

# Retrograde approach in CTO

*When and How ?*

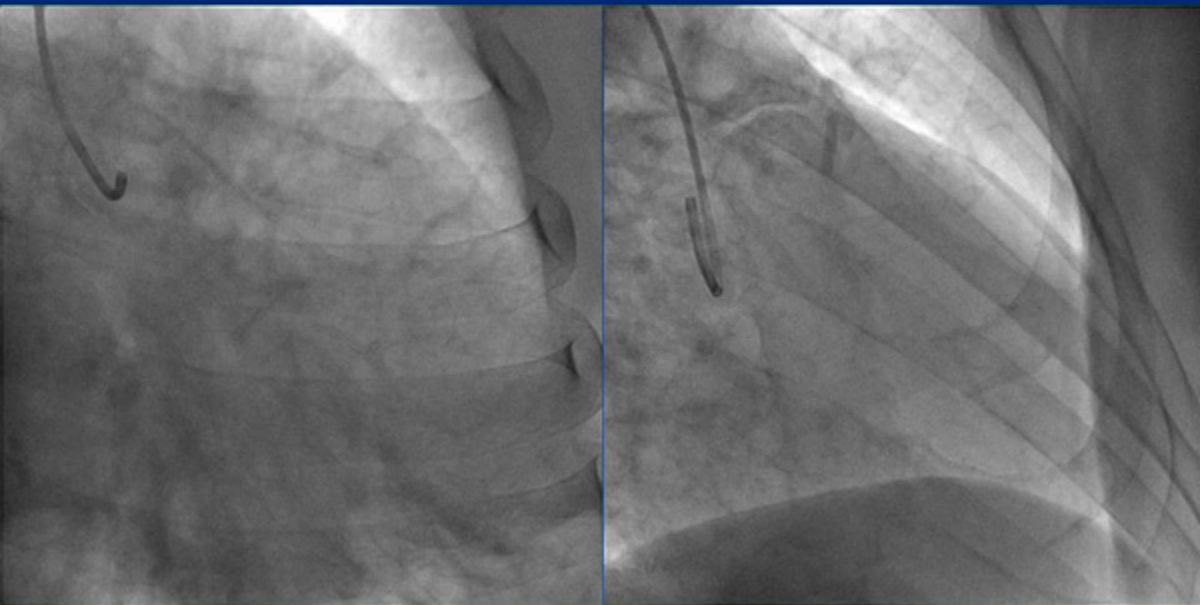
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## Patient Summary

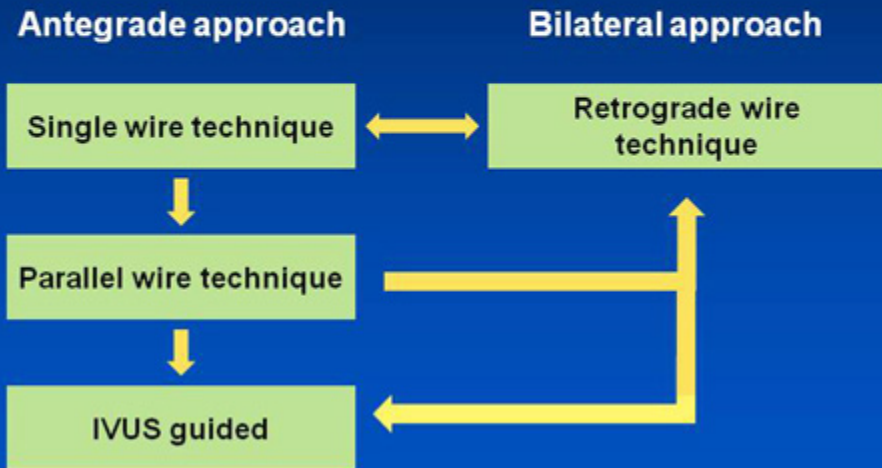
- Patient : 58-yr-old male
- PHx : Angina on effort and failed PCI (x2)
- Risk factor : Hypertension, Smoking, DM
- Echocardiogram :
  - Akinesia of LAD territory
  - LVEF = 53%
- Th-Scan :
  - Reversible defect on LAD territory
- Normal cardiac enzyme

## Baseline CAG



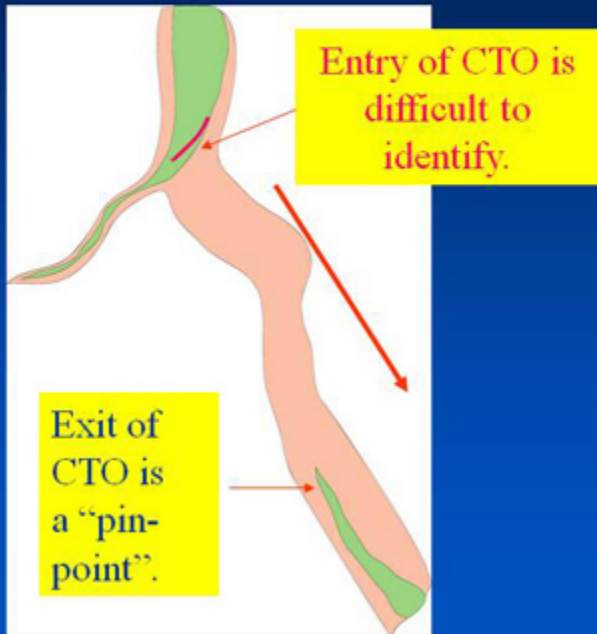
# Selection of Wire Crossing Technique

*Easier and Safer First!*



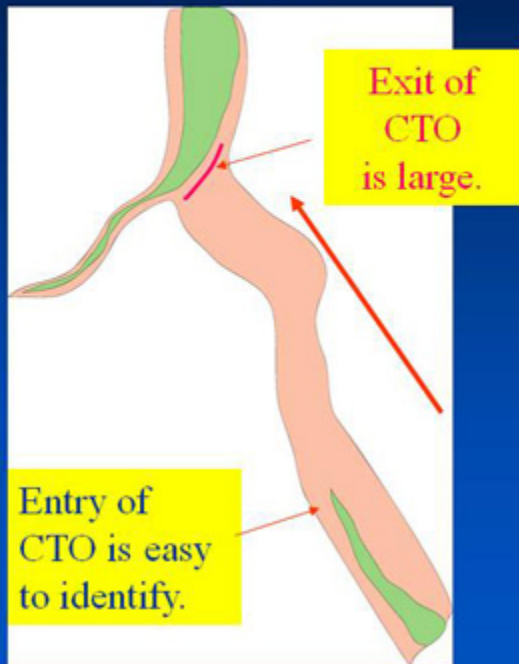
*- if antegrade approach is applied -*

### Difficult case



*- if retrograde approach is applied -*

Easy case



## Indication for retrograde PCI

- No definite indication
- However, if suitable collateral connection exist in hard CTO case especially with previous antegrade PCI failure, you must consider retrograde PCI.

**Retrograde  
Success rate (%)****Final  
Success rate(%)**

Lee NH (n=24) <sup>1</sup>	70	87
Lei GE (n=42) <sup>2</sup>	71	88
Saito S (n=45) <sup>3</sup>	69	83
Rathore S (n=157) <sup>4</sup>	66	85
<b>Overall (n=268)</b>	<b>69 (n=185)</b>	<b>86 (n=230)</b>

1. *Int J Cardiol*. 2010 ;144(2):219-29.

2. *Chin Med J*. 2010 ;123(7):857-63.

3. *Catheter Cardiovasc Interv*. 2008 ;71:8-19

4. *Circ Cardiovasc Interv*. 2009 (2):124-32.

Among the 83 failed retrograde cases, antegrade PCI save 45 cases, which means antegrade approach can save 53% of failed retrograde cases.

**Thus, in the case of the retrograde approach, strict case selection is necessary to avoid unnecessary efforts because this technique is more complex and more time-consuming, and has a higher likelihood of complications than the antegrade approach.**



# How to avoid unnecessary efforts ?

## *Look at the collateral !*

- **Location**

Septal

Epicardial

- **Collateral size**

CC0; no continuous connection

CC1; continuous thread-like connection;

CC2; continuous, small sidebranch-like connection

- **Donor vessel angle**

The angle that the CC makes with the donor vessel

- **CC tortuosity**

The most severe angulations seen during the whole collateral course

(a)  $< 90^\circ$ ; (b)  $90^\circ$  to  $180^\circ$ ; (c)  $> 180^\circ$ , (d) corkscrew,

- **Recipient vessel angle**

The angle that the collateral makes while joining the vessel

## Collateral Properties in Retrograde Success and Failure Groups

Channel Properties	All Patients (n=157)	Retrograde Success (n=103)	Retrograde Failure (n=54)	P
<b>Channel used</b>				
Septal	106 (67.5)	74 (71.8)	32 (59.3)	0.1508
Epicardial	39 (24.8)	19 (18.4)	20 (37)	0.0188
SVG	12 (7.7)	10 (9.7)	2 (3.7)	0.2210
<b>CC Type</b>				
0	23 (14.6)	3 (2.9)	20 (37)	<0.0001
1	78 (49.6)	66 (64.7)	12 (22.2)	<0.0001
2	55 (35.8)	33 (32.4)	22 (40.7)	0.02951
<b>Tortuosity</b>				
<90°	72 (53.3)	70 (68.0)	12 (22.2)	<0.0001
90° to 180°	20 (12.7)	13 (12.6)	7 (13.0)	1.0000
>180°	17 (10.8)	9 (8.7)	8 (14.9)	0.2836
Corkscrew type	38 (24.2)	11 (10.7)	27 (50)	<0.0001
<b>Donor vessel angle</b>				
<90°	113 (71.9)	78 (75.7)	35 (64.8)	0.1903
90° to 180°	40 (25.5)	24 (23.3)	16 (29.7%)	0.4921
>180°	3 (1.9)	1 (1.0)	2 (3.7)	0.2122
Corkscrew type	1 (0.6)	0 (0)	1 (1.9)	0.3439
<b>Recipient vessel angle</b>				
<90°	116 (73.9)	94 (91.3)	22 (40.7)	<0.0001
90° to 180°	24 (15.3)	8 (7.8)	16 (29.6)	0.0007
Not visible	17 (10.8)	1 (1.0)	16 (29.6)	<0.0001

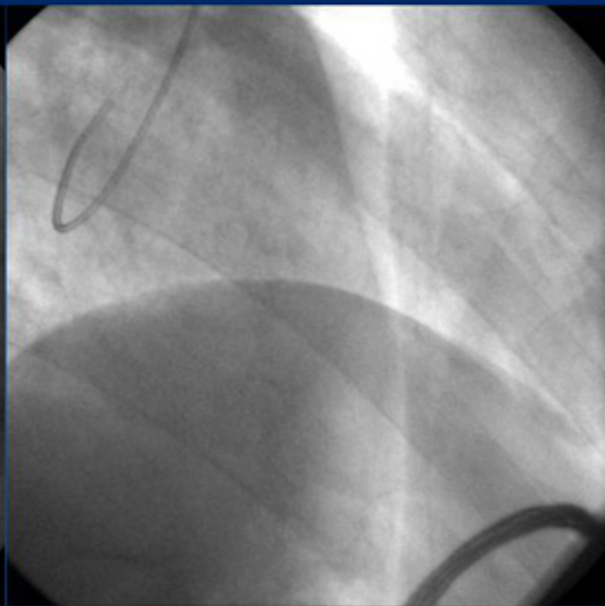
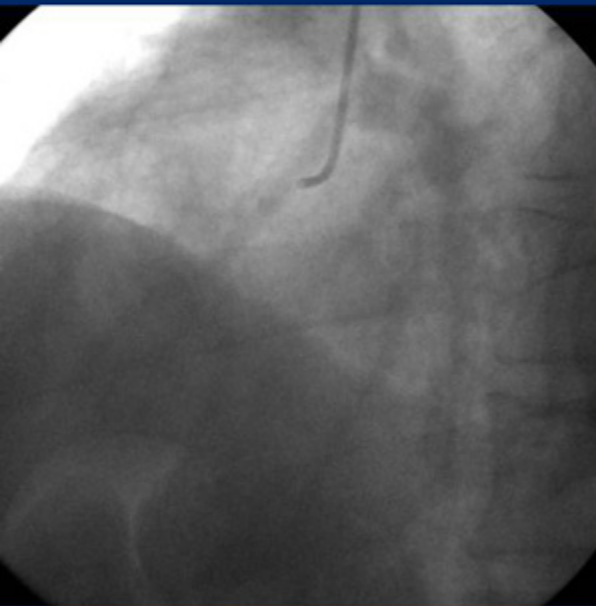
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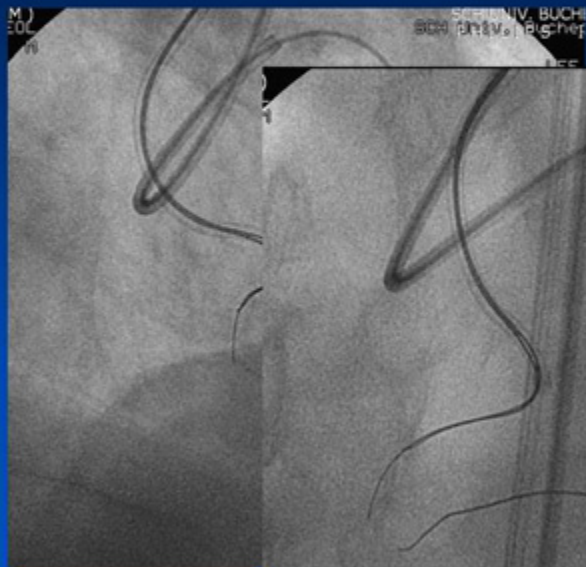
## Logistic Regression Analysis Showing Predictors of Retrograde Failure

Variable	Odds Ratio	95% CI	P
Channel used (epicardial)	0.515	0.28–9.57	0.656
Recipient vessel angle not visible	47.09	1.65–1340.42	0.024
Tortuosity of channel-corkscrew	8.31	1.63–42.36	0.011
CC1	2.16	0.43–10.74	0.346
Previous MI	0.419	0.04–3.81	0.440
In-stent restenosis	1.71	0.22–12.88	0.599
Bridging collaterals	1.09	0.29–4.00	0.896
Significant sidebranch	1.51	0.33–6.72	0.588
Severe tortuosity	0.757	0.11–4.94	0.771
Severe calcification	2.67	0.51–13.93	0.243
Ostial location	1.34	0.22–7.98	0.744
CTO length >20 mm	0.971	0.93–1.01	0.138
Age	1.01	0.96–1.07	0.547
Male sex	1.72	0.33–8.87	0.512

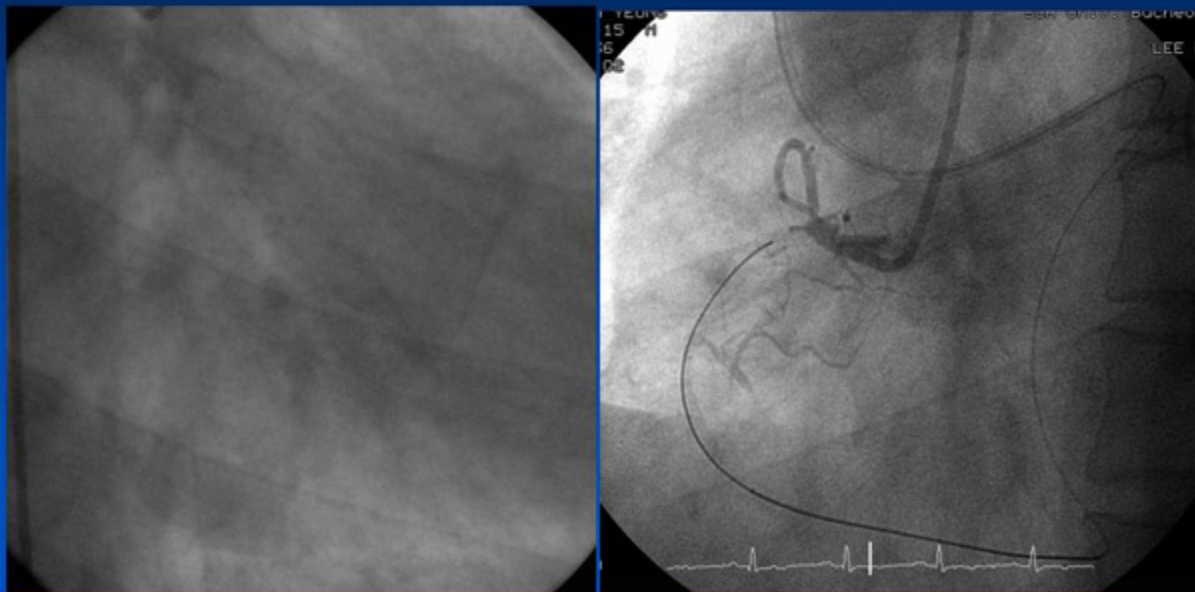
**CC 0: No definite continuous connection**



## ***CC 0: No definite continuous connection***



## CC 1: Thread-like continuous connection

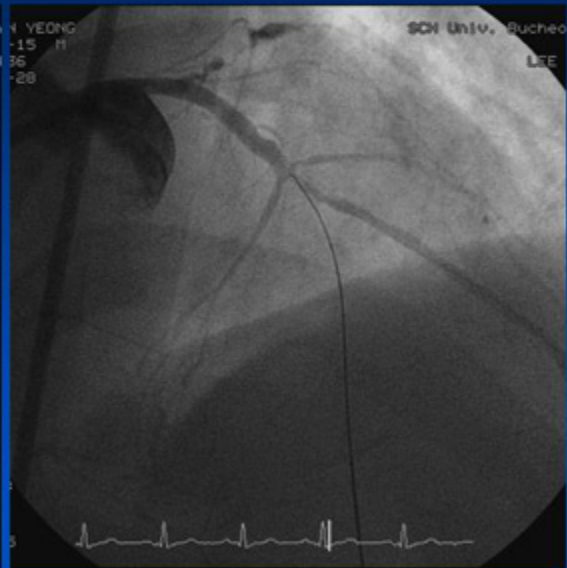
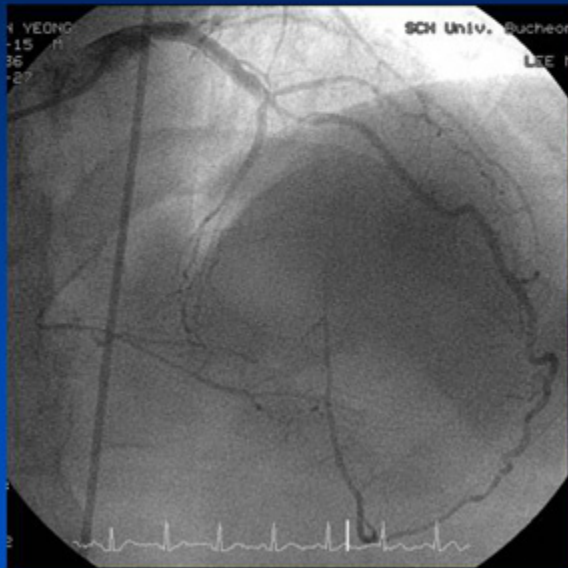


## CC 2: Small side branch-like size continuous connection

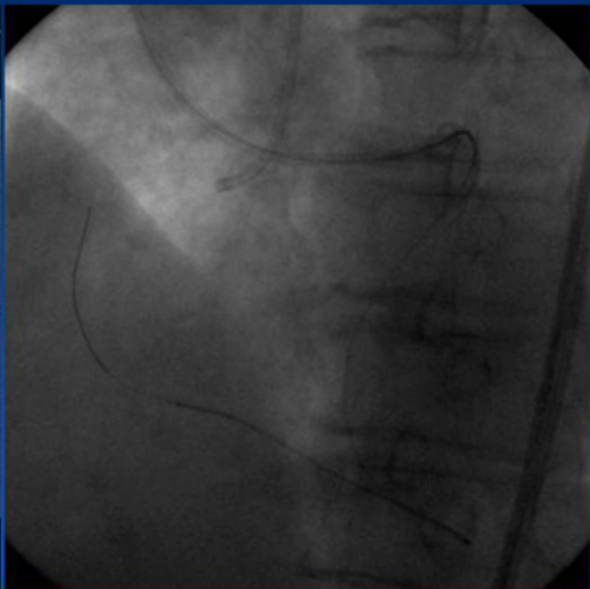
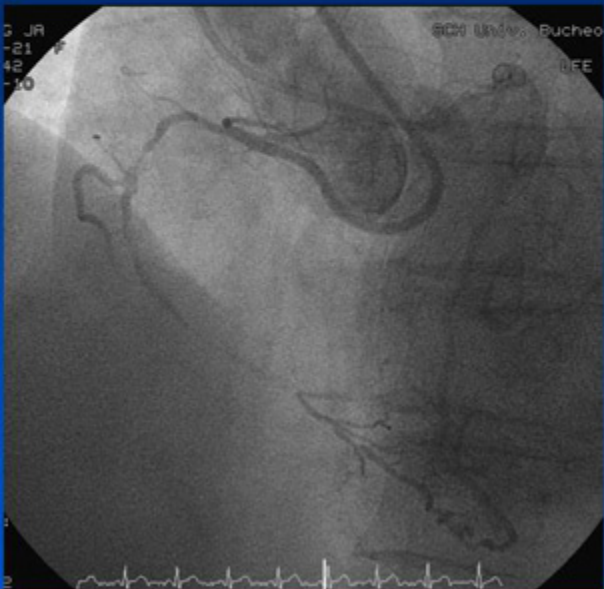


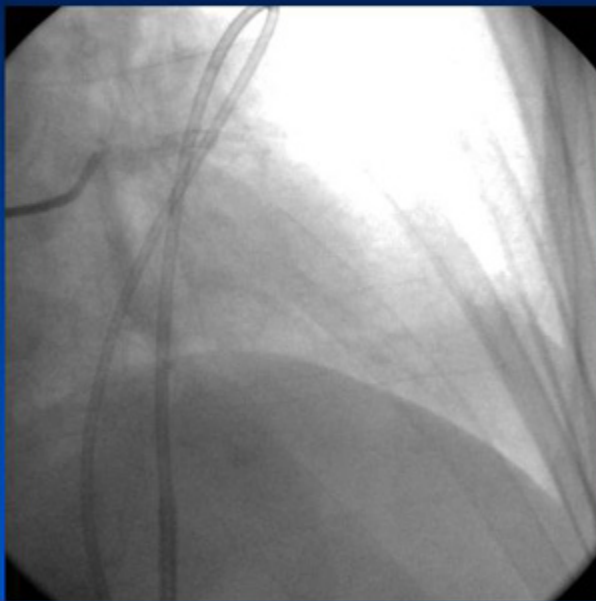


## CC 2 - Epicardial connection

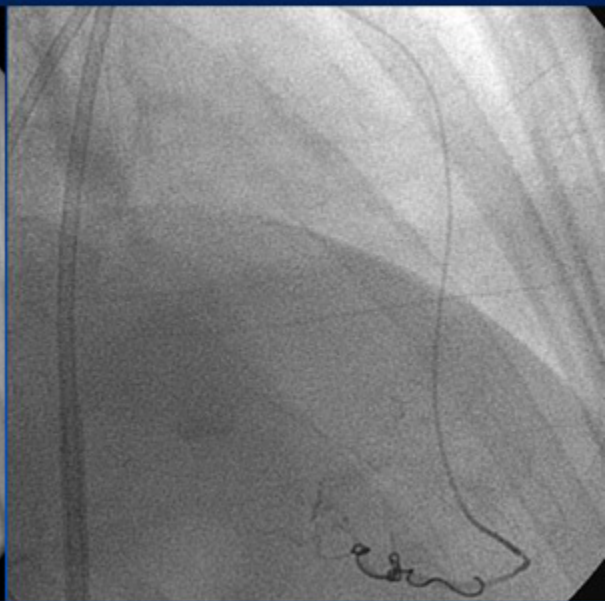


**F/76,  
Secondary approach**



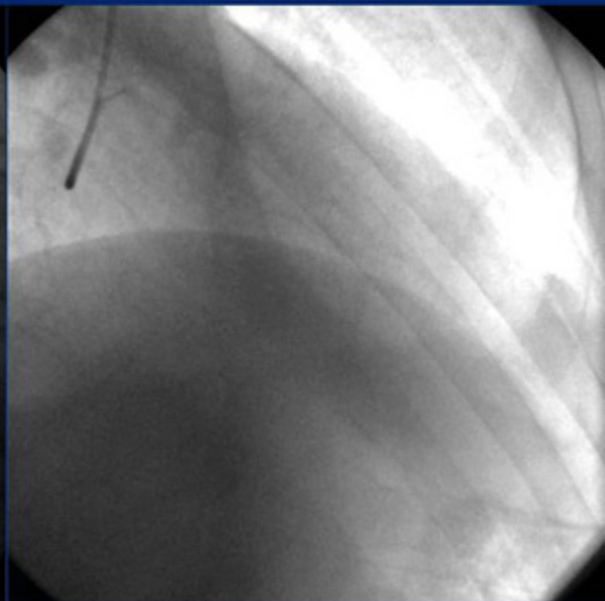
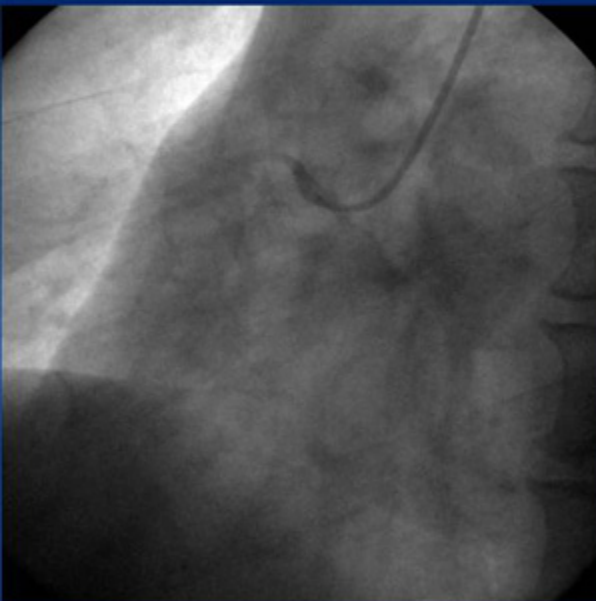


*Epicardial collateral perforation*

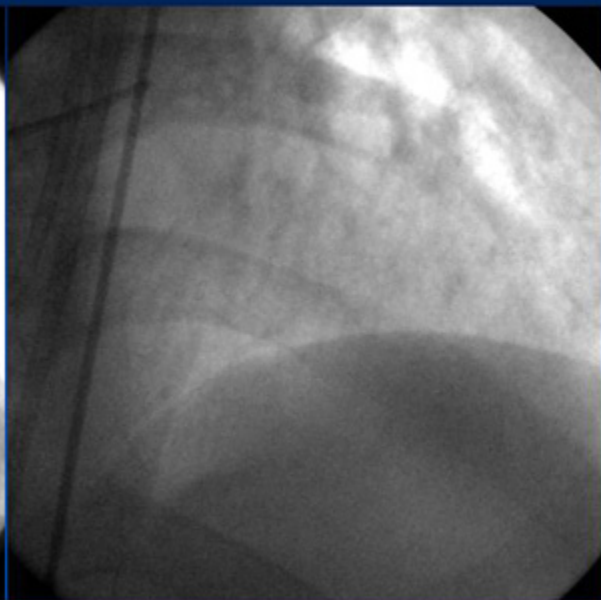
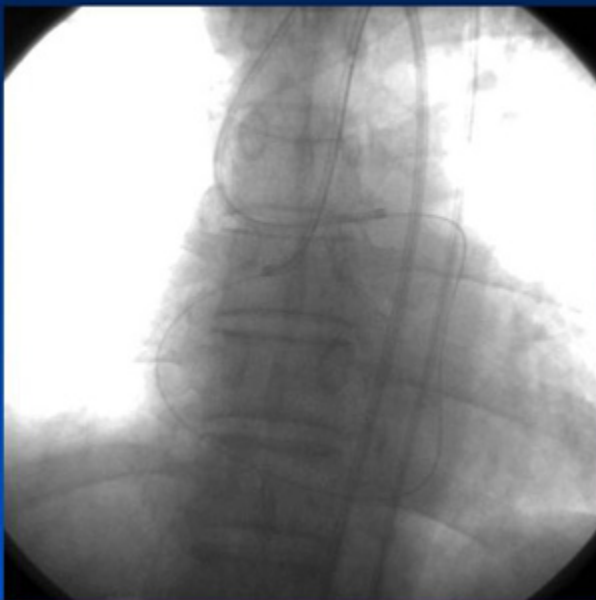


*Coil embolization*

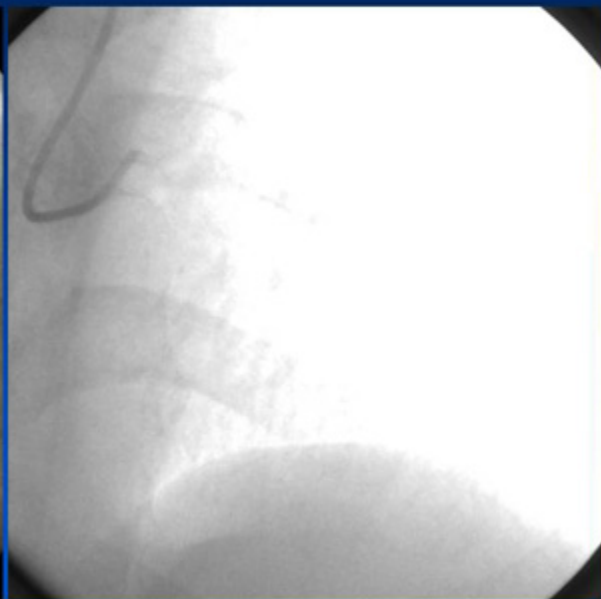
**M/ 52,  
Secondary approach**



*Donor vessel dissection  
& septal perforation*



Retrograde wire (choice PT) entered the opposite guiding catheter (7F JR-4) and got out of the body

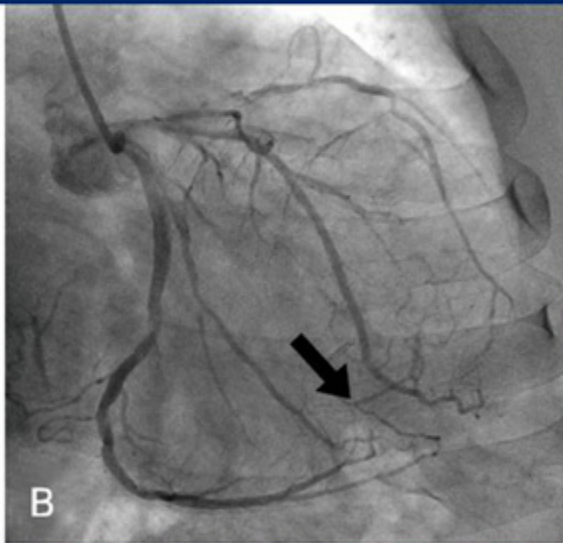
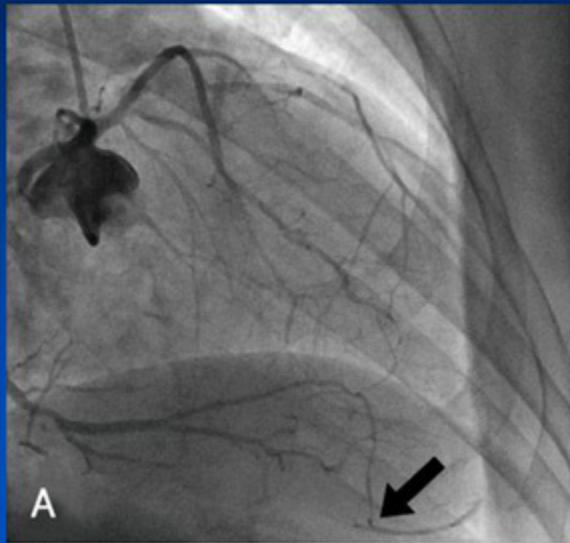


**8 month F/U**

## Selection of Collateral channel in retrograde PCI → Key procedure

- Septal is better than Epicardial (to prevent tamponade in case of vessel perforation)
- Visible continuous connection is better
- Not too much tortuous
- Needs selective injection of nitrates into the routes
- Testing with direct dye injection into the routes

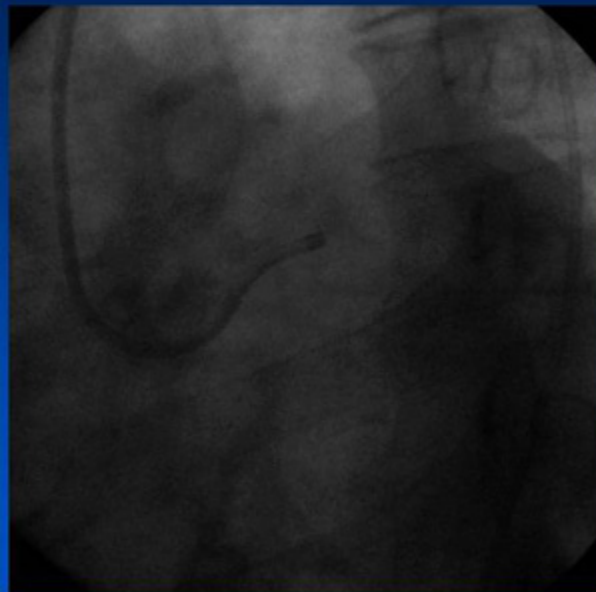
## How to approach this case?



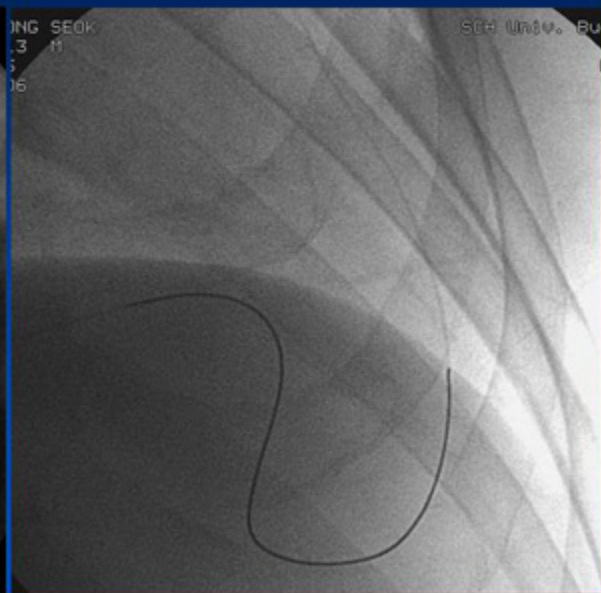
*Retrograde approach using dLCX → dLAD collateral!*



# Ipsilateral retrograde approach



Guiding catheter : 7 F AL-1 (90 cm)



Progreat microcatheter (150 cm)

***Once the retrograde wire is successfully introduced near the distal CTO site,***

***Various kinds of techniques are used for crossing the CTO.***

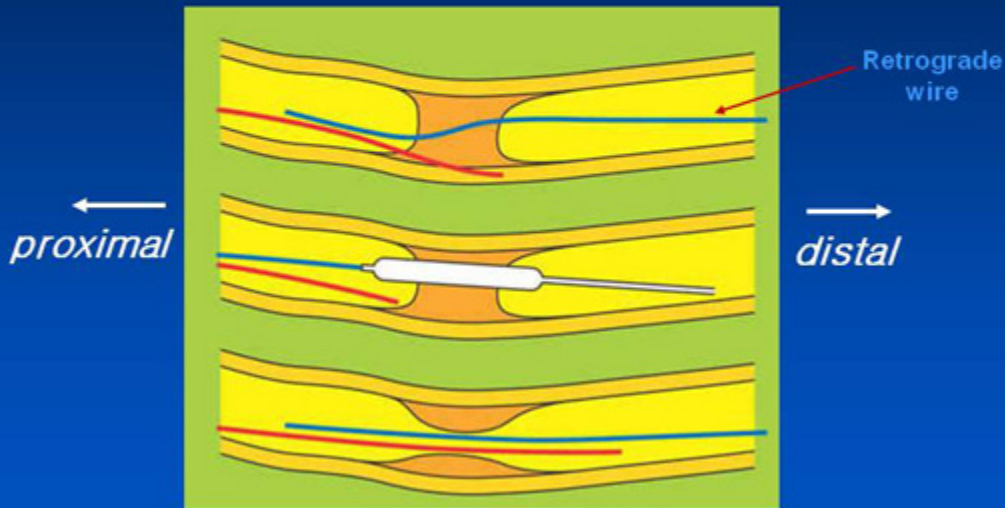
## Techniques for crossing the CTO site

- *Retrograde wire crossing*
- *Kissing wire technique*
- *CART technique*
- *Reverse CART*

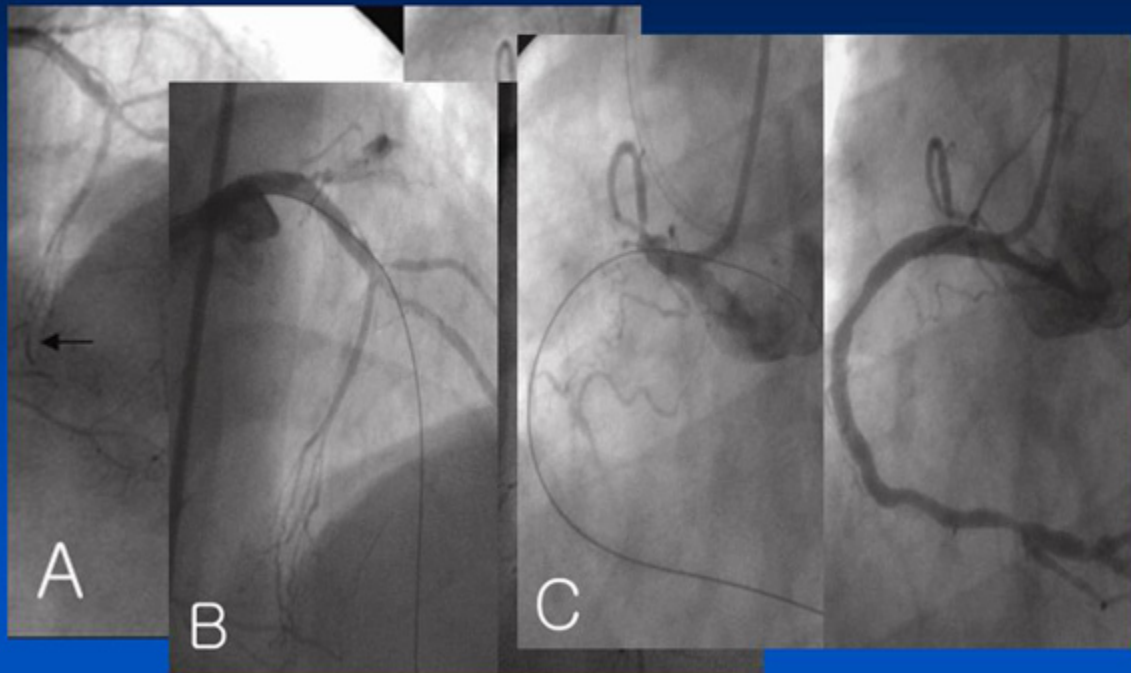


# Retrograde wire crossing

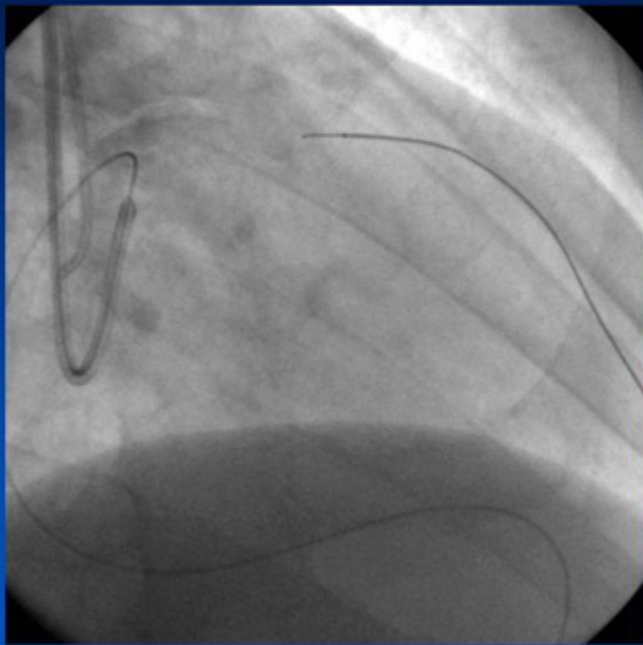
Direct crossing from distal to proximal lumen  
(Distal cap is tapered and softer than proximal cap)



An example of multiple CTOs treated by retrograde approach using retrograde wire crossing technique



## ***Retrograde wire crossing***



**Fielder-FC wire got to the distal CTO site.  
M3 → M12 → Conquest-pro wires were tried to cross the lesion.**

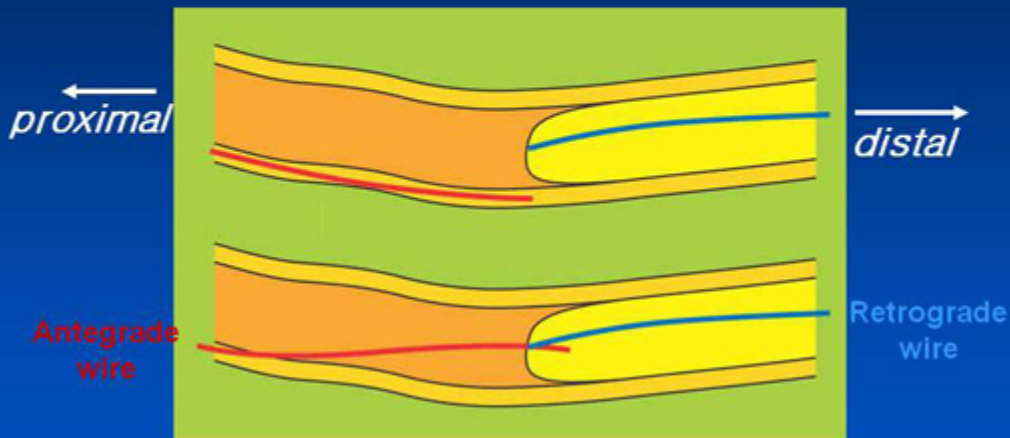
Retrograde wire crossing technique was failed.

*Next step ?*

*Kissing wire technique*

# Kissing wire technique

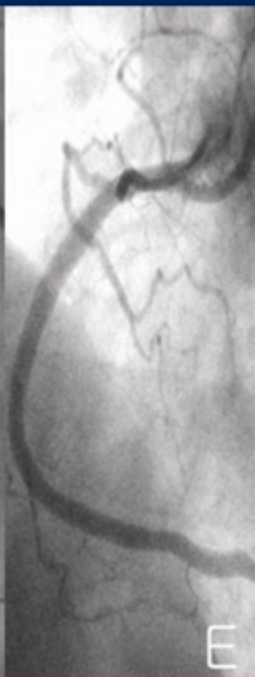
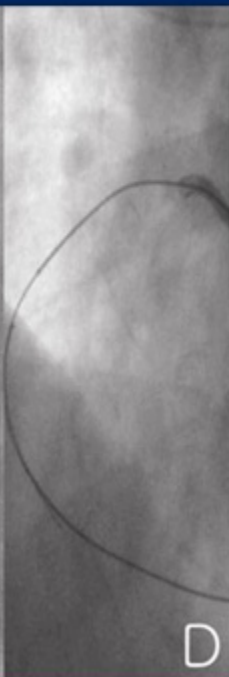
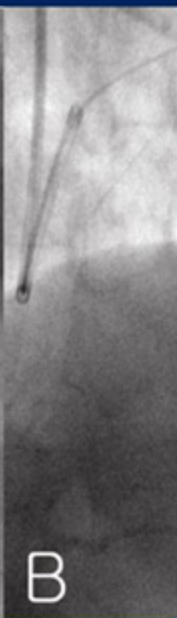
Landmark of distal true lumen



Can reduce dye amount



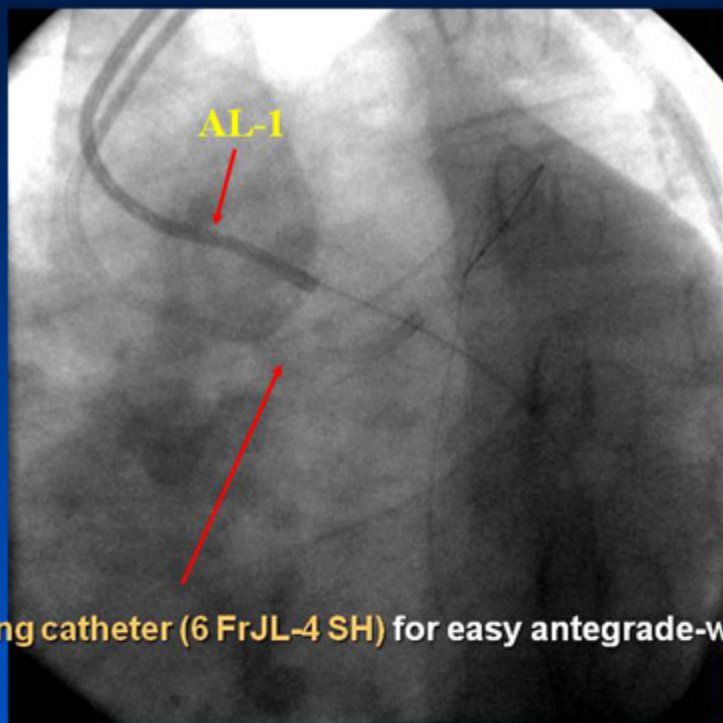
## An example of selective collateral dye injection and kissing wire technique



*However..,*

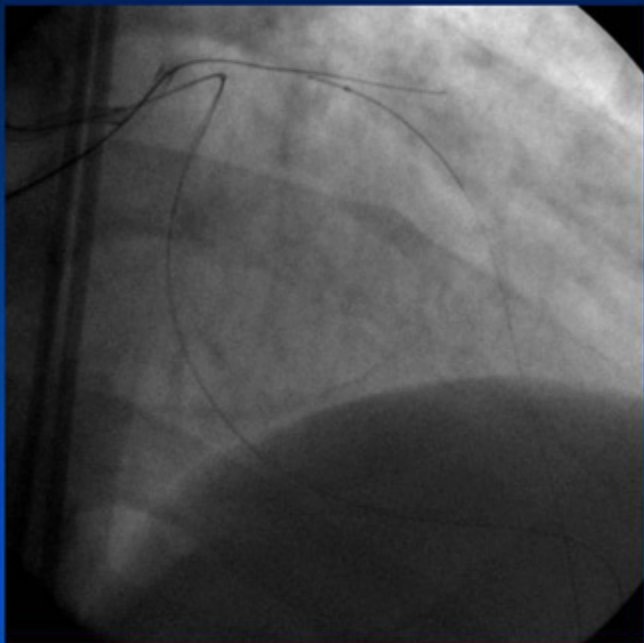
- **Short main artery and Amplatz guiding catheter**  
→ *poor wire control for the LAD lesion*
  
- **Antegrade/retrograde device in single guiding catheter**  
→ *problem of the friction between the antegrade and retrograde device in the same catheter*

*Thus, Judkins guiding catheter was applied simultaneously for better antegrade wire control*



**Another guiding catheter (6 FrJL-4 SH) for easy antegrade-wire control**

## *Kissing wire technique*



Only for 5 min.

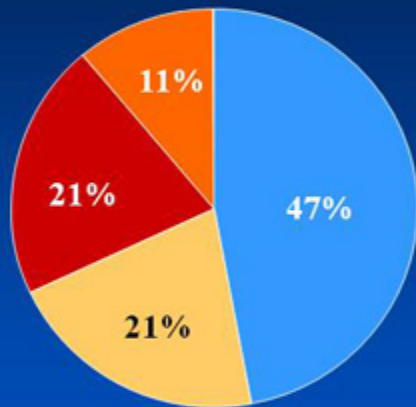
Kissing wire technique was failed.

*Next step ?*

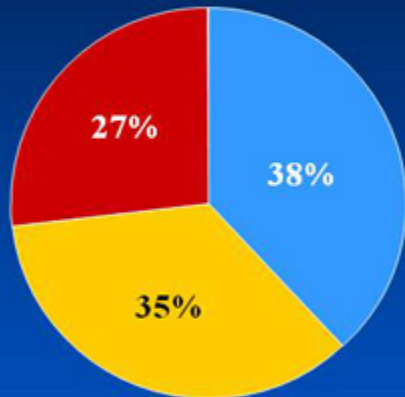
- Long course and angulations over the retrograde pathway → *retrograde wire handling (retrograde wire crossing) is difficult.*
- CTO lesion complexity such as long occlusion length and severe calcification → *antegrade wire handling (kissing wire technique) is difficult.*

*Thus, complex techniques, such as CART or reverse CART, are required to increase the success rate for crossing the CTO site.*

# Techniques for crossing the CTO site



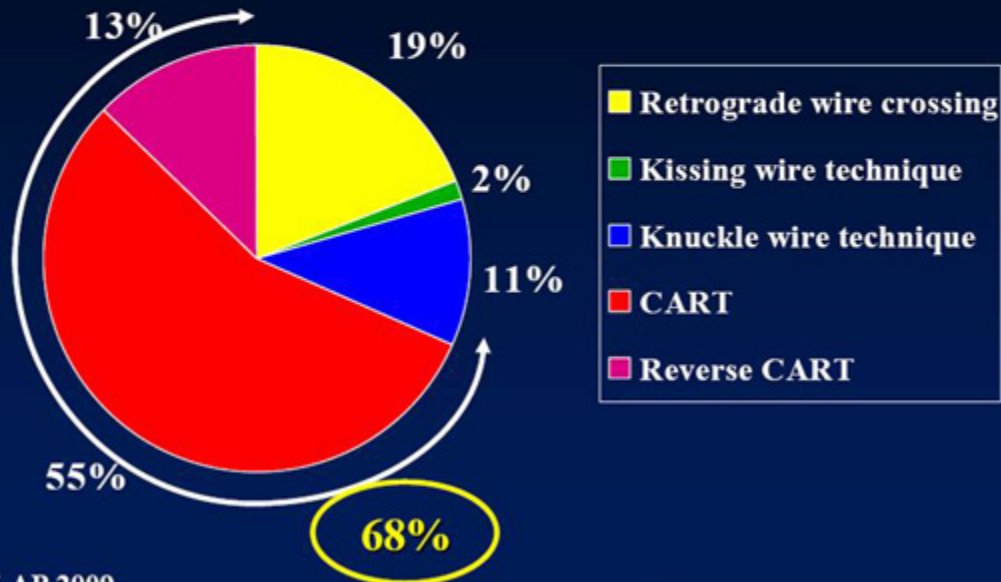
*Lee NH. Int J Cardiol*  
2009; May [E-pub ahead of print]



*Saito S. CCI 2008;71; 8-19*

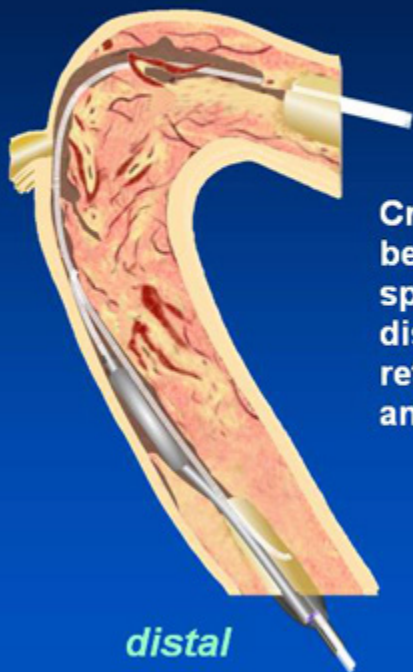


# Techniques for crossing the CTO site





*proximal*



**CART**

**Create a connection  
between the subintimal  
space of the CTO and the  
distal true lumen by  
retrograde ballooning for  
antegrade wire passage**

*distal*

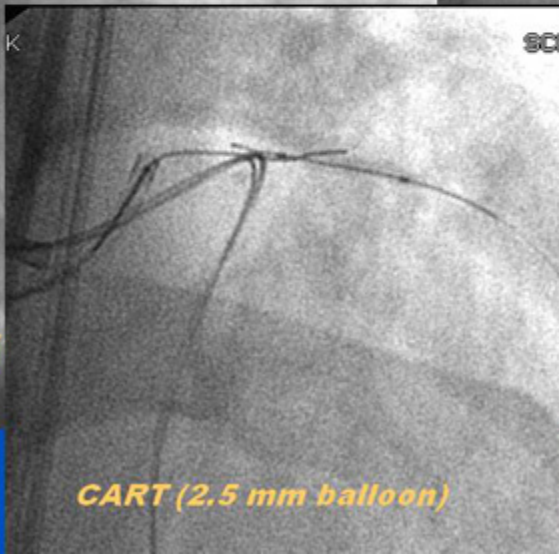
**CART (1.5 → 2.5 mm balloon)**



**CART (**

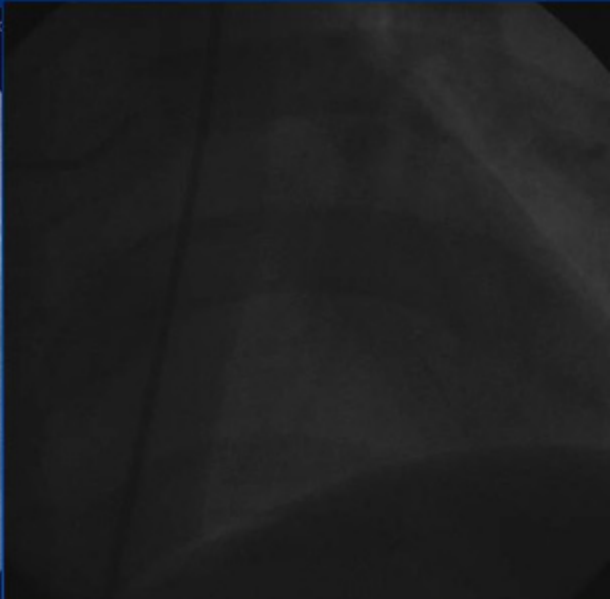


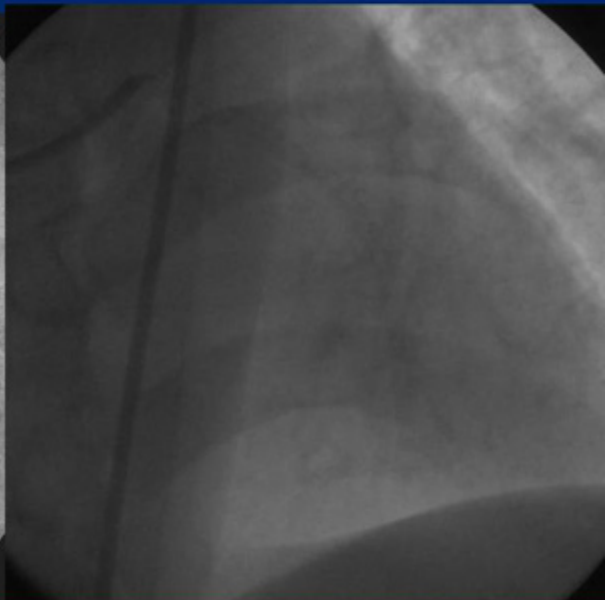
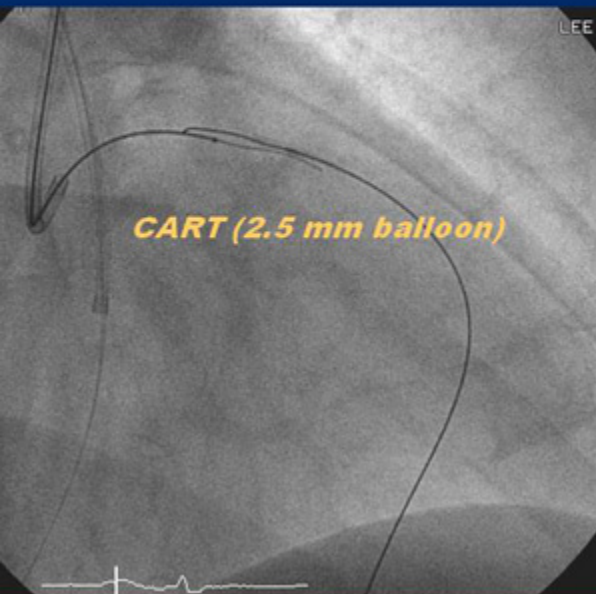
**Miracle-3**



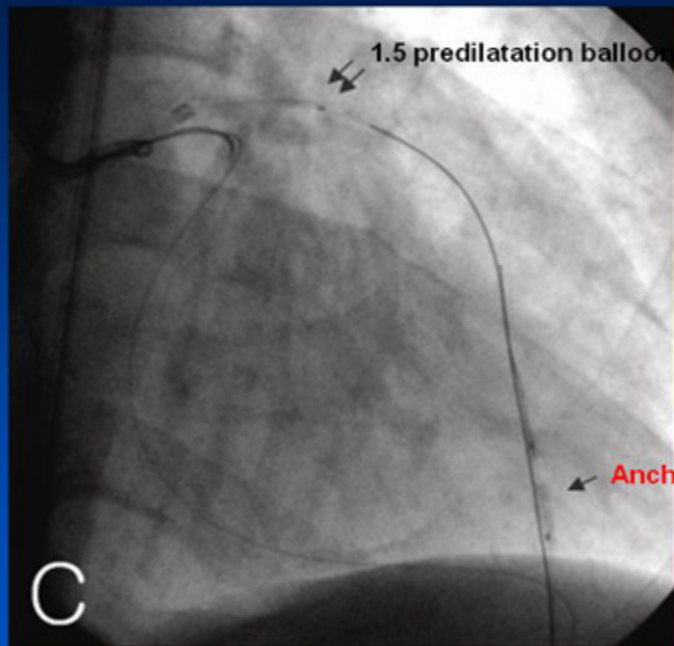
**CART (2.5 mm balloon)**

## *Other example of CART technique*





## *Distal anchor balloon technique after wire cross*



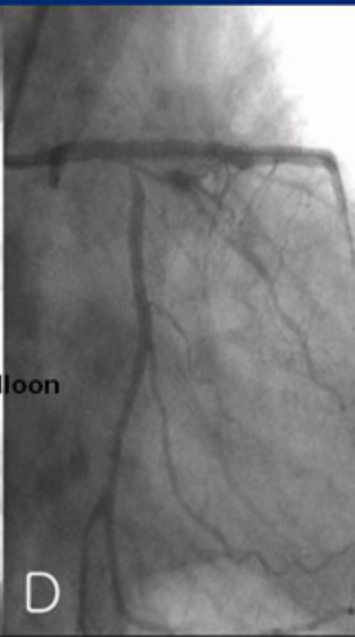
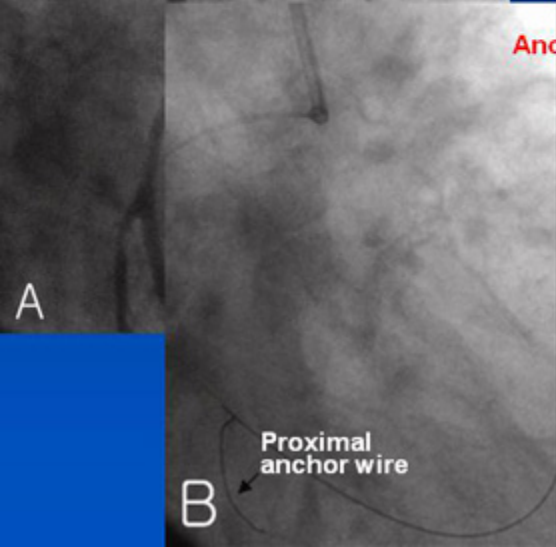
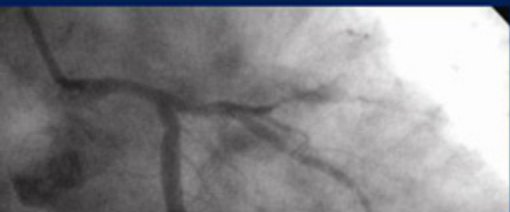
Antegrade wire was trapped by retrograde balloon(2.5 mm) for easy antegrade balloon (1.25 mm) passage

# Techniques to facilitate the balloon passage

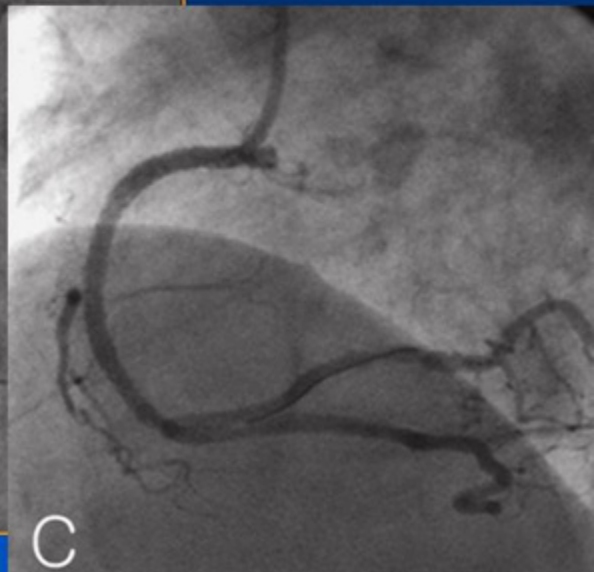
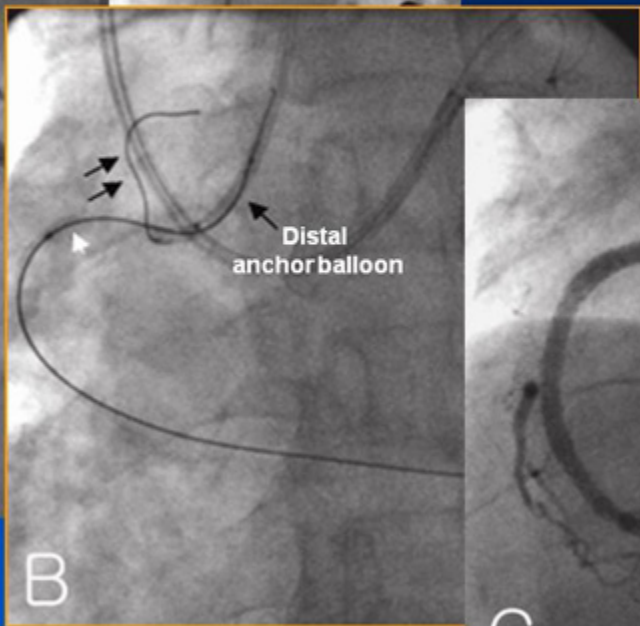
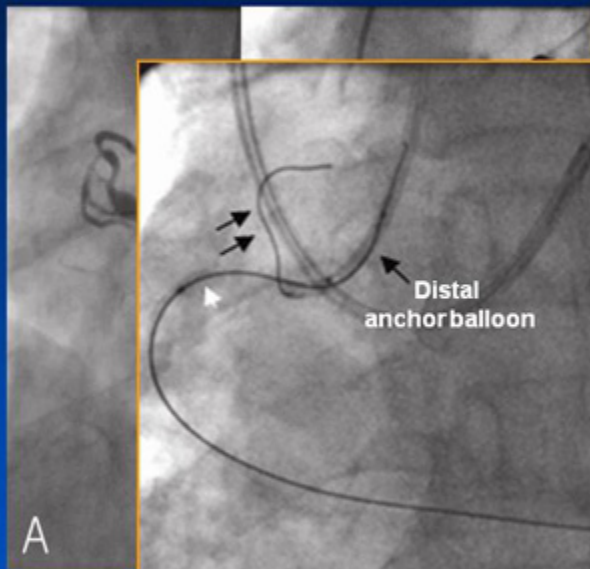
*Retrograde approach has an advantage for balloon passage because the presence of the antegrade and the retrograde wire in the same vessel makes it possible for **special anchor-balloon techniques***

- **Distal anchor balloon technique:** tip of the antegrade or retrograde guide wire that had already crossed the CTO lesion was trapped by the balloon inflation from the opposite direction, which generates stronger backup support for the passage of a balloon catheter
- **Double anchor balloon technique:** simultaneous application of the proximal anchoring balloon technique and the distal anchoring balloon technique, which generates maximal penetration power for balloon pass

## An example of the distal anchoring balloon technique

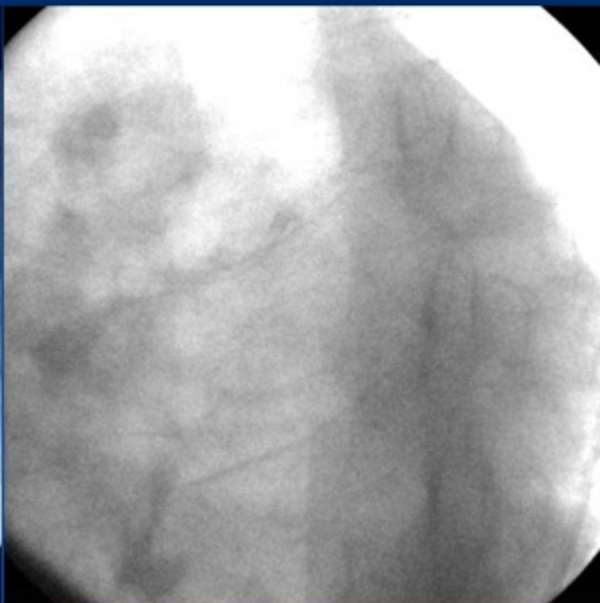
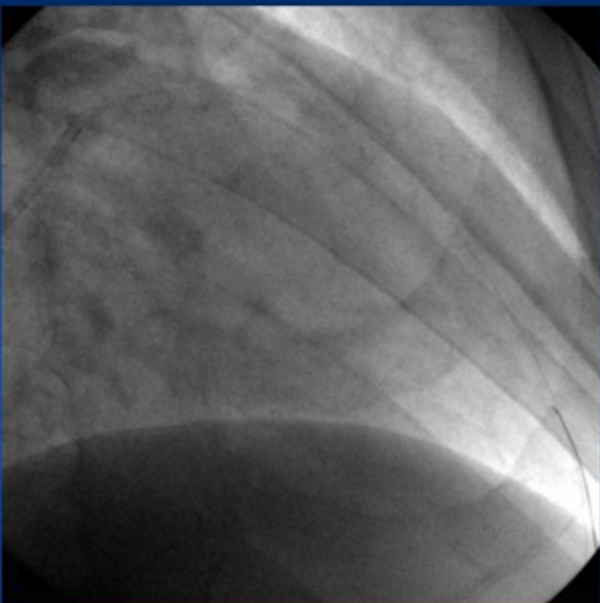


**An example of the double anchoring balloon technique to facilitate the passage of the retrograde balloon through hard CTO lesion**





# Final Result



In this case, CART was successful.

If CART technique were failed.

*Next step ?*

# Limitations of CART

- **In case of septal channel tracking**

*Dilatation of septal channel is mandatory to advance balloons.*

*→ Risk of septal channel perforation and septal hematoma.*

- **In case of epicardial channel tracking**

*It requires large and non tortuous collateral in epicardial tracking.*

*→ Risk of balloon trapping in tortuous case*

- **CART requires retrograde balloon access into CTO body.**  
However, it's sometimes difficult because of complex anatomy.

- **Long procedure time always carries the risk of donor artery trouble (thrombus formation, etc).**



## ***Reverse CART***

**Create a connection  
between the subintimal  
space of the CTO and the  
proximal true lumen by  
antegrade ballooning for  
retrograde wire passage**



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## ***Reverse CART***

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*proximal*



*distal*

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space of the CTO and the  
proximal true lumen by  
antegrade ballooning for  
retrograde wire passage**

*proximal*



*distal*

## ***Reverse CART***

**Create a connection  
between the subintimal  
space of the CTO and the  
proximal true lumen by  
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*distal*

## ***Reverse CART***

**Create a connection between the subintimal space of the CTO and the proximal true lumen by antegrade ballooning for retrograde wire passage**

*proximal*



*distal*

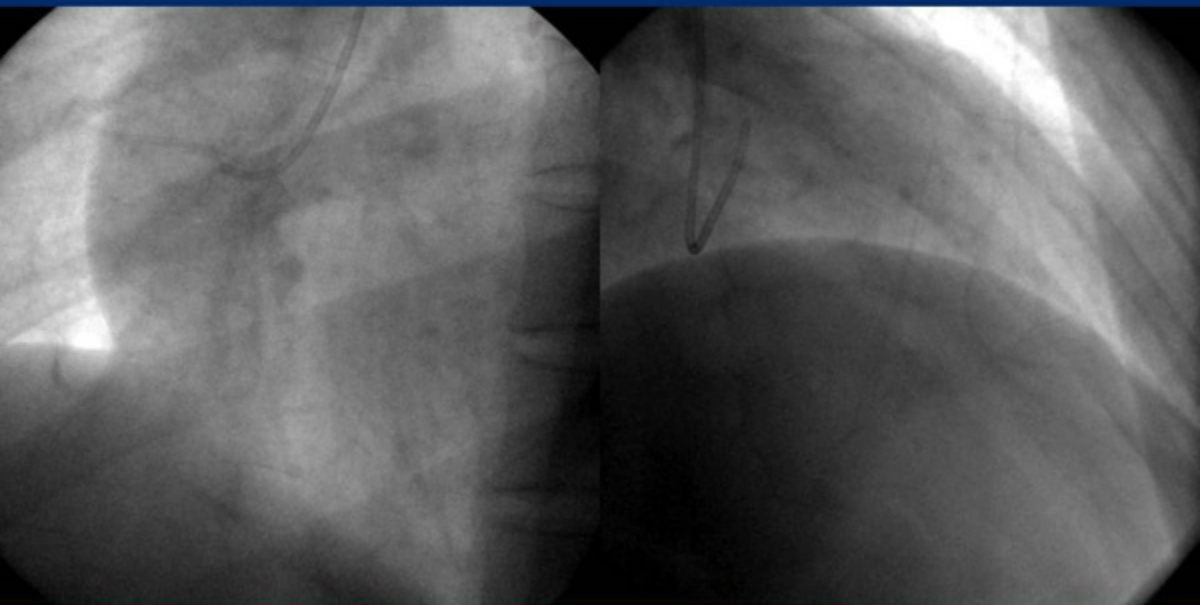
## ***Reverse CART***

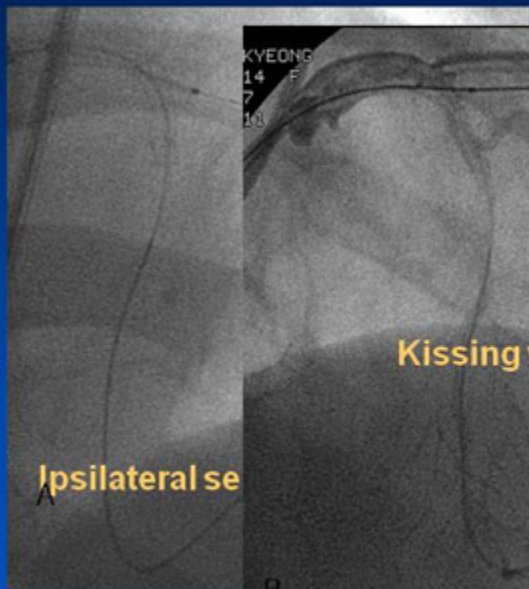
**Create a connection between the subintimal space of the CTO and the proximal true lumen by antegrade ballooning for retrograde wire passage**



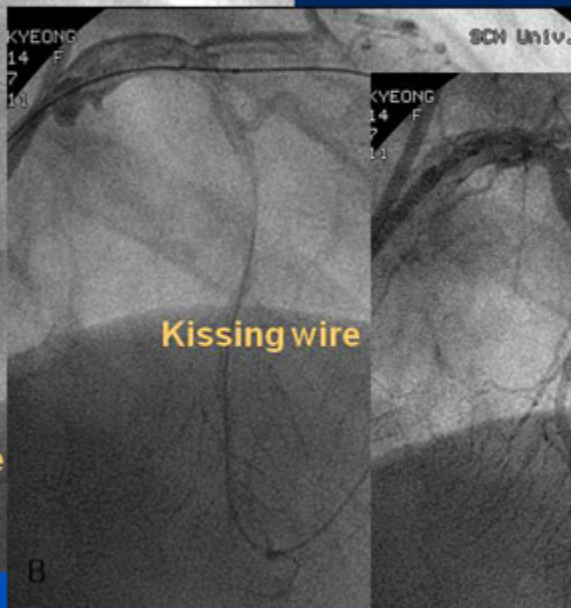
## An example of the reverse CART technique

*F 165, Multiple CTOs*





Ipsilateral se



Kissing wire



YEONG

4

ONG

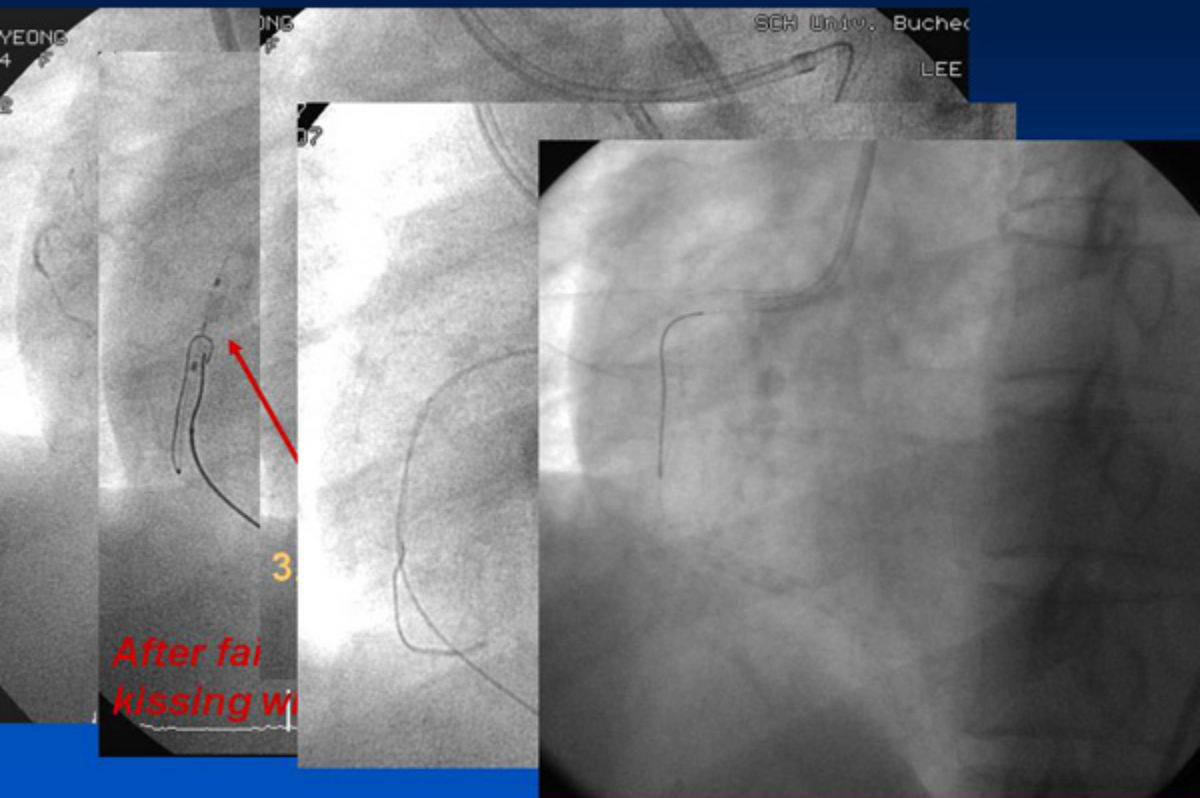
SCH Univ. Bucher

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07

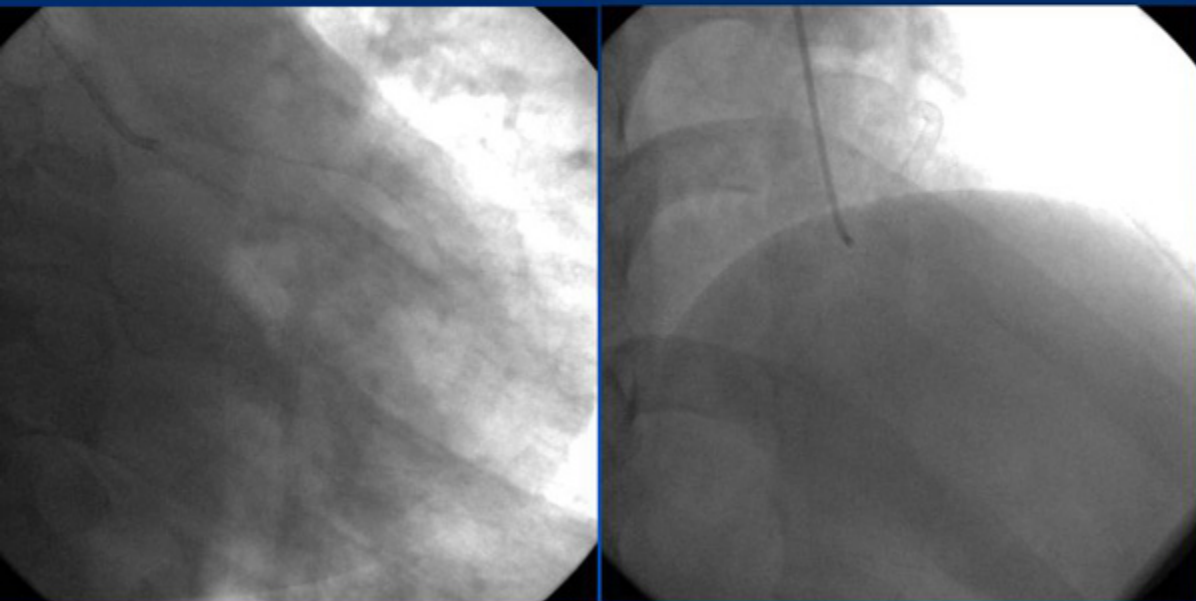
3

After fai  
kissing w

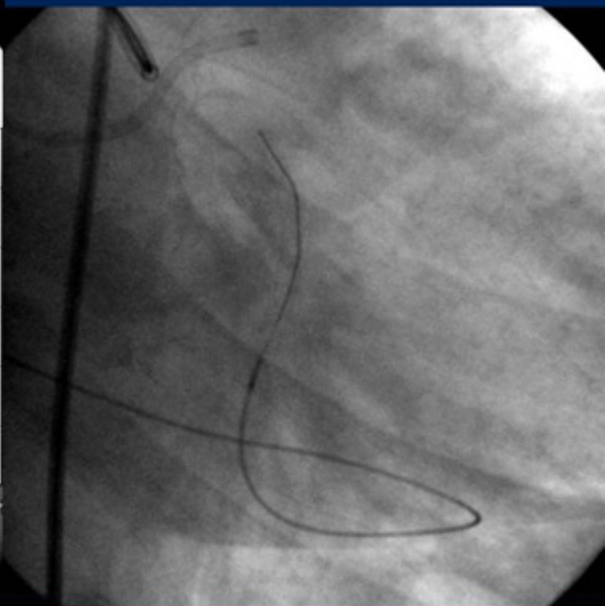
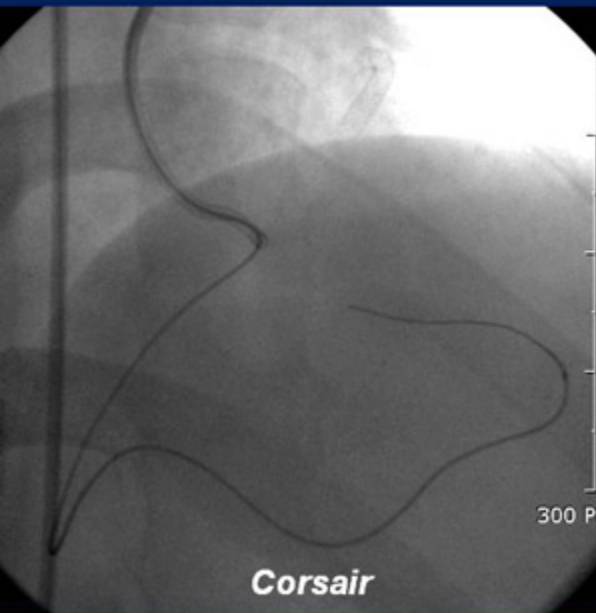


## An example of the reverse CART technique

*MI55, ISR-CTO (prior failed antegrade PCI )*

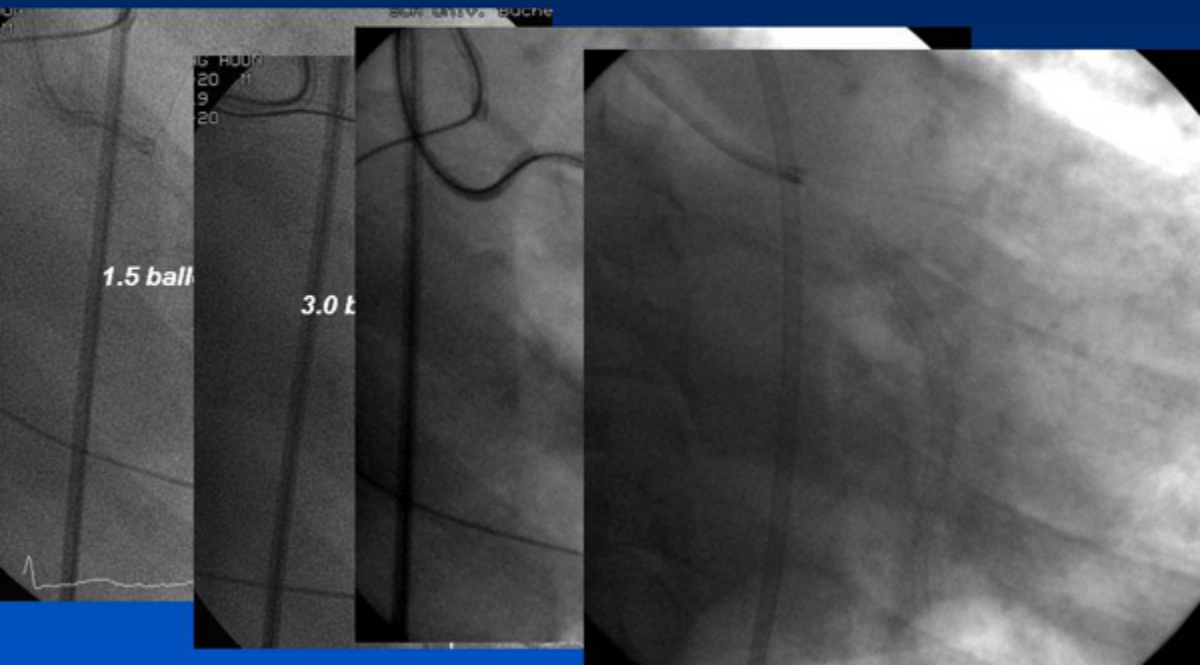


***Retrograde crossing was failed***

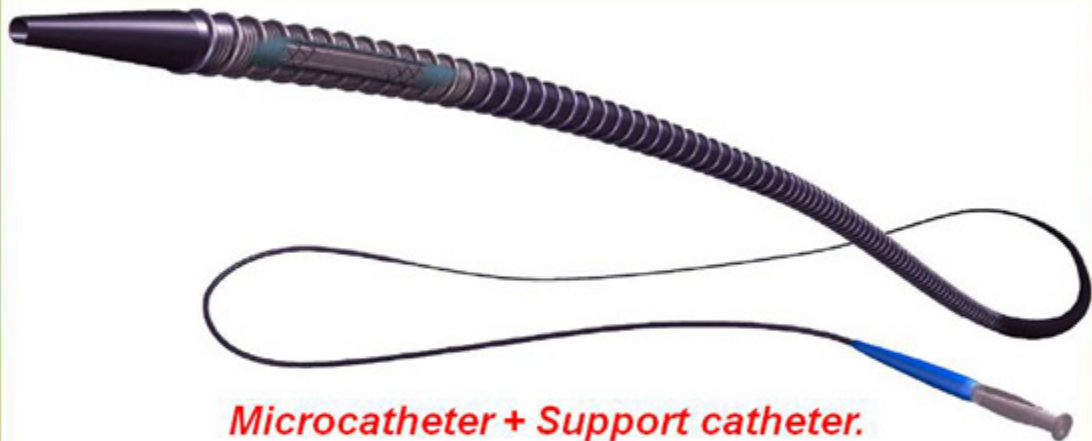


Rt: 7 Fr AL-2 (femoral)  
Lt: 6 Fr AL-2 (radial)

## *Antegrade balloon in CTO and proximal LCX*



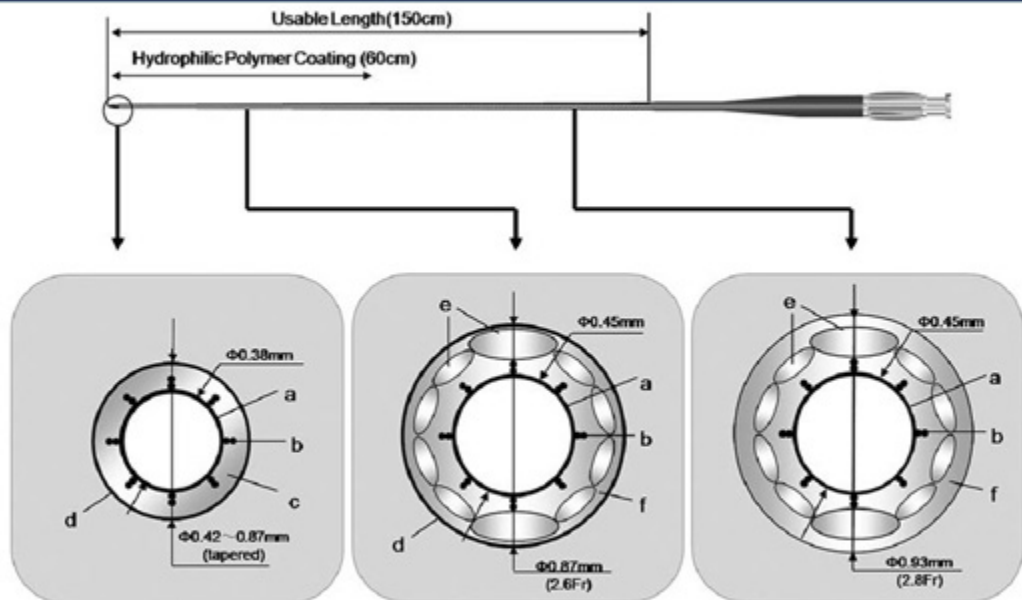
## Channel dilator (Corsair)



*Microcatheter + Support catheter.*

The shaft consists of 8 thin wires wound with 2 larger ones. This spiral structure allows bidirectional rotation to be transmitted to the distal shaft for crossing small tortuous collateral channels.

# Corsair catheter



- |                           |                                       |
|---------------------------|---------------------------------------|
| a: PTFE Inner Layer       | d: Hydrophilic Polymer Coating (60cm) |
| b: Tungsten Braiding      | e: Stainless Steel Wire               |
| c: Polyurethane elastomer | f: Polyamide elastomer                |



# The Advantage of Corsair

## For Channel Tracking

- Excellent cross-ability through collateral channel
- Tip injection
- No need of channel dilatation
- Less channel injury
- Expanded indication for epicardial channel

## For Retrograde Wiring of CTO

- Excellent support for wire manipulation
- Good cross-ability into/through the occlusion

## Retrograde PCI in Corsair era

- Reverse CART technique has become the most commonly used technique because retrograde balloon access is not required.
- Stiff wire is dispensable due to the improvement of retrograde wiring support.
- Floppy wires are sometimes good enough to connect the antegrade and retrograde channels under the reverse CART technique.

# Precautions for Reverse CART

- The accumulation of too much torque in 1 direction may destroy the Corsair itself. Thus, if the catheter becomes stuck, particularly in severely calcified occlusions, operator should stop turning the catheter in the same direction.
- Antegrade injection of contrast should be avoided to prevent enlargement of the dissection created by the antegrade ballooning.
- Instead, IVUS is recommended when it is necessary to check the position of the wire and/or the vessel size, and to determine the stent position.

# Summary

- Among the various PCI techniques for CTO, the retrograde PCI through native collateral channels is considered to be one of the most promising current techniques.
- Collateral channel is the key determinant in retrograde PCI.
- Step by step application of the different strategies and techniques are required to increase the success rate of retrograde PCI
- If simple techniques, such as retrograde crossing or kissing wire techniques are used exclusively without other more complex techniques, such as the CART or R-CART technique, a high success rate cannot be expected.
- Due to the introduction of channel dilator, R-CART can be a leading modality in retrograde PCI.