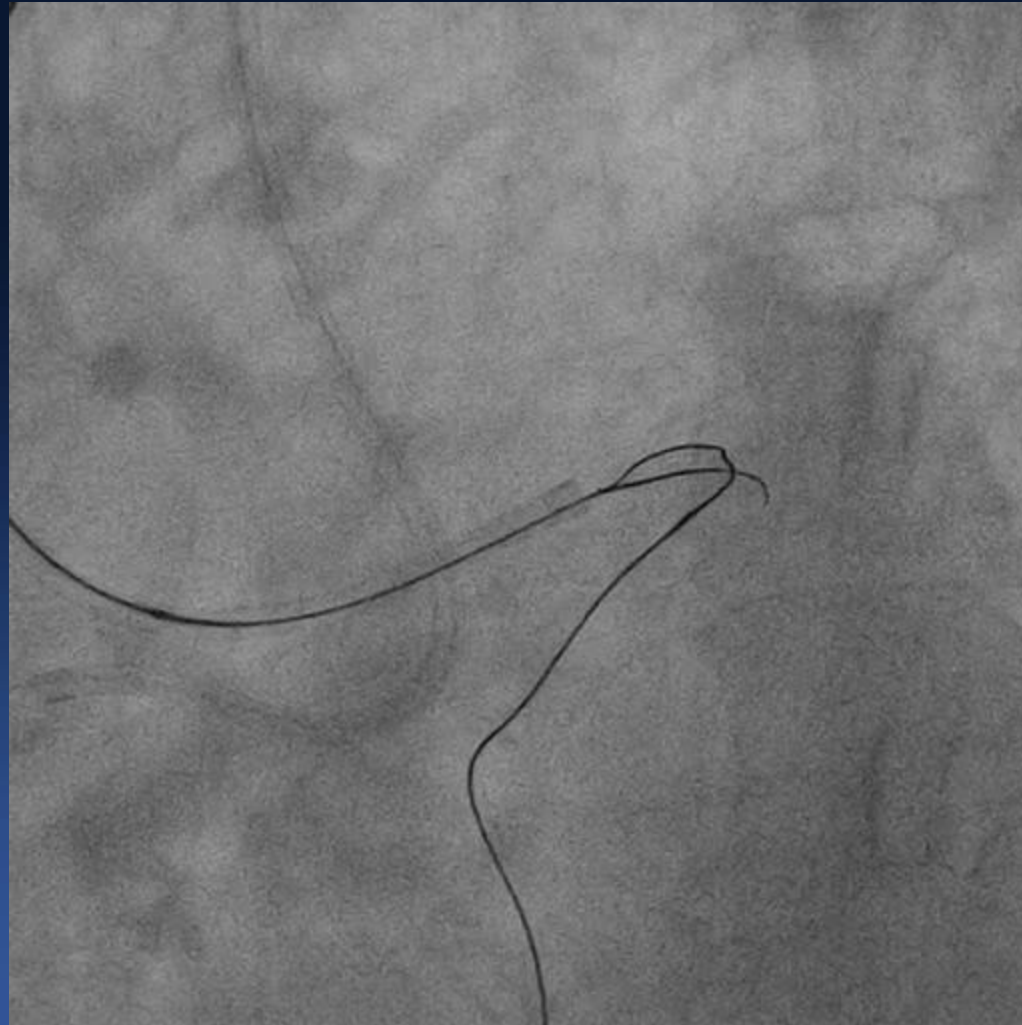
Reverse CART



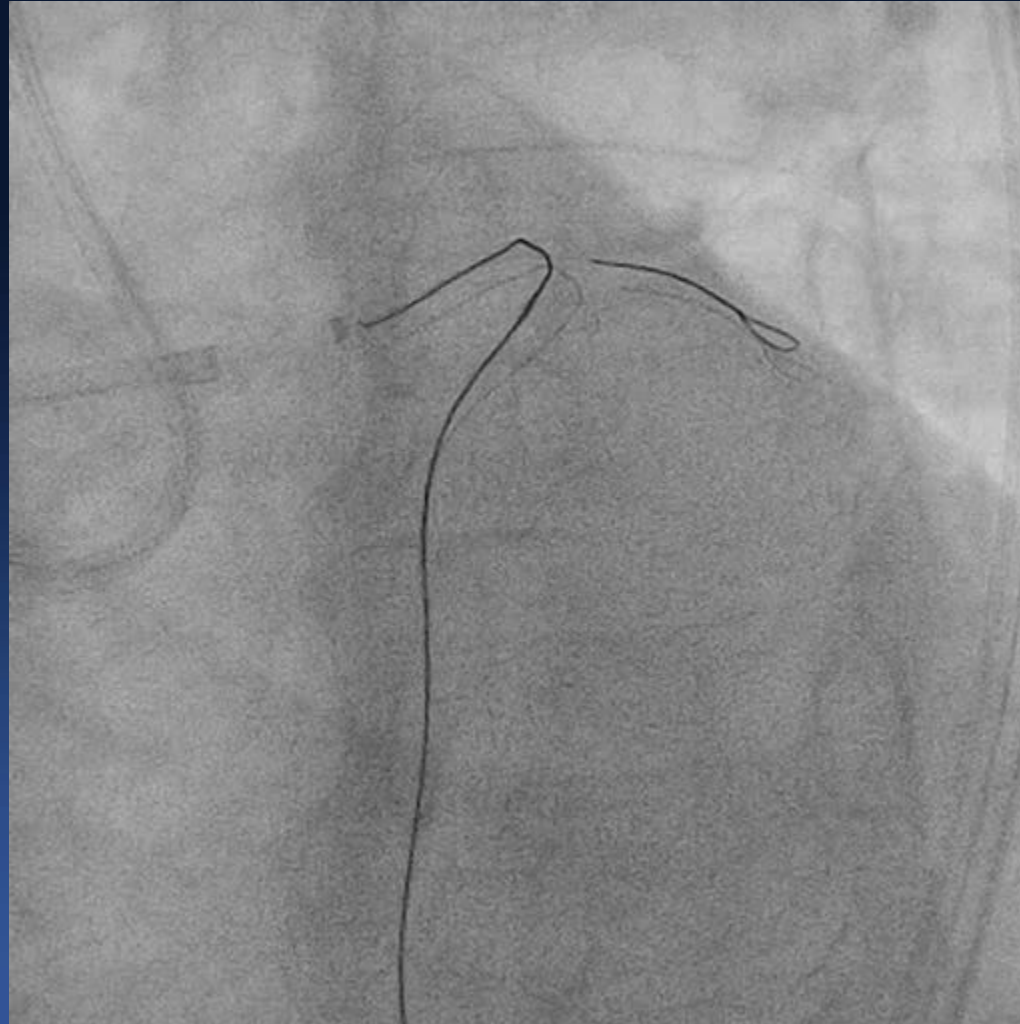
Reverse CART



Retrograde wiring into contralateral guiding



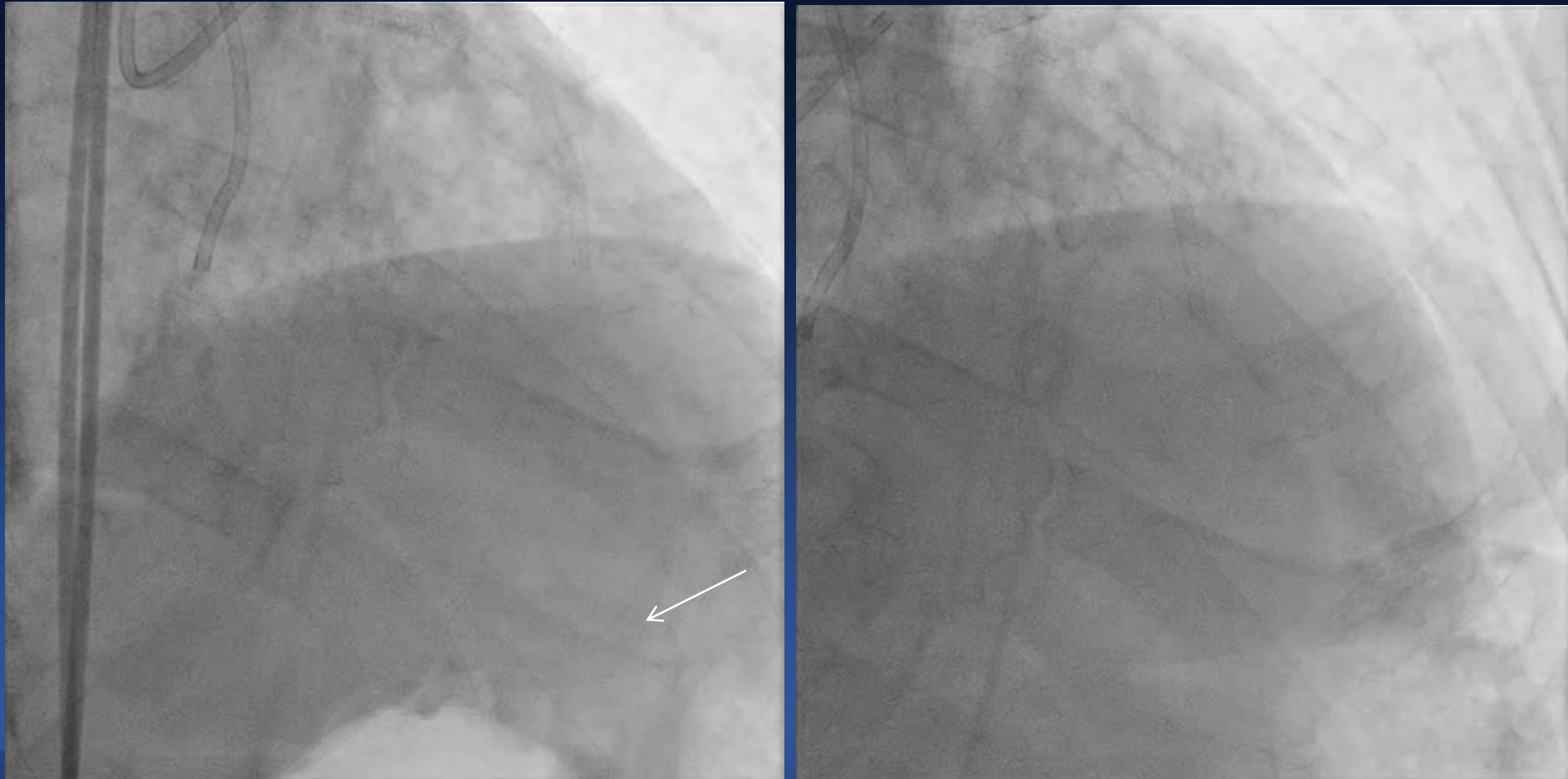
Retrograde wiring into contralateral guidezillar



MC removal after RG3 wiring to septal channel



Final angiography for checking channel damage



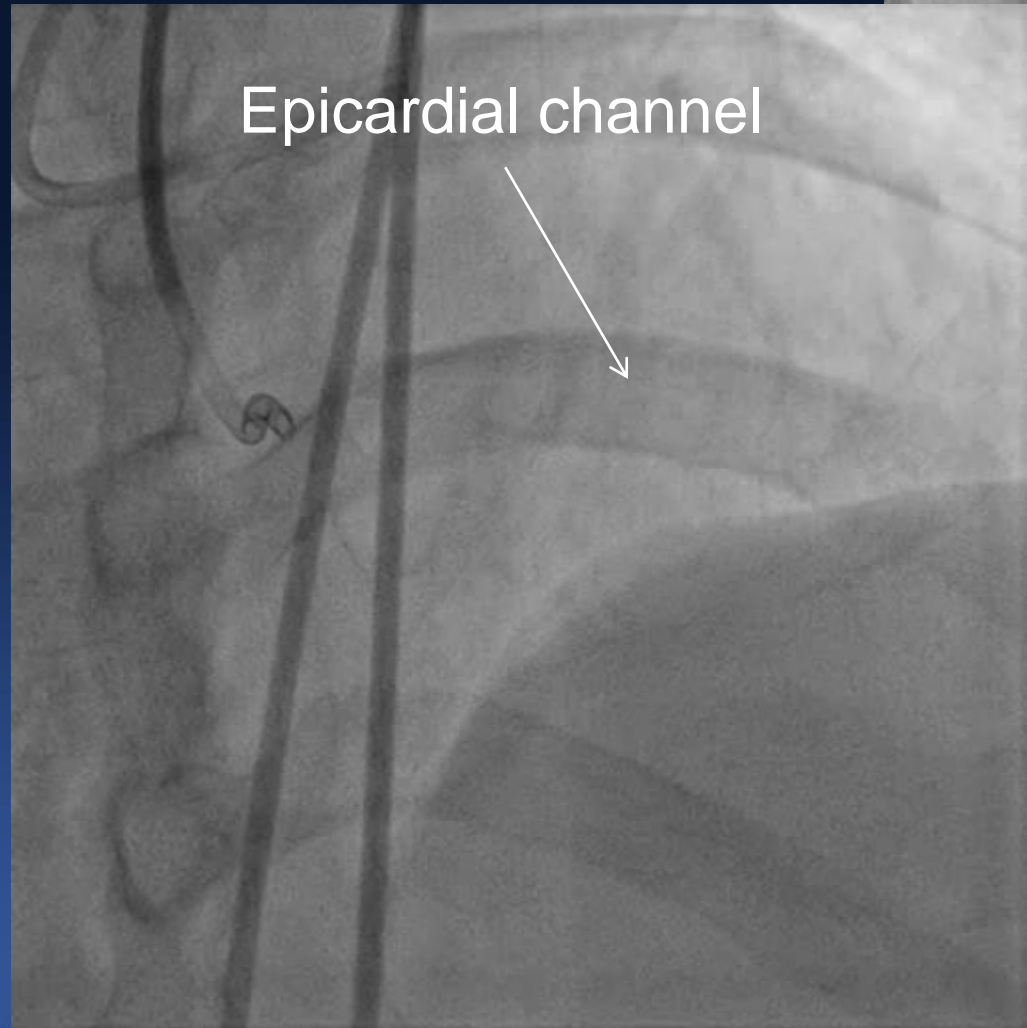
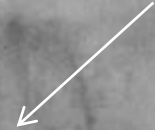
PROXIMAL LAD CTO

Epicardial channel

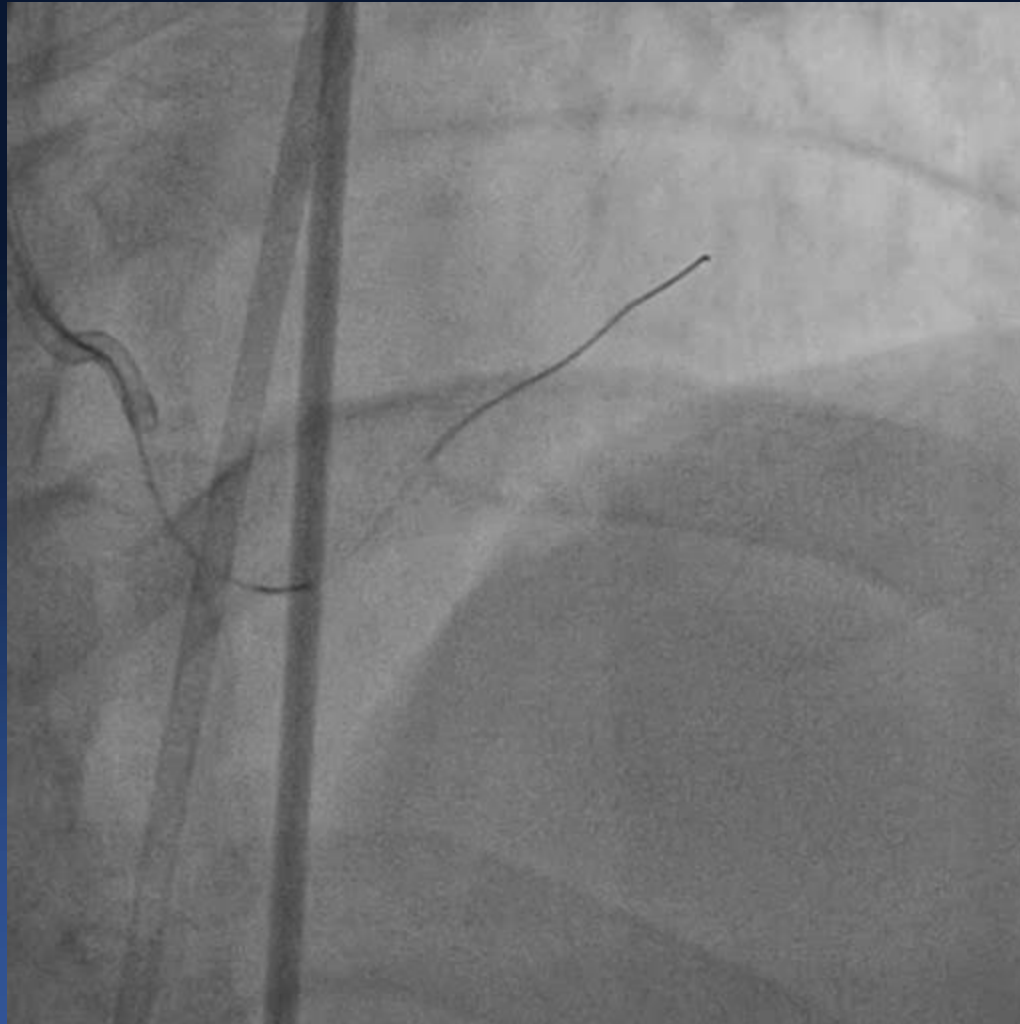


Prox LAD, CTO

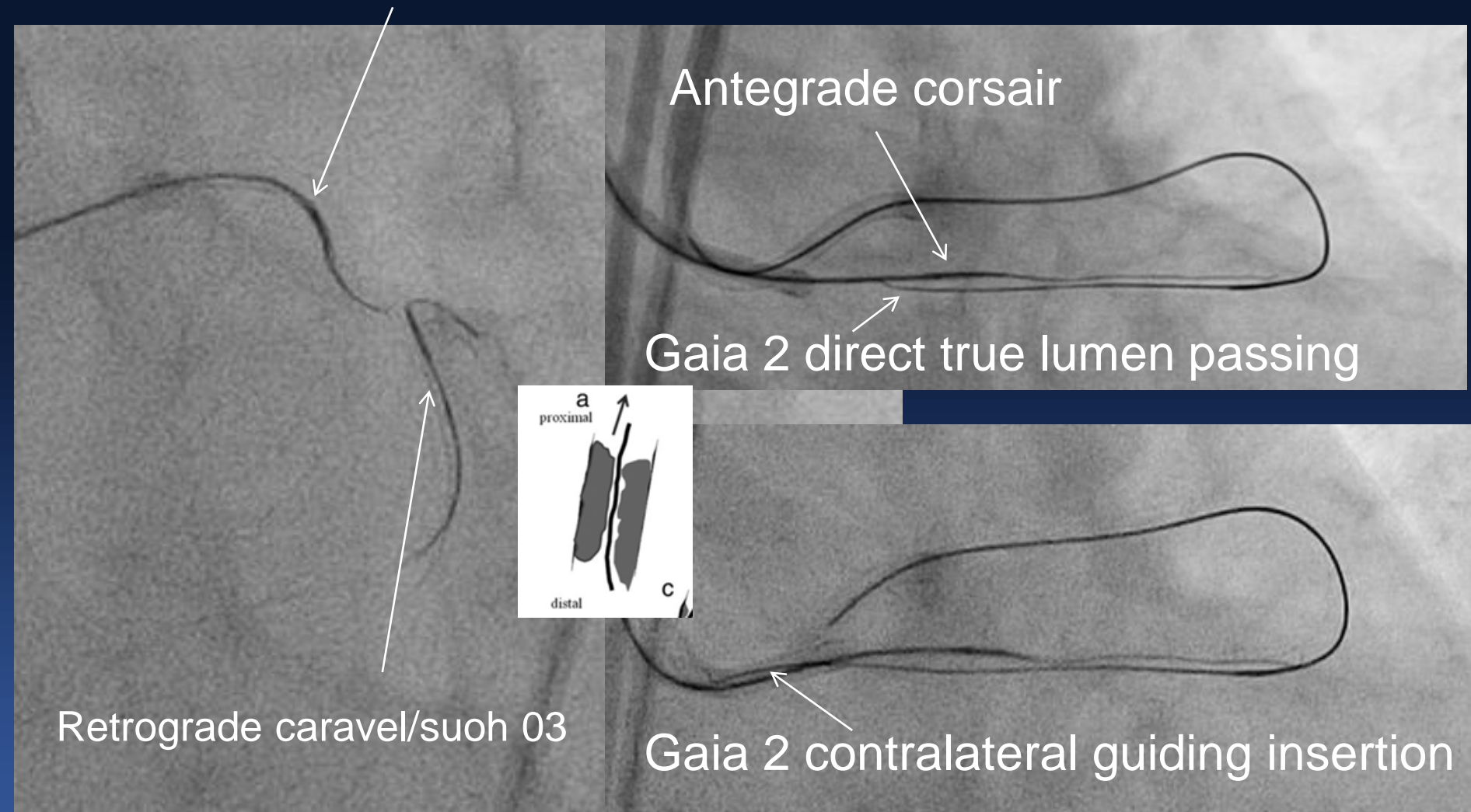
Failed antegrade wiring



Retrograde caravel/suoh 03 wire via epicardial channel

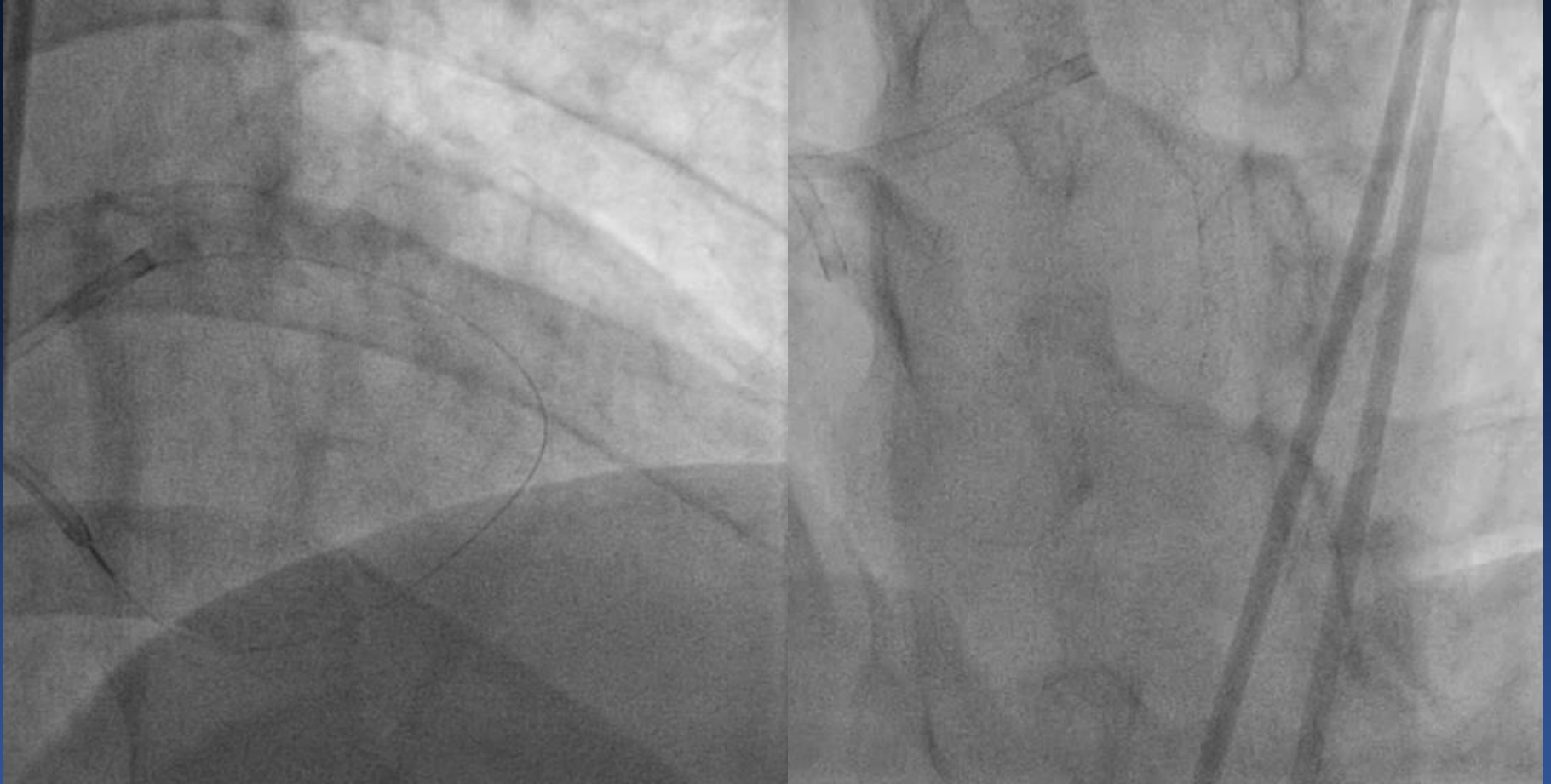


Antegrade corsair/Fielder XT wire

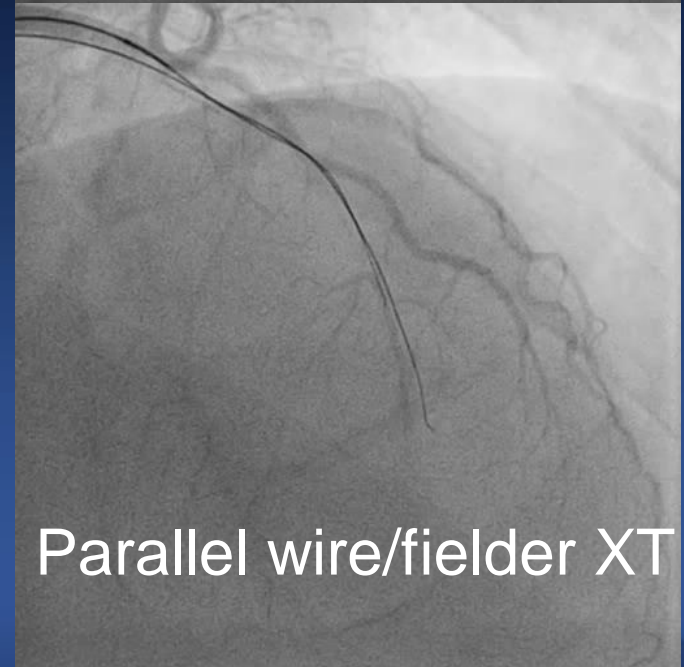
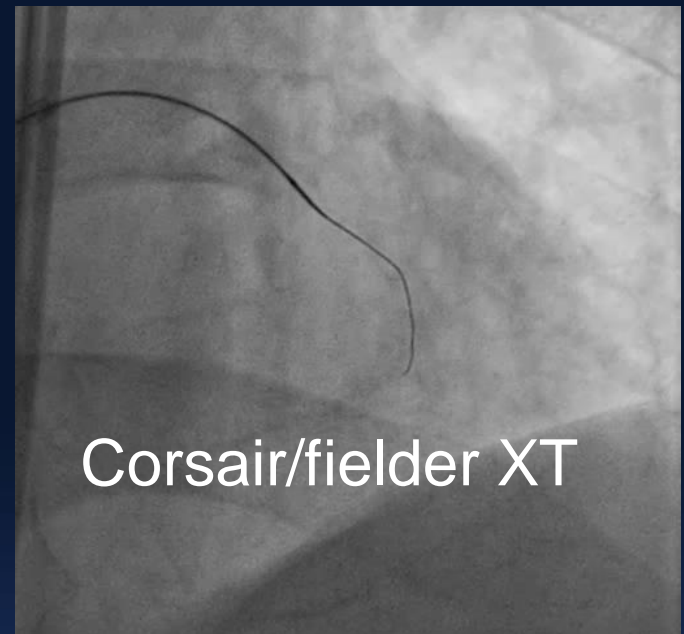
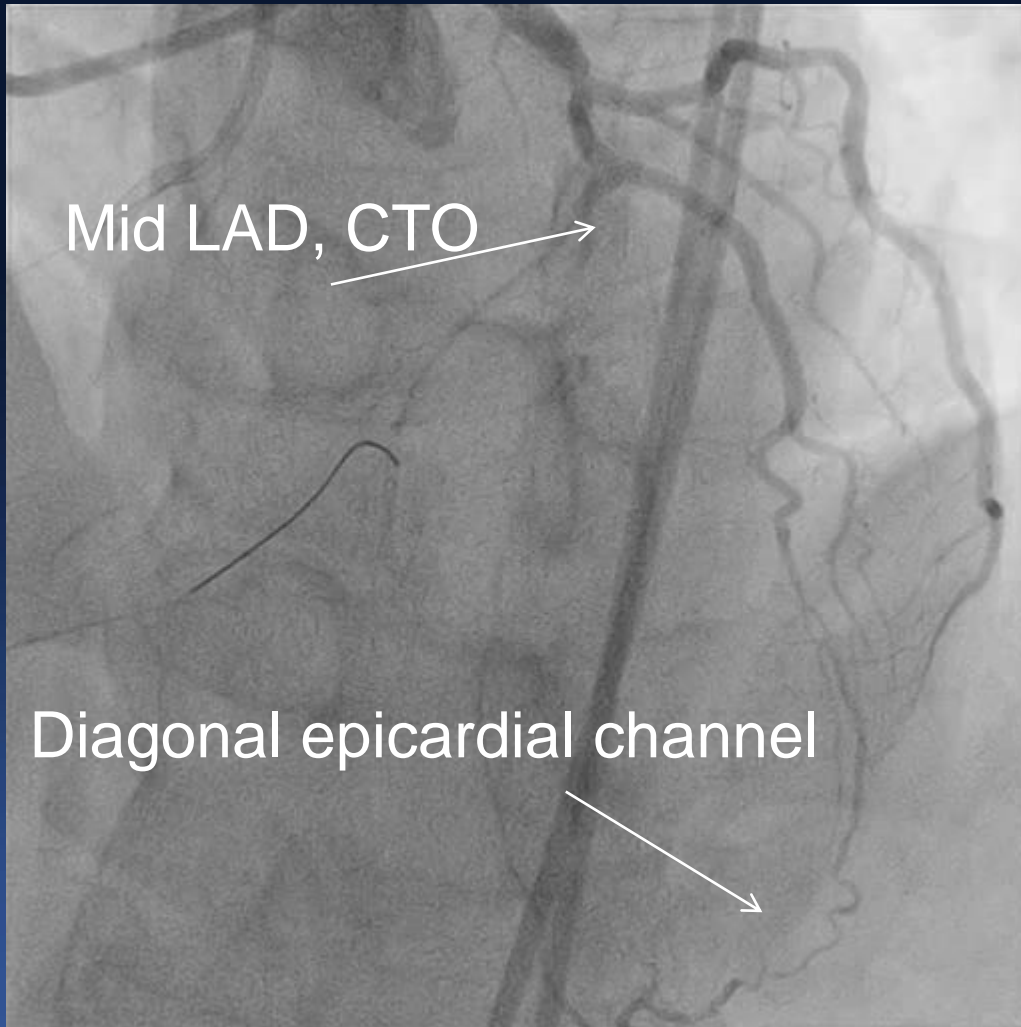


Final angiography

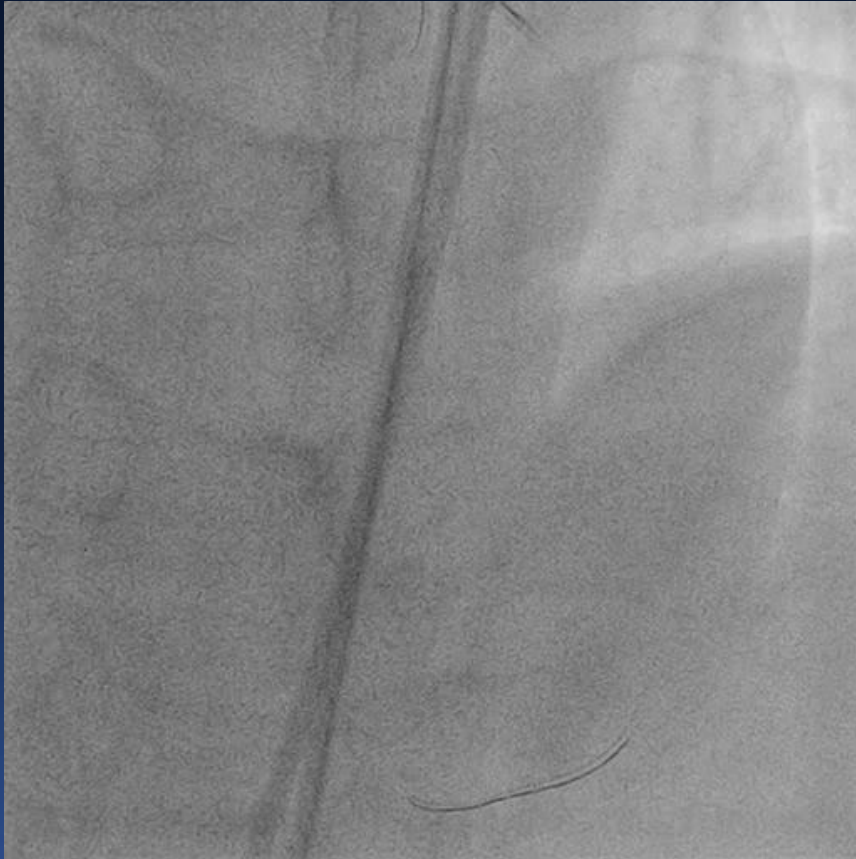
Wire externalization



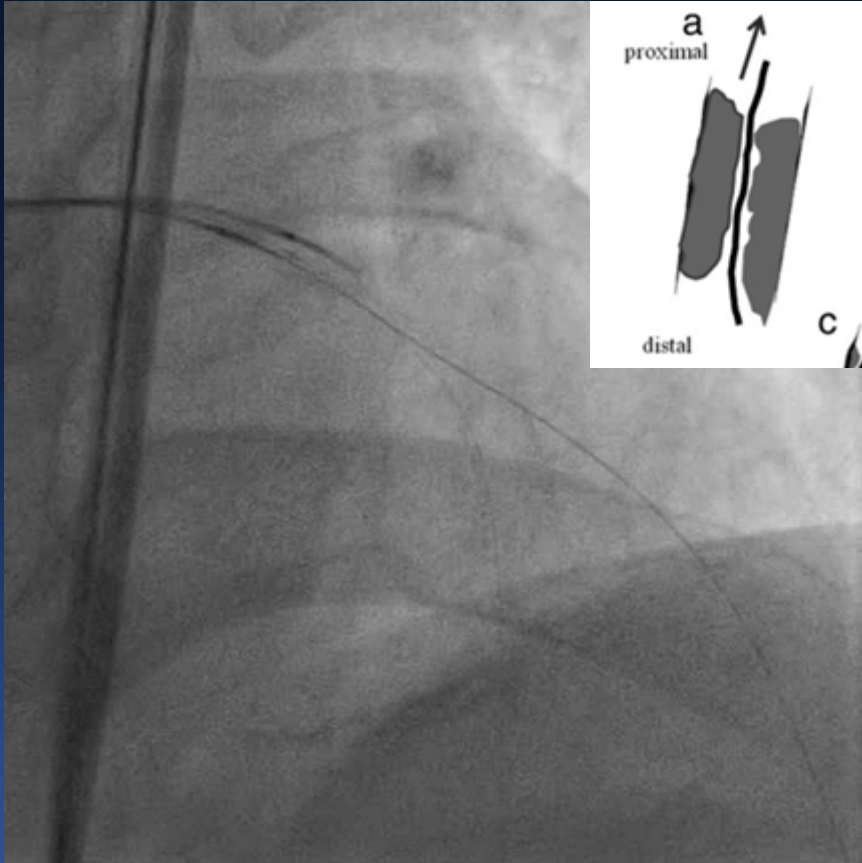
Mid LAD CTO



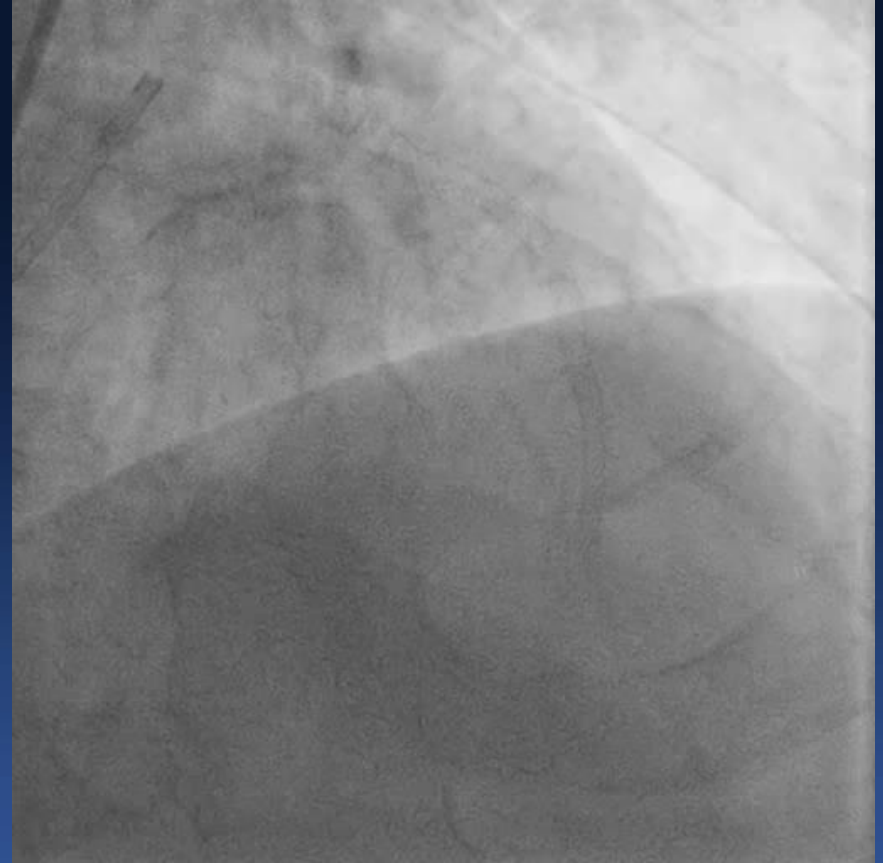
Retrograde corsair/Sion wire



Direct true lumen passing Caravel with sion wire



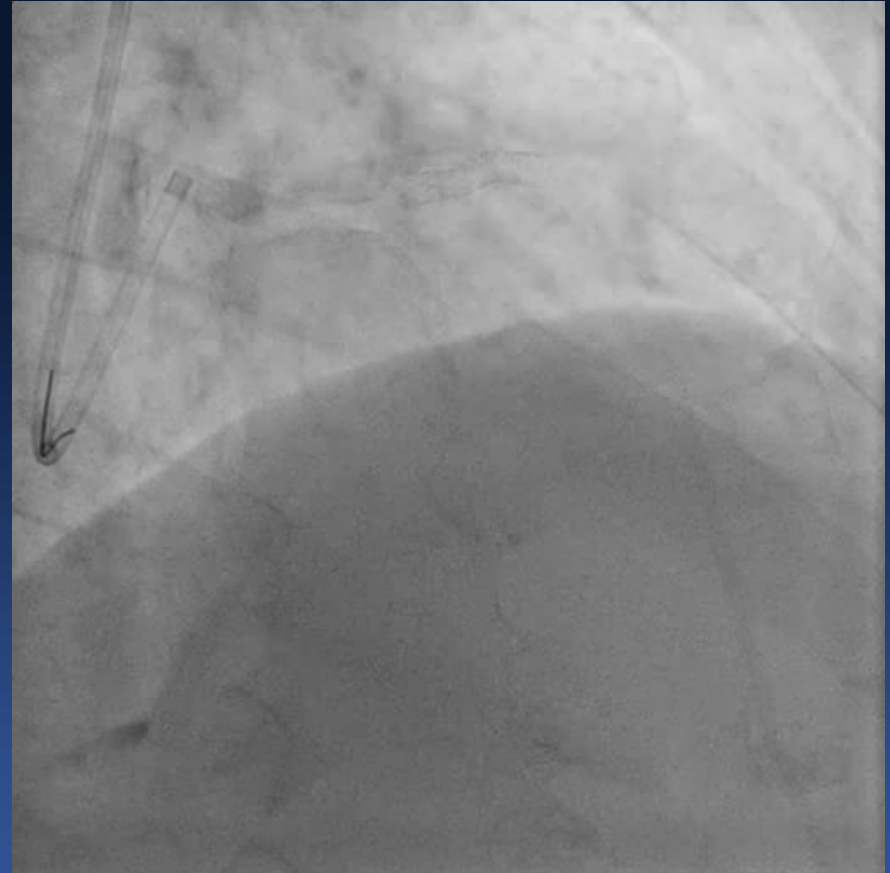
Final angiography



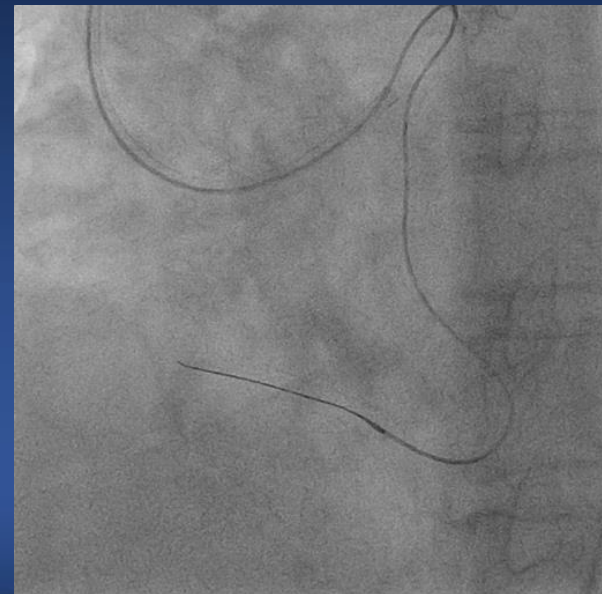
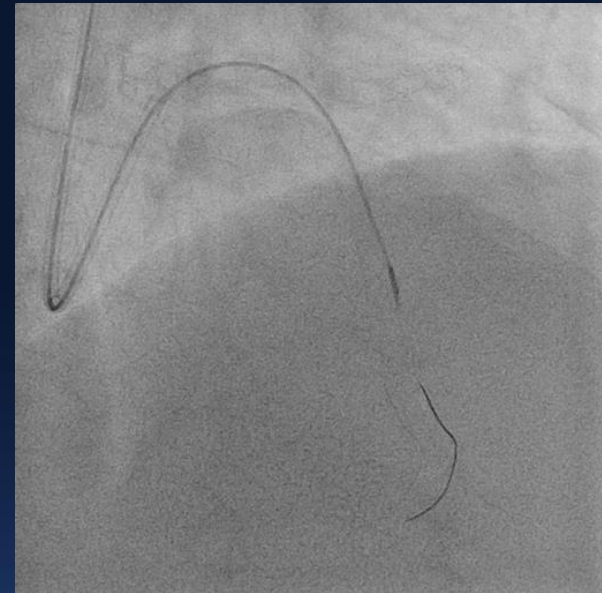
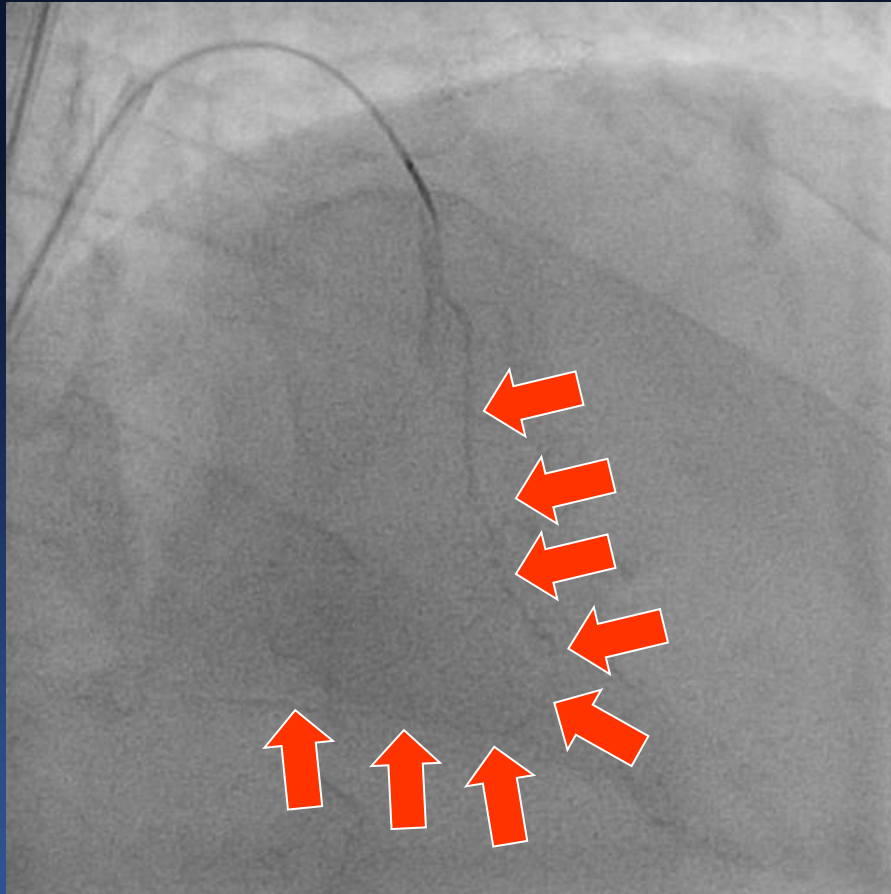
Wire strategy for retrograde CTO seg crossing

- Direct crossing: short segment CTO ($\leq 15-20$ mm)
- Reverse CART: Relatively long segment
- Knuckle wire: failed wire escalation, ambiguous, long, or calcific CTO
- Unclear wire position: IVUS use

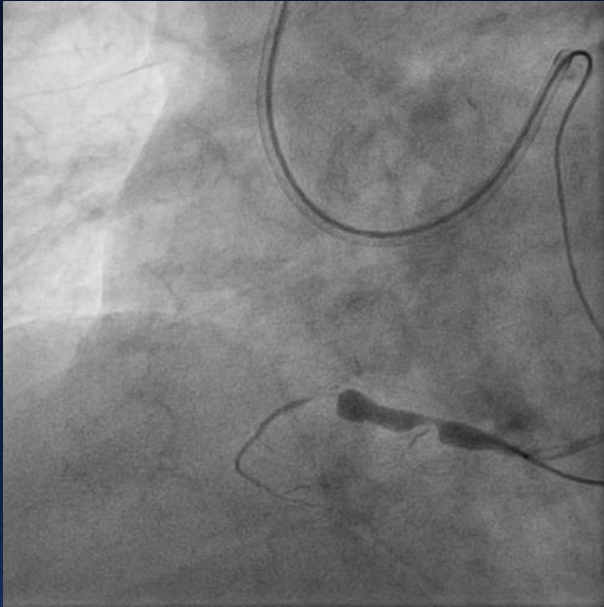
Long RCA CTO



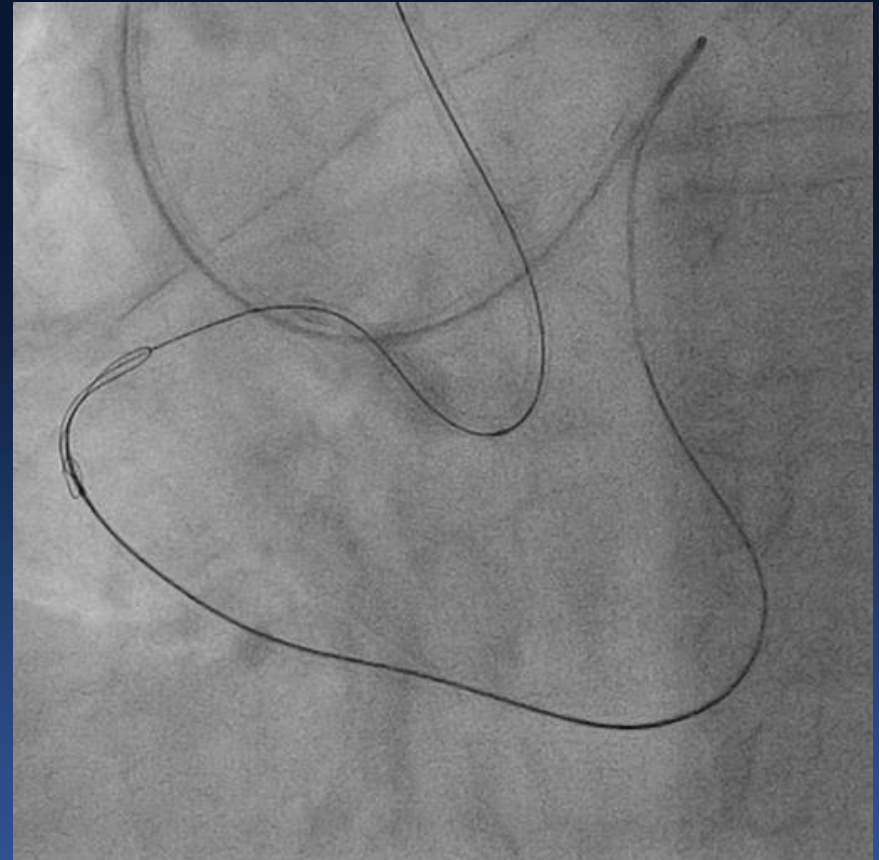
Tip angiography



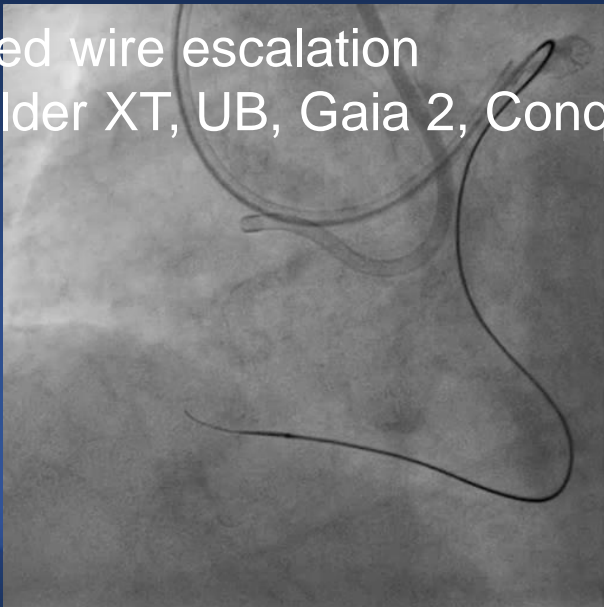
Tip angiography



Knuckle wire with fielder XT

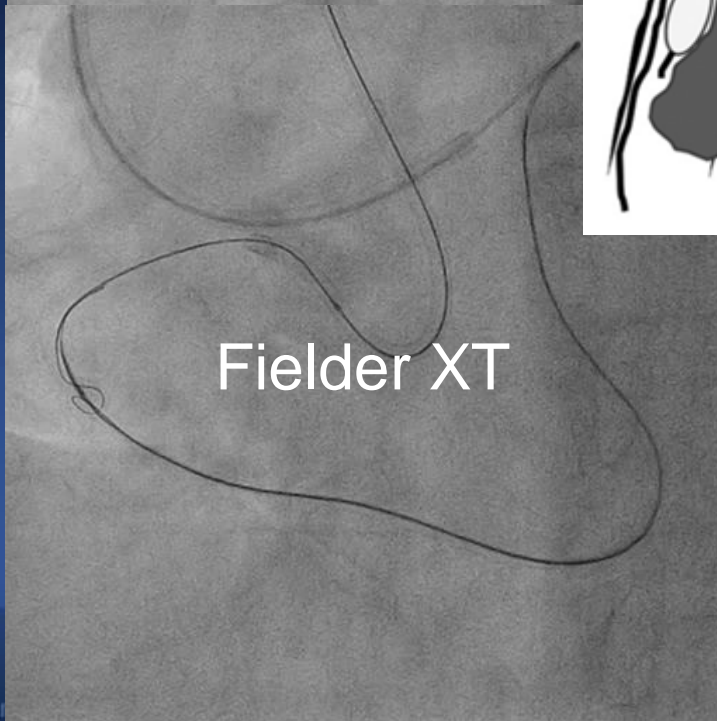
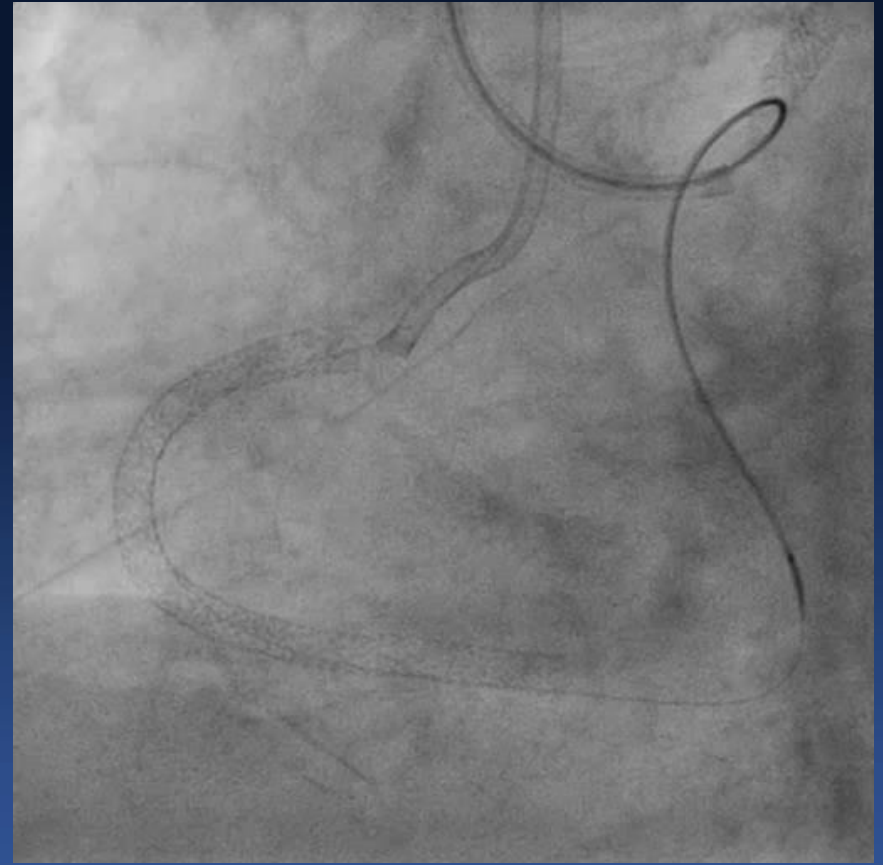
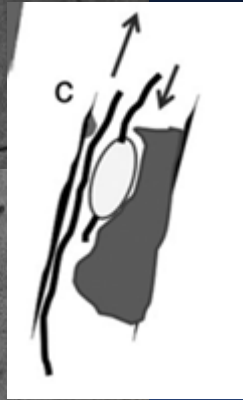
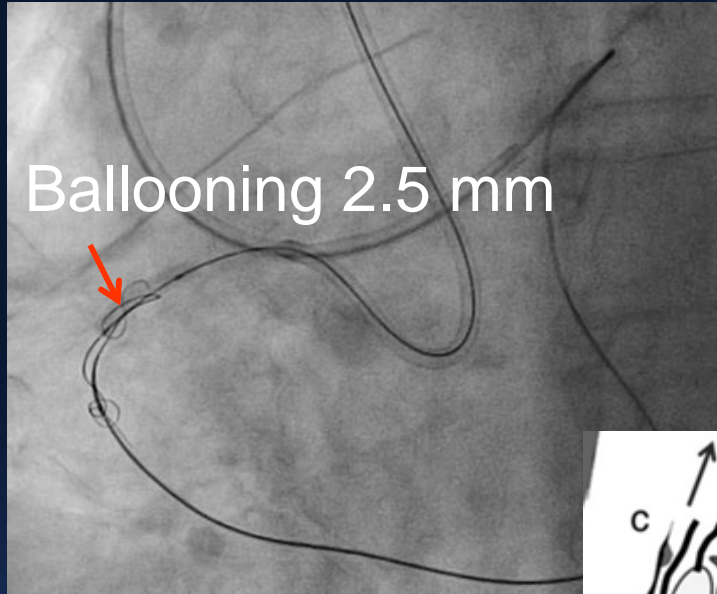


Failed wire escalation
(Fielder XT, UB, Gaia 2, Conquest)



Knuckle wiring with reverse CART

Final angiography



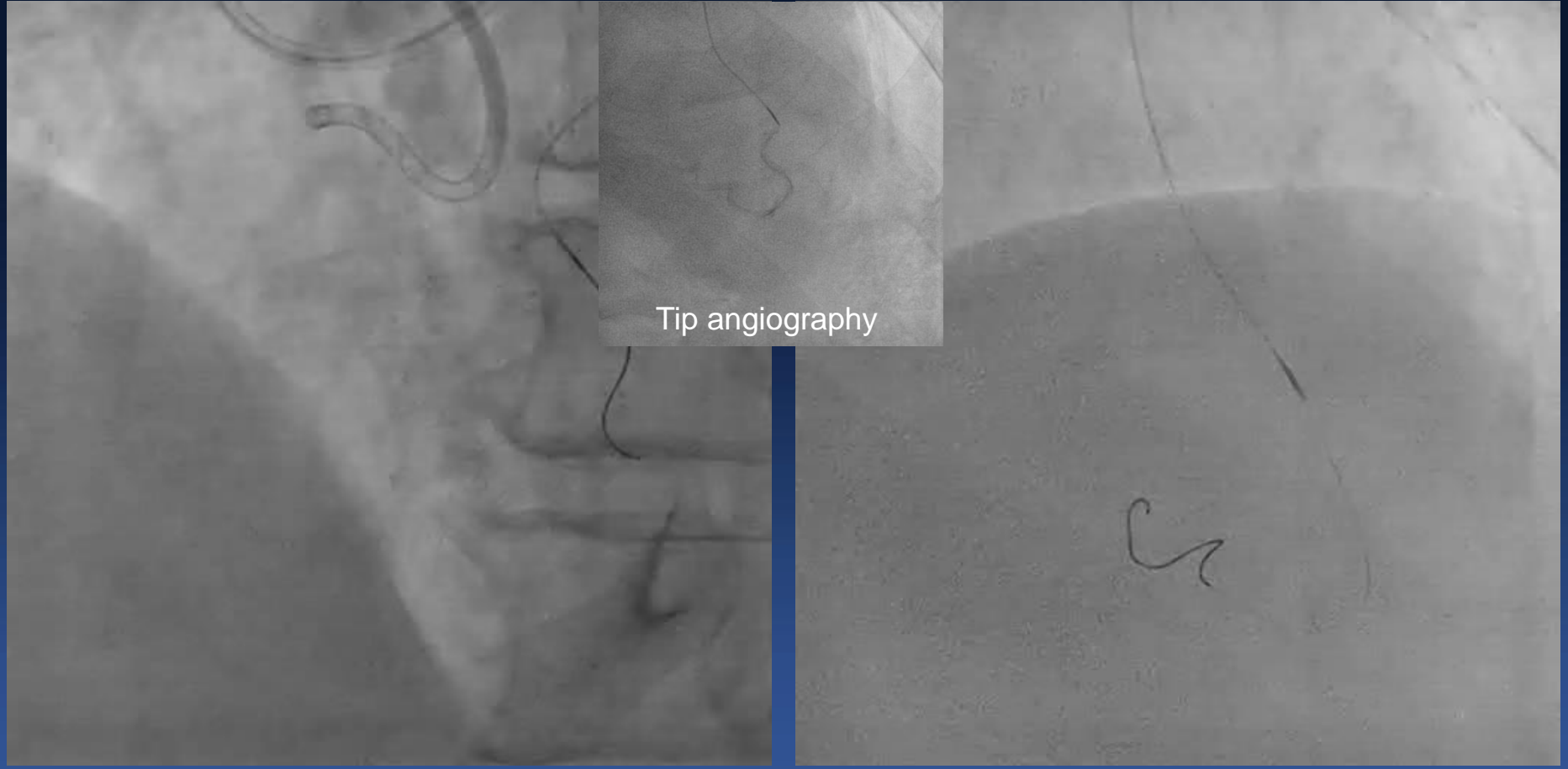
Wire strategy for retrograde CTO seg crossing

- Direct crossing: short segment CTO ($\leq 15-20$ mm)
- Reverse CART: Relatively long segment
- Knuckle wire: failed wire escalation, ambiguous, long, or calcific CTO
- **Wire mark technique**
- **Unclear wire position: IVUS use**

Proximal RCA CTO

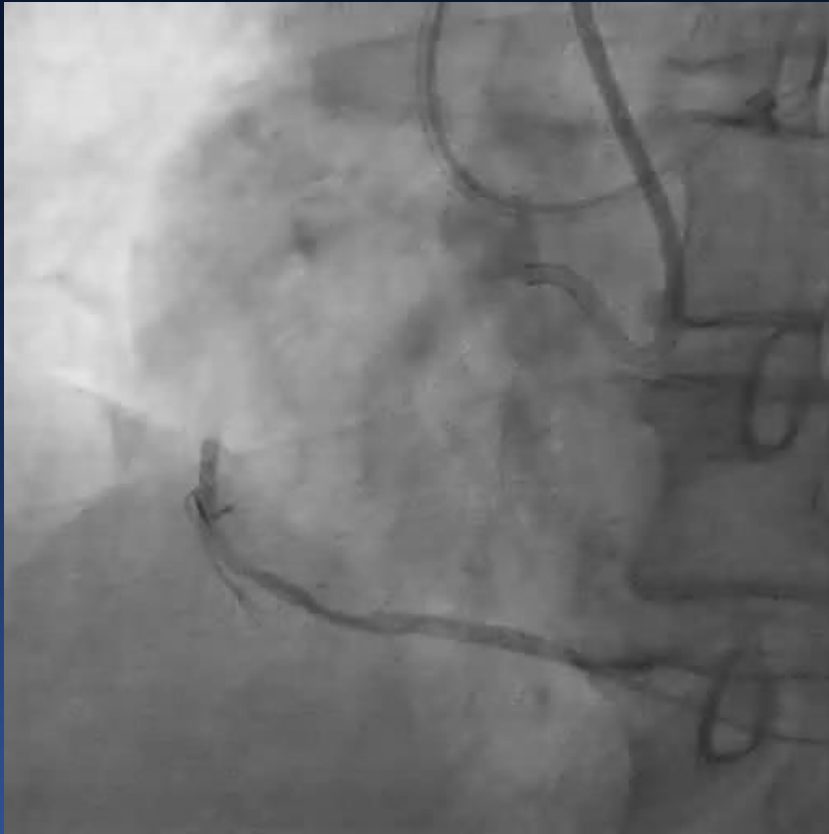
(epicardial channel LAD apex to PDA)

Caravel with Suoh03 wire

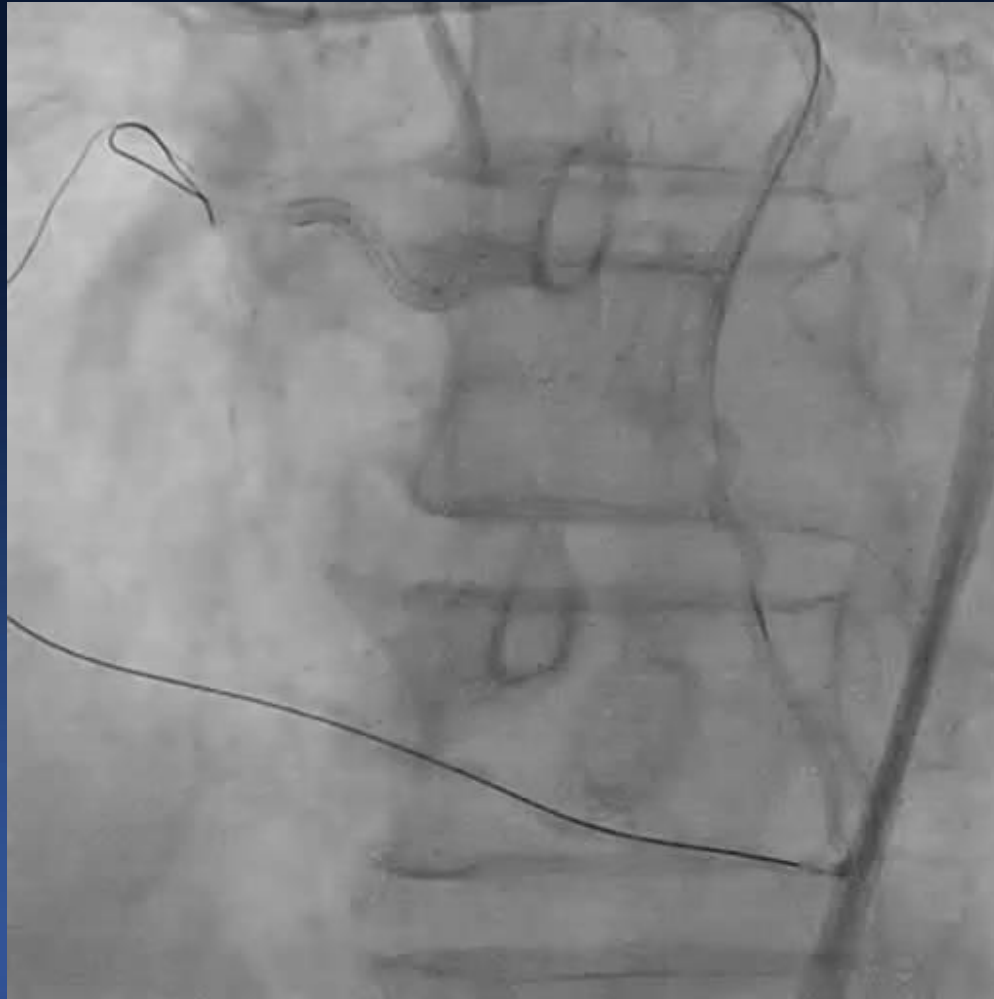


Retrograde wiring/fielder XT

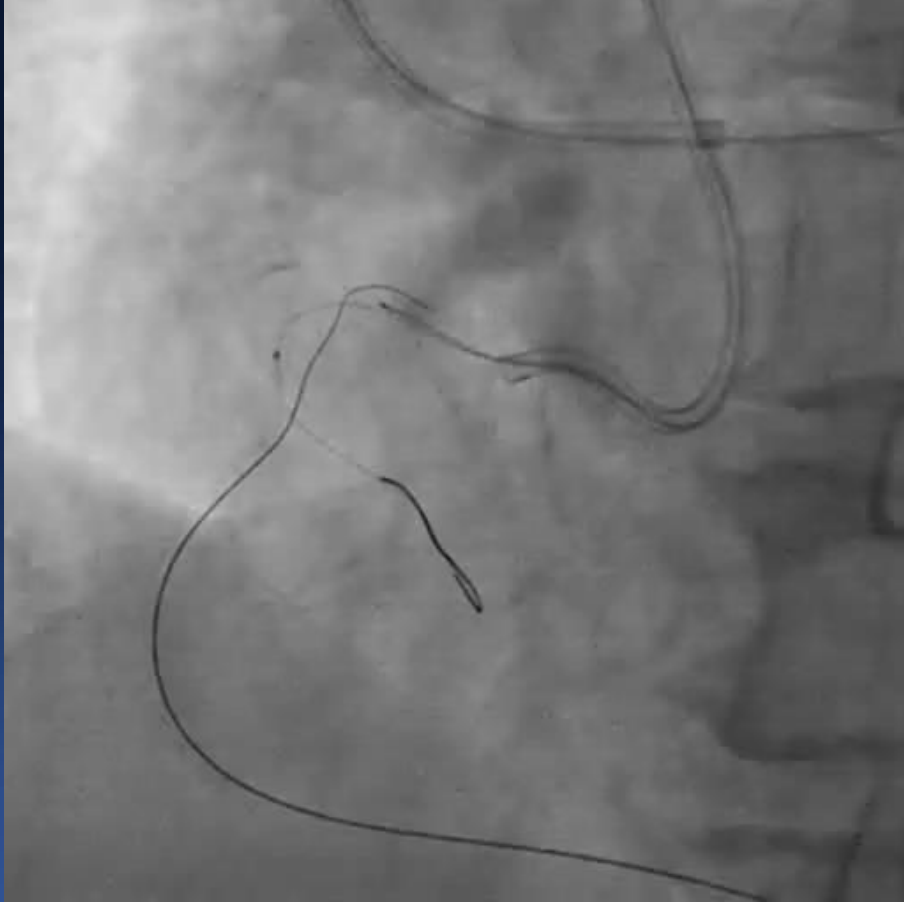
Tip angio for distal Cap



ST elevation/hypotension during wiring
---- pull back caravel to LAD with keeping the wire



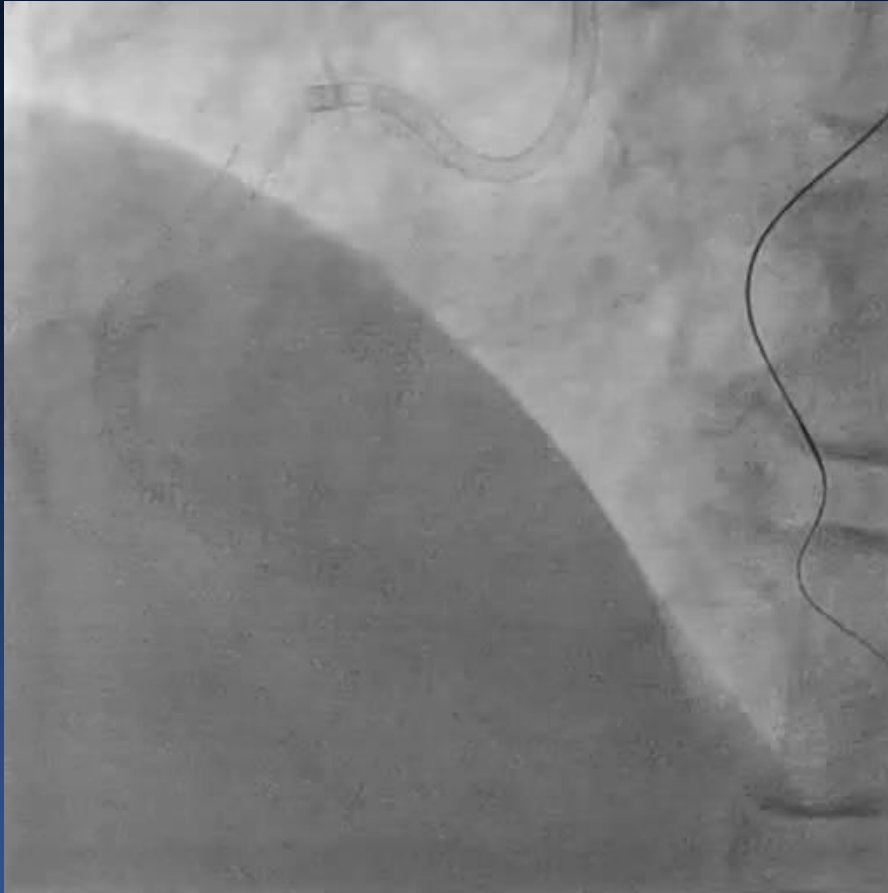
IVUS use for wire position
(Retro wire is in the true lumen)



Antegrade wiring (**wire mark technique**)
(Double lumen catheter/UB3 wire)



Final angiography



Check for channel damage



Retrograde approach over time



Period 1, 2007 – 2010, (n=111)

Period 2, 2011 – 2015, (n=132)

Retrograde approach over time (1)

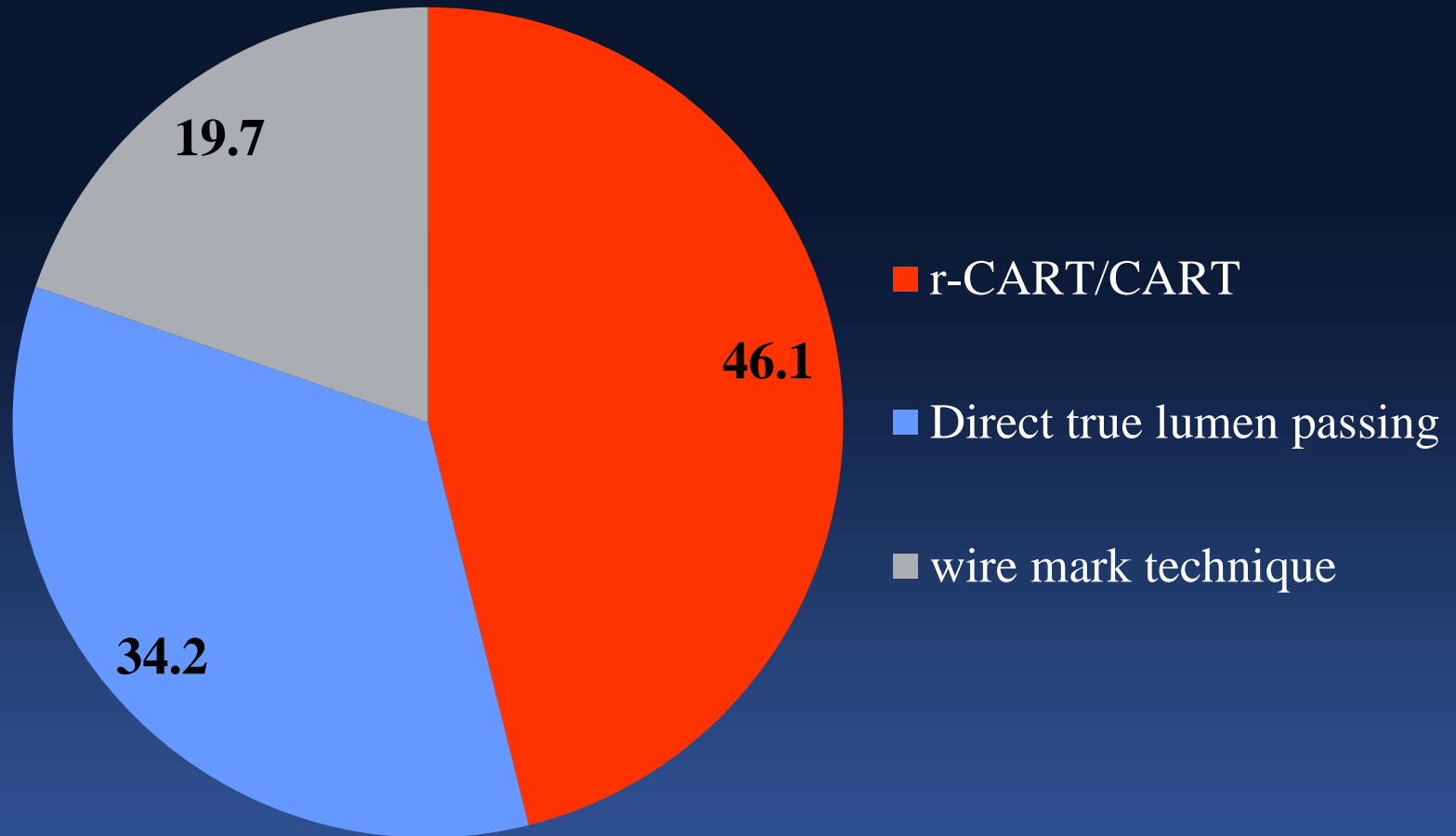
Total cases (n=243)	Period 1 2007 – 2010 (n=111)	Period 2 2011 – 2015 (n=132)	p value
Age	59.2 ± 9.2	58.7 ± 10.4	0.71
Men	101 (91.0)	125 (94.7)	0.26
Diabetes mellitus	32 (28.8)	36 (27.3)	0.79
LV ejection fraction	57.5 ± 9.5	57.6 ± 8.5	0.96
Multi-vessel disease	60 (54.1)	79 (59.8)	0.36
Target CTO lesions			0.26
Left anterior descending	51 (45.9)	57 (43.2)	
Left circumflex	2 (1.8)	0 (0.0)	
Right coronary	57 (51.4)	75 (56.8)	
Saphenous vein graft	1 (0.9)	0 (0.0)	
In-stent restenosis	6 (5.4)	11 (8.3)	0.37
J-CTO	2.5 ± 1.0	2.6 ± 1.0	0.51
Blunt stump	79 (68.7)	89 (69.5)	0.89
Calcification at CTO	54 (47.0)	78 (60.9)	0.03
Bending > 45°	53 (46.1)	64 (50.0)	0.54
Occlusion length ≥ 20 mm	65 (56.5)	65 (50.8)	0.37
Retry lesion	33 (28.7)	32 (25.0)	0.52
Primary retrograde approach	81 (73.0)	60 (45.5)	<0.001
Retrograde technique			0.001
CART	5 (4.5)	2 (1.5)	
Reverse CART	21 (18.9)	50 (37.9)	
Direct true lumen passing	21 (18.9)	36 (27.3)	
Wire mark technique	18 (16.2)	15 (11.4)	
Retrograde failure/halt	46 (51.4)	29 (22.0)	

Data are the mean ± standard deviation or numbers (%). *Only successfully stented cases were analyzed.

Retrograde approach over time (2)

Total cases (n=243 cases)	Period 1 2007 – 2010 (n=111)	Period 2 2011 – 2015 (n=132)	p value
Use of Collaterals			0.55
Septal	94 (84.7)	108 (81.8)	
Epicardial	17 (15.3)	24 (18.2)	
Type of treatment			<0.001
Balloon angioplasty	1 (0.9)	1 (0.8)	
1st-generation DES	30 (27.0)	2 (1.5)	
2 nd -generation DES	54 (48.6)	116 (87.6)	
Technical failure	26 (22.6)	13 (10.2)	
Number of stents*	2.3 ± 0.8	2.2 ± 0.7	0.68
Stent length*, mm	63.6 ± 22.9	69.0 ± 23.0	0.10
Average stent diameter*†, mm	3.2 ± 0.3	3.1 ± 0.4	0.56
4-year clinical outcomes of successfully stented patients‡ (n=202 patients)	Period 1 2007 – 2010 (n=84)	Period 2 2011 – 2015 (n=118)	
Cardiac death	4 (5.7)	4 (5.2)	0.97
Target-vessel MI	3 (4.0)	5 (4.3)	0.67
TVR/reocclusion	6 (8.1)	8 (11.2)	0.71
Target-vessel failure	11 (14.7)	16 (19.7)	0.46

Successful retrograde CTO crossing strategy



Clinical outcomes of the retrograde technique

Total cases (n=243 lesions)	CART/ reverse CART (n=78)	Direct true lum en passing (n=57)	Wire mark technique (n=33)	Retrograde f ailure/halt (n=75)	p value
In-hospital MACCE*	2 (2.6)	3 (5.3)	2 (6.1)	4 (5.3)	0.79
Death	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Procedure-related MI	2 (2.6)	2 (3.5)	2 (6.1)	3 (4.0)	0.84
Urgent repeat revascularization	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.3)	0.52
Tamponade requiring intervention	0 (0.0)	1 (0.0)	1 (3.0)	0 (0.0)	0.35
Stroke	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.3)	0.52
Long-term clinical outcomes† (n =202 patients)	CART/ reverse CART (n=77)	Direct true lumen passing (n=57)	Wire mark technique (n=33)	Retrograde failure/halt (n=35)	p value
All-cause death	7 (12.3)	4 (9.8)	2 (9.0)	3 (10.1)	0.95
Cardiac death	4 (7.0)	3 (7.7)	1 (5.0)	0 (0.0)	0.50
Target-vessel MI	3 (3.9)	3 (7.2)	2 (6.1)	0 (0.0)	0.56
TVR/reocclusion	7 (12.0)	4 (10.3)	0 (0.0)	3 (10.9)	0.39
Target-vessel failure	13 (21.3)	8 (19.0)	3 (11.0)	3 (10.9)	0.49

Failure mode of contemporary techniques from APCTO registry

Antegrade app (N=11)

Inability to wire to true lumen despite advanced antegrade wiring technique for example, parallel wiring or IVUS guided wiring: **wire passage failure (N=10, 90%)**.

Retrograde app (N=20)

Wire collateral channel passage failure; **6 (30%)**

Retrograde MC CTO passage failure: **6 (30%)**

Failed reverse CART; **6 (30%)**

Procedure complications: **4 (20%)**

Conclusion

- Bidirectional angiography
- Careful angiography (with CCTA) review
- Antegrade app first (single or parallel wire or ADR based on the lesion morphology) under selective guidance of IVUS (entry or rewiring)
- Retrograde channel cross: selective angiography and retrograde wire channel cross (Sion, Sion black, Suoh03, Fielder XT-R) and Microcatheter channel cross (Finecross, Corsair, Caravel, Turnpike LP)
- Retrograde CTO cross tech (retrograde direct wiring for short CTO, reverse CART/CART long CTO, knuckle wiring for ambiguous, long, calcific CTO, Wire mark tech for failed retrograde wiring) under selective guidance of IVUS for wire position

There is an easy-looking CTO, but there is no easy CTO to open. You must always do your best.

Thank you for your attention

All comer CTO-PCI strategy based on risk and benefit

PCI eligible CTO including De novo or ISR

J CTO score (0, 1, 2)

J CTO score (3, 4, 5)

Symptomatic or viable medium to larger size perfusion defect (>5%)

In MVD, non-CTO lesion should be corrected by PCI

PCI first

Medical treatment first (OMT)

PCI

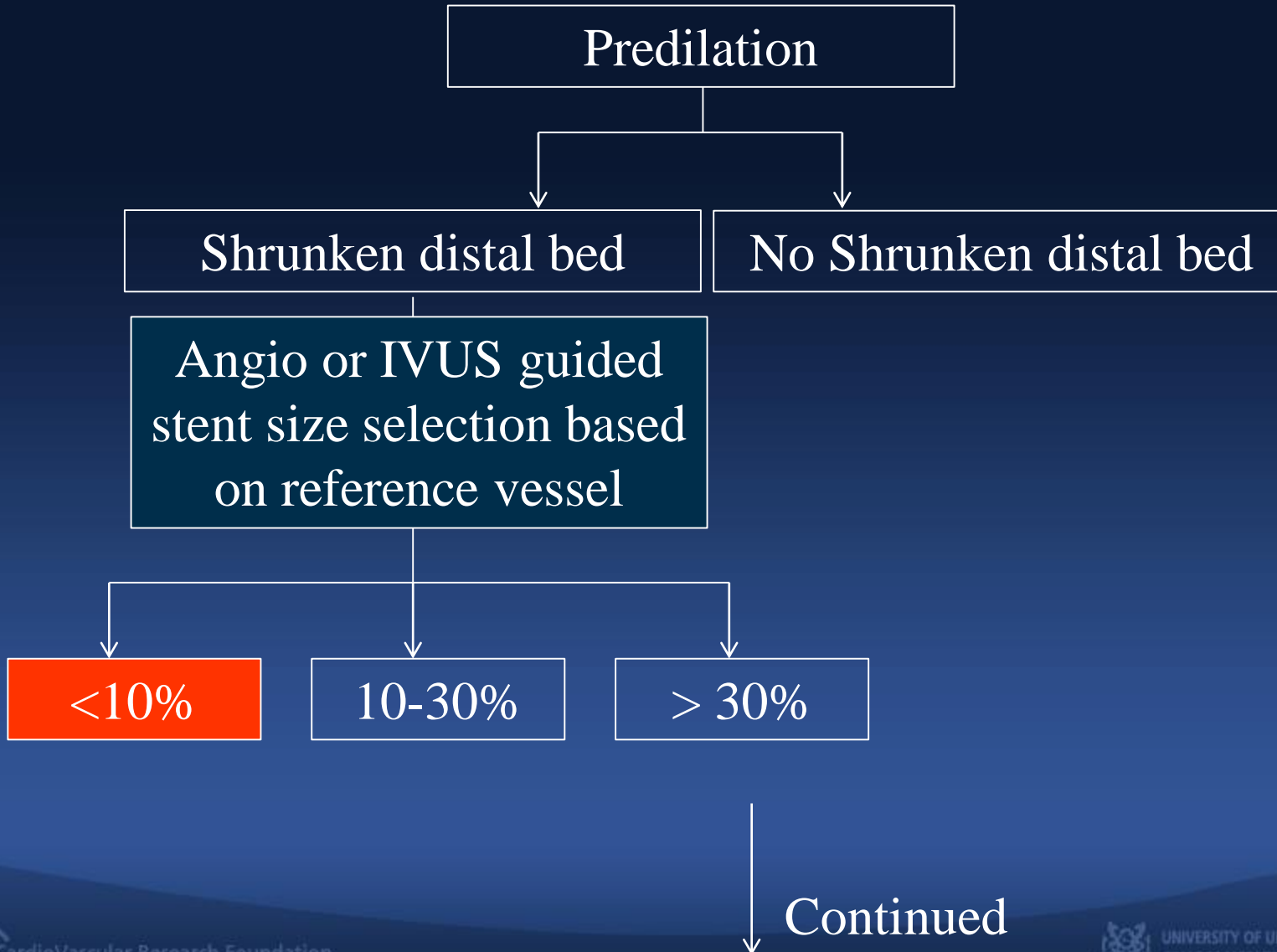
OMT

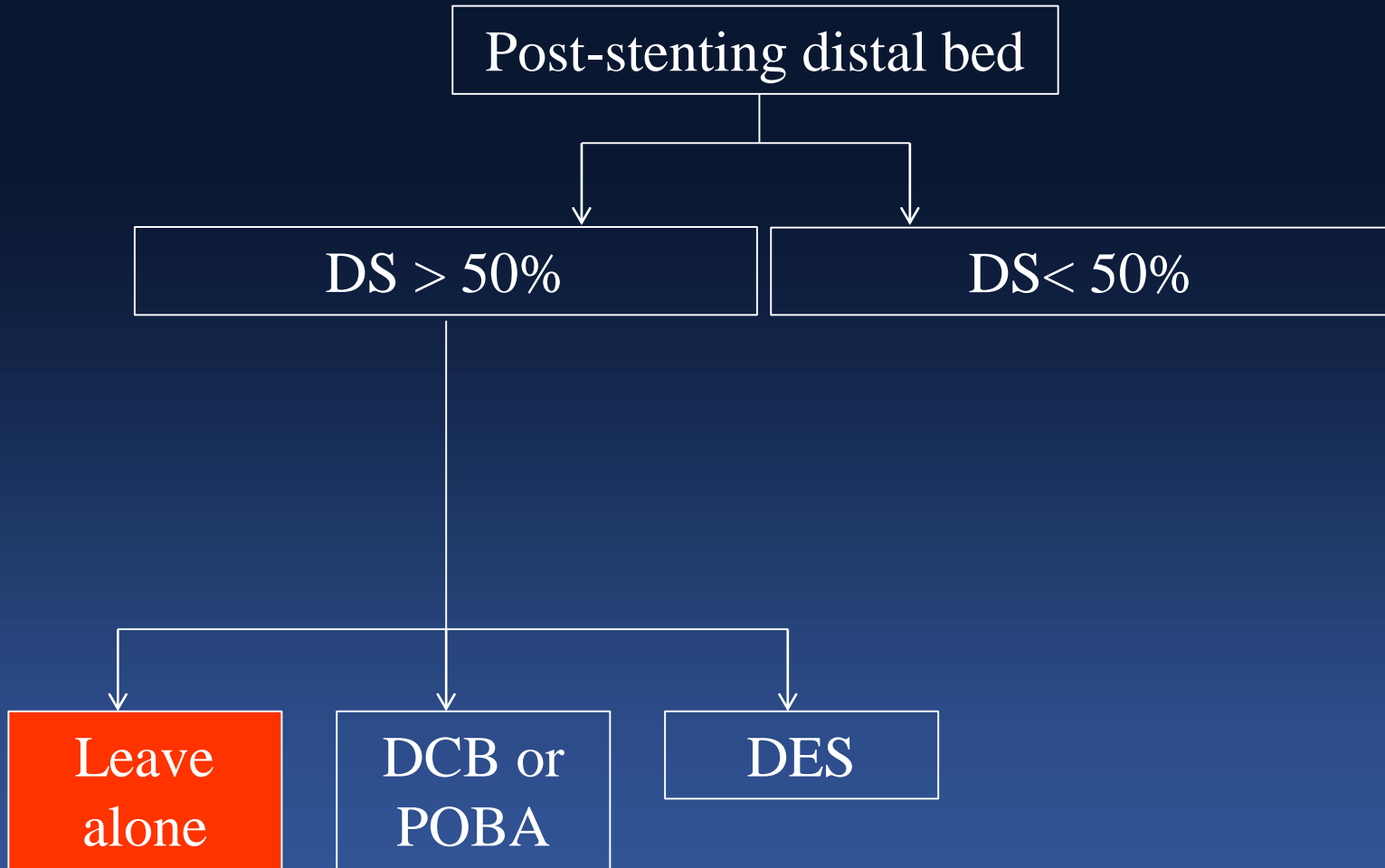
PCI

OMT

Continued

PCI stenting strategy





Complication or failure mode

- Mode of antegrade app only
Perforation (wire, MC, balloon....)
Thrombosis
Hemodynamic instability
- Mode of retrograde approach
Perforation (wire, MC, balloon....)
Thrombosis
Hemodynamic instability