

# CTO Intervention Related Complications

: How to Avoid? How to Overcome?

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# CTO PCI still have limitations

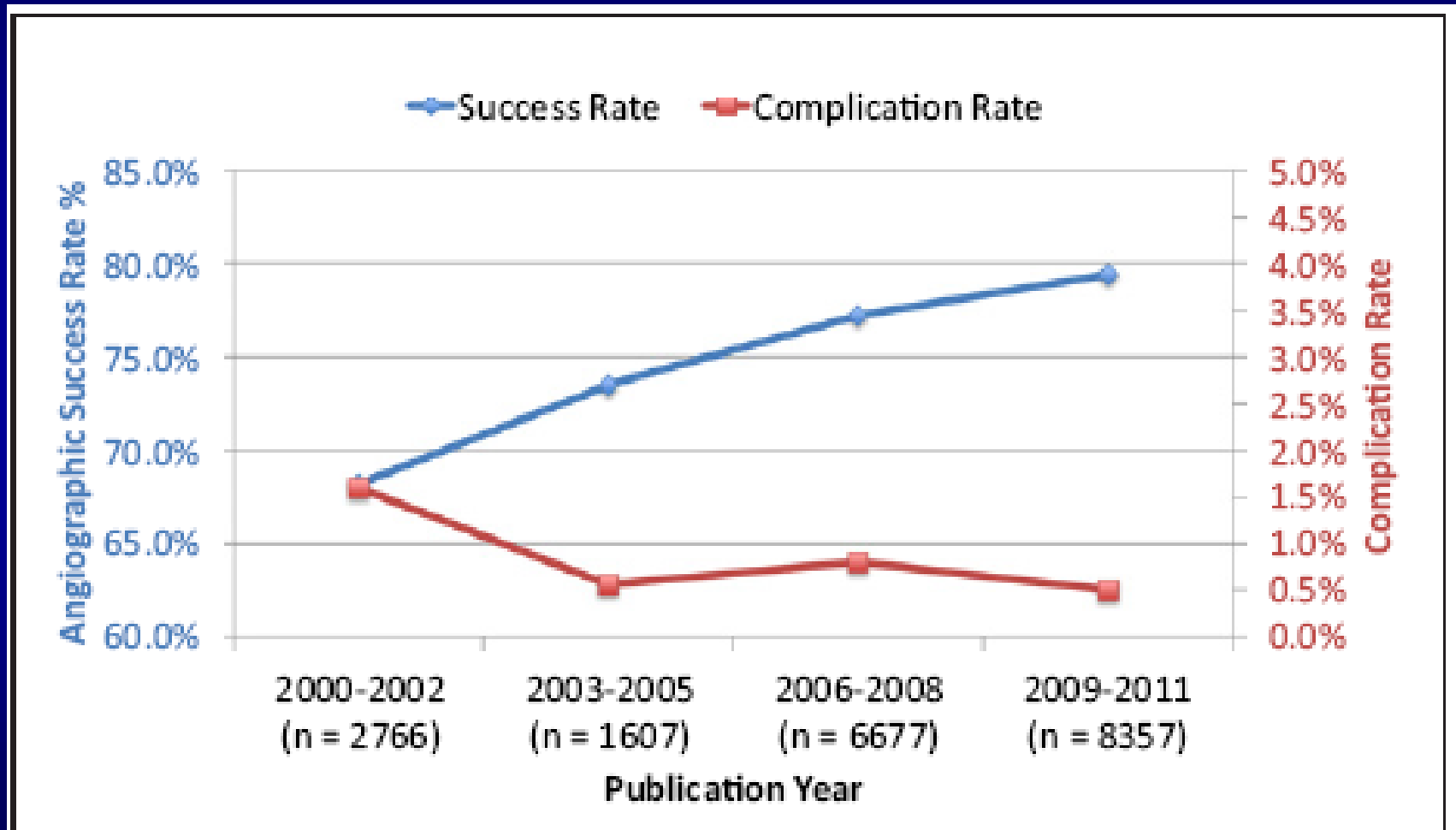
1. Successful PCI for CTO has been associated with symptom improvement of angina, left ventricular function, and also survival.

J Am Coll Cardiol Intv 2009;2:479-86.

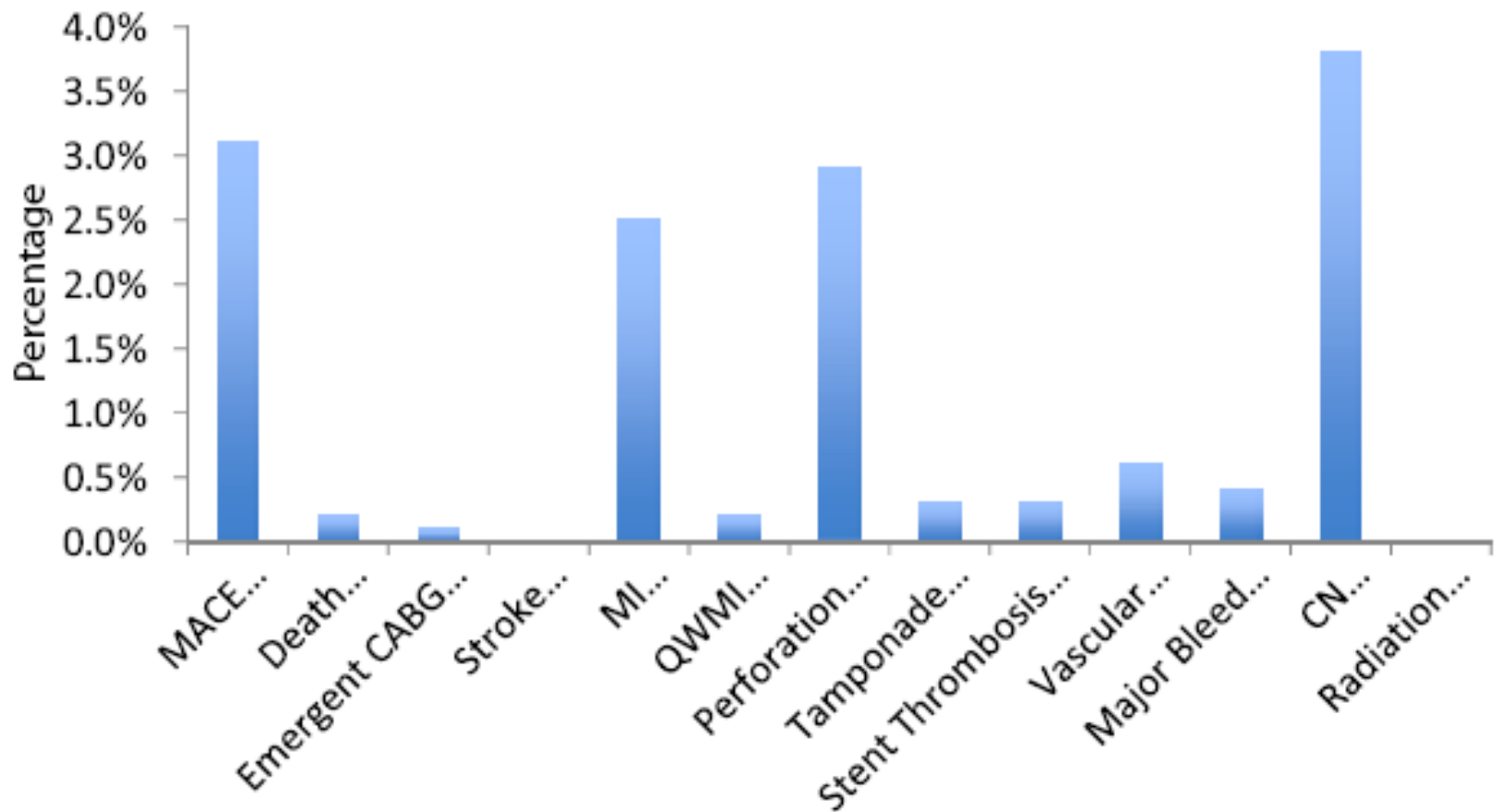
2. However, despite of these benefit, CTO intervention is not frequently being performed due to higher chance of technical difficulties, more elaboration for procedural success, relatively lower procedural success than usual cases, more consumption of expensive devices, and finally, the potential for peri-procedural complications.

**Complications from the  
Recently Published Western  
CTO data**

# Temporal trends in CTO complication rates



# Pooled Complication Rates



# Incidence of procedural complications in Successful vs. Unsuccessful CTO PCI

Outcomes, N (%)	Successful	Unsuccessful	P-value
<b>MACE</b>	84 (3.7)	14 (4.3)	0.68
<b>Death</b>	19 (0.4)	17 (1.5)	<0.0001
<b>Emergent CABG</b>	1 (0.03)	1 (0.17)	0.74
<b>Stroke</b>	3 (0.07)	4 (0.4)	0.04
<b>Myocardial infarction</b>	106 (2.8)	25 (3.0)	0.87
<b>Coronary perforation, per lesion</b>	67 (3.7)	55 (10.7)	<0.0001
<b>Tamponade</b>	0 (0)	7 (1.7)	<0.0001
<b>Vascular complication</b>	33 (1.7)	6 (0.9)	0.20
<b>Contrast nephropathy</b>	18 (5.0)	5 (4.6)	0.86

**CTO Complication Data from  
a Korean CTO Registry  
(Korea University Guro  
Hospital CTO Registry)**



# Procedure-related complications from KUGH (Korea Univ Guro Hospital) CTO registry

Variables, N (%)	Total (n=293)	Complications (n=91)	None (n=202)	P-value
Arrhythmia	6 (2.0)	6 (6.5)	0 (0.0)	0.003
Acute thrombosis	1 (0.3)	1 (1.0)	0 (0.0)	0.311
Rupture/Perforation	11 (3.7)	<b>11 (12.0)</b>	0 (0.0)	< 0.001
Spontaneously stopped.	3 (1.0)	3 (3.2)	0 (0.0)	
Graft stenting	3 (1.0)	3 (3.2)	0 (0.0)	
Balloon occlusion	5 (1.7)	5 (5.4)	0 (0.0)	
Coil	1 (0.3)	1 (1.0)	0 (0.0)	
Dissection	53 (18.0)	53 (58.2)	0 (0.0)	< 0.001
Stenting	26 (8.8)	26 (28.5)	0 (0.0)	
Stenting failure	1 (0.3)	1 (1.0)	0 (0.0)	
No reflow	9 (3.0)	<b>10 (10.9)</b>	0 (0.0)	< 0.001
Spasm	3 (1.0)	3 (3.2)	0 (0.0)	0.029
Access site hematoma	12 (4.0)	<b>12 (13.2)</b>	0 (0.0)	< 0.001
Any hematoma (<4cm)	8 (2.7)	8 (8.8)	0 (0.0)	< 0.001
Major hematoma (≥4cm)	4 (1.4)	4 (4.4)	0 (0.0)	0.009
Transfusion	3 (1.0)	3 (3.2)	0 (0.0)	0.029
Intraabdominal hematoma*				
Congestive heart failure	4 (1.3)	4 (4.3)	0 (0.0)	0.009
Acute renal failure	2 (0.6)	<b>2 (2.1)</b>	0 (0.0)	0.096
Cerebrovascular accident	2 (0.6)	<b>2 (2.1)</b>	0 (0.0)	0.096
Periprocedural MI	18/182 (9.8)	<b>18/56 (32.1)</b>	0/182 (0.0)	< 0.001

# In-hospital clinical outcomes from KUGH CTO registry

Variables, N (%)	Total (n=293)	Complications (n=91)	None (n=202)	P-value
<b>Mortality</b>	5 (1.7)	5 (5.4)	0 (0.0)	<b>0.003</b>
<b>Cardiac death</b>	3 (1.0)	3 (3.2)	0 (0.0)	0.029
<b>Non cardiac death</b>	2 (0.6)	2 (2.1)	0 (0.0)	0.096
<b>Myocardial infarction</b>	4 (1.3)	4 (4.3)	0 (0.0)	<b>0.009</b>
<b>Q-MI</b>	4 (1.3)	4 (4.3)	0 (0.0)	0.009
<b>Revascularization*</b>	1 (0.3)	1 (1.0)	0 (0.0)	0.311
<b>TLR</b>	1 (0.3)	1 (1.0)	0 (0.0)	0.311
<b>TVR</b>	1 (0.3)	1 (1.0)	0 (0.0)	0.311
<b>All MACE**</b>	6 (2.0)	6 (6.5)	0 (0.0)	<b>0.001</b>
<b>TLR MACE</b>	4 (1.3)	4 (4.3)	0 (0.0)	<b>0.009</b>
<b>TVR MACE</b>	6 (2.0)	6 (6.5)	0 (0.0)	<b>0.001</b>

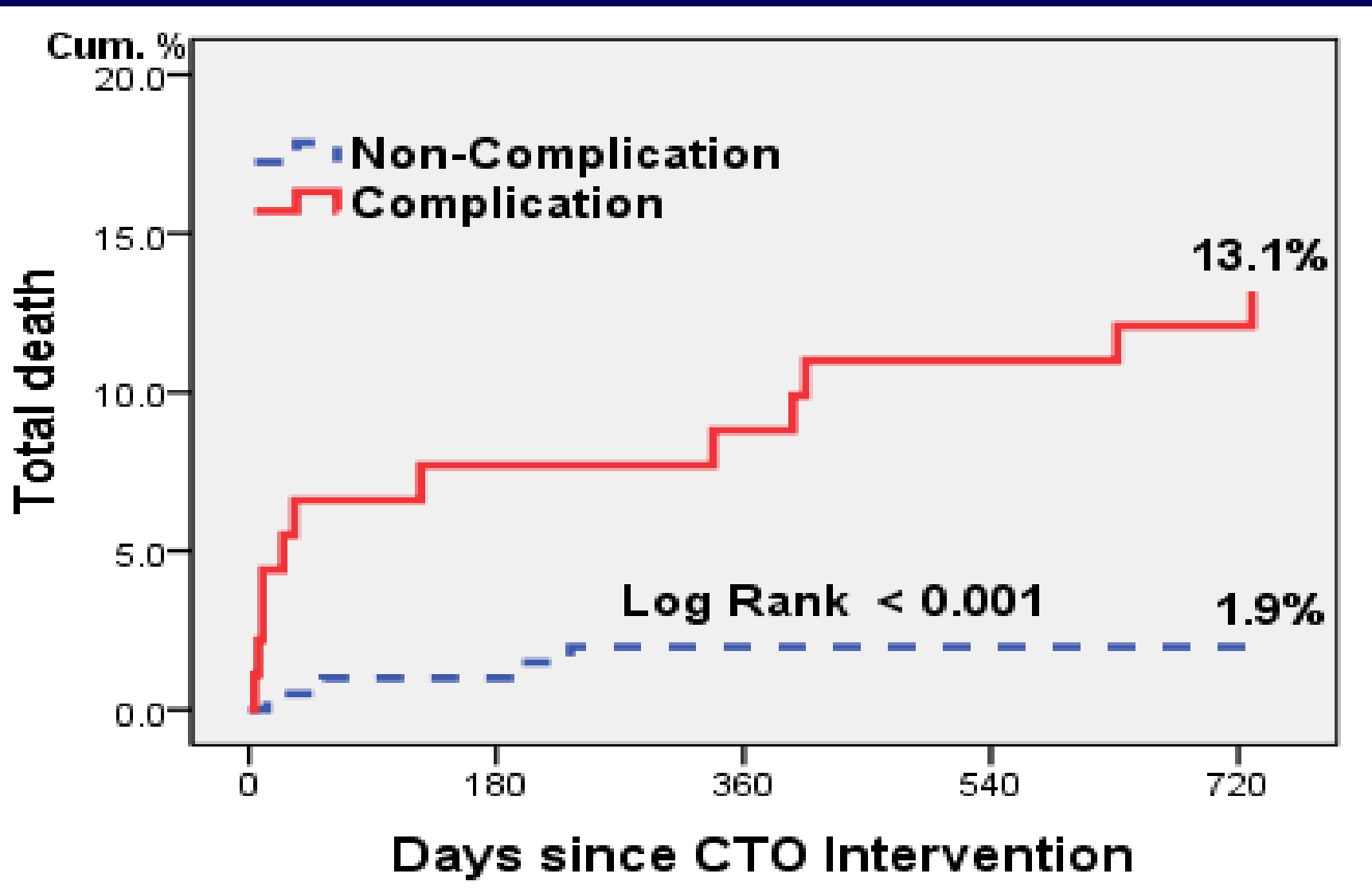
# Cumulative clinical outcomes at 2 years from KUGH CTO Registry

Variables, N (%)	Total (n=293)	Complications (n=91)	None (n=202)	P-value
<b>Mortality</b>	16 (5.4)	12 (13.1)	4 (1.9)	<b>&lt; 0.001</b>
<b>Cardiac death</b>	6 (2.0)	5 (5.4)	1 (0.4)	0.012
<b>Non cardiac death</b>	10 (3.4)	7 (7.6)	3 (1.4)	0.012
<b>Myocardial infarction</b>	7 (2.3)	5 (5.4)	2 (0.9)	<b>0.032</b>
<b>Q-MI</b>	6 (2.0)	4 (4.3)	2 (0.9)	0.077
<b>Non Q-MI</b>	1 (0.3)	1 (1.0)	0 (0.0)	0.311
<b>Revascularization</b>	39 (13.3)	8 (8.7)	31 (15.3)	0.126
<b>TLR</b>	28 (9.5)	7 (7.6)	21 (10.3)	0.466
<b>TVR</b>	33 (11.2)	8 (8.7)	25 (12.3)	0.369
<b>Non TVR</b>	5 (1.7)	0 (0.0)	5 (2.4)	0.329
<b>All MACE</b>	54 (18.4)	19 (20.8)	35 (17.3)	0.468
<b>TLR MACE</b>	35 (11.9)	12 (13.1)	23 (11.3)	0.660
<b>TVR MACE</b>	50 (17.0)	19 (20.8)	31 (15.3)	0.244
<b>Stents thrombosis</b>	2 (0.6)	2 (2.1)	0 (0.0)	<b>0.096</b>
<b>Acute</b>	1 (0.3)	1 (1.0)	0 (0.0)	0.525
<b>Subacute</b>	1 (0.3)	0 (0.0)	1 (0.4)	0.263

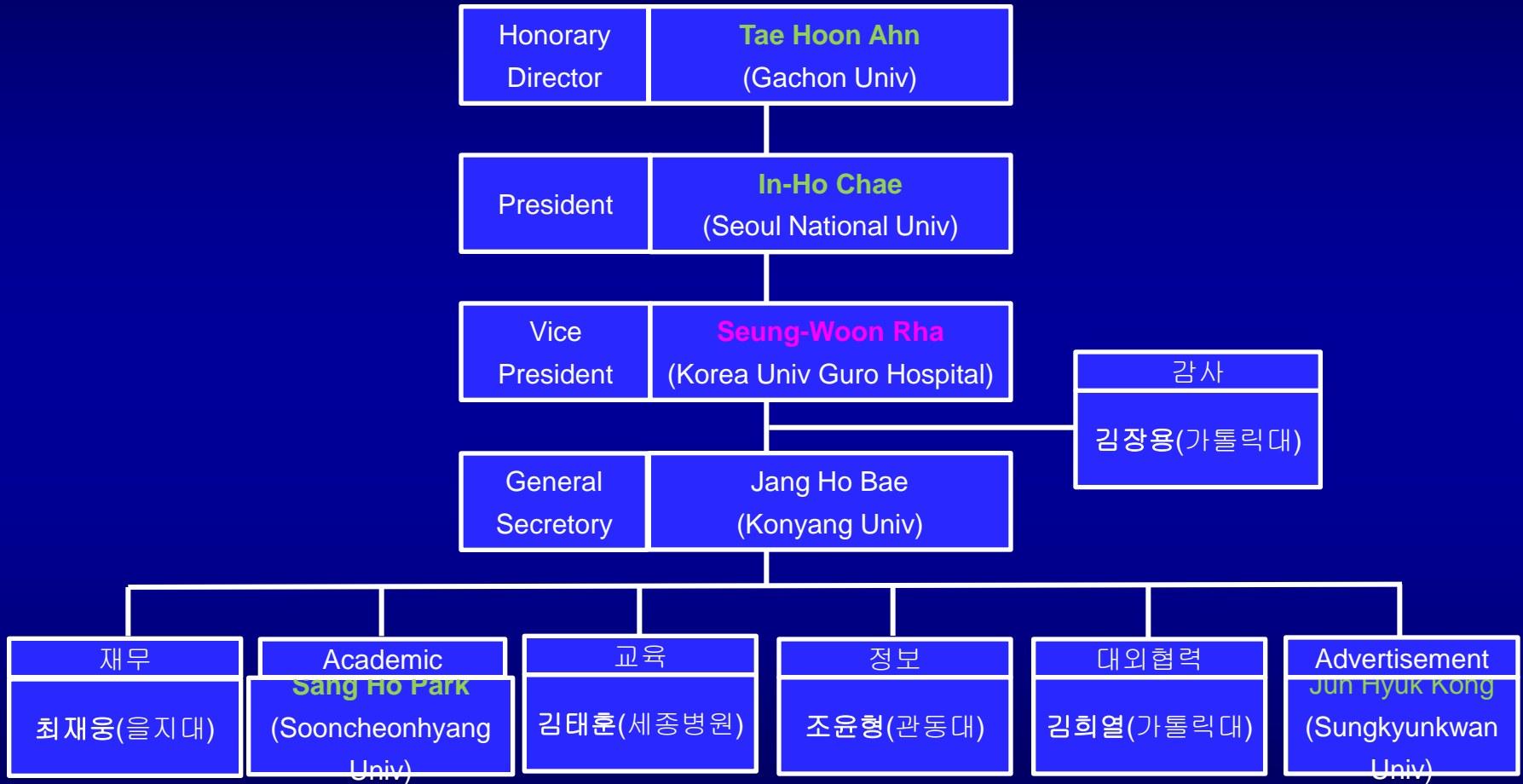
# Independent Predictors of Mortality at 2-year

Variables, n (%)	HR (95% C.I)	P-value
<b>Perforation / Rupture</b>	1.69 (0.15 - 18.3)	0.666
<b>Dissection</b>	1.57 (0.43 - 5.70)	0.492
<b>Acute thrombosis</b>	-	-
<b>Access site complications</b>		
<b>Any hematoma</b>	3.69 (0.40 - 33.4)	0.244
<b>Major hematoma</b>	8.67 (0.81 - 92.2)	0.073
<b>Acute heart failure</b>	7.36 (0.61 - 87.9)	0.115
<b>Acute renal failure</b>	23.4 (1.30 - 420.)	0.032
<b>Cerebrovascular accidents</b>	-	-

# Kaplan-Meyer Survival Curve; Cx vs. No Cx



# Korean Cardiovascular Complication Club (K-CCC, 2013.5-2014.12)



# K-CCC with HKSTENT/CICF 2014



K-CCC and CICF leaders  
at HKSTENT-CICF 2014

Mar 16, 2014

# **Prevention and Management of CTO related Complications**



# KUGH prevention and management protocol for CTO PCI Complications (1)

	Complications	Prevention	Management
	<b>Coronary Perforation/ Tamponade</b>	Careful wire selection and manipulation Adequate device size (balloon, stent) Cautions; calcified, angulated, tortuous vessel, hydrophilic wires, atheroablative devices	<ol style="list-style-type: none"> <li>1. Balloon tamponade</li> <li>2. Graftstent</li> <li>3. Coils, gelform, fat</li> <li>4. Tamponade; Pericardiocentesis</li> <li>5. Emergent surgery</li> </ol>
	<b>Contrast nephropathy</b>	Hydration Minimizing contrast amount, Premedications (Controversy)	Hydration Temporary hemodialysis
	<b>Major vascular and bleeding complications</b>	<ol style="list-style-type: none"> <li>1. Avoid too large caliber sheaths and limit the number of vascular access</li> <li>2. Optimize the antithrombotics and antiplatelets</li> <li>3. Female vs. Male; Female is more risky</li> </ol>	<ol style="list-style-type: none"> <li>1. Reducing bleeding tendency by medications/hydration</li> <li>2. Adequate closure devices and compression</li> <li>3. Surgery</li> </ol>

# KUGH prevention and management protocol for CTO PCI Complications (2)

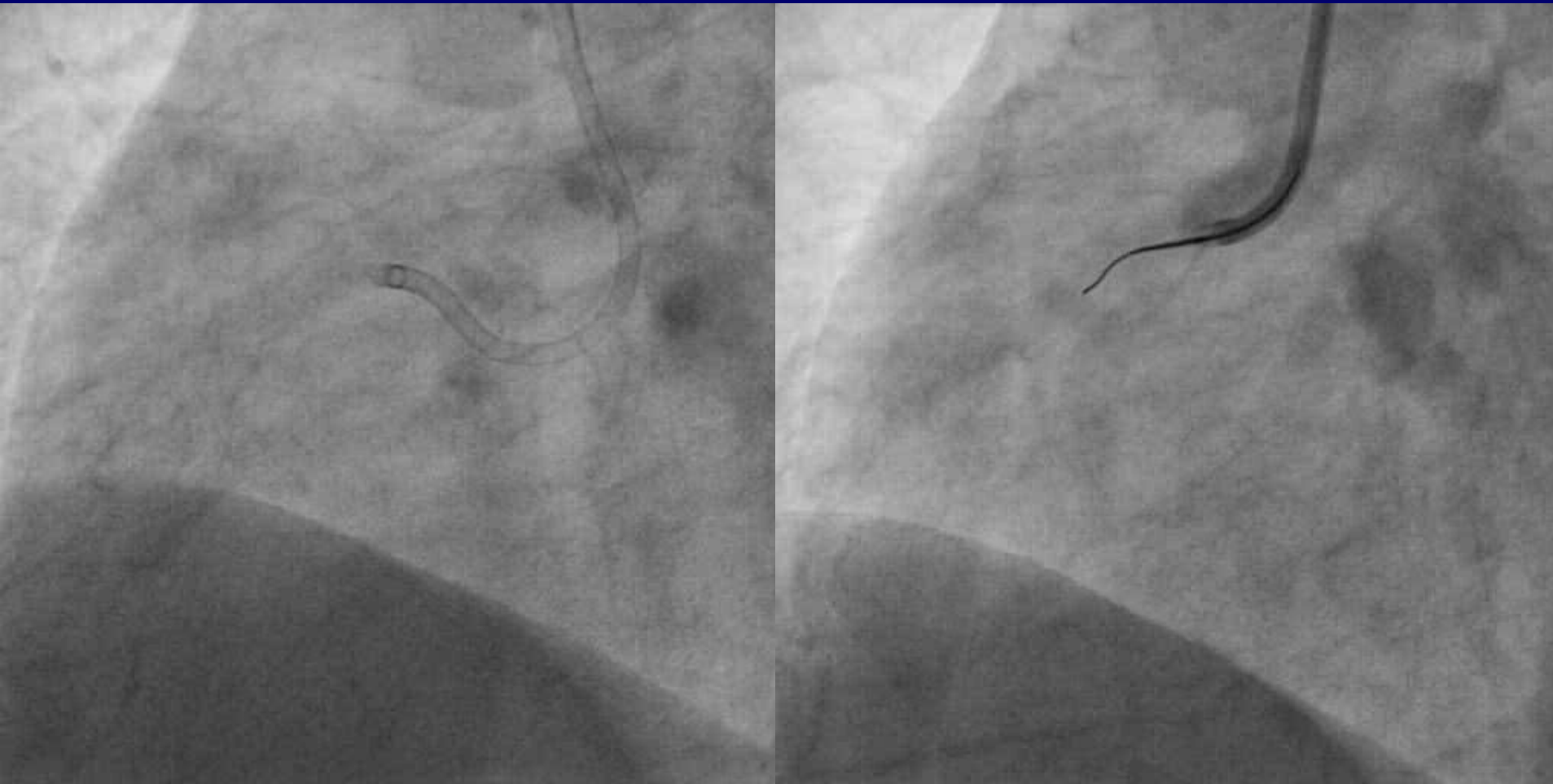
	Complications	Prevention	Management
	<b>Aorto-ostial dissection</b>	<ol style="list-style-type: none"> <li>1. Careful manipulation of guiding catheter, especially large caliber catheter</li> <li>2. Careful manipulation of retrograde CTO wires</li> <li>3. Avoid forceful contrast injection</li> <li>4. Cautions during deep intubation and 'Child in mother' technique</li> </ol>	<ol style="list-style-type: none"> <li>1. Stenting</li> <li>2. Surgery</li> </ol>
	<b>Radiation skin injury</b>	<ol style="list-style-type: none"> <li>1. Minimize fluoroscopy and cine-angiography exposure time.</li> <li>2. Regular checking up of radiation dose administered during CTO PCI (Postpone if &gt;8 to 10 air kerma exposure)</li> </ol>	Pharmacologic intervention for specific lesion including topical agents

# KUGH prevention and management protocol for CTO PCI Complications (3)

	Complications	Prevention	Management
	<b>Device entrapment including stent loss</b>	<ol style="list-style-type: none"> <li>1. Adequate lesion pretreatment (predilation and atheroablation)</li> <li>2. Checking the axis of guiding catheter during pullback of device (maintain co-axial)</li> </ol>	Small balloon technique Crushing stenting Snares (loop. Gooseneck) Twisted guidewires Multipurpose basket Myocardial biopsy forcep Distal protection device Surgery
	<b>No reflow/Slow flow</b>	Cautions in angiographic thrombi burden and vulnerable or attenuated plaque on IVUS → Consider distal protection device	Thrombus aspiration Drugs; Intracoronary injection Nicorandil, Nitroprusside, Verapamil, Nitroglycerin
	<b>Acute thrombosis</b>	<ol style="list-style-type: none"> <li>1. Regular ACT monitoring (every 1 hour in case of prolonged CTO PCI)</li> <li>2. Regular catheter flushing with heparinized saline</li> </ol>	<ol style="list-style-type: none"> <li>1. Thrombus aspiration</li> <li>2. Medication; additional heparin and GpIIb/IIIa inhibitor</li> <li>3. Stenting</li> <li>4. Hemodynamic support (IABP, EBS)</li> </ol>

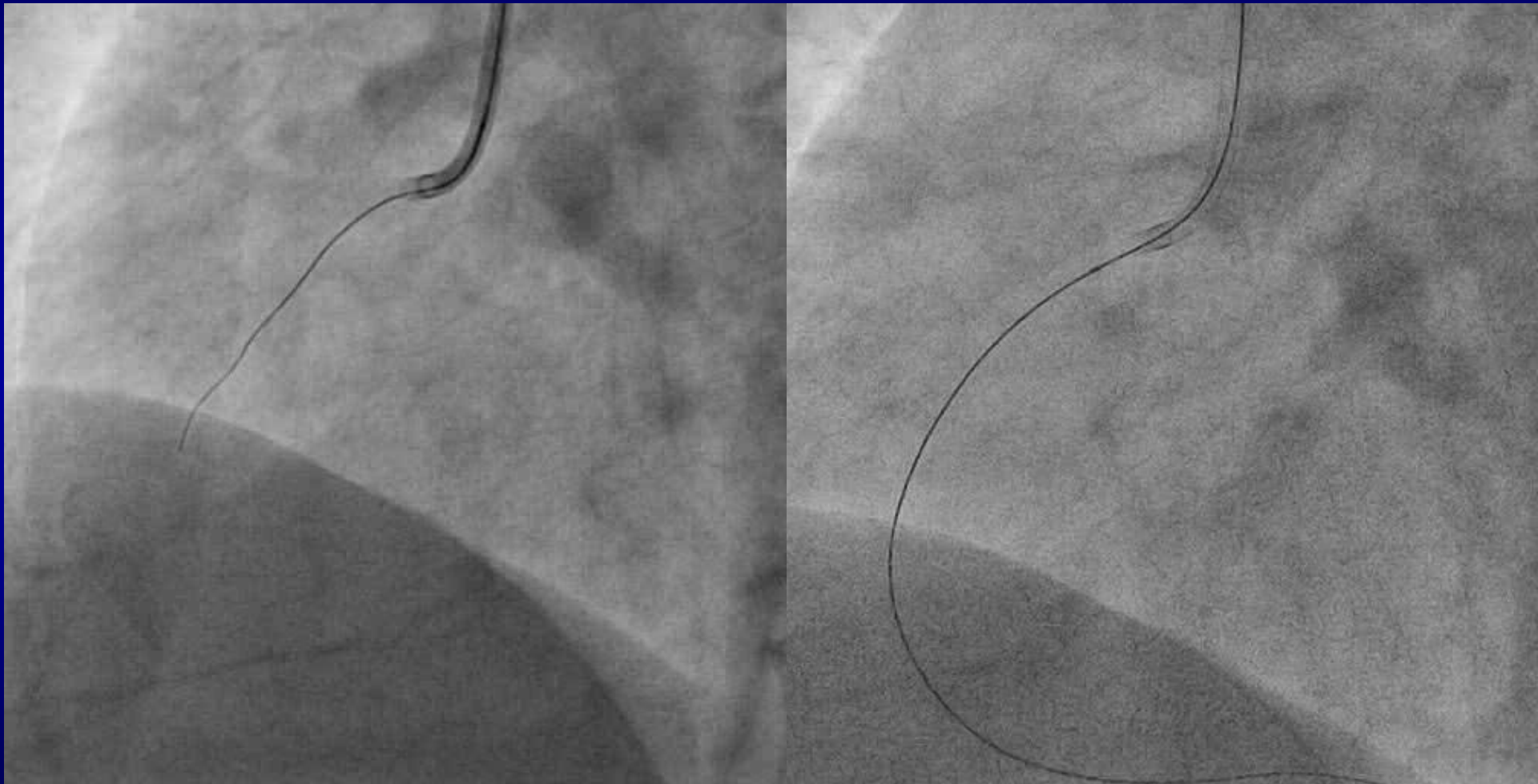
# CTO-PCI Complication Cases

# Dissection/Extravasation Case

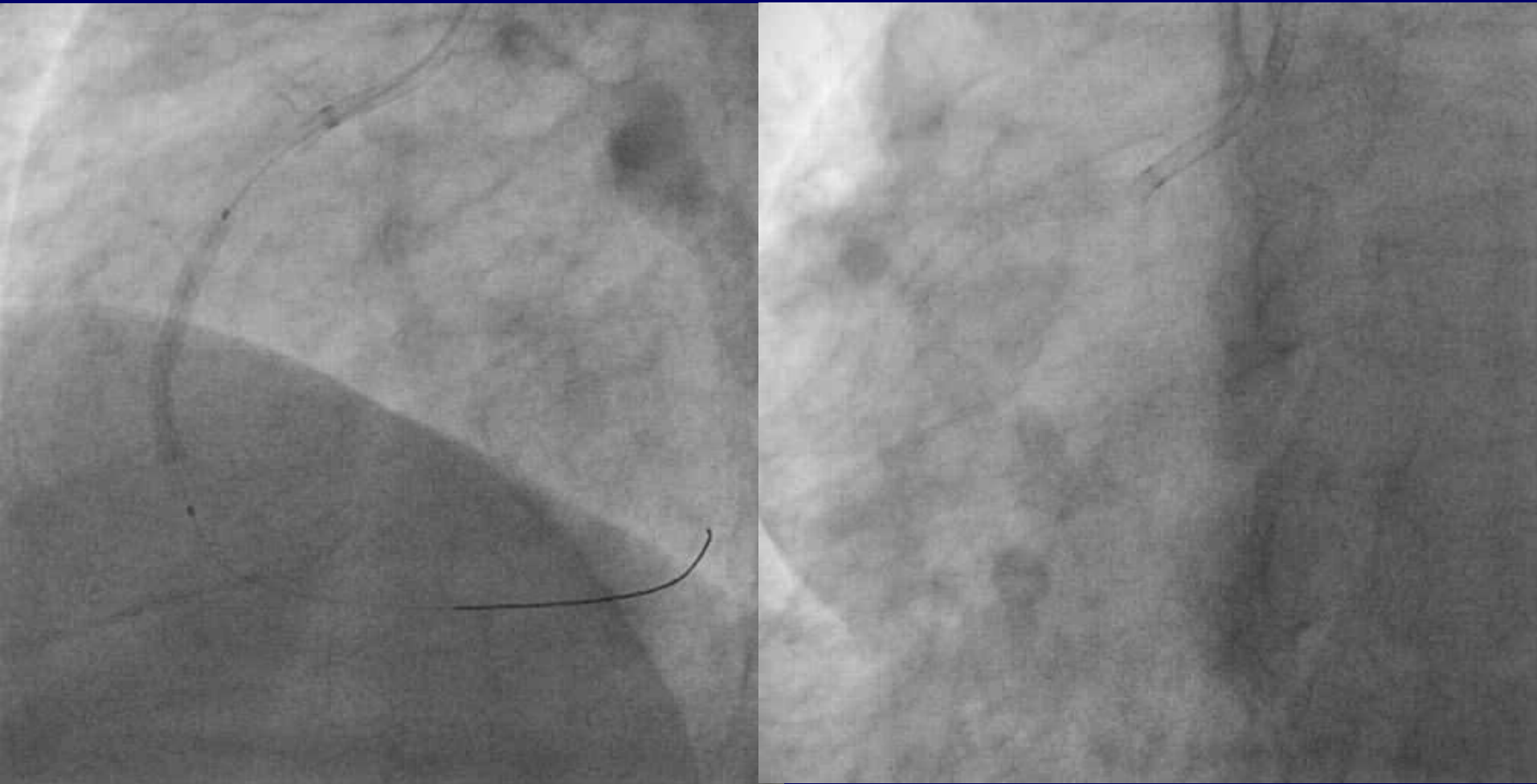


Baseline Angiography; Forceful injection at OS should be avoided!

# Intraluminal Wiring



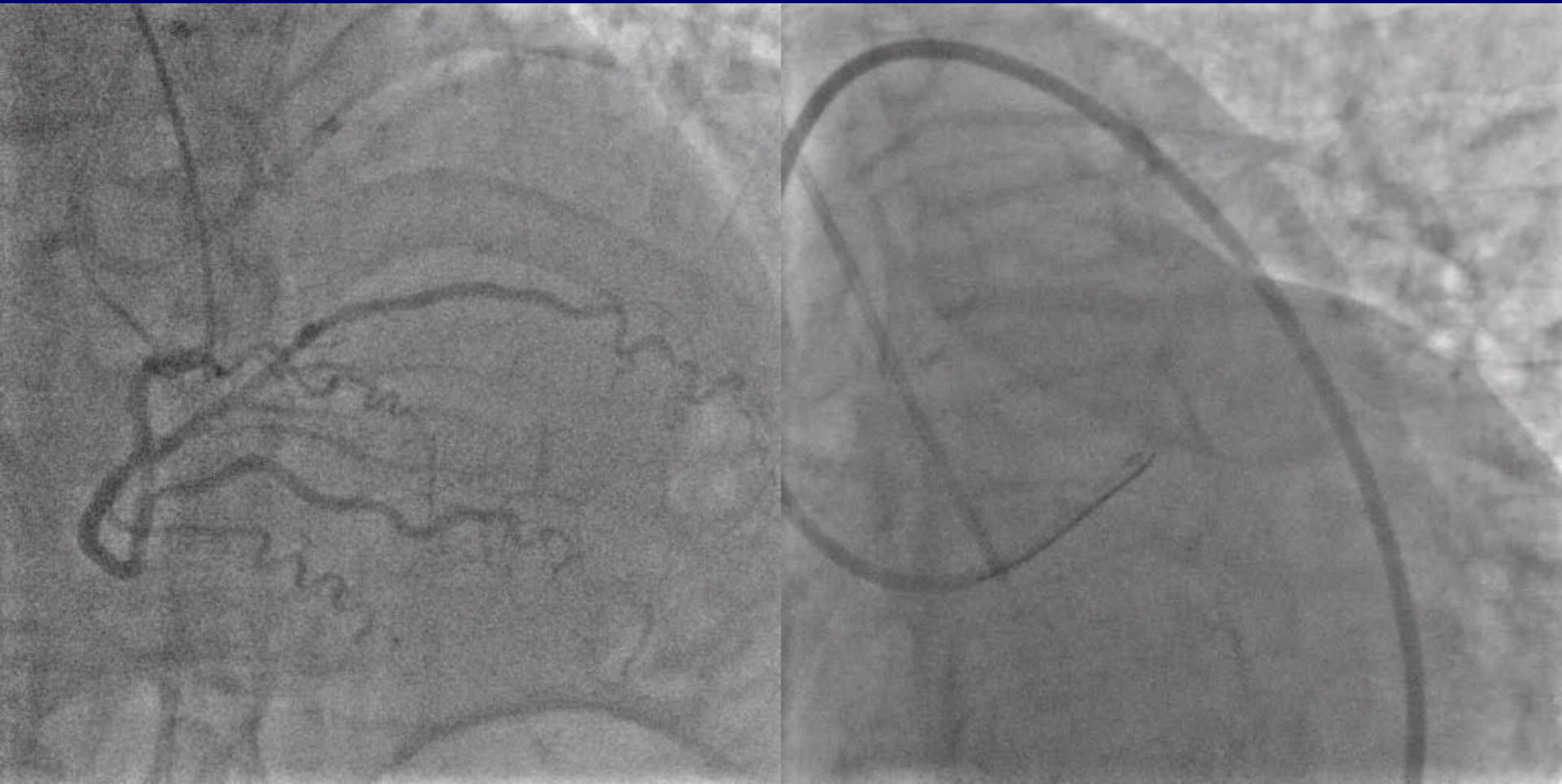
# Stenting-Final



Successful Intraluminal Wiring and Stenting is essential



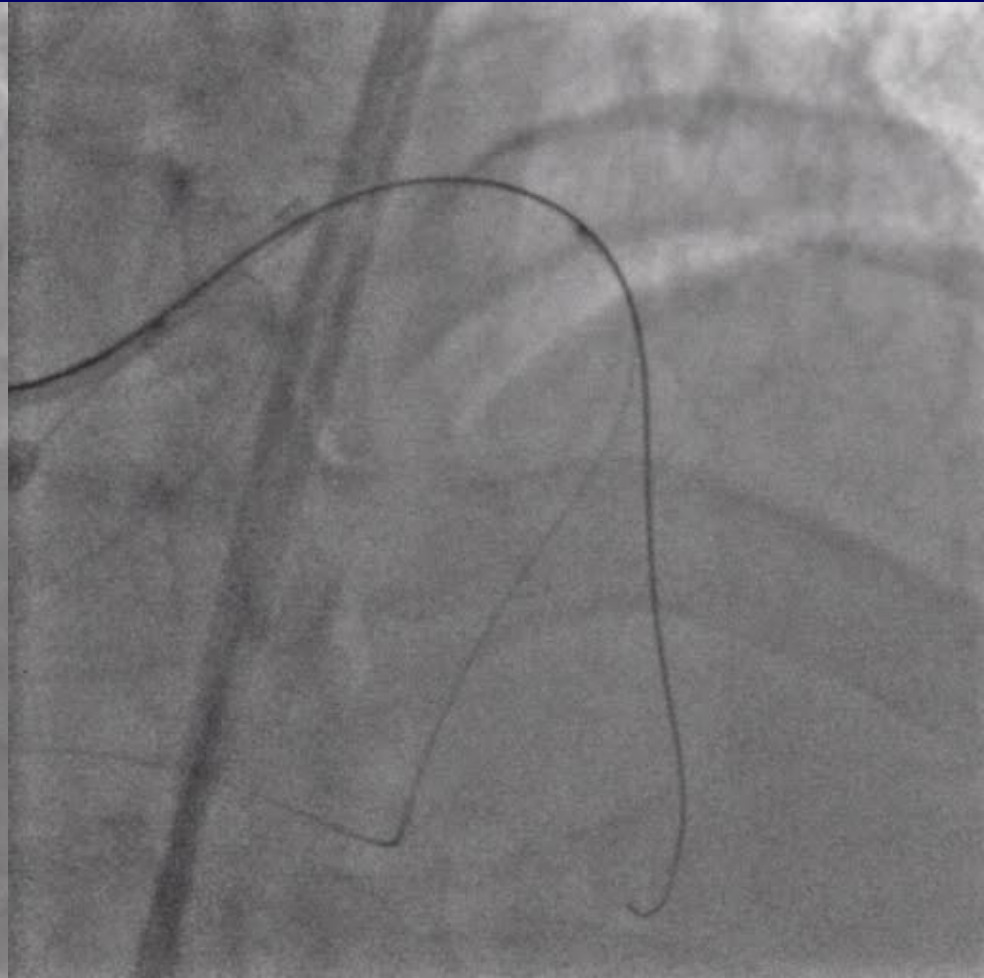
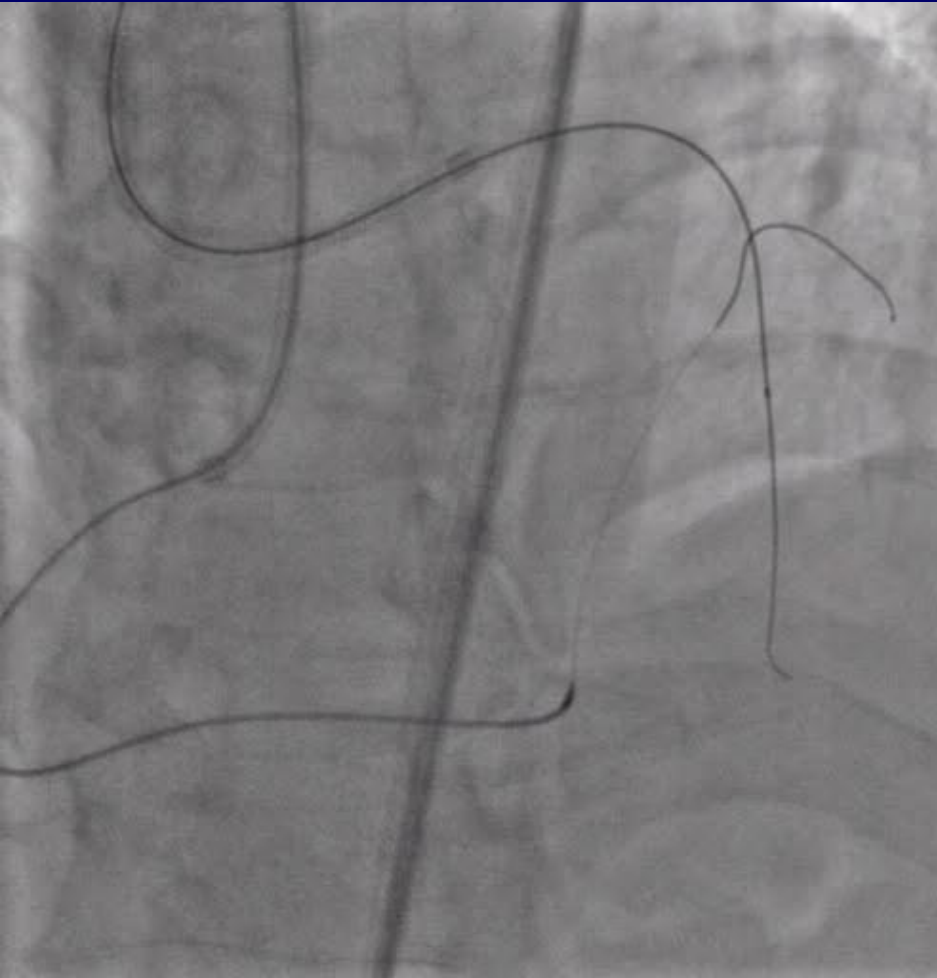
# Major Perforation/Tamponade Case



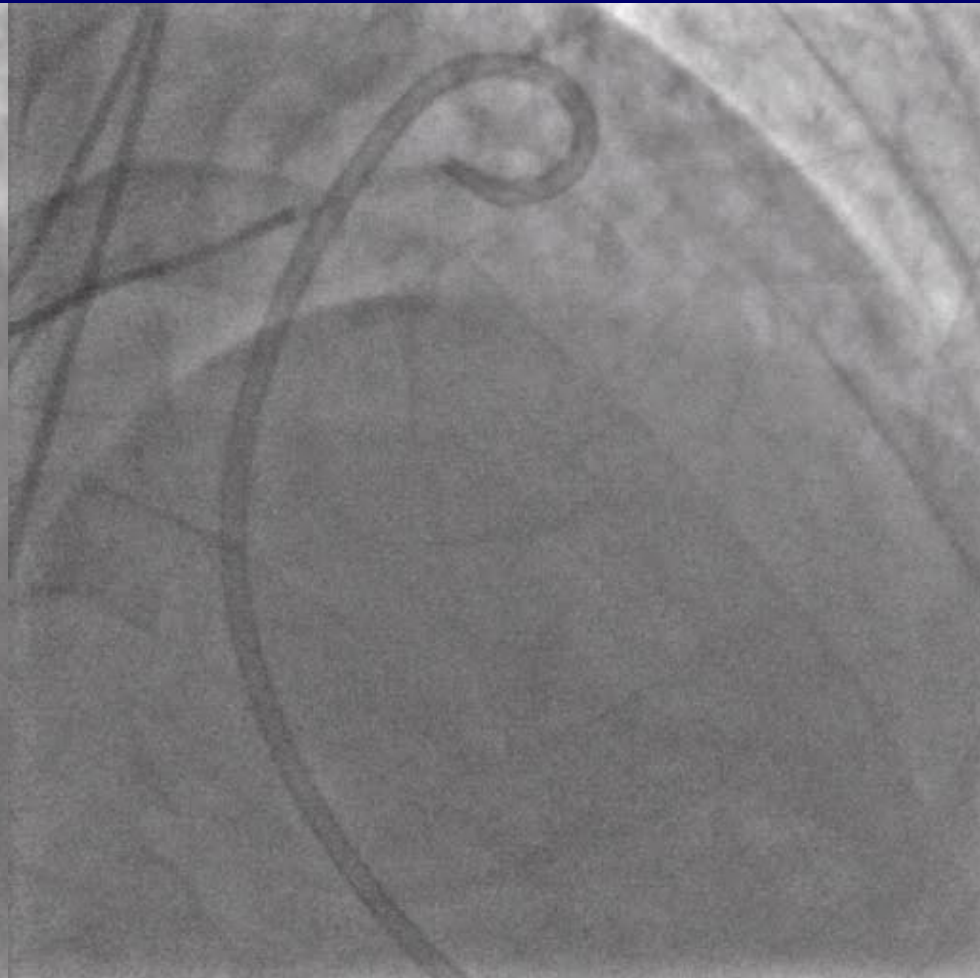
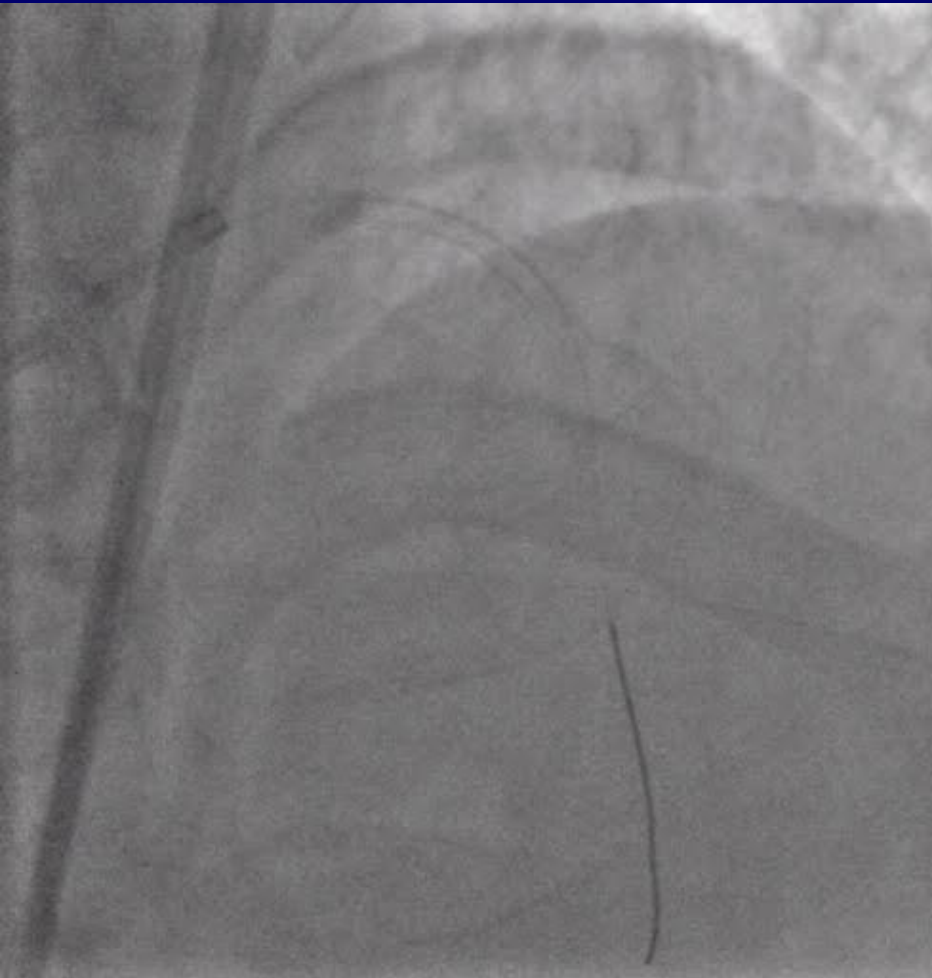
LAD CTO-Baseline CAG



# Retrograde & Antegrade Wire

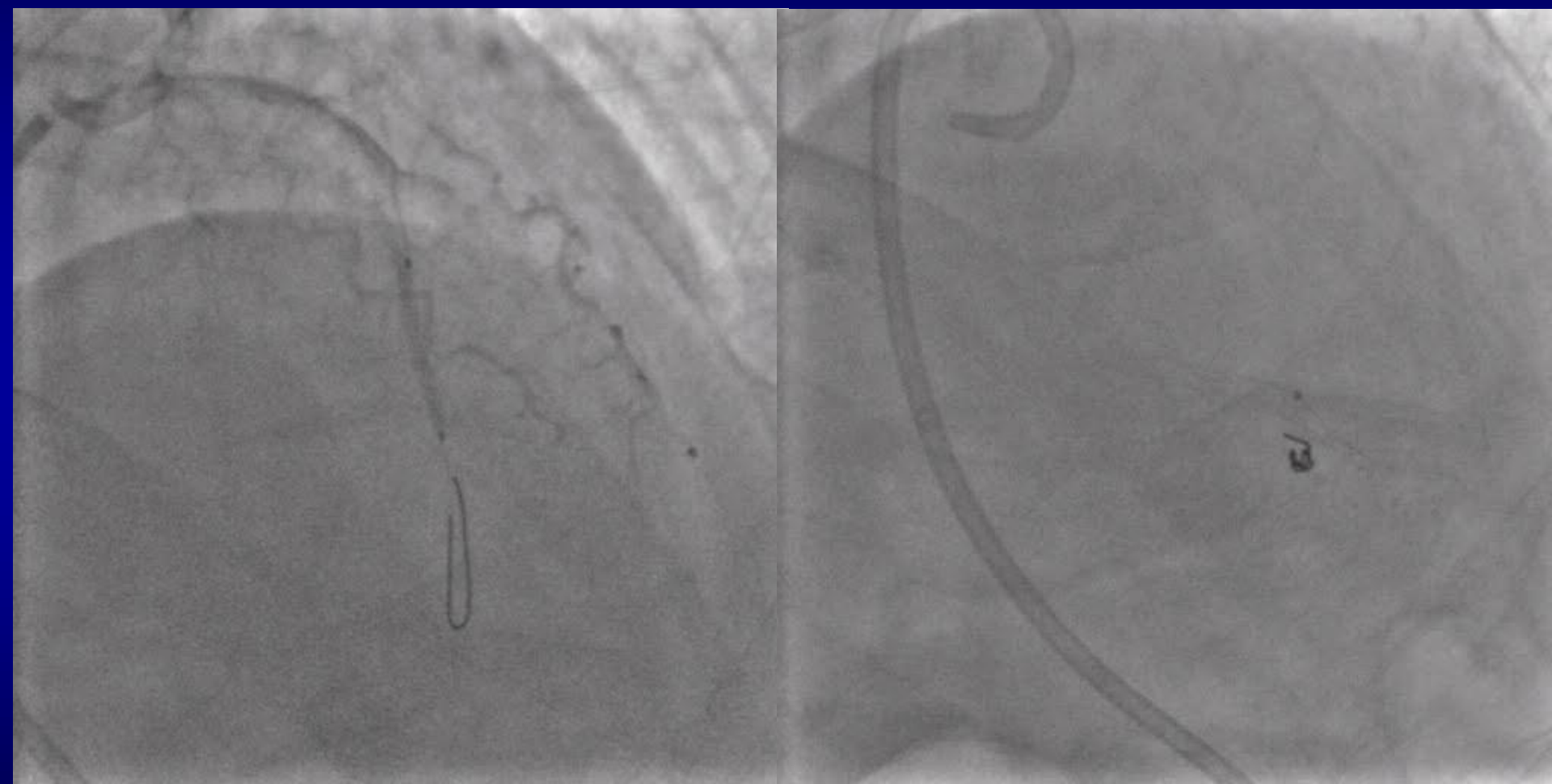


# Post-POBA



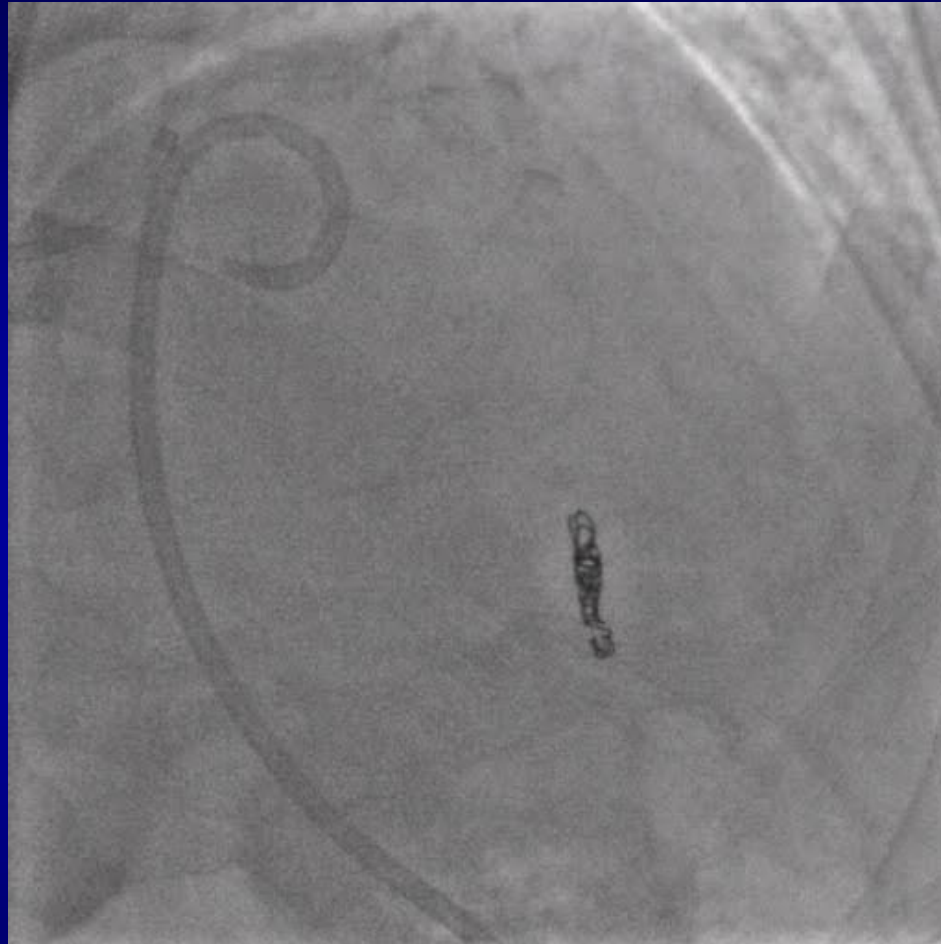
Urgent Pericardiocentesis

# Perforation-Coiling



Tornado microcoils (Cook)

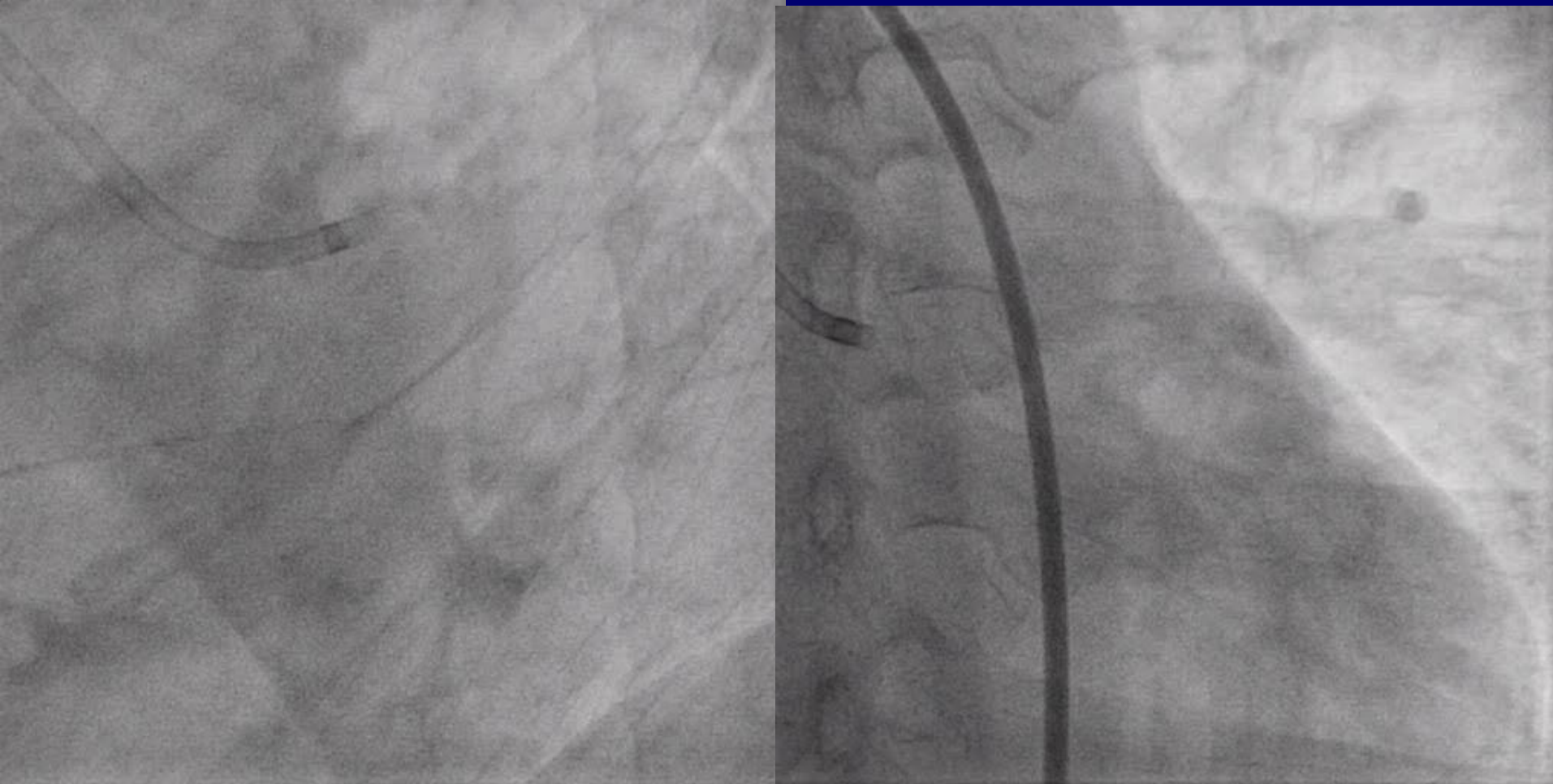
# Final Angiography



1. Too aggressive antegrade distal wiring with CTO wire is dangerous.
2. Urgent pericardiocentesis and hemostasis (coils and graftstents) should be ready during complex CTO PCI

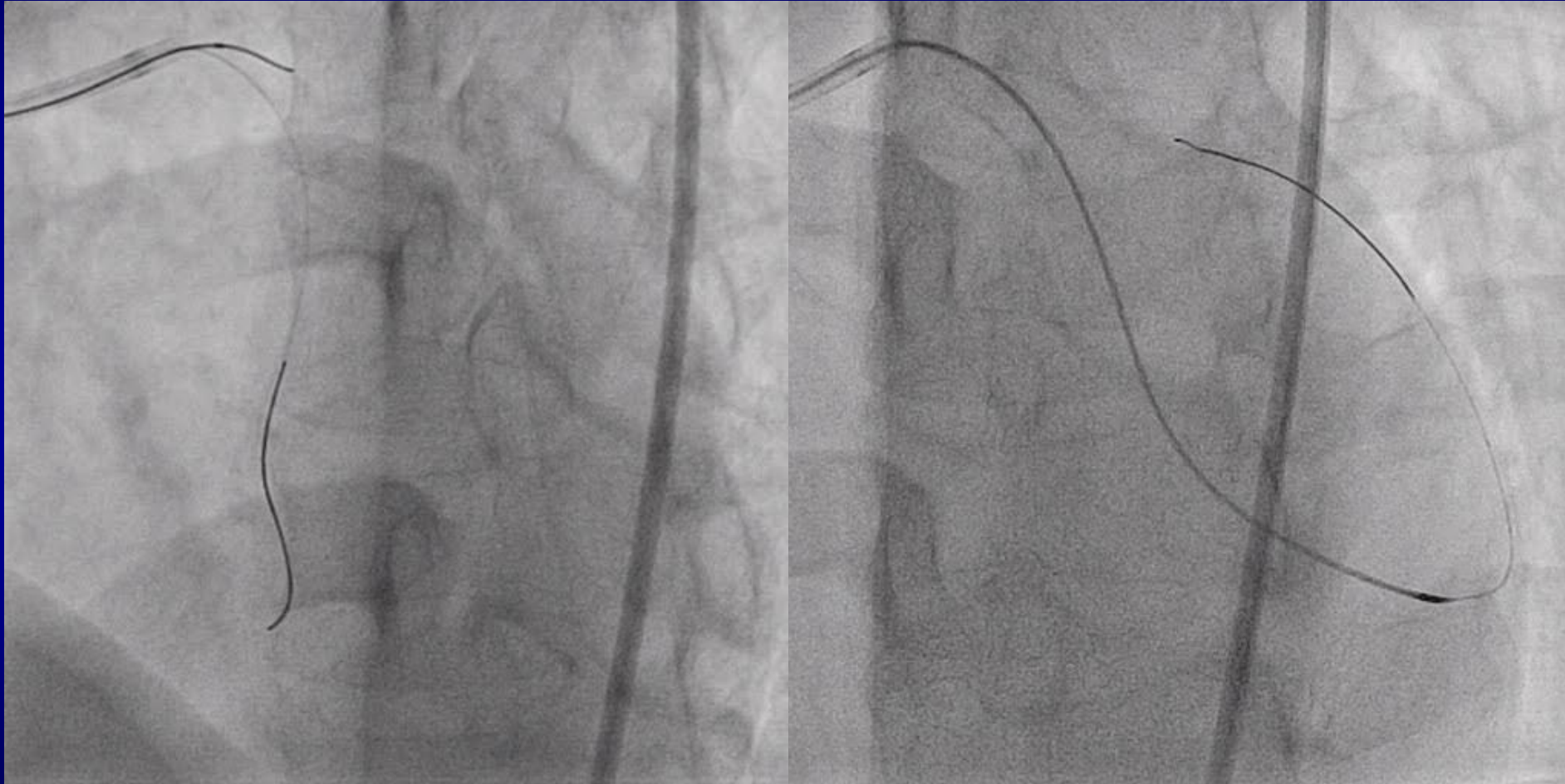


# LM Bifurcation injury case due to catheter and retrograde wire

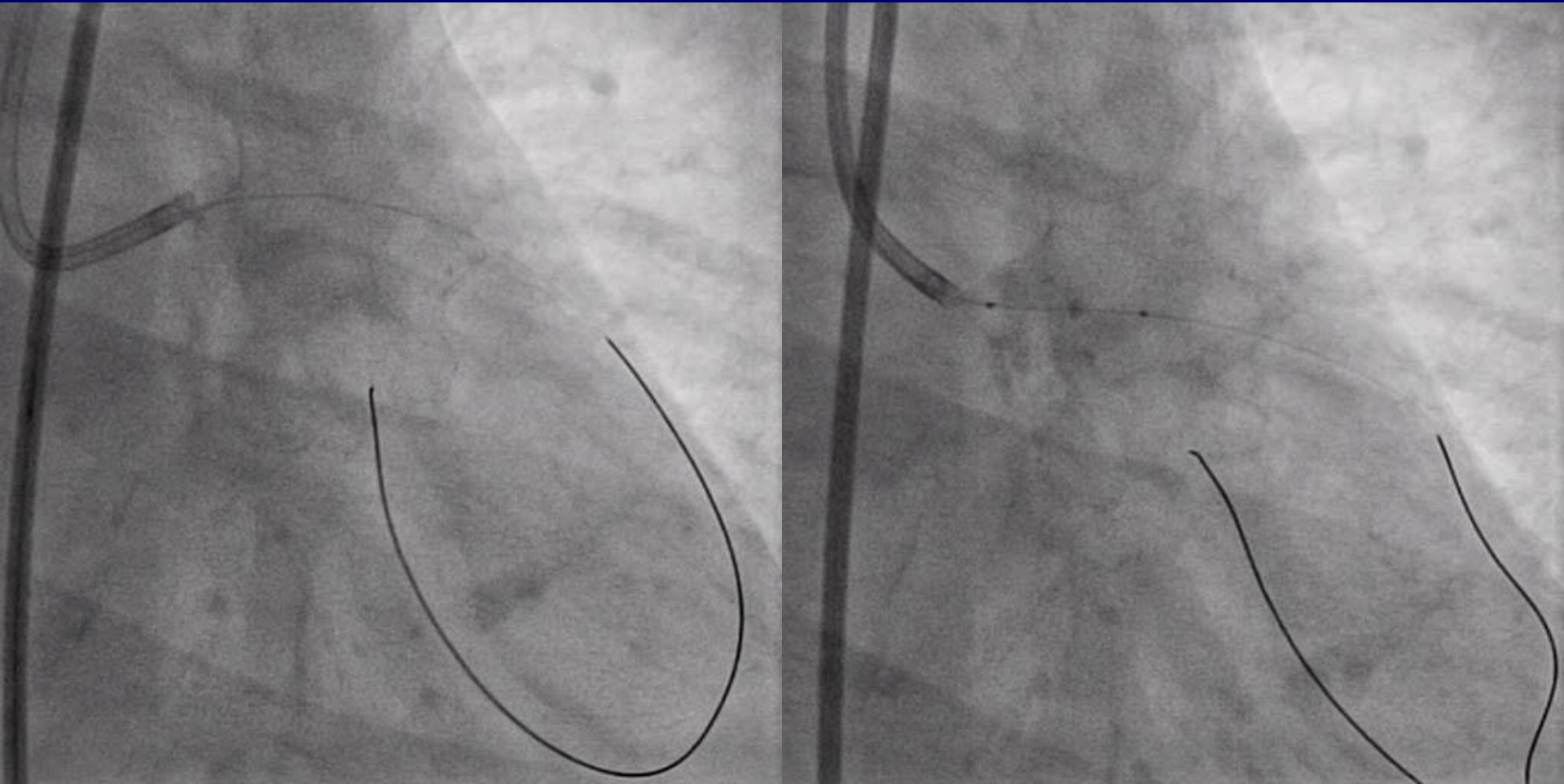


LCX CTO-Baseline Angiography

# Antegrade and Retrograde Wire

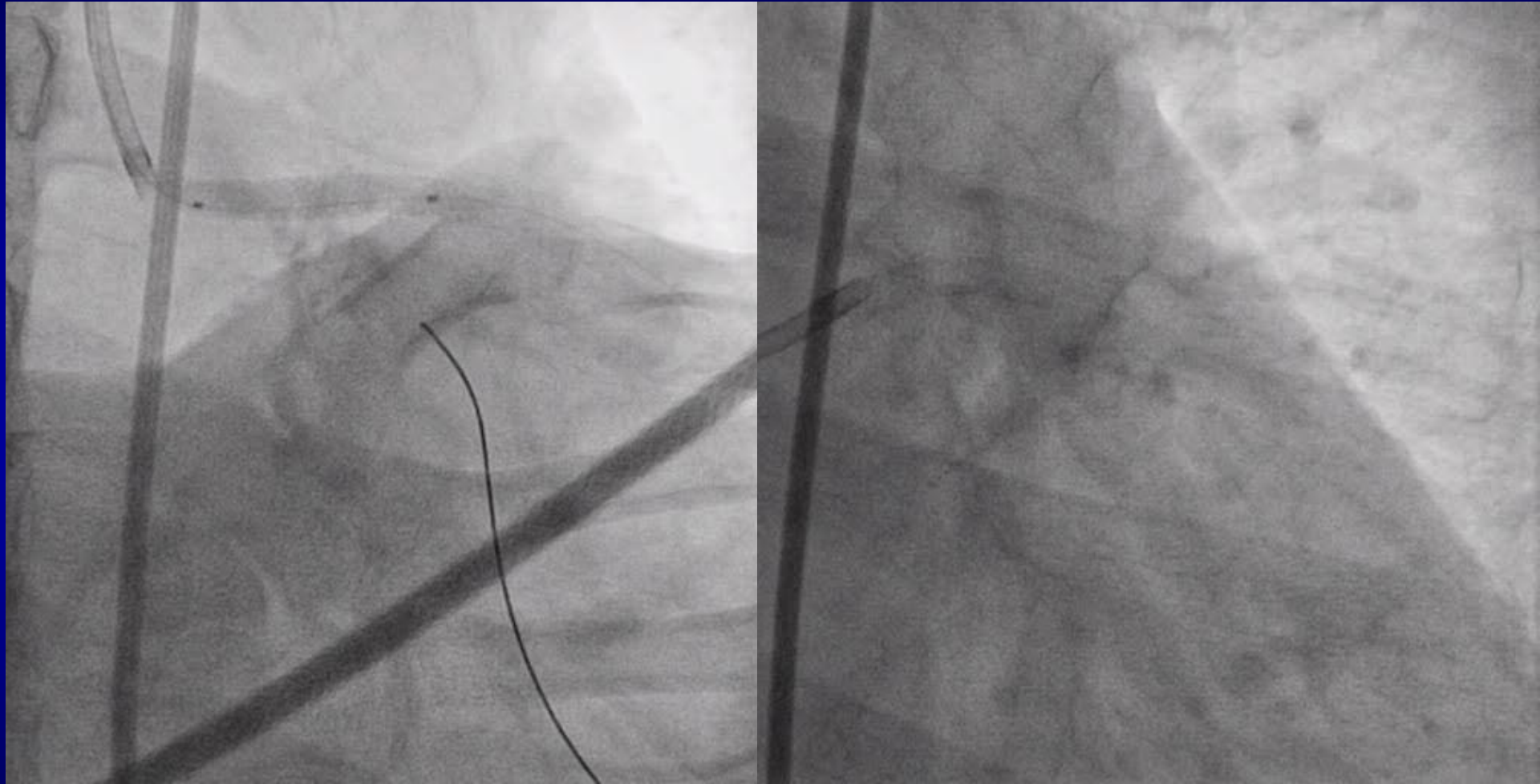


# LCX extravasation & LM lesion aggravated





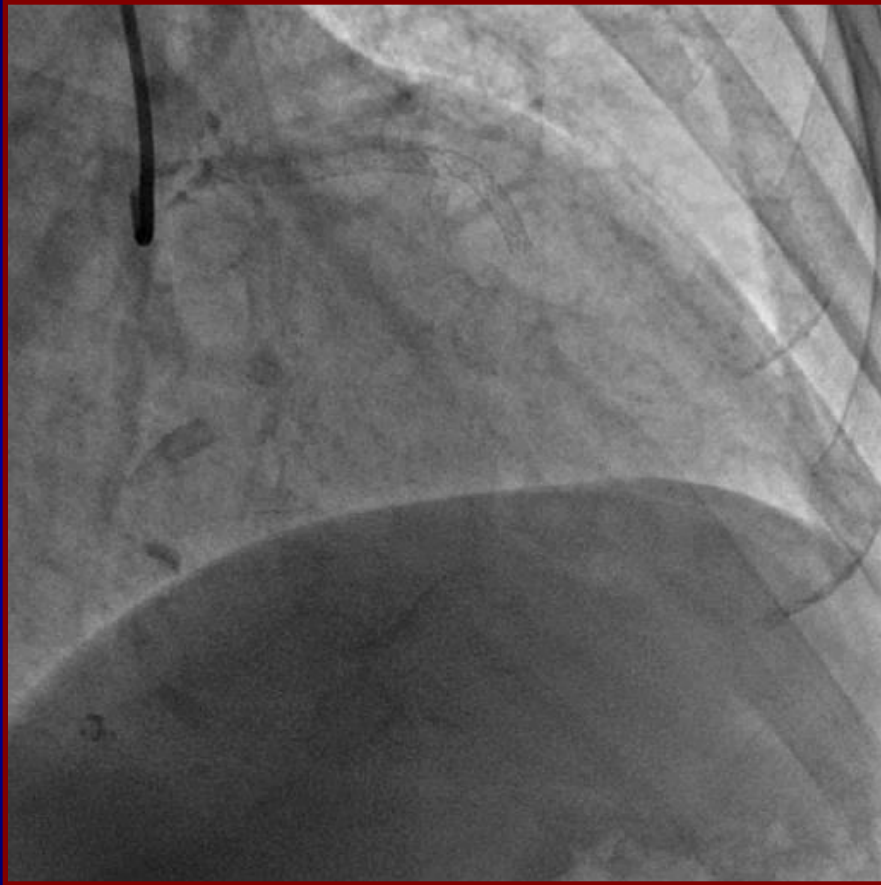
# Final Angiography



Donor artery injury should be avoided by guidings and wires,  
especially during ostial CTO PCI



# Donor artery thrombosis case

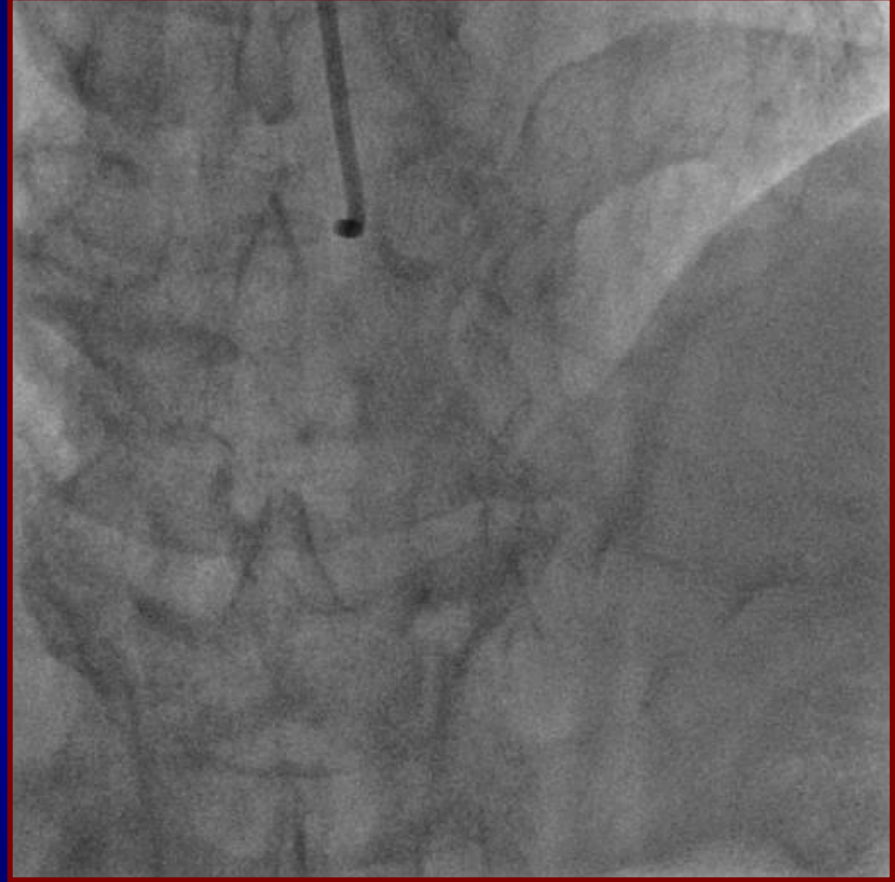
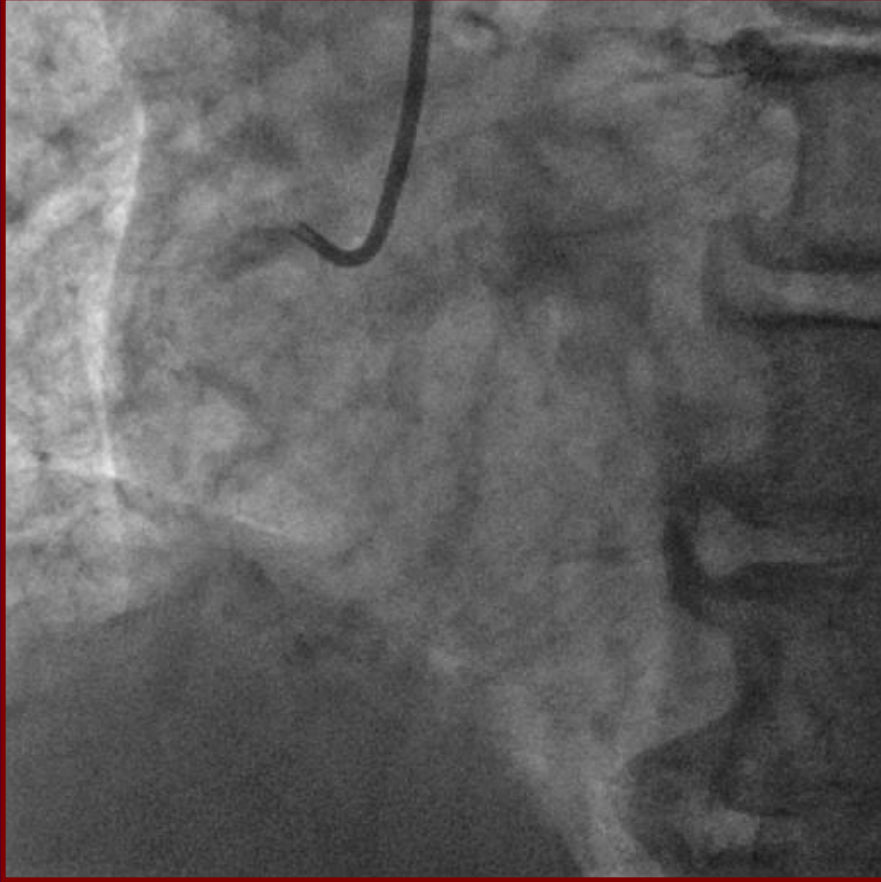


LCA-baseline

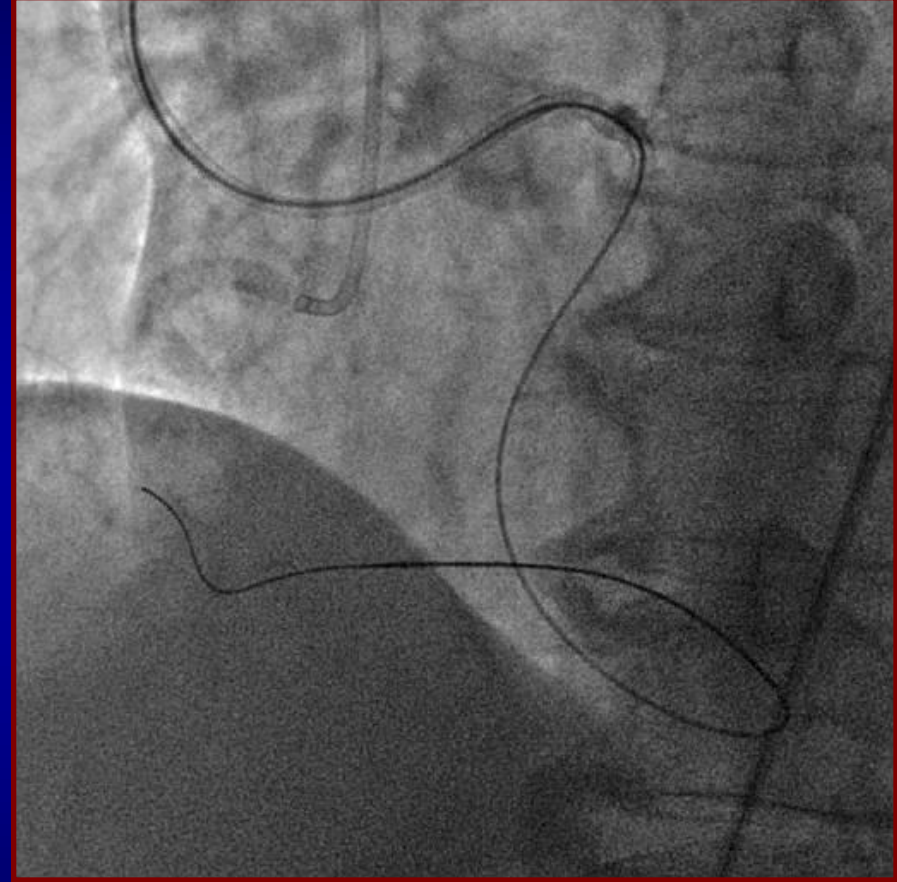
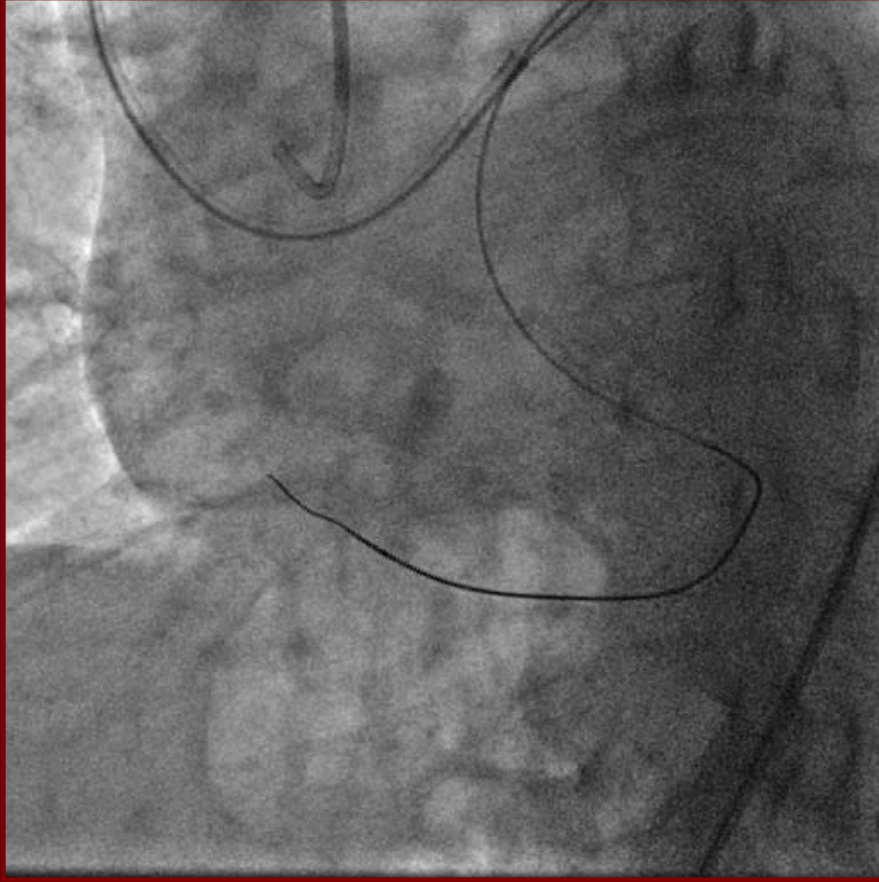


Kyungpook National Univ Hospital Case

# CAG-RCA

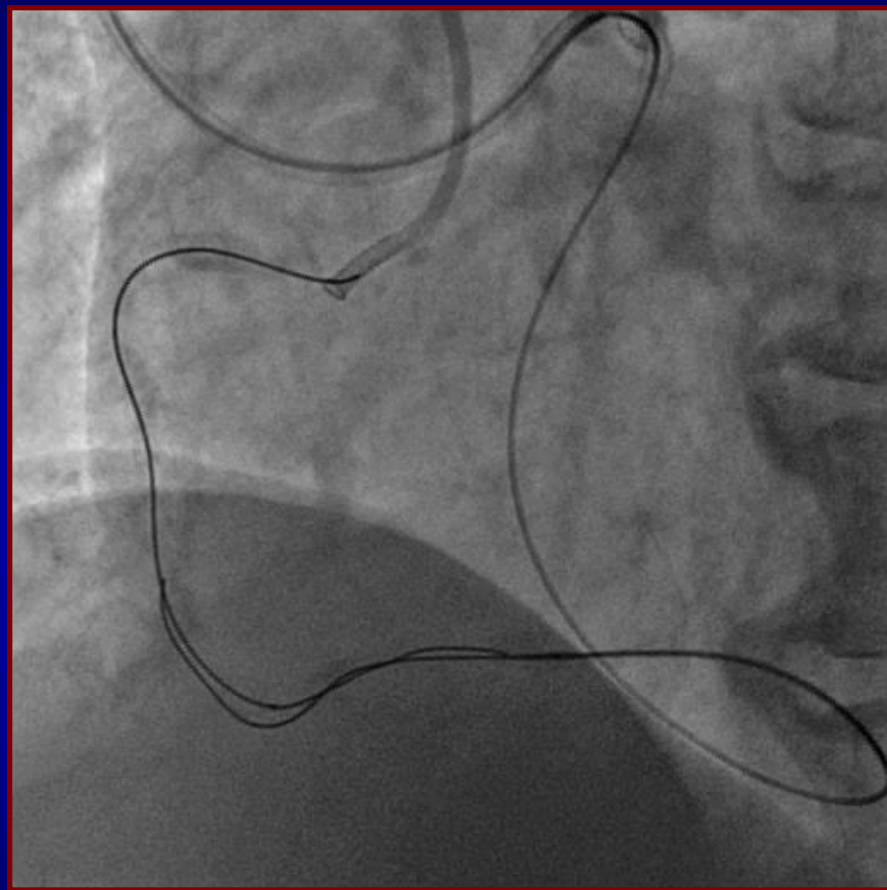
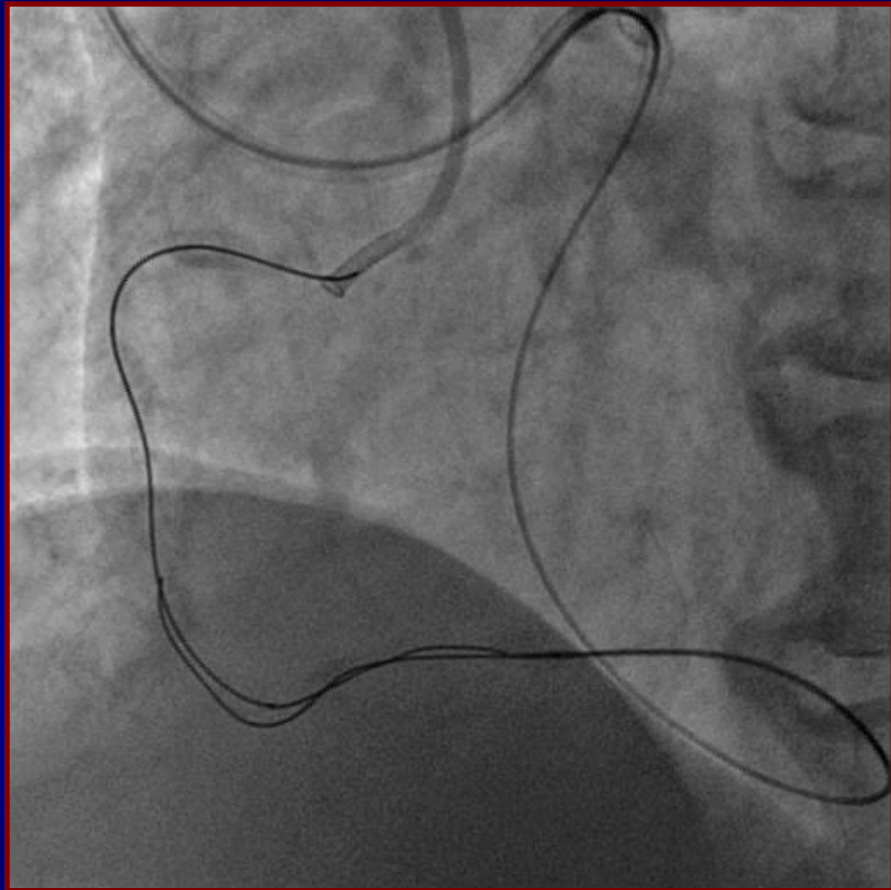


# Retrograde CTO wiring



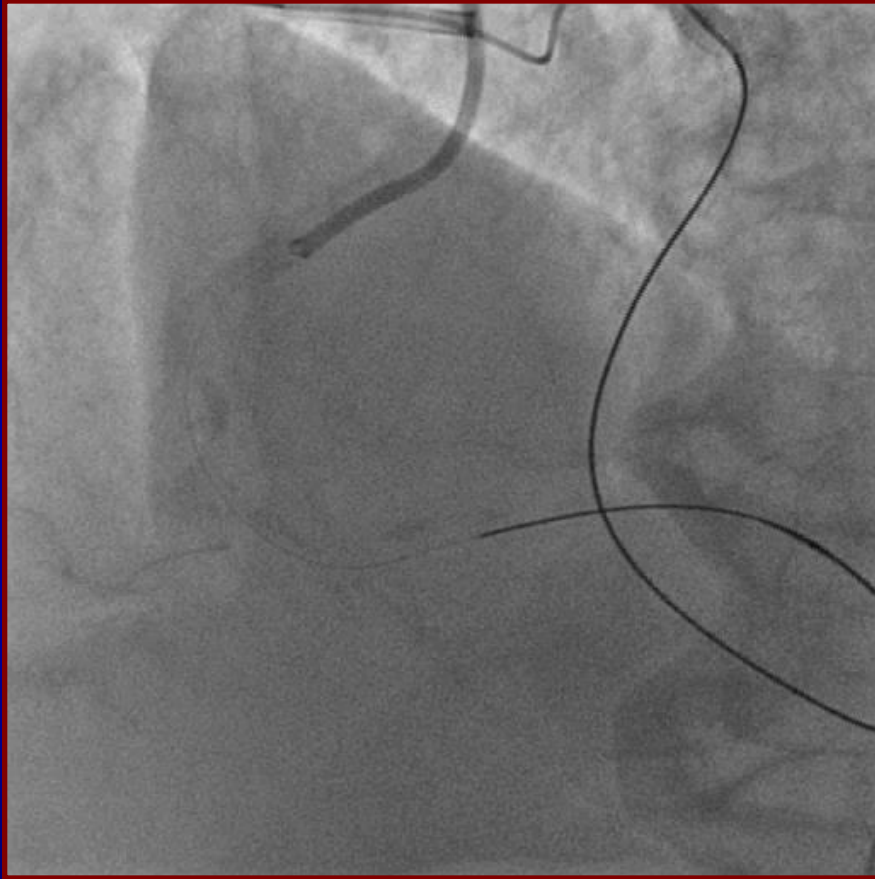
- wires : Sion - XT – Miracle 6 – Conquest 9 – Conquest 12

# Antegrade CTO wiring





# Post balloon angiography



# Disaster occurred !!!

**Contralateral Injection**

**Thrombus was shot into  
LCA**

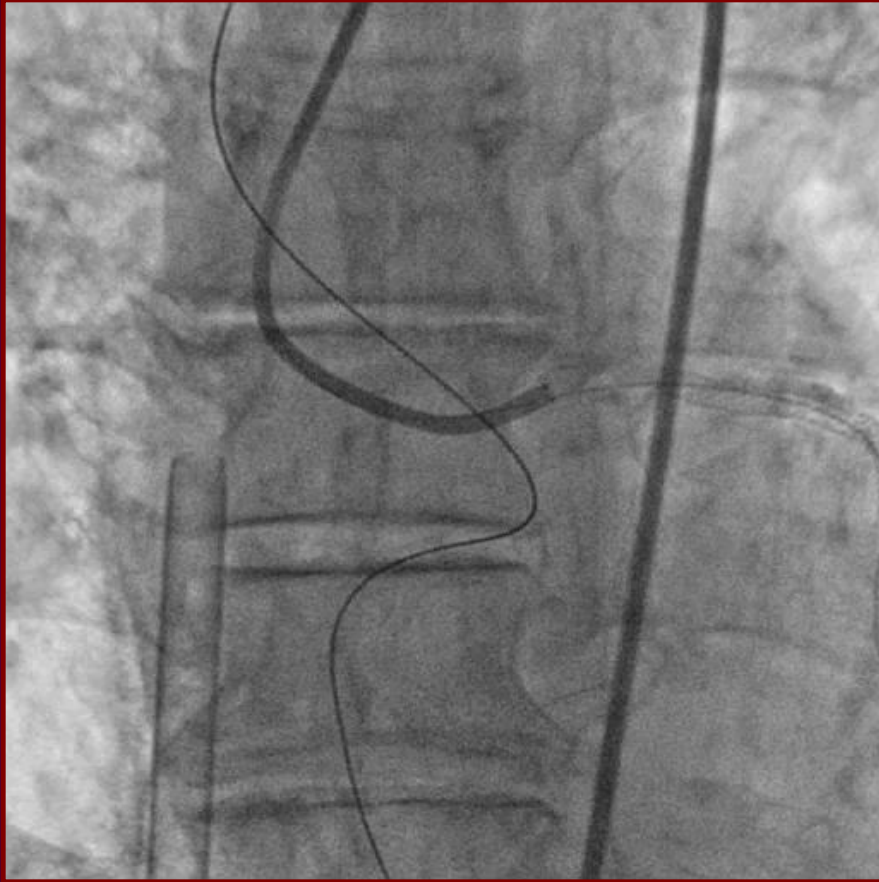
**VT : DC cardioversion**

**SHOCK**

**Intubation**

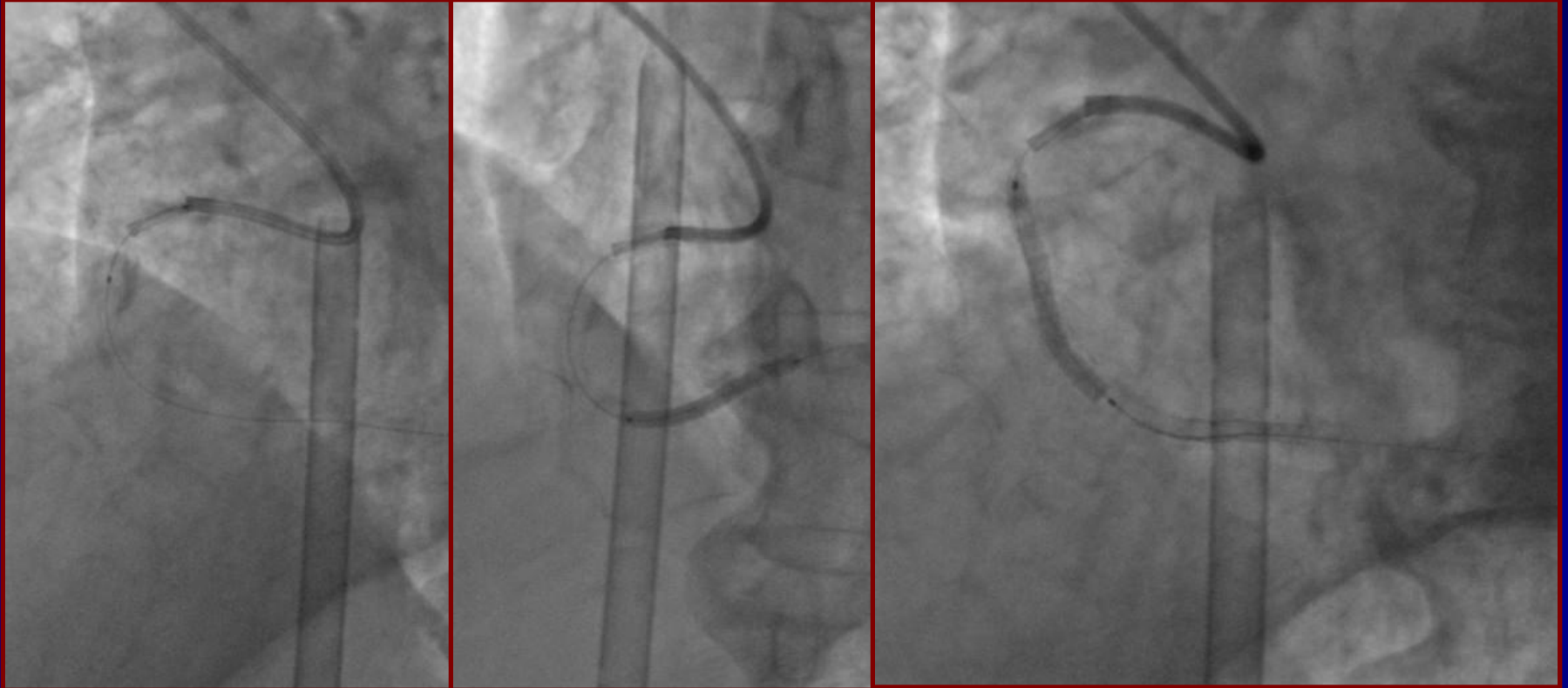


# Disaster occurred !!!



After thrombus aspiration

# Balloon and Stent delivery

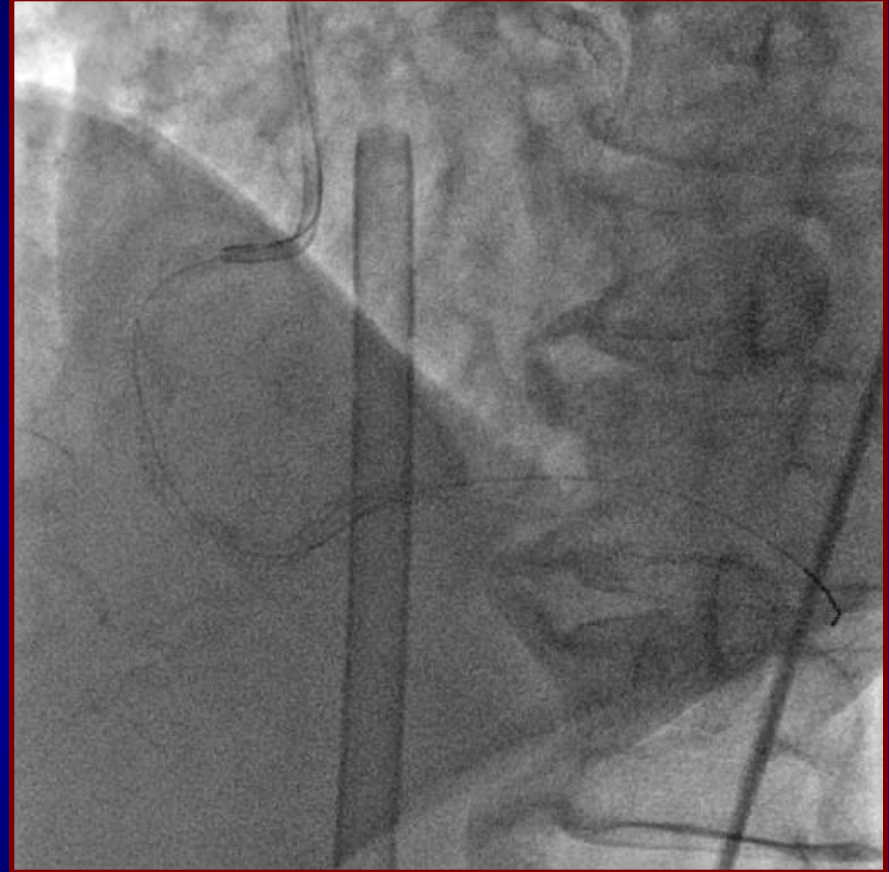
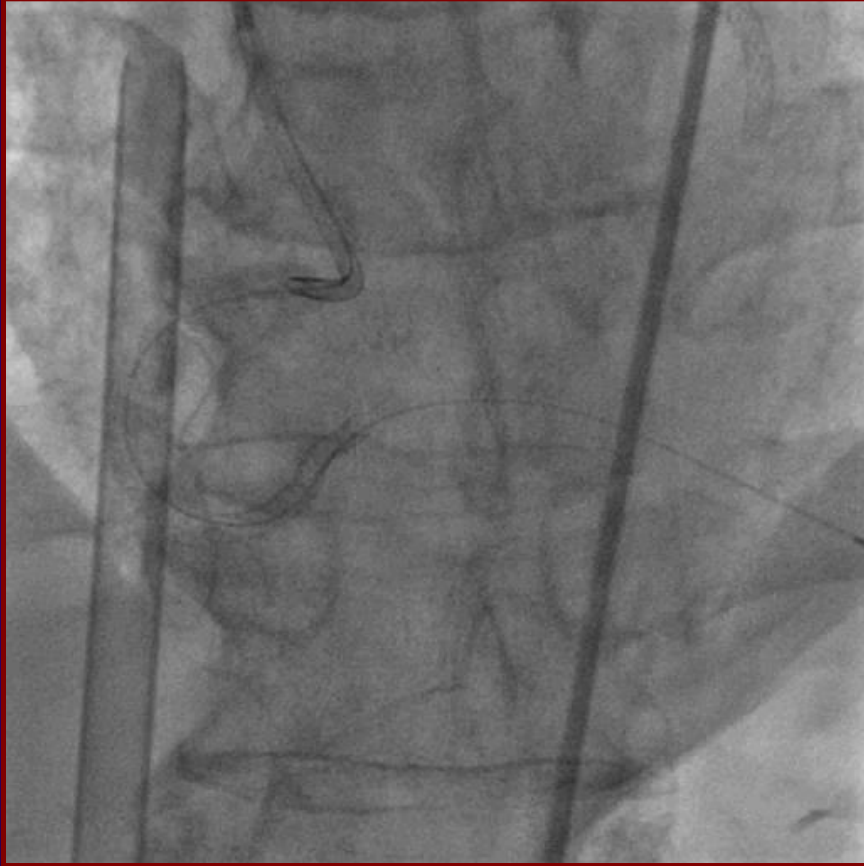


- 5 in 7, daughter catheter
  - 2.5mm balloon

- 2.5x28mm Nobori - dRCA
- 2.5x38mm Promus - mRCA

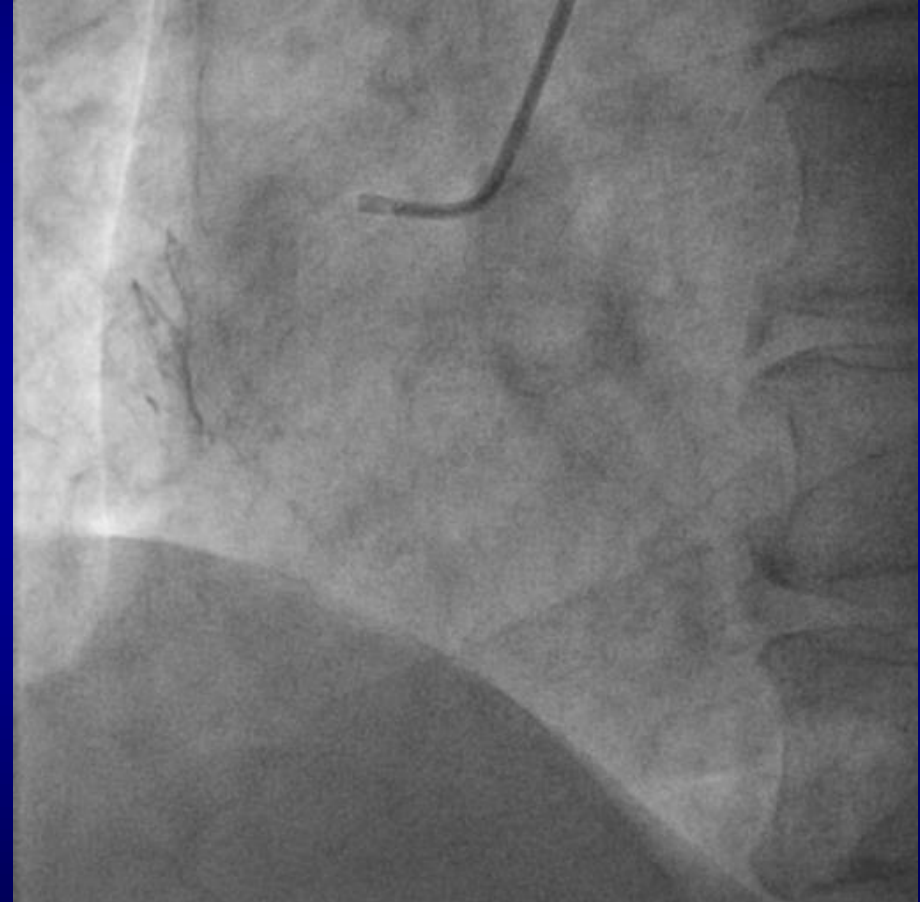
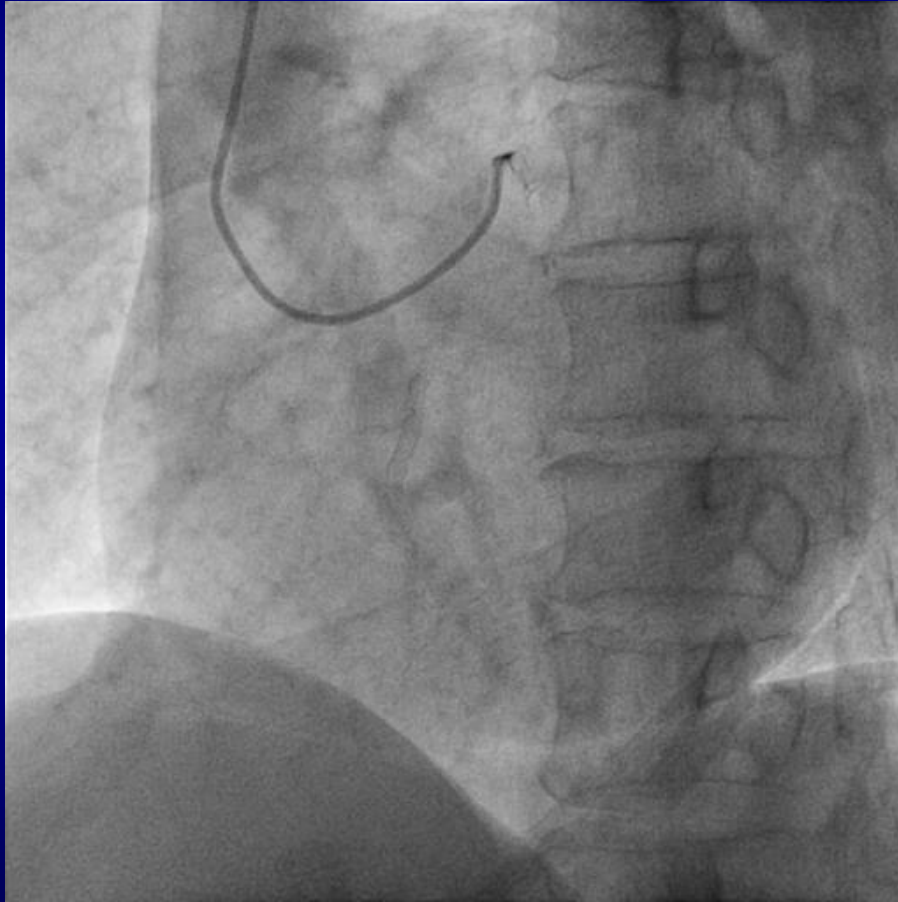


# Final CAG



Donor artery thrombosis by catheter induced injury  
or inadequate anticoagulation; be cautious!!

# Retrograde Wire Fracture Case



Baseline Angiography

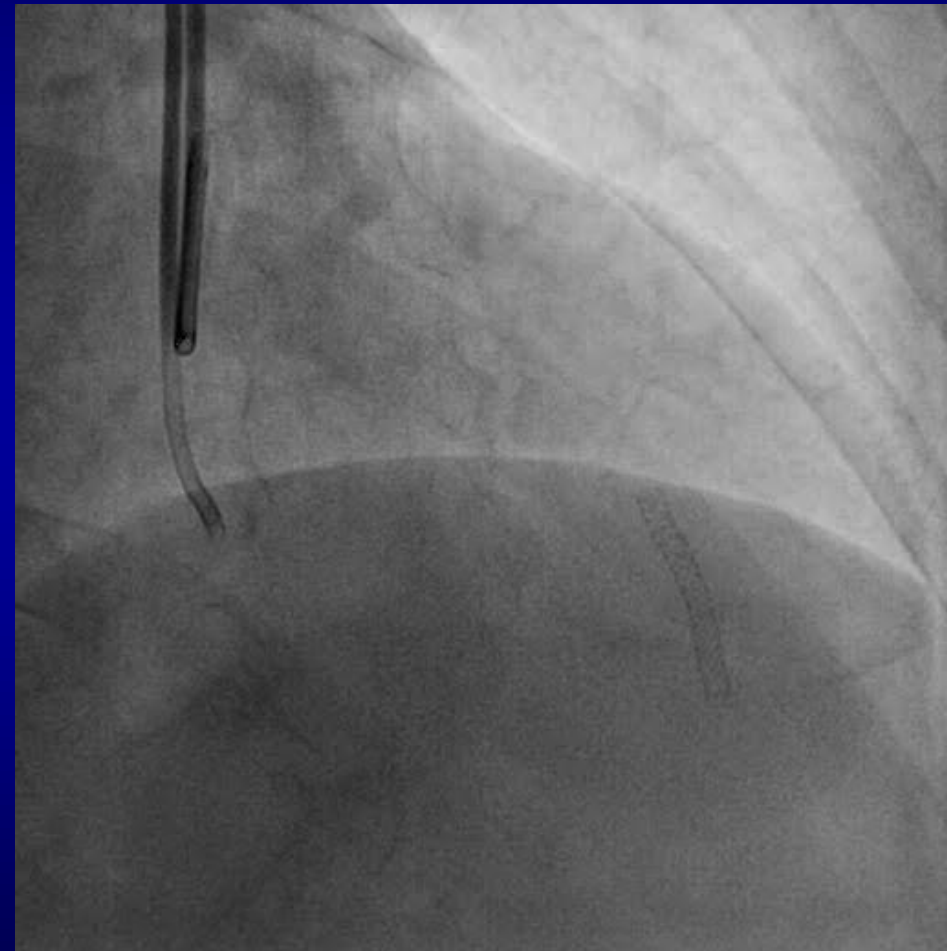
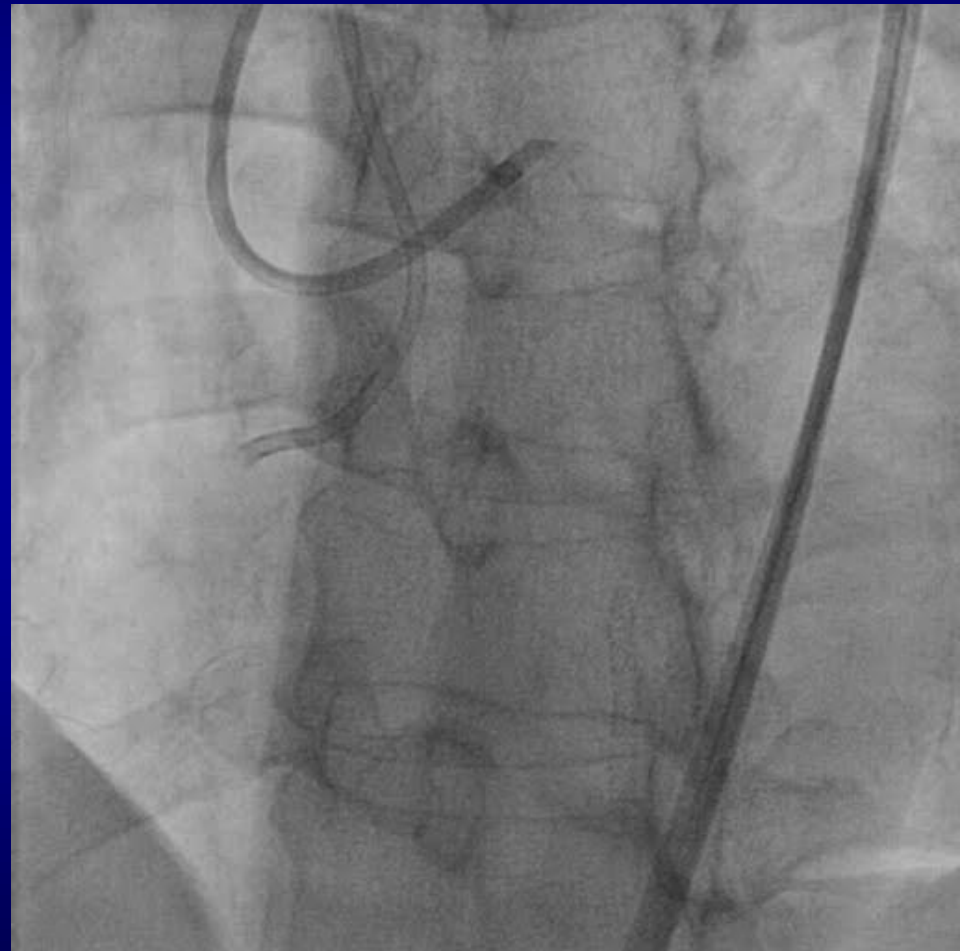
**PCI for RCA CTO :**

**3rd May 2014**

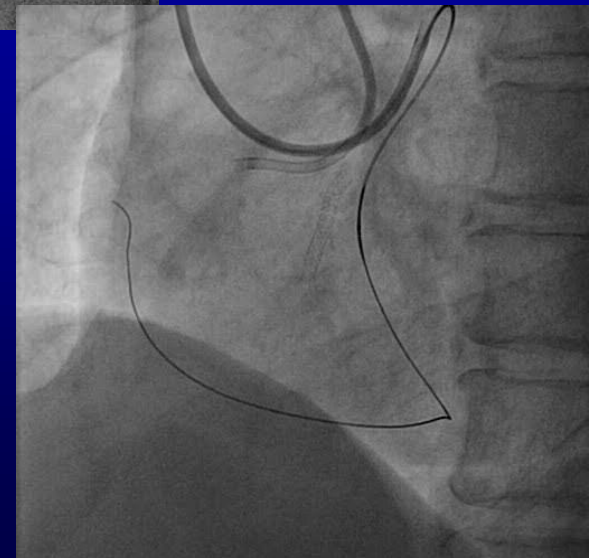
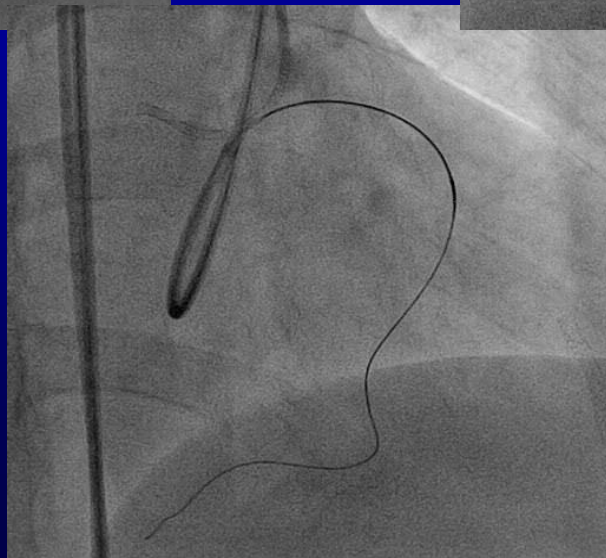
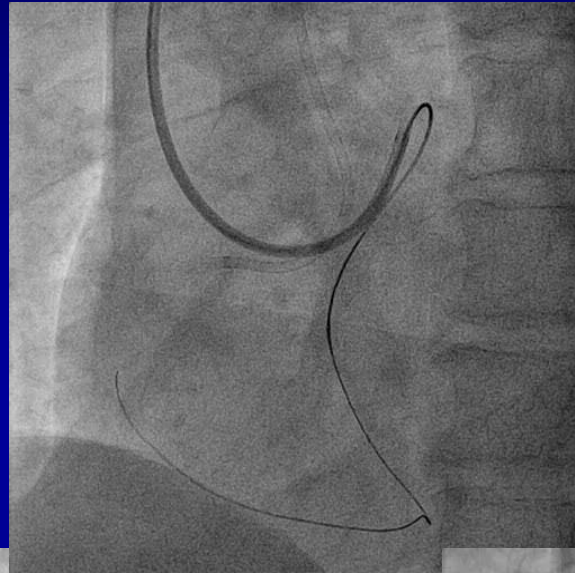
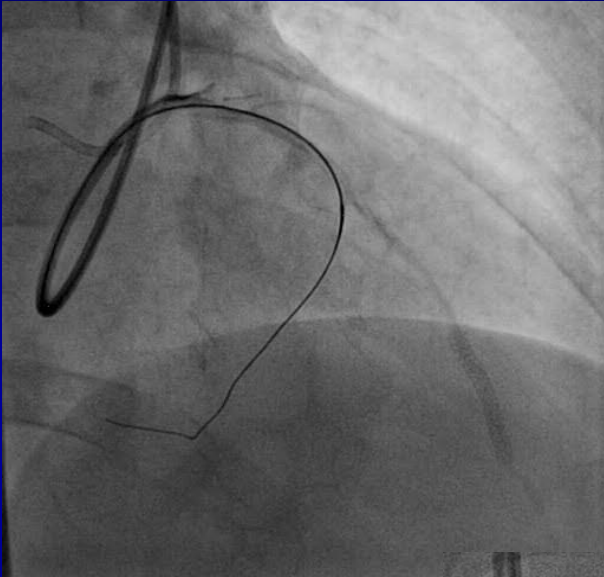
**PCI start time AM 2:36**

# Baseline CAG & Guiding catheter

; LCA → EBU3.5 7F, RCA → AL1 6F side hole short-tip

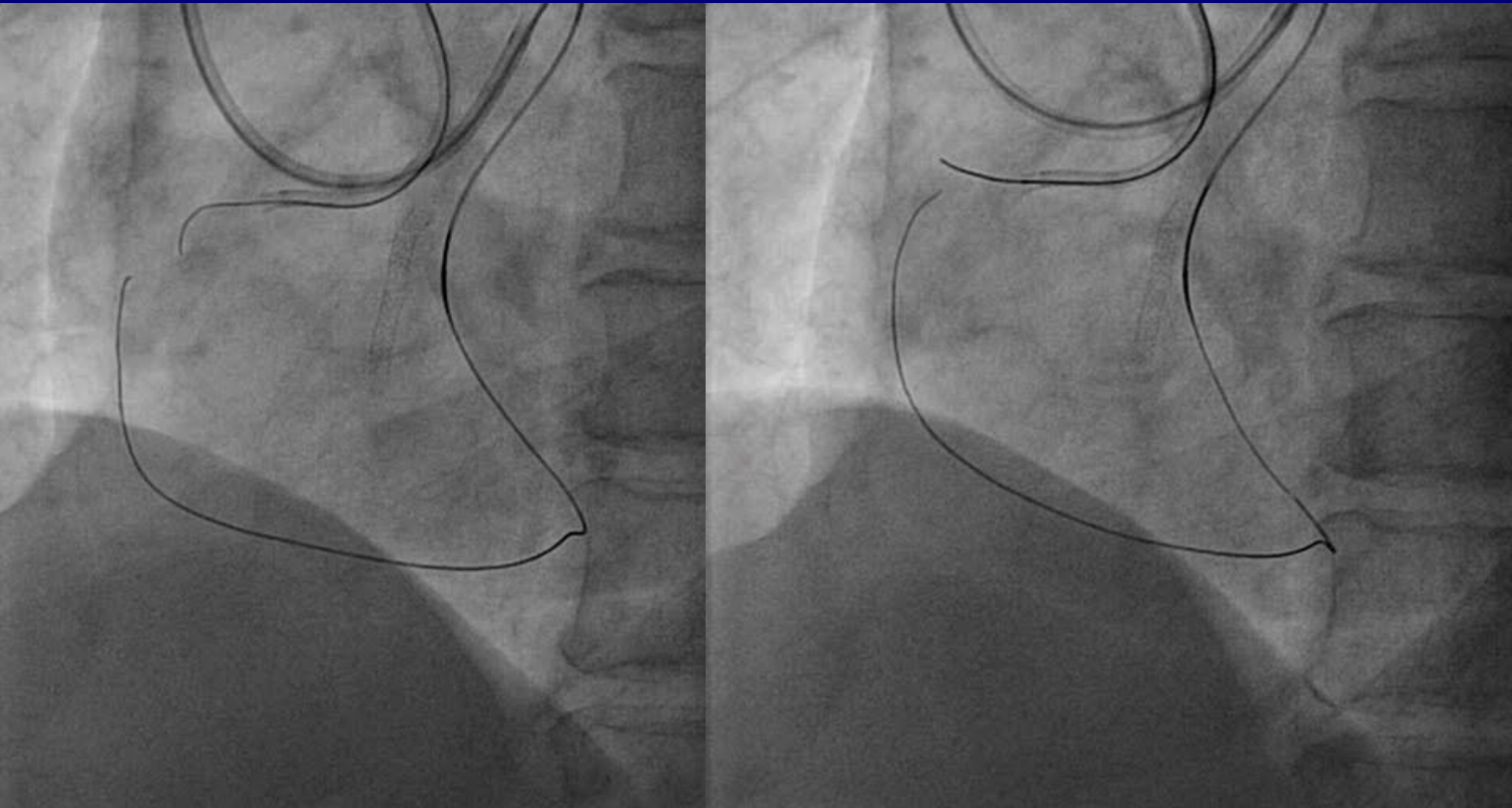


**Retrograde approach;** wiring (Fielder XT-R) in first septal branch → passage into PL branch



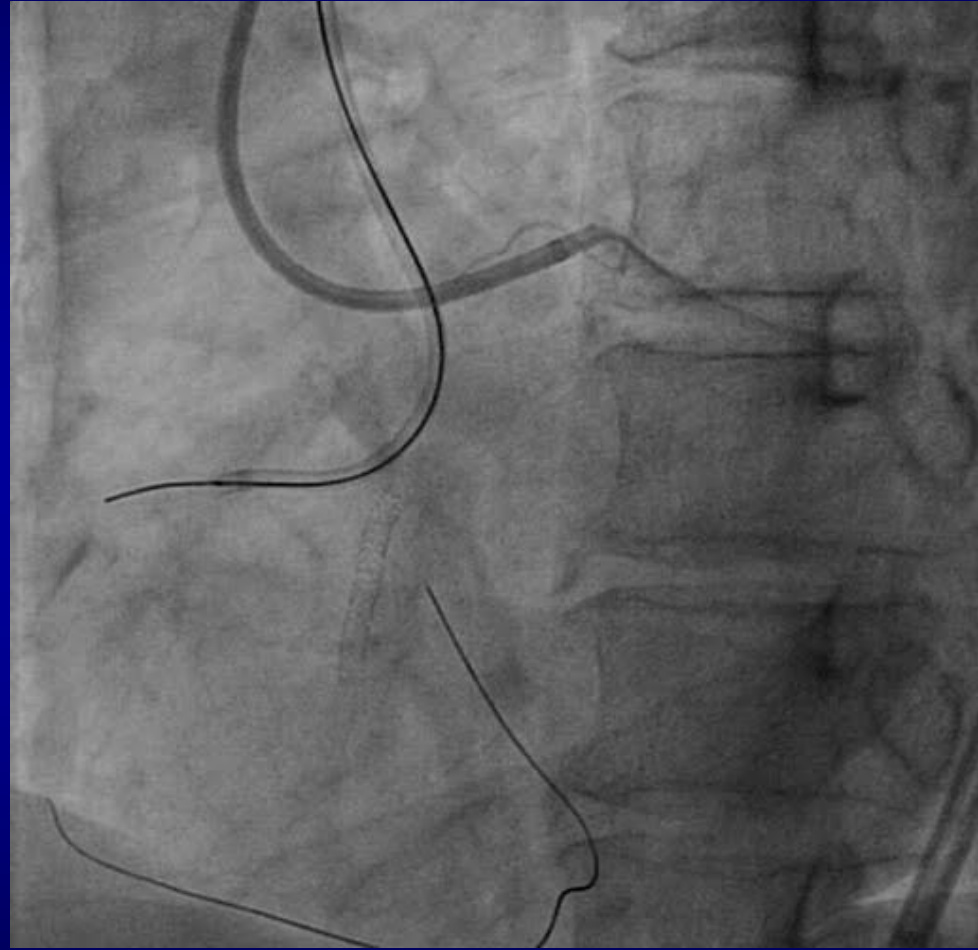
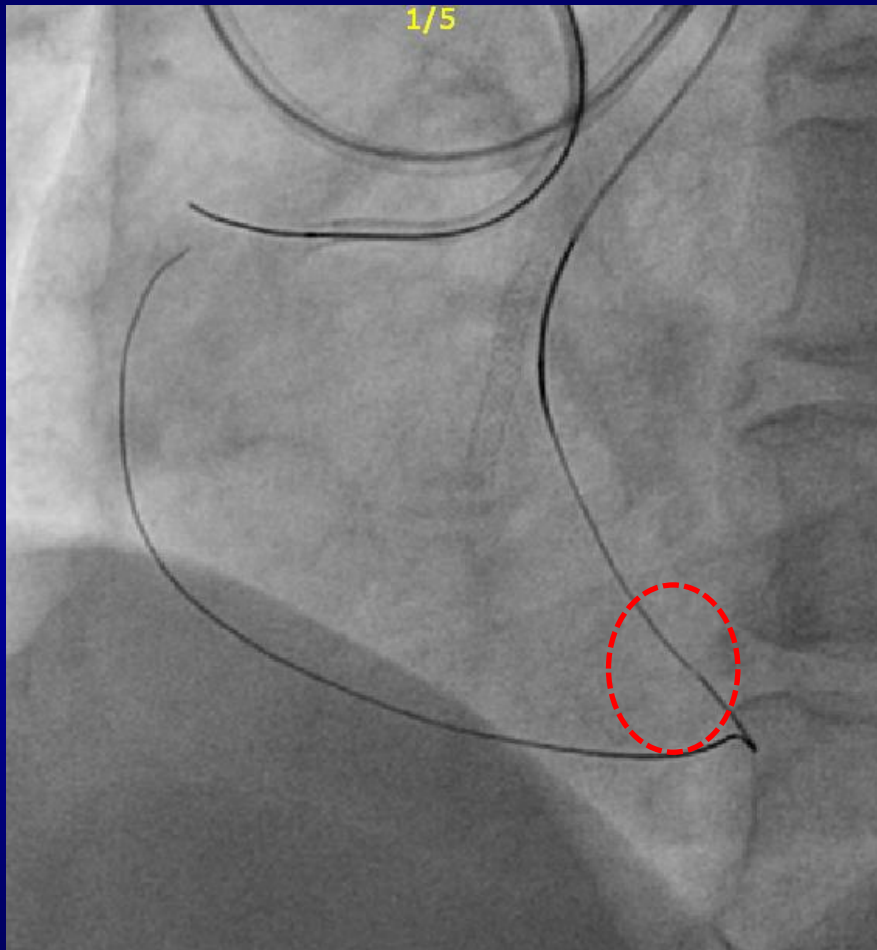


# Bidirectional guidewire tracking



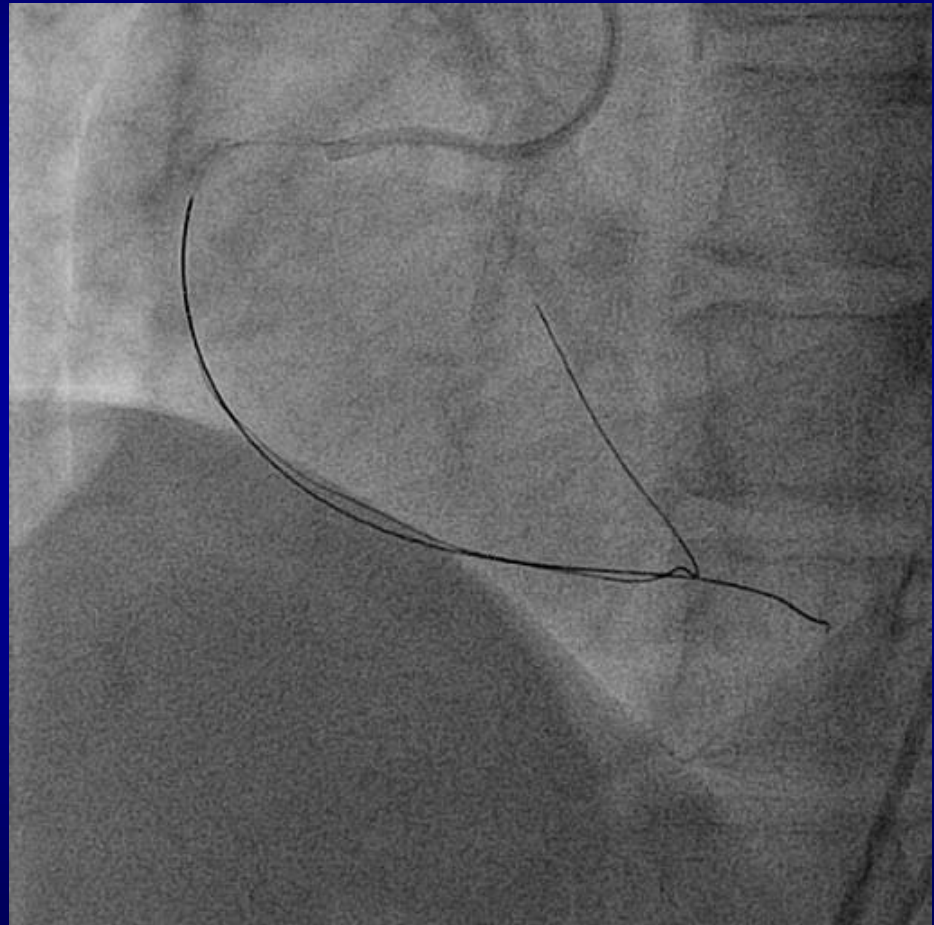
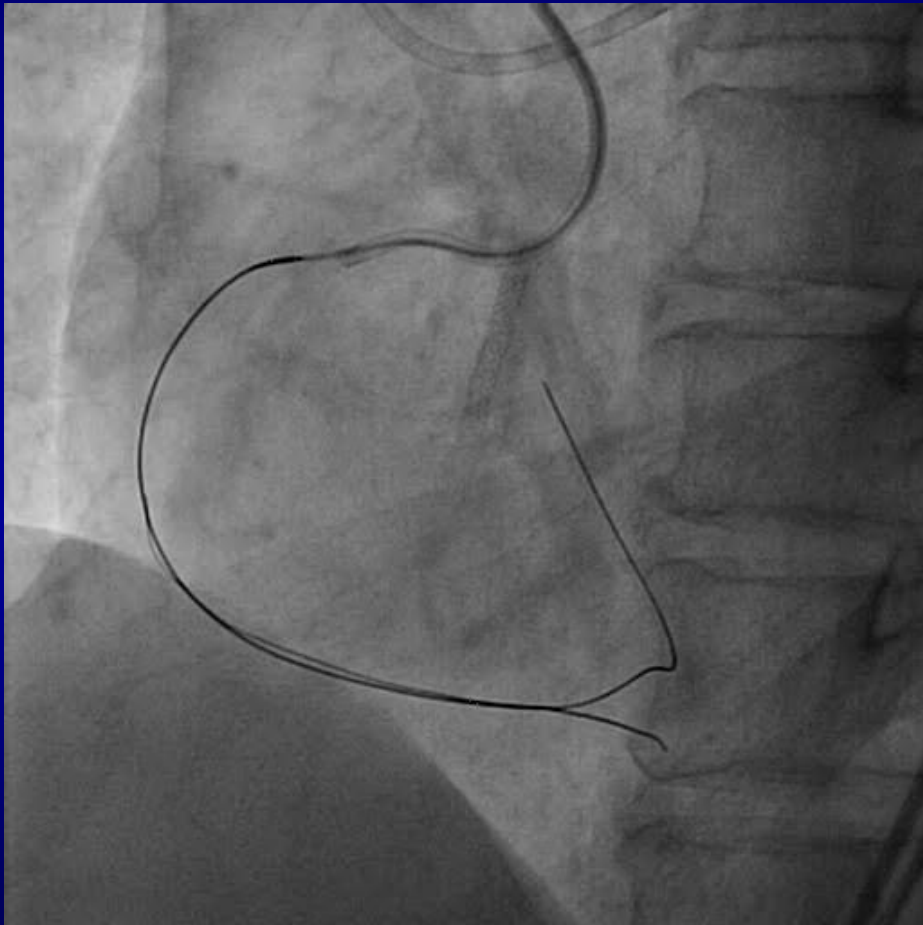
Corsair could not be deeply inserted due to invisible slender channel

# Guidewire fracture; Fielder-XT-R



How you would manage? 1) Percutaneous removal 2) Surgery 3) Observation

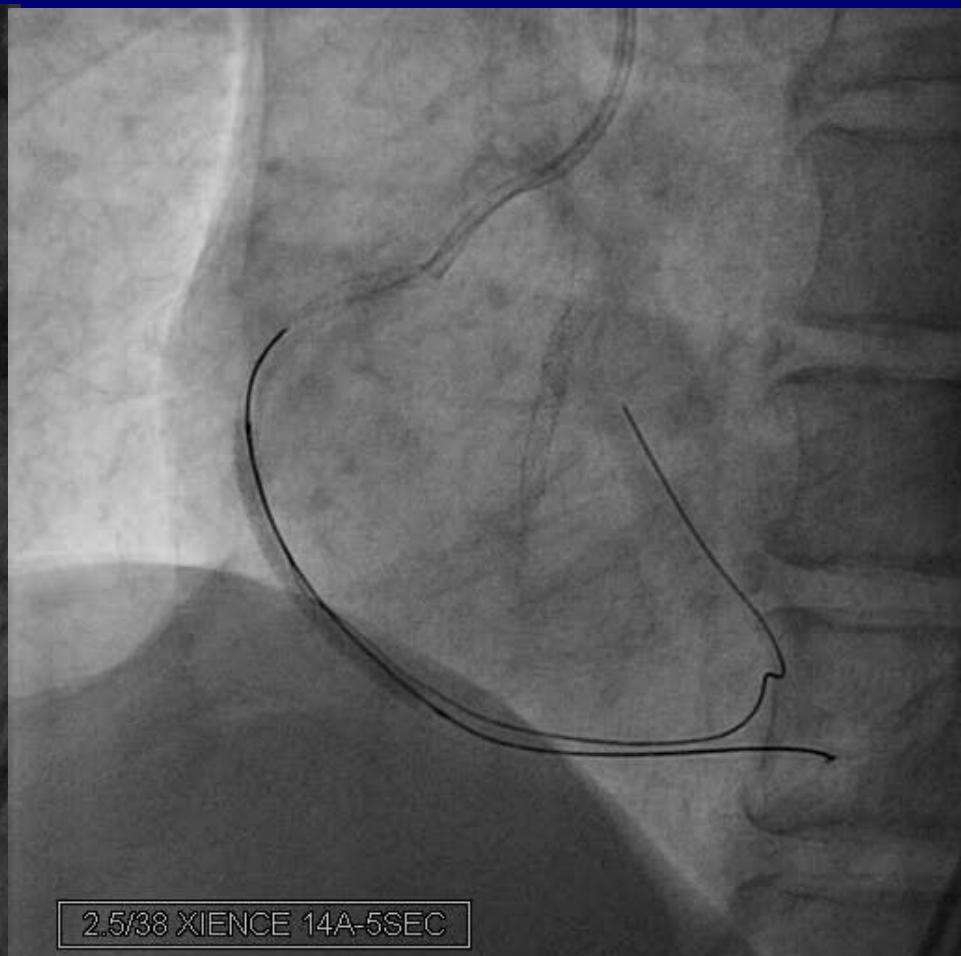
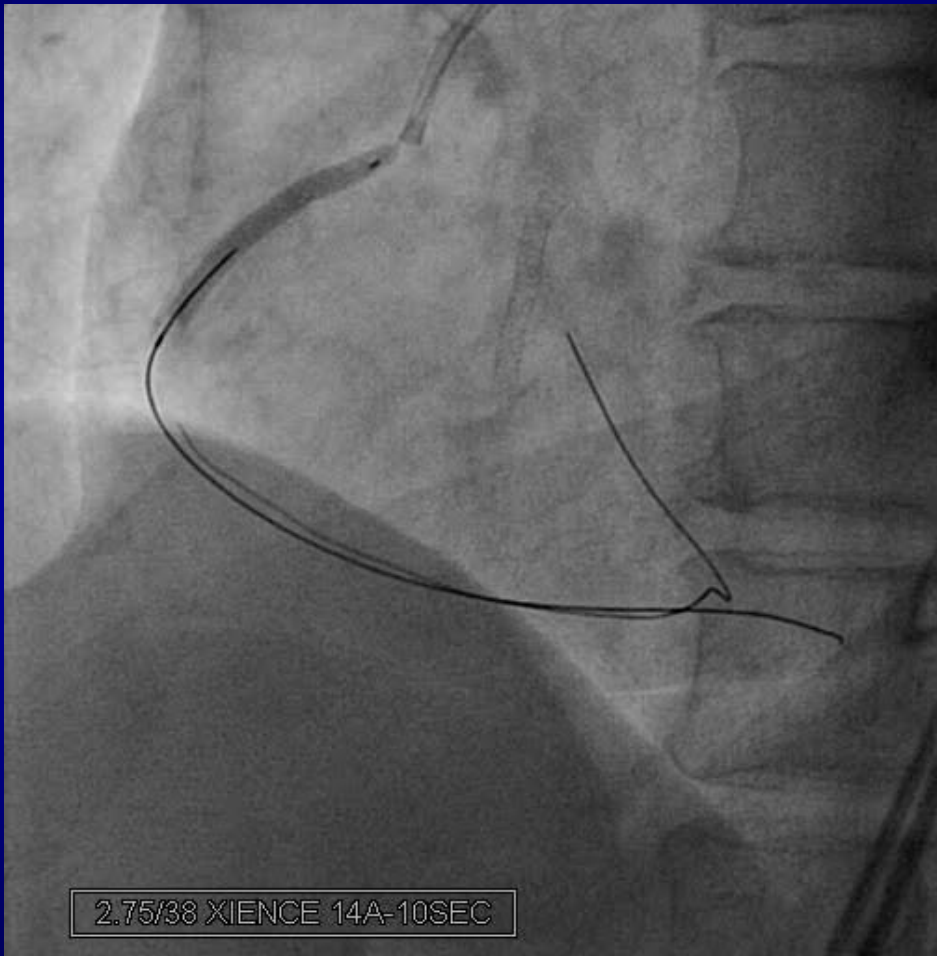
# Anterograde approach & ballooning



Not the exact parallel wiring along the intraluminal retrograde wire!

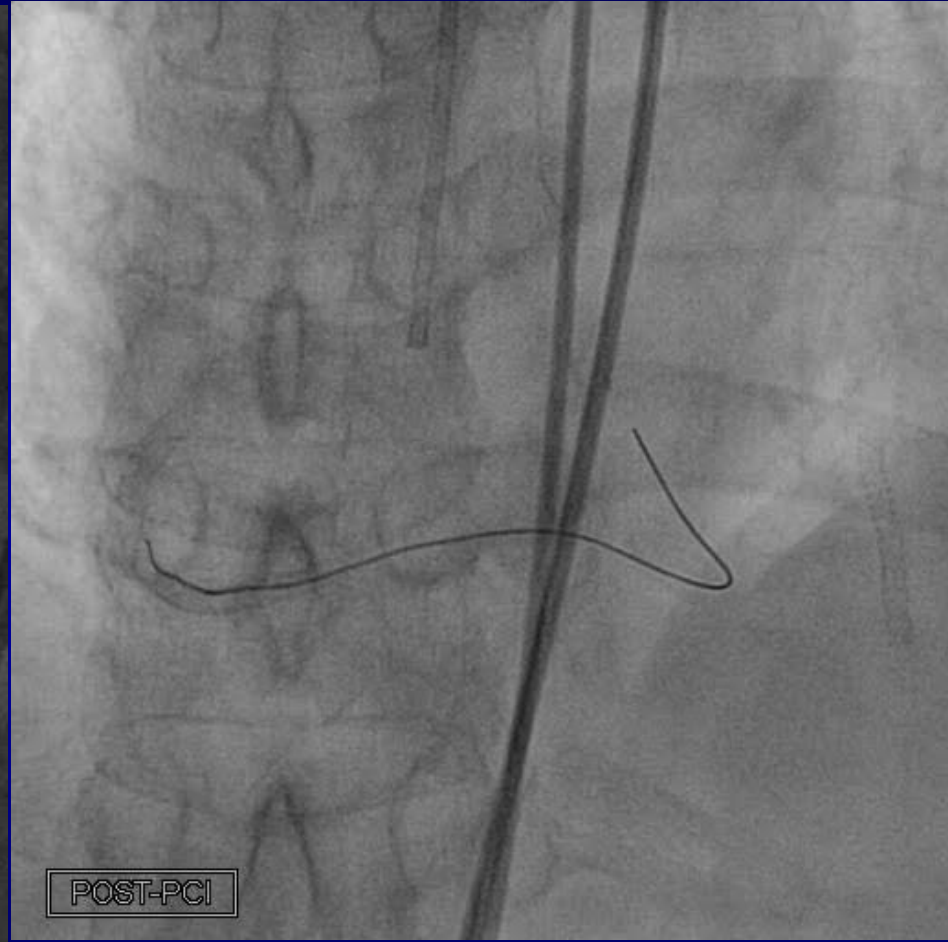
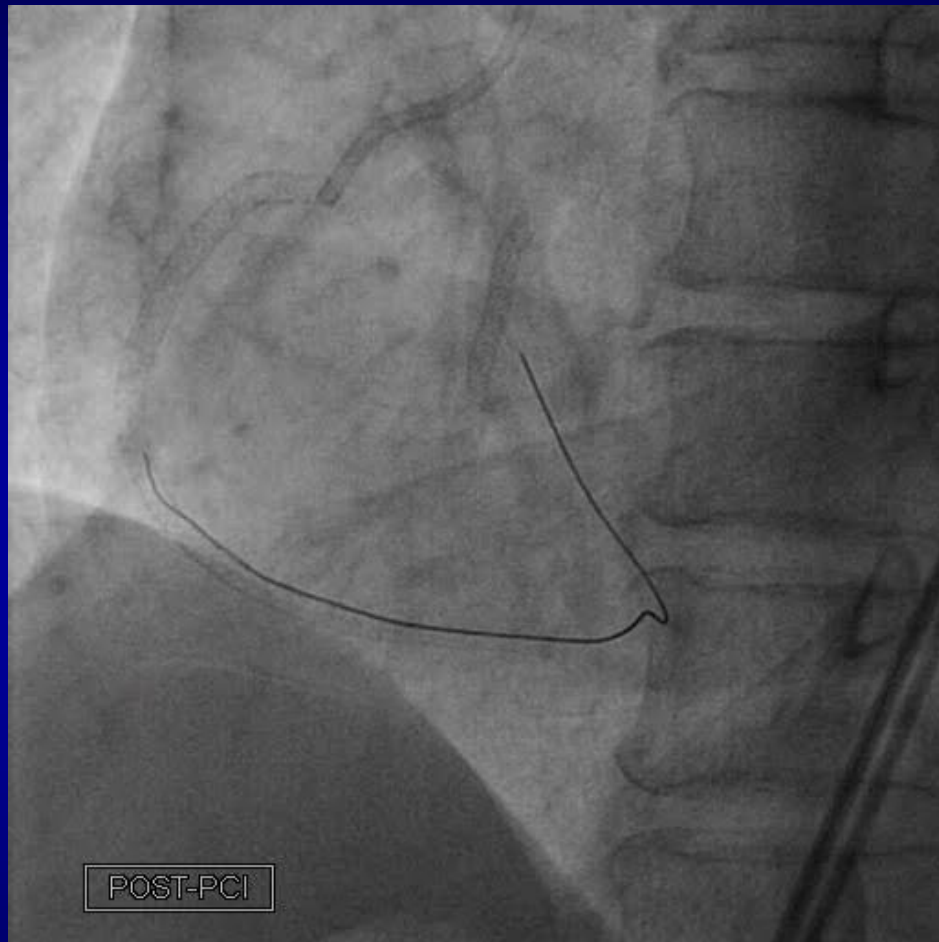


# RCA Stenting to immobilize the fractured wire



Xience 2.75X38mm, 2.5X38mm

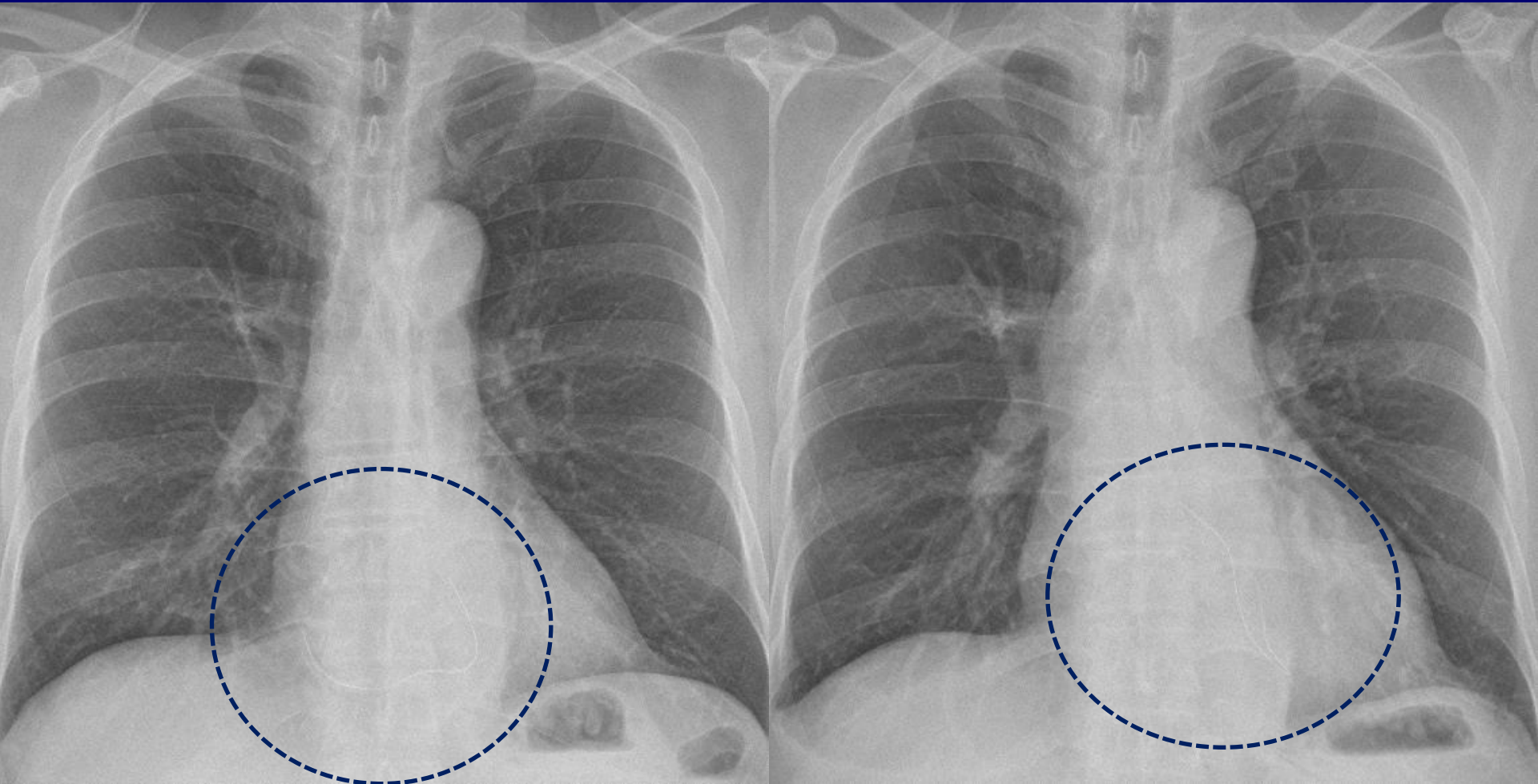
# Final angiography



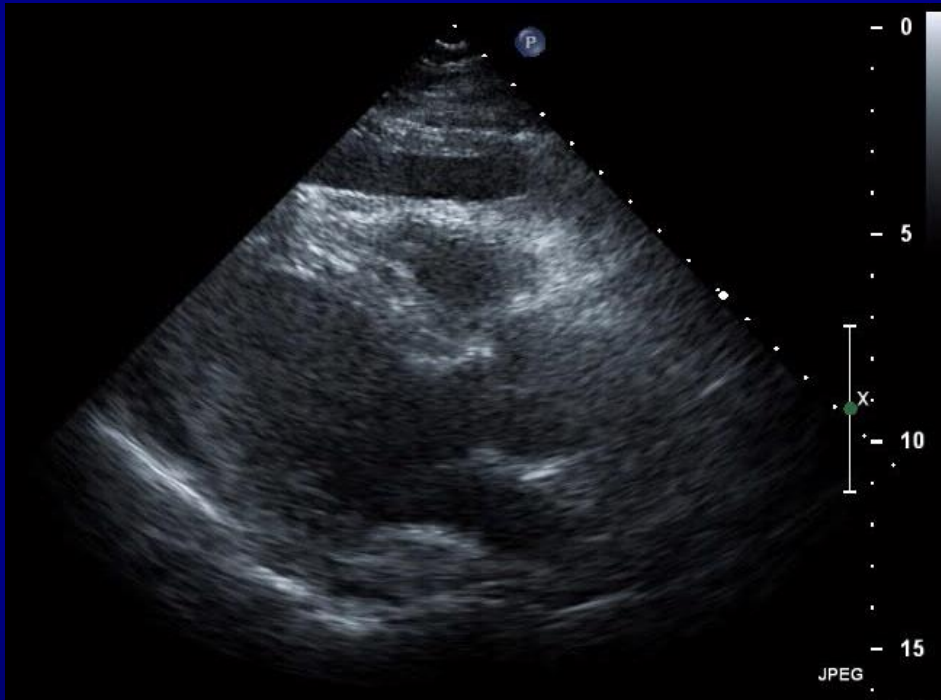
Q. Your expectation of this patient's clinical course?

- 1) It will be OK
- 2) May cause further complications

**Chest PA after 4 days and 11 days from index procedure; guidewire migration & cardiomegaly**

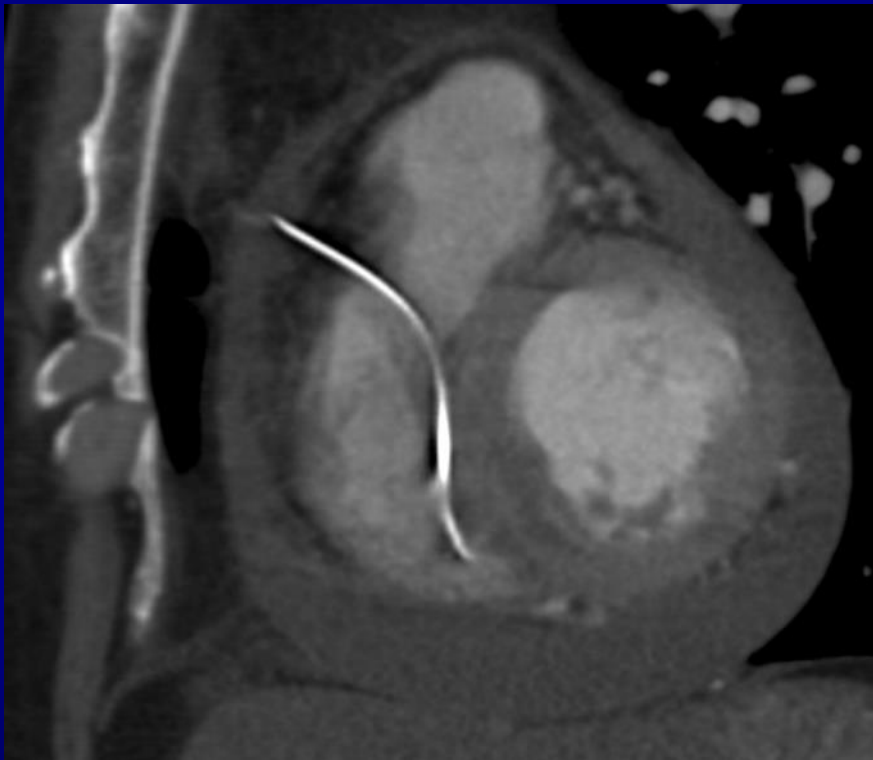


# Echo after 5 days and 11 days from index procedure; Pericardial effusion

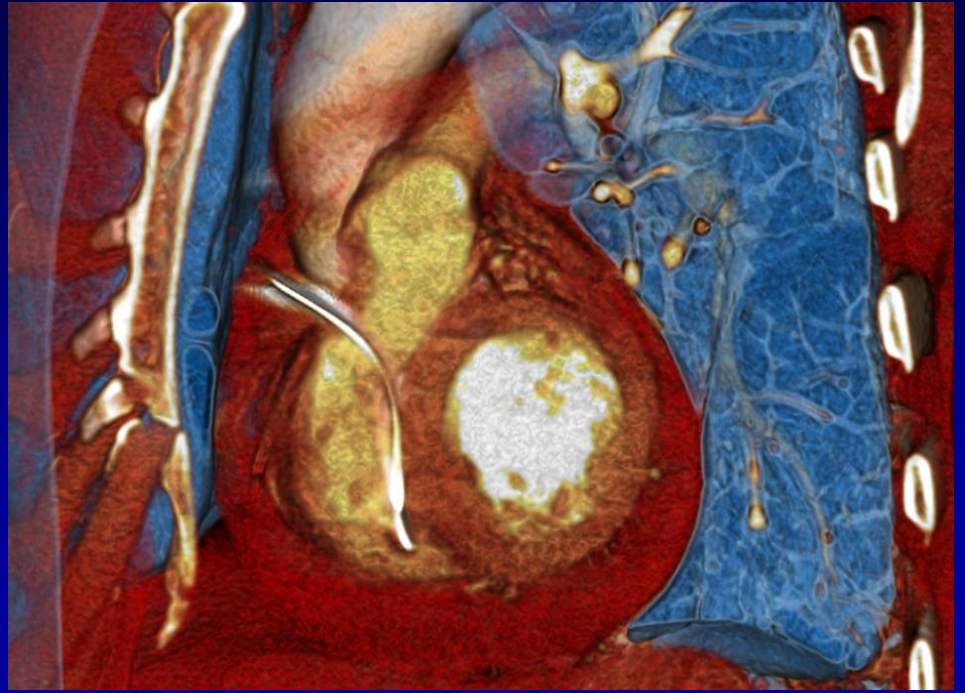




# Chest CT



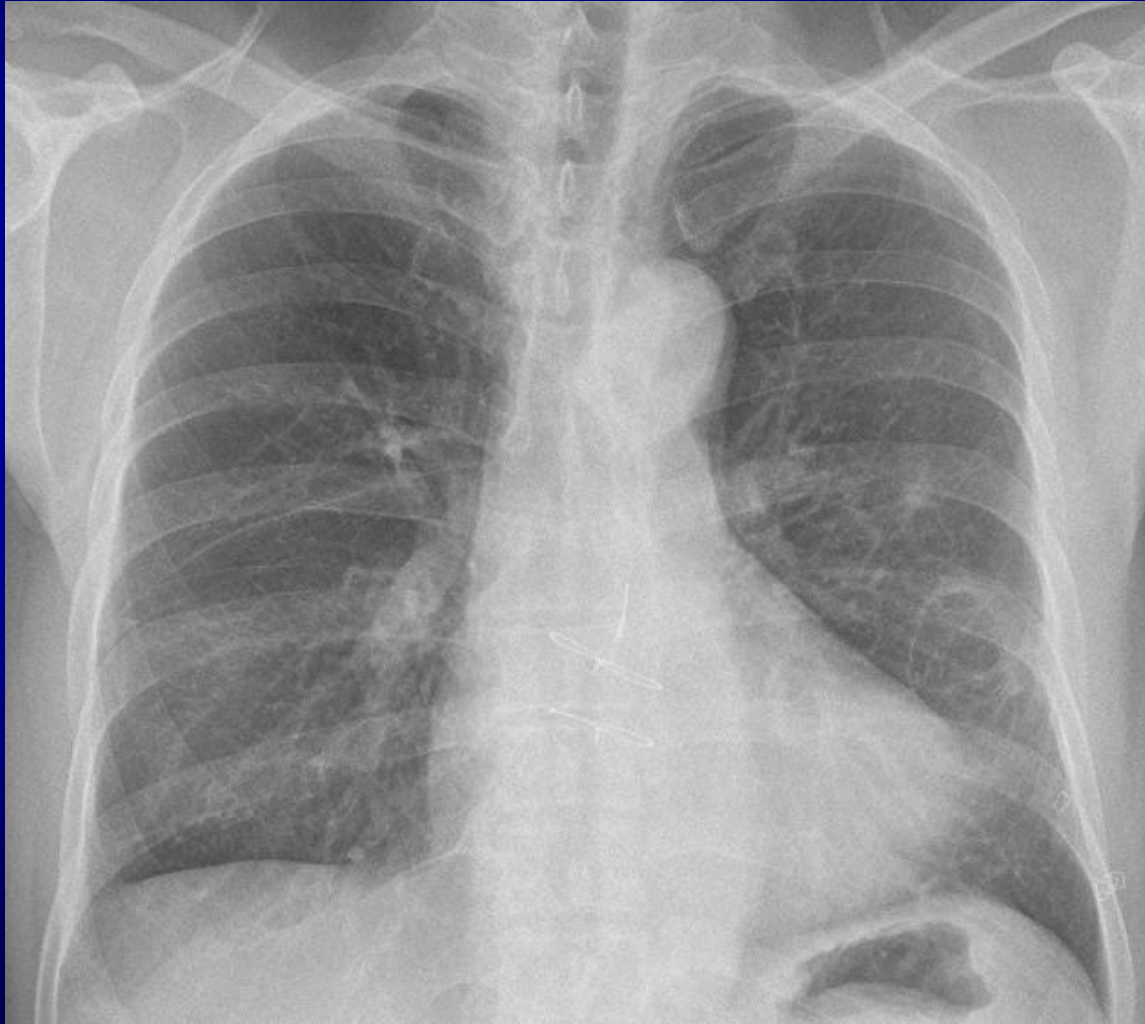
Ooops! Oh my God!!



# Surgically removed guidewire ; Fielder XT-R



**Chest PA after surgical removal  
; disappearance of guidewire shadow**



# Discussion Points

## 1. Prevention

; definite Corsair protection to prevent CTO wire fatigue and fracture

→ septal dilation with small balloon and reinsertion of the Corsair will be required.

## 2. Management

1) Intraluminal true lumen wiring and removal by snare or forcep by anterogradely

2) Surgical removal



# Research Fellow 2013-2014



Dr Jabar Ali (Pakistan)



Dr Hu Li (China)

# Research Fellow 2014



Jabar Ali, Harris Ngow, Xu Shaopeng

# Summary and Conclusion

1. CTO PCI success rate is improving and complication rates are decreasing, suggesting that CTO PCI carries a favorable risk/benefit ratio and supporting its increasing use for this particular tough subset of complex lesions and patients.
2. However, still special cautions should be exercised to prevent specific CTO PCI related dangerous complications.
3. Operators/catheterization laboratories should be ready to urgently manage the potential procedure-related complications.



# Thank You for Your Attention!!

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